

# Bambu: Matéria-prima para o Século XXI



竹子是上帝的恩賜

Antonio L. Beraldo

Prof. Titular

FT - Unicamp

[www.apuama.org](http://www.apuama.org)





















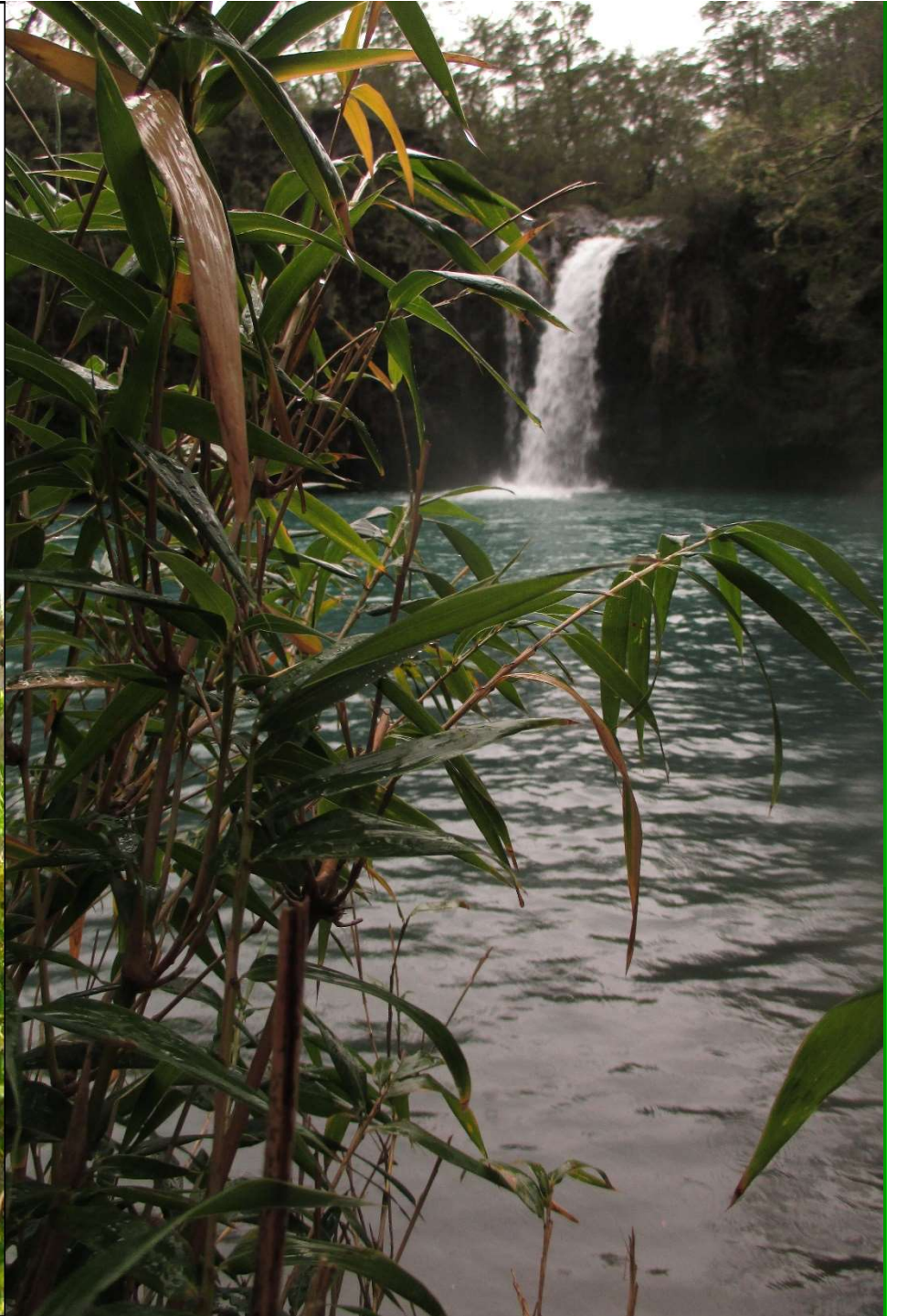
*Le Rasnail vert*

*Petit Déjeuner Parisien 9<sup>50</sup>€*

*Pain chaud, jus de fruits, viennoiserie,  
tartinade beurre et confiture  
Hot drink, fruit juice, viennoiserie,  
slice of bread, butter and jam*

*Petit déjeuner Big Ben 13<sup>50</sup>€*

*Pain chaud, jus de fruits, viennoiserie,  
tartinade beurre et confiture ou à votre goût  
oumeau, bacon, saumon fumé  
Hot drink, fruit juice, viennoiserie,  
slice of bread, butter and jam or egg at your choice  
bacon, ham, smoked salmon*









Santos-Dumont  
N° 20 "Demoiselle"



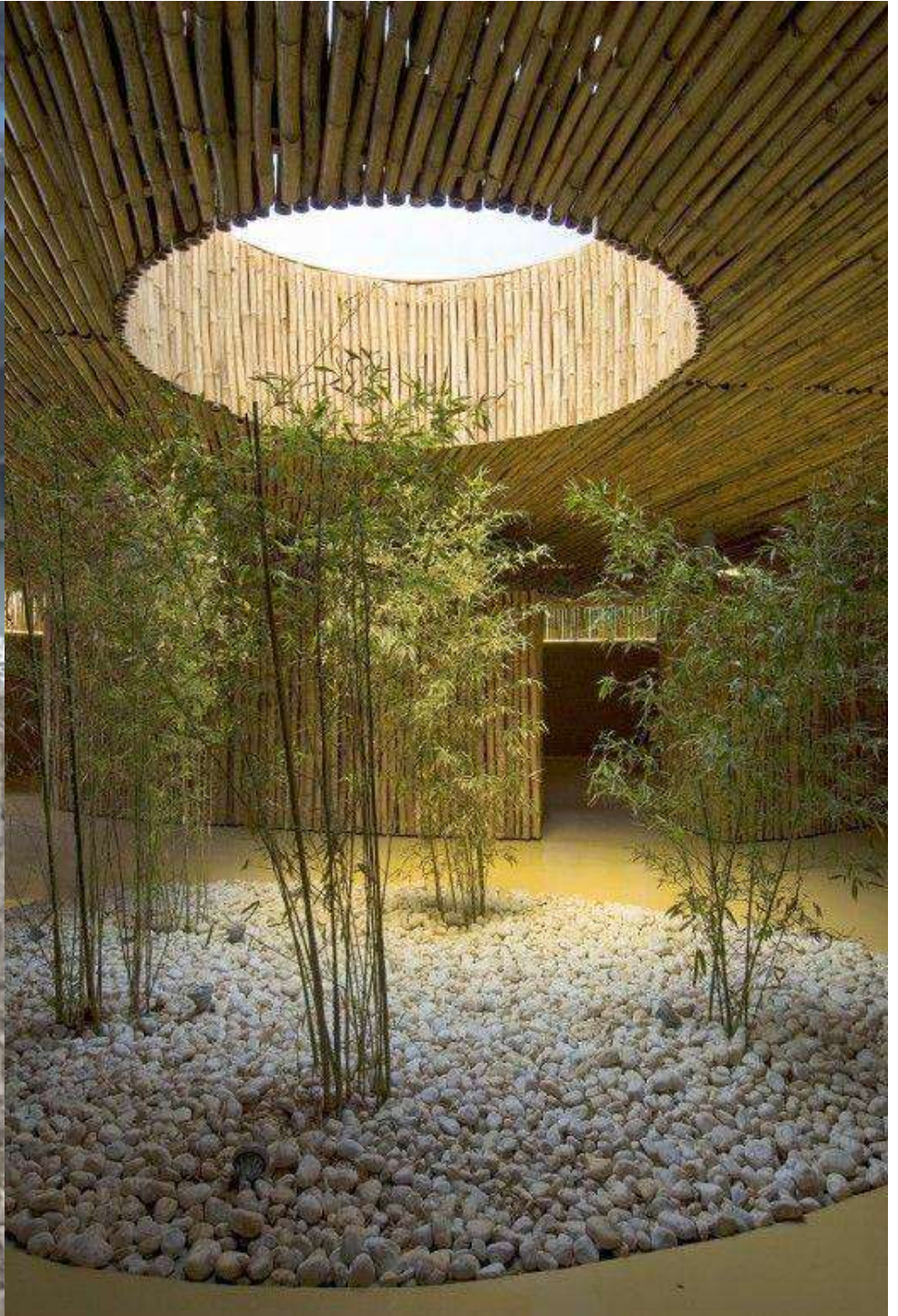








**Biboo**





72°W

60°

48°

36°

**Venezuela**

Santa Elena

Georgetown

Paramaribo

**French Guiana**

Suriname

Cayenne

**Colombia**

Boa Vista

**Guyana**

Macapá

Manaus

Santarém

Itaituba

Jacaracanga

Belém

**Maranhão**

São Luís

Teresina

**Ceará**

Fortaleza

Benjamin Constant

**Amazonas**

Pôrto Velho

**Rio Branco**

Humaitá

Vilhena

**Mato Grosso**

Cachimbo

Cuiabá

Miracema do Norte

Pôrto Franco

Natal

**João Pessoa**

Recife

Maceló

**Peru**

Urabamba  
Cuzco

**Bolivia**

La Paz

Puno

Arequipa

Mollendo

Arica

iquique

Uyuni

Antofagasta

Chile

La Serena

Vajparaiso

Mendoza

**Santiago**

**Argentina**

San Miguel de Tucumán

Córdoba

Santa Fe

Rosario

Paysandú

**Uruguay**

Buenos Aires

Montevideo

Brasilia

Goiânia

Liberlândia

Pirapora

Montes Claros

**Minas Gerais**

Belo Horizonte

Volta Redonda

Niterói

Rio de Janeiro

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**São Paulo**

Pôrto Alegre

Osório

Florianópolis

Santos

**Paraguay**

Asunción

Foz de Iguazú

Curitiba

São Paulo

Paraná

Curitiba

Santos

Paraná

Curitiba

Santos

12°S

24°

# Gêneros de bambus

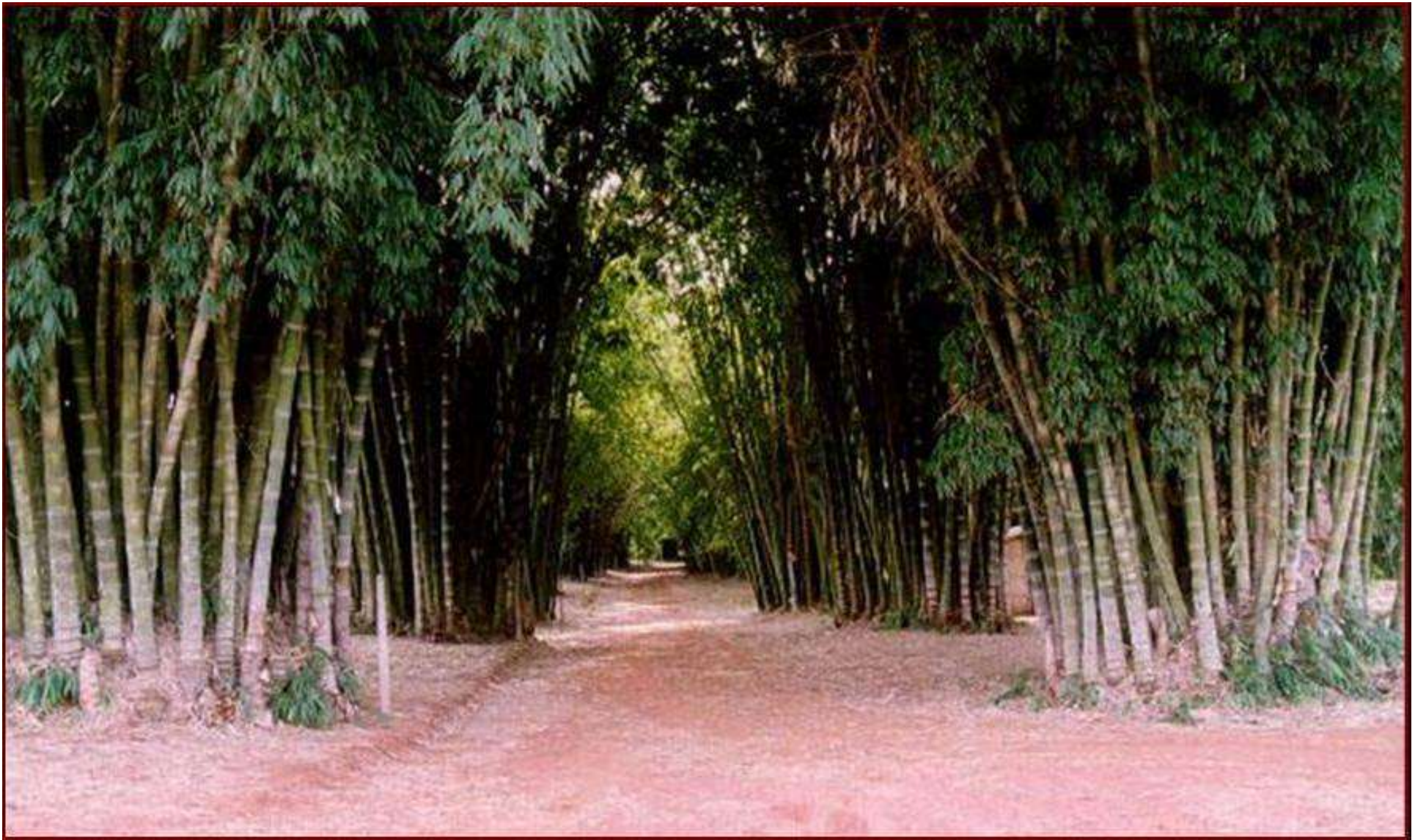
Acidosasa Ampelocalamus Arundinaria **Bambusa** Bashania  
Borinda Brachystachyum Cephalostachyum  
Chimonobambusa Chimonocalamus Chusquea  
**Dendrocalamus** Dinochloa Drepanostachyum Fargesia  
Ferrocalamus Gelidocalamus Gigantochloa **Guadua**  
Hibanobambusa Himalayacalamus Holttumochloa  
Indocalamus Indosasa Kinabaluchloa Klemachloa  
Maclurochloa Melocanna Melocalamus Merostachys  
Metasasa Nastus Neomicrocalamus Neosinocalamus  
Oligostachyum Ototea Oxytenanthera **Phyllostachys**  
Pleioblastus Pseudobambusa Pseudosasa Pseudostachyum  
Sasa Sasaella Semiarundinaria Shibataea Sinobambusa



# Tipos de rizomas



**Paquimorfo**      **Leptomorfo**



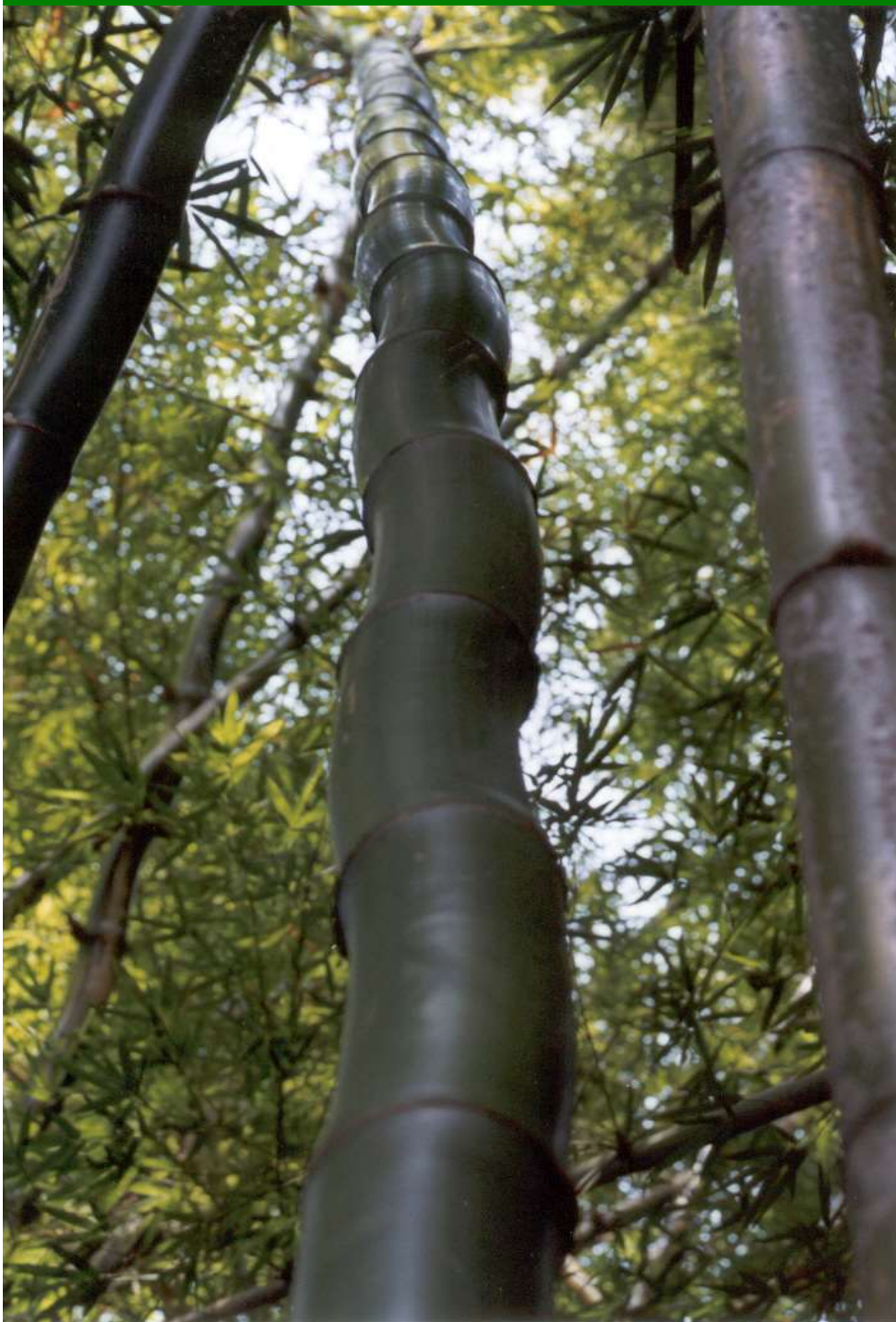
Tatuí – SP

*Dendrocalamus asper*  
 $h = 25\text{ m}$     $d = 15\text{ cm}$     $m = 85\text{ kg}$

















*Phyllostachys pubescens* – Bambu Mossô  
 $h = 12\text{ m}$     $d = 10\text{ cm}$     $m = 25\text{ kg}$





















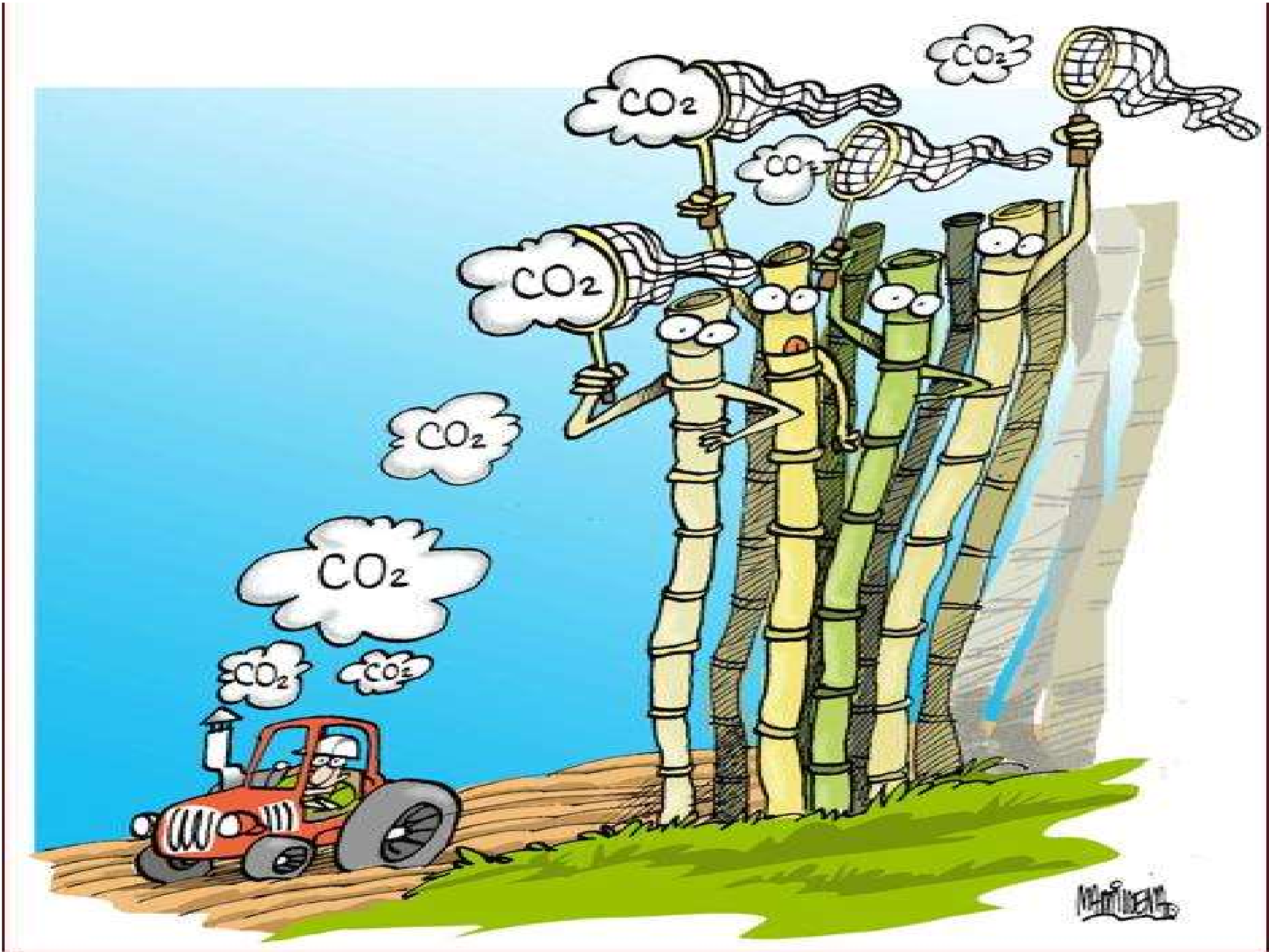














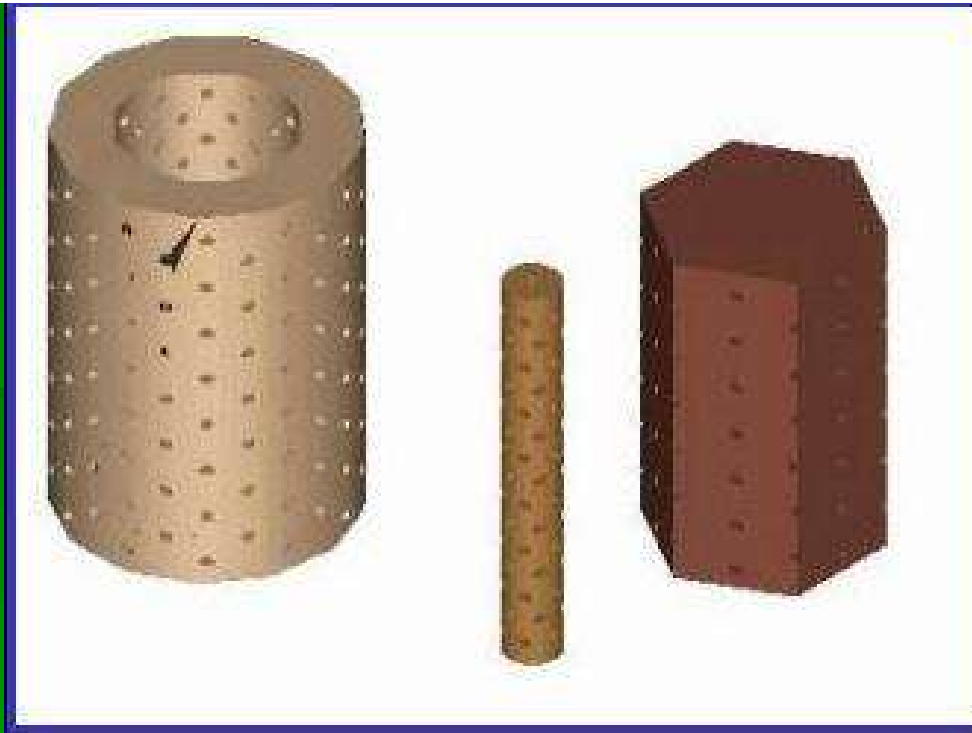
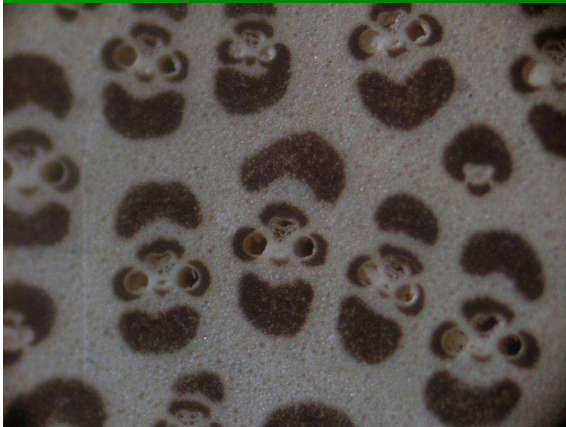








