WWW.TINATURK.ORG

TINA

MAY 2014 - MUNBER:1

Maritime Archaeology Periodical

TINA TURKISH UNDERWATER ARCHAEOLOGY FOUNDATION

FOUNDATION

Founded by a group of maritime-lover businessmen in 1999.

SCOPE

- To make the international society and scientists familiar with our abundant archaeological cultural heritage in Turkey and its seas. With this idea in mind, to make national and international publications, and organize conferences, panels, seminars, forums, symposiums, workshops, fairs, festivities, exhibitions, and artistic activities such as festivals, excursions and meetings.
- To support local and international scientific institutions, museums, and universities involved in activities of surveys, excavations, conservations and exhibitions under the approval and inspection of the Turkish Ministry of Culture and Tourism.
- To perform underwater surveys and excavations in our seas using scientific methods and current technological facilities under the approval and inspection of the Turkish Ministry of Culture and Tourism.
- To identify the archaeological artifacts lying underwater, reporting their whereabouts to relevant authorities for protection.
- To seek cooperation with the museums and institutions involved in the field and support their activities. To ensure enhancement of such museums and cultural activities, and take necessary steps to provide opportunities for new initiatives.
- To take necessary measures to prevent the pollution of our seas which becomes increasingly harder to fight back, ensure that such measures are taken, and cooperate with other institutions in this sense.
- To contribute to the educational and training institutions dealing with our scopes, and provide scholarships for dedicated students.

EXECUTIVE COMMITTEE

TINA MARITIME ARCHAEOLOGY PERIODICAL

PERIODICAL PUBLICATION OF THE TURKISH UNDERWATER ARCHAEOLOGY FOUNDATION

ISSN:

TINA Maritime Archaeology Periodical is published bi-annually during the months of May and November. The papers to be published should be sent 3 months before the publication date. The coverage of TINA Maritime Archaeology Periodical includes primarily the Anatolian shores, the Mediterranean Sea, and the work performed in the field of maritime archaeology from every corner of the world.

OWNED BY: TINA Turkish Underwater Archaeology Foundation

LICENSE HOLDER: Hüsnü Oğuz Aydemir

CHIEF EDITOR: Mehmet Bezdan

Papers sent to TINA Maritime Archaeology Periodical shall be published only if they comply with the format specified on the last page of this issue.

E-mail address to submit the papers to be published in the coming issues of TINA Maritime Archaeology Periodical: mehmetbezdan@gmail.com

TINA

ADDRESS: Türkiye Sualtı Arkeolojisi Vakfı
Koç Üniversitesi, Anadolu Medeniyetleri
Araştırma Merkezi, İstiklal Caddesi No:181
34430 Beyoğlu / İstanbul
PHONE: 0 212 393 61 30
FAX: +90 212 393 61 40
WEB: http://www.tinaturk.org/

TINA

Maritime Archaeology Periodical

PRESENTATION

UNRAVELING THE GLOBAL MARITIME HISTORY IS A SERVICE OF UTMOST SIGNIFICANCE FOR THE HISTORY OF HUMANITY

Being surrounded by sea on three sides, Turkey is one the countries that possesses the richest underwater archaeological cultural heritage. It has always been a focus of interest by its archaeological assets, particularly the cultural heritage in the field of underwater archaeology. The most tangible evidence on this interest is the history of underwater archaeological explorations exceeding more than fifty years, and variety and quality of revealed findings. The most ancient underwater archaeological findings, unparallelled artefacts exhibited in museums, and abundant maritime history prove that it is one of the most important centers in the world. Unquestionably, behind this archaeological wealth there are world-renown competent scientists.

TINA (Turkish Foundation for Underwater Archaeology), reaching almost 15 years from the date of its foundation, aims to elucidate the world's maritime history and publicize the scientific studies in this field by publishing the works of scientists from all over the world working in the field of "underwater archaeology".

We hope that continuity and effectiveness of our journal will contribute to the targeted service initiative.

Oğuz Aydemir

TINA Turkish Foundation for Underwater Archaeology
Chairman of the Board

EDITOR

Greetings to everyone from the first issue of TINA Maritime Archaeological Periodical.

An excavation performed at Cape Gelidonya on the southern coast of Turkey 54 years ago helped us better imagine the advancement of humankind throughout the history. Being aware of the fact that it is possible to perform an archaeological excavation under the water similar to the land archaeology, the team carried out excavation of the world's oldest known shipwreck at that time. As of now, archaeologists around the world keep exploring the maritime history both underwater and on land.

Archaeological excavations performed throughout the years revealed Turkey's significant role in the world's maritime history. And in 1999 TINA (Turkish Underwater Archaeological Foundation) was established. The objective is to inform the world society and scientists about the abundant archaeological cultural heritage in Turkey and its seas.

