CONVENTION ON INTERNATIONAL TRADE IN ENDANGERED SPECIES OF WILD FAUNA AND FLORA

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PLANTATIONS OF PAUBRASILIA ECHINATA IN ESPIRITO SANTO

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The Ascua Plantation

PLANTATIONS OF PAUBRASILIA ECHINATA IN ESPIRITO SANTO

New Information and Perspectives in 2025.
By Charles Espey
Photos by the

LOOKING FORWARD
The conclusions from my 2018 report on Paubrasilia echinata plantations have changed in 2025. Since that time there has been a greatly renewed interest in using plantation grown Paubrasilia echinata for bow wood as evidenced by the National Symposium for the Conservation, and Sustainable Production of Pau-brasil in Ilheus, Bahia, in December of 2024. Numerous ongoing studies by wood scientists including Geraldo Cuzzuol, Claudia Franc Barros, Dan Erico Lobao and Daniel Piotto were presented as well as the findings of botanists; including experts on the Mata Atlantica like Haroldo de Lima (one of the authors of the new genus) and W. Wayt Thomas of the NYBG.

I believe the consensus at the Symposium was that plantations are the most important solution to taking pressure off native populations of Pau-brasil. Although there is currently a refusal from IBAMA, the

regulation of the trade in plantation wood is within sight. It appears that a CITES appendix 1 listing will put a stop to this development with the risk of putting every existing plantation in jeopardy. Since so much of Paubrasilia echinata's diversity is contained in these plantations in Espirito Santo, loss of the plantations would be a real threat to the viability of that variety known as 'Folha media or Folha de cafe'. Writing this report was a fact finding mission that led to an unexpected discovery; there is enough Pau-brasil wood in two of the larger plantations in Espirito Santo state to sustainably supply the world's demand for bow wood. But first some background.

Haroldo de Lima at the Ilheus Symposium

IBAMA AND BRAZILIAN POLICY.

Giving a presentation at the Ilheus symposium was a representative from IBAMA, Filipe Guimaraes, an aggressive investigator. The clandestine cutting of Pau-brasil is a great concern but the level to which Paubrasilia echinata's diversity is currently being threatened is out of the scope of this report on plantations. In any case Brazilian bowmakers have been blocked by IBAMA from exporting bows of P. echinata since June of 2022; all their production uses Tabebuia sp. so its highly unlikely any illegal wood is destined to stay in Brazil.

IBAMA'S position as an enforcer of environmental laws is a given but conservation policy is another element. The problem with IBAMA's and specifically Guimaraes' approach has been a refusal to support plantations of Paubrasilia echinata trees ostensibly because that wood could be mixed with illegal wood. Of course but Guimaraes and IBAMA avoid the fact that there is a vast amount of plantation wood now that trees have started to mature; enough wood to supply the world's production of bows and greatly alleviate or replace the illegal exploitation of native trees. Nor does it value the importance of plantations as refuges for the tree's diversity. This is especially true in Espirito Santo where Pau-brasil's true habitat in the Atlantic Forest is reduced to a few fragments of 'capoeira' or second growth. IBAMA needs accurate information since some of their sources of information may have misled them or simply have been misinformed. Some of the problem may be misinformation within the bowmaking community as to the potential yield of plantations and the quality of the wood.

Sinval Dos Santos Marques at Santa Rosa plantation.

However the bigger plantations have been inspected and/or inventoried by independent forestry engineers and botanists. The remarkable Ascua grove, has been studied by Haroldo de Lima and other scientists. The Schaeffer plantation has been inventoried and an inventory of the Santa Rosa plantation has begun. The researcher Geraldo Cuzzuoli, a professor at the State University of Espírito Santo, told me that IBAMA never responded to his request for permission to cut down a single tree from a plantation for research. His research could establish independently the actual yield of individual bow sticks from a given log; a figure that IBAMA greatly underestimates. However this figure is critical to determining the yield of wood for bowmaking from a plantation. Also depreciated by IBAMA was the quality of planted wood and its suitability for bows. Independent research by several studies has shown the quality of plantation wood to be

suitable. Variations in quality exist depending on the regional variety and growing conditions however the largest plantations in Espirito Santo feature the excellent variety known locally as 'sartory' or Espirito Santo folha media. Virtually all of this wood falls within the range of useability in my opinion. See Appendix 3.

It appears entirely feasable to regulate the sale of wood from the existing plantations in Espirito Santo as there is no physical overlap with native populations and the amount of available wood in the plantations dwarfs that in native Atlantic forest. In fact in Espirito Santo where the biggest plantations are located there is no remaining Mata Atlantica in Pau brasil's habitat range. It is completely obvious the plantation trees were planted. The legal frameworks already exist to document the wood and create export documentation. All that is missing is IBAMA's willingness to regulate. It seems reasonable to assume that importers would choose wood with documents at a competitive price compared to the risks and difficulty of accessing wood cut clandestinely.

Another element that has influenced Brazilian opinion about a CITES 1 listing is that since IBAMA stopped issuing export permits to Brazilian bowmakers using Pau-brasil in June of 2022, they feel unjustly alienated by CITES and European and american organizations, creating the mentality that if the Brazilians can't use the wood then no one should. Also attending the Symposium was Sofia Rumiko Hirakuri, a consultant working for CITES in Geneva. She was able to to ask the directorate exactly what would be the result for Brazilian researchers, planters and bowmakers of a Appendix One listing. There was a significant level of misunderstanding among this group as to the impact of the listing. So even those with plantations and stood the most to lose had signed a letter requesting Appendix One without understanding the implications. Hirakuri can be reached at shirakuri@stcp.com.br.

Eucalyptus replacing native forest.

THE BRAZILIAN BOWMAKERS: BACKGROUND

It's worth stepping back to a historical perspective. In the 1970ies, precisely in Pau-brasil's limited habitat zone in Espirito Santo, the Mata Atlantica in its entirety was stripped, burned and replanted with Eucalyptus; a nightmare of clonal rows and so it remains today. All this was permitted by IBAMA and none of the investors or executives of Aracruz Cellulose, now the world's largest pulp mill, suffered any repercussions. Anecdotally the wood exporter Horst John pleaded with the pulp-mill to let him at least harvest the some Pau-brasil before it was logged but to no avail, the forest was burned. See: 'With Broadaxe and Firebrand" Warren Dean.