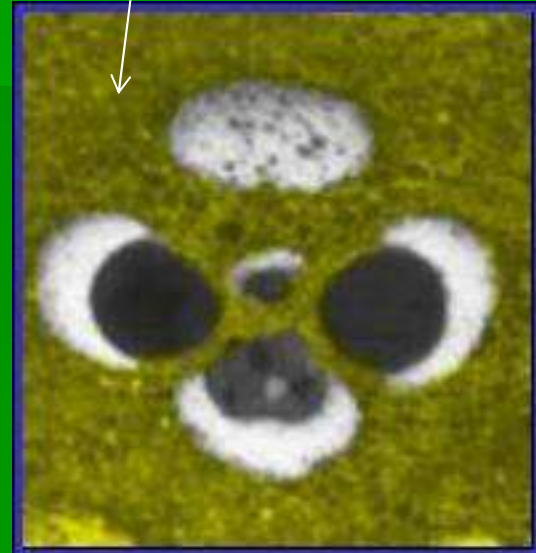
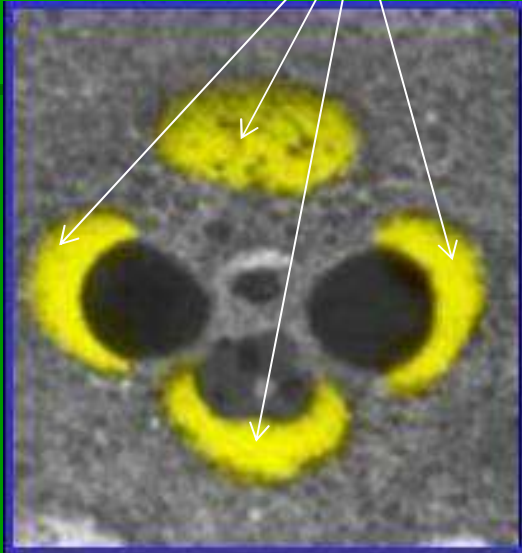
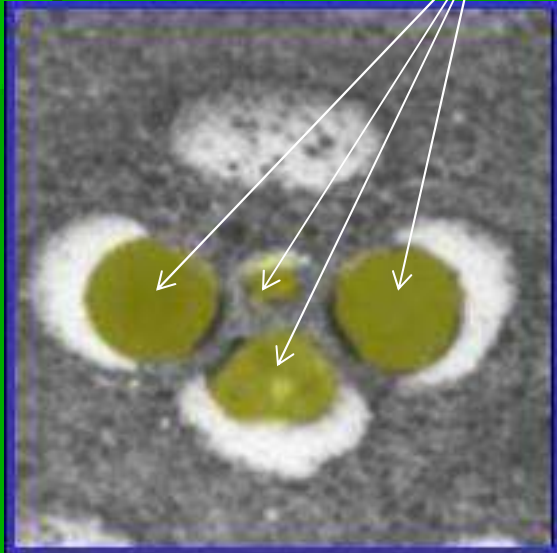


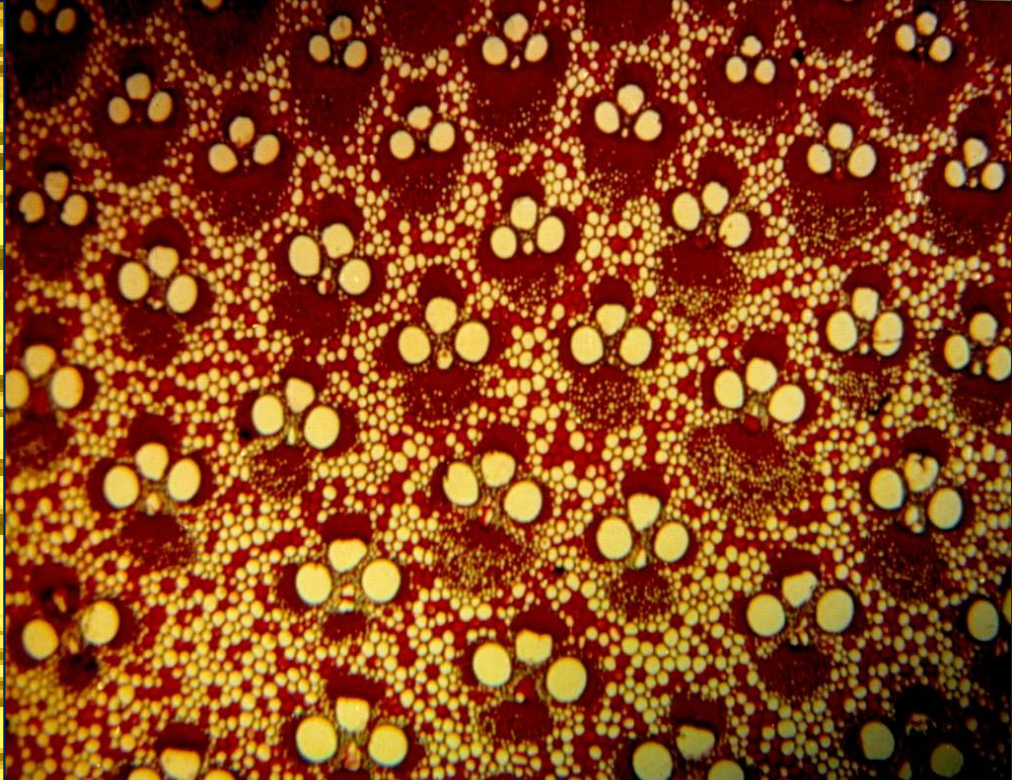
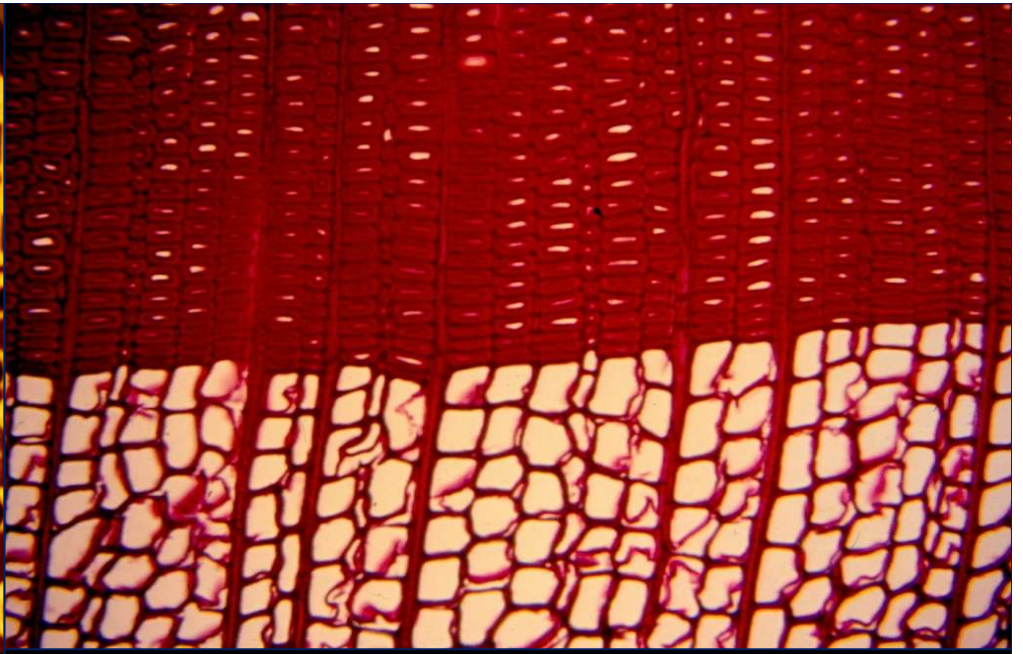
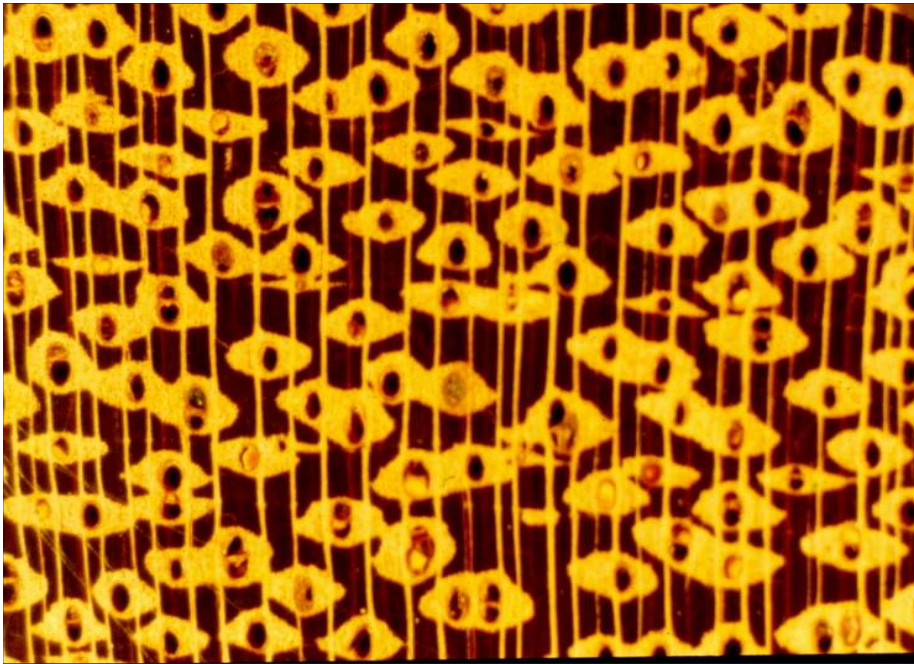


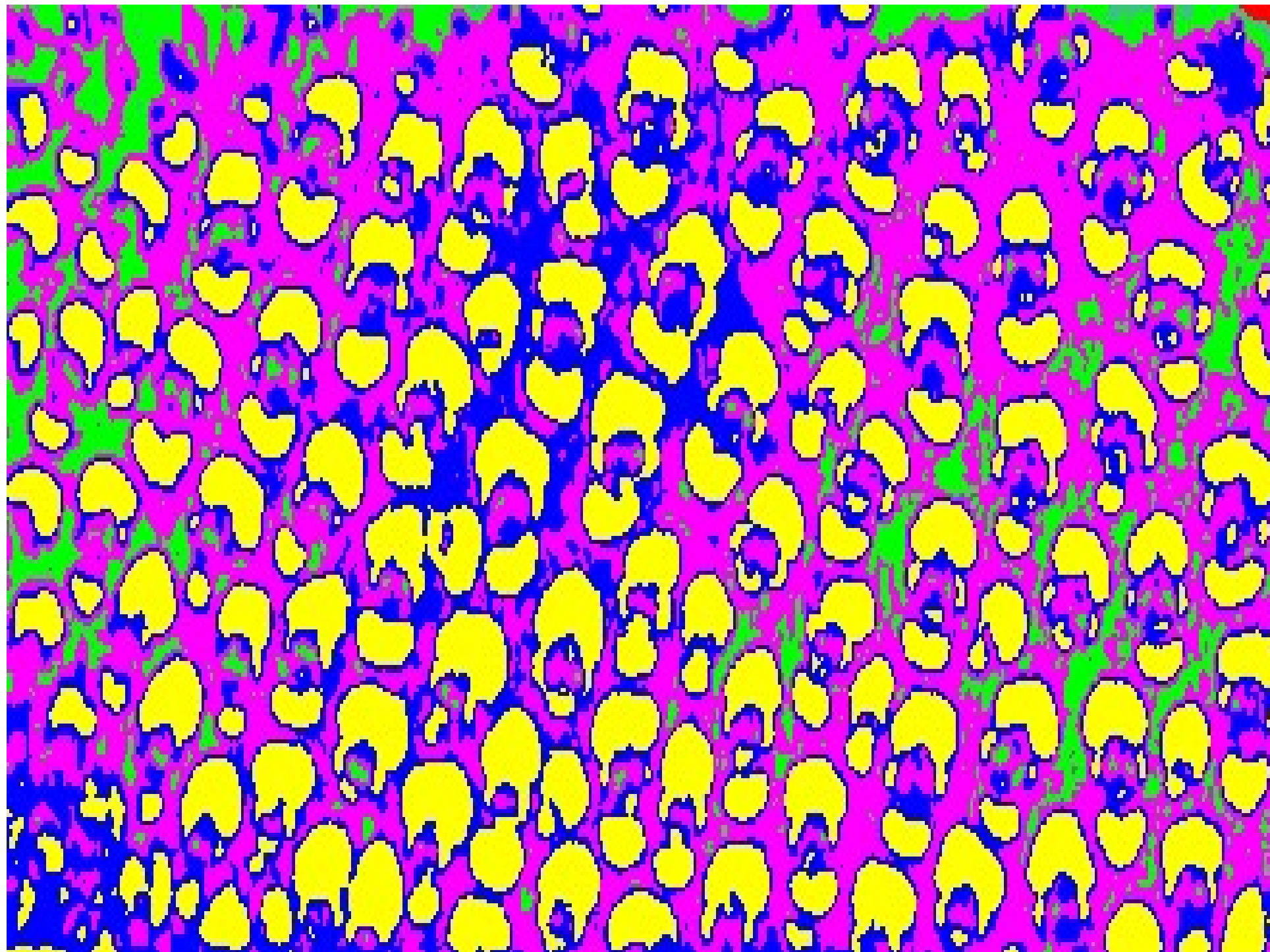
Vasos

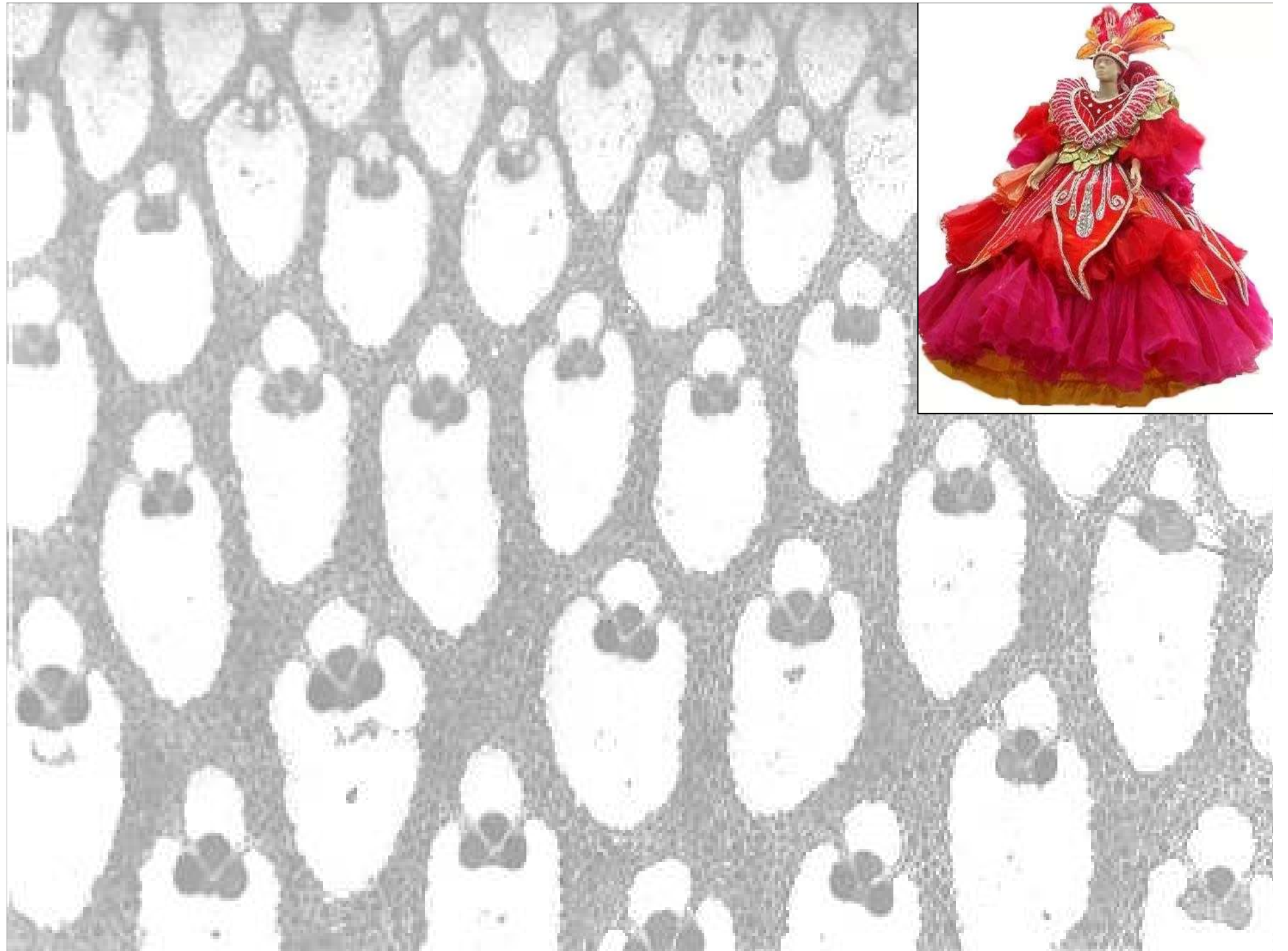
Fibras

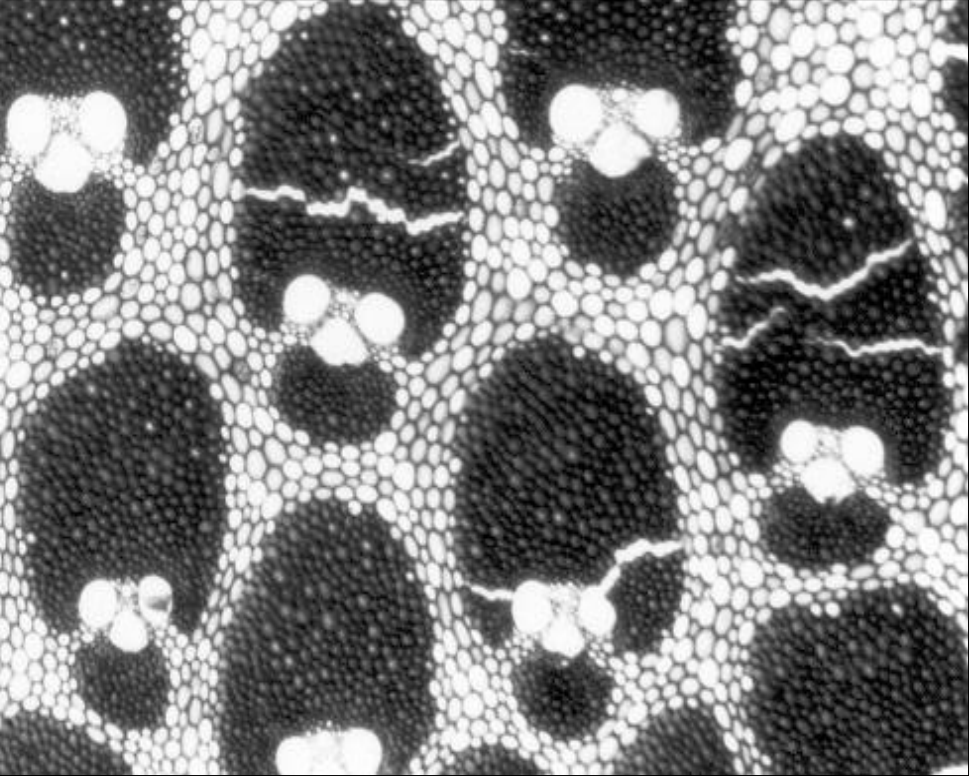
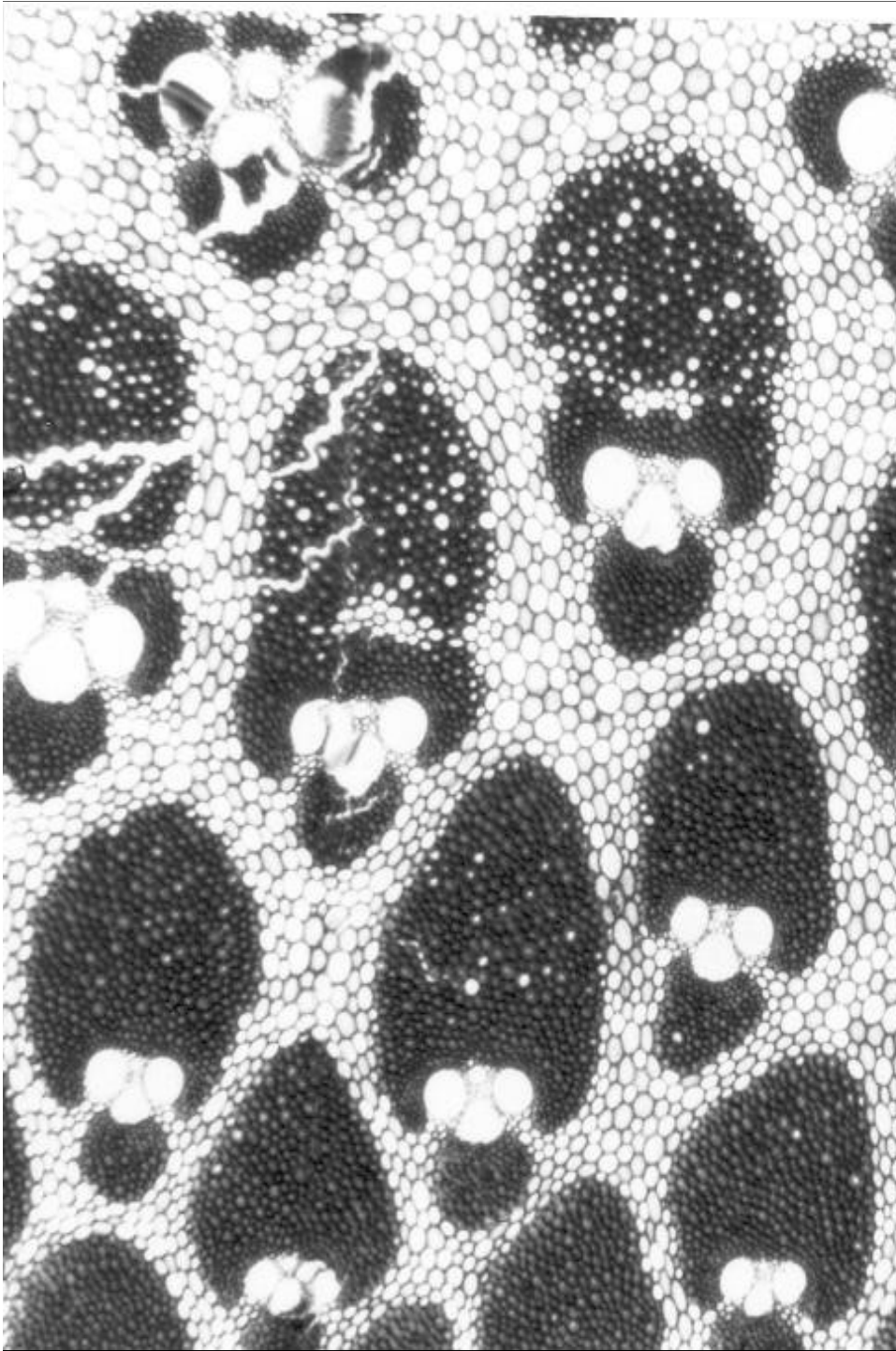
Parênquima