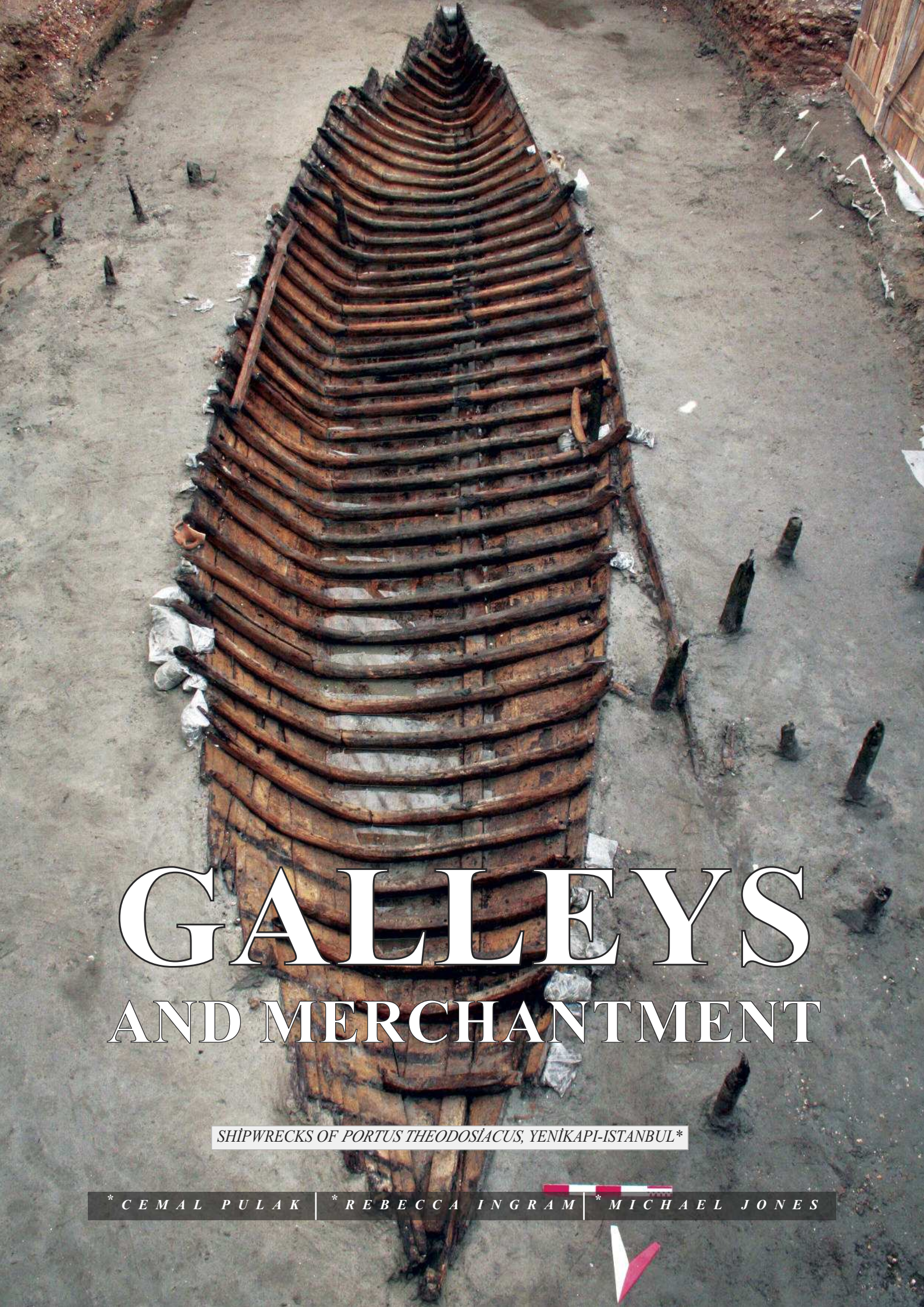
TINA Maritime Archaeological Periodical

TINA Maritime Archaeological Periodical is a periodical which aims to provide scientific contribution through presenting information on the "maritime archaeological activities" performed around the entire world.

Our goal is to create a magazine that discusses the works of maritime archaeologists working at every corner of the globe. Our pages will cover maritime archaeological excavations, scientific projects, news, conferences held in this line of work, university programmes and scientific education in the field as well as the new technologies. Of course, this will become true with you, our colleagues. We invite you to the magazine that will be enriched in coverage with your contributions.

Chief Editor, Publisher
Mehmet Bezdan
Contact via: mehmetbezdan@gmail.com

INDEX



GALLEYS AND MERCHANTMENT

*SHİPWRECKS OF PORTUS THEODOSİACUS, YENİKAPI-ISTANBUL**

* CEMAL PULAK | * REBECCA INGRAM | * MICHAEL JONES

Fig. 1: In situ documentation of shipwreck YK 1.

In 2004, construction work began on Istanbulís Marmaray Project, a major development of Turkeyís public transportation system that joins the Asian section of the city to the European part via an immersed-tube tunnel underneath the Bosporus Strait. The associated Metro Project will integrate this new segment of the railway with Istanbulís subway network. One of the primary interchange stations between the two systems will be located at Yenikapı, on the European portion of the new rail line. Istanbul Archaeological Museums initiated their preliminary archaeological excavations at Yenikapı in 2004 in preparation for construction at that site. In 2005, these excavations revealed the remains of a shipwreck (YK 1) ***(Fig. 1)****; thus, after more than 500 years, remains of Constantinopleís once-great harbor were again brought to light.*

*Assoc. Prof. Dr. Cemal Pulak - Frederick R. Mayer Professor in Nautical Archaeology I, Institute of Nautical Archaeology (INA) at Texas A&M University; Nautical Archaeology Program, Department of Anthropology, Texas A&M University, College Station, Texas 77843-4352, U.S.A.

*Dr. Rebecca Ingram, Dr. Michael Jones - Institute of Nautical Archaeology (INA), P.O. Drawer HG, College Station, Texas 77841-5137, U.S.A.

The Theodosian Harbor, *Portus Theodosiacus*, was the largest harbor in the Byzantine capital of Constantinople. This harbor was built during the reign of Theodosius I (A.D. 379-395), probably around A.D. 390, at the site of a natural bay in the cityís 12th district.[1] The Theodosian Harbor is mentioned in the *Notitia urbis Constantinopolitanae*, a list of the cityís monuments, in the 5th century A.D.[2] Over time, silt deposited by the Lykos River (Bayrampaşa Deresi), which flowed into the harbor, began accumulating at the harborís western end and gradually crept eastward, decreasing the usable portion of the harbor over its lifetime. By the 15th century, only a small part of the harbor remained in use, and the area seems to have been filled in completely by the 16th century.[3]

At the invitation of the Istanbul Archaeological Museums, Cemal Pulak, Vice-President of the Institute of Nautical Archaeology (INA) at Texas A&M University, identified shipwreck YK 1 as that of a late 10th- or early 11th-century Byzantine merchantman. Over the following years, excavations at the site uncovered the remains of 36 additional shipwrecks, dating from the 5th to the late 10th or possibly early 11th century A.D. These 37 shipwrecks are significant in that they represent the largest group of early medieval vessels revealed at a single archaeological site. These include small fishing boats, merchantmen of various sizes, and six 10th-century Byzantine galleys, the earliest medieval galleys ever discovered. Many of the ships appear to have sunk in a single catastrophic event around the end of the 10th or beginning of the 11th century, probably in a violent storm or series of storms.

