



WOODS OF BYZANTINE TRADE SHIPS OF YENIKAPI (ISTANBUL) AND CHANGES IN WOOD USE FROM 6th TO 11th CENTURY

Ünal Akkemik¹ and Ufuk Kocabaş²

¹ *Istanbul University, Faculty of Forestry, Department of Forest Botany, 34473 Bahçeköy – İstanbul, Turkey*

² *Istanbul University, Faculty of Letter, Department of Conservation and Restoration, Ordu St.34459 Laleli – İstanbul, Turkey*

Received: 21/01/2014

Accepted: 14/06/2014

Corresponding author: Ünal Akkemik (uakkemik@istanbul.edu.tr)

ABSTRACT

Archaeological excavations in Yenikapı revealed valuable information about the ship building techniques in Byzantine period. The purpose of this study is to perform wood identifications of the 27 trade ships of Yenikapı and to discuss and compare the wood use from 6th to 11th century. Using standard wood identification techniques, 3122 wood samples from 27 trade ships were identified. Wood identification revealed these important outcomes: Wood use changed from earlier time (5th - 6th) to later (7th - 9th and 10th - 11th). During 6th-8th centuries generally conifer woods were preferred. Later, during 9th - 11th broad-leaved trees (elm, oak, chestnut species) had been used. The reasons of this change may be (1) preferring more resistant woods, (2) obtaining of the wood material. Wood identification showed that the origin of the ships might be around of the Marmara Coasts and northern forests. Conifer trees in earlier ships might be from the planted areas by the Bosphorus, and broad-leaved trees in later ships might be from the northern forests. Most of the ships have also very low number of different woods such as walnut, poplar and hornbeam. These woods may indicate some small repairs in the ships.

KEYWORDS: Yenikapı excavations, Byzantine ships, old trade ships, old galleys, woods of Yenikapı ships

1. INTRODUCTION

The excavations in Yenikapı revealed crucial information about old Istanbul. The history of Istanbul was extended back to 8500 year after this excavation. One of the main parts of these archaeological excavations was finding of 37 shipwrecks. 28 of them were excavated and studied by Ufuk Kocabaş and his team from Istanbul University, Faculty of Letter, Department of Conservation of Marine Archaeological Objects (Kocabas, 2012a; Kocabas, 2012b). 4 of these 28 old ships were galleys and their wood identifications were explained by Akkemik and Kocabaş (2013). Results from this study showed that planking were made from pine and cedar trees. A huge amount of elm and plane trees were used in building of floor timber/futtock. On the other hand, the woods of the rest 9 of the 36 shipwrecks were collected by Cemal Pulak and Nili Liphshitz and the wood identification results of 3 (YK01, YK02 and YK05) of these 8 old ships were published by Liphshitz and Pulak (2007).

Wood identification of the wooden materials from archaeological excavations may have huge importance because of giving a part of culture of that time. Akkemik and Metin (2011) were explained that two coffins excavated in Juliopolis Necropolis (Ankara) were built by using juniper wood (*Juniperus foetidissima* Bieb.). This species has large trunks and very strong against decomposition. This species is also common in that area. In Theodosius Harbour area mainly oak woods were used (Doğu et al., 2011). These trees were common in Marmara, Thrace and Balkans. Because of being abundant and resistant, the oak trees were preferred in building and extending of the harbor area from 4th to 11th century.

Akkemik and Kocabaş (2013) presented the wood identification results of 4 galleys, which were from 7th to 10th centuries. The present study includes the wood identifications of 23 trade ships excavated from Yenikapı Theodosius Harbour, and wood using in ship-building from 6th century to 11th

century. The purpose of this study is (1) to submit the main wood identification results of all parts of the 27 trade ships, (2) to discuss the wood use changes from 6th to 11th century, (3) to compare the wood use in the galleys and trade ships, and (4) to discuss some repairing remarks on the ships.

2. MATERIAL AND METHODS

Wood materials from all parts of the trade ships (Figure 1 and Figure 2) were collected by Ufuk Kocabaş and his team by coded for each ship and kind of the sample (Table 1). All wood identification process was performed at the Wood Anatomy Laboratory of the Department of Forest Botany, Faculty of Forestry, Istanbul University. All references and process using in wood identifications are the same given in Akkemik and Kocabaş (2013). For that reason this information was not repeated.

Total 3122 wood samples including all galleys and trade ships were identified. 634 of these samples were from the galleys and presented by Akkemik and Kocabaş (2013). The rest 2488 samples from the trade ships were identified and presented in this study.

