

**Brazilian woods in Portuguese xylarium****Madeiras brasileiras em xilotecas portuguesas**

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**ABSTRACT**

The geographical origin of the wood samples in xylotheques (xylaria, wood collections) are part of the history of knowledge on the biodiversity of a given region. Portugal was the colonizer of Brazil and the transport of wood from the 16<sup>th</sup> century onwards played a significant part in the relationship of the two countries. This prompted the present study which has the following aims; to survey existing

Portuguese xylotheques, identify their samples of Brazilian woods and thus contribute to future studies concerning the origin and distribution of species of Brazil's tropical forests, analyse and characterise the different kinds of wood collection surveyed, as well as identify some woods described by means of data obtained from interviews. Sixteen xylotheques were identified and investigated in Portugal and a survey of the Brazilian species contained in them was carried out. These xylotheques were of qualitatively different types: scientific, technological, expository or historical. It was also observed that the concept of a xylarium in Portugal varies from a simple collection of wood samples in cabinet or a box, to a physical space of larger dimensions reserved specifically for the storage of samples or collections. A total of 3,126 Brazilian wood samples were found. Despite the many expeditions carried out from the 16<sup>th</sup> century and the numerous shipments of woods sent from Brazil to Portugal, especially from the 18<sup>th</sup> century onwards, no samples derived from them were identified except in historical xylarium. Instead it was found that most Brazilian samples had been obtained through donations and exchange with Brazilian institutions. In contrast, the African wood samples had been obtained by expeditions undertaken by Portuguese institutions from the 20<sup>th</sup> century onwards. This can be explained by the emergence only in that century of specialized laboratories. By then it had been recognized in Portugal that due to the increase in global consumption of wood, there was a need to develop technological and scientific expertise on such a valuable resource, and consequently in 1948 the Board of Overseas Scientific Investigations decided to set up the Laboratory of Wood Histology and Technology, with well-defined objectives.

**Keywords:** wood samples, conservation, biodiversity, collections.

## RESUMO

A origem geográfica das amostras de madeira existentes nas xilotecas contribui para a história do conhecimento da biodiversidade de determinada região. Sendo Portugal o colonizador do Brasil e as relações entre estes dois países, inclusive trânsito de madeiras, provindas desde o século XVI, este trabalho teve como objetivos, fazer o levantamento das xilotecas existentes em Portugal, identificar as coleções de madeiras brasileiras existentes nessas xilotecas, como contributo para futuros estudos referentes às origens e distribuição de espécies da floresta tropical brasileira, analisar os diferentes conceitos que se dá ao termo xiloteca e suas qualificações tipológicas, bem como realizar a identificação de algumas dessas madeiras descritas com base em dados gerados de entrevistas. Identificaram-se e investigaram-se dezesesseis xilotecas em Portugal, tendo-se feito o levantamento das espécies brasileiras, nelas existentes. Destas, observaram-se qualitativamente diferentes tipologias como: científica, técnica, expositiva e histórica. Além disso, notou-se que o conceito de xiloteca em Portugal varia desde uma coleção de amostras de madeiras, num armário ou caixa, até um espaço físico com dimensões razoáveis, reservado para a guarda das amostras ou coleções. Foram encontradas 3126 amostras de madeiras provenientes do Brasil. Apesar das diversas expedições ocorridas a partir do século XVI e das inúmeras remessas de madeiras que foram enviadas do Brasil para Portugal, com grande ênfase a partir do século XVIII, não se identificaram amostras dessas, com exceção na tipologia histórica. O que se observou foi que a maioria das amostras do Brasil são obtidas a partir de doações e trocas com instituições brasileiras. Diferente do que se observa para madeiras provenientes de África, que foram obtidas a partir das expedições realizadas por instituições portuguesas desde o século XX. Este fato pode ser explicado pelo surgimento, apenas neste século, de laboratórios especializados. Em Portugal, devido ao aumento do consumo mundial de madeiras, verificou-se a necessidade de evoluir nos conhecimentos técnicos e científicos deste tão nobre material e, no ano de 1948, a Junta de Investigações Científicas do Ultramar achou oportuno criar o Laboratório de Histologia e Tecnologia de Madeiras, com objetivos bem definidos.

**Palavras-chave:** amostras de madeiras, conservação, biodiversidade, coleções.

**1 INTRODUCTION**

Trees play a major role in the social and economic life of human populations. The trunk is of fundamental importance because it is the source of wood. It is made up of the sapwood and the heartwood which can usually be distinguished by their different colours. The sapwood is the external and paler zone and is active in transporting water and mineral salts throughout the tree, whereas the heartwood is internal and inactive.