Between July 2005 and December 2008, our team accomplished the in-situ recording, dismantling, and removal of eight of these shipwrecks (merchantmen YK 1, YK 5, YK 11, YK 14, YK 23, and YK 24 and galleys YK 2 and YK4). Post-excavation documentation and conservation on the shipwrecks is currently ongoing. The hull remains of YK 11, YK 14, YK 23, and YK 24 are being conserved in a water-soluble wax known as Polyethylene Glycol (PEG), at the conservation facility of INAís Bodrum Research Center.[4] Once their post-excavation study and conservation have been completed, the shipwrecks will be returned to the Istanbul Archaeological Museums.

*An expanded version of this article appeared in PULAK et al. 2013, 20-34.
[1] MANGO 1986, 121.
[2] MÜLLER - WIENER 1994, 4, 9.
[3] KUNIHOLM – GRIGGS – NEWTON 2007, 383; MÜLLER - WIENER 1994, 4; MAGDALINO 2000, 215.
[4] Four of the shipwrecks studied by Cemal Pulak and the INA team, YK 1, YK 2, YK 4, and YK 5, will be conserved by Ufuk Kocabaş and his team at Istanbul University.

Number	Date	Type	Estimated length	"Primary wood type(s)"	Date of excavation
YK 1	10th century	Merchantman	10 m	*Quercus cerris*	August 2005-January 2006
YK 2	10th century	Galley	30 m	*Pinus nigra, Platanus orientalis*	April-August 2006
YK 4	10th century	Galley	30 m	*Pinus nigra, Platanus orientalis*	September 2006-April 2007
YK 5	10th century	Merchantman	14,5 m	*Quercus cerris*	March-September 2006
YK 11	7th century	Merchantman	11 m	*Pinus brutia*	May 2008-November 2008
YK 14	9th century	Merchantman	14 m	*Quercus cerris*	April-September 2007
YK 23	9th century	Merchantman	15 m	*Quercus cerris*	December 2007-May 2008
YK 24	10th century	Merchantman	8 m	*Quercus cerris*	July-August 2007

Fig 2: Yenikapı shipwrecks studied by the Institute of Nautical Archaeology (INA).

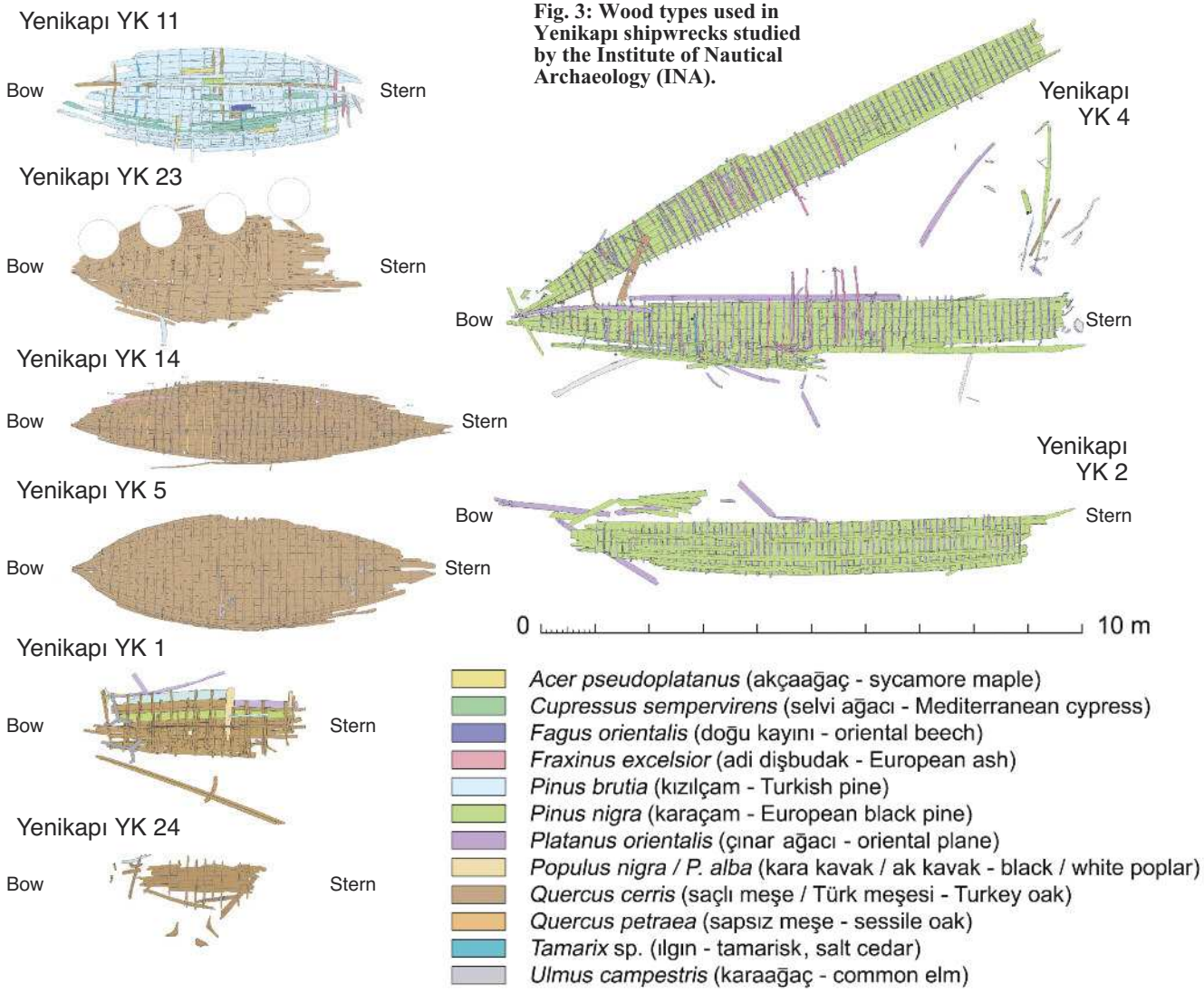


Fig. 3: Wood types used in Yenikapı shipwrecks studied by the Institute of Nautical Archaeology (INA).