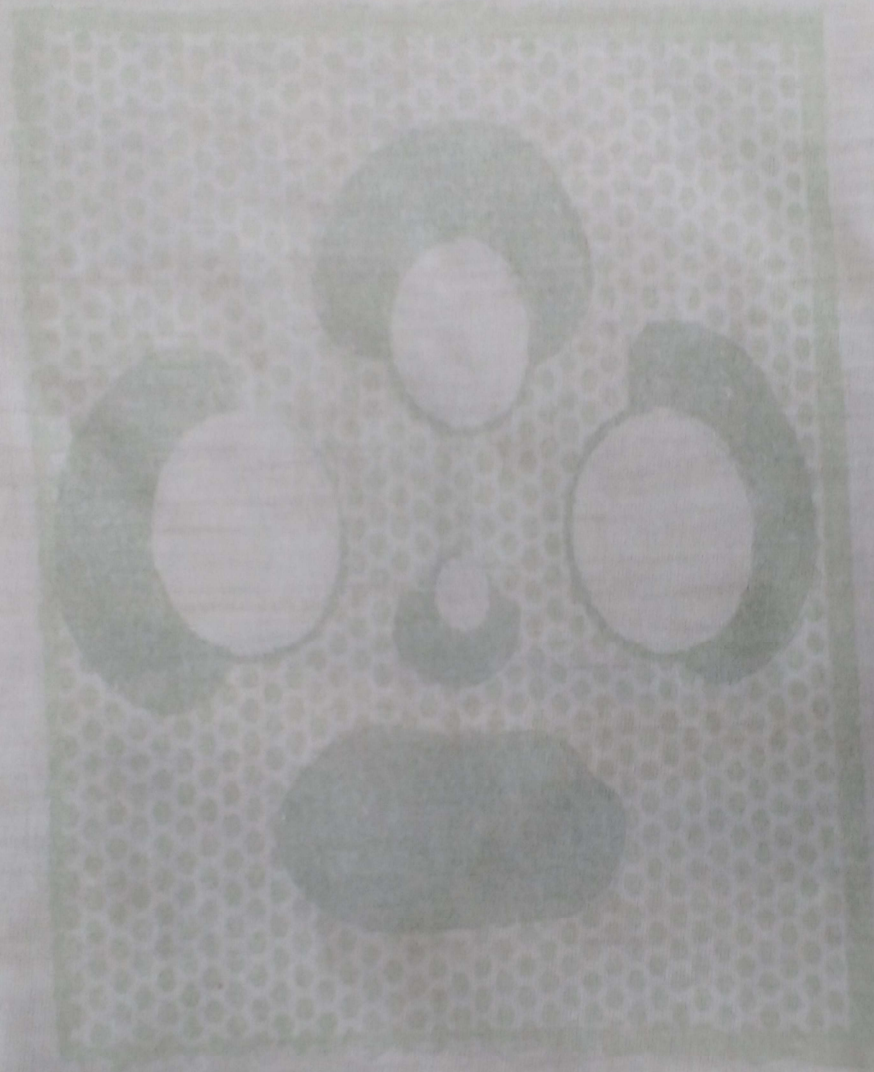




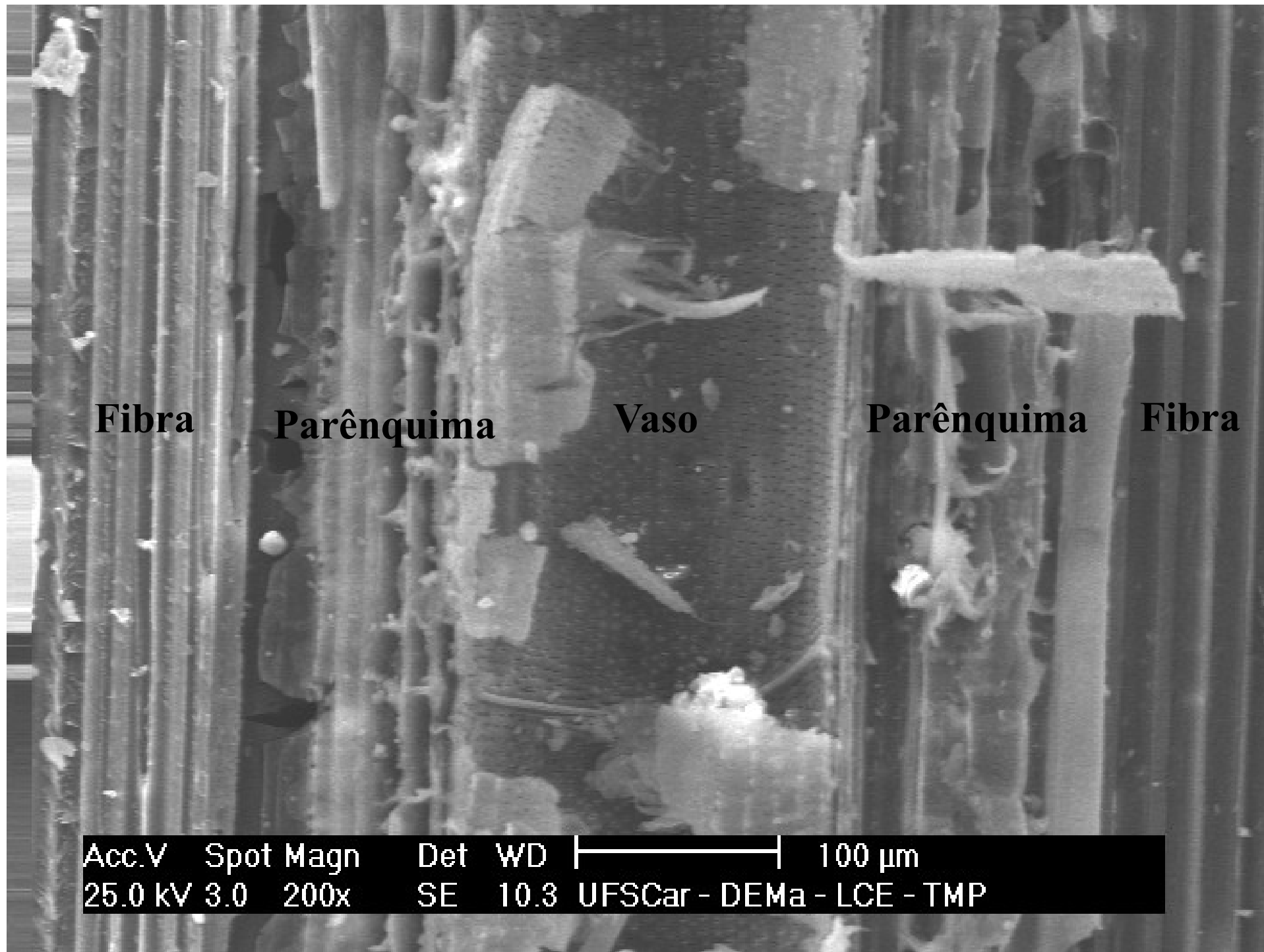








**Bambusa**vulgaris



Fibra

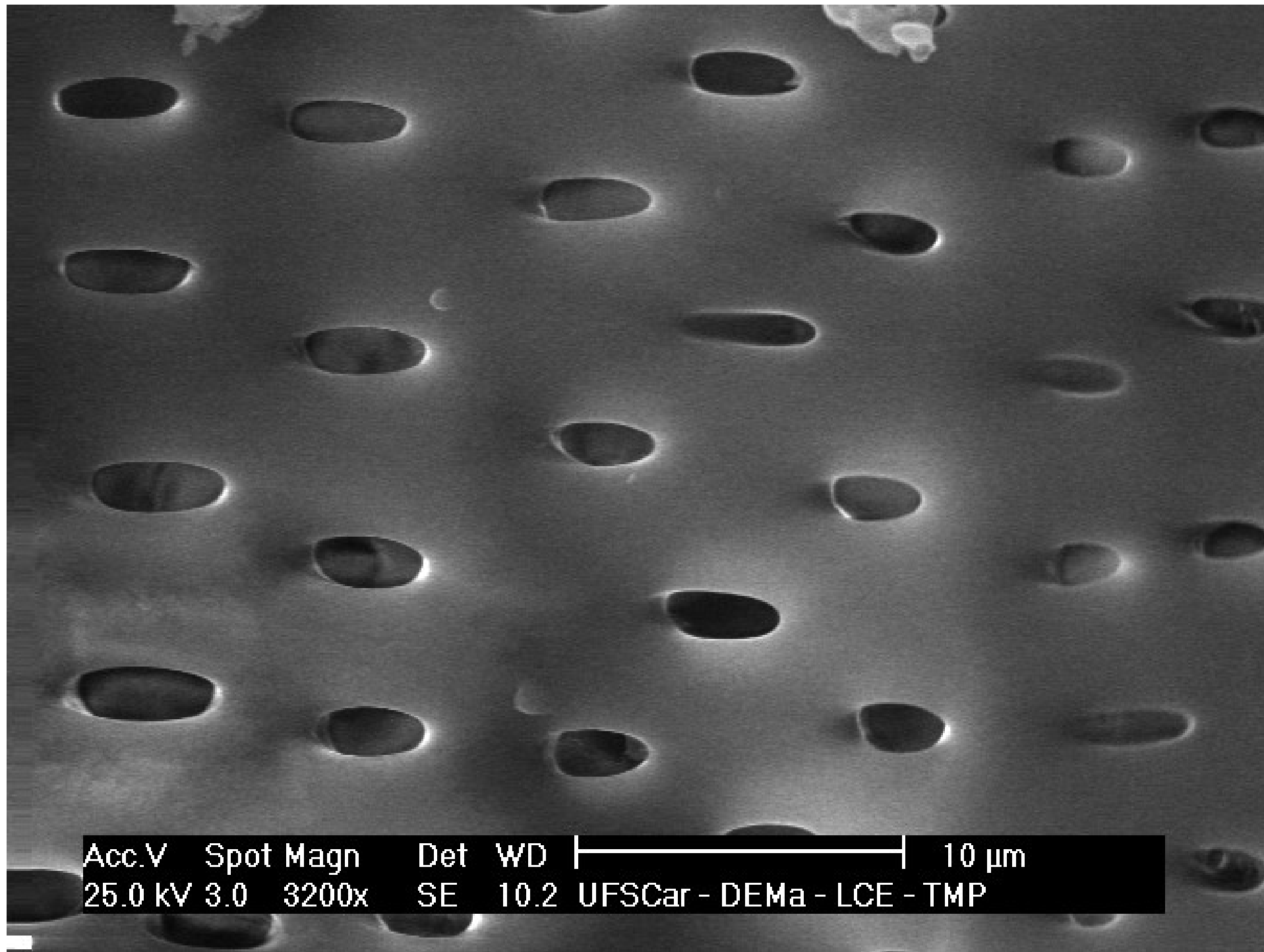
Parênquima

Vaso

Parênquima

Fibra

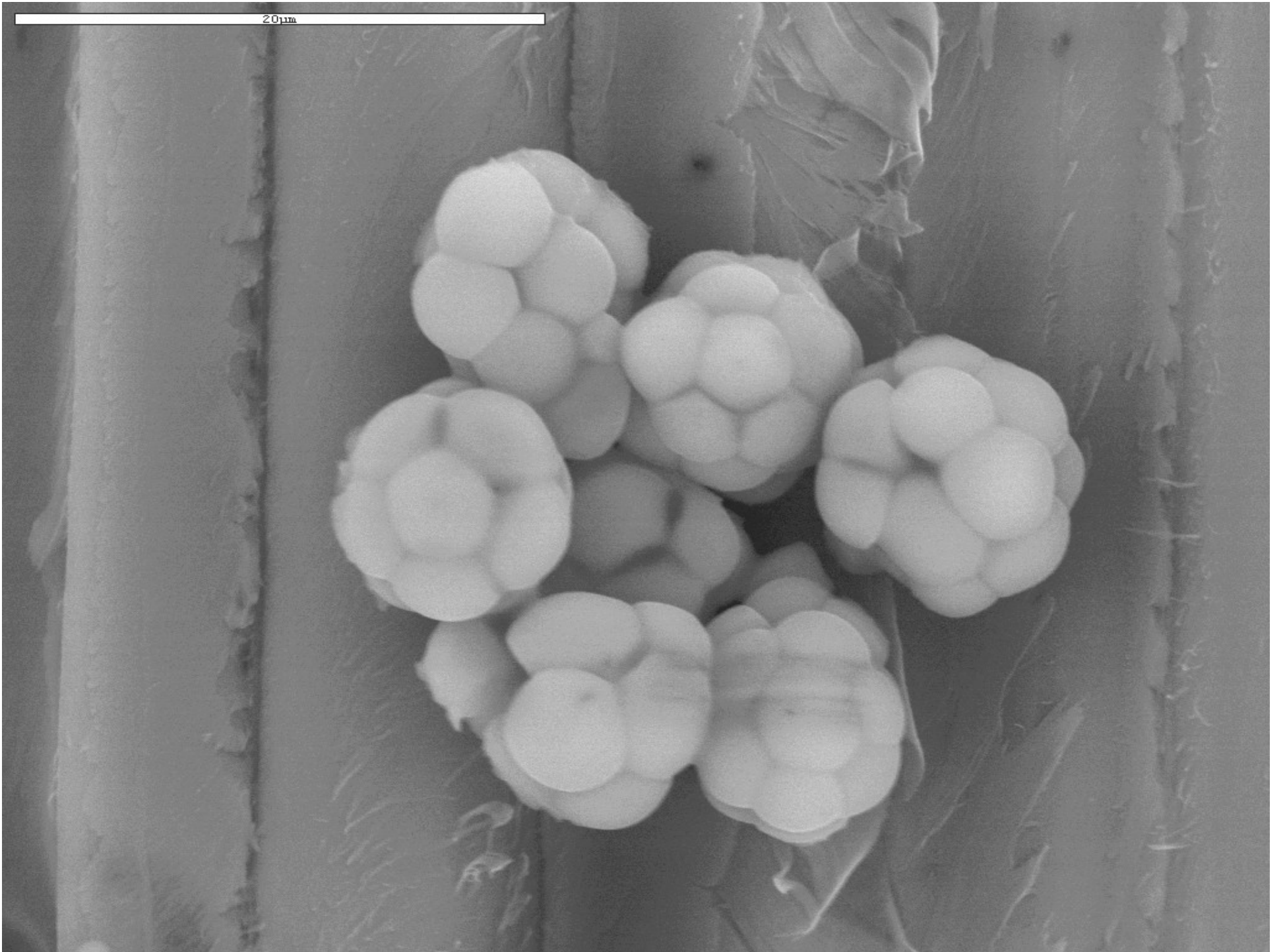
Acc.V 25.0 kV Spot 3.0 Magn 200x Det SE WD 10.3 100 μm  
UFSCar - DEMa - LCE - TMP



Acc.V	Spot	Magn	Det	WD	10 μm
25.0 kV	3.0	3200x	SE	10.2	UFSCar - DEMa - LCE - TMP

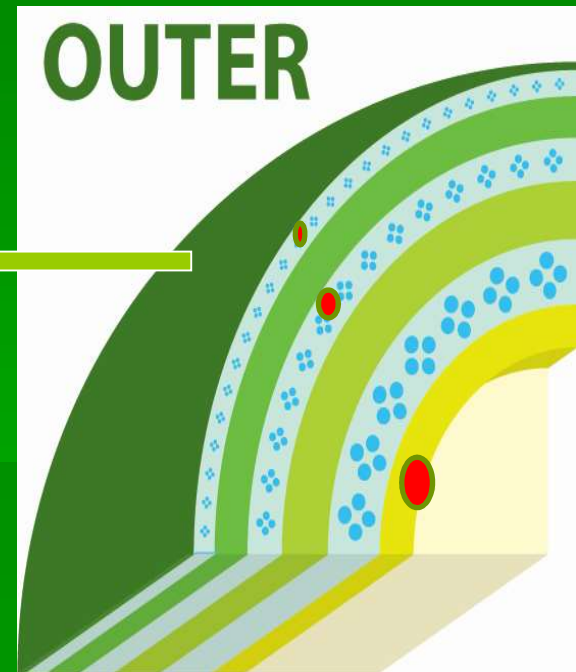
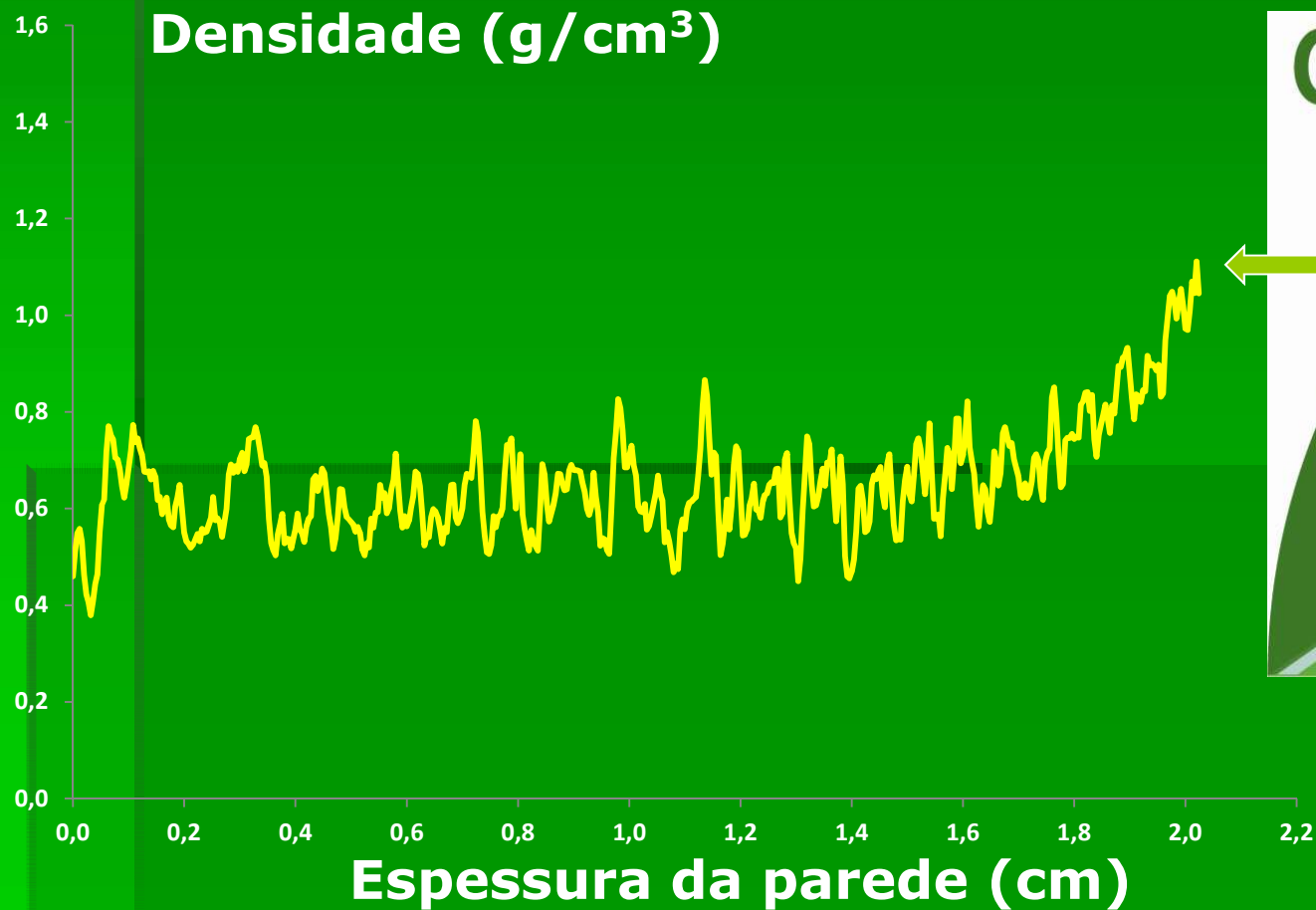


20µm



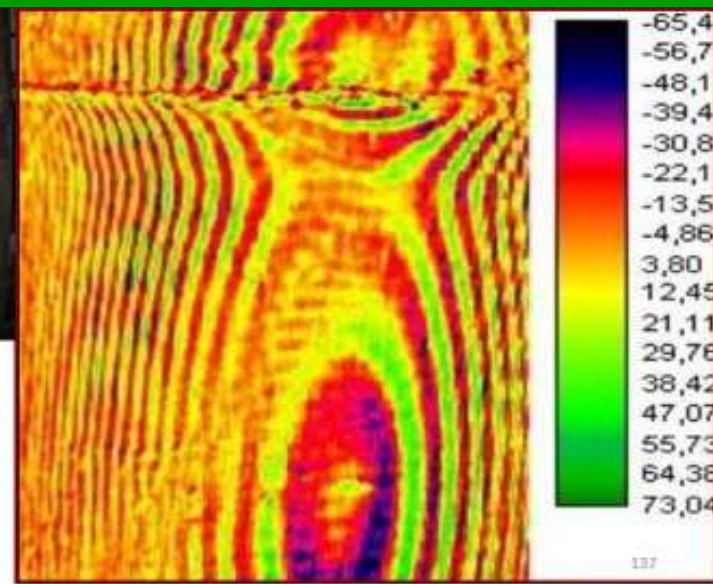
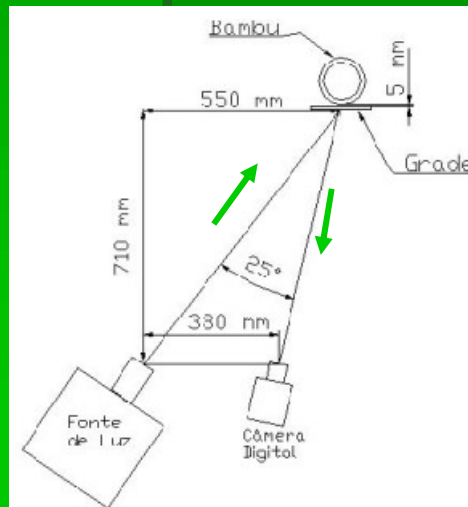
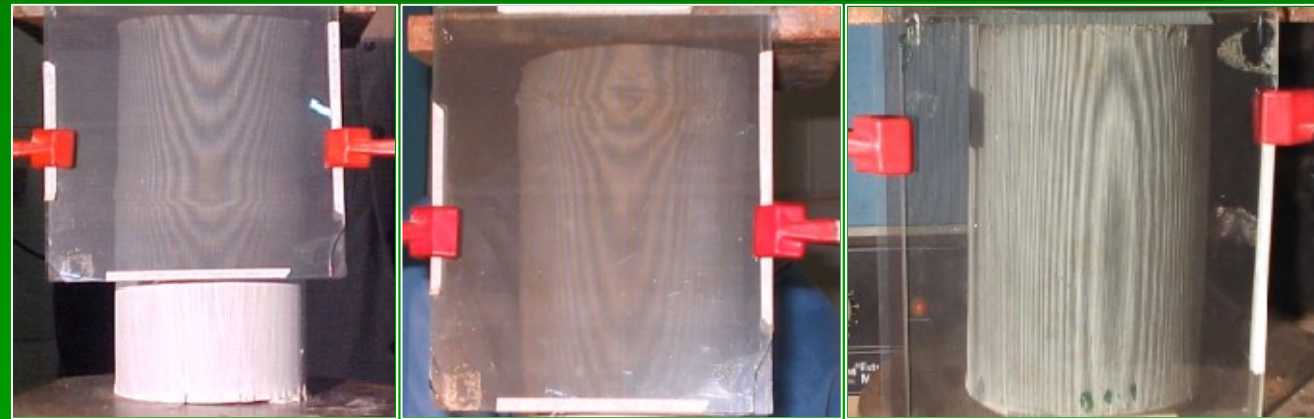
# Mario Tomazello Filho

