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Germination of
Caesalpinia echinata:
reproduction facilitated

BOTANY

Long life for pernambuco wood

Seeds of the plant are preserved for a year and a half, six times more than previously thought

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Published in February 2003

Half a millennium after the arrival of the Portuguese, a new raid on pernambuco wood is under way. This time, the would-be conquerors of this beautiful and slightly perfumed tree, native to the Atlantic Rain Forest, are some 20 researchers from the São Paulo Botanical Institute. Assisted by colleagues from other São Paulo institutions and even from abroad, they have been attacking on several fronts, for almost two year, this natural resource so intimately linked to with the history of the country. However, instead of extracting the brasilin, the dye that gave the ruddy tone to the clothes of the European royalty, or cutting down its precious timber, as did the tree's exploiters of the past, the multidisciplinary team of, so to speak, contemporary exploiters (in the best possible sense) of the today scarce and still threatened with extinction *Caesalpinia echinata* is pursuing more noble ends.

By means of experiments in physiology, biochemistry, anatomy, ecology, technology, and even historical research, the group is little by little throwing light on some shadowy zones that sometimes made – and still make – scientific knowledge about pernambuco wood obscure or inexact. Accordingly, more elements are appearing to steer the work of preserving the few remaining reserves of the species, and who knows, to assist in promoting its reforestation, or even its sustainable exploitation, if this proves viable one day. "We are gathering together scientists to study in-depth the historical, scientific and economic importance of this tree," explains Rita de Cássia Figueiredo Ribeiro, from the Botanical Institute, who coordinates the project and is holding an international symposium on pernambuco wood in São Paulo between March 12th and 14th. "A lot of people think that pernambuco wood has already been widely studied, but this impression is false."

In a short time, less than two years, the project has expanded scientific knowledge on pernambuco wood considerably. For the time being, the most significant discovery shows that the seeds of the tree, known as being relatively fragile and difficult to preserve in their natural environment, can be preserved, provided that they are submitted to certain conditions, for 18 months,

a period six times longer than used to be sustained by the sparse scientific literature on the theme. Until the publication of the results of this work, which reached the pages of the *Revista Brasileira de Botânica*[Brazilian Journal of Botany] in December, it used to be believed that the seeds of pernambuco wood were short living: they would last only one month if kept in a natural environment, and 90 days, at most, if kept in a cold chamber. This was the equivalent of saying that unless they were planted straight away, the seeds would not germinate and would rot. Mastering over more and more effective techniques for storing seeds of pernambuco wood makes the task easier for those who dedicate themselves to projects for preserving this tree and reforestation with it.

Seeds and flowers: discoveries encouraged conservation and reforestation projects

Some specialists went so far as to suspect that pernambuco wood seeds did not tolerate being dried, the main method used for the preservation of this kind of reproductive structure. For the seeds of a large number of plant species, reducing the water content of their total mass to levels lower than 10% is an effective way of ensuring their longevity. Desiccation almost paralyzes their metabolic activity and reduces the occurrence of harmful reactions, as well as reducing the activity of harmful microorganisms and insects. With pernambuco wood, this procedure did not seem to bring about a similar protective effect. Or so it seemed. Until the researchers from São Paulo showed that, with some additional precautions, drying extends the useful life of pernambuco wood seeds as well.

They selected only the best, mature seeds, and submitted them to heat from 40 to 50° Celsius (C), which left them with a humidity of a little over 8%. Finally, they stored them in an environment with the temperature controlled at around 8° C. "With these procedures, we managed to extend their longevity considerably," says Cláudio José Barbedo, who also comes from the Botanical Institute. "But the method only brings results when good quality seeds are used." The researchers found that when they followed the procedures described above, over 80% of the seeds would germinate, if kept in a refrigerated environment for a year and a half. "We are now trying to understand what metabolic changes make these dry seeds lose their viability at a given moment," explains Rita. "There are signs that this is related to alterations in their levels of soluble carbohydrates (sugars)."

