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Full Length Research Paper

Wood identification in Yıldız Palace Harem structures (19th century) in Istanbul

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Yıldız Palace was the last Ottoman Palace built. Harem Structures of this Palace are one of the important parts of the complex. These structures are composed of five parts: the apartments of the Sultan's consort I and II, the apartments of the concubines, the apartments of the Harem's chief treasurer, and the passages between apartments. In this research, the woods used in these parts of the complex were identified by using macroscopic and microscopic analysis. For this purpose, a total of 10 wood fragments were taken from the different buildings of Harem Structures: 6 from the apartments of the Harem's chief Treasurer, 3 from the apartments of the concubines and 1 from the apartments of the Sultan's consorts. The results obtained from macroscopic and microscopic tests of the samples have been analyzed and findings were presented in separate tables for each species. The research was finalized with the discussion and evaluation of the analysis and findings.

Key words: Yıldız Palace, Harem structures, macroscopic identification, microscopic identification, softwood species, hardwood species.

INTRODUCTION

The Beşiktaş Hill, on which Yıldız Palace is located, was praised in Byzantine poetry and made famous by the imaginary pan playing his flute in the daphnia forests. The hill with its beautiful view, first attracted the attention of Sultan Suleiman, and the land registered in the royal treasure was called the "Grove of the Sultan" (Gülersoy, 1979).

In 1876, Sultan Abdulaziz was removed from the throne following a military operation, during which the Dolmabahçe Palace was surrounded both from the sea and the land. Following that event, and due to the illness of Sultan Murad V, Sultan Abdulhamid II became the new sultan. As he saw the danger of being surrounded from the sea and the land so easily, he did not want to reside at Dolmabahçe Palace and moved to Yıldız Palace seven months after he came to the throne. The extravagance of every sultan building his own palace in the 19th century continued during the reign of Abdulhamid II with the construction of the Sultan's Palace at Yıldız (Batur, 1994). However, Yıldız Palace was the last Ottoman Palace built with the exception of some timber castles and houses (Kuban, 1996).

The construction principles of Yıldız Palace differed from other 19th century palaces such as Dolmabahçe and Çırağan. Because the Dolmabahçe and Çırağan palaces were not very old residences, the new palace was not designed as a big, single building, but rather as smaller houses and pavilions. The result was a planning and construction model resembling Topkapı Palace (Seçkin, 2003).

Yıldız Palace Harem Structures, which is the case study of this paper, are one of the important of parts of this complex. Harem Structures' construction had started in 1876 and continued with additional structures until 1906. Harem Structures are composed of five parts: the apartments of the Sultan's consort I and II, the apartments of the concubines, the apartments of the Harem's chief treasurer and the passages between apartments (Figure 1).

The aim of this paper is to identify the woods used in these parts of the complex using microscopic analysis. This will help to determine the species of the timber and to differentiate wood uses according to their location in the structure (stair handrail, stair flooring, floor covering,