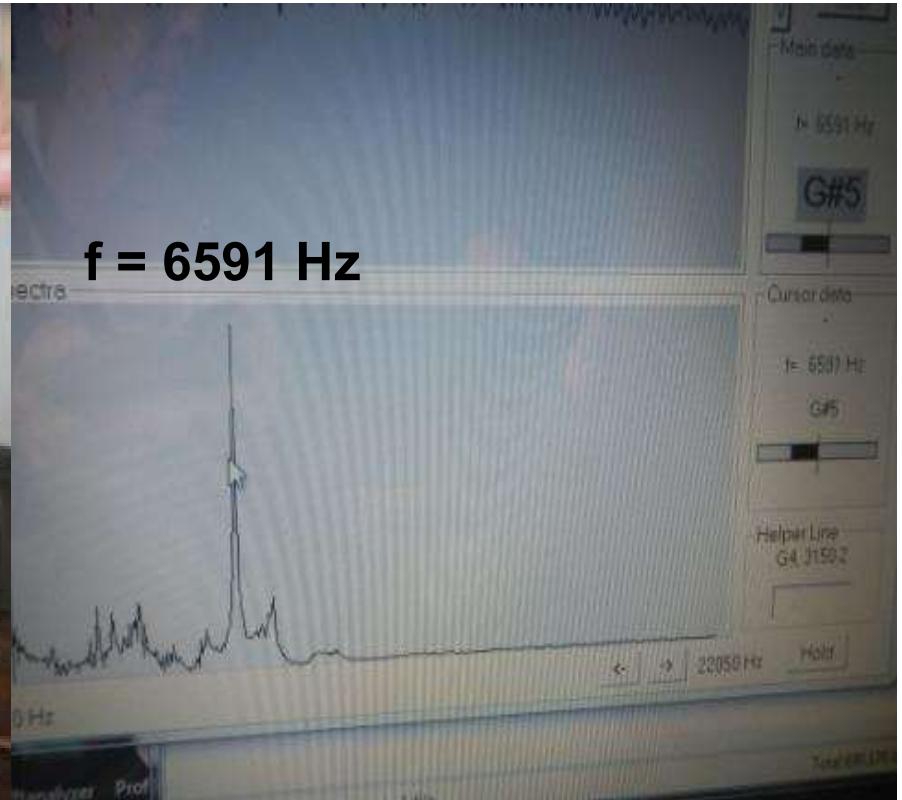
## ESALQ – Piracicaba - SP



# Técnica de Moiré aplicada al análisis de tensiones en compresión en el bambú Guadua

Beraldo, Dal Fabbro, Albiero, Rodrigues





$$L = 0,367 \text{ m}$$

$$v = 2 \cdot f \cdot L \rightarrow$$

$$v = 4833 \text{ m/s}$$

$$d = 1021 \text{ kg/m}^3$$

$$E_d = d \cdot (v^2) \rightarrow E_d = 24 \text{ GPa}$$

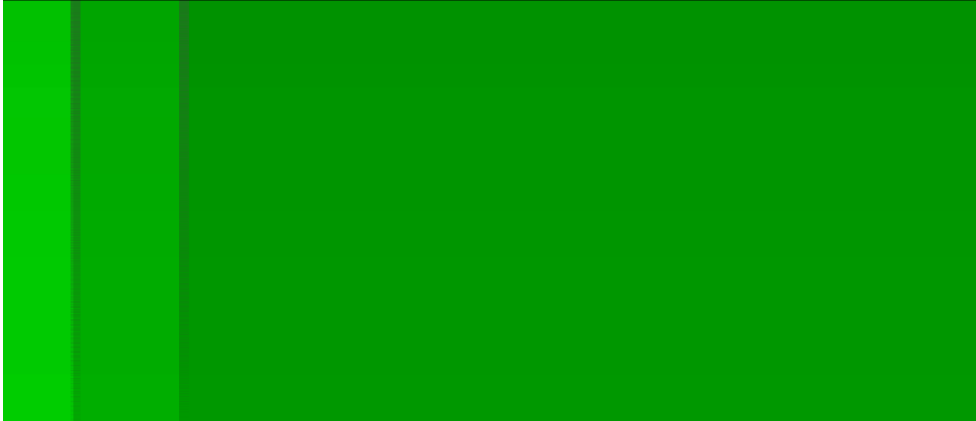
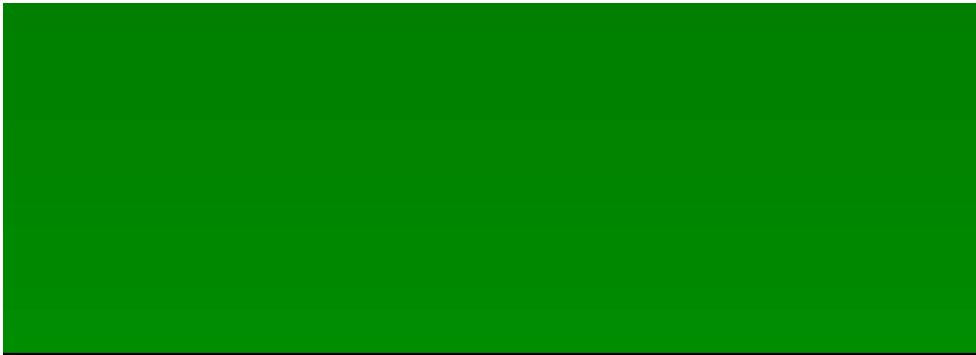


**Diâmetro = 180 mm**



**Carga suportada?**



















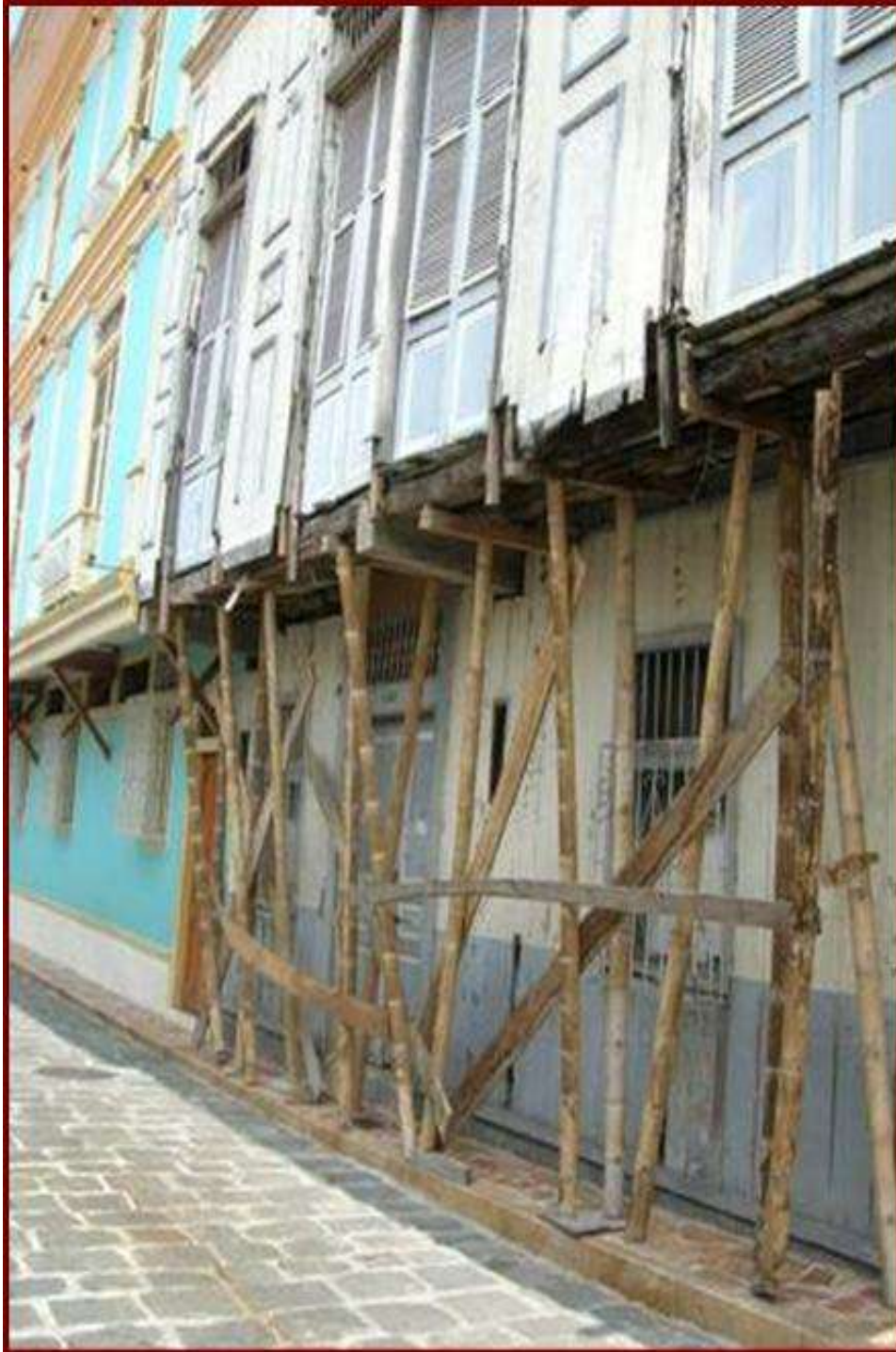


**Madeira dos pobres**



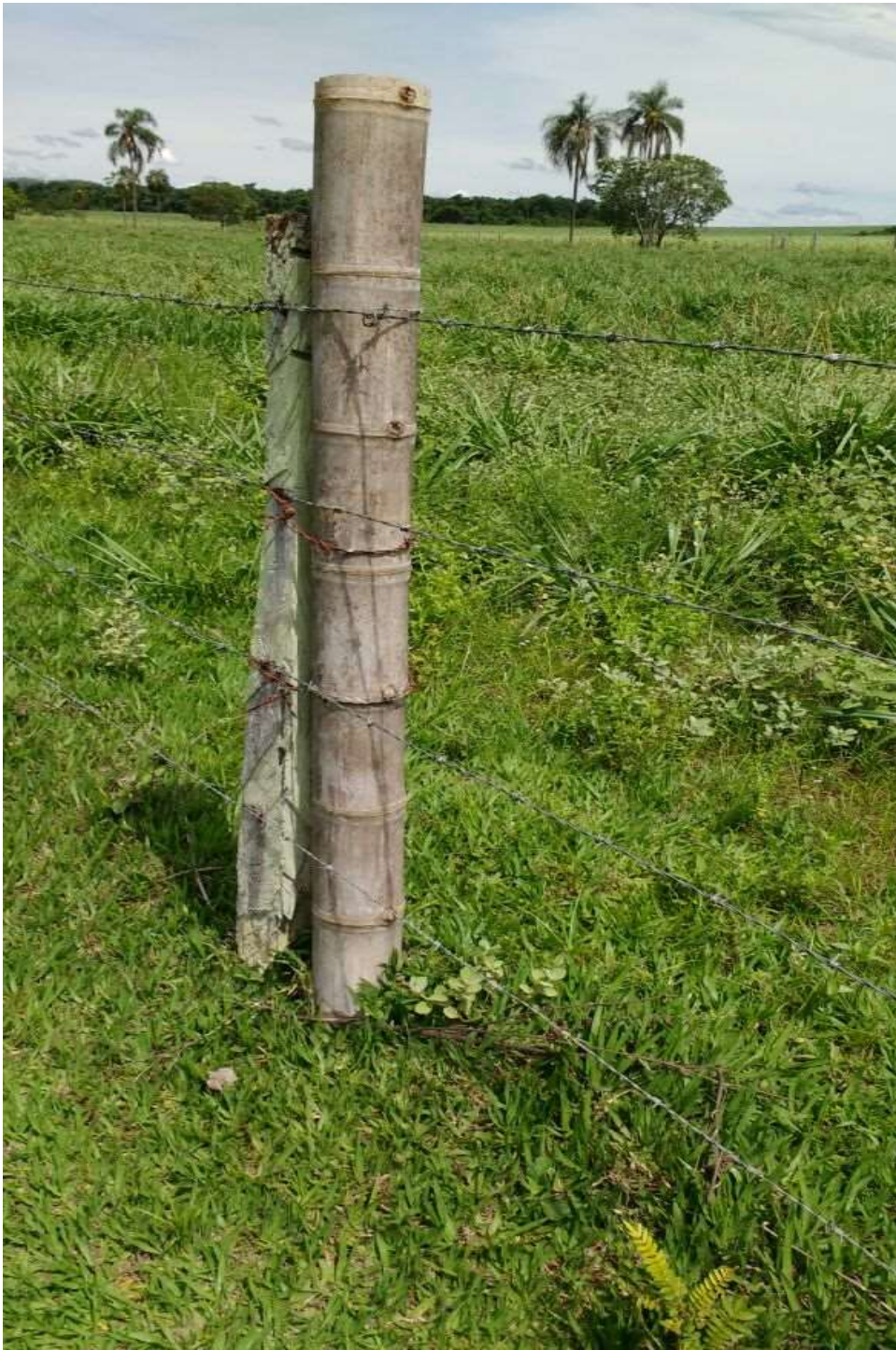














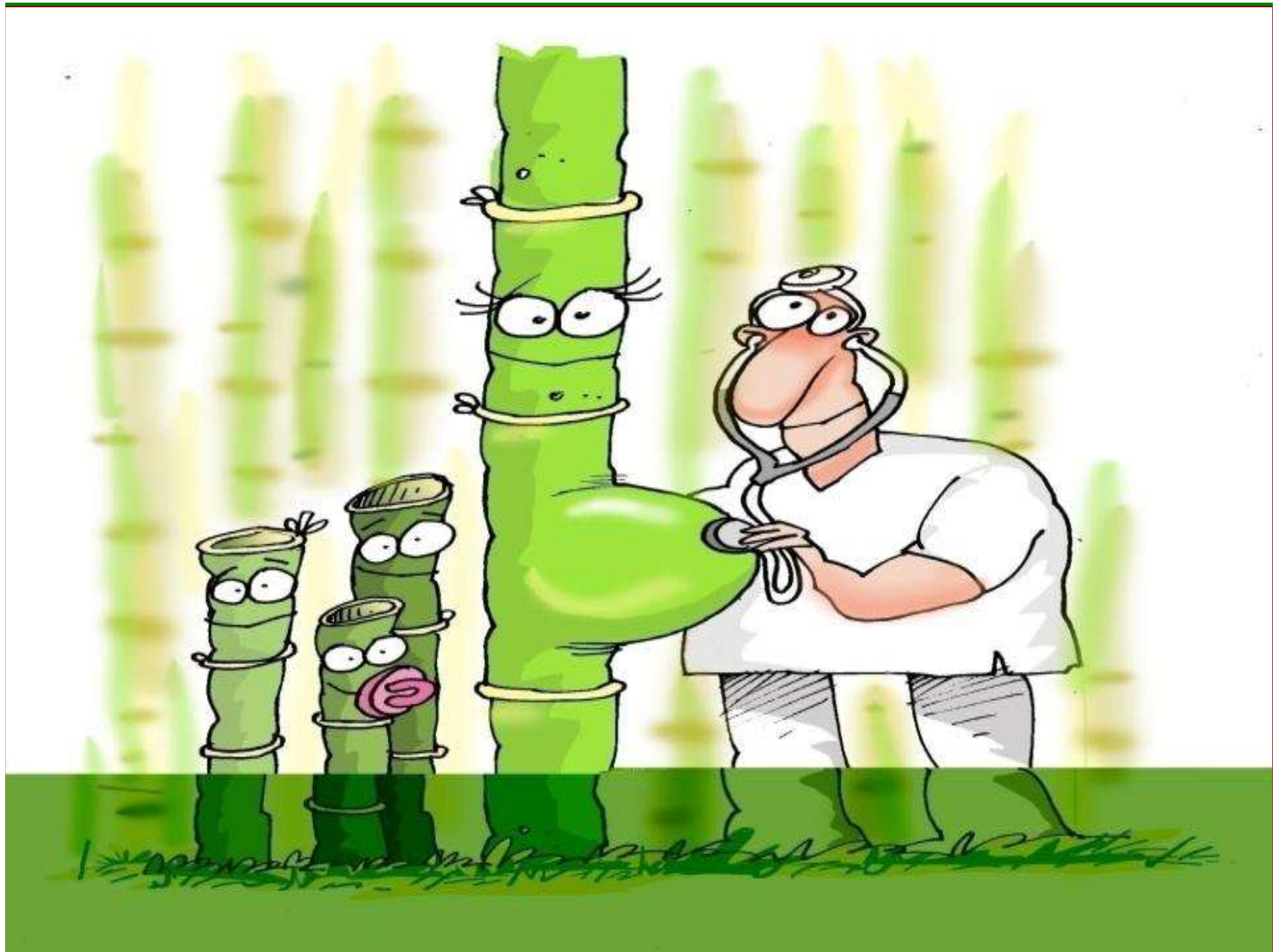


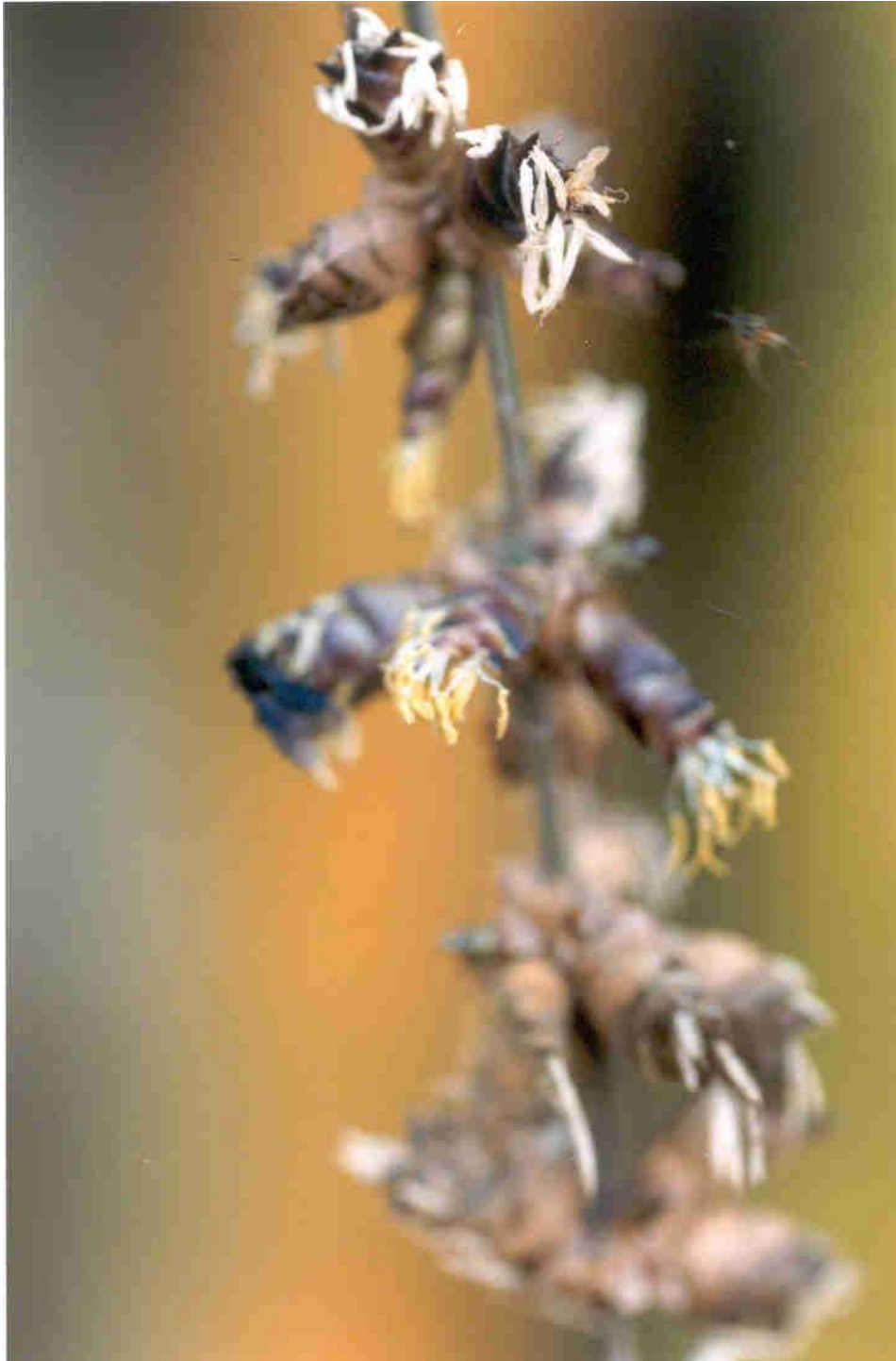


2006



2013







F. Iguaçú  
2008



J. Reis































**Renzo Piano - Itália**

**RWTH Aachen - Alemanha**

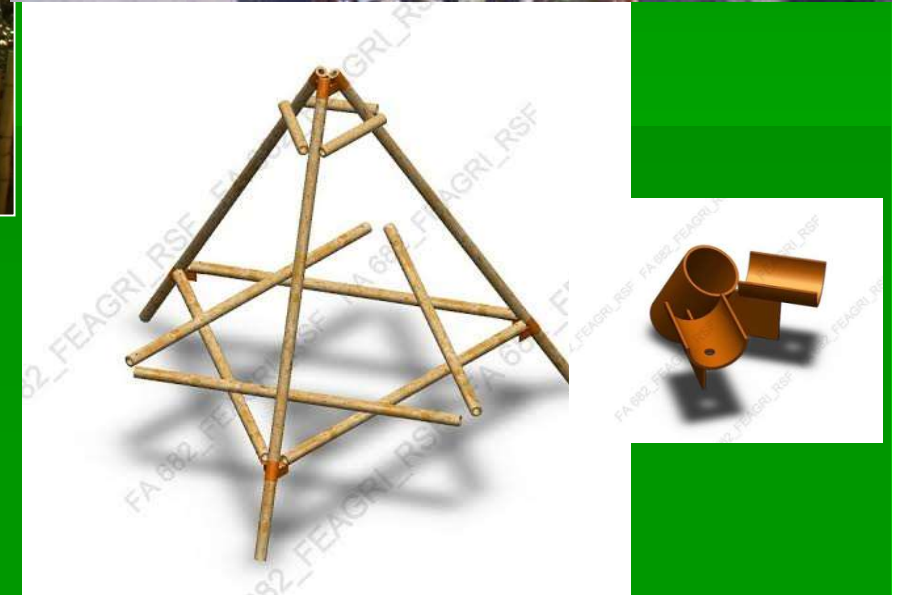


# Integral Bambu Brasília - DF

# Unicamp



**Rodrigo Primavera  
Florianópolis - SC**

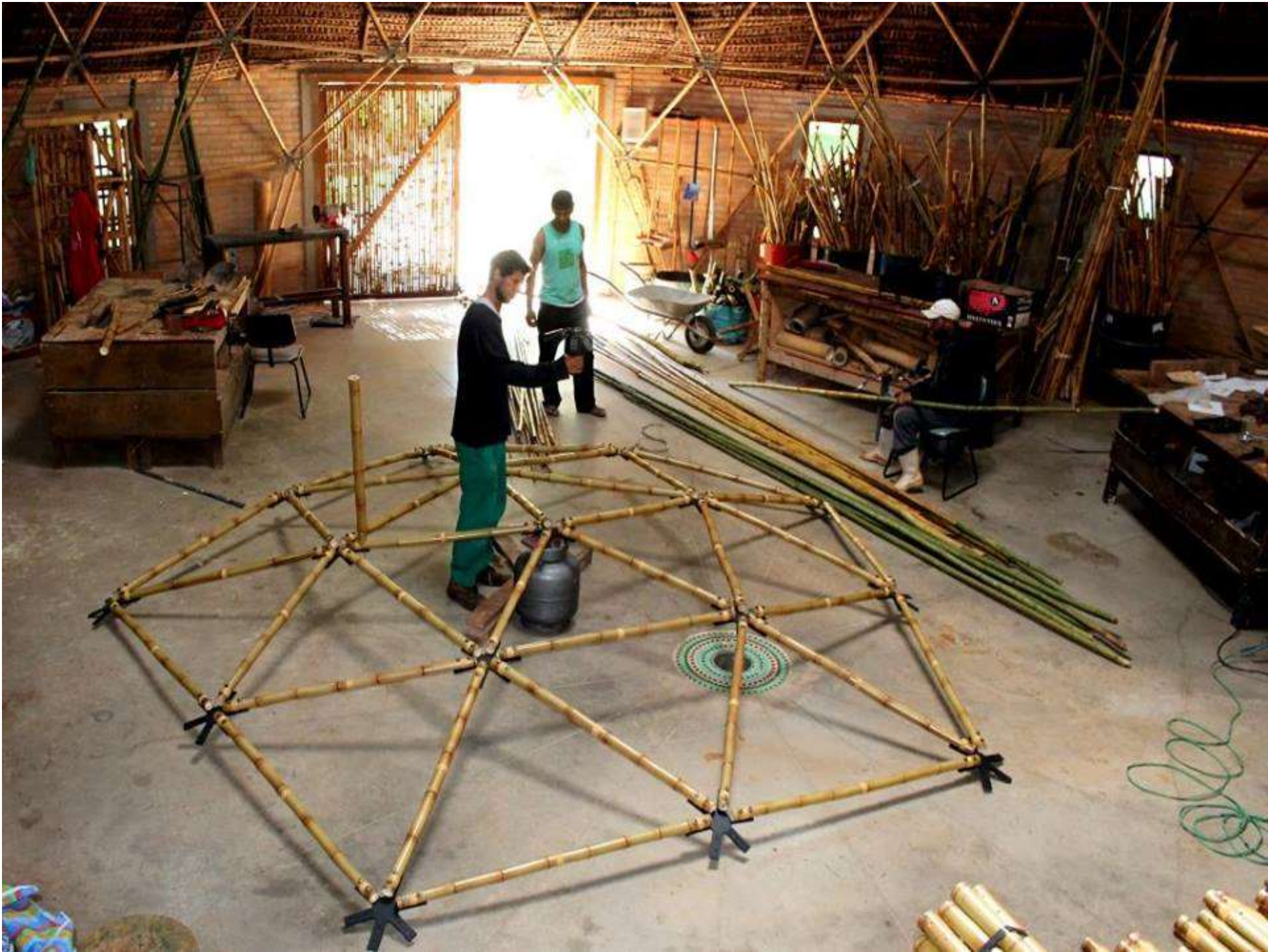




**Carbono Zero**

**MADE WITH WATERMARK MAKER**















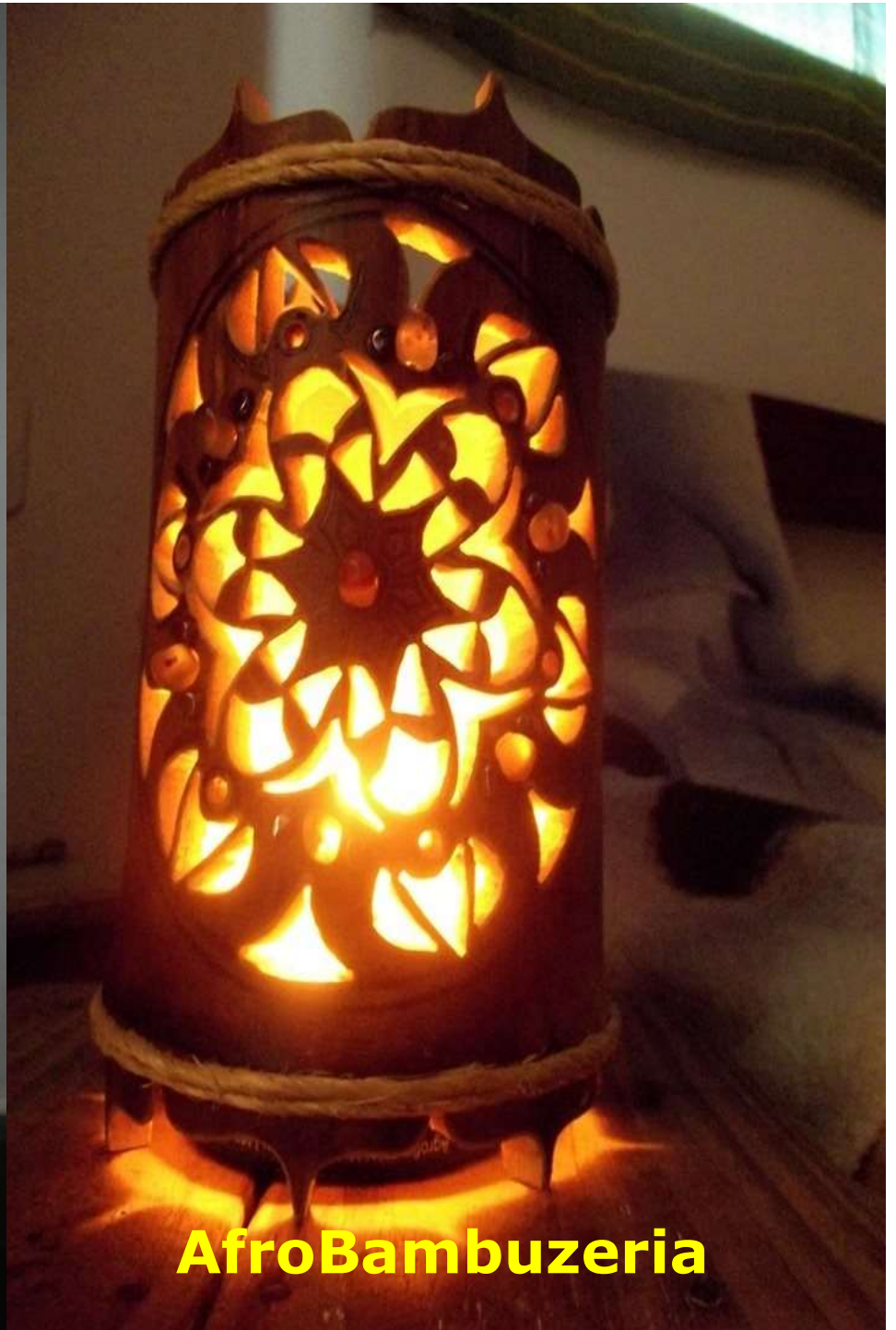




**Domebambu**



**F. Olliani**



**AfroBambuzeria**



# Bambudega











# Leiko Motomura

## Pardinho - SP



**T. Barata & M. Pereira**  
**UNESP – Bauru - SP**





**Nivaldo Feliciano**



**Nivaldo Feliciano**









J. Stamm - Cali





N. Feliciano



J. Nunes - Bamburevest - Bertioga - SP

## Bambu e PVA















San José – Costa Rica





**Haroldo Martins – Campinas - SP**



Flat folder



# Haroldo Martins Campinas - SP





**CANETAS  
ARTESANAIS**

*Haroldo Martins*

E-mail: [haroldo.martins@yahoo.com.br](mailto:haroldo.martins@yahoo.com.br)  
F.: (19) 3308-7551  
Ministramos aulas de torno artistico em madeira