Usually the heartwood is darker and varies in colour, e.g. brown to black as in the pau-ferro (*Caesalpinia ferrea* Mart ex Tul.), violet as in the miolo-de-negro or pau-violeta (*Dalbergia cearensis* Ducke) or red as in pau-brasil (*Paubrasilia echinata* (Lam.) Gagnon, H.C.Lima & G.P.Lewis), from which brazilwood dye is extracted and which was much sought after by Europeans, especially the Portuguese, during the colonial period. It should be emphasized that this variety of colours is due to chemical alterations that take place after cell death in the sapwood, resulting in a range of distinct chemical compounds that are responsible for the different colours seen in the heartwood (BESSA, 2009).

Trees produce a great deal of tannin, among other products and this also attracted the attention of the colonizers who used it for tanning leather and making glue. Tannin is abundant in mangue-vermelho (*Rhizophora mangle* L.) and the angicos (*Anadenanthera* spp. e *Piptadenia* spp.), which were species exported to Portugal in the 18<sup>th</sup> and 19<sup>th</sup> centuries (Remessa 578 ARF and other MUHNAC). Nevertheless, it was the great importance of wood for construction and manufacturing, as well as the demand for brazilwood dye, which led to the increase in exports of other woods from different species from the 16<sup>th</sup> century onwards.

The volume of timber shipped to Portugal increased considerably from the 18<sup>th</sup> century. This transport was in large part directly linked to the earthquake which razed Lisbon in 1755 and destroyed the timber stores, houses and other buildings of the Portuguese metropolis. This tragic event brought about the need for large scale shipments of all types of timber for shipbuilding, reconstruction of buildings including the royal palace of Lisbon, and the manufacture of furniture, stairways and in particular frigates.

The trade in wood corresponded to the first of the four economic cycles of Brazil. Pau-brasil is the species best studied and documented by historians. However, the focus on this species has resulted in a lack of information on other species that yielded timber of high quality and which were also exploited by the Portuguese (FADIGAS, 2011).

While timber and other exports such as coffee, sugar and tobacco were being taken to Portugal over the centuries, there was also a change in the kinds of transport which carried these exports. It began with sailing frigates, then came the steamships which were responsible for the mass transport

of Brazilian timbers, and finally transport by rail and road. These changes were also closely associated with the use of Brazilian wood, especially in the case of steamships, since they were built using the same Brazilian timbers they would transport, and it was in Brazil where they were constructed and repaired (ELLIS, 1950).

Wood is a resource with characteristics of great merit. It comes from trees, which live together with other plants and can be managed sustainably, meaning that timber can be exploited from trees without necessarily destroying the whole ecosystem. Paula (2005) says that "wood is one of the most highly valued features of trees and the most sought-after by human society". Wood has always been of fundamental importance in naval and civil construction and in the furniture industry; it is an excellent thermal insulator and in civil construction it offers the least expenditure of energy for house-building. The problem has always been the prevalence of its disorganized exploitation and the absence of rational sustainable use, which if implemented would ensure its long-term availability.

The Brazilian timbers transported to Portugal were not scientifically identified and there was no scientific understanding of their properties and applications. The identification of the structural anatomy of a timber makes it possible to detect variation among species as well as their different physical and mechanical properties. This structural variation facilitates the choice of the best species for particular applications (CORADIN; CAMARGOS, 2002; OLIVEIRA; SILVA, 2003; GONÇALVES et al., 2007). Historically the use of timbers was determined by the woodworker who decided which to use for what purpose. Senhor José Aniceto Raposo was an important master cabinetmaker of the late 18<sup>th</sup> and early 19<sup>th</sup> centuries who created many important works in Portugal and was also the first to stress the characteristics of different timbers and their conservation; he made an important early contribution to the creation of the different xylarium (OLIVEIRA, 2003).

Because the characteristics of the timbers were unknown to the Europeans, they were given the same names used by the indigenous people such as matataúba, tatajuba, cumaru etc. Among these some of the most frequently mentioned species are those used for shipbuilding: angelim (sternposts), jetaípeba (knees), pau-d'oleo (mast), pequi (keel), sapucaia (knees), pau-santo (right) e vinhático (panelling), which were used not only by the navy but also for the architectural reconstruction of Lisbon (LIMA, 2017).

The great economic importance of the exploitation, trade and use of timbers and the enormous diversity of species and their wood properties has led in the present era to the need for their identification, monitoring and technological characterisation (BESSA, 2009).

Some fifteenth century chroniclers referred to our natural resources, but nobody described the construction timbers better than Gabriel Soares de Souza in the century in which Brazil was discovered. An experienced explorer of the interior and a sugar planter, he was one of the first to list

the timber species used for shipbuilding, and the construction of houses and sugar mills in the region of Bahia. The list he made is of great historical importance, giving for each species its vernacular name, indigenous name and a description of its main characteristics, dimensions and uses (OLIVEIRA, 2003).

