

3

TAXONOMY - DISTRIBUTION OF BAMBOO IN THE WORLD

The purpose of the taxonomy is to distinguish, identify and classify plants. The identification of plants is mainly based on their flowers and fruits. However, the identification and classification of bamboos present more problems to taxonomists than any other group of flowering plants, because, as was explained before, most bamboos flower at long intervals, some only once or twice in a century and most of them die soon afterwards.

On the other hand, there are also species like *Bambusa vulgaris*, the most common species, which remains mostly sterile, and this makes the collection and study of their flowers and fruits difficult. Because of this problem botanists have been forced to make their identification on the basis of specimens either with flowers or with vegetative organs, but separately.

For this reason, there are many cases where the same specie has been classified by different botanists in different genera, or the same species may be described under different names. This has created a lot of confusion for bamboo taxonomy in the world. For example, Chao (1989) revised 42 species originally described under *Arundinaria* by Munro, Gamble, A. Camus and others. He found that only two species are considered to be true *Arundinaria*, the rest (40) have been transferred into seven other genera: *Sinarundinaria*, *Tamnocalamus*, *Chimono-bambusa*, *Recebambos*, *Acidosasa*, and others. Consequently bamboo classification is far from complete and most genera are still not very clear.

DISTRIBUTION OF BAMBOOS IN THE WORLD

Worldwide there are about 1,600 bamboo species distributed in about 121 genera (25 herbaceous and 96 woody). Geographically, these species are found in the tropical, subtropical and temperate areas of all the continents, except Europe where there are no indigenous species.

The approximate continental distribution of bamboos is as follows: 67% in Asia and Oceania; 3% in Africa, and 30% in the Americas.

1)- In the Americas. According to Thomas Soderstrom *et al* (1988), about 440 species native to the Americas have been identified, of which approximately 320 are woody and 120 herbaceous, distributed in 41 genera (20 woody, and 21 herbaceous). There are still a great number of woody species to be identified.

Horizontally these species are distributed in the Americas between 46° north latitude, in the temperate zone of the United States, and 47° south latitude, in lake Buenos Aires between Argentina and Chile, where is found the specie *Chusquea culeau*. Vertically they are distributed from sea level up to almost 5,000 meters in the

eastern chain of the Andes in South America, where the specie *Neurolepis aristata* can be found.

The giant woody species are distributed horizontally between the south of Mexico (22° north latitude) down to about 34° south latitude in the Parana river.

The herbaceous bamboos are distributed between 29° north latitude in Mexico and 34° south latitude, and they are confined to warm humid environments, within forests usually under dense shade. Vertically they are rarely found higher than 1,200 meters above sea level. (Soderstrom & Calderon 1979).

2)- In Asia and Oceania. Asia is the richest continent in bamboos, with more than 1,000 species and about 72 to 82 genera. They are found in large area, covering southeast Asia between a latitude as far north as 51° on Sakhalin Island where the specie *Sasa kurilensis* is found, and a southern limit at about 20° south latitude.

This area include the southern half of China, Japan, Korea, Vietnam, Thailand, Malaysia, Burma, Bangladesh, India, Sri Lanka, Taiwan, Philippines, Indonesia, New Guinea, the Northern Territory of Australia, and the Pacific Islands where, according to Watanabe (1987), many bamboos grow spontaneously on the Molucca islands, and a few bamboos are also distributed over the islands of Fiji, Samoa, Vanuatu, New Caledonia, and New Ireland. There are some in the Caroline Islands, but is not clear whether all of these bamboos are native.

The vertical distribution of bamboo in Asia is from sea level to a maximum of 4,000 meters in the subalpine zone of Himalayas in Sikkim and Buttan, where the specie *Arundinaria racemosa* is found. The greatest number of bamboo species and the greatest proportion of bamboo forests are found in India and China.

3)- In Africa. This continent has the smallest number of species (less than 12). But according to Watanabe (1987) the island of Madagascar has about 40 species and 11 genera. On the continent the species are distributed horizontally from a northern limit that goes from Southern Senegal (16° north latitude) over to the high mountains in Kenya and Uganda, and then going through the highlands of East Africa down to southern Mozambique, while on the Atlantic side, the distribution areas are spread across tropical areas in the Central Africa, and then to Cape in South Africa.

The vertical distribution in Africa reaches 2,000-3,300 m. above sea level on Mt. Kenya and high mountains where large communities of *Arundinaria alpina* are found. Other species such as *Oreobambos bunchwaldii* K. Sch. and *Oxytenanthera abyssinica* Munro grow indigenously from 200 - 2,000 m. in Rwanda and around Lake Tanganyika.

Fig. 3.1 ORIGINAL DISTRIBUTION OF BAMBOOS IN THE WORLD (up to 1960)

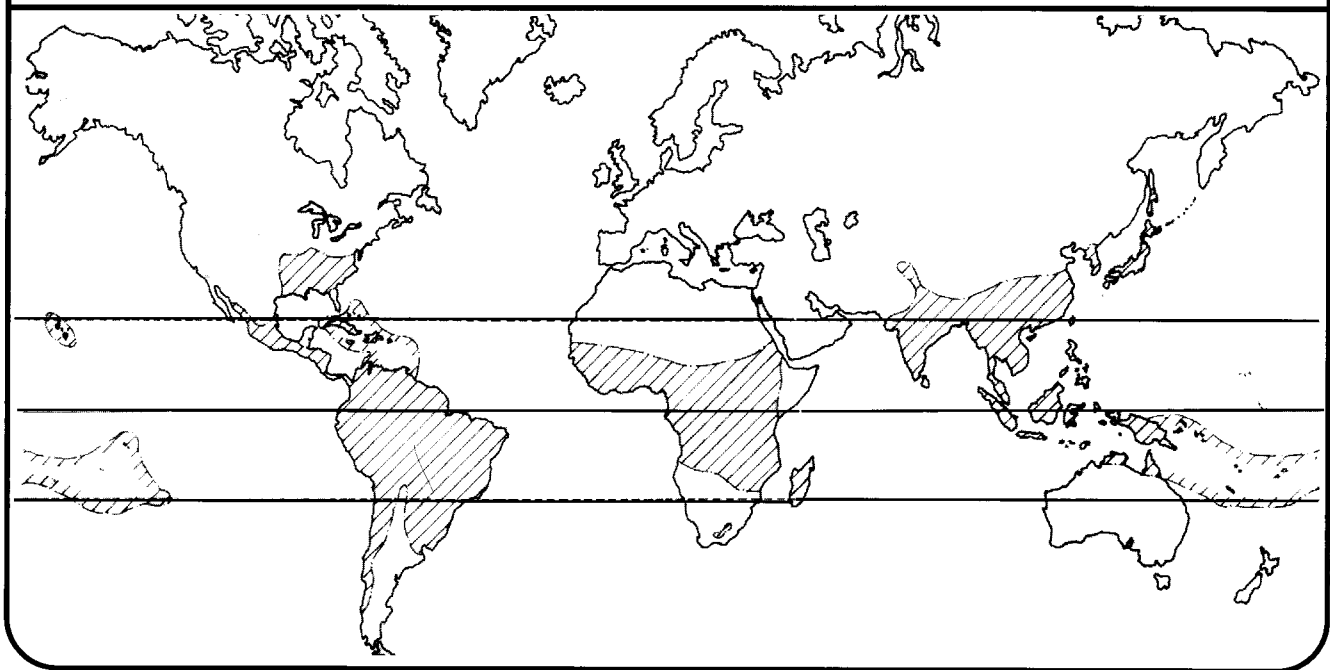


Table 3-1 GENERA OF BAMBOOS NATIVE TO THE AMERICAS

Woody bamboo genera		Herbaceous bamboo genera	
1.- <i>Actinocladum</i> Soderstrom	(1)-Brazil	1.- <i>Anomochloa</i> Brongniart	(1)-Brazil
2.- <i>Alvimia</i> Soders. & Londo.	(3) Brazil	2.- <i>Arberella</i> Soders. & Cald.	(7)-Costa Rica and Pana.
3.- <i>Apoclada</i> McClure	(4)- Brazil	3.- <i>Cryptochloa</i> Swallen	(10-15)-Brazil, Ecuador , San Blas, Panam to Mex.
4.- <i>Arthrostylidium</i> Ruprech	(20)- Brazil	4.- <i>Diandrolira</i> Stapf	(5)-Brazil
5.- <i>Arthroostachys</i> Bentham	(1)-Brazil	5.- <i>Ekmanochloa</i> Hitchcock	(2)- Cuba
6.- <i>Atractantha</i> McClure	(9-10)-Brazil	6.- <i>Eremitis</i> Doell	(5)-Brazil
7.- <i>Aulonemia</i> Goudot	(25-30)-From Mexico to Bolivia, Guiana and Brazil	7.- <i>Froesiochloa</i> G.A.Black	(1)-French Guiana, Brazil.
8.- <i>Chusquea</i> Kunth	(120)- Mexico to Argentina Chile, Juan Fernandez Islands, Uruguay, Brazil, Caribbean Islands	8.- <i>Lithachne</i> Palisot de Beao vois.	(4)-Central America, West Indies, Paraguay- Parana basin, Brazil.
9.- <i>Colantheia</i> McClure	(7)-Brazil	9.- <i>Maclurolyra</i> Cald. & Sod.	(1)-Panama
10.- <i>Criciuma</i> Sod. & Londoño	(1)-Brazil	10.- <i>Mniochloa</i> Chase	(2)-Cuba
11.- <i>Elytostachys</i> McClure	(2)From Venezuela and Colombia to Honduras	11.- <i>Olyra</i> Linnaeus	(23)-Mexico and nortnen Central America, Brazil
12.- <i>Eremocaulon</i> Sod. & Lond.	(1)-Brazil	12.- <i>Pariana</i> Fusee-Aublet	(30)-From Costa Rica to Bolivia, Brazil, Trinidad
13.- <i>Glaziophyton</i> Franchet	(1)-Brazil	13.- <i>Pharus</i> P. Brown	(7)-Mexico to Ecuador.
14.- <i>Guadua</i> Kunth	(35)-From Mexico to north Argentina and Brazil	14.- <i>Piresia</i> Swallen	(6)-Brazil, Guianas, Trinid.
15.- <i>Merostachys</i> Sprengel	(40)-From Guatemala to Argentina and Brazil	15.- <i>Raddia</i> A. Bertoloni	(5-7)-Venezuela, Guianas, Brazil.
16.- <i>Myriocladus</i> Swallen	(20)-Venezuela and Brazil	16.- <i>Raddiella</i> Swallen	(8)-Guianas, Colomb.Bra.
17.- <i>Neurolepis</i> Meisner	(10)- Venezuela and Col. to Peru, Brazil, Bolivia.	17.- <i>Rehia</i> Fijten	(1)-Surinam, Brazil
18.- <i>Olmeca</i> Soderstrom	(2)-Mexico	18.- <i>Reitzia</i> Swallen	(1)-Brazil
19.- <i>Otatea</i> Calderon & Sod.	(1)-Mexico and Central America	19.- <i>Streptochaeta</i> Nees fon Esenbeck	(3)- From Mexico to Argentina
20.- <i>Rhipidocladum</i> McClure	(15)-Mexico to Argentina, Trinidad	20.- <i>Streptogyna</i> Palisot de Beauvois.	(2)-Africa, India, Sri Lanca, South America.
		21.- <i>Sucrea</i> Soderstrom	(1)-Brazil

Source: Soderstrom et al (1988)-D. Ohmberger & J.Goerrings (1983).