Brazilian bowmaker Frank da Ros of Arcos Brasil.

Brazil has had an active and productive community of bow makers since its beginnings in the early 1980ies. They are largely based in or near Guarana, a town near Aracruz in Espirito Santo. They are skilled artisans in the unfortunate position of using a limited resource. The workshops range from two people to a few companies employing about 25 makers. Brazilian bows are of excellent quality and in the United States, if a budding young violinist needs a better bow their parents will probably invest in a Brazilian bow for them. Celso de Melo, the owner of Arcos Brasil, the largest bow company, told me that 70 to 75% of their bows were sold in the United States. They

produced 3,000 bows a year prior to the embargo. Overall 55% of the bows made in Brazil in 2023 were sold in the United States according to FINDES, a source of state statistics..

I was on the premises of the Brazilian bowmaking workshops 24 years ago in 2001 and 2002. I can attest to the fact that they were being issued permits for wood and these permits were posted on each and every stack of boards or sticks. Much of this wood dated to the late 80ies to mid 90ies. Typically permits to harvest and transport Pau-brasil were issued in Bahia state as a result of road building, reservoirs and other development, permits for farmers to clear a portion of their land and fires. Sudden visits from IBAMA to control the maker's stock were frequent. With political and/or policy change in Brasil, permits issued originally would be revoked and/or wood seized, ostensibly because it had been incorrectly permitted by other IBAMA agents, switched with other wood or other infractions. Then the whole lot would be auctioned off and re-permitted. In the meantime the bowmaking company would be faced with laying off all their bowmakers if they couldn't access wood to work with. Its clear there were transgressions depending on the company and it's no surprise. At the same time bow makers in Europe suffered no controls whatsoever. European or American bow makers have never been under the same constraints. They have simply purchased their Pau-brasil from middlemen leaving the export documentation up to them. Only by 2007 was the documentation of wood as pre-convention necessary in Europe. Further information the European trade can be had from Thomas Gerbeth; bogenbau@gerbeth.eu.

Documented Ipe sticks at Bogen Schaeffer.

Ipe Cello Bows at Bogen Schaeffer.

As previously stated, In June 2022, IBAMA at Guimaraes' instigation, issued a blanket embargo on Brazilian bowmakers ability to export their Pau-brasil wood bows and although P. echinata bows in Brazil are included in appendix 2, no export permits have been issued since that time. Clearly IBAMA intended to force every maker to leave their profession. Every Brazilian bow maker and his family faced financial ruin which compromized their ability to maintain their plantations.

Providentially Ipê or Tabebuia sp. worked adequately for bows and after some time 'Ipê' was substituted. Currently all Brazilian exports are of this wood which is also under appendix 2, with an annotation to exclude finished products. Their considerable stocks of Pau-brasil wood, most of which had IBAMA's certification are lying unused.

Now using Tabebuia sp. the Brazilian bowmakers are doing everything in their power to follow their documentation perfectly. Under the new DOF+ system an Ipe tree is documented by IBAMA from the farmer on whose land the tree is cut, usually in Rondonia state, to the dealer, the sawmill, the truck and the

roads it took to its destination where it needs yet another IBAMA inspection. Without the necessary manpower IBAMA can skip steps in the documentation but the bowmaker is liable. I learned today that a bowmaker who has 25 bowmakers working for him was refused the export of his Ipê bows for precisely this reason. Currently, in a story reminiscent of Kafka, if IBAMA won't help him recreate this paper trail it will be the end of his company. Another bowmaker is unable to export 400 Ipe bows he made for the same reason. . More than one of my respondants questioned whether IBAMA stopped exports and is promoting an Appendix 1 listing simply because they don't want to be burdened by the issuing of export permits. Vito Vissicaro can be contacted for clarifications regarding Brazilian bowmaking. .vito@arcosbrasil.com.

THE PLANTATIONS

Beginning in the late 1970ies, Brazilian bowmakers, realized they would have to show they had contributed to Pau-brasil's conservation if they were to use the wood in the long term. The most significant plantations were initiated by Horst John in Santa Rosa, followed by Floriano Schaeffer in Guarana, Renato Casara in Joao Neiva and Marco Raposo in Domingos Martins in the late 1990ies. Purchasing the land and hiring planters, skilled greenhouse staff year after year required an investment far exceeding anything government agencies or NGOs did and yet the Brazilian bowmakers were seldom credited. European trade organizations, wanting to distance themselves from their Brazilian colleagues' legal troubles, offered no support and instead invested in other projects in Bahia state. These Brazilian plantations are today essential to saving Paubrasilia echinata's diversity in Espirito Santo. They offer a clear solution to the conservation of the species.

A farm worker plants Pau-brasil on the Schaeffer plantation in 2018.

HORST JOHN PLANTATIONS:

The German wood exporter, Horst John, began planting Paubrasilia echinata in the late 1970ies; first on some land he purchased near Aracruz, E.S. and then on his 1.5 hectare compound in Guarana, ES. Also in the 1980ies Horst John sent several of his employees to Germany to study bowmaking there; this was the beginning of Brazilian bowmaking. Upon Horst John's death in 1995, his manager, Jacy Sousa inherited his business and continued his projects to plant pau-brasil as well as running a bowmaking workshop.

GUARANA

On December 20, 2024 I visited Jacy Sousa's compound where a parklike area of .75 hectares is intensely planted with Paubrasilia echinata. The plantings occurred first in the 1980ies and many of the first trees planted are over 40 years old. These trees range from 35 to 44 cm in diameter which is quite largefor P. echinata. Also spread through the compound are numerous trees of 19 to 22 cm diameter, well within the range that could be effectively harvested for bow wood. At one end of the planting are trees planted between 2005 and 2009. These were planted by Sousa with input from a forestry professional, using eucalyptus temporarily to provide shade and encourage straight growth. These trees, planted in rows, often have 3 or 4 meters of straight growth, greatly increasing the potential yield of the tree. According to Sousa, she has 1,200 pau-brasil trees growing in the area.

Jacy Souza with a Pau-brasil of 43 cm dia.