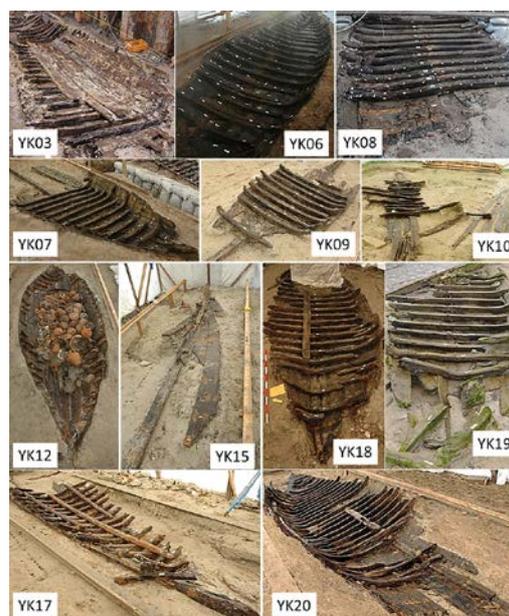


Figure 1. Some of the trade ships.

Table 1. The types and the numbers of the samples from the ships.

No	Code of the ship	Parts of the ships																			Total				
		Planking	Ceiling	Frame system	Keel	Garboard	Mast step	Tree nail	Wale	Bilge stringers	Stringer	Fish pond	One squad forward	Detent	Stempost	Larboard	Starboard	Deck beam	Stand	Stanchion		Wood	Piece from where is unclear	Unidentified piece	
1	YK 3	15	6	45	6	1				1														74	
2	YK 6	25	-	27	5	4	1																	62	
3	YK 7	22	-	14	2	2									1	1								42	
4	YK 8	35	-	10	2		7																	54	
5	YK 9	11	-	11	2	2																		26	
6	YK 10	27	-	35	-				2															64	
7	YK 12	31	46	45	5		3	262	1										1					394	
8	YK 13	19	-	113	2	6		30	2													4		176	
9	YK 15	7	-	-	3																			10	
10	YK 16	27	-	172	5	5		19	3	2												6		239	
11	YK 17	13	-	26	1				2	3										1				46	
12	YK 18	45	-	27	3	4		4	1															84	
13	YK 19	8		12	2	5																17		44	
14	YK 20	54	-	56	3	4	1	4	2	2							1							127	
15	YK 21	52		25	2	2		8																89	
16	YK 22	73	17	111	2				4	3													48	258	
17	YK 25	15	-	73	-	2		49		4									1					144	
18	YK 26	15	-	2	-																			17	
19	YK 27	46	5	69	2	4				5													9	140	
20	YK 28	13	-	22	-	1																	1	37	
21	YK 29	48	14	36	2		1			6	3													110	
22	YK 30	3	-	3	1																			7	
23	YK 31	25	13	28	3	4			1	3	4											1		82	
24	YK 32	22	-	26	4	1								1									4	58	
25	YK 34	33	15	51	3	2		10	3	1		12	3										2	135	
26	YK 35	95	254	126	7	2	7		5	20											1		11	528	
27	YK 36	33	1	25	1					2												1	12	75	
Total		812	371	1190	68	51	13	393	24	53	1	7	12	3	1	1	1	1	1	1	1	2	29	87	3122

3. RESULTS AND DISCUSSION

Identification results revealed that woods of 14 different genera were used in the trade ships. The genera/species list of the identified woods from the ships was composed of 4 genera from gymnosperms and 10 genera from angiosperms (Table 2).

The geological dates given by Algan et al. (2008) and from ¹⁴C dating of the ships were grouped as 5th-6th, 7th-9th, 9th-11th centuries. A clear change in wood use from 5th-6th centuries to 9th-11th centuries were recognized for different parts of the ships (Table 3). The changes were evaluated as different parts of the ships as follows:



Figure 2. Some of the trade ships.