Table 3-3

THE CLASSIFICATION OF WOODY BAMBOO GENERA

<p>FAMILY <i>Poacea (Gramineae)</i></p> <p>SUBFAMILY <i>Bambusoideae A. & G.</i></p> <p>TRIBE <i>Bambuseae Nees</i></p>																																																											
<p>1.-SUBTRIBE <i>Arthrostylydiinae</i> 13 genera confined to the Americas</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%;"><i>Actinocladum</i></td> <td style="width: 50%;"><i>Colantheria</i></td> </tr> <tr> <td><i>Alvimia</i></td> <td><i>Elytrostachys</i></td> </tr> <tr> <td><i>Apoclada</i></td> <td><i>Glaziophyton</i></td> </tr> <tr> <td><i>Arthroostachys</i></td> <td><i>Merostachys</i></td> </tr> <tr> <td><i>Arthrostyloidium</i></td> <td><i>Myriocladus</i></td> </tr> <tr> <td><i>Atractantha</i></td> <td><i>Rhipidocladum</i></td> </tr> <tr> <td><i>Aulonemia</i></td> <td></td> </tr> </table> <p>2.-SUBTRIBE <i>Arundinariinae</i> 14 genera confined to temperate regions and high mountains in the tropics of Asia and United States in North America (*).</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%;"><i>Acidosasa</i></td> <td style="width: 50%;"><i>Himalayacalamus</i></td> </tr> <tr> <td><i>Ampelocalamus</i></td> <td><i>Indocalamus</i></td> </tr> <tr> <td><i>Arundinaria</i> (*)</td> <td><i>Indosasa</i></td> </tr> <tr> <td><i>Borinda</i></td> <td><i>Pseudosasa</i></td> </tr> <tr> <td><i>Chimonocalamus</i></td> <td><i>Sasa</i></td> </tr> <tr> <td><i>Drepanostachyum</i></td> <td><i>Thamnocalamus</i></td> </tr> <tr> <td><i>Fargesia</i></td> <td><i>Yushania</i></td> </tr> </table> <p>3.- SUBTRIBE <i>Bambusinae</i> 13 genera, mostly tropical Asia</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%;"><i>Bambusa</i></td> <td style="width: 50%;"><i>Melocalamus</i></td> </tr> <tr> <td><i>Dendrocalamus</i></td> <td><i>Oreobambos</i></td> </tr> <tr> <td><i>Dinochloa</i></td> <td><i>Oxytenanthera</i></td> </tr> <tr> <td><i>Gigantochloa</i></td> <td><i>Soejatmia</i></td> </tr> <tr> <td><i>Holttumochloa</i></td> <td><i>Sphaerobambos</i></td> </tr> <tr> <td><i>Kinabaluchloa</i></td> <td><i>Thyrsostachys</i></td> </tr> <tr> <td><i>Maclurochloa</i></td> <td></td> </tr> </table> <p>4.-SUBTRIBE <i>Chusqueinae</i> 2 genera, Americas <i>Chusquea</i> <i>Neurolepis</i></p>	<i>Actinocladum</i>	<i>Colantheria</i>	<i>Alvimia</i>	<i>Elytrostachys</i>	<i>Apoclada</i>	<i>Glaziophyton</i>	<i>Arthroostachys</i>	<i>Merostachys</i>	<i>Arthrostyloidium</i>	<i>Myriocladus</i>	<i>Atractantha</i>	<i>Rhipidocladum</i>	<i>Aulonemia</i>		<i>Acidosasa</i>	<i>Himalayacalamus</i>	<i>Ampelocalamus</i>	<i>Indocalamus</i>	<i>Arundinaria</i> (*)	<i>Indosasa</i>	<i>Borinda</i>	<i>Pseudosasa</i>	<i>Chimonocalamus</i>	<i>Sasa</i>	<i>Drepanostachyum</i>	<i>Thamnocalamus</i>	<i>Fargesia</i>	<i>Yushania</i>	<i>Bambusa</i>	<i>Melocalamus</i>	<i>Dendrocalamus</i>	<i>Oreobambos</i>	<i>Dinochloa</i>	<i>Oxytenanthera</i>	<i>Gigantochloa</i>	<i>Soejatmia</i>	<i>Holttumochloa</i>	<i>Sphaerobambos</i>	<i>Kinabaluchloa</i>	<i>Thyrsostachys</i>	<i>Maclurochloa</i>		<p>5.- SUBTRIBE <i>Guaduinae</i> 5 genera confined to Americas tropics <i>Criciuma</i> <i>Eremocaulon</i> <i>Guadua</i> <i>Olmeca</i> <i>Otatea</i></p> <p>6.- SUBTRIBE <i>Melocanninae</i>= <i>Schizostachyidinae</i> 8 genera mostly tropical Asia.</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%;"><i>Cephalostachyum</i></td> <td style="width: 50%;"><i>Ochlandra</i></td> </tr> <tr> <td><i>Davidsea</i></td> <td><i>Pseudostachyum</i></td> </tr> <tr> <td><i>Melocanna</i></td> <td><i>Schizostachyum</i></td> </tr> <tr> <td><i>Neohouzeaua</i></td> <td><i>Teinostachyum</i></td> </tr> </table> <p>7.- SUBTRIBE <i>Nastinae</i> 6 genera, mostly in the southern hemisphere of the Old World tropics.</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%;"><i>Decaryochloa</i></td> <td style="width: 50%;"><i>Hitchcockella</i></td> </tr> <tr> <td><i>Greslania</i></td> <td><i>Nastus</i></td> </tr> <tr> <td><i>Hickelia</i></td> <td><i>Perrierbambus</i></td> </tr> <tr> <td><i>Hickelia</i></td> <td></td> </tr> </table> <p>8.-SUBTRIBE <i>Racemobambosinae</i> 3 genera, Himalaya and tropical Asia <i>Neomicrocalamus</i> <i>Racemobambos</i> <i>Vietnamosasa</i></p> <p>9.-SUBTRIBE <i>Shibateinae</i> 5 genera, temperate Asia <i>Chimonobambusa</i> <i>Phyllostachys</i> <i>Semiarundinaria</i> <i>Shibataea</i> <i>Sinobambusa</i></p>	<i>Cephalostachyum</i>	<i>Ochlandra</i>	<i>Davidsea</i>	<i>Pseudostachyum</i>	<i>Melocanna</i>	<i>Schizostachyum</i>	<i>Neohouzeaua</i>	<i>Teinostachyum</i>	<i>Decaryochloa</i>	<i>Hitchcockella</i>	<i>Greslania</i>	<i>Nastus</i>	<i>Hickelia</i>	<i>Perrierbambus</i>	<i>Hickelia</i>	
<i>Actinocladum</i>	<i>Colantheria</i>																																																										
<i>Alvimia</i>	<i>Elytrostachys</i>																																																										
<i>Apoclada</i>	<i>Glaziophyton</i>																																																										
<i>Arthroostachys</i>	<i>Merostachys</i>																																																										
<i>Arthrostyloidium</i>	<i>Myriocladus</i>																																																										
<i>Atractantha</i>	<i>Rhipidocladum</i>																																																										
<i>Aulonemia</i>																																																											
<i>Acidosasa</i>	<i>Himalayacalamus</i>																																																										
<i>Ampelocalamus</i>	<i>Indocalamus</i>																																																										
<i>Arundinaria</i> (*)	<i>Indosasa</i>																																																										
<i>Borinda</i>	<i>Pseudosasa</i>																																																										
<i>Chimonocalamus</i>	<i>Sasa</i>																																																										
<i>Drepanostachyum</i>	<i>Thamnocalamus</i>																																																										
<i>Fargesia</i>	<i>Yushania</i>																																																										
<i>Bambusa</i>	<i>Melocalamus</i>																																																										
<i>Dendrocalamus</i>	<i>Oreobambos</i>																																																										
<i>Dinochloa</i>	<i>Oxytenanthera</i>																																																										
<i>Gigantochloa</i>	<i>Soejatmia</i>																																																										
<i>Holttumochloa</i>	<i>Sphaerobambos</i>																																																										
<i>Kinabaluchloa</i>	<i>Thyrsostachys</i>																																																										
<i>Maclurochloa</i>																																																											
<i>Cephalostachyum</i>	<i>Ochlandra</i>																																																										
<i>Davidsea</i>	<i>Pseudostachyum</i>																																																										
<i>Melocanna</i>	<i>Schizostachyum</i>																																																										
<i>Neohouzeaua</i>	<i>Teinostachyum</i>																																																										
<i>Decaryochloa</i>	<i>Hitchcockella</i>																																																										
<i>Greslania</i>	<i>Nastus</i>																																																										
<i>Hickelia</i>	<i>Perrierbambus</i>																																																										
<i>Hickelia</i>																																																											
<p>Source: Soderstrom & Ellis, (1987). - Prosea (1995).</p>																																																											

THE MOST IMPORTANT SPECIES OF ASIA AND THE AMERICAS

The most important species of Asia

In South East Asia, where there are more than 1,000 species, only about 250 species (200 from China and 50 from other countries) have some economic value in different fields such as human food, housing construction, handicrafts and industrial purposes.

The most outstanding species from Asia, from the economical point of view are the following: *Bambusa bambos* Voss; *B. blumeana* J.A & J.H Schultes; *B. polymorpha* Munro; *B. textilis* McClure; *B. tulda* Roxb.; *B. vulgaris* Schrad.ex Wendl.; *Cephalostachyum pergracile* Munro; *Dendrocalamus asper* (Schultes f.) Backer ex Heyne; *D. giganteus* Munro; *D. latiflorus* Munro; *D. strictus* (Roxb.) Nees; *Gigantochloa apus* J.A y J.H. Schultes; *G. levis* (Blanco) Merrill; *G.pseudoarundinacea* (Steud.) Widjaja; *Melocanna baccifera* (Roxb.) Kurz; *Ochlandra Thw.*(Spp); *Phyllostachys aurea* Carr. ex A & C Riviere; *Ph. bambusoides* Sieb.; *Ph. pubescens* Mazel ex H. de Leh.; and *Thyrsochloa siamensis* (Kurz) Gamble.

The most important species of genus *Guadua* in the Americas

Of the about 440 native species which there are in the Americas (320 woody and 120 herbaceous). Non of the herbaceous and about the 95% of the woody species have had any application so far. Only about 15 species (5%) of the woody species which belong to the genus *Guadua*, are considered to be the best species of the Americas. This is because of their large size, their use in construction and, specially their industrial potential. However, up to the present time, this has not been taken into consideration, due to our ignorance regarding these species, which in our countries are regarded as weeds, used only by Indians and poor people in the construction of their houses

For this reason, non of our countries have been interested in the study, cultivation and preservation of their species. On the contrary, bamboos have been destroyed to the point that most of the 15 giant species which grew from the southern Mexico down to Argentina and Uruguay have disappeared from many of our countries or are on the brink of extinction, except in Colombia which is the only country in the Americas which has preserved most of their native giant species.