HORST JOHN SANTA ROSA PLANTATION

On December 20, 2024 I contracted the Forestry engineer Sinval Dos Santos Marques to take me to Horst John's Santa Rosa Plantation. Marques was familiar with the property having done work for his dissertation there. We were accompanied by Jacy Sousa the owner. This 30 Hectare plantation was initially 'capoeira'; scrub second growth and pasture when originally purchased by Horst John in the 70ies but is now densely forested. It was planted with Paubrasilia echinata in the late 70ies to mid 80ies initially, then planted again with P. echinata between 2005 and 2009 with the addition of some Tabebuia serratifolia and Dalbergia nigra.

Marques measures a 24cm Pau-brasil. 2025

Paubrasilia echinata at Santa Rosa.

We were not able to cover the entire area and apparently missed some of the largest trees but saw many trees in the 22 to 33 cm diameter range. Most of these trees had clear straight trunks of 2 or more meters indicating a a high yield. Sinval Dos Santos Marques had not yet conducted an inventory but by his estimation the plantation held from 10,000 to 12,000 pau-brasil trees in excess of 13cm in diameter. The yield of wood from these trees, even if there were only a few thousand, would be significant since by my estimation trees of 16 cm diameter would already be capable of producing wood for bows. A discussion of how to determine this and other yields follows this paper in Appendix 1. Using these guidelines I concluded that the Santa Rosa plantation alone could sustainably meet the entire worlds demand for bows; currently estimated at 15,000 bows by Thomas Gerbeth; bogenbau@gerbeth.eu.

The Santa Rosa plantation also had second and third generations of young trees ranging from 1 to 8 cm in diameter. The profusion was breathtaking and seed from the larger trees had germinated creating carpets of seedlings blanketing the forest floor. One could not take a step without

Paubrasilia echinata growing from dispersed seed.

seeing 4 or 5 Pau-brasil trees in every direction. Also interesting was the size of the Dalbergia nigra trees planted in 2025. The 'Ipé amarelo' or Tabebuia sp. were also everywhere. The forestry engineer Sinval Dos Santos Marques has been contracted to do an inventory of the Santa Rosa plantation. It will be available on March 7, 2025.

In 2005, according to Souza, she petitioned for a 'Forest Management Plan' covering her compound in Guarana and the Horst John plantation in Santa Rosa. which was signed off by IBAMA and IDAF, the state enviromental agency responsible for issuing harvesting permits. It gives her the legal right to harvest a portion the trees on her property. However this has not been tested or initiated.

Floriano Schaeffer and Pau-brasil 2001

Schaeffer's greenhouse in 2001

CORREGO PROSPERIDADE. FLORIANO SCHAEFFER. PLANTATION
The bowmaker, Floriano Schaeffer. developed his interest in botany as a boy assisting the botanist Augusto Ruschi in Santa Teresa, ES. He has an expert vernacular knowledge of Atlantic Forest flora. He was a manager for the German wood exporter, Horst John, through the eighties and has a vast knowledge of Pau-brasils varieties. He recognizes three varieties in Espirito santo and some five in Bahia from morphological characteristics of bark, leaves and wood.

When he left Horst John's employ in 1995 he acquired his 27.5 hectare farm and started his plantation 1997. Althought the Espirito Santo varieties figure strongly in his plantings he wanted to experiment with other varieties and planted the Bahian varieties as well. Schaeffer was interested to see how the Bahian varieties would develop in the more sandy soil and lower rainfall of Espirito santo. Now that these early plantings have matured to harvestable size, they represent a unique opportunity for bowmakers and wood scientists to study and experiment with these varieties which are protected in Bahia.

I visited Schaeffers plantation in 2001 and noted his trees which were already overhead and his shade house where he was propagating approximately 50,000 Paubrasilia echinata seedlings a year. Most of these seedlings were distributed for free or provided to the Aracruz Cellulose Pulp mill to plant in the steep watersheds where Eucalyptus could not be planted. I estimate Schaeffer has distributed over half a million Paubrasilia echinata seedlings.

His tree planting started among mixed plantings of coffee and papaya and these are the largest trees today at up to 36cm in diameter. Next he planted a hillside and included other Mata Atlantica species. It is now densely wooded and walking this area today with Schaeffer is a remarkable experience for anyone interested in Pau-brasil and its variation. At the end of this wooded area his plantings turn up into a flatter area and here Schaeffer planted a monoculture of Paubrasilia echinata with trees roughly 3 meters apart. However this area

Floriano Schaeffer and his trees in 2018

Newly planted Pau-brasil in 2018

is filled with smaller pau-brasil trees and seedlings as well. At one side of this planting are the Bahian varieties 'Folha d'arruda', 'Folha do cafe' or Folha Media' and 'Folha da Laranja'. At the time of my visits here in December of 2024 there were numerous trees of over 20cm diameter and well into harvestable size in this monoculture.

In October of 2022 Schaeffer contracted with the forestry engineer Fernando Moreno del Piero to conduct an independent inventory of his plantation. I have a pdf of this 94 page document. One of the conclusions arrive at 7028 trees and a total of 662 cubic meters of wood. It also has statistics on the number of cubic meters of wood that would accrue per annum which appears to be 53.9 m/cu. I'm not able to assess confidently how many bows this adds up to but its evident that it represent a significant quantity of wood, possibly a good portion of the world's usage. It would be such a welcome change if this wood could be openly harvested and studied or made available to bowmakers here.

Schaeffer's bowmaking business was ended when IBAMA stopped export permits in 2022, however in time his workshop started making bows again with Ipe or Tabebuia species. Floriano Schaeffer has developed health issues. His son Flavio Schaeffer is a talented bowmaker but also a coffee farmer and not enthusiastic about a plantation that has no return on the investment. This is yet another case of the need for regulation and documented sale of wood from the Espirito Santo plantations; they are not likely to survive in the long term under appendix One and an IBAMA interdiction on harvest.

Floriano Schaeffer in mixed plantings. 2025

In October of 2020 Schaeffer was issued a warrant from IBAMA forbidding him to engage in any planting, pruning or growing of seedlings on his plantation. In December of 2024 I saw and copied this document signed by Filipe Guimaraes which appears to penalize him for infractions like spacing his trees incorrectly. He has to hire forestry professionals to manage the plantation, something he could never afford. His greenhouse, full of seedlings during my visit in 2019 has now collapsed.