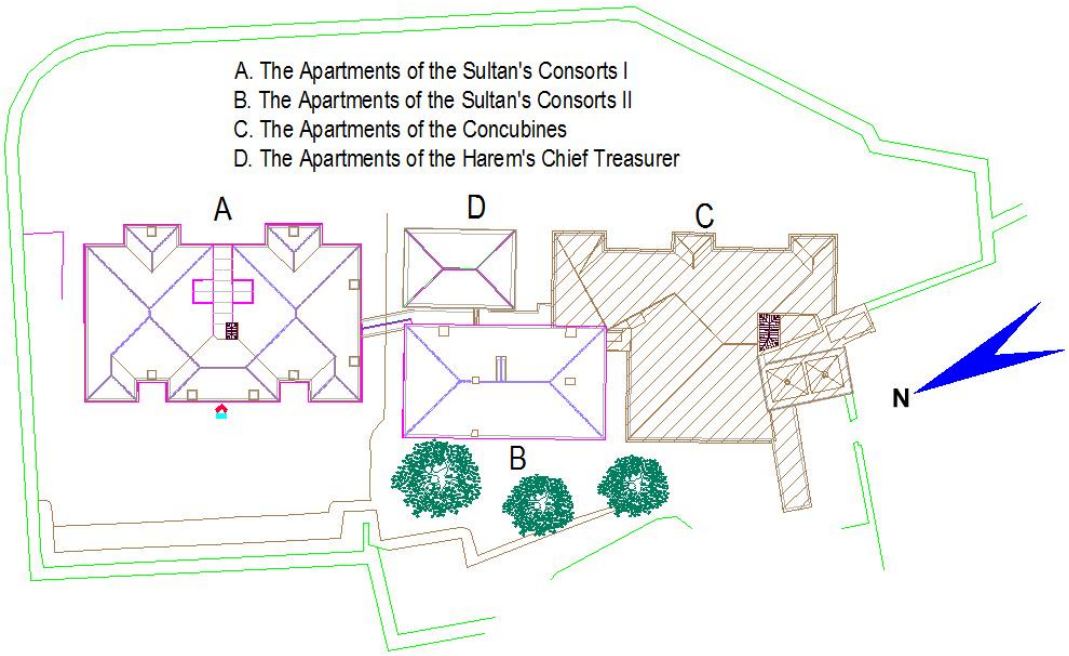


Figure 1. Site plan of the Harem Structures (İnkaya, 2009).

Table 1. Names and places of the elements that samples were taken.

Sample No.	Name of the apartments	Floor number	Name of the element
S1	The apartments of the concubines	1st floor	Lath
S2		1st floor	Joist
S3		Ground floor	Stair handrail
S4	The apartments of the Harem's chief treasurer	Ground floor	Stud at the façade
S5		Ground floor	Belt
S6		Ground floor	Entrance door
S7		1st floor	Sash
S8		1st floor	Stair covering
S9		1st floor	Floor flooring
S10	The Apartments of the Sultan's consorts	1st floor	Floor covering

joist, stud, belt, lath, door and sash). All of this information will be necessary and beneficial for future restoration works.

MATERIALS AND METHODS

During this study, a total of ten wood fragments were taken from the different buildings of Harem Structures: six from the apartments of the Harem's chief treasurer, three from the apartments of the concubines and one from the apartments of the Sultan's consorts (Kudeb, 2011). Table 1 shows the elements of these buildings that samples were taken, and the locations are also indicated in Figure 2. The sizes of the fragments ranged from 1 to about 13 mm in width, and several millimeters in length (up to 3 cm).

Following the sampling, macroscopic and microscopic diagnoses were studied in order, for finalizing the research (Seçkin, 2010).

DISCUSSION

The macroscopic features of wood material are the anatomical and physical (color, brightness, odor, texture, hardness, etc.) features that could be seen with a magnifying glass, a stereomicroscope or naked eye. In this study, macroscopic examination is performed by Olympus stereomicroscopes.

Figure 2. The locations of the samples (2011).

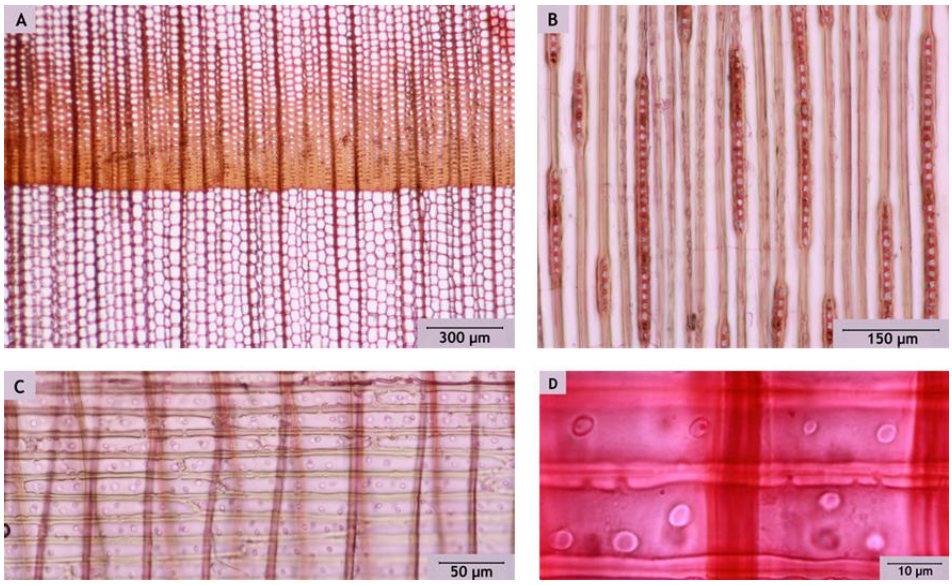


Figure 3. Microstructure of *Abies* sp. A, No resin canals; B, average ray height 15 to 25 (sometimes up to 60) cells; C, rays homocellular; D, taxodioid pits in earlywood rays.