THE GALLEYS

The INA team conducted the in-situ documentation, dismantling, and detailed study of two of the siteís six galleys (YK 2, YK 4). **(Fig. 2-3)** These long, slender vessels, the first shipwrecks of this kind from the Byzantine period to be excavated, were previously known only from textual and iconographic sources, both of which are often difficult to interpret. As such, well-preserved galleys such as those at Yenikapı are of fundamental importance and will likely form the basis for much of our understanding of Byzantine naval technology.

Fig. 4: Photomosaic of galley YK 2. Source: Image by R. Piercy.

Based on radiocarbon dating and their stratigraphic location relative to other artifacts uncovered at the site, YK 2 was probably built at the end of the 8th or early in the 9th century and YK 4 at the end of the 9th or early in the 10th century, and both ships sank in the 10th century.

These ships would originally have been approximately 30 m in length and 4 m in breadth. They were built with an emphasis on flexibility and speed, as would be expected of a naval galley. Based on their size, form, and construction, they were likely what the Byzantines referred to as *galeai*, which were light war galleys with a single bank of oars. Such sleek ships would have been used for scouting, speedy communication, and light naval warfare.

The lesser-preserved galley, YK 2, consisted of the port half of the shipís bottom, up to just beyond the turn of the bilge, for a length of 14.5 m. **(Fig. 4)** The study of the extant timbers showed that this ship, lacking any major repairs, was reasonably new when it sank in the 10th century, probably in a violent storm. Analysis by Nili Liphschitz of Tel Aviv University indicates that the outer shell of YK 2 was built of long, wide, flexible planks of European black pine (*Pinus nigra*).[5] Most (about 80%) of the shipís extant frames were of oriental plane (*Platanus orientalis*), a light wood; the remaining frames were of common elm (*Ulmus campestris*). The YK 2 frames were attached to the planking with a combination of treenails and iron nails. The planks were edge-fastened to one another with widely-spaced wooden dowels called coaks. Both the treenails and the coaks were of Turkey oak (*Quercus cerris*). Flat stringers of European black pine (*Pinus nigra*), placed over the frames, also provided some internal support to this galley.

[5] LIPHSCHITZ — PULAK 2009, 168-169.

Fig. 5: Sider strakes of galley YK 4, showing oarport strake.

YK 4 is the most extensively preserved galley at Yenikapı. It had split into two sides along its keel and was preserved for a length of 18 m, up to the turn of the bilge on the starboard side and up to the level of the oarport strake on the port side; much of the shipís bow was also preserved. Although only a relatively small portion of the oarport strake survived, it is significant in that it was the only *in-situ* oarport strake found on a galley at Yenikapı; this piece is thus of great significance, as it reveals the spacing of rowers (positioned 94.5 cm or approximately 3 Byzantine feet apart) relative to a specific location in the shipís hull. The location of the rowersí benches is also indicated by notches in the lowest wale of YK 4, thus revealing the vertical distance and offset between bench and oarport. **(Fig. 5)** In addition, staining and small fastener holes identified on the outer face of the oarport strake constitute the first archaeological evidence of the use of leather sleeves placed outboard of the oarports; these sleeves through which the oars were passed prevented water from entering the hull through the oarports. **(Fig. 6)** In addition to having rowers sitting along the full length of the ship, most likely 25 rowers per side, Byzantine texts indicate that such ships could also be sailed; YK 2 and YK 4 thus would have been equipped with a single mast fitted with a large lateen sail, although no direct evidence thereof was preserved.

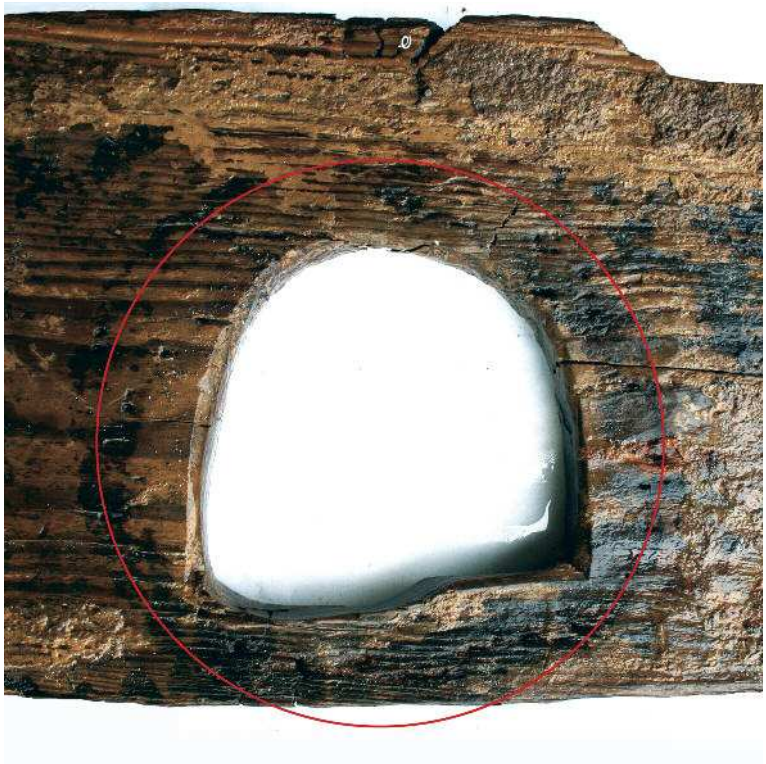


Fig. 6: Outer face of YK 4 oarport strake, showing staining and fastener holes from attachment of leather sleeves.