ASCUA

This remarkable grove of Paubrasilia echinata was planted by Floriano Schaeffer and some aquaintences in the late 1980s on a private ranch. Instead of propagating trees from seed, seedlings were dug up and transplanted from fragments of the original Atlantic Forest prior to it's clearing by the Aracruz Cellulose Pulp-mill. Ascua is no doubt the most important pure preserve of the 'Folha media' variety's genetic diversity. It is an important source of seed. The hope is that this grove will be protected, something Floriano Schaeffer has been taking responsibility for.

Paubrasilia echinata bark details at Ascua.

I visited the Ascua plantation again in January of 2025. A fire ran though the plantation in its early days which induced many trees to fork. In this case the bases are often around 36cm diameter or more and the forks 20 to 24cm diameter. There's also a number of 18 to 24cm trees as well. Small seedlings are carpeting the area. The planting, which covers about one hectare, is ajacent to 'capoeira' or second growth forest and the Paubrasilia echinata extends into this densely wooded area with many mature trees. Further in are numerous small trees that grew from seed. To my knowledge Ascua has not been inventoried but there appear to be many hundreds of trees by a rough calculation.

Marco Raposo's Pau-brasil seedling production 2019.

The Marco Raposo with Paubrasila echinata.

THE MARCO RAPOSO PLANTATION

The bow maker Marco Raposo has his workshop and plantation in the hill town of Domingos Martins, ES. He started his mountainside plantation in the year 2000. His plantation has 700 trees in excess of 14cm in diameter on an area of two hectares. When I visited his plantation in 2019 I saw trees over 20cm diameter. Raposo also maintains a large propagation facility where he raises Pau-brasil seedlings as well as seedlings of other Atlantic Forest species. Over the last 27 years this facility produced 700,000 Paubrasilia echinata seedlings distrubuted by INCAPER, a rural extention service https://incaper.es.gov.br/ as well as donated to the Aracruz Celulose pulp mill.

RENATO CASARA PLANTATION.

Renato Casara and Pau-brasil in 2019

The bowmaker Renato Casara began his plantation in 1995 near the village of Dimetrio Ribeiro and initially was able to source 400 Pau-brasil seedlings to plant. The following year he planted 300 and started producing seedlings in his own greenhouse.. In 2001 he planted 7500 seedlings and distributed 2000 more. From 2002 to 2015 he continued to produce and distribute Pau-brasil His initial planting was up to 25cm in diameter in 2019 when I visited in 2019. An area planted in recent years goes up a hillside and has young trees several meters in height. He keeps a shade house for producing seedlings.

SMALLER PLANTATIONS:

TRÈS IRMAÕS.

This example of Pau-brasil planted to shade cacao and coffee is near the hamlet of Très Irmaõs in Espirito Santo. It has not been inventoried but consists of approximately two hectares thickly planted with Pau-brasil. This is a more recent plantation and the saplings range from 2-4cm in diameter. They have already started to shade the cacao. The variety planted here was the small-leaf or 'folia d'arruda' type native to southern Bahia.

JACUPEMBA This small plantation, designated as a reserve, was planted by the owner of a big farm near the town of Jacupemba, ES. I originally visited the plantation in 2019 and when I visited in January of 2025 it had grown appeciably. In a rough count, there were 336 trees, a number of which were from 14 to 20cm in diameter.

Jacupemba 2024

FAZENDA BOTTONI. The bowmaker Jose Bottoni has a small plantation of Pau-brasil on his farm near Jacupemba, ES. His trees were up to 20cm in diameter in 2019.

Jose Bottoni with Pau-brasil 2018

Jose Bottoni 2018

Fazenda Andre Pissoti 2018

FAZENDA ANDRE PISSOTI. This cocoa farmer has a small plantation of Pau-brasil up to 20cm in diameter in 2019.

TINTORI. The bowmaker Alexandre Tintori started a plantation on his family's farm in the hills above João Neiva in 2019. To date he has planted over 1000 seedlings some of which are several meters in height.

GUARANA TOWN. From seedlings distributed by Floriano Schaeffer beginning in the 1980ies, Pau-brasil is a very common tree found in people's gardens throughout the town and along streets. Pau-brasil is valued for its glossy foliage and bright yellow flowers. Some of these 40 year old trees are up to 40cm in diameter.

RIACHOS or VALÃO

Small steep ravines and creekbeds were exempted from planting eucalyptus on lands of Aracruz Cellulose, later Fibria and now 'Suzano'. pulpmill. (Their eucalyptus plantations cover 320,000 hectares in Espirito Santo state). The ravines were cleared and burned but the company was obliged to replant native vegetation protected as a reserve. Several of the Brazilian bowmakers supplied Paubrasilia echinata seedlings to the mill which were planted in these areas. Floriano Schaeffer's company alone donated over 50,000 seedlings. I have seen and copied the original receipt dated Nov 4, 2005 from the pulpmill. Although many seedlings will not have survived, it can be assumed there is Paubrasil growing in these areas. Personally I have seen scores of small Pau-brasil trees in one of these watersheds on the pulpmill's land with plenty of evidence of regeneration. They have not been inventoried as of yet.

P. echinata on pulpmill land.

FOREST FRAGMENTS:

A handful of second growth woodlands on private land do remain where Paubrasilia echinata historically grew.

CÓRREGO D'AGUA. This forest fragment was selectively logged over the years but was originally ideal Pau-brasil habitat. I first visited here in 2001 then revisited in 2019 and 2024.

Regenerating Pau-brasil at Corrego D'Agua 2025

Flavio Schaeffer with Pau-brasil regeneration at Fazenda Limao. 2018

FAZENDA LIMAO.

This forest fragment was originally adjacent to a lemon orchard. Although selectively logged and encroached upon by coffee plantations, it shows extensive regeneration of Pau-brasil. Trees are generally a few cm in diameter but occasionally up to 13cm. Typically farmers who want to expand their farms, clear and set fire to adjacent forest and this enables them to plant grass for their cattle. However areas that are cleared but not burned regenerate rapidly into a scrub woodland known as 'capoeira'. Pau-brasil invariably sends out shoots

from a stump that can become as large as the original tree and will in time flower. Inaddition the trees are usually surrounded by germinating seed and seedlings waiting for an opening in the canopy.