Table 2. The characteristics that helped to identify *Abies* sp. (Esteban et al., 2009; IAWA, 2004; Ozdemir, 2004; Merev, 2003; Schweingruber, 1990).

Characteristics	Description
Transverse section	Growth ring boundaries distinct No resin canals
Radial section	Horizontal ray walls thick, smooth to dentate, walls of marginate ray cells thin Tangential walls of rays distinct nodular chains Taxodioid pits in earlywood rays, in latewood piceoid pits Average ray height 15 to 25 (sometimes up to 60) cells
Tangential section	Usually uniseriate, sometimes biseriate pits in radial tracheid walls Rays homocellular

Figure 8 illustrates the results of macroscopic diagnosis of the samples studied at Harem Structures. For the microscopic identification, all samples were boiled in water first, and 25 micron sections (cross, tangential and radial) were cut on a Leica sliding microtome.

Following the microtoming, sections were studied under Olympus CX31 microscope connected to a Kameram image analysis system for anatomical characterization and identification. Some textbooks (Porter, 2006; Merev, 2003), atlases (Schweingruber, 1990; Jacquiot, 1955) and IAWA committee indications were used for the classification of the anatomical characteristics.

Softwoods

Softwood species were identified in six samples and they belong to *Abies, Piceaand Pinus* wood types.

Abies identification

Abies sp. was found in one sample (Figure 3). It was identified due to its characteristics shown in the Table 2. In addition to characteristics above, a further study was developed during which some specific researches on *Abies* sp. (Esteban et al., 2009; Özdemir, 2004) were studied and sample 2 is identified as *Abies bornmuelleriana*.

Picea identification

The features at Table 3 were observed in sample 10, and with these characteristics, it is identified as *Picea* sp. (Figure 4). The *Picea* sp. cannot be distinguished from each other on the basis of their wood anatomy.

Table 3. The characteristics that helped to identify *Picea* sp. (IAWA, 2004; Merev, 2003; Schweingruber, 1990).

Characteristics	Description
Transverse section	Resin canals surrounded (bordered) by 8 to 12 rather thick-walled epithelial cells Parenchyma absent
Radial section	Longitudinal tracheids generally with uniseriate, rarely biseriate pits Rays hetero-cellular Ray tracheids present, with smooth walls Ray parenchyma cells thick-walled; tangential walls nodular Ray pits in earlywood generally piceoid, in part cupressoid; in latewood piceoid Occasionally crystals in ray cells
Tangential section	Average height of rays 10 to 15 cells Rays with resin canals Resin canals with thick-walled epithelial cells