The hull of YK 4, like that of YK 2, was built of long, wide strakes of planking and wales of European black pine (*Pinus nigra*).[6] While most frames (about 85%) were of oriental plane (*Platanus orientalis*), several other wood types were represented, including common ash (*Fraxinus excelsior*), sycamore maple (*Acer pseudoplatanus*), Turkey oak (*Quercus cerris*), tamarisk (*Tamarix* [X5]), and European black pine (*Pinus nigra*). YK 4 was an aging hull when it sank, as evidenced by a number of frames added to the ship around amidships and toward the bow; these frames were inserted between existing frame locations, thereby doubling up the framing and providing essential reinforcement to these key areas. These later additions to the shipís framing are of woods other than oriental plane (*Platanus orientalis*). As on YK 2, the YK 4 framing was attached with a combination of treenails and iron nails, with planks edge-fastened to one another with widely-spaced coaks; both treenails and coaks were primarily of Turkey oak (*Quercus cerris*). The YK 4 keel and stemson were of oriental plane (*Platanus orientalis*), a lightweight hardwood.

In summary, both YK 2 and YK 4 were designed to be light and sleek, yet durable hulls. The use of long and wide planks that could be readily obtained from European black pine (*Pinus nigra*) minimized the number of joints or scarfs[7] in the planking, which would be a point of weakness in a long, narrow, flexible hull. The coaks and treenails used in fastening timbers together were furthermore made primarily of young and, therefore, flexible branches of Turkey oak (*Quercus cerris*). This provided additional flexibility to a hull that was designed to bend and flex in the water. Oriental plane (*Platanus orientalis*), not usually seen in the merchant vessels at Yenikapı, is a hardwood that is lighter than oak. Framing and other elements of the galleys fashioned from this wood thus contributed reasonable strength to the hull without excessive weight.

The INA team worked with merchantmen representing a chronological progression from the early 7th to the late 10th century.

THE MERCHANTMEN

In contrast to the light, sleek, flexible galleys, most of the merchantmen at Yenikapı were built primarily of large and heavy frames of solid oak, resulting in sturdy, broad vessels that could carry heavier loads (relative to their size) and withstand more regular and sustained use. Of the six merchant vessels studied by the INA group at Yenikapı, five were built primarily of Turkey oak (*Quercus cerris*): YK 1, YK 5, YK 14, YK 23, and YK 24. The sixth ship, YK 11, the earliest Yenikapı ship studied by the INA group, was instead built primarily of Turkish pine (*Pinus brutia*). The merchantmen found at Yenikapı date from the 5th to the 11th centuries A.D., a period during which a profound change was occurring in Mediterranean shipbuilding. Shipbuilding in the Mediterranean developed from a shell-based approach to a skeleton-based approach between the 4th and 11th centuries A.D., the approximate period represented by the finds at Yenikapı. This transition remains to be fully understood, however, and there is debate on the earliest date at which skeleton-based shipbuilding developed: Researchers in Israel contend that it may have emerged as early as the 6th century A.D., based on finds at Tantura Lagoon.[8] Due to the significance of this period in the study of shipbuilding in the Mediterranean, the finds from Yenikapı are particularly valuable: The opportunity to fully excavate, dismantle, record, and study these ships in detail has the potential to unlock vital clues to the nature and timing of this transition.

The INA team worked with merchantmen representing a chronological progression from the early 7th to the late 10th century. Based on its construction and the surrounding stratigraphy, as well as radiocarbon dating, the earliest ship, YK 11, dates to the early 7th century.

---

[6] LIPHSCHITZ — PULAK 2009, 169.
[7] A scarf is an overlapping joint used to connect two timbers or planks without increasing their dimensions. STEFFY 1994, 279, figs. G-11a-11b on 291-92.
[8] KAHANOV – ROYAL – HALL 2004, 113-126; POMEY – KAHANOV – RIETH 2012, 237, 291-308.