Haroldo de Lima & Edmond Ganem

BAHIA. EDMOND GANEM PLANTATION

Although this report focuses on Espirito Santo state, numerous other plantings exist in the state of Bahia. In December of 2024 I visited the cocoa plantation belonging to Edmond Ganem. In Bahia, cocoa is grown in the shade of native forest trees in a system called 'Cabruca' and pau-brasil has always been a compontent of this matrix of trees. Starting 19 years ago Ganem decided to plant pau-brasil and other species with the intention of starting to harvest when they reached maturity. The diameter of some of his 19 year old Paubrasilia echinata trees exceeds 40 cm, well beyond the threshhold of approximately 16 cm necesary for harvest. His two plantations consist of 279 hectares and 19 years ago were planted with 13,000 Paubrasilia seedlings prepared by the

Biofabrica and the Ceplac institute. At his estimation approximately 7,000 seedling were successful, including the three varieties known in Southern Bahia. Below these trees numberous seedlings were coming up, readily transplanted to other locations if needed. In addition to Paubrasilia echinata his plantation includes a number of important Atlantic Forest species like Dalbergia nigra.

CONCLUSIONS.

One aspect of the plantations to note is that all trees were propagated from native populations in Espirito Santo with the exception of several locations where varieties from Southern Bahia were planted. Seed is collected randomly from diverse locations in the region and up to the present no attempts have been made to improve the tree's yield other than management techniques like providing shade. For this reason the plantations represent a wide diversity. This could be improved by collecting seed from an even greater number of trees. Most plantations don't fit the image of 'plantation'; most, like the Santa Rosa plantation are well wooded with a range of species. Typically a designated area is set aside in a reserve as part of the forest management plan for a plantation. To my knowledge there are no plantations of Paubrasilia echinata on public land in Espirito santo with the exception in the urban landscape of parks and streets.

Seed pods and foliage, Espirito Santo variety of Paubrasilia echinata.

Years ago within the bowmaking trade there was an image of 100 year old Pau-brasil trees in the primeval forest slowly growing and thereby increasing the quality of the wood. This conception discouraged the idea of replanting for future use. The Brazilian bowmakers planted without actually knowing their trees would mature. But Pau-brasil trees reach harvestable size in a cycle of about 20 years and this has changed the picture radically. I can't see reasons to believe a planted tree is any different from a wild one as long as the growing conditions are similar. Much remains to be discovered by researchers like Geraldo Cuzzuol, but there's no reason to assume a tree in an established forest will grow slower, on the contrary. Pau-brasil seedlings wait for an opening in the canopy and then shoot up to the light. There may be more soil moisture in a forested area. In some areas planted trees, especially in a monoculture, appear to be growing slower than their forested counterparts. There is also great variation in physical characteristics between Pau-brasil trees in the same location.

Inflorescence, Espirito Santo Folia Media variety of P. echinata.

Currently some researchers are looking at selecting for the best varieties to plant. Its also very important to replicate the diversity of the native populations that are or were in the Mata Atlantica. I purchased my personal stock of wood between 1984 and 1988 in Espirito Santo. After some 40 years of using the Espirito Santo variety exclusively for my bows I marvel at the variation in this wood, known locally as 'Sartory' or 'Folha Media'. Densities are ideal, ranging from 1.05 to 1.19 specific gravity. Its also worth noting that the trees this wood came from were commonly under 24cm in diameter. This is the variety in the Espirito Santo plantations I am reporting on.

One observation I've been able to make is that the plantations are not in stasis, Pau-brasil is fecund. Seed is falling and germinating and small trees are constantly growing bigger; all within about a 20 year cycle. Trees I personally planted on Schaffer's plantation in 2019 are now 4 to 7 centimeters in diameter and 3 to 4 meters tall. According to Schaeffer, Pau-brasil trees on his plantation are already flowering and producing seed after ten years. This cycle also applies to native populations that were exploited, either historically or in recent times assuming the land wasn't burned and taken over by agriculture. The image of an illicitly cut tree being gone forever is inaccurate; in ten or twenty years there will be another. It is actually very difficult to kill a Pau-brasil tree because they sucker or send up new shoots. The greatest threat is deforestation.

Pau-brasil planted by the author in 2019 is now 7cm dia. in 2025.

Plantations have the potential to supply all the wood needed by bowmakers and this is only the beginning as the trees are constantly adding girth. Also the sheer numbers of trees in a plethora of locations though Espirito Santo and Bahia make the tree's genetic viability appear much more secure than it was when originally classed. However there are hurdles created by the very measures designed to protect Paubrasilia echinata. Regulation is creating a level of bureaucracy such that the only logical outcomes have included the blanket ban on export of Pau-brasil bows in Brazil. Appendix 1 could be applied to Paubrasilia echinata simply because IBAMA doesn't have the resources; technical or human, nor a willingness to find positive solutions. Appendix one will not stop the illegal cutting of trees but it will put a stop to replanting and at the

same time the plantations will fall into disuse and be eventually set on fire to liberate the land for agriculture. If the owners of the plantations were free to harvest and sell their wood and Brazilian bowmakers were free to export their bows made from it, the paradigm would shift. Would it not be more efficient to help plantation owners provide all the wood the trade needs than invest in ever more complex systems of enforcement and tracking?

Paubrasilia echinata is at a watershed. There is hope for both implementing the use of planted wood and ensuring the species' continuation. With an overture several things need to happen. There has to be a political push to permit the harvesting of Pau-brasil plantations. Someone up the ladder in government may need to address the changes; that leadership may not necessarily come from IBAMA. . Its is important that the wood be openly available to anyone in order to remove all incentive to purchase illegal wood. The Pau-brasil tree has so much importance to so many people for so many reasons.