Table 2. The woods identified. Their genera and possible species of the woods

Genera identified	Their potential species
<i>Gymnosperms</i>	
Pine (<i>Pinus</i> L.)	Black pine (<i>Pinus nigra</i> Arn), Calabrian pine (<i>Pinus brutia</i> Ten.), Stone pine (<i>Pinus pinea</i> L.)
Cypress (<i>Cupressus</i> L.)	Mediterranean cypress (<i>Cupressus sempervirens</i> L.)
Cedar (<i>Cedrus</i> L.)	Taurus cedar (<i>Cedrus libani</i> A.Rich.)
Fir (<i>Abies</i> L.)	Caucasian fir (<i>Abies nordmanniana</i>) / Taurus fir (<i>Abies cilicica</i>)
<i>Angiosperms</i>	
Oak (<i>Quercus</i> L.)	White oaks (<i>Quercus petraea</i> , <i>Q. robur</i> , <i>Q. frainetto</i> , <i>Q. infectoria</i> .) Red oaks (<i>Quercus cerris</i> , <i>Q. ithaburensis</i> subsp. <i>macrolepis</i>) Evergreen oaks (<i>Quercus ilex</i> , <i>Q. coccifera</i>)
Chestnut (<i>Castanea</i> L.)	Spanish chestnut (<i>Castanea sativa</i> L.)
Plane (<i>Platanus</i> L.)	Oriental plane (<i>Platanus orientalis</i> L.)
Elm (<i>Ulmus</i> L.)	Field elm (<i>Ulmus minor</i>) / Mountain elm (<i>Ulmus glabra</i>) / European white elm (<i>Ulmus laevis</i>)
Spanish broom (<i>Spartium</i> L.)	Spanish broom (<i>Spartium junceum</i> L.)
Hornbeam (<i>Carpinus</i> L.)	Common hornbeam (<i>Carpinus betulus</i> L.)
Beech (<i>Fagus</i> L.)	Oriental beech (<i>Fagus orientalis</i> Lipsky.) / European beech <i>sylvatica</i> L.)
Ash (<i>Fraxinus</i> L.)	Common ash (<i>Fraxinus excelsior</i>) / Narrow-leaved ash (<i>Fraxinus angustifolia</i>) / Manna ash (<i>Fraxinus ornus</i>)
Walnut (<i>Juglans</i> L.)	Common walnut (<i>Juglans regia</i> L.)
Poplar (<i>Populus</i> L.)	Black poplar (<i>Populus nigra</i> L.) / Afghan poplar (<i>Populus afghanica</i> (Aiton & Hemsley) C.K. Schneider)

3.1 Planking

During 5th-6th centuries Cypress, Calabrian pine, Stone pine, Black pine and Turkey oak were used in building of planking. During 7th to 9th centuries a similar wood use was observed. On the contrary, after 9th century and during 10th - 11th centuries mainly White oaks and Chestnut were used. The result revealed that there was a clear change from conifer trees to white oaks and Chestnut. D'Amato (2009) stated that in planking of the Mediterranean ships conifer trees were used during Roman

time. Our identifications are about the parallel with this explanation. After Roman time, similar wood use was continued during early and middle Byzantine period. On the contrary, change in wood use was started after middle Byzantine period and completely changed in the late Byzantine period. During Ottoman period and at present Chestnut and Oak trees have been used widely in ship-building because of having resistant wood. This change can clearly be seen as follows:

Planking in the trade ships

5 th - 6 th centuries		7 th - 9 th centuries		9 th - 11 th centuries
Calabrian pine	➡	Calabrian pine	➡	Oak
Stone pine		Stone pine		Chestnut
Cypress		Cypress		
Black pine		White oak		
Red oak		Chestnut		

Bozkurt (1971) stated that these trees are also preferred in planking of the ship at present. In Byzantine period the reason of this change in wood use from 5th - 6th centuries to 11th century may be: (1) preferring of more resistant wood to water, or, (2) the abundance of the wood material. The woods (Cypress and Stone pine), which were left during later centuries were not common trees. Yaltırık et al. (1997) stated that Cypress trees were planted by the Eu-

ropean side of the Bosphorus to use in ship building. On the contrary Oak and Chestnut were natural and the most abundant trees around the Marmara region.

The trade ships belonging to 6th- 8th centuries might be built by using planted conifer trees. Later ones were built by using Oak and Chestnut trees, which had wide forests around Marmara region and especially in Istanbul.

Table 3. The main tree genera/species used in different centuries. The codes in the parenthesis indicate the ship numbers.