Due to this destruction, of the 15 giant native species which there were in the fifties, today there are only 8 of which 4 are the most widely used in Colombia in construction, and 4 are found in Brazil and northeastern part of South America.

In the Americas, most of the giant native species of the genus *Guadua*, have been described by European botanists. Some of them visited several of our countries in the the nineteenth century. Others made the identification using the specimens that were transported to different herbariums in Europe.

Alexander von Humboldt and Aimé Bonpland, who visited several of our countries including Colombia, Ecuador, Peru, Venezuela and Mexico. In 1806, in Colombia they described two of our giant species of bamboo and gave them

the scientific names of *Bambusa guadua* and *Bambusa latifolia*. They included these species in the Asiatic genus *Bambusa*, due to the similarities which they found between the South American and the Asiatic species which belong to this genus, as it is indicated in the book *Plantae Equinoc-tialis* published by them in Paris in 1908.

In 1822, the German Carl S. Kunth, decided to place the two New World species in a new genus that he called *Guadua*. Later, Alonzo McClure (1973), uncertain of its generic separation, reduced it again to a subgenus of *Bambusa*, and in 1987 Soderstrom and Londoño restored *Guadua* to generic status based on a number of distinctive features, i.e., a triangular sheath leave in which the margins of the sheath and blade are continuous or almost so, presence of thorns on the culms and branches, a distinctive band of short white hairs both above and below the scar or nodal line, and a palea of firm texture with prominent wings emanating from the keals.

At present, the genus *Guadua* includes about 36 identified species and some still unidentified giant species, with diameters which varies between one and 22 cm, and heights which varies between and 30 meters and more. Around 20 species of this genus are native from Brazil, and 8 are native from Colombia.

The other countries of Latin America (with the exception of Chile where these giant species do not grow), originally had from one to 3 native species. Unfortunately due to the lack of interest which exists in all the countries towards our giant species, most of these countries, such as Mexico, Venezuela and the Central American countries have destroyed all of their native species. Colombia is the only country that has preserved most of its species.

The most outstanding giant species of Colombia are the following: members of the genus *Guadua*:

a) "guadua macana" (*Guadua angustifolia* Kunth). Its diameter varies from 10 to 14 cm and its height from 18 to 23 m. It is considered to be one of the best species of the world due to its durability and high strength; it is the most widely used bamboo in Colombia and Ecuador in construction. This species grew from Colombia to the north of Argentina, and Venezuela, but it has disappeared from the latter country.

b) "guadua de castilla", native to Colombia, it still has not been identified. It is the largest species in Colombia with a maximum diameter of 20 cm and about 30 meters height. It is the best material for the manufacture of bamboo boards used in the construction of walls, floor, ceilings and it is the most appropriate for the manufacture of plywood and other composite materials. This species is in the brink of extinction.

c) "Guadua cebolla" (Onion *guadua*). This species is native to Colombia, and has diameters of 10 cms and is 17 meters height. It is an excellent material for construction and for the manufacture of woven boards.

d) "Guadua rayada verde" (*Guadua angustifolia* var. *bicolor*). This is the most beautiful species in the Americas, but it is now on the brink of extinction. It is used in construction. Its diameter physical and mechanical characteristics are similar to "guadua macana".

THE THREE MOST IMPORTANT NATIVE SPECIES OF THE GENUS *GUADUA* IN COLOMBIA

Fig. 3.2 *Guadua angustifolia* Kunth (macana)
The strongest bamboo of the Americas and the most durable of the world. It has branches with thorns on the lower part of the culm.



Fig.3.3 "*Guadua cebolla*" (onion guadua) Still has not been identified. It is one of the best for construction and weaving. It has no branches on the lower part of the culm.

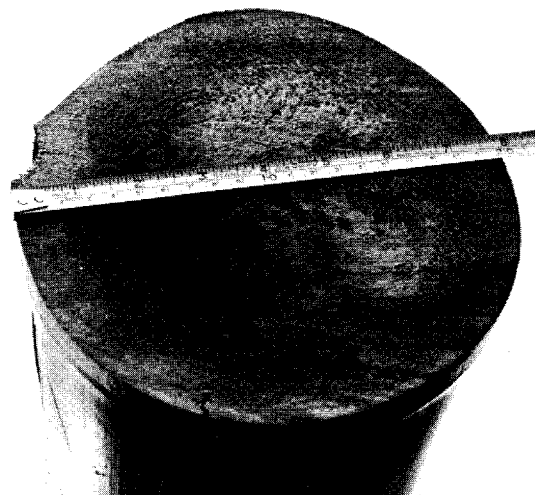


Fig. 3.4 "*Guadua de castilla*" .is still not identified. It has a maximum diameter of 20 centimeters and its height varies between 30 and 36 meters. This species has an excellent industrial use in the manufacture of composite materials such as plybamboo and laminated structures.

The following list includes most species of genus *Guadua* which existed in the nineteen fifties and the place where they grow; most of it was made at that time by Dr. Alonzo McClure at the Smithsonian Institution. Unfortunately the list is not complete and in many cases only the scientific name of the species was indicated. In most cases I have included some additional information that I got from E.G. Camus(1913) It is very important to point out that many of these species have disappeared from the places indicated by Dr. McClure. and Camus.

1.-*Guadua angustifolia* Kunth, 1822 b: 253.

As was mentioned above, this is one of the the most important species in the world, due to its great strength and durability and consequently it is the best material for building structures, and it has a great potential for the manufacture of composite materials.

Its diameter varies from 10 to 14 cm and the height of the culms varies from 17 to 23 metros. One of the characteristics of this species is the long branches with long thorns which grow in the lower part of the culm.

This species is native to South America where it grew originally from Panama and northern Colombia to about 28° south latitud along the Parana River on the north border between Argentina and Paraguay. This species was originally found in the banks and in the basins of the largest rivers of Colombia, Ecuador, Venezuela, the Guayanas, Brazil and Paraguay. It grew in the banks of the Paraná River from Minas Geraes and Goias down to Posadas and Corrientes in Argentina on the border with Paraguay. Unfortunately it has been destroyed in Venezuela and in most of the countries of Central and South America , except in Colombia .

This specie is known by different common names in each country: In Panama is known as "Cañaza"; in Colombia "guadua" or "macana"; in Ecuador as "caña guadúa or caña brava"; in Venezuela as "guafa"; in Brazil as "tacuarucu"; in Argentina, as "tacuara"; en Paraguay as "tacurú-pucú; and in Perú as "caña de Guayaquil".

2.-*Guadua angustifolia* var. *bicolor*, McClure Londoño (1989). I have seen this specie only in Colombia

where it is known with the vernacular name of "guadua rayada ". Culms 15 to 18 meters high and 10 to 11 cms in diameter. The color of the culm is green with yellow stripes.

3.-*Guadua aculeata* Ruprecht ex Fournie 1881 -130. Originally this species grew from the southern Mexico and Central America to Panama.. Its diameter is 9-13 cms. and its height is 15-18 meters. This species is closely related to *Guadua angustifolia* and it can be diferenciaded only by means of vegetative features and also by the culm habit; in this species the culms are broadly arched above,while in *Gudua angustifolia* the culms are erect. In Mexico and Guatemala this species was known with the vernacular names of "tarro" and also as "cañabrava" due to the long thorns on their branches. This species is on the brink of extinction in all the countries from Mexico to Panama. and in some of them it has dissapeared .

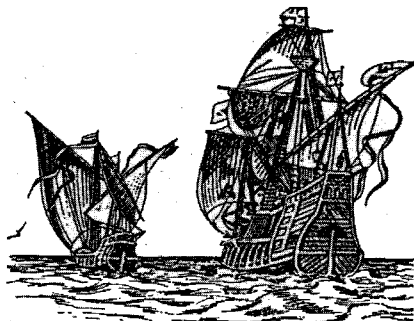
4.-*Guadua amplexifolia* Presl, 1830: 256.This species was distributed on the Atlantic coast of Venezuela, Colombia, and also from Central America to theYucatan in Mexico. In Venezuela it is known by the vernacular name of "guafa", in Colombia as "guaduilla" and in Mexico where it grows in swampy areas of Yucatan, it is known as "jimba". The culm of this species is almost solid at the base with a small lumen. Diameter is 6-10 cms, and the height is 10-12 meters.

According to McClure (1973), this species is very thorny in Venezuela and Colombia up to El Salvador in Central America and progressively less thorny forms appear from El Salvador northward, and a completely unarmed form is found in the state of Sinaloa in Mexico. This species flowers gregariously every 25 years and dies after flowering. Of all the giant species of genus *Guadua* this species is the less useful and it is not recommended for construction because it is easily attacked by insects.

5.-*Guadua barbata* Trinius, 1835:627. This species grows grows in Brazil in the state of Minas Gerais.

6.-*Guadua capitata* (Trinius) Munro, 1868:81. It grows in Brazil in the state of Matogroso do Sul on the Pardo River, which a tributary of the Paraná River.

THE ENCOUNTER OF COLUMBUS WITH THE GIANT SPECIES OF THE AMERICAS



In September of the year 1502 on his fourth and final trip to the Americas, Cristopher Columbus, arrived at the cape that he called "Gracias a Dios", in Central America between Honduras and Nicaragua Several

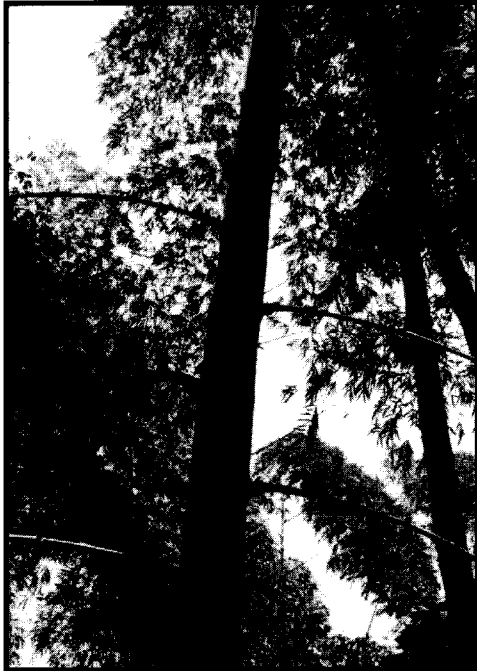
weeks later, he visited the mouth of the San Juan River which today is the border between Nicaragua and Costa Rica There he saw for the first time the beautiful giant bamboo species of the Americas that he describes as "canes so thick as the legs of a strong man". He was referring to *Guadua aculeata* and *Guadua inermis*, native to Mexico and Central America.

The encounter of Columbus with these giant bamboo species contributed to the clarification of the mystery of the origin of the giant canes which, according to Fray Pedro Simon, Spanish Clergyman, were periodically seen on the beaches of several European countries, where

they were dragged by the sea, but nobody new their origin. These circumstances also contributed to the discovery of the Mexico Gulf Stream.

The reason for this mystery was that in the rainy season, many bamboo culms from the forests of Mexico were carried by the flooding of the rivers to the Gulf of Mexico, and from there they were carried to the European coasts by the gulf streams.

The discovery of the Gulf Streams in which bamboo had a great part, made it posible for European ships to travel faster from Mexico and Central America to Europe.