2

1









By  
P. Foggiano





# BaLC – Bambu Laminado Colado



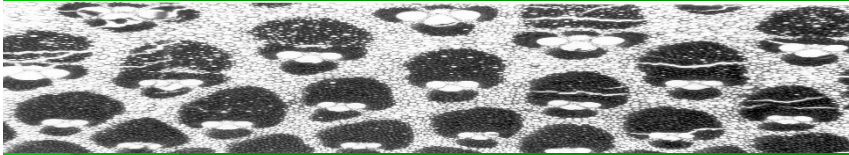
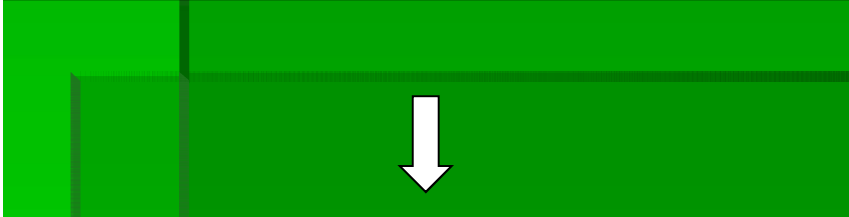
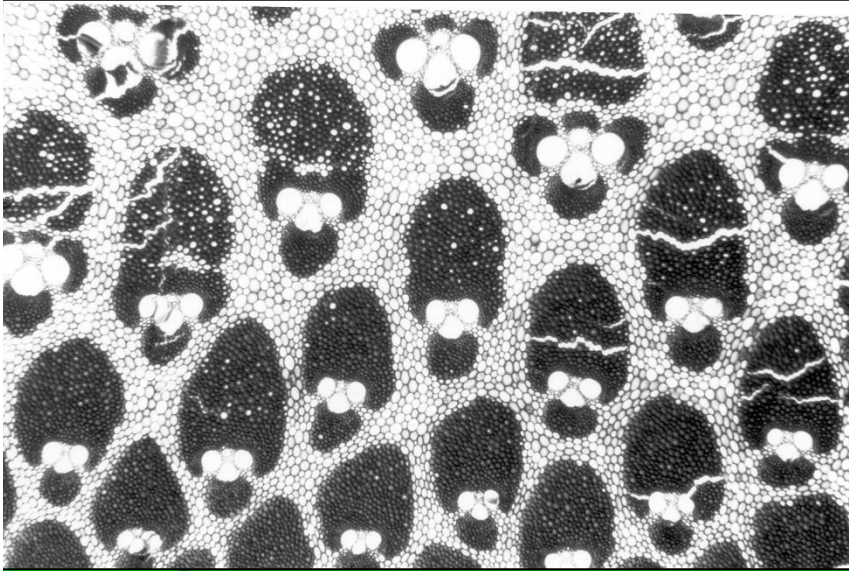
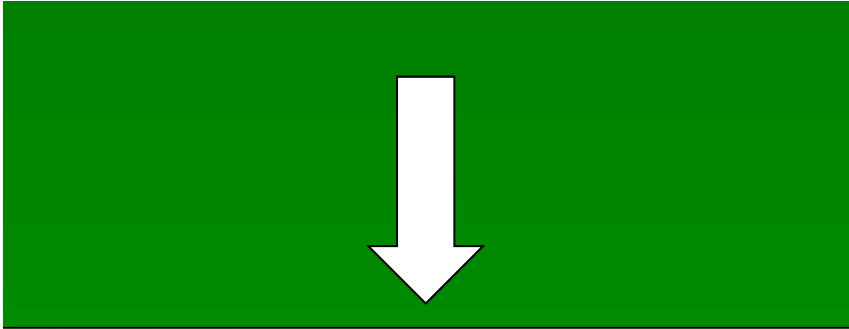




J. Stamm



Aeropuerto Barajas - Madrid



Adesivo Poliuretano à base de óleo de mamona  
(*Ricinus communis*)



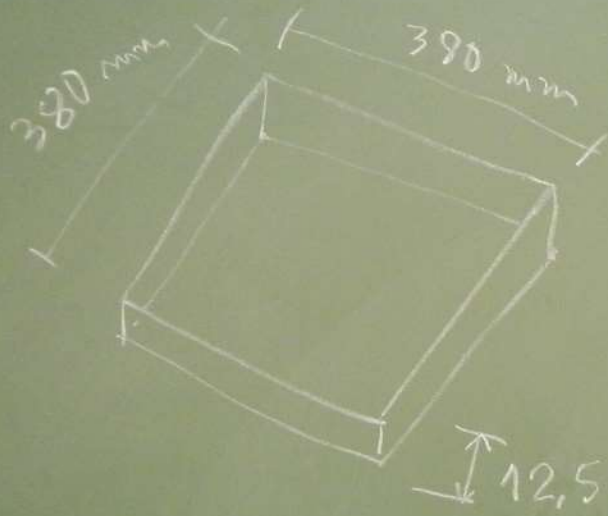












$$V = 1805 \text{ cm}^3$$

$$\rho = 700 \text{ g/cm}^3$$

$$m = 1264 \text{ g (total)}$$



$$\text{bamboo} = 1200$$

$$\text{adesivo} = 130$$

$$300/600/300$$

$$G = 3,92$$

$$M = 2,06 + 0,24$$

$$F = 5,04 + 0,84$$

$$p = 0,08$$







# Compósito Bambu e Polímero – CBP Rotomoldagem













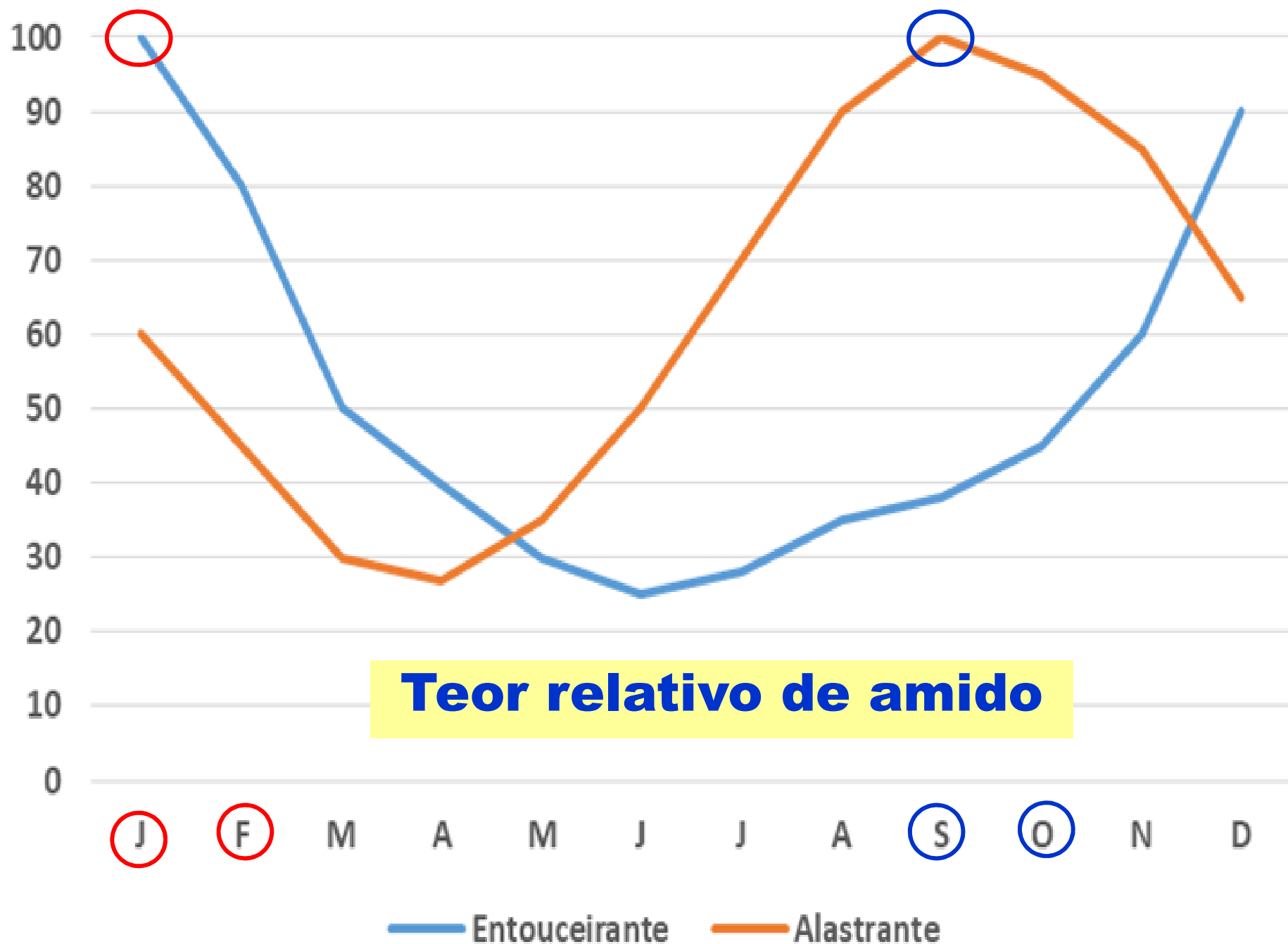




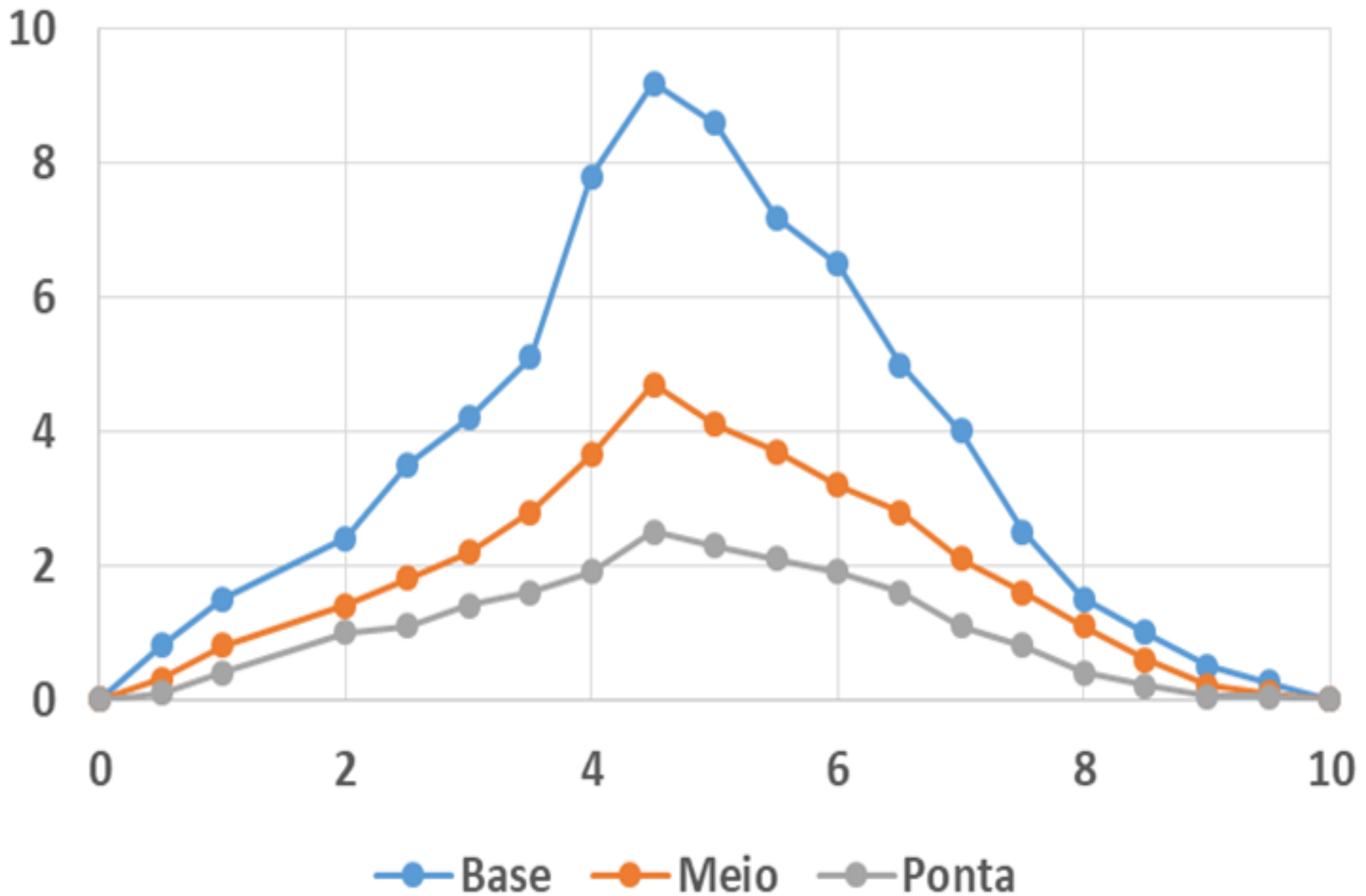


## **Fatores que interferem na eficiência do tratamento**

- . Espécie de bambu**
- . Época do corte (Paquimorfo ou Leptomorfo)**
- . Teor de umidade (seco ou verde)**
- . Idade do colmo e posição da amostra (B, M ou T)**
- . Geometria da amostra (colmo ou ripa)**
- . Conservante (tipo, concentração e método)**
- . Site (protegido ou exposto)**
- . Tipo de solo (argiloso ou arenoso)**





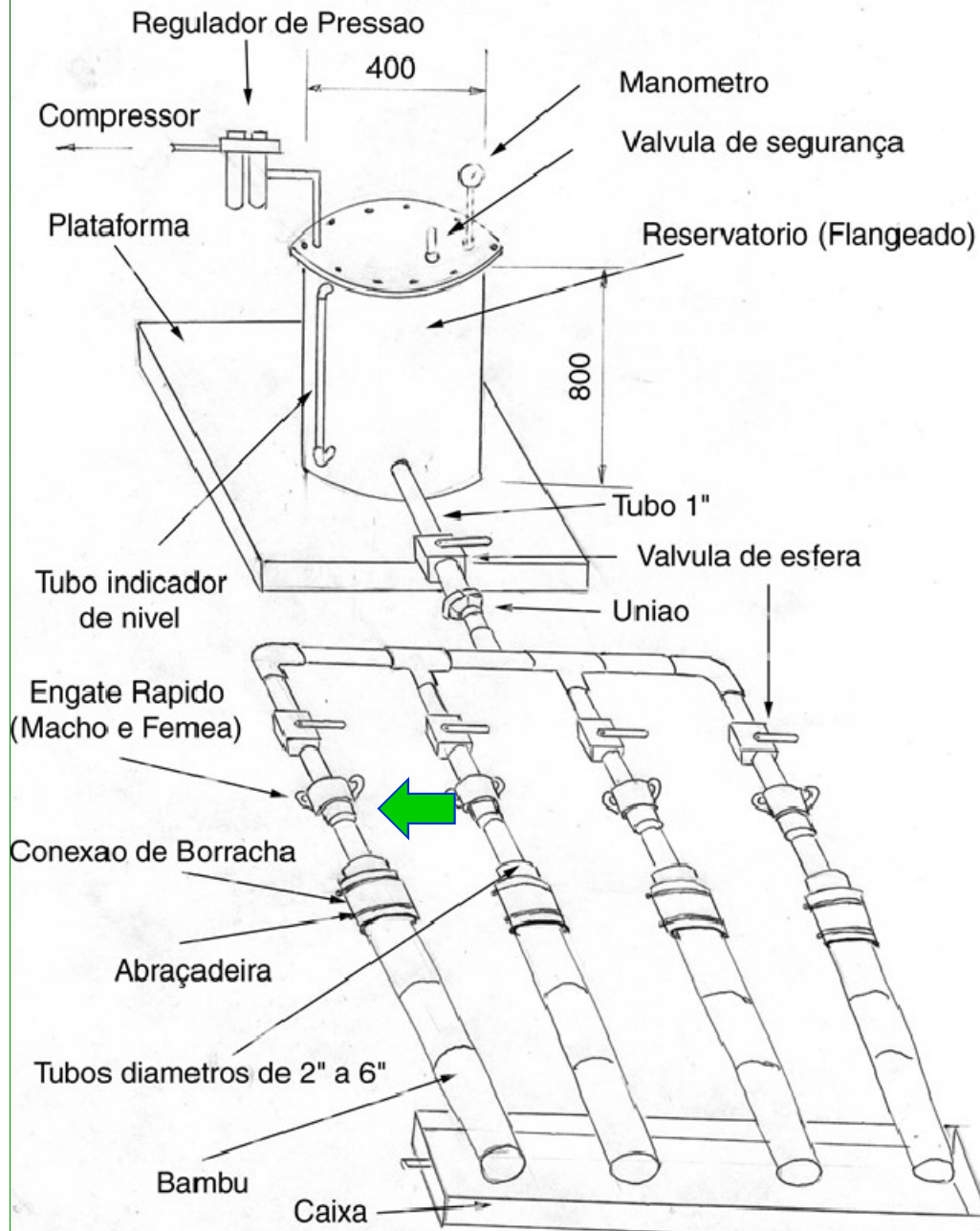


**Teor de amido (%) vs idade vs posição**





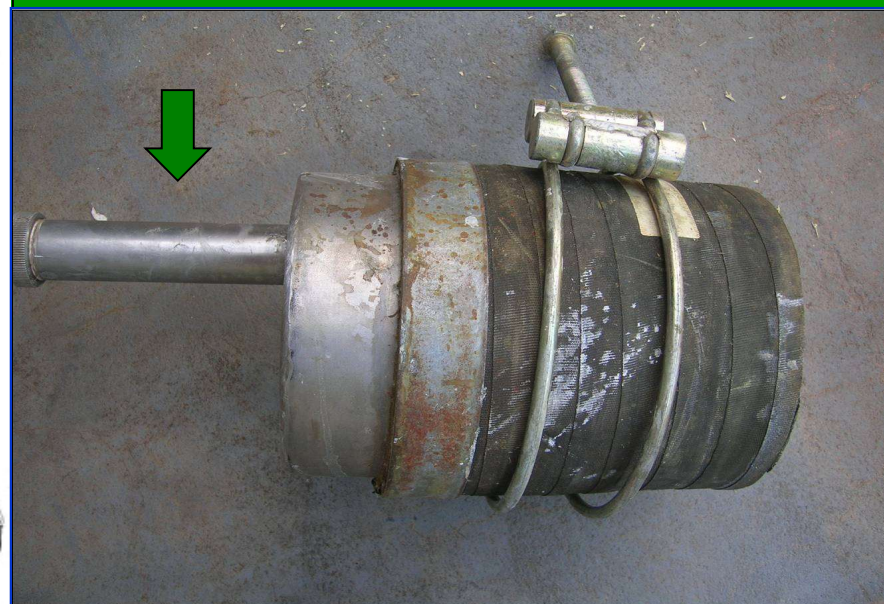
# Equipamento para tratamento químico de "Bambu"