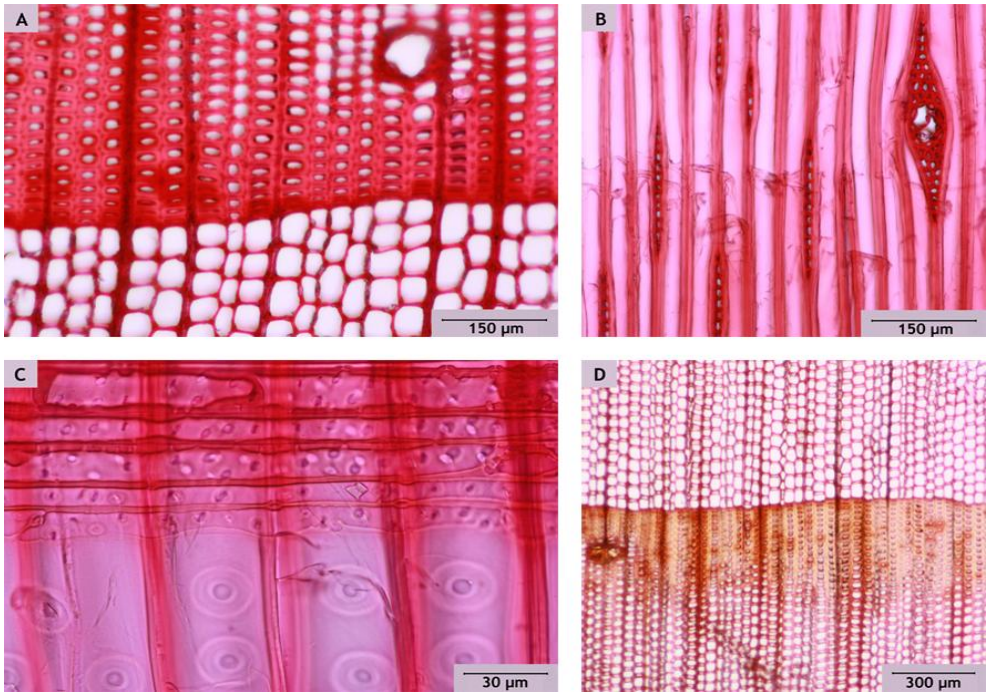


Figure 4. Microstructure of *Picea* sp. A, Resin canals surrounded (bordered) by 8 to 12 rather thick-walled epithelial cells; B, resin canals with thick-walled epithelial cells; C, rays hetero-cellular and ray tracheids present, with smooth walls; D, early-latewood transition is gradual.

Pinus identification

Pinus sylvestris were found in four samples (Figure 5). Each was identified by its characteristics illustrated in the Table 4.

Hardwoods

Softwood species were identified in four samples and they belong to either *Ulmus* or *Quercus* wood types.

Quercus identification

Three samples were identified as *Quercus* sp. (Figure 6) based on its key characteristics illustrated in the Table 5. Samples 3, 4 and 5 were identified as white oak group.

Ulmus identification

Ulmus sp. was found in one sample (Figure 7). It was

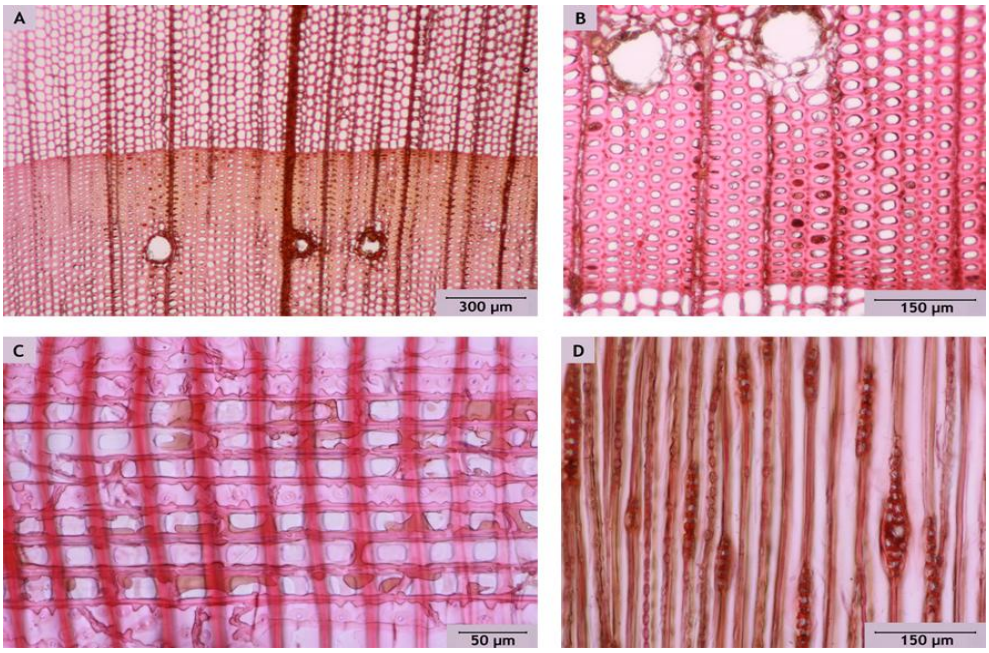


Figure 5. Microstructure of *Pinus* sp. A, Resin canals mostly located in latewood; B, resin canals are large with thin-walled epithelial cells; C, raytracheids with dentated walls and large fenestriform (window-like) pits; D, rays with resin canals.