Other findings have germinated from the pernambuco wood seed. The scientist found that the covering of the pernambuco wood seeds is not so thick and is made up of a different kind of cell from that usually present in seeds of leguminosae, the family to which *C. echinata* belongs. "In the place of the cell structures that give rigidity to the covering of leguminous seeds, we found stomata in pernambuco wood seeds," says a specialist in plant anatomy, Simone Teixeira de Pádua, from the School of Pharmaceutical Sciences at the University of São Paulo (USP) in Ribeirão Preto. Normally located in the leaves of plants, where they regulate the exchange of gases with the environment and work like pores, stomata rarely occur in seeds.

Fragility - This anatomical peculiarity may be one of the reasons why the pernambuco wood shows seeds that are more fragile and complicated to preserve than other leguminous plants. A little bit of comparative anatomy helps one to understand this situation. Simone compared seeds from the pernambuco wood and from the Brazilian ironwood (*Caesalpinia ferrea*), a typical leguminous plant. More specifically, she analyzed the testa of the two seeds, the coat or integument that wraps and protects the embryo, popularly called the shell. The conclusion: the testa of the ironwood seed shows two layers of cells rich in lignin, the same substances that makes wood rigid, while the pernambuco wood's testa is, literally, more porous, with stomata. It comes as no surprise, then, that the two kinds of germinative structure behave quite differently when put in their natural environment. "The ironwood seeds are so hard and resistant that they can preserve themselves in the ground, without germinating, for up to two years, which does not happen with the pernambuco wood seeds," Simone notes.

Other lines of research have also arrived at important preliminary results. Agronomist engineer Marcelo Dornelas, who is doing postdoctoral studies at USP's Luiz de Queiroz College of

Agriculture in Piracicaba, is studying the species' reproductive capacity and observed that the development of the flowers of the *C. echinata* occurs in a similar way to other leguminous plants," Dornelas believes.

There are also surveys that seek to understand the reactions of the tropical species under quite different environmental conditions from those in the Atlantic Rain Forest. In this line of investigation, experiments carried out in the city of São Paulo and in a Spanish study center indicate that the pernambuco wood seems to grow less in environments with a high level of a specific king of pollutant, ozone gas, and develops better in places where the air is pure. "Apparently, the species is more affected by the presence of ozone than by the primary pollutants, such as carbon monoxide or sulfur dioxide," comments Marisa Domingos, from the ecology section of the Botanical Institute. The first clue in this direction was provided by the as yet preliminary results of a comparative study that has been under way for ten months in the capital city of São Paulo.

Resistance to pollutants - About 600 pernambuco wood plants were exposed at four different points of the city: the Ibirapuera Park, Congonhas Airport, a large garden maintained by the State Secretariat for the Environment on the banks of the Pinheiros River (the Orchard Project), and a special nursery (Vegetation House) at the Botanical Institute. Each one of these places was chosen as a result of the pollutants to which they are most frequently exposed. At Congonhas, there is a large quantity of the so-called primary air pollutants, gases like carbon monoxide and sulfur dioxide, which are direct byproducts of fuel burning. In Ibirapuera, ozone predominates, a secondary pollutant that is not emitted directly by any polluting source: it is formed naturally in the atmosphere by chemical reactions between molecules of hydrocarbons and nitrogen oxides, mediated by sunlight. In the Orchard Project, there is a bit of everything: primary and secondary

The tree in the cities: concentration of ozone limits growth

The unbeatable Pernambuco

Some 230 years ago, Frenchman François Tourte constructed the first violin bow with pernambuco, a wood that gathers together a rare combination of physical attributes: rigidity, flexibility, density, beauty, and a capacity for keeping its curve for years on end. Since then, nobody has discovered any material, synthetic or natural, better than pernambuco for making bows for violins, violas, cellos and string basses. "It is possible to make bows to an extremely high standard with other wood, such as 'ipê', but musicians are traditionalists and are prejudiced against new materials," says Daniel Romeu Lombardi, aged 54, a graduated architect who in the 80s became a bowmaker, as these craftsmen who sculpt this fundamental accessory for the string instruments of an orchestra are called.