Croqui sem escala, medidas em milímetros



Método de Boucherie Modificado sob pressão





E. Montagno











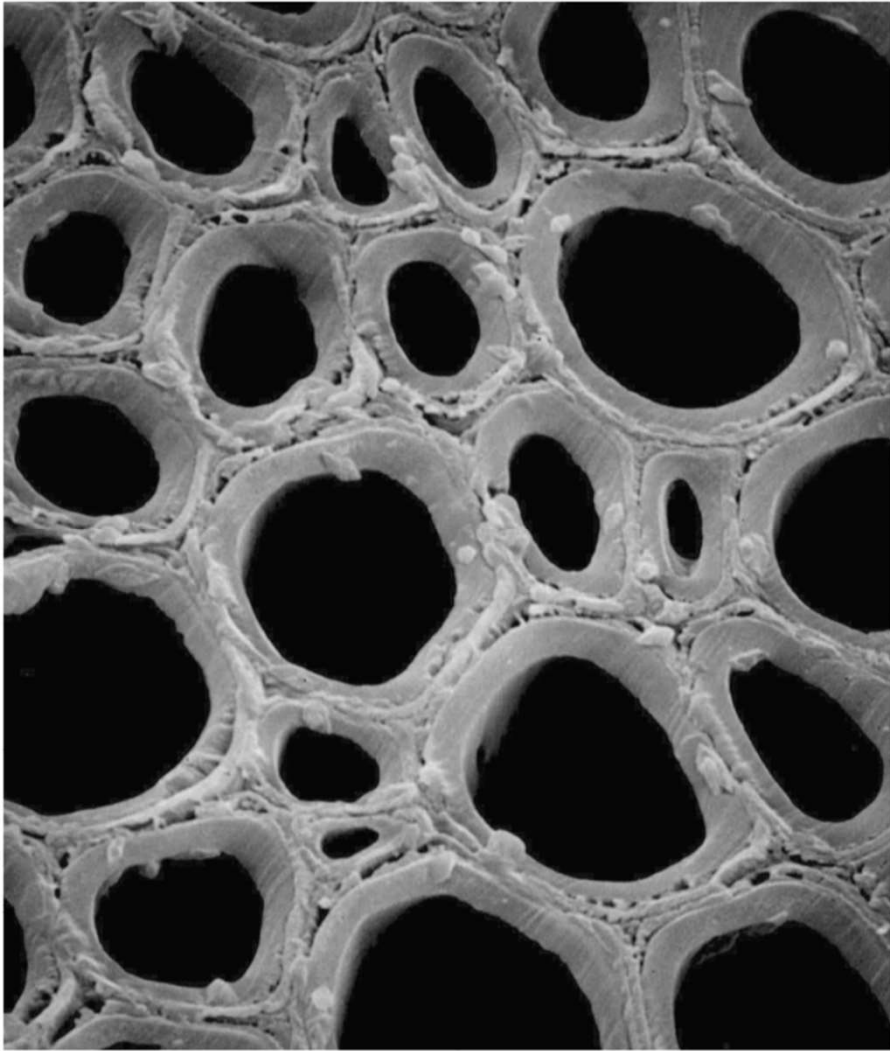
# Ensaio de Campo



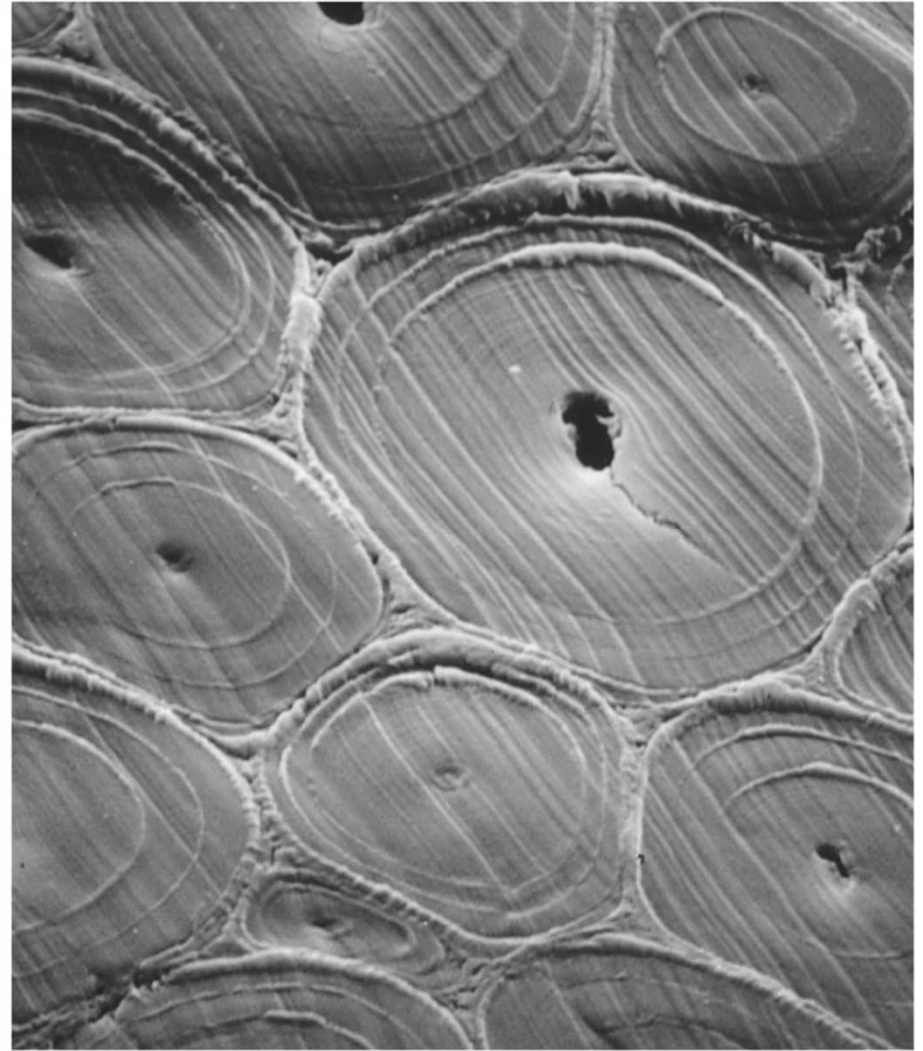
Cemitério

1 Mês

8  
Meses



1 ano



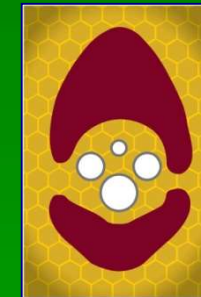
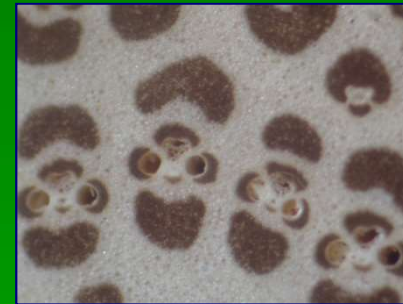
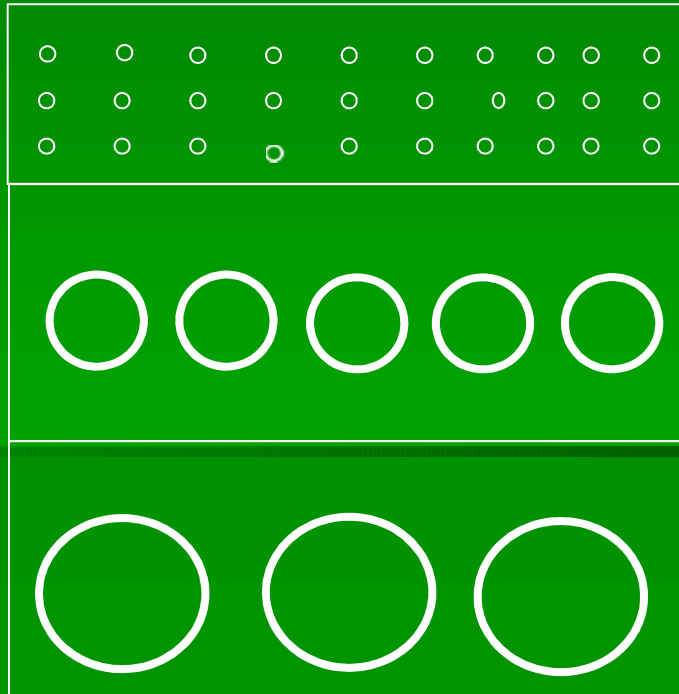
12 anos

*Phyllostachys viridiglaucescens*  
Adaptado de W. Liese

# Uma solução fluirá através de todos os elementos anatômicos?

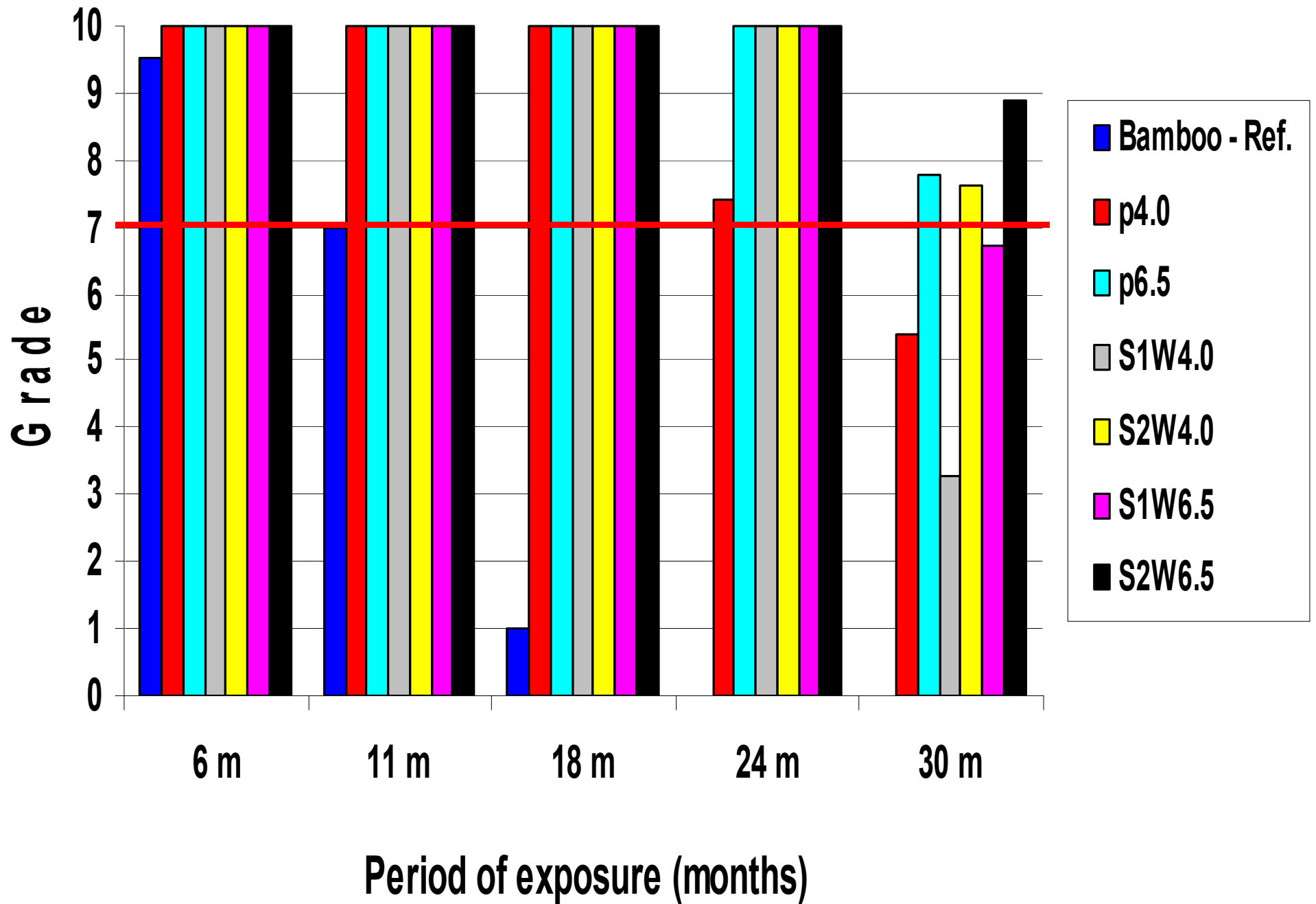
## Feixes de vasos

18 mm

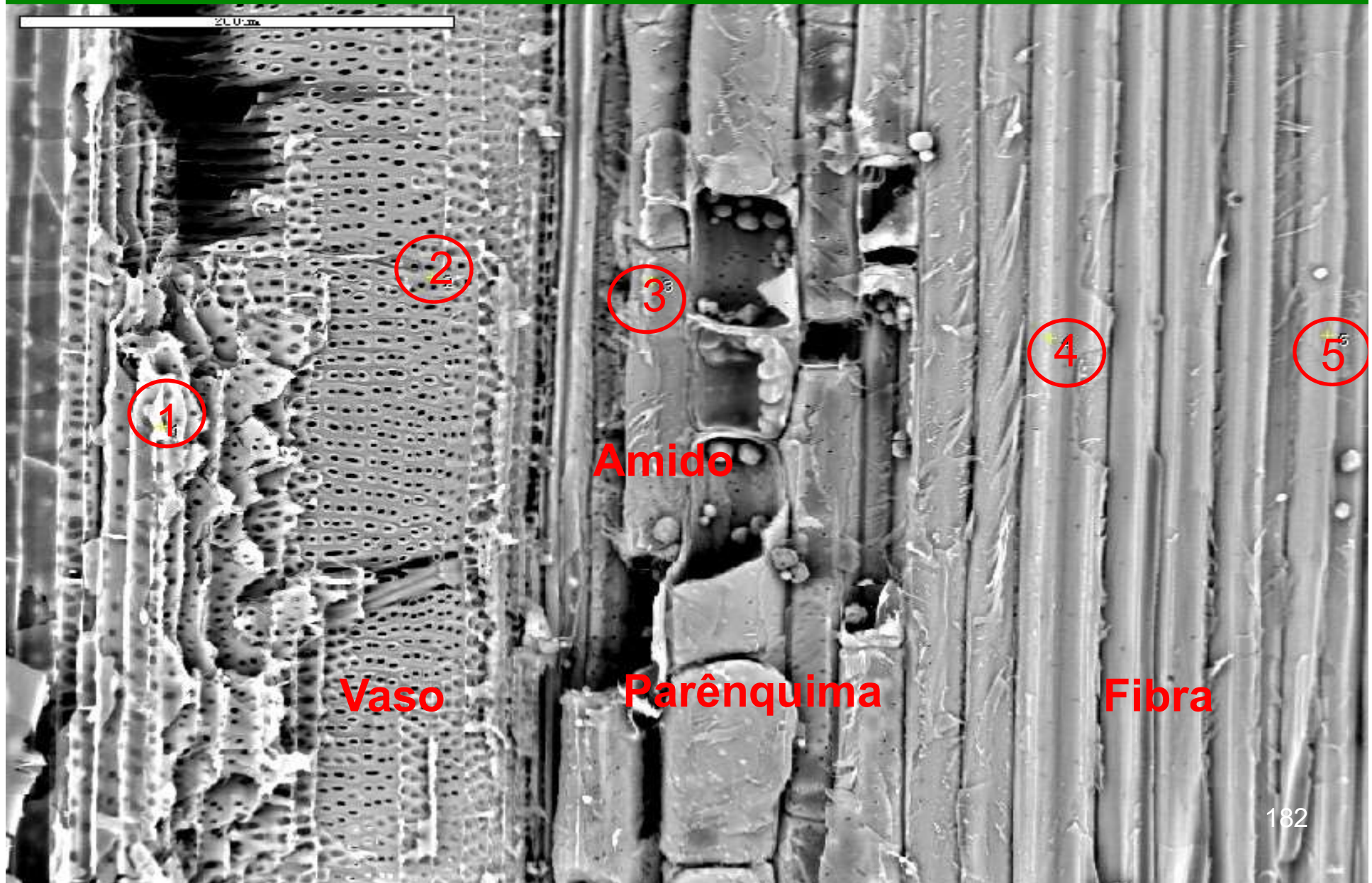


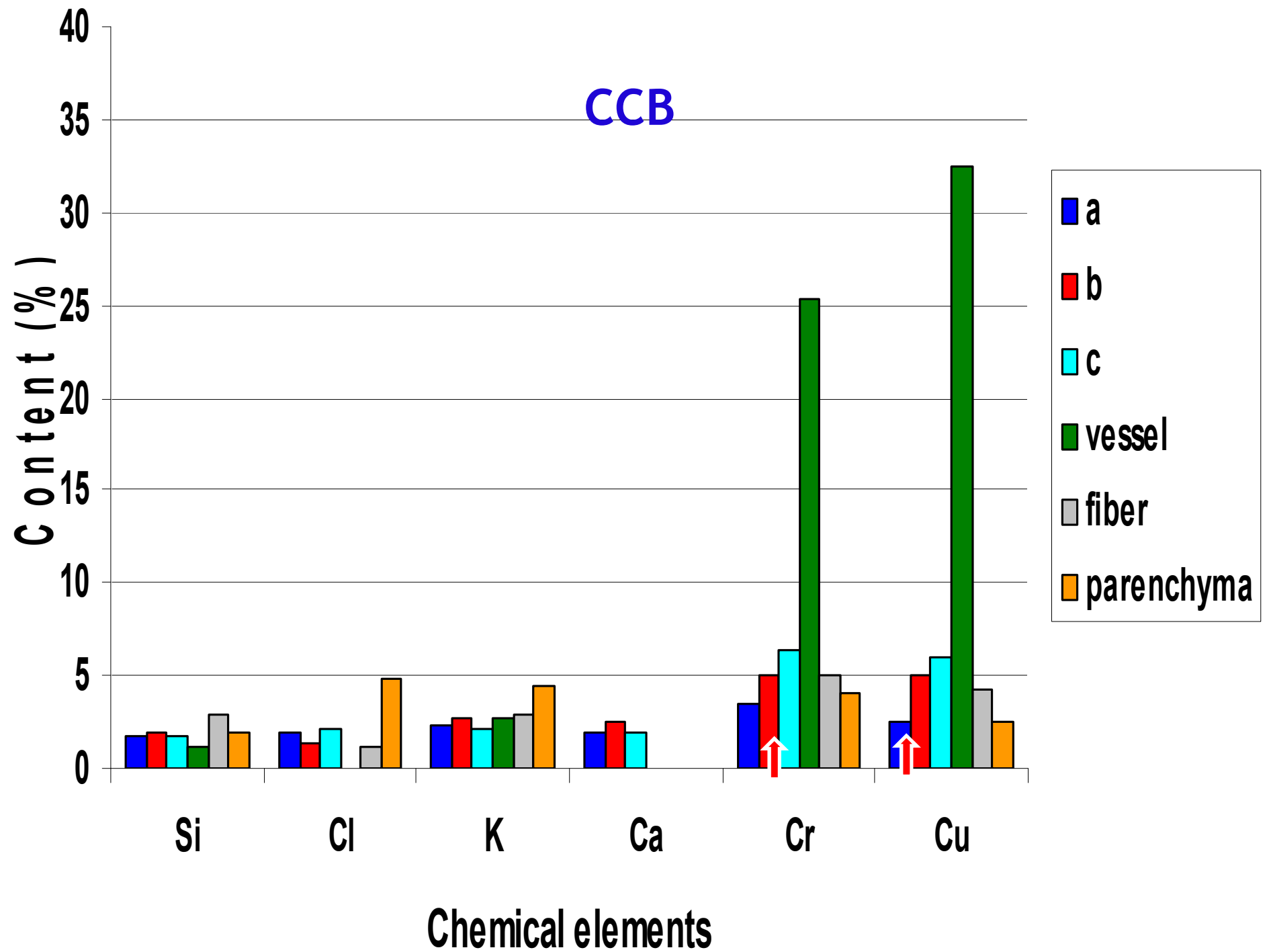
Diâmetro ( $\mu\text{m}$ )	Número
20	120
150	48
200	45

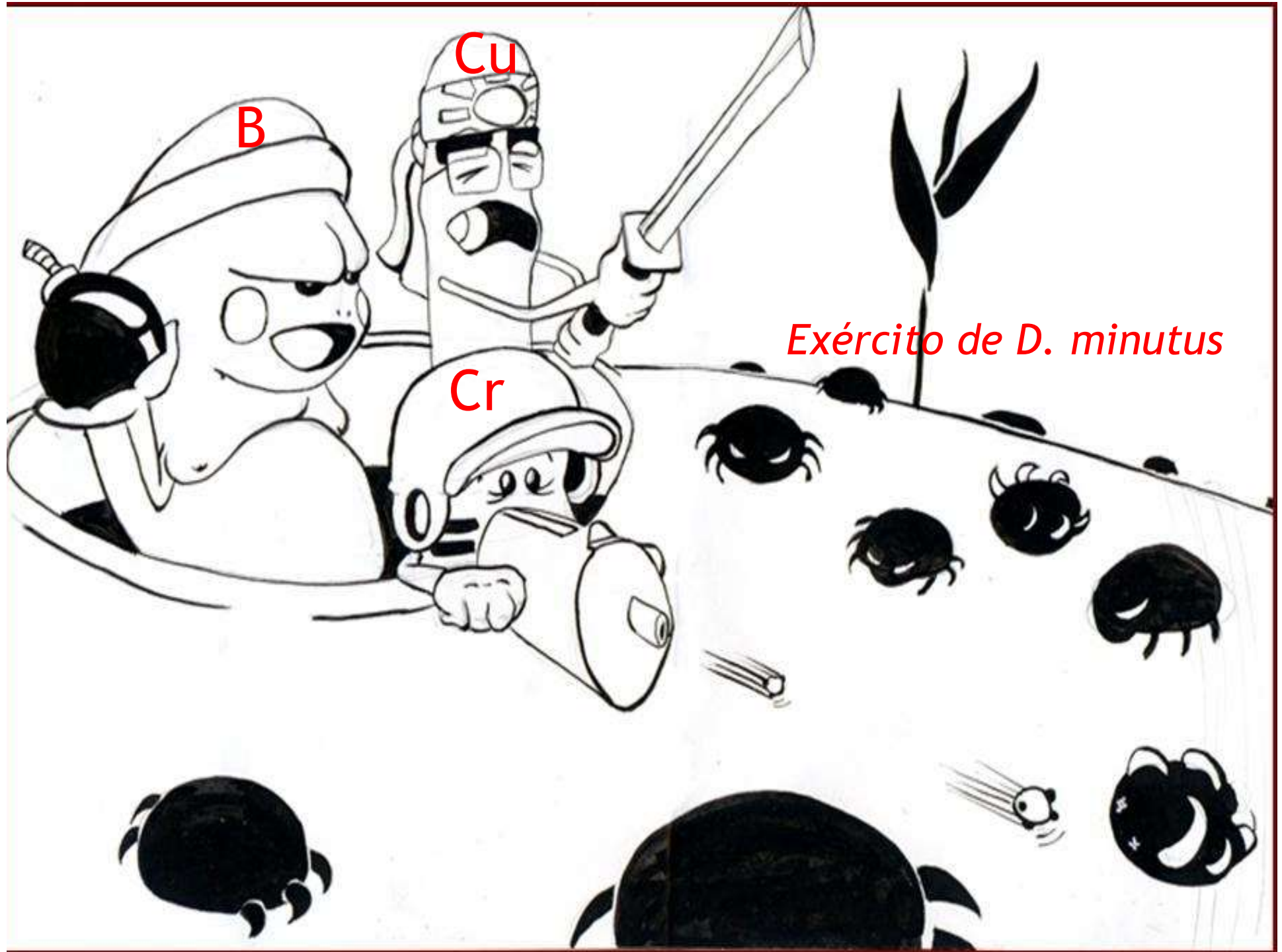
10 mm → Força de fricção  $\sim K \cdot D^{-5}$