Table 4. The characteristics that helped to identify *P. sylvestris* (IAWA, 2004; Merev, 2003; Schweingruber, 1990; Jacquiot, 1995).

Characteristics	Description
Transverse section	Growth ring boundaries always distinct
	Resin canals are large with thin-walled epithelial cells
	Resin canals mostly located in latewood
	Parenchyma absent
	Tracheids uniformly thin-walled
Radial section	Tracheid pits almost uniseriate
	Rays heterocellular
	Ray tracheids with dentated walls
	Cross-fields from parenchyma cells to tracheids with one (rarely two) large fenestriform (window-like) pits
Tangential section	Average height of rays 15 cells
	Rays with resin canals
	Resin canals in rays with thin-walled epithelial cells

identified based on its features shown in the Table 6. In addition to characteristics above, a further study was developed. During this study, some specific researches on *Ulmus* sp. (Wiegrefe et al., 1994; Merev, 2003; Wheeler and Manchester, 2007) were studied and sample 8 is identified as Ulmus glabra.

RESULTS

According to macroscopic and microscopic diagnosis, the results below have been reached:

1. The joist in the first floor of the apartments of the concubines is Bornmueller's Fir (*Abies bornmuelleriana*). Fir has low resistance to shock loads and has no insect or decay resistance qualities after logging. Because of these features, the wood of most firs is considered unsuitable for general timber use, and it is onlyrecommended for indoor use. In accordance with this recommendation, the builders of the Harem structures used it interior construction of the apartments of the