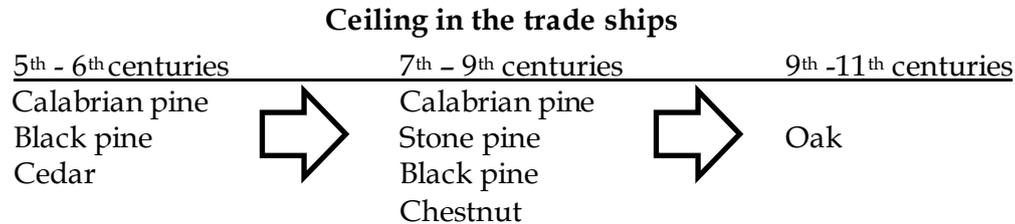
Century	Trade Ships			
	Planking	Ceiling	Keel	Floor timber/Futtock
5 th -6 th Centuries	Cypress, Stone pine (YK10)	---	---	Stone pine (YK10)
	Cypress, Calabrian pine (YK22) Red oak (YK26) Black pine (YK34) Cypress (YK35)	Calabrian pine (YK22) --- Black pine, Calabrian pine (YK34) Calabrian pine, Cedar(YK35)	Cypress (YK22) --- Red oak, Beech(YK34) Elm tree, Cypress, Calabrian pine (YK35)	White oak, Red oak (YK22) --- Red oak (YK34) Elm tree, Cypress, Calabrian pine, Red oak (YK35)
7 th -9 th Centuries	Black pine (YK03)	Black pine (YK03)	Plane (YK03)	Plane, Elm tree, Ash (YK03)
	Stone pine (YK15) Stone pine (YK17) Stone pine (YK27)	--- --- Stone pine (YK27) ---	White oak (YK15) Stone pine (YK17) Red oak (YK27) ---	--- Stone pine (YK17) Evergreen oak, Elm tree (YK27) Red oak, Elm tree (YK28)
	Calabrian pine, White oak (YK28) Cypress (YK29)	Calabrian pine, Stone pine, Chestnut (YK29)	Calabrian pine (YK29)	Elm tree, Calabrian pine (YK29)
	Cypress, White oak (YK30) Chestnut, Oak (YK32) Chestnut (YK12) Chestnut (YK20)	--- --- Oak (YK12) ---	White oak (YK30) White oak (YK32) Hornbeam, Beech(YK12) Beech(YK20)	Red oak, Calabrian pine (YK30) White oak, Red oak (YK32) Ash, Oak (YK12) Oak (YK20)
9 th -11 th Centuries	Chestnut, Oak (YK31) Chestnut, White oak (YK06)	Oak (YK31) ---	Oak (YK31) Hornbeam (YK06)	Oak (YK31) White oak (YK06)
	Chestnut, Oak (YK07)	---	Red oak (YK07)	White oak (YK07)
	Chestnut, Oak (YK08)	---	Beech(YK08)	White oak (YK08)
	White oak (YK09)	---	White oak (YK09)	White oak (YK09)
	White oak, Chestnut (YK18) White oak (YK19) Oak (YK21)	--- --- ---	White oak, Plane (YK18) White oak, Plane (YK19) Oak, Plane (YK21)	White oak (YK18) White oak (YK19) Oak (YK21)
Century	Galleys			
7 th -10 th Centuries	Black pine (YK13) Black pine (YK16) Black pine, Cedar(YK25)	--- --- ---	Oak, Plane (YK13) Plane (YK16) ---	Plane, Elm tree (YK13) Plane, Elm tree (YK16) Plane (YK25)
	Chestnut, Black pine (YK36)	---	Plane (YK36)	Plane (YK36)

3.2 Ceiling

The lowest number of the samples was belonging to ceiling in the ships. A few samples of ceiling from 9th - 11th centuries were found. No ceiling was found in the galleys (Akkemik and Kocabaş, 2013).

However, some results were obtained that pine trees were used in 5th-9th centuries and oak trees in 9th-11th centuries.

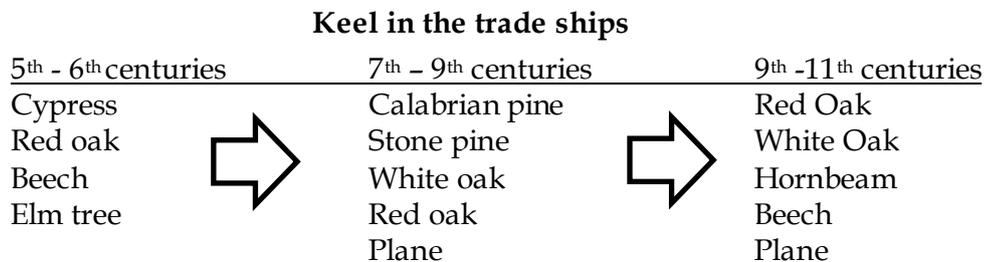
This result is about the same with wood use in planking. The details may be seen as follows:



3.3 Keel

In building of keel a periodical change was not observed. White oak, Red oak, Beech, Plane, Stone pine, Calabrian pine and Cypress trees were used in different times. However, use of gymnosperm woods was also left in later centuries like in that of planking and ceiling.