**Fig. 3.5**

Guadua angustifolia, native to South America. In Colombia is known as "macana" and in Ecuador as "cañabrava". It is very similar to *Guadua aculeata* which is native to Mexico. Its culm is erect with a little curve at the top.

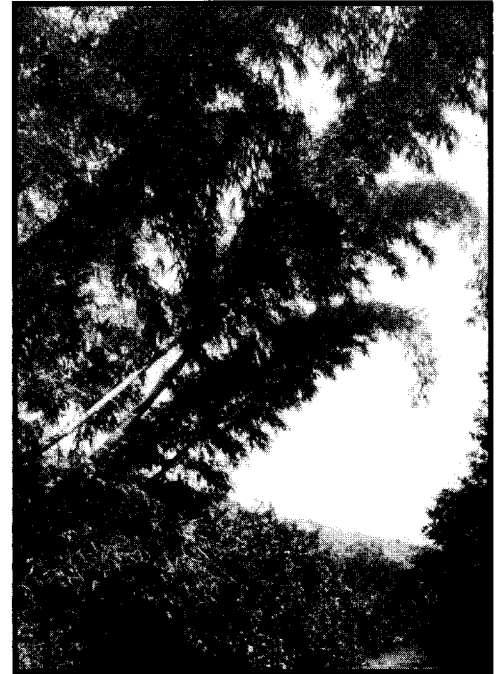


Fig. 3.6 *Guadua aculeata*, is known as "caña brava" in Mexico and Central America. Its culm is curved at the base.

7.-*Guadua Chacoensis* (Rojas) Londoño. The Culms are 10-20 meters height; with a diameter 8-15 cms. It grows in the northern part of Argentina, southern Paraguay and southeastern Bolivia. at elevations between 75 to 450 meters above sea level.

8.-*Guadua distorta* Nees, 1834:470. This species grows in Brasil in the state of Santa Catarina and in Sao Paulo in the Serra of Catareira.

9.-*Guadua glaziovii* (Hackel) Camus, 1903:194. This species is found in the state of Rio de Janeiro.

10.-*Guadua glomerata* Munro, 1868:79. It grows in the state of Amazonas, Brazil; Barra, Gapo on the Negro river; state of Para; Santarem and Guayanas.

11.-*Guadua inermis* Ruprech ex Fournie. This species grew in Mexico and Central America. According to the information I got in Mexico in 1980, it disappeared from Mexico and Central America in the nineteen fifties because it has not thorns and therefore was the most commonly used for construction. Due to its lack of thorns, this specie was known by the vernacular name of caña mansa".

12.-*Guadua Lindmani* Camus 1913. It grows in Brazil, State of Rio Grande do Sul. Colonia Martius.

13.-*Guadua latifolia* (Humboldt et Bonpland 1808: 67), Kunth, 1822:254. This species. grows in Brazil, State of Amazonas, Negro river, from Barcellos to San Gabriel.

14.-*Guadua longifimbriata* E.-G. Camus, 1913, I: 113. Brazil, in the State of Rio de Janeiro; in Petropolis; San Cristavao (where the Don Pedro Palace which is now the National Museum is located)- This is probably the same species being cultivated in Costa Rica that I call by the vernacular name of "guadua brasilera" (See "guadua brasilera" at the end of this list).

15.-*Guadua macrostachya* Ruprech, 1839:39. This species is found in Brazil, in the state of Para. from Santarem to Obidos. Cayena (French Guyana).

16.-*Guadua maculosa* (Hackel) E.G. Camus, 1913, I:106. This species is found in Brazil, in Goias.

17.-*Guadua paniculata* Munro, 1868:85. This species grows from sea level to 1,300 meters, from the north

of Paraguay to Venezuela, Panamá, Nicaragua, El Salvador, Mexico and Brazil in the state of Goias, Porto imperial, and Tocantins river. Culms from 9 to 12 meters height; diameters 5 to 7 cms. It has thick but weak walls (Swallen, 1955).

18.-*Guadua paraguayana* Doell, in Martius 1880 179. This species has solid culms 3-5 mts high and diameters 2 -4 cms in the base. It could be found in the Paraguay river from the north of the country to Reconquista, state of Santa Fe in Argentina. (Parodi, 1936).

19.-*Guadua refracta* Munro, 1868:84 Brazil, in the state of Goiaz. From the capital of Goiaz to Calvacante.

20.-*Guadua riograndensis* (Dutra) Herter, 1941: 49. It is found in Brazil, in the state of Rio Grande do sul,

21.-*Guadua spinosa* (Swallen) McClure, 1954:82. (*Arthrostylidium spinosum Swallen*). Known also with the vernacular name of "Jimba" in México, Guatemala and Belice. The culms 5 m high, and 5 cms in diameter, thorny, often clambering bamboo, found at low elevations (up to 60 meters) along rivers and in poorly drained areas.

22.-*Guadua spinosissima* (Hackell) E.G. Camus 1913; I:112. This species grows in Brazil, in the state of Santa Catarina near Blumenau.

23.-*Guadua superba* Huber, 1904:479. This species has culms up to 20 meters high with a diameter of 10 to 15 cms at the base. It is found in Peru and Brazil, in the state of Acre, along the Purus River, and in the state of Amazonas, at Redondo lake near Bom Logar.

24.-*Guadua tagoara* (Nees) Kunth, 1834:611. This species is found in Brazil, in the state of Sao Paulo at Taubati and Lorenau and in the state of Parana at Ca-pao Bonito and Santa Catarina. The culms are 20 to 25 meters high and the diameter is 8 to 15 cms.

25.-*Guadua tessmannii* Pilger, 1924:124 (?)

26.-*Guadua tomentosa* Hackell & Lidman, in Lidman, 1900:20. Is found in Brazil at Rio Branco do sul and Colonia Ijuhy.

27.-*Guadua Trinii* (Nees) Nees ex Ruprech, 1839: 40. Culms from 6 -10 meters high with a diameter of 3 to 5



Fig.3.7 *Guadua brasileria*, native from de Brasil. The largest bamboo from the Americas.

cms. It grows from the south of Brazil (Rio Grande do Sul) up to 340 40' south latitud in Argentina. It grows in the Parana delta and tributaries of Uruguay river. This specie has a flowering cicle of 30 years. (Parodi, 1936,1955).

28.-Guadua venezuelae Munro 1868:86. This species is found in Venezuela, along the Orinoco River up to Maranhao.

29.-Guadua virgata (Trinius) Ruprech, 1839: 40. This species is found in Brazil in the state of Minas Gerais at Mount Geraldo.

30.-Guadua weberbaueri Pilger, 1905:152. This species has the longest internodes of this genus; they have an average of 90 cms. The culms are 8-10 meters high and have a diameter of 5-6 cms. The thickness of the wall is about 4 to 6 mm. It is found in Brazil in the states of Acre and Amazonas, and in Peru in the Amazon area.

Species of the genus *Guadua* that still have not been identified

The following giant bamboo species from Colombia, and Brasil, still do not have scientific names. They include three of the most outstanding species in the world, and are considered among the best for construction. They are known by the following vernacular names:

31 x.-"Guadua de castilla". This species is native to Colombia. It is the largest species in this country with a culm height of 30-34 meters and diameters from 17 to 20 centimeters. This bamboo is the most used in the manufacture of bamboo boards. It has an excellent potential in the manufacture of composite materials. This species is on the brink of extinction.

32 x.-"Guadua cebolla" (onion guadua). This species is native to Colombia and Ecuador, where it is known as "caña mansa" because it has no spines. It is on the brink of extinction. In Venezuela (guafa) has been eliminated. In Colombia ,it is commonly used for construction and for many other purposes.

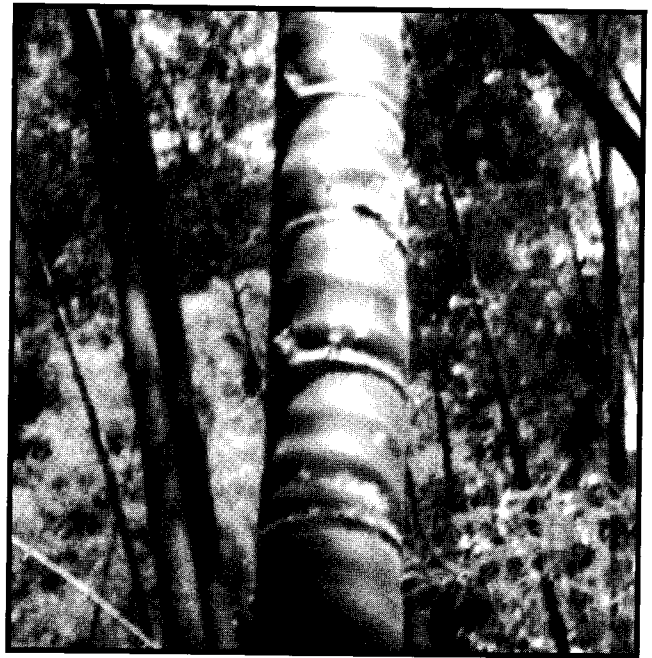


Fig. 3.8 "*Guadua cotuda* " from Colombia.

33 x- "Guadua cotuda" (goiter guadua). This specie presents a protruding zone which surrounds the top and the lower part of each internode. I saw this characteristic in about ten culms located in the central area of a *Guadua angustifolia* plantation in Caicedonia, near Armenia in Colombia. For this reason, I think that these culms are abnormalities of *Guadua angustifolia*. (See Abnormalities of the internodes). The height of the culm is about 20 meters and the diameter is 10-14cms.

34 x.-"Guadua rayada negra". This species was only found on one farm located in the Quindio state in Colombia. It is black with yellow stripes and its characteristics are similar to those of *Guadua angustifolia*. (See Abnormalities of the internodes).

35 x.-"Guadua brasileria". This is the largest species of the Americas. The culms are 30-36 meters in height and the diameters are up to 22 centimeters. This species is native to Brazil, but it disappeared from that country many years ago. Fortunately, this species was introduced to Costa Rica and cultivated on the Bremen Ranch, in Canton Siquirres, by the owner, Mr. Manuel Rojas Quiroz. During a conversation I had with Mr. Rojas at his home in San Jose, Costa Rica, on January 25, 1989, he told me that in 1946 he brought the rhizomes of this species from the Quitandinha Hotel located in Petropolis near Rio de Janeiro in Brazil, where he and his wife spent their honeymoon. At that time the hotel and the gardens were surrounded by these huge and beautiful bamboos. The rhizomes which he brought were planted first on the Eva farm (Canton Sarchi) and then on Atirro farm in Turrialba and finally on the Bremen farm where I saw this specie for the first time..This species is one of the best in the world.

In 1995 , I had to travel to Brazil to give a seminar on bamboo at the Pontifica Universidad Catolica of Rio de Janeiro. After the seminar, I traveled with Professor Khosrow Ghavami to Petropolis, where we visited the famous old Quitandinha Hotel. We found out that in the sixties the hotel was transformed into an apartment building but preserving its beautiful original German architecture. Most of the gardens

have disappeared and all the bamboos had been destroyed, and replaced by new streets, avenues and several apartment buildings and houses.

The same day we traveled throughout the region looking for this specie but we could not find it, and nobody gave us information about this plant. I think that it can be found in other place of of Brazil.