ABOUT THE AUTHOR

The bow maker, Charles Espey studied bow making in Paris. Between 1984 and 1988, he became fluent in Portuguese and spent many months in Espirito Santo State in Brazil where he selected the wood that would last his career. At that time he met Floriano Schaeffer who introduced him to the incredible diversity of the Atlantic Forest. In 2000-2003 he assisted in the development of a major Paubrasilia echinata conservation initiative in Bahia and was able to witness the beginnings of the Brazilian plantations in Espirito Santo. Concurrently he introduced new methods for conserving wood in the milling process. In 2018-2019 he spent several months in Brazil visiting and reporting on plantations and helping plant and propagate Pau-brasil. Presently he is in Brazil for two months researching and working to support the plantation efforts.
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Photographs by the author.

APPENDIX 1
CALCULATING THE YIELD OF BOW WOOD FROM TREES

If plantations are going to be considered as a solution to the issues facing Paubrasilia echinata as well as the world of classical music and its artisans, there needs to be an accepted way to quantify their potential to supply wood. Cubic meters are often used to define the amount of wood coming from trees or logs but they do not reliably predict the number of bows they could represent or trees they might contain; which is what we really want to know.

We want to know without question the potential of various plantations to supply the world's makers of bows. Do the plantations have enough wood right now to unmistakably and sustainably provide all the wood needed while providing a sanctuary for Paubrasilia echinata as a species? Yes or no?

Historically bowmakers and wood dealers in Brazil had a system for milling wood that was wasteful. I have demonstrated that the potential yield will at least double with good techniques and equipment. Clandestine cutting of wood is especially wasteful. In general there has been a lot of confusion about yield and in fact there are a lot of variables.; the sapwood can be wider than average or there could be cracking or knots. My approach here is to calculate the ideal potential yield of a tree of given diameter and then simply reduce it by a factor of three so there is no question it can provide at least that number of bow sticks. A factor of 2 may be more realistic.

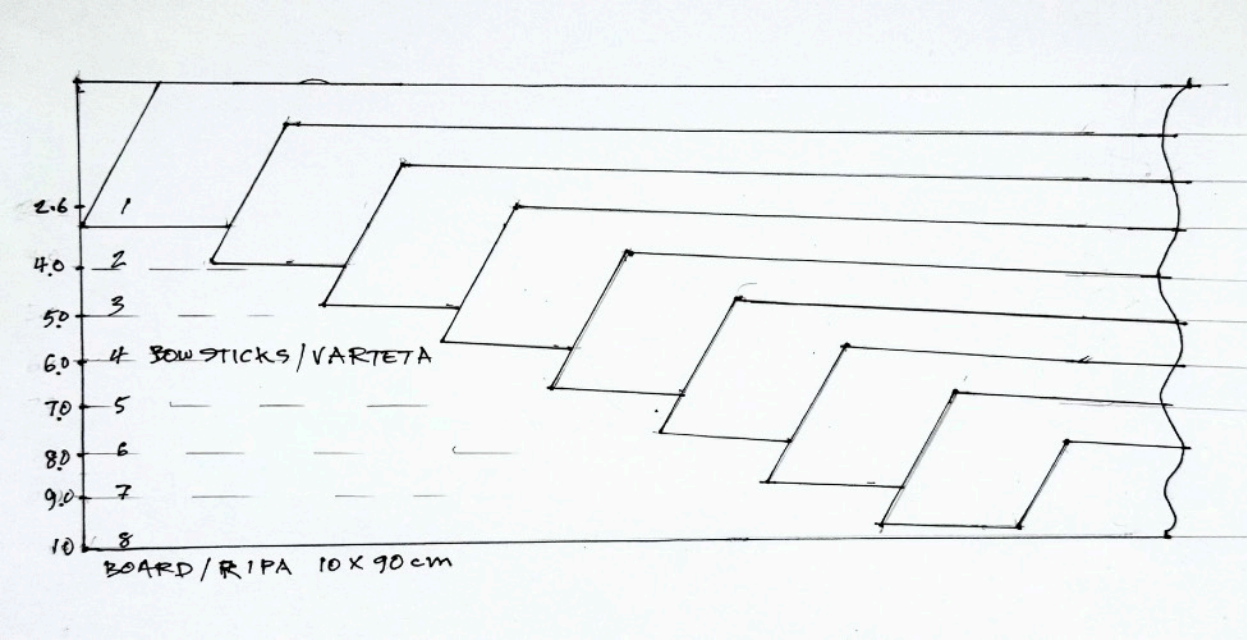


Fig. 1.
Here the diagram shows how a board is traditionally cut in France into bow sticks of the right orientation. Each head is sandwiched to the next and as noted a board of 6cm in width
can produce 4 sticks and so on. So when we look at the end of the log at Fig. 2 we can see the ends of the boards and their potential yield in sticks.