# Rastreabilidade dos elementos químicos







B

Cu

Cr

*Exército de D. minutus*

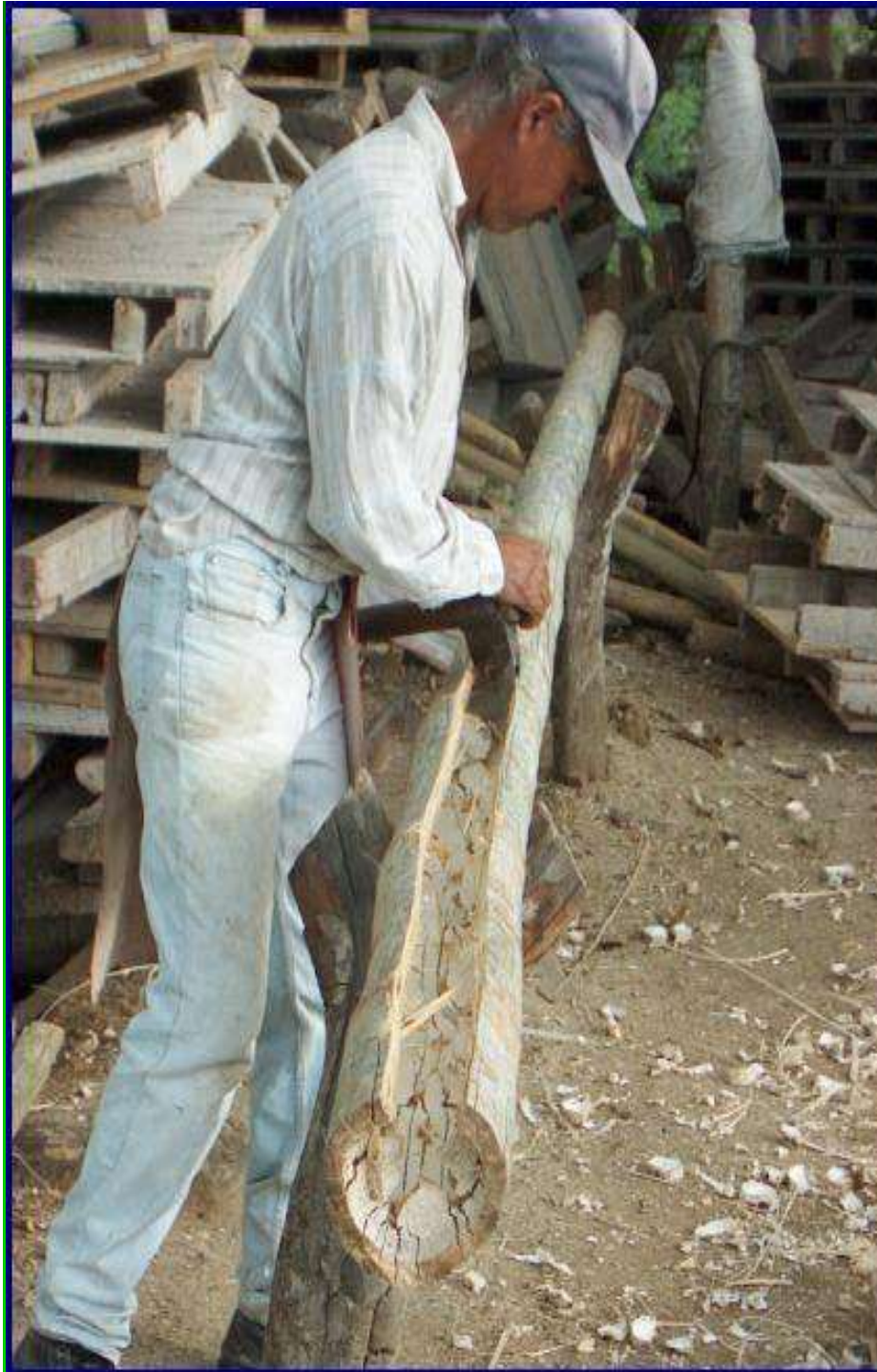




**J. Stamm**



Hogar de Cristo  
Más que una casa, un hogar



































1999



2016





































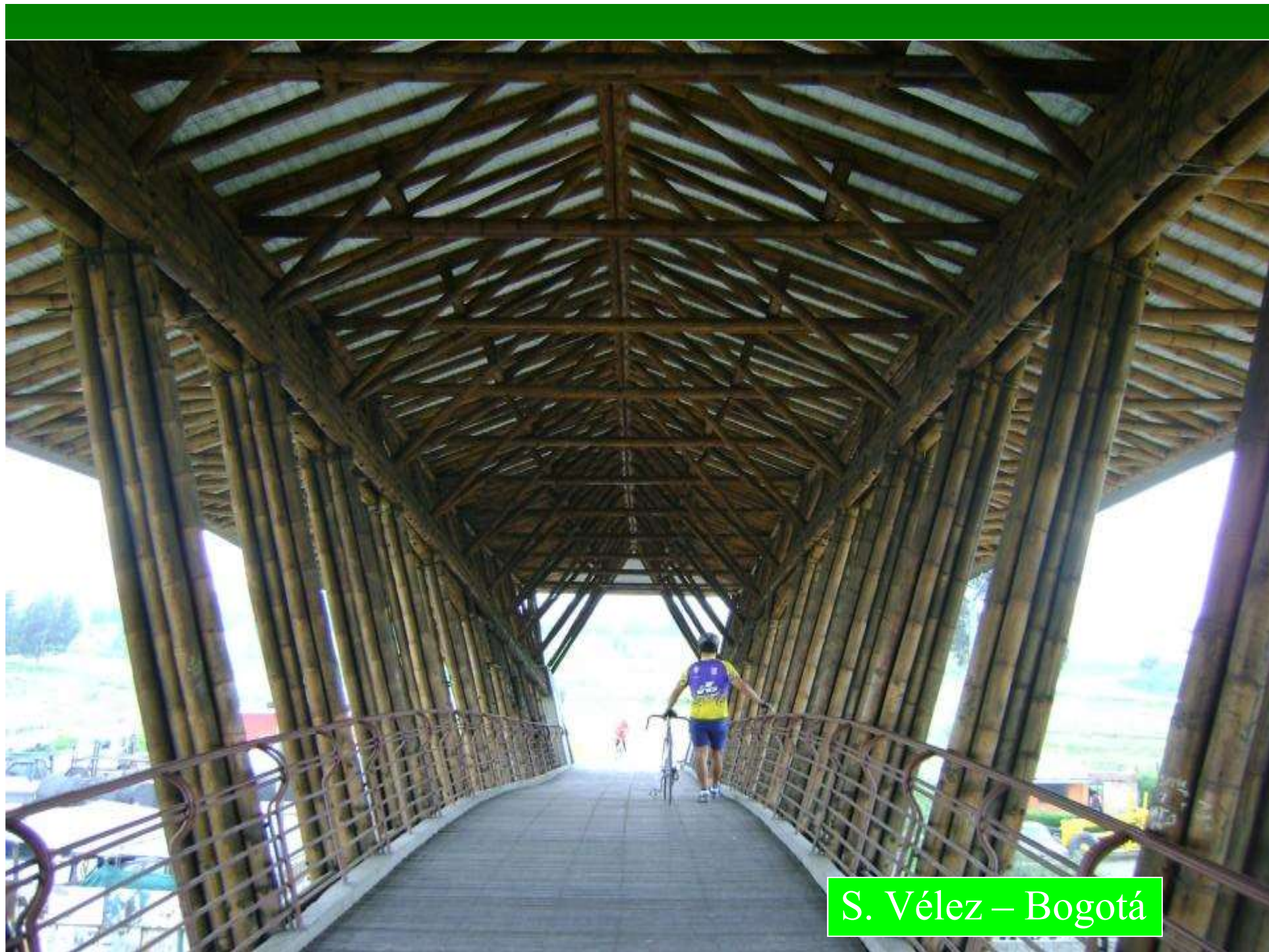








J. Stamm – Cali



S. Vélez – Bogotá



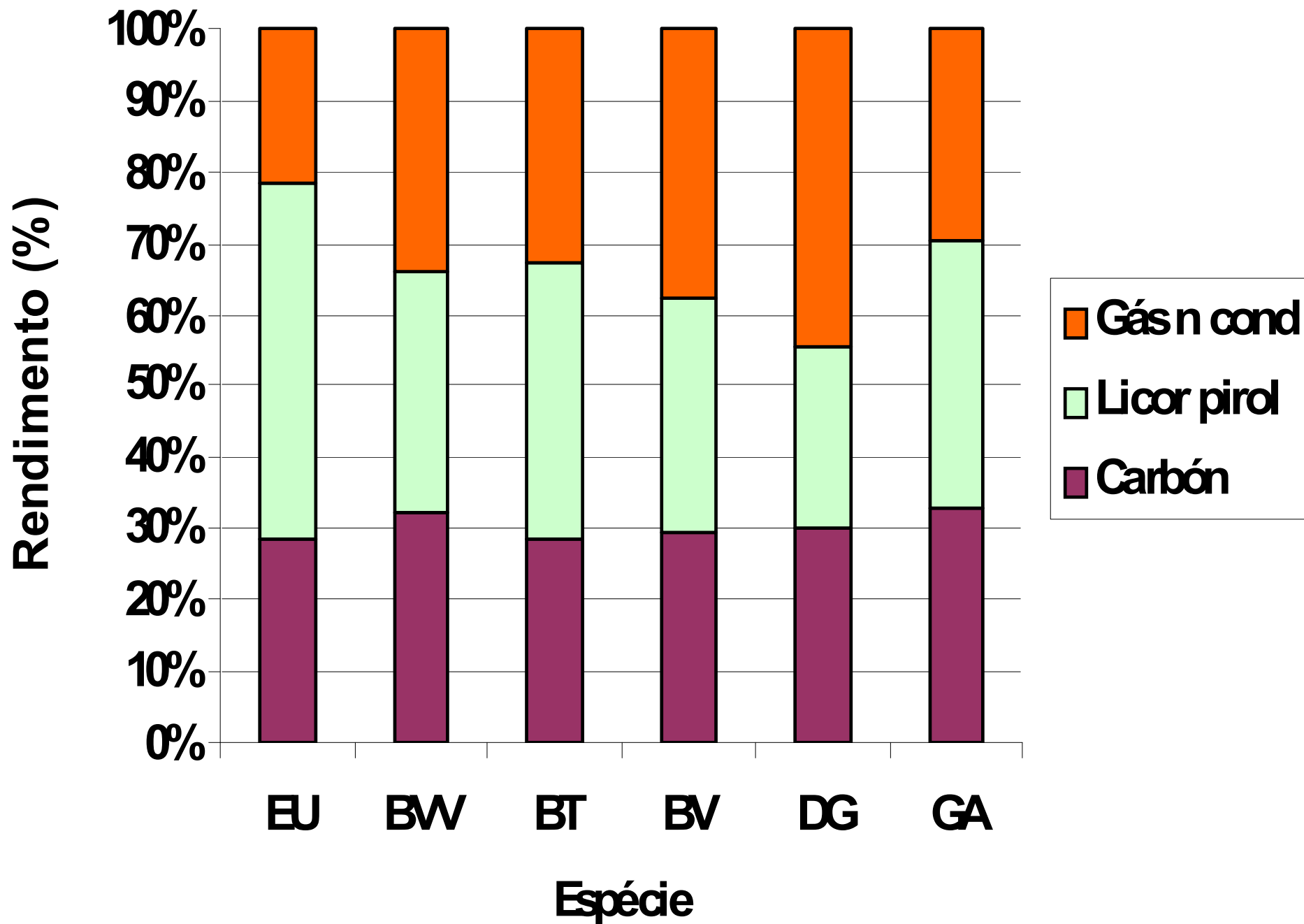




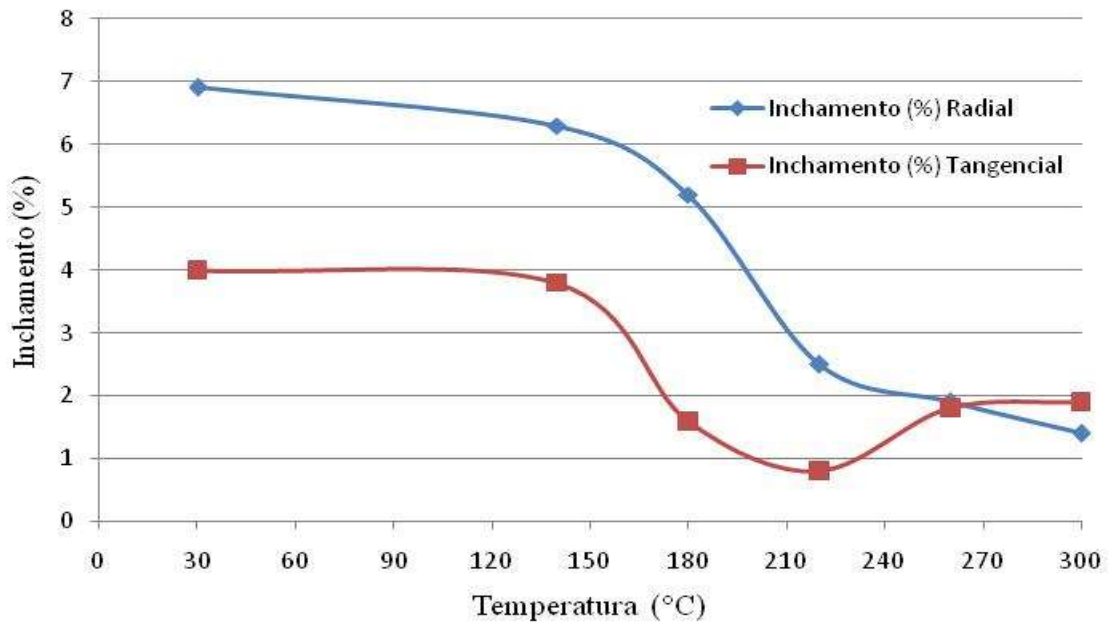
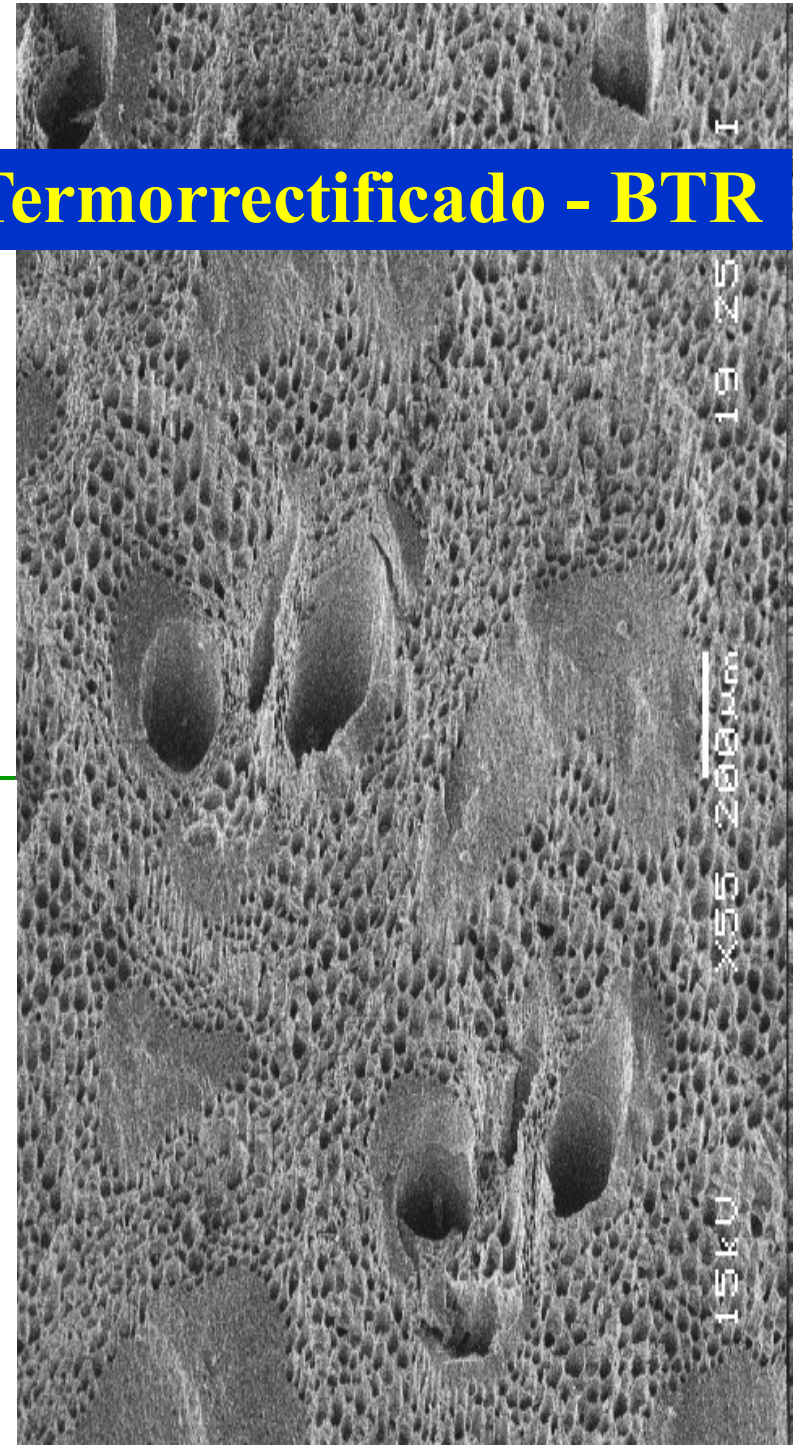
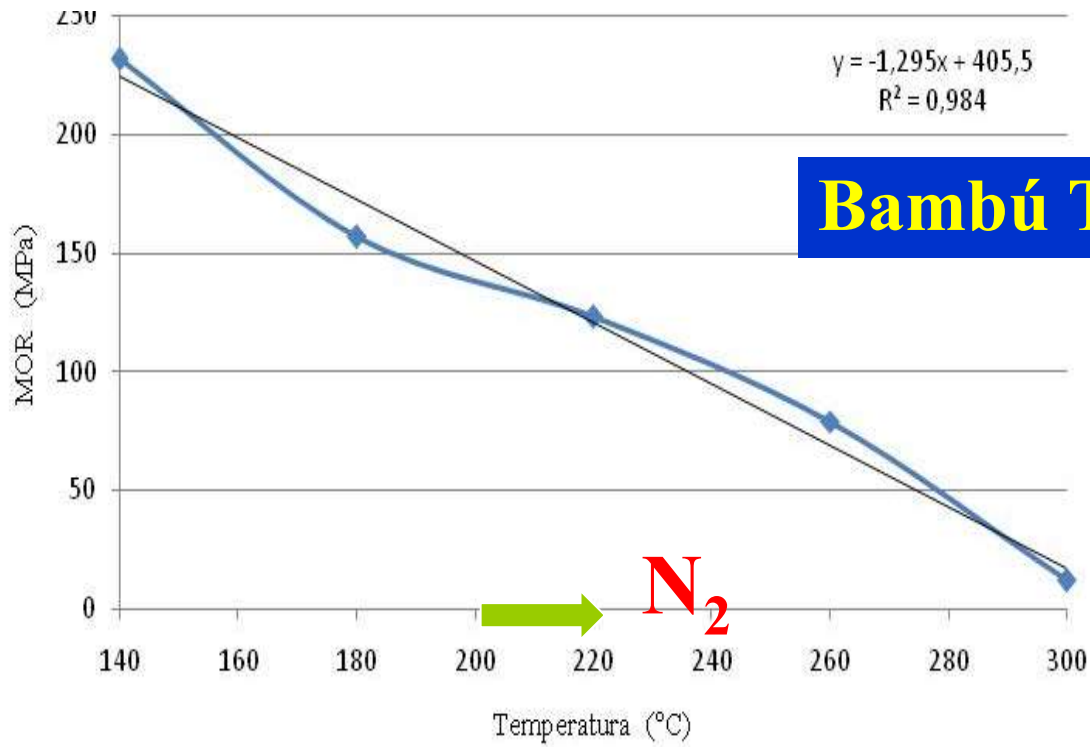








# Bambú Termorretractado - BTR



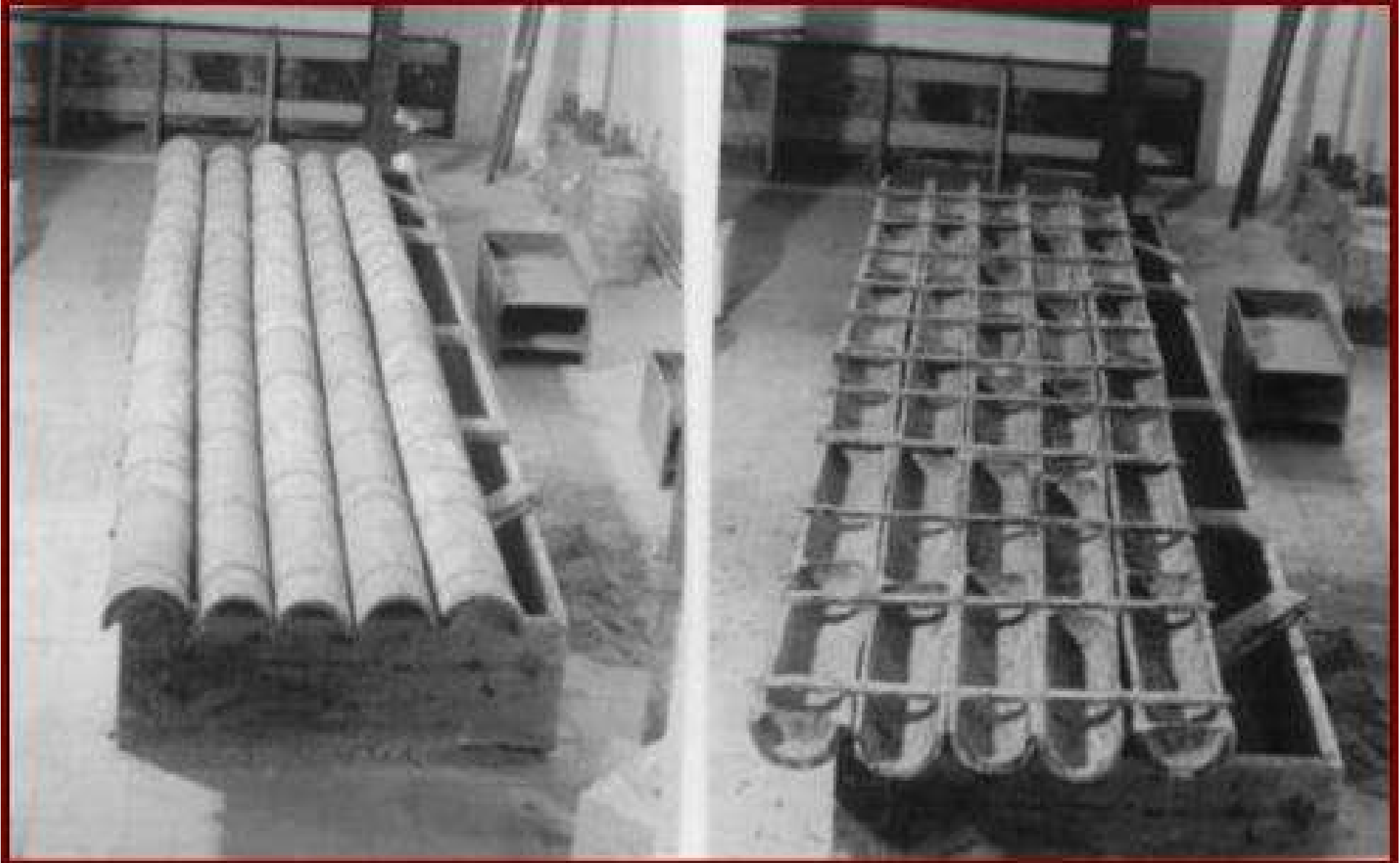






**1979 – K. Ghavami**

**PUC - RJ**



# 1985 - Bambucreto

Concreto reforçado com bambu



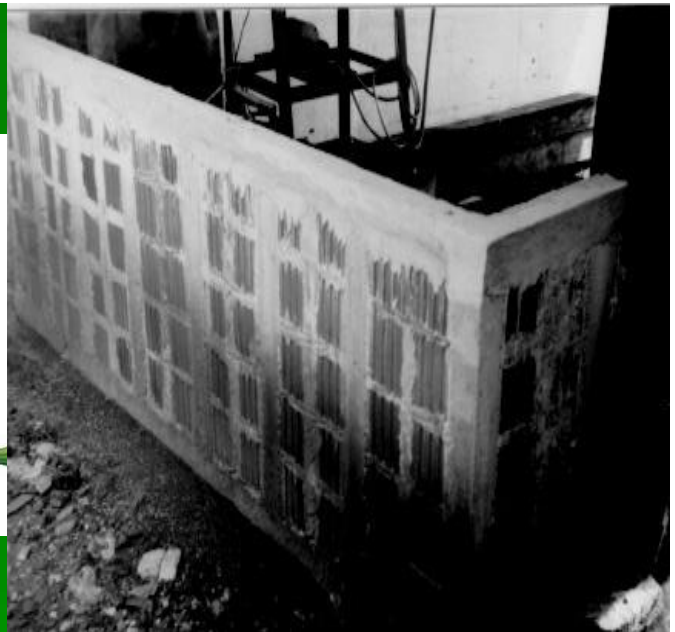
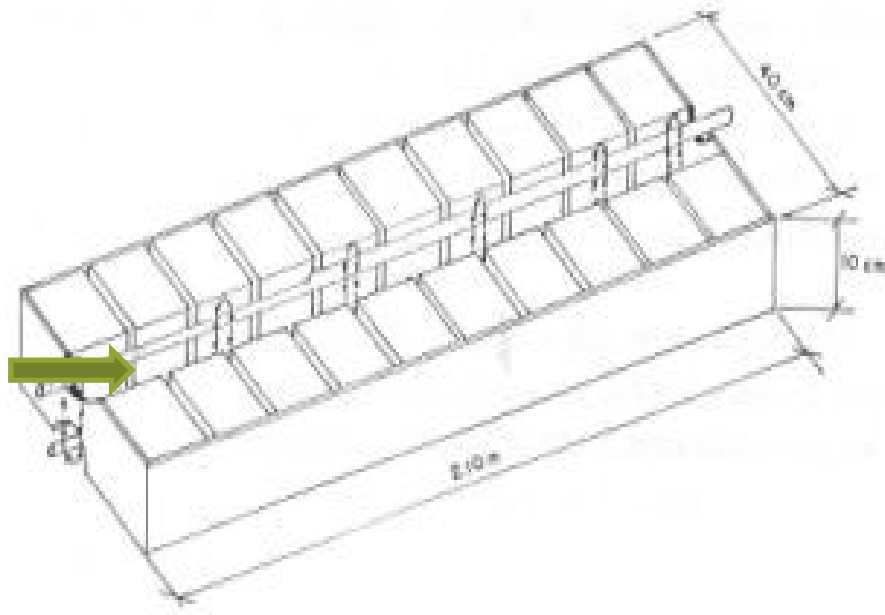
**1985 – A. L. Beraldo**  
**Campinas – SP**







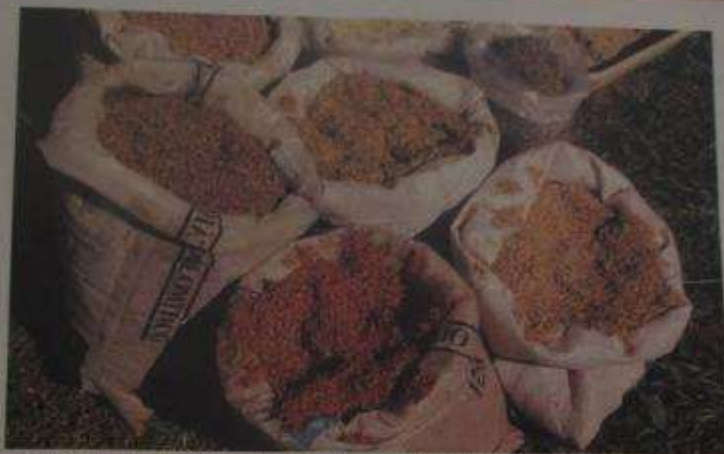
1989 - 2011



# BIOKRETO®

## Compósito de biomassa vegetal e cimento

**BENFEITORIA**



■ Fibras de madeira, tugaço de cana e casca de arroz usados no Biokreto

**CONSTRUÇÃO**

### Concreto de fibra

*Unicamp dispõe de tecnologia para uso de restos vegetais na fabricação de tijolos e blocos leves e de baixo custo*

*Por Maria Aparecida P. Ramos/Fotos Anilton Vieira*

**R**estos vegetais, em geral ainda pouco aproveitados no meio rural, podem ser utilizados na construção civil com tecnologia desenvolvida pelo professor Antonio Ludovico Beraldo, especialista em construções rurais da Feagri — Faculdade de Engenharia Agrícola da Universidade Estadual de Campinas, a partir de práticas milenares. Os antigos egípcios já costumavam misturar vegetais picados na massa usada para fabricar tijolos e outros objetos, evitando a formação de fissuras nas peças e tornando-as mais resistentes.