Because of the great value of tropical timbers, especially those of Brazil, their export to Portugal took place on a large scale and reached its peak in the 18<sup>th</sup> century. To showcase their characteristics, sample collections were prepared from the wood of the logs (*páos ou paus*) sent for different uses, together with other botanical and zoological specimens that accompanied the shipments. In general, wood collections around the world were assembled for study purposes in agricultural and forestry colleges and research institutes, including those dedicated to wood technology (STERN, 1957; IICT, 1983). Thenceforth, from the 18<sup>th</sup> century, the first Portuguese xylarium came into being.

Various definitions of the term xylotheque (Greek *xylon* = wood; *theke* = cabinet, box, repository):

- **Leon (2009):** a collection of wood samples organized according to some definite criterion.
- **Oliveira (2015):** the name given to wood collections in a particular place, dedicated to forestry and technological studies and research.
- **Thulasidas (2003):** a collection of authenticated and prepared wood samples.
- **Beeckman (2003):** a collection of wood samples from woody plants.
- **Bessa (2009):** an archive of timbers or a place where collections of identified wood samples of various species from different geographical origins can be found.

This shows that the concept of a xylotheque is quite wide and within this range there are certain common practices concerning the use of the wood samples for study, procedures which have to do with the way the samples are stored and preserved. However, during our survey of Portuguese xylotheques we found the use of this term was somewhat different to that we had previously encountered, the term xylotheque being used in various different ways, e.g. for a collection of wood samples stored in a cabinet or a box, or in a physical space with a stable environment and ample space for housing samples or collections. The way the xylotheque concept is applied in practice in Portugal will be explained later in more detail.

For many decades, the wood collection of the Forest Products Laboratory in Madison (USA), with around 100,000 wood samples, was considered the largest in the world. However, Baas (2011) stated that the richest wood collection was in the Netherlands, with more than 100,000 samples in

three xylotheques at Wageningen, the Utrecht Collection and the Amsterdam Collection. In addition to these there is the collection at the Royal Botanic Gardens Kew (UK) of which the original specimens were housed in the Museum of Economic Botany, inaugurated in 1847. Kew began as a simple garden belonging to the royal family and was then expanded into a botanic garden before a period of decline in the early 19<sup>th</sup> century. In 1840 it was revived as a government institute and the wood collection then grew later in the 19<sup>th</sup> century with the addition of collections from various explorers and botanists; today it is a leading plant science research centre (CORNISH et al., 2014).

In Brazil there are about 32 xylotheques in five major regions: North (5), Northeast (7), Centre-West (4), Southeast (12) and South (4), comprising a total of 184,395 specimens (BARROS & CORADIN, 2015). According to these authors the Dr. Calvino Mainieri Xylotheque of the Institute for Technological Research of the State of São Paulo S.A. – IPT (BCTw) is the largest and oldest in terms of the number of specimens. The Professora Dra. Maria Aparecida Mourão Brasil Xylotheque, at the Julio de Mesquita Filho Paulista State University (UESP) contains wood samples from the cerrado and is important for the species diversity there represented. The most recent Brazilian xylarium are: the Profa. Dra. Maria Aparecida Mourão Brasil Xylarium, State University of São Paulo (Universidade Estadual de São Paulo) (2005); the Joinville Xylarium (Universidade Rural de Joinville) (2005); the Cecília Gonçalves Costa Xylarium (UENF) (2005); the Professor José Pereira de Souza Xylarium, Federal University of Bahia, Salvador (UFBA) (2012) and the Pontifícia Xylarium Catholic University of Rio de Janeiro (2012).

The Professor José Pereira de Souza Xylotheque (PJPSw), previously mentioned as one of the newest in Brazil, has 1300 specimens (INDEX XYLARIORUM). It is also important in bringing together wood samples of species that are of historical importance for the epoch when Brazil was a colony of Portugal, during which Salvador was the first capital and a centre for the export and application of the many uses of the native timbers. This collection is thus a research centre for the study of timbers that were important in the colonial period.

According to the xylarium's function, each specimen must be registered with data giving the taxonomic identification and geographical origin of the collection (FONSECA et al., 2005). This is critical for the use of the specimens in scientific and technological research and as reference material for comparisons, providing support to the timber trade and to the legal authorities charged with controlling and monitoring the sustainable use of wood.

The geographical origin of the wood samples in xylarium contributes to the history of the scientific knowledge of the biodiversity of a given region. Knowledge of the occurrence of particular species in a given locality can provide a basis for various kinds of research study involving the solution of taxonomic, phylogenetic, anatomical and ecological problems (FONSECA et al., 2005).



However, wood samples are often received by laboratories without any information, even their geographic origin. To resolve this difficulty wood anatomists have undertaken many studies to identify differentiating characters which permit the identification of timbers using their anatomy, and this is especially important for tropical woods which have such vast diversity.