Each month, four bows leave his atelier in the city of São Paulo – actually, it is a room at the back of his house, in the Perdizes district. The most expensive, which can cost as much as US$1,000, are always made of pernambuco wood. This does not mean to say that any piece of *Caesalpinia echinata* shows a potential for taking on the shape of a

Bowmaker Lombardi: bows of up to US$ 1,000

pollutants, plus the baleful effects from being in the vicinity of a river in its death throes. The Vegetation House works as a control point, with its maximum temperature controlled at 28° C and pure, filtered air, to represent an urban spot free from pollution.

Although they have not yet reached the middle of the study, the researchers have already noted a tendency: plants cultivated in the nursery with pure air, where they receive sunlight normally, grow more than the others, and those exposed to an environment with a lot of ozone apparently develop less significantly than those from other places. To see whether an excess of ozone may be the cause of this retardation in the growth of the Ibirapuera seedlings, a more detailed study was carried out at the Fundación Centro de Estudios Ambientales del Mediterráneo (Ceam), in Valencia. In special chambers, pernambuco wood cuttings remained for one month in three environments with different characteristics: one with pure air, another with of ozone, and a third with a greater quantity of this gas. "Generally speaking, we saw that the higher the level of ozone in the atmosphere, the lower the levels of photosynthesis of the plants and the production of antistress (antioxidant) substances," says Marisa.

Cities and termites - Why study the behavior of a tree that is typical of the Atlantic Rain Forest outside its natural habitat and, on top of all that, in polluted places? The answer: to see if it makes sense to establish a public policy to stimulate the planting of pernambuco wood in the major Brazilian cities, a project that, besides its undeniable symbolic and historical value, could help to embellish urban centers. Capable of imparting to the air a subtle aroma that is reminiscent of jasmine, pernambuco wood is, leaving patriotism aside, a pretty ornamental tree, above all in the period in which its yellow flowers blossom, between August and November, and it can reach a height of 20 meters, although its dimensions are not great enough for it to have a massive presence in an urban setting.

With an equally practical approach, but focused on the physical and acoustic characteristics of the pernambuco wood's timber, laboratory tests carried out at the Technological Research Institute (IPT) are beginning to come up with the first signs that the tree's ruddy trunk that in other times gave color to the world may offer good natural resistance to the actions of termites. The species seems to have properties similar to those of the curupay or angico-preto (*Anadenanthera macrocarpa*), a tree that stands up well to being attacked by these insects (and to fungus as well). "For the time being, we have seen that the wear and tear experienced by the pernambuco wood, when it is in contact with the termites, is limited to the surface", says biologist Maria Beatriz Bacellar Monteiro. Also at the IPT, a study is being performed about the mechanical and acoustic properties of pernambuco wood, an attempt to understand why this wood is preferred by the makers of bows for string instruments (violins, violas, cellos and string-bass), perhaps the only commercial use still maintained by this tropical tree (*see article above*).

Following a path that is uncommon in botany projects, the efforts of the researchers at the Botanical Institute are considering an onslaught on the pernambuco wood and a review of its geographical distribution in Brazilian territory, in the past and in the present – today, this species is found naturally in the states of Pernambuco, Bahia and

first class bow. "There can be a lot of difference between two pieces of pernambuco wood", warrants Lombardi, who, on an informal basis, exchanges practical information with Edenise Segala Alves, a researcher from the São Paulo Botanical Institute. She coordinates the anatomical studies with the wood that serves as raw material for his work. "That is why I sometimes have to discard some pieces." With the assistance of an Italian apparatus, which emits an electrical field in the strips of pernambuco wood in their semi-raw state that are intended to be transformed into bows, the bowmaker measures what he believes to be the acoustic potential of the bit being examined. When the result of the test is rather unpromising, Lombardi simply discards the strip of a doubtful standard. In Japan, researchers have already tried to transfer some chemical compounds from pernambuco wood to other woods, in the hope of passing on the acoustic characteristics of the Brazilian tree. But the results are still not encouraging. Nature is winning this battle - for the time being.