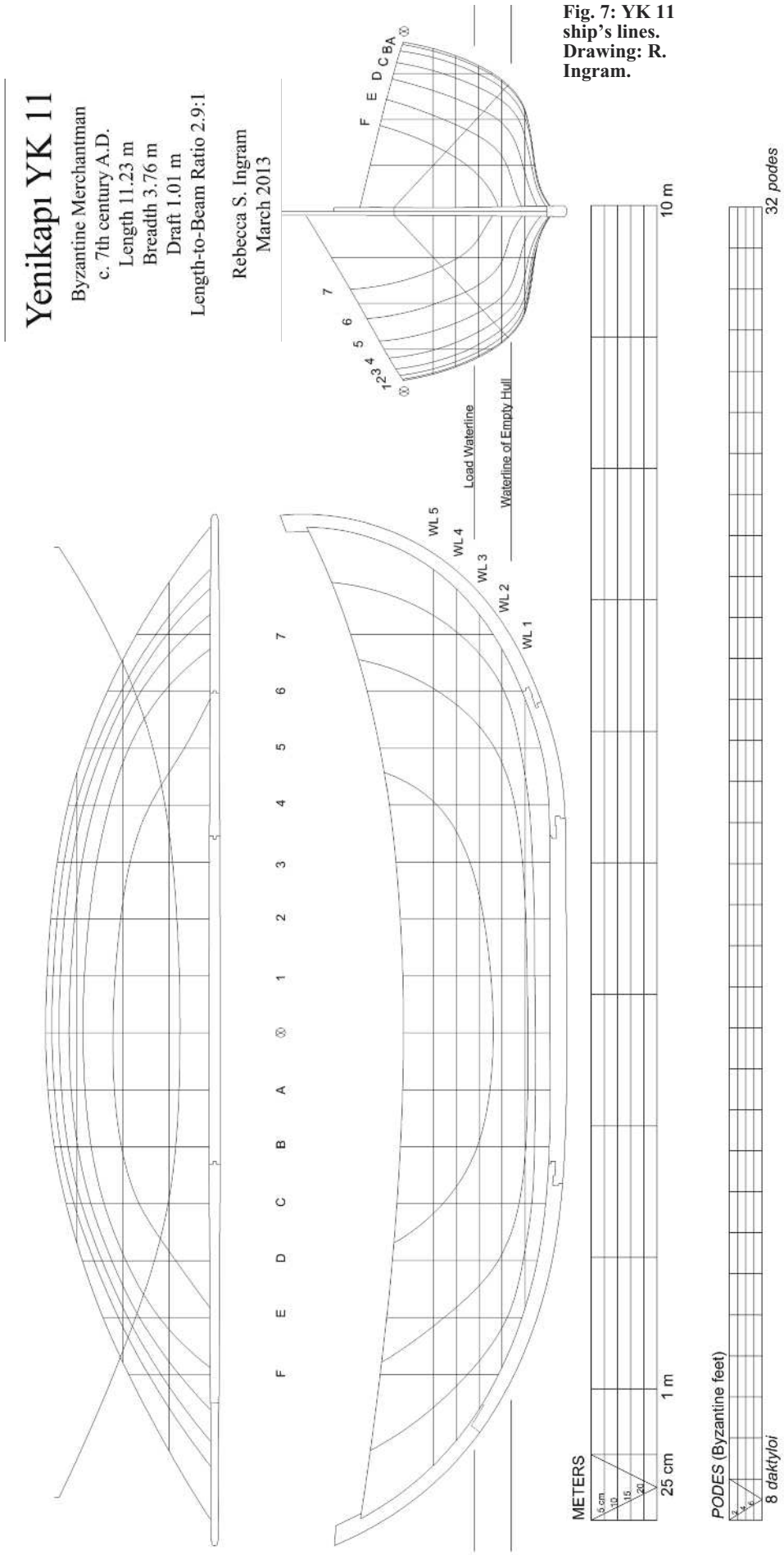


Fig. 7: YK 11 ship's lines. Drawing: R. Ingram.

YK 11 was excavated and dismantled in 2008, and documented in detail between 2009 and 2012.[9] Unlike most other later merchantmen at Yenikapı, YK 11 was built primarily of Turkish pine (*Pinus brutia*), with a keel of Turkey oak (*Quercus cerris*). The ship is approximately 11.25 m in length and 3.75 m in breadth, with a length-to-breadth ratio of 2.9:1. This is a typical ratio for such an efficient merchantmen. **(Fig. 7)** As on the 7th-century Yassıada ship, the planking of YK 11 was edge-joined with small, unpegged mortise-and-tenon joints below the waterline; above the waterline, the shipwright followed skeleton-first techniques, attaching planking directly to pre-erected frames. Detailed study has revealed that this ship had undergone several major overhauls during its lifetime, including the replacement of framing as well as planking.

[9] INGRAM - JONES 2011, 13-14.

Shipwreck YK 23, found near the center of the Yenikapı excavation site, was likely built early in the 9th-century, based on its construction details as well as coins found in association with the ship **(Fig. 8)**. YK 23 was probably 15 m in length and 5 m in breadth. Unlike YK 11, YK 23 was built primarily of Turkey oak (*Quercus cerris*), and planks of the ship were edge-joined with coaks rather than mortise-and-tenon joints. Although not as heavily repaired as YK 11, YK 23 had evidence of several repairs, revealing a long service life. YK 23 is noteworthy for its heavy construction; the massive frames, thick planks, and substantial keelóapproximately 30 cm in thicknessóindicate a strong, sturdy vessel.

YK 14, in contrast to YK 23, was a more lightly-built, sleek cargo vessel. **(Fig. 9)** Based on dendochronological and radiocarbon analyses, this ship can most likely be dated to the first half of the 9th century. After excavation and *in-situ* documentation in the spring and summer of 2007, detailed post-excavation recording of the hull timbers were carried out between 2009 and 2012.[10] Based on its excellent preservation and a near-absence of shipworm damage, it is likely that YK 14 sank and was buried quickly, probably the result of a storm. Built primarily of Turkey oak (*Quercus cerris*) and sessile oak (*Quercus petraea*), the ship was originally approximately 14.65 m in length and 3.4 m in breadth, with a length-to-breadth ratio of 4.2:1.[11] Unlike most other merchantmen at Yenikapı, YK 14 boasts a slender, graceful design; the reason for this design is unclear, but perhaps this hull was constructed for speed as well as for use in shallow coastal waters and rivers.

[10] JONES (in press), INGRAM —JONES 2011, 13-14.
[11] LIPHSCHITZ — PULAK 2009, 168.

Fig. 8: Concrete pillars through side of shipwreck YK 23.

The presence of multiple repairs suggests it had been in use for an extended period when it sank. YK 14, like YK 23, was built with oak planks that were edge-joined to one another with closely-spaced coaks below the waterline. However, the framing pattern reflects an innovation: instead of alternating floors and paired half-frames, YK 14 was built with flat, L-shaped floor timbers whose long arm alternated in orientation with each successive frame. This configuration allowed the positioning of floor-futtock joints to alternate between the frames, thereby avoiding potential points of weakness in the hull. This framing pattern,[12] similar to that used in the late 9th-century Bozburun ship and 11th-century Serçe Limanı ship, also allowed for more standardized and easily fabricated frames.

The least preserved of the Yenikapı merchantmen built during the 10th century and studied by INA, YK 24, was also the smallest, only 8 m in length and 2.5 m in breadth. Based on its size, this was probably a small cargo vessel or fishing boat intended for local use. **(Fig. 10)** This ship was built of Turkey oak (*Quercus cerris*), with flat, L-shaped floor timbers and planks edge-joined with coaks. Numerous repairs to the planking and keel of this ship indicate a somewhat dilapidated, aging hull that had seen many years of service.

[12] HARPSTER 2009, 301-310; BASS vd. 2004, 93.

Fig. 9: Measuring YK 14 with Total Station.

Fig. 10: Shipwreck YK 24 during *in situ* documentation.