Since Portugal was the colonizing power in Brazil and the connections between the two countries date back to the 16th century, this study aimed to make an inventory of the xylotheques of Portugal, identify the collections of Brazilian woods housed in them thus contributing to future studies concerning the origin and distribution of the species of the Brazilian tropical forest, study the different definitions and use of the term xylotheque and carry out the identification of some of these woods which have been described on the basis of information from interviews.

## **2 METHODS**

The surveys of Portuguese xylotheques were carried out between October 2014 and March 2015. The data thus obtained were used to make an inventory of the Brazilian species existing in these collections.

### **2.1 ANALYSIS OF INTERVIEWS**

Interviews were undertaken with the coordinators and curators of the museums, universities and other institutions housing the xylotheques visited. The questionnaires contained headings for the name and description of the collection, the number of Brazilian specimens, the preservation methods, the procedures for accession of specimens into the collection and the manner in which specimens were obtained from Brazil.

In addition, the vernacular names given in the documents that accompanied samples shipped to Portugal from Brazil were recorded and compared with current information.

### **2.2 MACROSCOPIC IDENTIFICATION OF THE TIMBERS**

For macroscopic identification information from interviews was used which contained the names of samples of Brazilian woods from the 18<sup>th</sup>, 19<sup>th</sup> and 20<sup>th</sup> centuries and these were recorded in an Excel worksheet. The Brahm's data base of the José Pereira de Souza Xylotheque (PJPSw) of the Biological Institute (IBIO) of the Federal University of Bahia (UFBA) was then used to search for these names. This data base contains the vernacular and scientific names of woods that occur in Bahia and throughout Brazil based on the metadata of wood specimens in xylotheques, allowing comparison with the names of Brazilian woods from the 18<sup>th</sup> to 20<sup>th</sup> century which had been found in Portuguese documents and obtained through interviews in Portugal.

Based on this, identification consisted in applying the probably scientific names to the specimens. Finally, macroscopic identification was carried out using wood specimens of the José Pereira de Souza Xylotheque (PJPSw) as supporting material for comparing the characteristics of the woods identified in the interviews with modern literature, in order to discover the true scientific identity of these woods. The reference works used to confirm the probable scientific names of the woods were: “Atlas da Diversidade de Madeiras do Cerrado Paulista” and “Fichas de Características das Madeiras Brasileiras”. In addition the online data base Flora do Brasil was also consulted. The anatomical characters used were: type and arrangement of the axial parenchyma, arrangement and grouping type of pores/vessels, distribution of the rays and visibility of the growth rings.

### **3 RESULTS AND DISCUSSION**

#### **3.1 ANALYSIS OF INTERVIEWS**

Approximately sixteen xylotheques were identified which were classified into four types: **Historical, Scientific, Expository and Technological** (Table 1, Fig. 1). Apart from the historical collections, the included samples consist of 1,148 specimens of Brazilian woods sent to Portugal in the 20<sup>th</sup> century (Table 1, Fig. 1) and acquired in different ways. Although there were many expeditions to Brazil from the 16<sup>th</sup> century onwards, particularly from the 18<sup>th</sup> century, there appears to have been no recognition of the need to create a xylotheque on the one hand and on the other to continue to add wood specimens to it with the aim of building a collection to be used for various purposes. What we observed was that most Brazilian specimens in Portuguese xylotheques were obtained by donation and exchange with Brazilian institutions. Lourenço (2009) explained that lack of funding is one of the causes for the lack of motivation in the continuation of these collections, reflected also in university collections, and this vulnerability poses a risk to this heritage. This same author proposes the adoption of the measures taken in Great Britain, the only European country to have resolved this problem. The UK government found that there was a significant part of the national heritage held in universities that had been abandoned without adequate methods of preservation and was practically inaccessible. With the aid of sponsors, the government obtained direct financial support for the artistic, scientific and cultural heritage of the universities which made the British university museums the most well established in Europe. A different situation could be observed in the case of woods originating in Africa which were acquired by means of expeditions carried out by Portuguese institutions during the 20<sup>th</sup> century. At that time, and due to the increasing global consumption of timber, there was a recognition of the need to set up specialized laboratories.