I gave to this specie the vernacular name of "guadua brasilera" in order to avoid confusion, because it was erroneously identified as *Guadua angustifolia*, later as *Guadua aculeata*, an finally as *Guadua chacoensis*. Probably the scientific name of this specie is *Guadua longjfrimbiata*.

The rizomes of *guadua brasilera* have the characteristic that they are samall and grow almost vertically and consequently their culms are very near each other, which is a problem for harvesting them. According to Eng. Francisco Castaño from Colombia, who made in Costa Rica a study of the number of culms per hectarea of *guadua Brasilera* in 1996, there were an average of about 60.000 culms per hectare, while in a hectare of *Guadua angustifolia* there are only between 7.000 and 10.000 culms due to the length of the rhizome neck, the rhizome length and the fact that the position of the rhizome is horizontal.

This bamboo species is considered to be the most outstanding species of the Americas from the economic point of view. I consider *guadua brasilera* to be the best material for the manufacture of bamboo boards which are used in the construction of walls, ceilings, floor and roofs and in the manufacture of plybamboo and bamboo laminated beams and other composite materials.

Original distribution of the giant species of the genus *Guadua* in the Americas

As it was explained before, these 18 giant species, of genus *Guadua* (which probably they were many more in precolumbian times), were originally distributed between Mexiico and northern of Argentina, in five large areas or regions, located along the basins of the largest rivers of the Americas, forming immense natural pure and mixed bamboo forests, which are gradually disappearing.. Today most of the largest original forests have disappeared and only very small patches can be seen in a few of our countries but they too will soon disappear. The original distribution of this giant species is as follows:

The first region coversd the North and Central America, from Mexico to Panama. The largest pure bamboo forests consists of *Guadua aculeata* (caña brava) and *Guadua inermis* (tarro). In Panama alone. there were 3 species including *Guadua angustifolia* which in this country is known with the vernacular name of "cañaza".

It is said that the extraordinary qualities of *Guadua angustifolia* were discovered by the Mayas and Aztecs of Guatemala and Mexico who in precolumbian times used to come to the Darien mountains, between Panama and Colombia in order to get medicinal plants. On their return trips they took with them seedlings of this specie of bamboo which they planted along the main road in order to facilitate its future transportation to their countries. This is probably why this species can be found in several Central American countries.

Today, in Mexico and Central America the specie *G. inermis* has disappeared, and *G. aculeata* is in the brink of extinction. In Panama most of the species have been destroyed and there are only very small patches of *G. angustifolia* in the state of Chiriqui near the border with Costa Rica. The only countries in Central America which have planted giant bamboo species are Costa Rica and El Salvador.

The second region is located between the northern Colombia and the Gulf of Guayaquil in Ecuador. This region consist of two areas: the area of Colombia and the area of Ecuador. The area of Colombia originally had the largest forests and the largest number of species, which at that time were distributed along the basins of the Cauca and Magdalena rivers.

Today, in this area there are only about 7 giant species, of which only three have a scientific name while the other 4 are known by their common names. They are: *Guadua angustifolia* (*guadua macana*), *Guadua angustifolia* var. *bicolor* (*guadua rayada*). *Guadua amplexifolia* (*guaduilla*), and the other 4 are: " *guadua de castilla*, *guadua cebolla*, *guadua cotuda*, *guadua rayada negra*". All of these giant species are known in Colombia by the vernacular name of "guaduas".

In the area of Ecuador, there are only two species: *Guadua angustifolia*, which also is known as "caña brava" because of the thorns, and the other is known as "caña mansa", which is the same species known in Colombia as "guadua cebolla". Both species are known in Ecuador by the vernacular name of "cañas guadúas". these species are found mainly in the basins of the Napo, Santiago, Cayapas, Daule and Babahoyo Rivers. and will disappear from Ecuador in three or four years if their destruction is not stopped or controlled. The biggest problem in Ecuador is the aversion which exists towards the giant species of bamboo which are generally used by the poor people for the construction of houses of very low quality and an unpleasant aspect.

The third region is located in South America and covers Venezuela, Guyana, Surinam, and French Guyana. The bamboo forests are located along the basin of the Orinoco river. In this region there are several species: the first is *Guadua angustifolia*; the second is the same species known in Colombia as "guadua cebolla"; the third one is *Guadua amplexifolia*; and the fourth is *G. venezuelae*. All of these giant species are known in Venezuela by the vernacular name of "guafas" and all of them are in the period of extinction, due to the aversion which exists towards this plant because it is considered to be a weed.

The fourth region of natural pure bamboo forests was formed by the basin of the Parana River, covering Brazil, Paraguay, Uruguay and Northern Argentina. In this area several species, which include *Guadua angustifolia*, *G. Chacoensis*, *G. trinii*, and *G. Paraguayana*, were found. Today, in many places these species have disappeared because people are not interested in preserving them and only very small patches that will probably disappear soon can be seen.

In my trip to Paraguay in August of 1996 I saw several small forests of *G. Paraguayana* that probably will disappear if they are not used in any purpose. I think that is. very important for this country to make a study about its poten-

tial in the paper industry, or in the manufacture of composite materials like fiberboards (See the chapter of composite materials).

The fifth region was located in the Amazon jungle, in Acre, in the border of Brasil, Bolivia and Peru, and in the basin of the Purus River, an affluent of the Amazon River.. It was the largest mixed forest of the Americas.

According to the Colombian newspaper "El Pais" (1976), in that year the RADAM organization (Radar de Amazonas), using aerial photographs as part of its survey of Brazilian vegetation, discovered an area of 85.000 sq. kilometers which include around four giant species around this location.

Destruction of the giant bamboo species of the genus *Guadua* in Latin America

1) Destruction of the giant native species in the Amazon area of Brasil. In 1993, 17 years after the RADAM Organization (Radar de Amazonas) found this huge area of giant bamboos on the Purus river, the publication: "Diagnostico Geoambiental e Socio-Economico PMACI (Projeto de Protecao do Meio Ambiente e das Comunidades Indigenas)- IBGE - IPEA) stated that there were only 32.000 sq. kilometers on the Purus river. This means that in 17 years 53.000 sq. kilometers were destroyed (3.100 square. km.per year).

In order to study the possibility of saving these species by cultivating them in other areas of Brazil, in August 1996, I visited part of the area of the Purus River, in Acre, Brasil, near the town of Sena Madureira. I was very lucky to find kindly families that invited me to spend several days at their homes on the Purus River, like the family of Manuel Marquez de Oliveira and his wife Lourdes, and Adolar Rosella, for whom I feel the deepest gratitude.

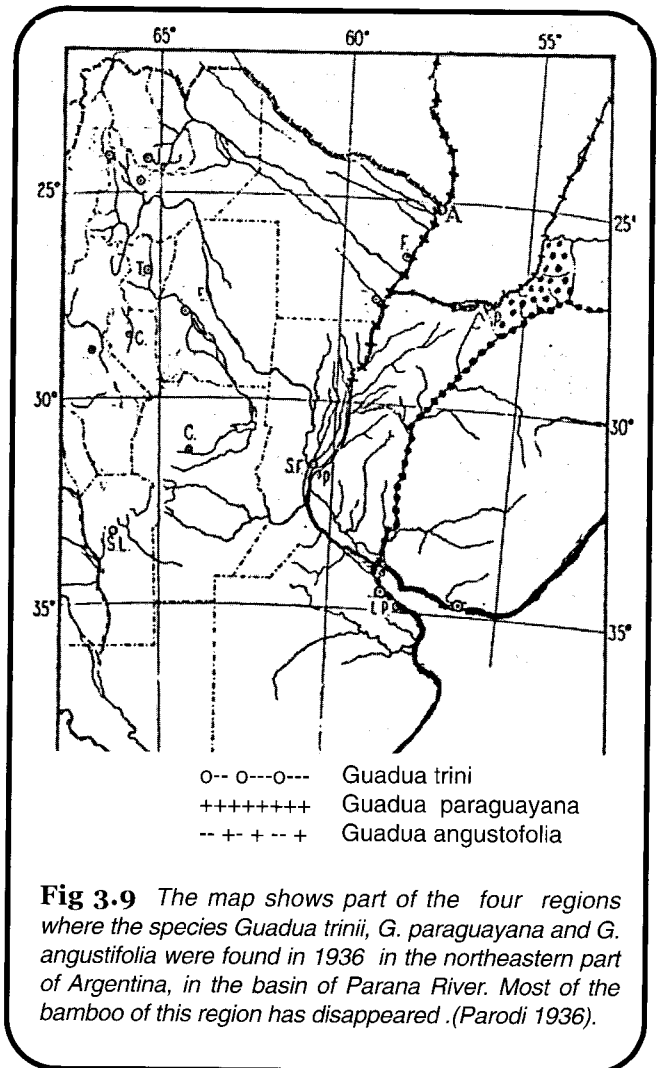
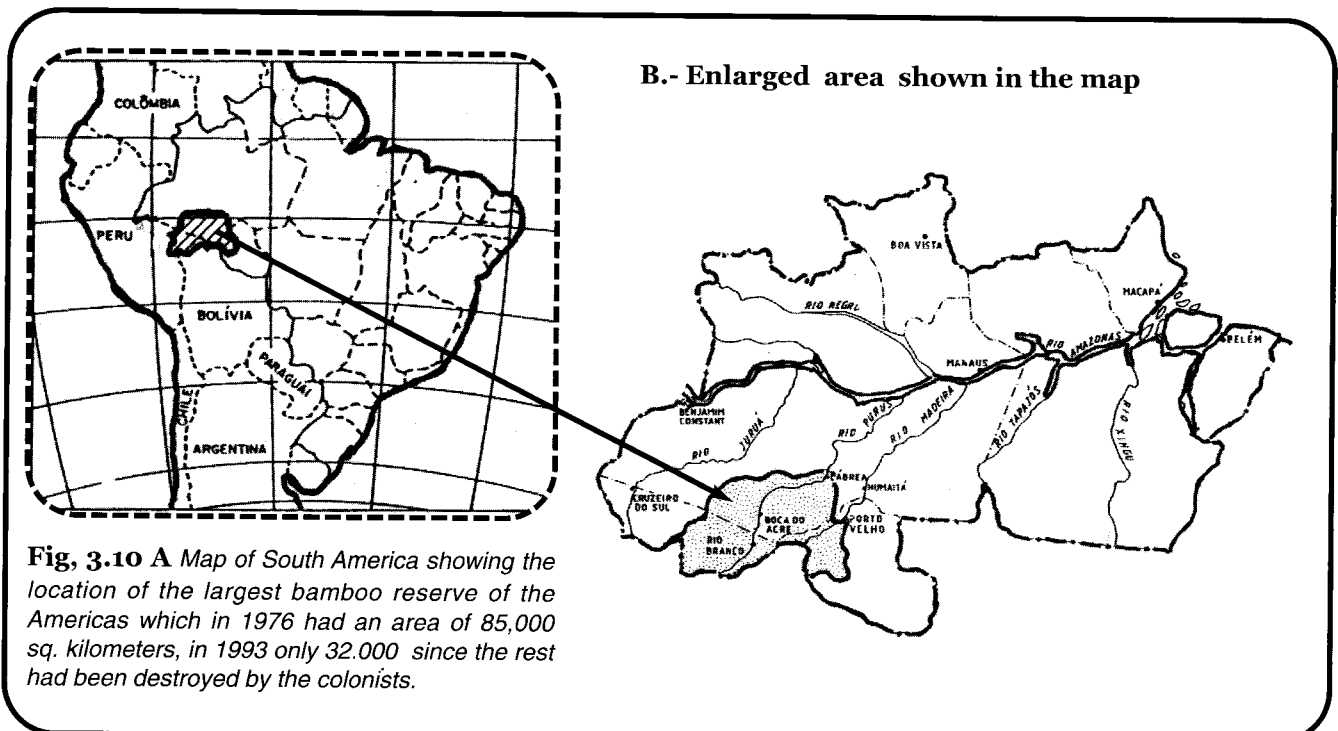


Fig 3.9 The map shows part of the four regions where the species *Guadua trini*, *G. paraguayana* and *G. angustifolia* were found in 1936 in the northeastern part of Argentina, in the basin of Parana River. Most of the bamboo of this region has disappeared. (Parodi 1936).