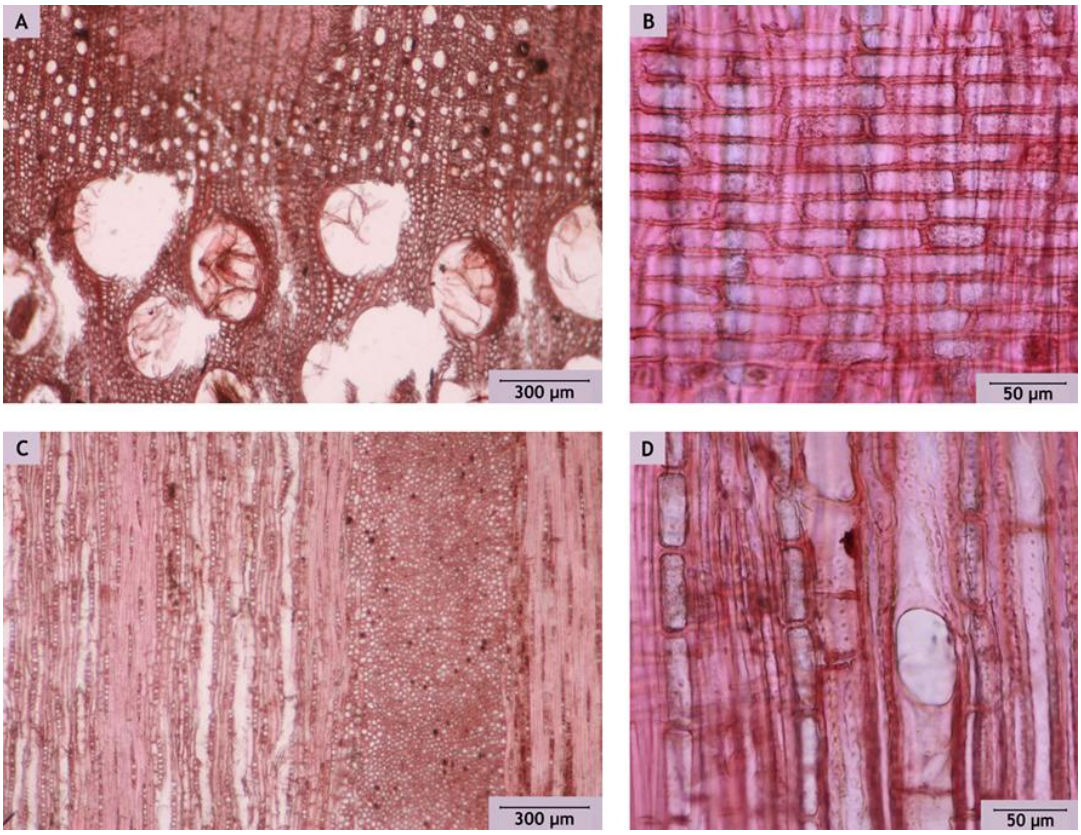


Figure 6. Microstructure of *Quercus* sp. A, Tyloses in earlywood vessels is common; B, procumbent ray cells; C, rays of two distinct sizes; D, simple perforation plates.

Table 5. The characteristics that helped to identify *Quercus* sp. (Merev, 2003; Schweingruber, 1990; IAWA, 1989).

Characteristics	Description
Transverse section	Ring-porous Earlywood pore ring with one to many rows of pores, more or less compact Latewood pores solitary or in more or less radially oriented groups In wide growth rings pore groups radial to dendritic Tyloses in earlywood vessels of heartwood sparse Libriformfibres thick-walled, in irregular patches Apotracheal parenchyma either diffuse or in uniseriate diagonal and tangential bands, frequency variable Broad rays visible to the naked eye
Radial section	Rays homogeneous Libriformfibres and vasicentrictracheids Simple perforation plates Apertures of the vessel-ray pits enlarged, often oval to slit-like
Tangential section	Rays uni- to multiseriate Multiseriate rays up to 1 mm wide

concubines.

2. The floor covering in the first floor of the apartments of the Sultan's consorts is spruce (*Picea* sp.). Spruce has low stiffness, medium crushing and bending strength. It works easily with hand tools, and it is very suitable material for floor covering, woodworking and interior