Much better preserved, YK 5 comprises the bottom and much of the port side of the ship, and is approximately 14.5 m in length and 5 m in breadth, with a length-to-breadth ratio of 2.9:1. This 10th-century merchantman was built entirely of Turkey oak (*Quercus cerris*). Based on its near-pristine condition and a lack of repairs, YK 5 was probably new when it collided with galley YK 4 and sank, probably during a violent storm; the hull of YK 5 was found resting atop galley YK 4 toward the eastern end of the excavation site. **(Fig. 11)** YK 5 was built with flat, L-shaped floors. This was preferred for producing a wider and more flat-bottomed hull shape, likely in an effort to maximize cargo capacity. YK 5 planks were edge-joined with widely-spaced coaks below the waterline.

Of the 31 merchant vessels recovered at Yenikapı, only three were found with much of their cargo still present. One of these, YK 1, was the first shipwreck discovered at the site. The area above and around the wreck was covered with dozens of Ganos-class wine amphoras, many of which survived intact. The remains indicate that the ship engaged in regional trade in the Sea of Marmara in the late 10th and early 11th centuries[13]. The presence of cargo as well as two iron, Y-shaped anchors at the shipís bow strongly suggest that the ship sank during a storm and was quickly covered with a thick layer of sand, thus protecting the valuable iron anchors from the notice of salvors. **(Fig. 12)** The intact YK 1 anchors are one of the only three sets of anchors found in association with any of the shipwrecks excavated at the site.

[13] GÜNSENİN 2009, 147.

Fig. 11: Shipwreck YK 5 during in situ documentation.

Of the 31 merchant vessels recovered at Yenikapı, only three were found with much of their cargo still present. One of these, YK 1, was the first shipwreck discovered at the site. The area above and around the wreck was covered with dozens of Ganos-class wine amphoras, many of which survived intact. The remains indicate that the ship engaged in regional trade in the Sea of Marmara in the late 10th and early 11th centuries[13].

Fig. 12: One of two iron anchors found on shipwreck YK 1.

A noteworthy aspect of YK 1 is that the starboard side of the ship was preserved, from the turn of the bilge up to, and including, the shipís caprail. **(Fig. 1)** The ship was built of Turkey oak (*Quercus cerris*). It would have been approximately 10 m in length and 3.5 m in breadth, resulting in a length-to-breadth ratio of 2.9:1[14]. It was initially built with techniques identical to those used in the construction of YK 14, YK 24, and YK 5, although the keel of YK 1 was slightly curved or ìrockeredî, which would have resulted in a more rounded hull. **(Fig. 13)** Similar to the planking of many of the other merchantmen, the YK 1 planking was edge-joined with closely-spaced coaks below the waterline. Above the waterline, the side of the ship was strengthened longitudinally with four, half-log wales. At some point during its lifetime, the ship was subjected to a major overhaul, in which the sides were raised by about 60 cm to increase the vesselís freeboard. During the overhaul, 12 secondary futtocks were inserted between the shipís 16 existing futtocks, providing a framework supporting the newly-added strakes and caprail[15].

In overview, these six Yenikapı merchantmen reflect a gradual progression in the transition from shell-based to skeleton-based shipbuilding that occurred in the second half of the first millennium. All of these merchantmen were built with edge-fastened planking below the waterline, primarily with shell-based techniques, while the ship was built primarily according to skeleton-first techniques above the waterline, with planking attached to pre-assembled framing. This mix of shell-based and skeleton-first techniques is typical of transitional shipbuilding of this period.