Fig, 3.10 A Map of South America showing the location of the largest bamboo reserve of the Americas which in 1976 had an area of 85,000 sq. kilometers, in 1993 only 32.000 since the rest had been destroyed by the colonists.



Fig.3.11 Even this type of bamboo, which does not belong to the Genus *Guadua*, could be used for the manufacture of particle boards.

I will remember with terror for the rest of my life, the four hours that we got lost in the jungle with Manuel Marquez, looking for a bamboo species.

During my visit to the Purus river I could observe how the bamboos were set on fire. Figs. 3.11 and 3.12. The problem is so serious that according to the colonists that I met in Sena Madureira and Rio Branco on my return, at the present rate of destruction, the remaining species in this area, which in the nineteen seventies was the largest bamboo reserve of the Americas, will disappear in the first decade of the 21 st century.

Unfortunately, all the efforts that I have made up to now to get financial support for saving these species, have been in vain because in Brazil and in general in the Americas nobody is interested in the preservation of our native giant species of bamboo, and the American foundations which I have asked for money have answered that they do not have money or that they are not interested on bamboos.

The only collaboration that I received in Brazil, which I

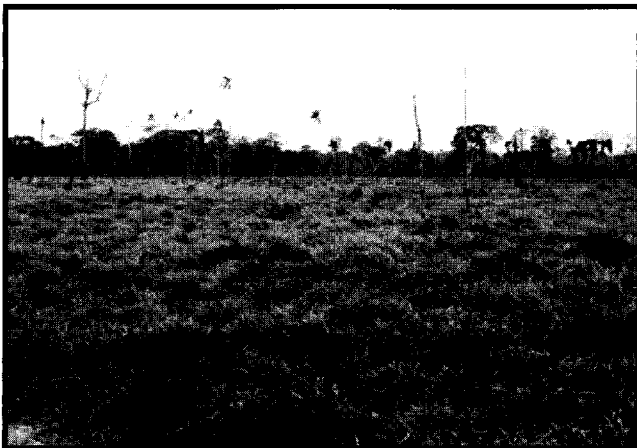


Fig. 3.13 After everything is consumed by the fire, grass is planted for the cattle. In other countries, instead of grass different crops are planted .



Fig.3.12. The destruction of the jungle. All of the large trees are cut and sold. The rest, including bamboos, are destroyed by fire.

have appreciated very much, is the offer of lands for planting this species that I received from FUNTAC (Fundação de Tecnologia do Estado do Acre) in Rio Branco. They offered me 40,000 hectares, when I needed only 20 hectares. Also the University Estadual Paulista UNESP, and the Botanical Garden of Bauru, Sao Paulo, both offered me small areas for cultivating and preserving these species.

I also want to thank also to Paulo Roberto Zandomingues, Director of researches in FUNTAC and Prof. Marco Antonio Pereira of the UNESP for their interest in helping me.

During the ten days I spent in the Amazon jungle I was only able to visit two places on the Purus River thanks to Manuel and Adolar. My purpose was to visit other places on the Purus River, but to rent a canoe with a driver, two helpers and fuel was very expensive and I could not afford it (\$ 2,000 U.S dollars for three days) and the money that was obtained from a Hawaiian foundation for this purpose disappeared.



Fig. 3.14 The Purus river in the dry season. In the basin of this river, the largest bamboo reserve of the Americas which may disappear in few years is located.



Fig. 3.15 This species is *Guadua angustifolia* because it has the same characteristics: one main branch in each node and the lower branches are long with thorns.

For this reason I could not visit other places that were located far away. But in these two places I found the two types of culms of genus *Guadua*, shown in Fig 3.15 and 3.16. They are different varieties because the base of the branches are different

The diameter of both culms are 14 centimeters, the thickness of the walls at the base is 2.5 cm and the height is about 20 meters. The quality of the culms is very good and they could be used in the manufacture of composite materials and structures.

On my return from Sena Madureira to the city of Rio Branco, I met Mr. Nielson Paulo Piovesan who had traveled to this city in order to buy an area of about 3.330 hectares in the Amazon jungle which he was to transform in pasture in about 8 to 10 years. Two of his friends bought the rest of the land in order to complete one million hectares. Mr Piovesan told me that between 1975 and 1994, a jungle area of 600 kilometers long by 200 kilometers wide located between Porto-Velho and Cuiba was transformed into large cities and towns. In this area millions of bamboos were destroyed.

If the government of Brazil would have established the norm that the colonists had to leave temporarily small patches with different species of bamboo, they had not disappeared.

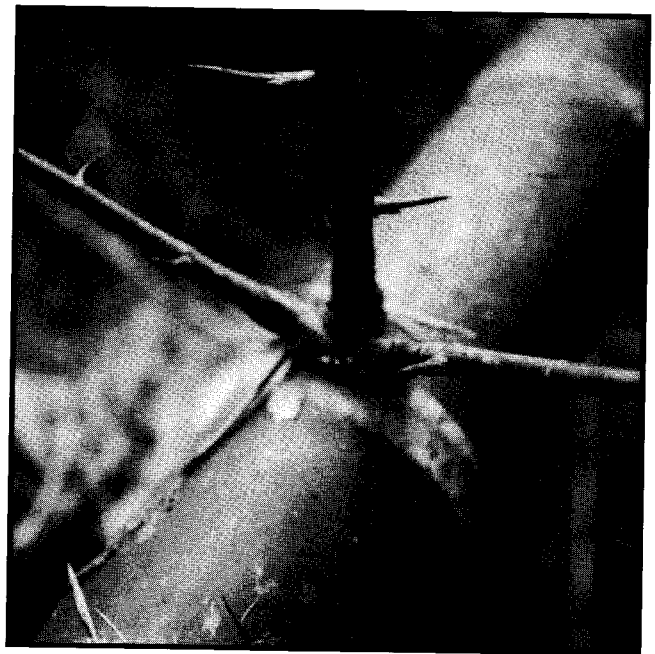


Fig. 3.16 In this species that we found in the Amazon jungle the main branch has two lateral branches which are not seen in the Fig. 3.15. This species is probably *Guadua superba* Huber. This species has the same diameter and height as that shown in Fig 3.15.

2) The destruction of the giant native species from Mexico to Ecuador.

The destruction of the giant bamboo species of the Americas which originally grew in all the countries from southern Mexico to northern Argentina, began during the conquest of the Americas with the arrival of the Spanish conquerors to Mexico, Central America and northern South America, where they started a sanguinary persecution against the Indians in order to steal their treasures or with the purpose of dominating them.

This period ended in the sixteenth century with the genocide of 90% of the indigenous population of the Americas, many of which perished incinerated by the Spanish conquerors in the bamboo forests where they sought protection or where they used to have their towns. With them, their traditions disappeared as did the precolumbian bamboo culture that existed in most countries from Mexico to Peru. Consequently, many large cities, such as Guamarcaah in Guatemala, disappeared.

According to Resinos (1952), Guamarcaah, the largest and most important city in Central America, was the capital of the Quiche culture, whose people were the descendants of the Mayas. The Aztecs of Mexico called this city Utatlan, which means the city of "cañaverales" or canefields, because it was surrounded by bamboo forests. This city was set on fire by the Spanish conquerors after killing the king, and most of the inhabitants were incinerated.

In order to have an idea of the largest bamboo forests which existed in Colombia in the sixteenth century, inside of which the Indians used to build their towns, I would like to quote Fray Geronimo Escobar, a Spanish clergyman who made the following reference to the city of Cartago, which at first was located at the present site of the city of Pereira in the state of Risaralda, Colombia, "This town is surrounded by a dense bamboo forest with large canes more than ten leagues wide" (Patiño 1975). (One league=5,752 meters).

This means that the bamboo ring which surrounded the city was more than 57 kilometers wide. Today it is necessary to travel almost the same distance from Pereira in order to find a small bamboo grove. Needless to say, thousands of square kilometers of bamboo were destroyed by fire by the Spanish conquerors, not only during the conquest of the Americas, but also during the colonial period when the largest cattle farms were established by Spanish families.

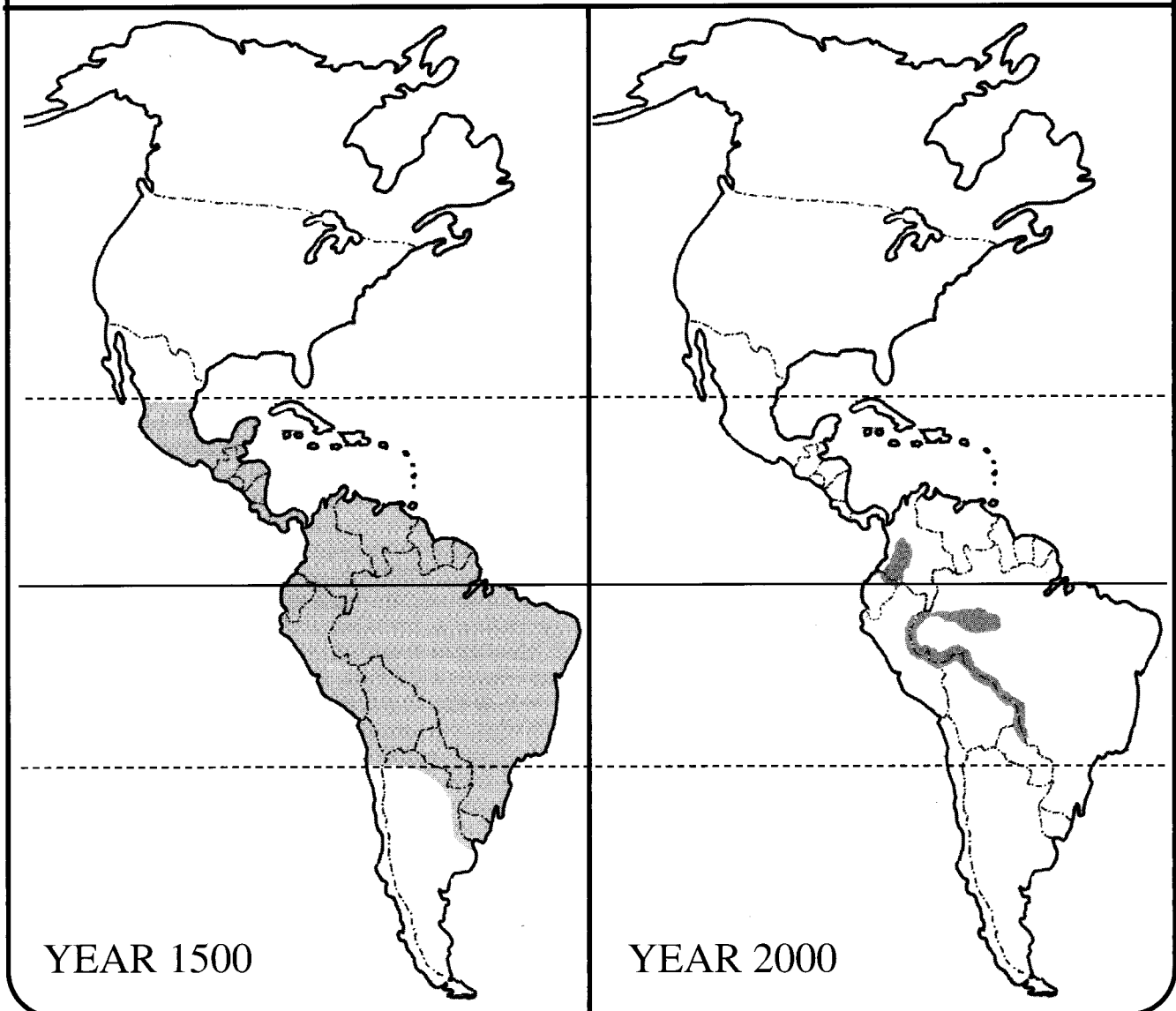
At the beginning of the nineteenth century, the second largest destruction of bamboo in Central America, Colombia and Ecuador occurred. It began in 1899, when the United