While Plane and Oak were the main elements of the keel in the galleys (Akkemik and Kocabaş, 2013), Oak, pine, Chestnut, Beech, Hornbeam and Plane trees were used in the trade ships during 6th century to 11th century. D'Amato (2009) explained that Oak and Beech trees were preferred in building of keel in the ships of Roman period. Thus, the evolution in trade ships is:



Whereas Plane, Hornbeam and Beech trees were used during Roman and Byzantine periods, at present they are mostly not preferred in ship buildings because of having sensitive wood to the wet conditions.

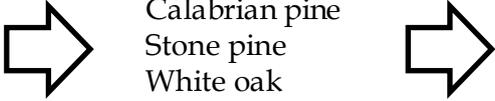
The woods of these three genera are almost similar to each other and maybe because of this, they were used in the keel of the same ship together. In some ships when the main part of the keel was plane, horn-

beam was used as another part (maybe it was a repairing part).

3.4 Floor timber / Futtock

When Stone pine, Calabrian pine, White oak, Red oak, Evergreen Oak, Ash and Elm trees were used during 5th-9th centuries, only White oak and Ash woods were identified in the floor timber/futtock during 9th-11th centuries. The details may be seen as follows:

Floor timber/Futtocks in the trade ships

5 th - 6 th centuries		7 th - 9 th centuries		9 th -11 th centuries
Stone pine		Calabrian pine		White Oak
Red oak		Stone pine		Ash
White oak		White oak		
Cypress		Red oak		
Calabrian pine		Evergreen Oak		
Elm tree		Elm tree		

3.5 Tree nails

In making of tree nails Oak and Spanish broom were used in both of the galleys (Akkemik and Kocabaş, 2013) and the trade ships. Because the Spanish broom had a thin stem, they were used without making thinner. Thin branches of oaks were also used like that of Spanish broom woods. However some wider oak woods (probably stem woods) were also used after making thinner. A huge number (262 samples) of the tree nails were obtained from YK12 and identified as mainly white oak, except two samples. These two tree nails were identified as Hornbeam wood.

3.6 Some Questions on the Use of Woods

In the trade ships a clear period was obtained from 5th century to the 11th century. Regarding with these changes some questions may be asked to be answered:

1. Where were the building places of the ships?
2. What is the reason of the change in wood use from conifer woods to oak and chestnut?
3. What is the wood use in trade ships and the galleys?
4. Is there any repair signals on the ships?

Bozkurt (1992) stated that oak and chestnut trees were very resistant trees against the water. These trees were also abundant in the forests of Marmara Region. The reasons of the changes in wood use from 5th century to the 11th century may be (1) the resistance of the woods, (2) transportation opportunities (lower cost), and (3) abundance in the forests. Another reason may

be the origins of the ships. The origin may have been changed from the Mediterranean coasts to the Marmara coasts. However, because all these genera have very wide distribution areas through the Black Sea and Marmara regions and in Europe, it is impossible to find the exact origins of the ships based on the tree genera given here. For overcoming this issue dendrochronological studies are needed. Liphshitz and Pulak (2007) stated that the origin of the Yenikapı ships might most likely be west-north western Aegean coast. The ships from 5th - 6th century ships may be belonging the area, where was pointed by Liphshitz and Pulak (2007). However, Yalçırık et al. (1997) stated that there was a wide planted Cypress forest by the European side of the Bosphorus and Cypress trees were used in ship building. Cypress trees were planted to use their woods in ship building during Byzantine period. Based on this explanation we can conclude that the origin of the trade ships from 5th - 6th may also be Istanbul. The case in the later ships is some clearer that they may most likely be belonging to the Marmara coast. All main trees may be from the northern forests of İstanbul. Because of being planted trees, Mediterranean Cypress and Stone Pine trees were a restricted source for wood material. Increasing amount of wood need might cause to use alternative woods such as oak and chestnut. This change might also cause a change in ship building technique in the later time of Byzantine period.

In planking and floor timbers a clear difference can be recognized easily. However in tree nail there is no any difference. In the

building of keels the same tree species were used, but Plane trees were more preferred than the others in the galleys when oak was more preferred in the trade ships (Table 4).