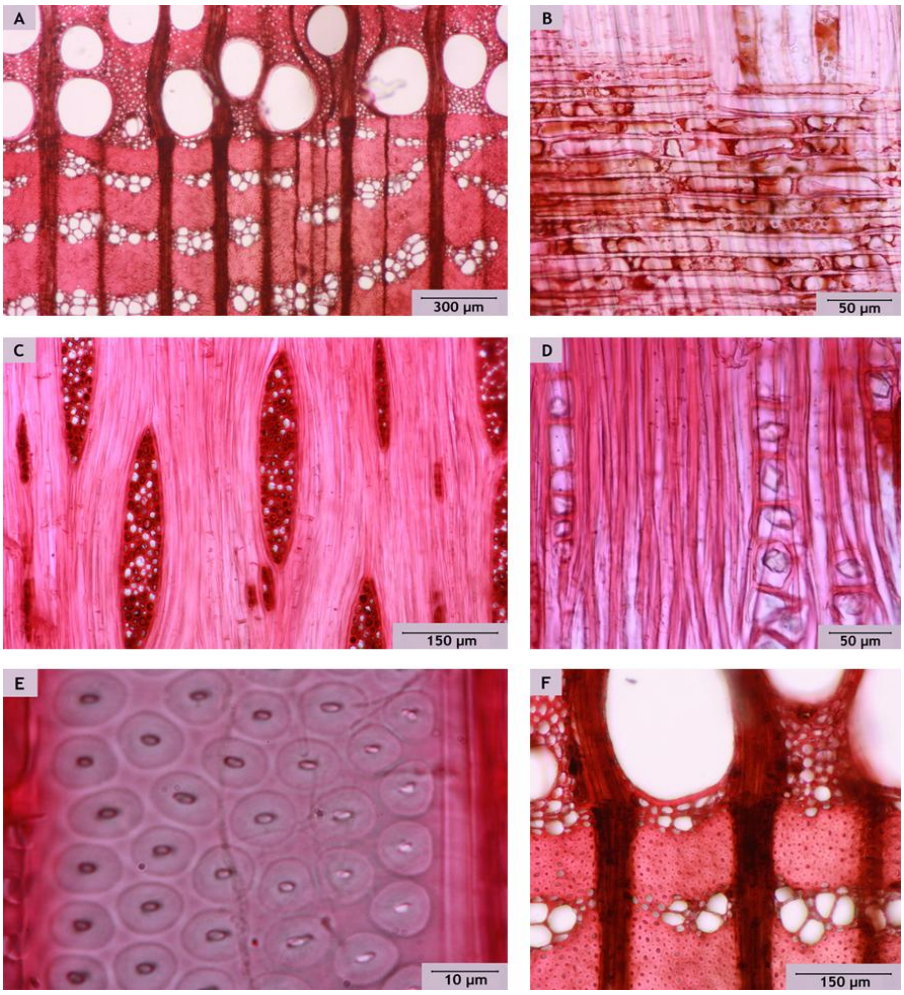


Figure 7. Microstructure of *Ulmus* sp. A, Vessels in tangential bands; B, procumbent ray cells; C, rays of two distinct sizes; D, prismatic crystals present; E, alternate intervessel pits; F, thick-walled ground tissue.

Table 6. The characteristics that helped to identify *Ulmus* sp. (Wheeler and Manchester, 2007; Merev, 2003; Wiegrefe et al 1994; Schweingruber, 1990; IAWA, 1989).

Characteristics	Description
Transverse section	Ring-porous Earlywood with one to 3 rows of pores In latewood pores grouped in more or less long, tangential to slightly oblique, bi- to 4 seriate bands together with vascular tracheids and parenchyma Tyloses occasionally present in earlywood Ground tissue thick-walled Para-tracheal parenchyma abundant in earlywood and among vessel groups in latewood
Radial section	Rays generally homogeneous Libriformfibres and vascular tracheids present Simple perforation plates Christals in rays and parenchyma
Tangential section	Rays generally 4 to 5 seriate, occasionally narrower or wider

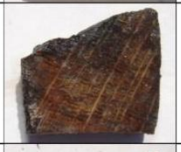
Sample No	Images of samples	Growth ring boundaries	Vessels	Rays	Color	Holes	Tunnels	Wood situation
S1		Distinct	-	-	Light yellow	1 mm diameter holes on wood	2 mm diameter tunnels on wood	Decayed wood
S2		Distinct	-	-	Light yellow	1 mm diameter holes on wood	2 mm diameter tunnels on wood	Robust wood
S3		Distinct	Distinct	Distinct	Light brown	-	-	Robust wood
S4		Distinct	Distinct	Distinct	Light brown	-	Many termite tunnels on wood	Decayed wood
S5		Distinct	Distinct	Distinct	Light brown	-	-	Robust wood
S6		Distinct	-	-	Light yellow	-	-	Robust wood
S7		Distinct	-	-	Light reddish brown	-	-	Decayed wood
S8		Distinct	Distinct	-	Light brown	-	-	Robust wood
S9		Distinct	-	-	Light yellow	1 mm diameter holes on wood	Many termite tunnels with 6 mm diameter	Decayed wood
S10		Distinct	-	-	Yellow	-	-	Robust wood

Figure 8. The results of macroscopic diagnosis of the samples studied.

construction (Bozkurt and Göker, 1996).

3. The floor covering and the sash in the first floor of the apartments of the Harem's chief treasurer, the entrance door of same building and the lath taken from the first floor of the apartments of the concubines are yellow pine (*Pinus slyvestris*). Pine has low resistance to shock loads, low stiffness and low to medium bending and crushing strength. Due to its low stiffness, it works well with hand tools. With this feature,it is a very suitable material for jointing and carpentry, as it was used in Harem Structures.

4. The stud and the belt at the façade of the apartments of the Harem's chief treasurer, and the stair handrail in the ground floor of the apartments of the concubines are

oak (*Quercus* sp.). They all belong to white oak group. Oak isa fairly hard, heavy and dense material, with high crushing and bending strength, low stiffness and resistance to shock loads. With these properties, it is suitable to use in wood construction and carpentry.

5. The stair flooring in the first floor of the apartments of the Harem's chief treasurer is wychelm (*Ulmus glabra*). Elm is quiet heavy and dense wood, with a fairly high bending and crushing strength and medium hardness. It generally works well with hand tools and it is typically preferred in making furniture, veneering and flooring as it is in Harem Structures.

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