Fruit Co. of the United States, was established in Colombia and Ecuador, and based on the belief that the species *Guadua angustifolia*, *G. aculeata* and *G. amplexifolia* were plants indicative of good soil for planting bananas, this company transformed great extensions of pure bamboo forests into banana plantations in these countries. In Colombia alone, this company destroyed more than 60,000 hectares of bamboo forests which were transformed into 41 banana plantations, which were reduced to 4,000 hectares in 1986 (*El Tiempo*, November 9, 1991).

But the largest scale destruction of the bamboo forests in Latin America started after the Second World War, in the nineteen fifties, when President Eisenhower of the United States promoted agricultural and cattle development in most Latin American countries. Since that time, millions of hectares of bamboo forests have been razed to be replaced by coffee, rice, sugar cane, corn, or bananas and cattle development.

The worst part, though, is the fact that from that time up to the present, it has been impossible to restrain this

Fig. 3.17 - 500 YEARS OF DESTRUCTION OF THE GIANT SPECIES OF THE GENUS GUADUA



destruction, because none of the governments of our countries were opposed to it. Colombia was the only country which, in the nineteen sixties, could stop the destruction of our native species when they were on the brink of extinction, thanks to the Colombian Institute of Natural Resources (INDERENA), which at that time established a regulation that is still in effect. According to this regulation, it is forbidden to cut bamboo, and it is necessary to get permission from the INDERENA (or its representatives) in order to cut it. Thanks to this entity, we have preserved most of our native species. Otherwise these species would have disappeared from Colombia many years ago, as has happened in the rest of Latin American countries, including Mexico, Venezuela and some Central American countries where their native giant species were razed while in other countries they are on the brink of extinction, as in Ecuador.

On the other hand, in Colombia bamboo is the most important material for farmers who live in areas where this plant grows because this material is used in rural areas in the construction of houses, warehouses, milk pails, henhouses, bridges, telephone and electrical posts, fences etc. For this reason, on most farms, there are one or several bamboo patches depending on the size of the farm. This is why farmers believe that a farm which has one or several patches of "guadua" is more valuable, whereas on the coast of Ecuador, farmers believe the opposite: that a farm with bamboo patches has a lower value and it is necessary to cut them in order to increase its value. This is due to the aversion which exists in Ecuador towards the giant native species of bamboo because of the low quality houses that they build with this material.

Consequences of the aversion and ignorance which exist in our countries towards the giant native species.

The aversion towards the native giant bamboo species is found in Colombia and other Latin American countries, but to a lesser degree than in Ecuador. It is possible that we have inherited it from the Spaniards who came to the Americas in the sixteenth century and who had as a maxim that "Spaniards who have any self respect do not live in bamboo houses but in adobe houses". This was not interpreted as a safety measure (although the Indians used to set fire to the Spaniard's houses when they first lived in bamboo houses), but was considered as an aversion towards the giant bamboos, which, due to their abundance, were looked upon weeds that were only used by the Indians and poor people in the construction of their houses. Consequently these plants were considered as the Cinderella of our natural resources.

This aversion has been the cause of the lack of interest in studying the giant bamboo species in the scientific and technical fields or for preserving these species, that exists in our universities and forestal research centers. This is why many species have disappeared from the Americas, as was explained before. If we revise the great diversity of treatises which Latin American botanists have written about the flora of their countries, we find very thorough studies, even on plants with practically no economic value.

However, the most ironic part of this is that in these treatises one cannot find any botanical information about any of the native bamboo species, not even in Colombia where this plant has made the greatest contribution to the

economic and social development of the country.

On the other hand, in most countries in Southeast Asia and particularly in China, Japan and India, bamboo is the plant which for many centuries has exerted a great influence on their life, culture and economy and today they are the leaders in the research on their most important native bamboo species. Many studies and publications have been made by their universities and research centers, not only in the scientific fields, which include taxonomy, morphology, physiology, anatomy, ecology and genetics, but also in the technological field in which the industrial uses of their most important species have been studied.

Due to the lack of technical and scientific information which exists in our countries about our bamboo species, there are no professors in our schools and universities, and particularly in the forestry engineering and agricultural colleges, who transmit to their students the most elemental knowledge about this plant. As a consequence, the great majority of professionals who complete their studies in these colleges not only ignore the fact that our giant species are not trees, but also how to cultivate them. They believe that if they have not received any information about the bamboos in their colleges, it is because this plant really is a weed which is not important for the country. Due to this, when they get high positions in the management of forestry programs, they do not include our bamboo species because they have no interest in this plant.

As a consequence of the above, there is a complete ignorance in all social, economic and academic levels in our countries about our giant bamboo species and particularly about the botany of this plant, which has generated the following problems:

1.-Most people associate the term bamboo only with the plant which generally has yellow culms with green stripes and adorns the parks of our towns and cities (*Bambusa vulgaris* var. *vittata*), which is believed to be native to India or Burma. There is the belief that the giant green bamboo species are not bamboos but trees because many times they are found mixed with trees in the forests of our countries. For this reason, it is very common to see articles in the newspapers and magazines in Colombia in which reference is made to "guadua and bamboo" and really "guadua" is a bamboo.

2.-As was mentioned before, the giant bamboo species of the genus *Guadua* were originally distributed from Mexico to Argentina and in each country (except Chile where this species do not grow) there were generally a minimum of 2-3 different giant species. In Colombia, there were about 7-8 giant species and in Brazil about 12. Some of these species grew in several countries, as is the case of *Guadua angustifolia* which grew in most of the countries in South America.

3.-Due to the similarity which exists among all the giant bamboo species in relation to the shape of their shoot and the shape and color of the culms of all the species once they are developed, the majority of people in different Latin American countries believe that all their native species are the same with different dimensions. This is why in each country, all of their native giant species are known by one vernacular name which varies from one country to another.

For example, in Colombia all of the 7 giant species are

known by the vernacular name of "guadua"; in Ecuador as "caña guadua"; in Peru as "caña de Guayaquil"; in Bolivia as "tacuarembu"; in Argentina as "tacuara"; in Paraguay as "tacurupucu"; in Brasil as "tacuarucu"; in Venezuela as "guafa"; in Panama as "cañaza"; and in Mexico and other Central America countries they are known by the vernacular names of "tarro" and "cañabrava". The term "cañabrava" is also used for other species of canes.

4.-The erroneous belief that in Colombia there is only one giant bamboo species which is known by the vernacular name of "guadua" and by the scientific name of *Guadua angustifolia*, has caused a lot of confusion in the thesis written by engineering students about studies of the physical and mechanical properties of this material. Generally the titles of these thesis are "Study of the Physical and Mechanical Properties of Guadua" or "Physical and Mechanical Properties of *Guadua Angustifolia*". These studies have no value, because in the first case they do not indicate which of the 7 species of "guadua" was used in the experiments.

The second case, it is very difficult to know if the students really used "macana" (*Guadua angustifolia*) or if they used "guadua cebolla" or "guadua de castilla" or some other species which, for them, has the same scientific name. Consequently these studies are not trustworthy.

The same problem exists in Argentina in relation to the study about the physical and mechanical properties of "tacuara" (the vernacular name of the giant bamboo species in this country) which was carried out in one of the schools of engineering with the title "Physical and Mechanical Studies of Tacuara". The thesis did not indicate which of the 3 species of tacuara that they have in Argentina was used in this study. On the other hand, the students who know that there are only 2 species believe that both have the same mechanical and physical properties, and this is not true, as we will see in the chapter on mechanical properties.

5.-Some of the people who are in charge of bamboo nurseries confirm the belief that there is only one species in Colombia, based on the fact that there are no clear differences between the seedlings of different species of "guadua" (when they are small). They erroneously believe that any of the seedlings of "guadua" that they are selling will generate one of the 3 best known species used in construction, depending on the place or habitat where it is cultivated. In other words, any guadua seedling can generate "guadua de castilla", "guadua cebolla", or *Guadua angustifolia*, depending on where it is cultivated. This is as absurd as believing that if a lemon seed is planted at 200 meters above the sea level, this seed will produce oranges and at 700 meters, it will produce grapefruit. As a consequence, if anyone goes to a bamboos nursery and wants to buy *Guadua angustifolia*, they could sell him a different species, for example "guadua cebolla". I want to clarify that the people at the nurseries do not do this in bad faith but rather out of ignorance.

6.- The most common problem is that most people, including many of those who work in the bamboo nurseries,

do not know how to distinguish one species from another in the forest, for example, *Guadua angustifolia* from "guadua cebolla", with the exception of "guadua rayada amarilla" or "guadua rayada negra". As a consequence, the same problem mentioned in item 5 will occur, that is, if someone goes to a bamboos nursery and wants to buy *Guadua angustifolia*, they could sell him a different species. I believe that this problem has caused the one described in item 5.

7.-Another problem that causes a lot of confusion occurs when the common or vernacular name that is given to a specific species of bamboo in one country or region, is the same as that given to a different species of bamboo or to a cane that is not a bamboo in another country or region. For instance, in Ecuador the term "caña brava" is used as the vernacular name of the species *Guadua angustifolia*, on account of the thorns on its branches. In Mexico and Guatemala the species *Guadua aculeata* is known by the same vernacular name for the same reason. This has originated such confusion that there is an article in a magazine in which the author said that "the same bamboo species, known as caña brava in Ecuador grows in Mexico". But the term "caña brava" is also the common or vernacular name that, in many countries, is given to a native cane that is not a bamboo. This cane has the scientific name of *Gynerium sagittatum* and is also used in the construction of walls and ceilings in several countries.