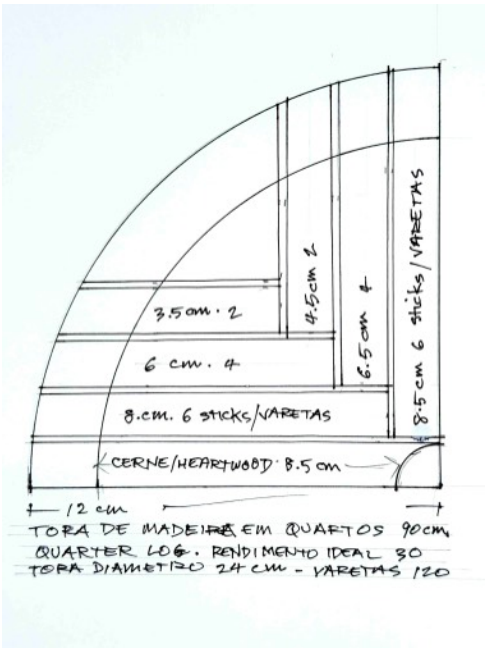
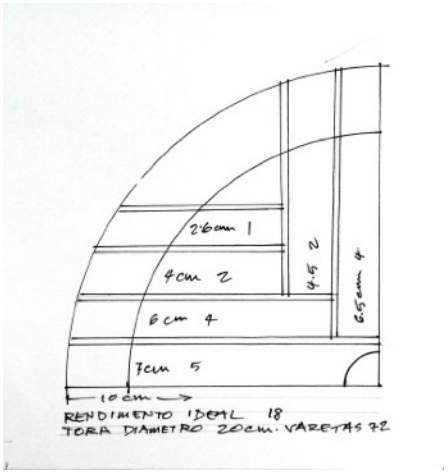
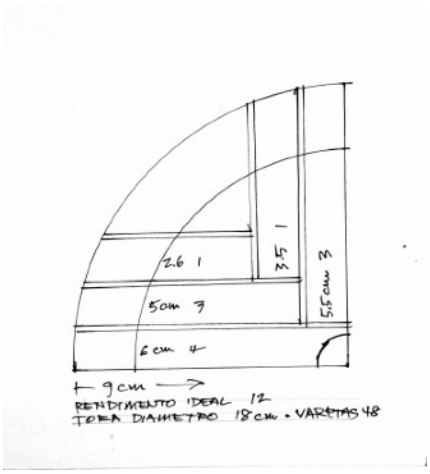
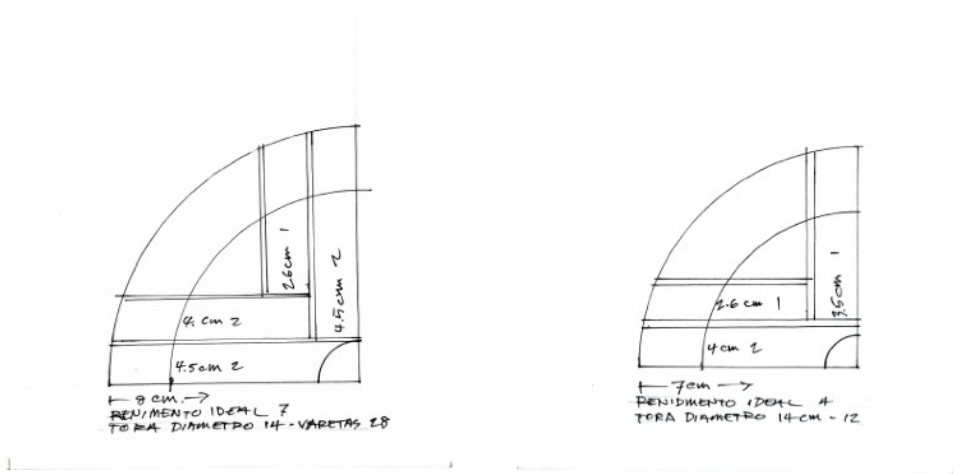


Fig. 2.
Traditionally each log section is cut into quarters following the centerline and subsequently boards are cut out in a 'herringbone' pattern As on the diagram, the presence of white sapwood reduces the useable wood by 2 cm. Then the center usually has some cracking so we can reduce by about 1 centimeter. In this case the log is 24cm diameter and the ideal yield of the quarter or cant is 30 sticks or 120 for the whole log section. In figures 3-6, it can be seen that the yield goes up dramatically with increases in diameter. Going from 16cm diameter to 20cm diameter the potential number of sticks goes from 28 to 72, more than doubling. In order to have a reasonable yield we would like a tree to be of at least 16 cm in diameter. This enables a heartwood board of about 4cm in width, often wide enough to produce 3 bow sticks.







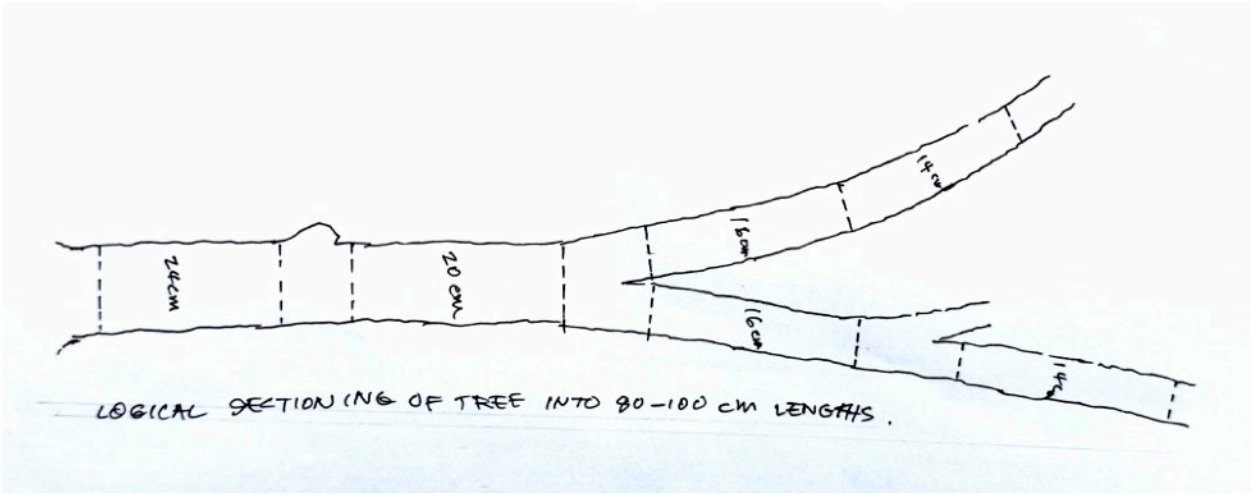


Fig. 7
Pau-brasil logs are sectioned logically to avoid issues like knots but they are typically one meter long and but can range between 75 and 100 cm. Each section is approached individually. Depending on exposure to light and other elements a tree often forks several times. There is some disagreement in Brazil as to whether the upper parts of a tree are referred to as branches or continuations of the trunk but the important factor is a diameter of at least 13cm.

Sections of a trunk can arc or bend to one side. In this case the entire log can be cut into flitches in the plane of the curve. Then individual sticks can be marked to the curve with a bent batten. In this case about 60% of the wood can be used.

An example. In figure 7. there are 6 sections with potential yield. Based on our calculations for sections of various diameters we can predict the ideal potential yield of the tree:
24cm = 120
20cm = 72
16cm = 28 x 2= 56
14cm = 12 x 2= 24
———————
Total = 272 ideal potential bow sticks.

Divided by factor of 3= 90 Sticks.
Going further we can take the total world output of pau-brasil bows estimated at 15,000 and divide it by 90. Thus 166 trees of that size would fulfill the usage. But since the average tree is smaller we are still trying to know for sure without a complete survey whether the Santa Rosa plantation can fulfill the demand. If an average tree had only two 20cm diameter lengths then the potential number would be 142 and divided by 3 it would be 47. If the average tree only produced 47 sticks, 320 trees would still only be a small fraction of the estimated inventory of 10,000 trees. The answer is yes, The Santa Rosa plantation alone can supply the worlds use of Paubrasilia echinata wood.