Only four historical xylotheques were found, that is, consisting of woods organized during previous centuries (Table 1, Fig. 1). These xylotheques consist of specimens of tropical woods,



mostly Brazilian, contained in exquisitely crafted containers and arranged according to the vernacular names used in the past, and in many cases still used today. The Academia de Ciências de Lisboa (ACL) has two of these xylotheques. Both consist of wooden cabinets with the specimens beautifully organized in drawers (Table 2). One of these is situated in the Brazil Room of the ACL and has been studied by Machado & Antunes (2015). According to these authors it is one of four such collections prepared by Aniceto Raposo that were commissioned in 1805 by the Prince Regent of Portugal, Dom João, the future King Dom João VI. According to its documentation, it consists of 1,213 specimens from Brazil and 12 of different origins, which came from a shipment of 5,008 wood specimens from Brazil sent in 1784 by the Viceroy of Brazil Luís de Vasconcelos to the Royal Arsenal of the Army in Lisbon. There is another historical xylotheque (Table 1, Fig. 1) at the National Museum for Fine Art (Museu Nacional de Arte Antiga) consisting of a wooden cabinet containing the specimens exquisitely organized in drawers similar to those at the ACL. According to Machado & Antunes (2015), this xylotheque was also made by Aniceto Raposo. They base this conclusion on the fact that this craftman had received a payment in 1802 to prepare a showcase of exotic woods, as well as the presence of his cabinetmaker's stamp (JAR) on the cabinet. This is certainly one of the four xylotheques to which Machado & Antunes (2015) refer and which are cited in a note in the *Jornal de Coimbra* p. 324, vol. 1, n. 5 on 5 May 1812, which runs as follows:

"In the year 1805 Our Lord the Prince Regent (D. Pedro III) was pleased to send to the University of Coimbra a collection of woods from Brazil comprising 1,095 highly polished wooden blocks with their beautiful natural colours. They are not from all States of Brazil but only from the Capitánias of Pernambuco, Maranhão, Pará and Bahia. José Aniceto Raposo of the city of Lisbon was entrusted by High Order to put the 4 collections into good order: one for a gift made by His Royal Highness, another for Coimbra, another for the Ajuda Cabinet and another for the Chamber of His Royal Highness."

In the search for the other xylotheques cited in the study of Machado & Antunes (2015), another cabinet very similar to those at the ACL and Museum of Fine Art was found at the University of Coimbra. However, this one was empty and was being used to store histological slides, according to information obtained there. More detailed study is needed of these historical xylotheques, especially to identify scientifically the woods that they contain.

According to our interviews, the Faculty of Sciences of the University of Porto is the institution has the xylotheque with the largest (762) number of Brazilian specimens, from the regions of São Paulo, Rio de Janeiro and Pernambuco. Next largest is the Xylotheque of the Lisbon Academy of Science with 500 specimens, and the Xylotheque of the Tropical Botanic Garden with 343 specimens

(Table 1). The Portuguese xylotheque with the fewest Brazilian wood specimens is the Xylotheque of the University of Lisbon/Natural History and Science Museum, with only 14 specimens (Table 1).

Most Portuguese xylotheques vary considerably in the organization of their collections: storage of the wood samples in open or closed cabinets, bookcases with shelves and drawers; the samples fitted into a frame with a surrounding moulding that secures them (Table 2). In the Museum of Évora there is a historical xylotheque very different from others known for Brazilian specimens which consists of a wooden case containing 250 samples of Brazilian woods (Table 1; Fig. 1). The name of this xylotheque is that of Frei Manuel do Cenáculo, but is also called Caixa-Xiloteca ME 1341. The collection is organized in a case with the wood specimens preserved by poisoning, and access to them is by vernacular name (Table 2).

Preservation of the woods in Portuguese xylotheques is usually by means of climatic control, poisoning and deinfestation (Table 2). Brazilian specimens have been obtained for the most part by donation (Table 2).

Table 1. List of Portuguese xylotheques: Number of Brazilian specimens in descending order. *SI* = No information. *SN* = No name. *NT* = Absent.

<b>Name of Xylotheque</b>	<b>Institution</b>	<b>N° Brazilian specimens</b>	<b>Purpose</b>
<i>SN</i>	Faculdade de Ciência da Universidade do Porto	762	Scientific and expository
ACL	Academia de Ciência de Lisboa	+ 500	Historical
<i>SN</i>	Museu Nacional de Arte Antiga	+500	Historical
Jardim Botânico Tropical	Instituto de Investigação Científica e Tropical	343	Scientific and expository
Florestas e Produtos Florestais	Instituto Superior de Agronomia da Universidade de Lisboa	290	Scientific
Frei Manuel do Cenáculo	Museu de Évora	250	Historical
<i>SN</i> . A coleção de madeiras faz parte do acervo de Botânica do MCUC	Universidade de Coimbra	183	Scientific
Albino de Carvalho (ALCw)	Instituto Nacional de Investigação Agronômica e Veterinária (INIAV)	99	Technological and Scientific
Madeiras da Amazônia	Laboratório José Figueiredo II (Mobiliário)	50	Technological
Laboratório José Figueiredo	Laboratório José Figueiredo I/ Direção Geral do Patrimônio Cultural	-50	Technological
Mostruário brasileiro	Laboratório José Figueiredo I/ Direção Geral do Patrimônio cultural	45	Technological
<i>SN</i>	Colégio Militar de Lisboa	40	Expository