8.-The lack of scientific names for some of the giant species that are the most used in construction in Colombia, such as "guadua de castilla" and "guadua cebolla", has been a barrier for the use and the identification of these species in technical and scientific works.

In September of 1980 I asked two of the most important botanists in the United States, who were dedicated to the study and identification of herbaceous bamboos of the Americas, why there was more interest in the study of herbaceous bamboos, that are not so important from the economic standpoint instead of first studying the giant bamboos that are used the most and do not yet have a scientific name.

The answer was, "First, because the herbaceous species are disappearing from the Americas, and second, because the woody giant species of the genus *Guadua* are the most difficult to identify. For these reasons, most taxonomists are more dedicated to the identification of herbaceous bamboos than they are to the identification of the giant woody species."

I still don't understand how it was possible that Humbolt & Bonpland, Kunth and other European botanists who came to the Americas at the beginning of the nineteenth century could have identified most of the giant species using a small low quality magnifying glass without any information about bamboos because at that time there were not any scientific publications about this plant. How is it that today, when the best electronic microscopes exist, and the most complete information about bamboos has been developed in Japan, China and India, it is still difficult to identify the giant bamboo species of the genus *Guadua*?

DNA (Deoxyribonucleic acid) and the identification of species

Colombia is the only country in the Americas where still exists a bamboo culture but related to the use of its largest native species in construction. In this field this country has developed the best construction technologies which exist in the world. Nevertheless, as I explained above there is in this country the most complete ignorance about our giant species and particularly of the four giant species which are the most used in construction.

As I explained before, most of the people believe that all these giant native species are the same specie which is known with the common name of "guadua" and with the scientific name of *Guadua angustifolia*. This is due to the similarity which exists among the culms and particularly among the seedlings of these species when they are small. Due to this reason some people which works in bamboo nurseries believe that if one of these seedlings is cultivated in different locations they can generate "guadua macana", *Guadua angustifolia* or "guadua de castilla", or "guadua cebolla" depending of the habitat where the seedling is cultivated.

In order to solve these problems and the identification of our giant species which still has not scientific name it is very important to study the DNA of each one of our most important species. By the other hand this information will solve the doubts which exists about the identification of some of our native species in Colombia and other countries of the Americas.

What is DNA?

Information governing the characteristics of all organisms is stored in long thin molecules of deoxyribonucleic acid (DNA).. DNA molecules contain regions (genes) that specify the structure of other molecules called proteins. Protein-molecules in turn control cellular chemistry and contribute to cell structure.

The basic unit of life is the cell, an organized set of chemical reactions bounded by a membrane and capable of self-perpetuation. Our bodies are collections of trillions of cells working together, with each cell having its own identity and function. With few exceptions, every cell contains all the information required for an independent existence; indeed, under the right conditions, human cells can be removed from the body and grown in laboratory dishes.

According to Drlica (1992), the information necessary to control the chemistry of the cell (i.e. the chemistry of life) is stored in the long thin fibers called DNA. Each DNA fiber is a molecule, a group of atoms joined together to form a distinct unit. DNA fibers are found in every cell except mature red blood cells, and they dictate how a particular cells behaves. Thus DNA controls our body chemistry by controlling the chemistry of each of our cells.

Isolated DNA looks like a tangled mass of string. Our cells, which are generally less than a millimeter long, contain about two meters of DNA specially packaged to fit inside. DNA can be bent, wrapped, looped, twisted, and even tied into knots. Many DNA molecules are circles, which are sometimes found interlinked like a magician's rings. In terms of three-dimensional structure, DNA is very flexible, but in terms of information content, DNA is quite

rigid, for the same information must pass from generation to generation. Distinct regions of DNA contain distinct bits of information. The specific regions of information are called genes. In some ways DNA is similar to motion picture film. Like film, DNA is subdivided into "frames" that make sense when seen in the correct order. In DNA the "frames" correspond to the letters in the genetic code. When a number of frames or genetic letters are organized into a specific combination, they create a scene in the case of film and a gene in the case of DNA.

Information in genes is used primarily for the manufacture of proteins. Proteins are chainlike molecules that fold in a precise way to form specific structures. Some proteins contribute to the architecture of the cell while others directly control cell chemistry.

Occasionally we can easily see the effects of particular genes and proteins; for example, a small group of genes is responsible for determining eye color. It is the specific information in the DNA, in the genes, that makes human beings different from honey bees or fir trees. Information in your DNA makes you different from anyone else on earth, unless you have an identical twin (Drlica 1992).

1.- Chromosome number in bamboo

If bamboo is going to be fully domesticated and used in breeding programs, an understanding of its basic genetics is a prerequisite; unfortunately genetics of bamboo remain to be unravelled and the study of bamboo genetics has been restricted mainly to chromosome counts. In many bamboos, the somatic numbers may differ between tissues, and the number referred to is the most common number. Common numbers are $2n = 48$ for temperate bamboos, and $2n = 72$ for tropical bamboos. In subtropical China, a number of species are found with chromosome numbers $2n = 64$. The highest chromosome number is in *Bambusa variostratus* where $2n = 96$ (Guangzhu 1987).

2.- Fingerprints of bamboo

According to Gielis, 2001 (personal communication) In the second half of the twentieth century very rapid progress has been made in unravelling the secrets of life, in DNA and proteins. Several biotechnological techniques and tools make it possible today to study the DNA of bamboo. One of the most promising techniques is fingerprinting of bamboos. With tools such as Amplified Fragment Length Polymorphism fingerprints can be generated that allow to distinguish every individual bamboo, or every single seed in a seed lot. While today taxonomists, ecologists and foresters have great difficulty in distinguishing different bamboos within a single species, DNA-based technology circumvents all problems.

Building a database of such fingerprints will be an important aid for bamboo study. It would allow to distinguish several clones of *Guadua* that are nowadays considered as the same species. Besides fingerprinting DNA based technology will also allow in the future to precisely determine specific gene sequences in bamboo, and this in turn will allow to modify certain characteristics of bamboo. The main problem for genetic improvement through breeding

however is the complete lack of controllable bamboo flowering, which still remains one of the greatest mysteries in botany.

3.- Estimation of DNA content of some bamboos

To estimate if the complexity of the DNA of bamboo was comparable to rice DNA, Gielis, et al (1997), carried out an estimation of the DNA content of 16 temperate and 10 tropical bamboo genotypes using flow cytometry (FCM). When a fluorochrome is applied to the cells and binds to the DNA, this DNA gives a fluorescent color when illuminated by a laser beam and the color intensity is measured by the Flow Cytometer. The range of application is very large; among other uses, FCM can measure cell size and DNA content.

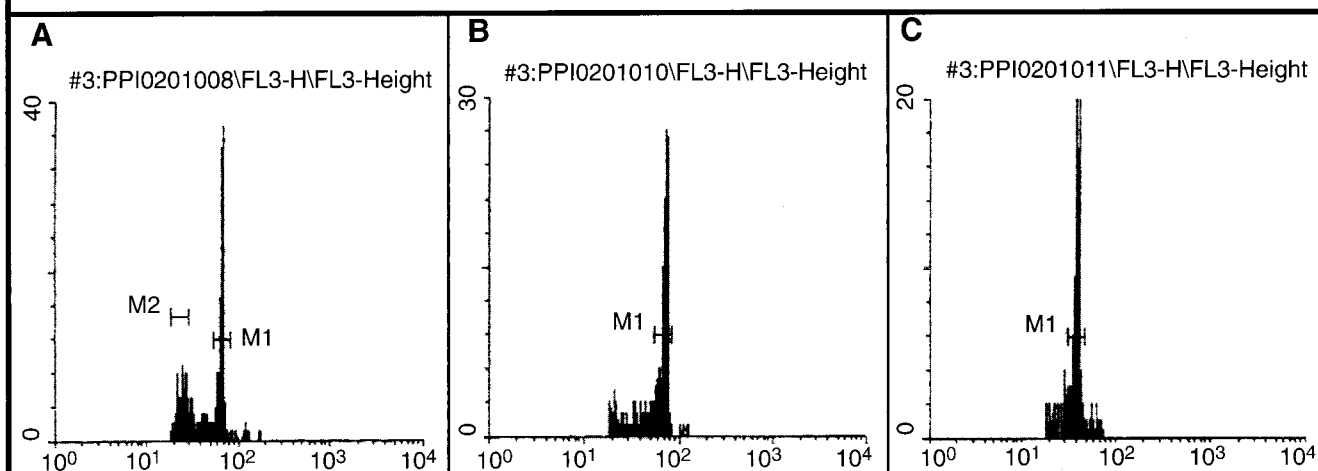
An important result has been that two distinct groups of bamboo exist, namely tropical bamboos and temperate bamboos. The latter group has fewer chromosomes ($2n = 48$), but it has a higher DNA content than tropical bamboos which have 72 chromosomes. The chromosomes of tropical bamboos are more numerous, but they are also much smaller. The DNA content in bamboo is comparable to the amount present in rice if calculated per chromosome (rice has only 24 chromosomes in the vegetative state). This confirms the very close evolutionary relationship between bamboo and rice (Gielis 2001).

Table 3-4 Estimation of DNA content in 16 temperate and 10 tropical bamboo species using flow cytometry (FC) and confocal laser scanning microscopy (CLSM)

Bamboos	DNA (pg) 2C M	
	FC	CLSM
<i>Bashania fargesii</i>	4.45	
<i>Chimonobambusa quadrangularis</i>	5.17	
<i>Chimonobambusa marmorata</i>	4.4	
<i>Fargesia murielae</i>	5.11	5.32
<i>Indocalamus tessellatus</i>	5.18	
<i>Phyllostachys aurea</i>	4.18	4.8
<i>Ph. bambusoides</i>	4.18	
<i>Ph. edulis</i>	4.19	
<i>Ph. nigra</i>	4.17	
<i>Ph. vivax</i>	4.25	
<i>Pleioblastus viridistriatus</i>	4.67	
<i>Pi. pygmaeus var. pygmaeus</i>	4.66	
<i>Sasaella glabra f. albostrata</i>	5.35	
<i>Sasa palmata</i>	4.95	
<i>Shibataea kumasasa</i>	5.11	5.3
<i>Yushania anceps</i>	4.5	
<i>Bambusa multiplex</i>	3.03	
<i>Bambusa multiplex cv. Fern leaf</i>	3.23	
<i>Bambusa vulgaris</i>		
Old leaves	2.45	2.56
Young leaves	2.85	2.98
TC leaves	3.02	
<i>Bambusa striata</i>		
Young leaves	2.7	2.68
Old leaves		2.39
<i>Dendrocalamus asper</i>	3.04	
<i>Dendrocalamus strictus</i>	2.9	
<i>Guadua angustifolia</i>	3.03	
<i>Oxytheranthera abissinica</i>	2.94	3.11
<i>Thyrsostachys siamensis</i>	2.353.6	
<i>Lithachne humilis</i>		3.56

Source: J. Gielis, P. Valente, C. Bridts & J.P. V. 1997.

Fig. 3.18 Flow cytometry peaks of bamboos: A. *Fargesia murielae*. B. *Shibataea kumasasa*. C. *Bambusa vulgaris striata*



Source: J. Gielis, P. Valente, C. Bridts & J.P. V. 1997.