Table 4. A general comparison of the trade ships and the galleys belonging to 7th-10th centuries

Ship parts	Trade ships	Galleys
Planking	Chestnut, White oak	Black pine, Cedar
Ceiling	--	--
Floor timber/Futtock	White oak	Plane, Elm tree
Keel	Oak, Hornbeam, Plane, Beech	Plane, Oak
Tree nail	Oak, Spanish broom	Oak, Spanish broom

Based on the woods used in the ships, we may discuss some remarks of repair. The woods mentioned above were the main parts of the ships. However, very low amount of the other wood pieces was used in most of the ships. We thought that these extra woods might be used during any repair. Some walnut, poplar, hornbeam etc. trees were identified in some of the ships. These trees were not the main trees and therefore we thought that the trees like these might be repairing parts. Some ships having wood pieces like these were given below:

- YK06: Floor timbers were made from oak trees. However 2 walnut and 2 poplar woods were also used in floor timbers. These walnut and poplar trees might be the repairing parts in this ship.
- YK08: Floor timbers were made from white oaks. One walnut sample used as floor timber might be a repairing part.
- YK09: Floor timbers were made from white oak trees. 2 Calabrian pines and 1 Hornbeam used as floor timber might be belonging to a repair.
- YK12: A few walnut and hornbeam trees might be used in a repair.

- YK18: Floor timbers were made from white oak trees. Because 2 of the floor timbers were Stone pine, they might be a repair part. 3 plane woods were used as planking. No other use of the plane trees as planking. Therefore this might point to an urgent repair. Because plane trees are not resistant trees and did not use as planking.
- YK19: The main materials were oak in this ship. However, 2 Hornbeam trees used in floor timber were identified. These trees might be a part of a repair.
- YK20: 5 Black pine woods used in planking might be put during a repair. Because Oak and Chestnut woods were the main materials in this ship.
- YK27: 1 beech and 1 poplar woods might be belong to a repair in this ship.
- YK31: 1 walnut wood was probably used in planking during a repair. Because the main materials were oak and chestnut.
- YK35: Beech woods used in ceiling between Cypress, Calabrian pine and Elm woods might be repairing parts.
- We didn't find any repair in the ships coded YK03, YK10, YK13, YK15, YK16, YK17, YK22, YK25, YK26, YK28, YK29, YK30, YK32, YK34 and YK36.

We reached these results based on the different woods used between the main parts. A repair might be made by using the same wood species and in this case it is very difficult to reach exact information about repair.

4. CONCLUSION

This study revealed some important outcomes about the ship building techniques

of Byzantine period based on the wood identification:

- Wood use changed from earlier time (5th - 6th) to the later (9th - 11th). During 5th - 8th generally conifer woods were preferred. On the contrary, during 9th - 11th century's elm, oak, chestnut species had been used.
- The reason of the changes in wood use may be (1) preferring more resistant woods, (2) obtaining the materials from near forests to reduce the costs, and (3) the abundance of the material. All these reasons may be possible to select the broad-leaved trees.
- The origin of the ships may be around the Marmara Sea. Trees of the woods identified grow naturally or planted in the Marmara Region. Conifer woods might be from the planted trees, and broad-leaved trees constituted forests in the northern side might be from the natural forests.
- Most of the ships have some remarks belonging to some small repairs.

ACKNOWLEDGEMENTS

This study was supported by the Research Fund of the Istanbul University. Project numbers: 12155 and 46803.