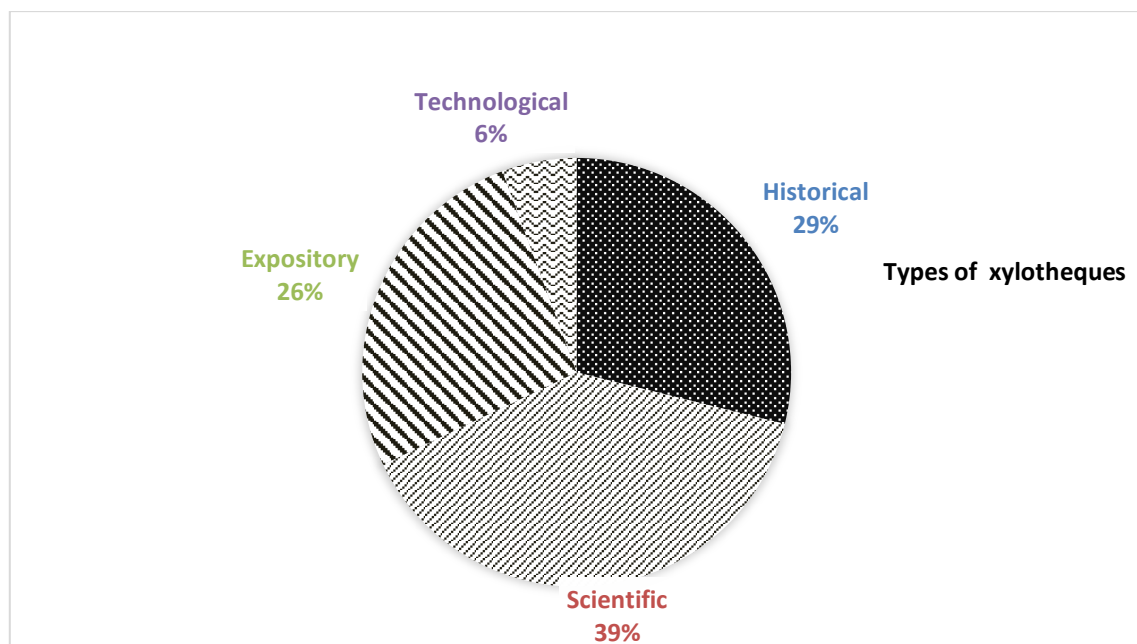
<i>SN</i> . Integrada na Coleção de Objetos Naturais e Etnobotânica. Jardim Botânico MUHNAC	Universidade de Lisboa/ Museu Nacional de História Natural e da Ciência	14	Scientific
ACL	Academia de Ciência de Lisboa	<i>SI</i>	Historical
Madeiras da África	Laboratório José Figueiredo II (Mobiliário)	<i>NT</i>	Technological and Expository
TOTAL		+3126	

Table 2. List of Portuguese xylotheques: General characteristics of their organization.  
*SI* = No information. *SN* = No name.

Name of Xylotheque	Institution	Collections organization	Form of preservation	Cataloguing	Origin of Brazilian accessions	Purpose
ACL	Academia de Ciência de Lisboa	Cupboards with drawers	<i>SI</i>	<i>SI</i>	Unknown	Historical
ACL	Academia de Ciência de Lisboa	Cupboards with drawers	<i>SI</i>	<i>SI</i>	Unknown	Historical
Frei Manuel do Cenáculo	Museu de Évora	Boxes	Poisoning	Vernacular name	<i>SI</i>	Historical
<i>SN</i>	Museu Nacional de Arte Antiga	Gavetas	<i>SI</i>	<i>SI</i>	<i>SI</i>	Historical
<i>SN</i> . The wood collection is part of the collections of the botanical department of MCUC	Universidade de Coimbra/ Museu da Ciência (MCUC)	Closed cupboards	Deinfestation of the Museum space	Vernacular name and/or scientific name	Donations/ exchange with Brazilian institutions	Scientific
Tropical Botanic Garden (Jardim Botânico Tropical)	Instituto de Investigação Científica e Tecnológica	Standard test specimens	<i>SI</i>	Scientific name and plant family	<i>SI</i>	Expositiva e Científica
Forests and Forest Products (Florestas e Produtos Florestais)	Instituto Superior de Agronomia da Universidade de Lisboa	Bookcases with drawers and shelves	Climatic control	Scientific name	Exchange	Scientific
Albino de Carvalho (ALCw)	Instituto Nacional de Investigação Agronômica e Veterinária (INIAV)	Closed or open cupboards/bookcases with shelves	Poisoning	Scientific name	Donations and exchange	Technological and scientific
<i>SN</i>	Faculdade de Ciência da Universidade do Porto	Bookcases with drawers and shelves	<i>SI</i>	Scientific name	Donations	Scientific and expository
Laboratório José Figueiredo	Laboratório José Figueiredo I/ Direção Geral do Patrimônio Cultural	Closed cupboards	Climatic control	Scientific name and vernacular name	Donations	Technological