■ Blocos para construção, leves e resistentes



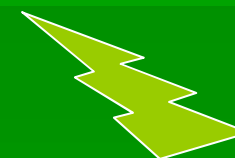
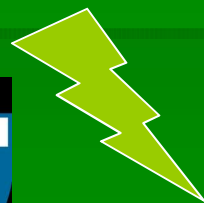
Na Feagri, peças feitas com fibras de eucalipto, peroba, pinus, arroz e cana



Prof. Beraldo exhibe amostras de tijolo e telha; no detalhe, pla

1996

# Cimento vs Biomassa

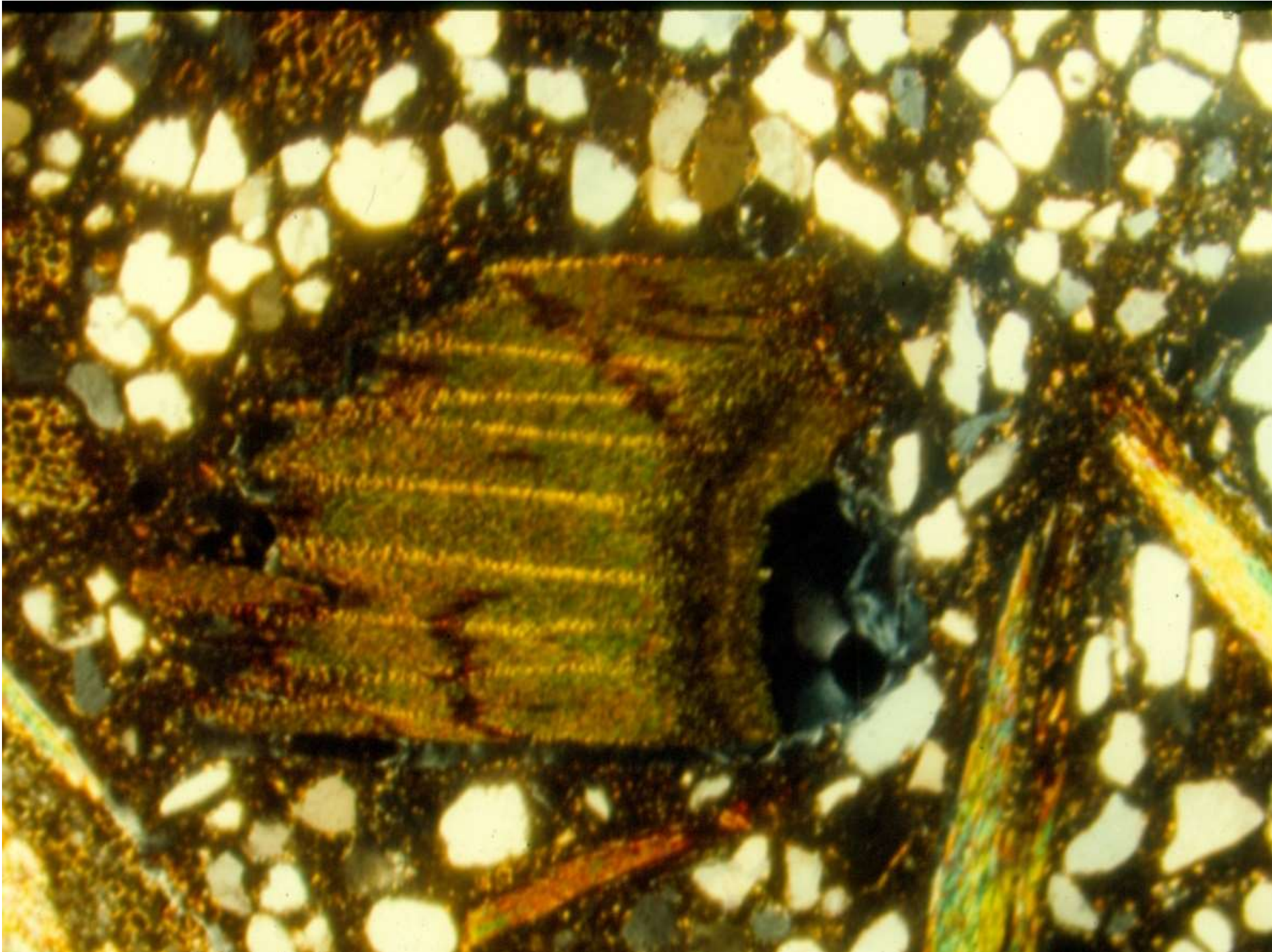


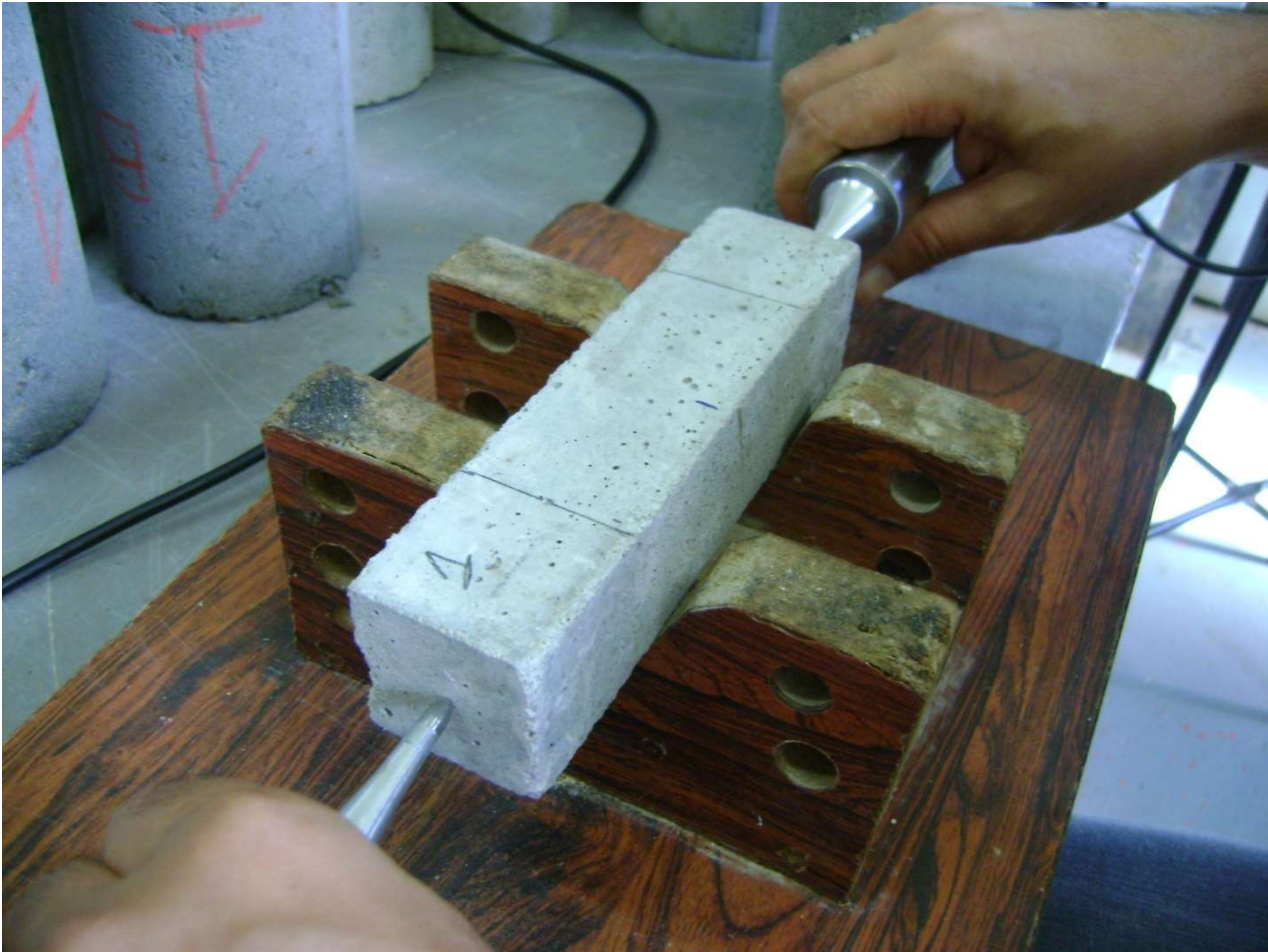














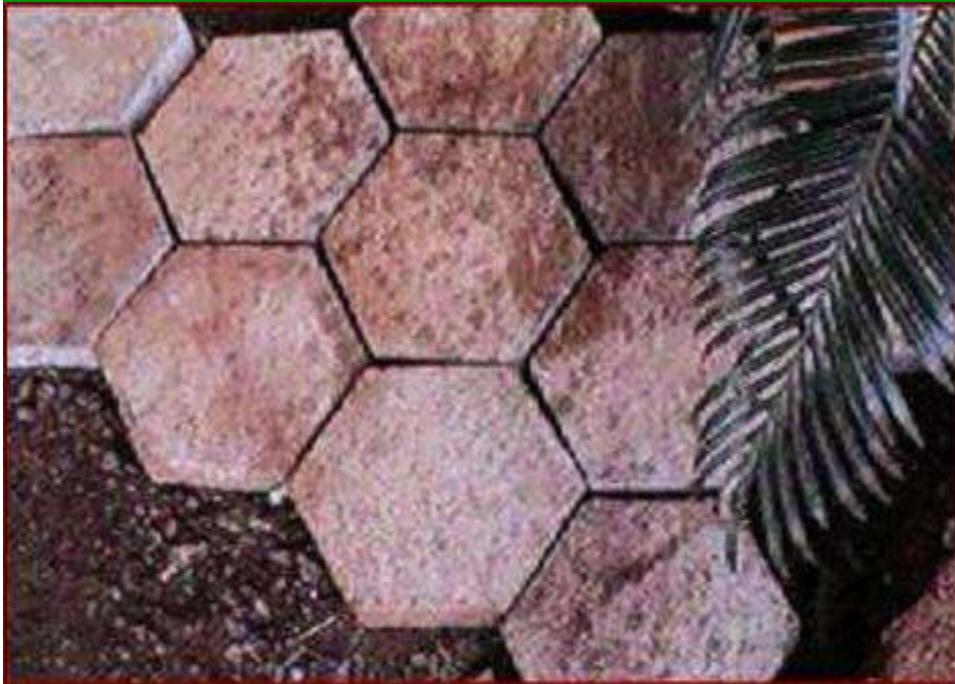








**Pisos – pavers**

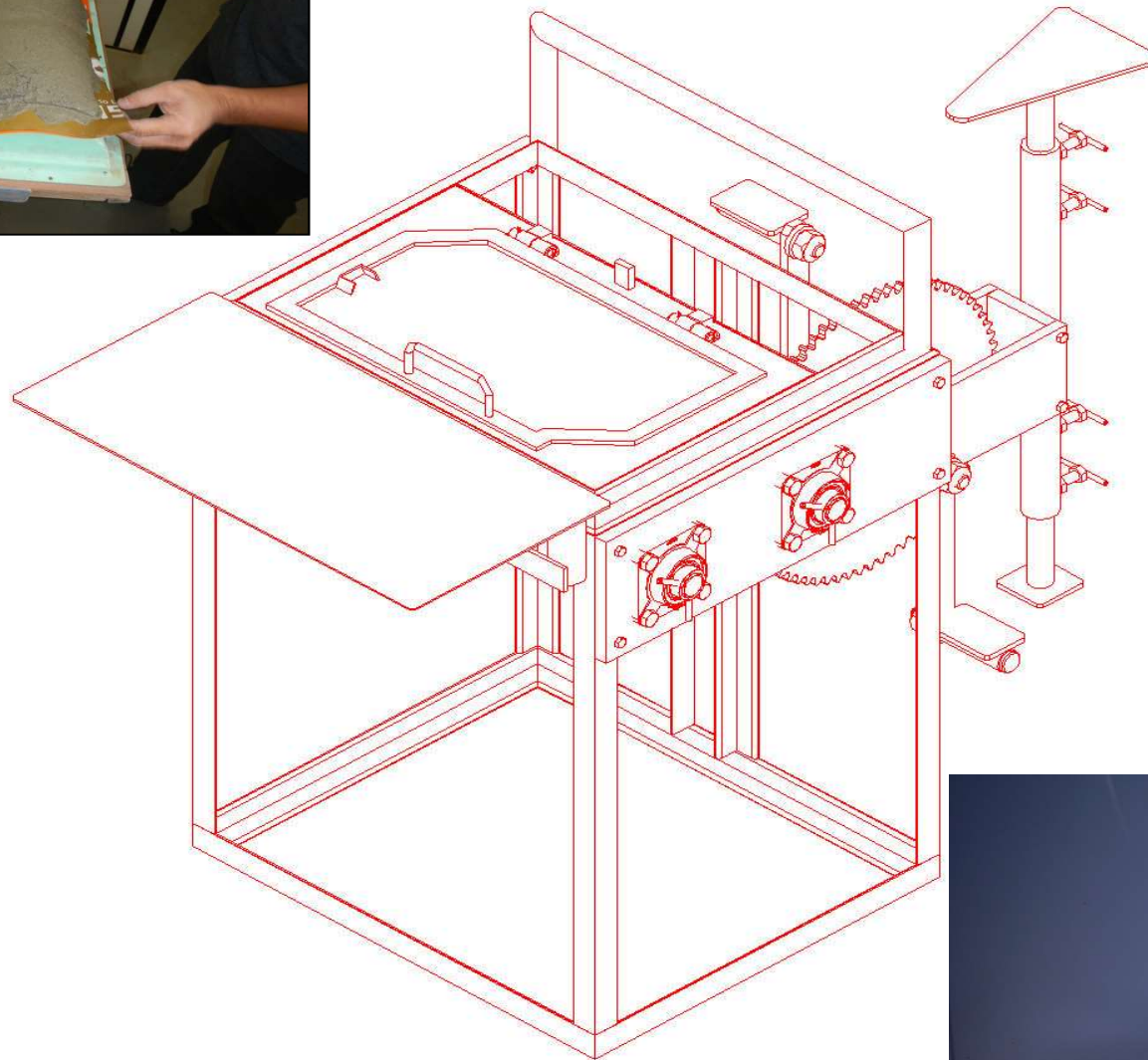
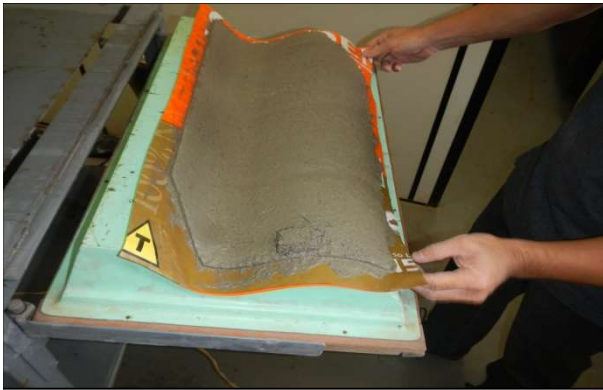


**1998 - 2017**









**Projeto Moçambique**





**Rogério de Araújo Almeida**  
**UFG – Goiânia - GO**



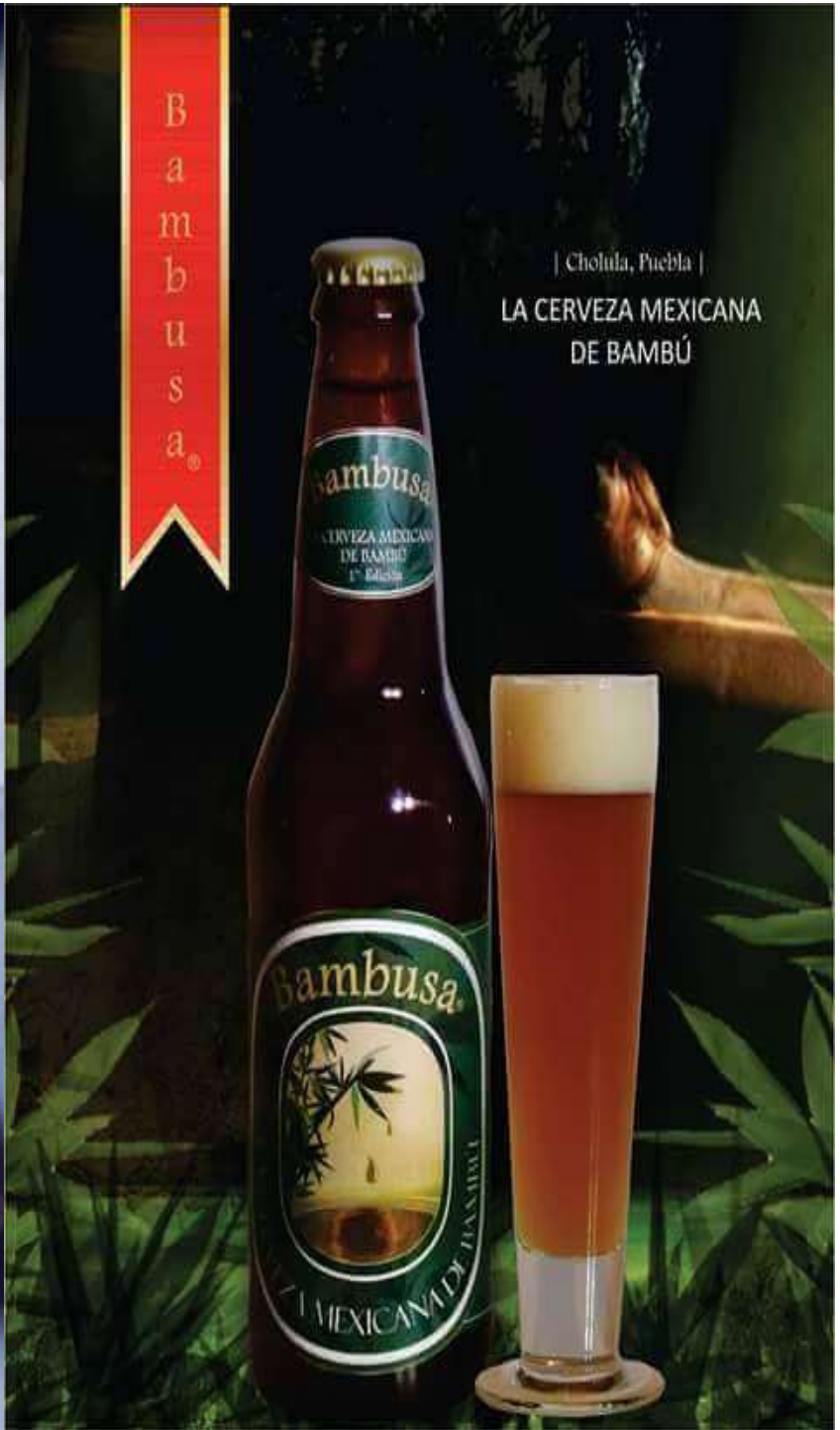
**Tratamento de resíduos industriais**





**Feagri  
Unicamp**







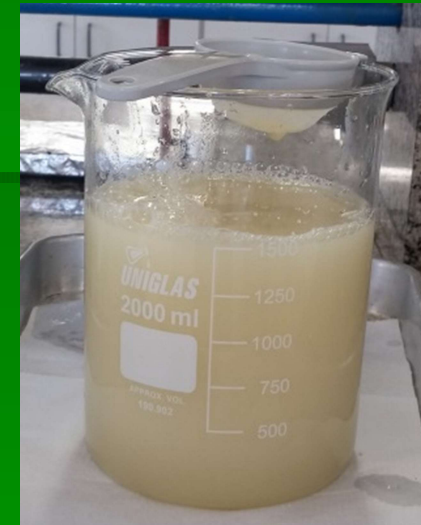
# Curso de Produção de Broto de Bambu em Conserva

7 de outubro – 8 de outubro das 09 as 18h





# Farinha de colmo jovem de bambu



**Amido**

**Resíduo**



# Effect of the addition of young bamboo culm flour as a sugar and/or fat substitute in cookie formulations



**FC**

**F2**

**F3**

FC - Control

F2 - 50% of sugar reduction

F3 - 50% of fat reduction



**LABOCEB**  
**MACARRÃO**  
1,75% FIBRA DE BROTO DE BAMBU  
1,755% FARINHA DE COLMO DE BAMBU



**LABOCEB**  
**MACARRÃO**  
1,75% FIBRA DE BROTO DE BAMBU  
1,755% FARINHA DE COLMO DE BAMBU



**LABOCEB**  
**BISCOITO**  
15% FARINHA DE COLMO DE BAMBU



**LABOCEB**  
**BISCOITO**  
15% FARINHA DE COLMO DE BAMBU



# TECNOLOGIAS E MATERIAIS ALTERNATIVOS DE CONSTRUÇÃO

Coordenação

WESLEY JORGE FREIRE  
ANTONIO LUDOVICO BERALDO

2003



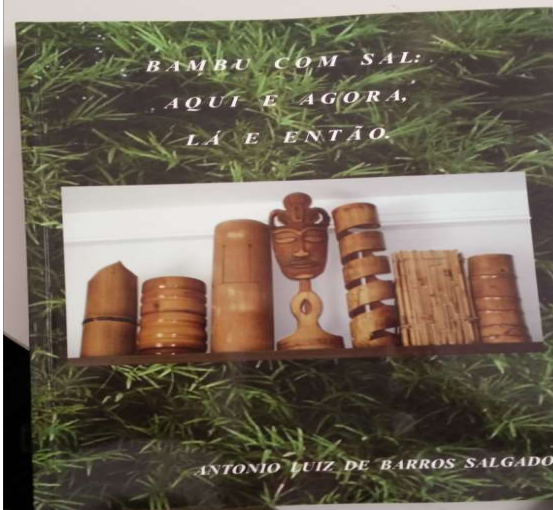
2007

MARCO A. R. PEREIRA · ANTONIO L. BERALDO  
(Colaboração de Betty Terra)

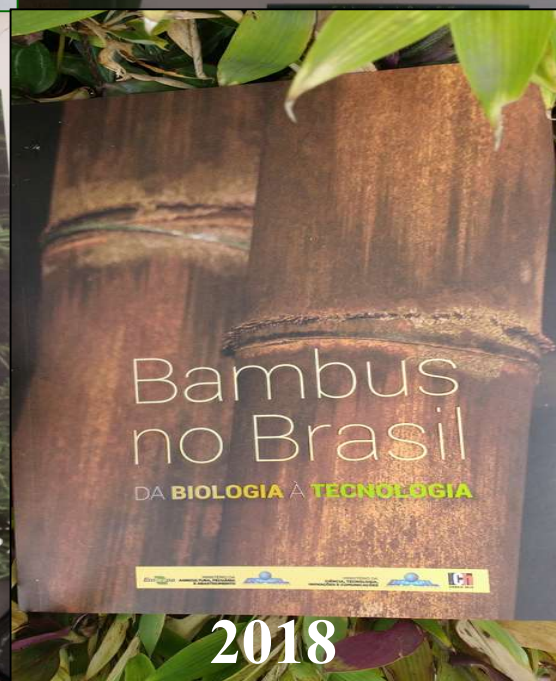
# BAMBU DE CORPO E ALMA



2016



2015



2018



**CURSO**

CONSTRUÇÃO COM BAMBU

**15 A 18 DE JUNHO**

FAÇA SUA INSCRIÇÃO ATRAVÉS DA NOSSA PÁGINA



**MOBILIÁRIO  
EM BAMBU**

**15 A 16 DE JULHO**

TÉCNICAS BÁSICAS,  
DESENVOLVIMENTO  
CRIATIVO E  
PRÁTICA

EQUIPE EBIOBAMBU  
INVESTIMENTO R\$ 590,00  
VILA DE MIRA - RIO DE JANEIRO  
CARTÃO 1411 COM R. 6101  
WWW.EBIOBAMBU.COM.BR  
WHATSAPP: +55 21 447541004



## Futuro

- **MSC-00379/2014** - Acordo com a Rede Internacional do Bambu e do Ratã - **INBAR**, celebrado em Pequim, em 06/11/**1997**.....  
..... **2017**... BRASIL é membro!

**LEI Nº 12.484, DE 08/09/2011.**

Política Nacional de Incentivo ao manejo sustentável e ao cultivo do Bambu.....

# Futuro

NORMA  
BRASILEIRA

ABNT NBR  
XXXXX-1

=====  
**Parte 1 - Projeto de Estruturas de bambu**

NORMA  
BRASILEIRA

ABNT NBR  
XXXXX-2

=====  
Estruturas de bambu

**Parte 2: Determinação das propriedades físicas e mecânicas do bambu**