REFERENCES

- Akkemik, Ü. (2008) *Yenikapı 12 batığı ahşaplarının cins/ tür teşhisleri*. The Old Ships of the "New Gate" (Yenikapı'nın Eski Gemileri) (Ed. Ufuk Kocabaş). Pp: 201-212.
- Akkemik, Ü. and Yaman, B. (2012) *Wood Anatomy Atlas of Eastern Mediterranean Species*. Kessel Publishing House. Germany
- Akkemik, Ü. and Kocabaş, U. (2013) Woods of the old galleys of Yenikapı, Istanbul. *The Mediterranean Archaeology and Archaeometry*. 13 (2): 31-41
- Algan, O., Yalçın, M.N., Yılmaz, İ., Kırıcı-Elmas, E., Sarı, E., Ongan, D., Bulkan-Yeşiladalı, Ö., Perinçek, D., Özdoğan, M., Yılmaz, Y. and Karamut, İ. (2010) *Antik Theodosius Limanı'nın (Yenikapı) Jeo-Arkeolojisi*. İstanbul Arkeoloji Müzeleri 1. Marmaray-Metro Kurtarma Kazıları Sempozyumu Bildiriler Kitabı 5-6 Mayıs 2008 (Ed. Ufuk Kocabaş). İstanbul, pp.175-180.
- Aytuğ, B. (1970) Arkeolojik araştırmaların ışığı altında İç Anadolu stebi. *İ.Ü. Orman Fakültesi Dergisi*, 20 (A-1): 127-143.
- Başaran, S. (2008) "Demirden Yollar" ve Marmara Kıyısında Eski Bir Liman. Yenikapı'nın Eski Gemileri I (Ed. Ufuk Kocabaş). Cilt I: 1-22
- Bean, G.E. (1979) *Turkey's Southern Shore*. 2. Edition, John Murray, London, 154 pp.
- Berkel, A. and Bozkurt, A.Y. (1961) *Türkiye'nin önemli Oak türleri odunlarının makroskopik ve mikroskopik özellikleri hakkında araştırmalar*. İ.Ü.Orman Fakültesi Yayını. Yayın No: 922/73, İstanbul
- Bozkurt, A.Y. (1971) *Önemli bazı ağaç türleri odunlarının tanımı, teknolojik özellikleri ve kullanım yerleri*. İ.Ü. Orman Fakültesi Yayınları No: 1653/177.
- Bozkurt, A. Y. (1992) *Odun Anatomisi*. İ.Ü.Orman Fakültesi Yayın No: 3652/415
- Bozkurt, A.Y. and Erdin, N. (1995) *Odun Anatomisi II*, İ.Ü. Yayın No:3907, Fen Bilimleri Ens. Yayın No:6, ISBN:975-404-406-6, İstanbul.
- Bozkurt, A.Y. and Erdin, N. (1997) *Ağaç Teknolojisi*. İ.Ü.Orman Fakültesi Yayın No: 445, İstanbul
- Bozkurt, A.Y. and Erdin, N. (2000) *Odun Anatomisi*. İ.Ü. Orman Fakültesi Yayınları No: 4263/466.

- Çolak, A.H. and Rotherdam, I.D. (2006) *A review of the forest vegetation of Turkey: Its status past and present and its future conservation*. Biology and Environment: Proceedings of the Royal Irish Academy. Vol. 106B. No.3: 343-354
- D'Amato, R. (2009) *Imperial Roman Naval Forces 31BC-AD500*. Osprey Publishing.
- Dingil, S. (1990) *Bitkilerle Anadolu*. Yeniçağ Matbaası. Ankara, 142 pp.
- Doğu, D., Köse, C., Kartal, S.N. and Erdin, N. (2011) Wood Identification of Wooden Marine Piles from the Ancient Byzantine Port of Eleutherius / Theodosius. *Biore-sources*. 6 (2): 987-1019.
- Fahn, A., Werker, E. and Baas, P. (1986) *Wood Anatomy and Identification of Trees and Shrubs from Israel and Adjacent Regions*. The Israel Academy of Science and Humanities Publication, pp. 221.
- Greguss, P. (1955) *Xylotomische Bestimmung der Heute Lebenden Gymnospermen*, Academia Kiado, Budapest.
- Hafner, F. (1968) Son beşbin yıl içerisinde Anadolu'da orman durumu (Çeviren: Refik Baş). *İ.Ü. Orman Fakültesi Dergisi* 18 (B-2): 211-234.
- Kızıltan, Z. (2008) *Marmaray-Metro Projeleri kapsamında yapılan Yenikapı, Sirkeci ve Üsküdar Kazıları*. İstanbul Arkeoloji Müzeleri 1.Marmaray-Metro Kurtarma Kazıları Sempozyumu Bildiriler Kitabı 5-8 Mayıs 2008 (Ed. Ufuk Kocabaş). İstanbul pp : 1-16
- Kocabaş, U. (2012a) The Latest Link in the Long Tradition of Maritime Archaeology in Turkey: TheYenikapı Shipwrecks. *European Journal of Archaeology*, 15 (1):1-15.
- Kocabaş, U. (2012b) *The Yenikapı Byzantine Ships, Istanbul-Turkey*. In: N.Günsenin (ed) *Between Continents, Proceedings of the Twelfth Symposium on Boat and Ship Archaeology, Istanbul 2009*. 107-113. İstanbul.
- Kocabaş, U. and Özsait-Kocabaş, I. (2007) *İstanbul Üniversitesi Yenikapı Bizans Batıkları Projesi Kapsamındaki Gemilerin Yapım Teknikleri ve Özellikleri*. Gün Işığında İstanbul'un 8000 Yılı, Marmaray, Metro, Sultanahmet Kazıları. Vehbi Koç Vakfı pp.196-201.
- Kocabaş, U. (2008) *İstanbul Üniversitesi Yenikapı Batıkları Projesi: Gemiler*. İstanbul Arkeoloji Müzeleri 1. Marmaray-Metro Kurtarma Kazıları Sempozyumu Bildiriler Kitabı. 5-6 Mayıs 2008. pp.23-34.
- Kuniholm, P., Wazny, T. and Perinçek, D. (2010) *Aegean Dendrochronology Project-Yenikapı 2005-2010*. Sunum-İstanbul Arkeoloji Müzeleri Müdürlüğü
- Liphschitz, N. and Pulak, C. (2007) Wood species used in ancient shipbuilding in Turkey. Evidence from dendroarchaeological studies. *Skyllis*: 73-82.
- Merev, N. (1998) *Türkiye Meşelerinin (Quercus L.) Odun Anatomisi*. Kasnak Meşesi ve Türkiye Florası Sempozyumu, 21-23 Eylül, İ.Ü. Orman Fak. Orman Botanigi Anabilim Dalı, İstanbul, Çantay Kitapevi, pp. 215 -226
- Merev, N. (2003) *Odun Anatomisi ve Odun Tanımı*. Karadeniz Teknik Üniversitesi Orman Fakültesi Yayın no: 210/32.
- Onar, V., Pazvant, G., Armutak, A., Alpak, H., Karamut, İ. and Gökçay, M. (2010) *Yenikapı Marmaray-Metro Kazılarında Ortaya Çıkarılan Hayvan İskelet Kalıntılarının Ön İnceleme Sonuçları*. İstanbul Arkeoloji Müzeleri 1.Marmaray-Metro Kurtarma Kazıları Sempozyumu Bildiriler Kitabı 5-8 Mayıs 2008 (Ed. Ufuk Kocabaş). İstanbul pp : 223-232
- Oybak-Dönmez, E. (2008) *İstanbul Marmaray ve Metro Kazılarında Yapılan Arkeobotanik Çalışmaları*. İstanbul Arkeoloji Müzeleri 1.Marmaray-Metro Kurtarma Kazıları Sempozyumu Bildiriler Kitabı 5-8 Mayıs 2008, İstanbul pp : 233-248
- Özsait-Kocabaş, I. (2010) *Yenikapı Batıklarında İn Situ Koruma*. İstanbul Arkeoloji Müzeleri 1. Marmaray-Metro Kurtarma Kazıları Sempozyumu Bildiriler Kitabı 5-6 Mayıs 2008. (Ed. Ufuk Kocabaş). İstanbul, pp. 35-52.