Brazilian showcase (Mostruário brasileiro)	Laboratório José Figueiredo II	Specimens set into a frame with a surrounding moulding that secures them	<i>SI</i>	Vernacular name	Donations	Technological
Amazonian Woods (Madeiras da Amazônia)	Laboratório José Figueiredo II (Mobiliário)	Box	No special conditions applied	Vernacular name, scientific name and plant family.	<i>SI</i>	Technological
African Woods (Madeiras da África)	Laboratório José Figueiredo II	Box	No special conditions applied	Vernacular name	<i>SI</i>	Technological and expository
National Laboratory of Civil Engineering (Laboratório Nacional de Engenharia Civil)	Laboratório Nacional de Engenharia Civil-LNEC	<i>SI</i>	<i>SI</i>	<i>SI</i>	<i>SI</i>	Technological
<i>SN</i>	Colégio Militar de Lisboa	Closed cupboard and drawers	<i>SI</i>	Vernacular name, scientific name and plant family.	Unknown	Expository
<i>SN</i> . Part of the Herbarium collections	Universidade de Lisboa/ Museu Nacional de História Natural e da Ciência	Closed cupboards	<i>SI</i>	Scientific name	Unknown	Scientific

Figure 1. Percentage of Brazilian specimens in Portuguese xylotheques.



**3.2 MACROSCOPIC IDENTIFICATION**

Seven wood specimens were identified, for the the present macroscopically, while checking the list of specimnes of Brazilian woods described in interviews arising from the historical Portuguese Frei Manuel do Cenáculo Xylotheque at the Museum of Évora. These are: Oiti (*Licania tomentosa* (Benth.) Fritsch), Pequi (*Caryocar brasiliense* A.St.-Hil.), Angelim-Pedra (*Hymenolobium petraeum* Ducke), Roxinho (*Peltogyne recifensis* Ducke), Gonçalves-alves (*Astronium macrocalyx* Engl.), Louro vermelho (*Nectandra rubra* (Mez) C.K. Allen), Vinhático (*Plathymenia foliosa* Benth.).

Even though they were unaware of the scientific properties of the woods of Brazil, especially of those taken from the Atlantic Forest, the Portuguese exported them intensively for civil and naval use. In the 18<sup>th</sup> century, however, there is an official letter from Lieutenant José Gonçalves Galeão, dated 12 April 1780 from Bahia, to the Secretary of State for the Navy and Overseas Martinho de Melo e Castro, concerning experiments with wood carried out by Colonel Teodósio da Silva Reboxo (AHU –CU-005-01, Cx. 54 Doc. 10527-10531). On the same date another letter was sent by the Naval Intendant Rodrigo da Costa de Almeida to Secretary of State for the Navy and Overseas Martinho de Melo e Castro concerning a shipment of timbers sent by Colonel Teodósio da Silva Reboxo for the purpose of repeating in Lisbon the experiments he had made in Bahia on the resistance of wood (AHU –CU-005-01, Cx. 55 Doc. 10566-10567). These may be the first attempts to determine more precisely the resistance of this material.

A concern for the quality and identification of timbers can also be observed in the 19<sup>th</sup> century. This is shown in a note in the *Jornal de Coimbra*, p. 324, vol. 1, n. 5, May 1812, in which it is reported that the Prince Regent Dom João, future King D. João VI, mindful of a consignment of 1,095 pieces of timber from the State of Brazil, originating from the Capitánias of Pernambuco, Maranhão, Pará and Bahia, ordered that four xylotheques be made from them and that the leftovers should be studied:

"His Royal Highness was also pleased to require that the leftover pieces of the woods of the collections mentioned be given to Dr. Constantino Botelho de Lacerda Lobo, Master of Experimental Physics of the University of Coimbra, so that he might determine their resistance, specific gravity and other properties. He has been occupied with these researches for more than six years and has carried out all possible experiments, which he will present to the public."

In spite of the exploitation and import of different Brazilian timbers from the 16<sup>th</sup> century, and especially from the 18<sup>th</sup>, it was only in the 20<sup>th</sup> century that it came to be justified by the increase in global consumption of timber. The progress of the development of tropical countries, the constraints and disorders resulting from wars, and the excessive deforestation of the temperate zones led to the formulation of the written plan for the organization of laboratories for research on the wood anatomy and technology of colonial timbers (ALMADO, 1983). In 1948 the Laboratory of Wood Histology

and Technology was created by the Board of Overseas Scientific Investigations. As a consequence, the two main Portuguese xylotheques were associated with the Institute for the Investigation of Tropical Science, today within the University of Lisbon, while the others located by the present survey were only created in the 20<sup>th</sup> century apart from four reported here, i.e. the two belonging to the Lisbon Academy of Sciences (ACL), one at the Museum of Évora and one at the National Museum of Fine Art.