Cello bow: the wood has unique properties

Rio de Janeiro. Last year, working as a mixture of a historian and a taxonomist, agronomist engineer Yuri Taveres Rocha, from the Botanical Institute, went on two long journeys. In April and May, he was in Portugal, from where he brought back copies of some 800 documents dating from the 16th to 19th centuries The main source of his research was the Ultramarine Historical Archives (AHU) in Lisbon. There, Rocha examined 500 manuscripts, with the purpose of providing input for telling the story of the exploitation and trade in pernambuco wood in the 17th and 18th centuries, based on the analysis of the cargoes of the ships that left the Brazilian coast, above all Pernambuco, on route to Portugal. "Until now, it is not known for sure how much pernambuco wood left Brazil and where it was that this tree used to occur naturally", says Rocha.

Swapped identities - In the second trip, Rocha covered 12 São Paulo cities by car, to carry out a survey of the main spots in the state where the pernambuco wood cuttings were planted. "This information is fundamental for us to know how the conservation *ex situ* (away from its natural habitat) of pernambuco wood in São Paulo," the researcher comments. A few findings: in Iperó, in the pernambuco wood Copse, for Conservation *Ex Situ*, there are over one thousand specimens of this tree, planted in 1999; in Paulínia, in the Brazil 500 Copse, there are another 500 specimens; on Lageado Farm on Unesp's campus in Botucatu, Rocha came across a pernambuco wood tree 15 meters high, and probably 80 years old.

The travelling through the state of São Paulo also tried to answer a question that intrigues scientists and historians: did the species occur spontaneously in São Paulo? There are reports that there were native reserves of pernambuco wood in Ilhabela and Ubatuba, but up to now there has not been any scientific proof. Rocha went along trails in the Ilhabela State Park, always with the same result: all the tree formations pointed out to him as being pernambuco wood were instead, specimens of other species, whose popular names swing between the funny and the nearly obscene: jacarandá-bico-de-pato (duck-billed rosewood-*Machaerium sp.*), cockroach shell or palm-fiber rope (*Xylopia brasiliensis*), araçá-piranga or big guava (*Eugenia leitonii*) and sow's nipple (*Zanthoxylum rhoifolium*). The confusion was due to the fact that these trees have red bark or spine-shaped protuberances (aculei) on the trunk or branches, characteristics that are reminiscent of pernambuco wood.

In spite of having had fundamental importance for the history and the economy of colonial and even imperial Brazil, in many aspects, to use a hackneyed phrase, pernambuco wood is still an illustrious stranger. In the hands of man, the calling of this natural resource was almost an unwritten maxim: a good tree was a felled tree. In the course of some 370 years, between the beginning of the 16th century and the end of the 19th, while the Atlantic Rain Frest still had considerable stocks of this tropical tree and artificial dyes had not yet made headway, *C. echinata* imparted its tones of fire to clothes, paper and pictures, besides being used in construction and shipbuilding. After this, it was forgotten or relegated to a superficial role in the history books. Fortunately, this scenario is starting to change, with the advance of the efforts to preserve the species, which were given an impulse three years ago, during the commemorations of the discovery of Brazil 500 years ago and the launch of major scientific projects on the most Brazilian of trees. •

THE PROJECT

Caesalpinia echinata Lam. *(pernambuco wood): from the Seed to the Wood, a Model for Studies of Brazilian Tropical Arboreal Plants*

MODALITY
Thematic project

COORDINATOR
Rita de Cássia Leone Figueiredo Ribeiro – Botanical Institute

INVESTMENT
R$ 400,648.82 and US$ 68,754.88