APPENDIX 2
CONSUMPTION OF PAUBRASILA ECHINATA BY BOWMAKING.
Its is out of the scope of this report to define the actual yearly demand for Paubrasilia echinata wood but its important to illustrate the overall picture because this picture is very complex. Basically if there was an open market for wood, how much would be purchased in a given year? How much wood should the plantations be prepared to supply to take care of the world's use of Paubrasilia echinata? The underlying objective is to remove any incentive for anyone to purchase wood from the native forests in Bahia or elsewhere.

Bow makers work from stocks of wood that usually were purchased many years ago. This is partly to ensure that the wood dries and seasons but also to be supplied in the event of a lack in availablity which is what actually occured some years ago. The larger Brazilian, German and possible Chinese bowmaking firms had stocks that enabled them to work for years until plantation trees matured. I have seen the stocks of wood at Bogen Schaeffer and also those of Arcos Brasil, another of the biggest bowmakers in Brazil. I can't imagine them needing to get more in the next years. Much of this wood was purchased in the nineties or earlier when the permitting of wood was simpler. These stocks are certified by IBAMA and accompanied with all the paperwork. In the case of some companies IBAMA has questioned the proper documentation or outright legality of some of their stocks and confiscated wood. But it doesn't change the fact that the great majority of this wood is accompanied by documentation; if it wasn't it would have been seized.

This brings up the intrinsic difficulty in quantifying Pau-brasil wood and for IBAMA to keep track of what bowmakers have. The actual yeald of useable wood from any form of wood varies enormously based on how the wood is selected, cut and prepared into bow-sticks. Then the bow sticks themselves in any given lot will have a percentage of sticks that will not make a bow depending on how many defects got through the selection process. The original logs could be cut wrong losing 50% of the potential yeald. Or the logs could be cut into boards without selecting out defects. Since IBAMA historically has had a strong level of distrust for the bowmakers, sometimes with good reason; this was exagerated by the variability of the wood. If a maker did a good job of preparing and cutting wood into sticks they would be suspected of adding sticks of illegal origin to the mix. If a maker had a poor yield of sticks then that would reinforce the idea that a given amount of wood could only produce that many sticks. If there was a given quantity of sticks the bowmaker could be suspected of putting in unusable sticks that would be replaced with undocumented wood. In addition there could be a certain number of sticks in a given stack of wood but an IBAMA inspector might not believe it. But they might not have the time it took to do the counting. This made for a painful and disfunctional system of monitoring bowmaker's stock over the years.. If only all this could be relegated to the past and makers could have all the wood they needed from a plantation.

The type of wood is also a variable. The more common wood available in the plantations would easily satisfy the needs of the Brazilian and German companies who are making large numbers of student bows. But the makers of professional bows have to meet high standards and they are working from seasoned stocks. In this case we are talking about very small quantities of wood relatively but if these makers could access documented wood of high quality how much would they want in order to replenish their supplies for the future? I believe that highly selected wood from the plantations will fill this need because they include enough trees of the Bahian varietes that are also desired by some bowmakers.

So when wood in the plantations becomes available will bowmakers in general want to replenish their stocks? It seems likely. We don't know exactly what this demand is but we can use the number of bows in different categories sold per annum worldwide. The German bowmaker, Thomas Gerbeth, informed me that the current world production of Pau-brasil bows per annum was 15,000, down from about 25,000 pre-pandemic. I have arbitrarily used the figure of 15,000 to look at the potential of plantations to supply wood. It seems reasonable to be able to double this figure if necessary.

APPENDIX 3

QUALITY DEMANDS ON PAUBRASILA ECHINATA FOR BOWMAKING.

The requirements for bow making wood should be discussed here because they illustrate how the wood from plantations can be used. IBAMA in particular has questioned whether the plantation wood is of high enough quality to actually use. It is true that probably a small percentage would be suitable for professional level bows but they only represent a few percent of the bows made today. There is always a range of physical charteristics between trees of any poplulation of Paubrasilia echinata and there are ways to evaluate them before they are cut. Methods include an increment borer that extracts a small sample and the Pilodyne which drives a small pin about a centimeter deep into a tree's sapwood.

Bowmaking wood typically needs to dry and this can be best achieved in a relatively dry environment with the wood cut into sticks of the minimum size. In this case it can be ready to use in as little as one or two years for student grade bows. This can be reduced in a dehumidified environement. However wood also goes through a seasoning process in which the woods' physical properties improve over the years. Wood in general is allowed to season as long as possible especially for professional grade bows. This is why bowmakers normally buy their wood in advance.

Bows are made in three grades; nickel, silver, professional.. Nickel bows are for beginning students and represent about 60 percent of the market. Silver bows are destined for more gifted student or amateurs and represent perhaps 38% of the market. Professionals and young artists playing in a conservatory and headed for a professional career will usually have either a professional level contemporary bow (also with silver mounts) or one made by an old master.

The bows in the nickel category do not need high quality wood, virtually any pau-brasil in the Espirito Santo plantations will be adequate. So 60% of the bows can use any wood the plantations produce. The Silver bows demand wood that is a bit denser and stiffer. The bowmakers flex each stick and assign it to either nickel or silver. I am assuming that the better half of selected plantation trees will be perfectly adequate for 'silver grade' bows.

The professional level bows use wood that is more attractive, usually denser and stiffer but it depends on the bow maker's taste and the demands of the particular bow. There are several regional varieties of Paubrasilia echinata valued for professional level bows and some of the Espirito Santo plantations have these Bahian varieties growing as well. The maker of professional bows is willing to pay a premium to select the top few percent in quality. I am guessing that there there may be no more than 1,200 bows a year in this category but most of these makers already own pre-convention stocks of wood they are using. I estimate that those selected stocks worldwide if shared would supply the makers of professional level bows for at least ten or twenty years. They typically make between 10 and 24 bows per year.

The three varieties of Paubrasilia echinata in Bahia. top: Folia Da Cafe, bottom: Folia Da Laranja, left: Folia d'Arruda.