The major difficulty in studying these specimens, as already pointed out by Machado & Antunes (2014), is their scientific identification.

As Bessa (2009) reported, the difficulty of identifying wood increases with the degree of alteration. In nature, identification is based on the botanical morphology of the tree, but as the processing of the wood proceeds the complexities of its identification increase until only microscopical examination can produce reliable results.

Wood identification is a specialized field because of the huge diversity of species (in temperate, subtropical and tropical regions). The anatomical characterization of wood is fundamental to identification and includes a macroscopic and microscopic description, and biometric measurements. Bessa (2009) noted that various problems often arise in wood identification. While macroscopic study is more subjective, microscopic observations are more precise and biometric data also contribute to identification, but in the case of wood from art objects yet further expertise is needed since it is not always possible to remove a sufficiently large sample for the necessary observations.

In wood identification a reference collection of wood specimens, i.e. a xylotheque, is necessary and also when possible, a collection of histological sections (a slide collection) to enable anatomical comparison of the wood under study with previously identified specimens (Bessa 2009). In the present case, the study took advantage of the facilities of the Biological Institute of the Federal University of Bahia (Brazil) which include the Laboratory of Plant Anatomy and Wood Identification (LAVIM) with its large collection of anatomical slides of tropical species, including those of historical importance, and the wood collection of the PJPSw Xylotheque.

As explained above, wood identification can be carried out both macroscopically and microscopically. The former is simpler and less invasive for the object in question. However, the second, sometimes necessary because more accurate, requires the removal of part of the object, which in the case of historical material may be problematic and may result in an impasse as regards scientific identification. A collection which is thus unmodified or untouched by scientific investigation nevertheless has an overall scientific value – this is a discussion which needs further exploration.

Heady et al. (2010), in a study of historical furniture, proposed a method of sampling the wood using a veterinary injection needle by means of which a sample sufficient for anatomical



identification was obtained without the need for more invasive procedures. Another approach is exemplified by an electronic tropical xylotheque (e-xylotheque) already created for characterising and identifying economically important timbers in which all data relating to collections from Mozambique, Timor and India (including the former Portuguese colony of Goa) have been databased (Bessa 2009). Boschetti et al. (2014), in a study of the identification of woods of historical importance, identified macroscopically 24 samples of species used in the construction of an estate called "Fazenda Fortaleza" near Alegre, in the State of Espírito Santo in Brazil. From these specimens, 12 species were identified of which two had been described previously in a land demarcation in 1842 and seven in an agricultural manual from the 19<sup>th</sup> century.

Table 3. List of confirmed identifications of Brazilian woods from interviews carried out in Portugal, describing specimens belonging to the Historical Xylotheque Frei Manuel do Cenáculo (Museum of Évora).

Specimen names	Probable names	Scientific names	Plant family	Represented in the Professor José Pereira de Souza Xylotheque (PJPSw, Bahia, Brazil)
Angeli-pedra	Angelim pedra	<i>Hymenolobium petraeum</i> Ducke	Fabaceae	X
Gonçalo-alves	Gonçalo-alves	<i>Astronium macrocalyx</i> Engl.	Anacardiaceae	X
Louro-canela	Louro-vermelho	<i>Nectandra rubra</i> (Mez) C.K. Allen	Lauraceae	X
Oity	Oiti	<i>Licania tomentosa</i> (Benth.) Fritsch	Chrysobalanaceae	X
Pequi	Pequi	<i>Caryocar brasiliense</i> A.St.-Hil.	Caryocaraceae	X
Roxinho	Pau -roxou ou roxinho	<i>Peltogyne recifensis</i> Ducke	Caesalpiniaceae	X
Vinhático	Vinhático	<i>Plathymenia foliosa</i> Benth.	Fabaceae	X

**4 FINAL CONSIDERATIONS**

The data produced in this study are of value for botanical research and as part of the record of the diversity and usage of these tropical timber species. The study also provides interdisciplinary links with other areas of knowledge, such as historical enquiries on timbers that shed a broad and revealing light on the economic and social conditions of Portugal during earlier periods when imports of Brazilian wood were significant. It shows that other timber species were considered valuable at this time beyond the famous Brazilwood (pau-brasil). The existence in Portugal of four kinds of xylotheques is established: historical, scientific, technological and expository. We can thereby obtain a clearer understanding of the value of xylotheques as repositories of knowledge and identification of timbers traded in Brazil and which are found today in Portugal.

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