- Perinçek, D. (2010) *Yenikapı Kazı Alanı'nın son 8000 yıllık jeo-arkeolojisi ve doğal afetlerin jeolojik kesitteki izleri*. İstanbul Arkeoloji Müzeleri 1. Marmaray-Metro Kurtarma Kazıları Sempozyumu Bildiriler Kitabı (Ed. Ufuk Kocabaş) 5-6 Mayıs 2008. İstanbul, pp.191-218.
- Pulak, C. (2007) *Yenikapı Bizans Batıkları. Gün Işığında İstanbul'un 8.000 Yılı, Marmaray, Metro, Sultanahmet Kazıları*. Vehbi Koç Vakfı, s. 202-215.
- Schweingruber, F.H. (1988) *Anatomy of European Woods*. Paul Haupt. Bern/Stuttgart
- Willich, A.F.M. (1802) *Domestic Encyclopedia or A Dictionary of Facts and Useful Knowledge*. Cilt III. Printed and Published by Abraham Small. Philadelphia.
- Yaltrık, F. (1966) *Belgrad Orman vejetasyonunun floristik analizi ve ana meşcere tiplerinin kompozisyonu üzerine araştırmalar*. Tarım Bakanlığı Orman Genel Müdürlüğü Yayınları Sıra No:436, Seri No: 6.
- Yaltrık, F. (1988) *Gymnospermae (Açık Tohumlular)*. İ.Ü. Orman Fakültesi Yayınları. Yayın No: 3443/386
- Yaltrık, F., Efe, A. and Uzun, A. (1997) *Tarih Boyunca İstanbul'un Park Bahçe ve Koruları Egzotik Ağaç ve Çahları*. İSFALT Yayın No: 4, İstanbul
- Yeşilkaya, Y. (1992) *Tarihsel ve kültürel yönü ile sedir*. In Eler, Ü. (Ed.) *Sedir*. Ormancılık Araştırma Enstitüsü Yayını Seri: 6. pp:19-32