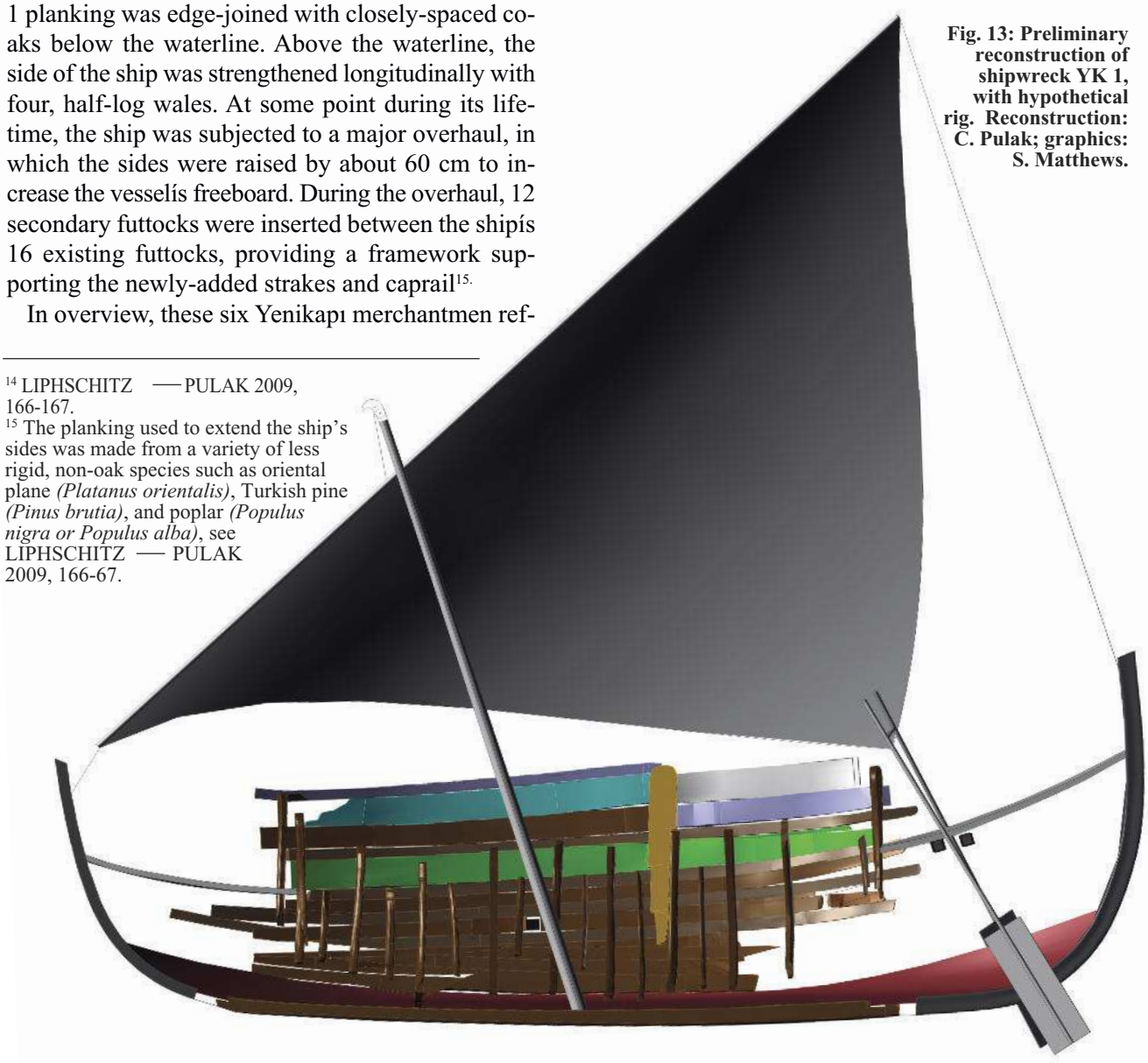


Fig. 13: Preliminary reconstruction of shipwreck YK 1, with hypothetical rig. Reconstruction: C. Pulak; graphics: S. Matthews.

[14] LIPHSCHITZ — PULAK 2009, 166-167.

[15] The planking used to extend the ship's sides was made from a variety of less rigid, non-oak species such as oriental plane *(Platanus orientalis)*, Turkish pine *(Pinus brutia)*, and poplar *(Populus nigra or Populus alba)*, see LIPHSCHITZ — PULAK 2009, 166-67.

CONCLUSIONS

The Yenikapı shipwrecks are the first direct archaeological evidence for ships associated with the trade, economy, and defense of the Byzantine capital. Although Byzantine-period ships have been excavated elsewhere in the Mediterranean, no other site has provided so many well-preserved vessels from this period. Understanding the transition from shell-based to skeleton-based shipbuilding has been particularly problematic due to the relative lack of well-preserved, fully excavated shipwrecks available for study and comparison. The Yenikapı shipwrecks promise to add a significant body of new information toward elucidating this complex process, due both to the large number and varied types of ships discovered at the site and to their exceptional state of preservation. Preliminary research indicates that the long, sleek galleys, built primarily of wide and long planks of flexible pine, were specifically designed to result in flexible, fast and highly maneuverable vessels. The merchantmen at Yenikapı, in contrast, were usually built of oak; based on their design, shipwrights strove to create a strong, sturdy vessel that maximized cargo capacity. Altogether, these ships show that the development of Mediterranean shipbuilding in late antiquity was a more complex process than previously thought. Byzantine shipwrights seem to have been adapting to the often harsh economic circumstances and political conditions of their times by retaining some aspects of older technology and traditions while experimenting with or modifying others. As post-excavation research continues on these vessels from Yenikapı, nautical archaeologists will be better able to understand how and why these changes took place.

BIBLIOGRAPHY

BASS vd. 2004 — Bass, G.F., S.D. Matthews, J.R. Steffy, van Doorninck, F.H. Jr., *Serçe Limanı. An Eleventh-Century Shipwreck Vol.1: The Ship and its Anchorage,* Crew *and Passengers,* College Station, Texas A&M University Press, 2004.

DEAR – KEMP 2002 — Dear, I., Kemp, P., *A'dan Z'ye Yelkende Denizcilik Terimleri Sözlüğü*, çev. O. Soyer, Oxford, 2002.

GÜNSENİN 2009 — Günsenin, N., "Ganos Wine and its Circulation in the 11th Century", *Byzantine Trade, 4th-12th Centuries* içinde, (ed.) M. M. Mango., Burlington, Ashgate Publishing Company, 2009, 145-153.

HARPSTER 2009 — Harpster, M., "Designing the 9th- Century AD Vessel from Bozburun, Turkey", *International Journal of Nautical Archaeology* 38, 2009, 297-313.

INGRAM – JONES 2011 — Ingram, R., Jones, M., "Yenikapı: Documenting Two Byzantine Merchant Ships from the Yenikapı Excavations in Istanbul, Turkey", *The Institute of Naitucal Archaeology Annual,* 2011, 8-17.

JONES (baskıda) — Jones, M.R., "A Middle Byzantine Period Cargo Vessel from the Yenikapı Excavations in Istanbul: A Preliminary Analysis", *Proceedings of the Research Center for Anatolian* Civilizations' *Fifth Annual Symposium, "Istanbul and Water",* 2010 (ed.) P. Magdalino ve N. Ergin. Louvain, Peeters, (baskıda).

KAHANOV – ROYAL – HALL 2004 — Kahanov, Y., Royal, J., Hall, J., "The Tantura Wrecks and Ancient Mediterranean Shipbuilding", *The Philosophy of Shipbuilding: Conceptual Approaches to the Study of Wooden Ships* içinde, (ed.) F. M. Hocker, C.A. Ward, College Station, Texas A&M University Press, 2004, 113-127.

KUNIHOLM – GRIGGS – NEWTON 2007 — Kuniholm, P.I., Griggs, C.B., Newton, M.W., "Evidence for Early Timber Trade in the Mediterranean", *Byzantina Mediterráneo. Festschrift für Johannes Köder zum 65. Geburtstag* içinde, (ed.) K. Belke, E. Kislinger, A. Külzer, M.A. Stassinopoulou, Viyana, Böhlan, 2007, 365-385.

LIPHSCHITZ – PULAK 2009 — Liphschitz, N., Pulak, C., "Shipwrecks of Portus Theodosiacus. Types of Wood Used in Some Byzantine Roundships and Longships found at Yenikapı, Istanbul", *Skyllis, Zeitschrift für Unterwasserarchäologie* 9 (2), 2009, 164-171.

MAGDALINO 2000 — Magdalino, P., "The Maritime Neighborhoods of Constantinople: Commercial and Residential Functions, Sixth to Twelfth Centuries", *Dumbarton Oaks Papers* 54, 2000, 209-226.

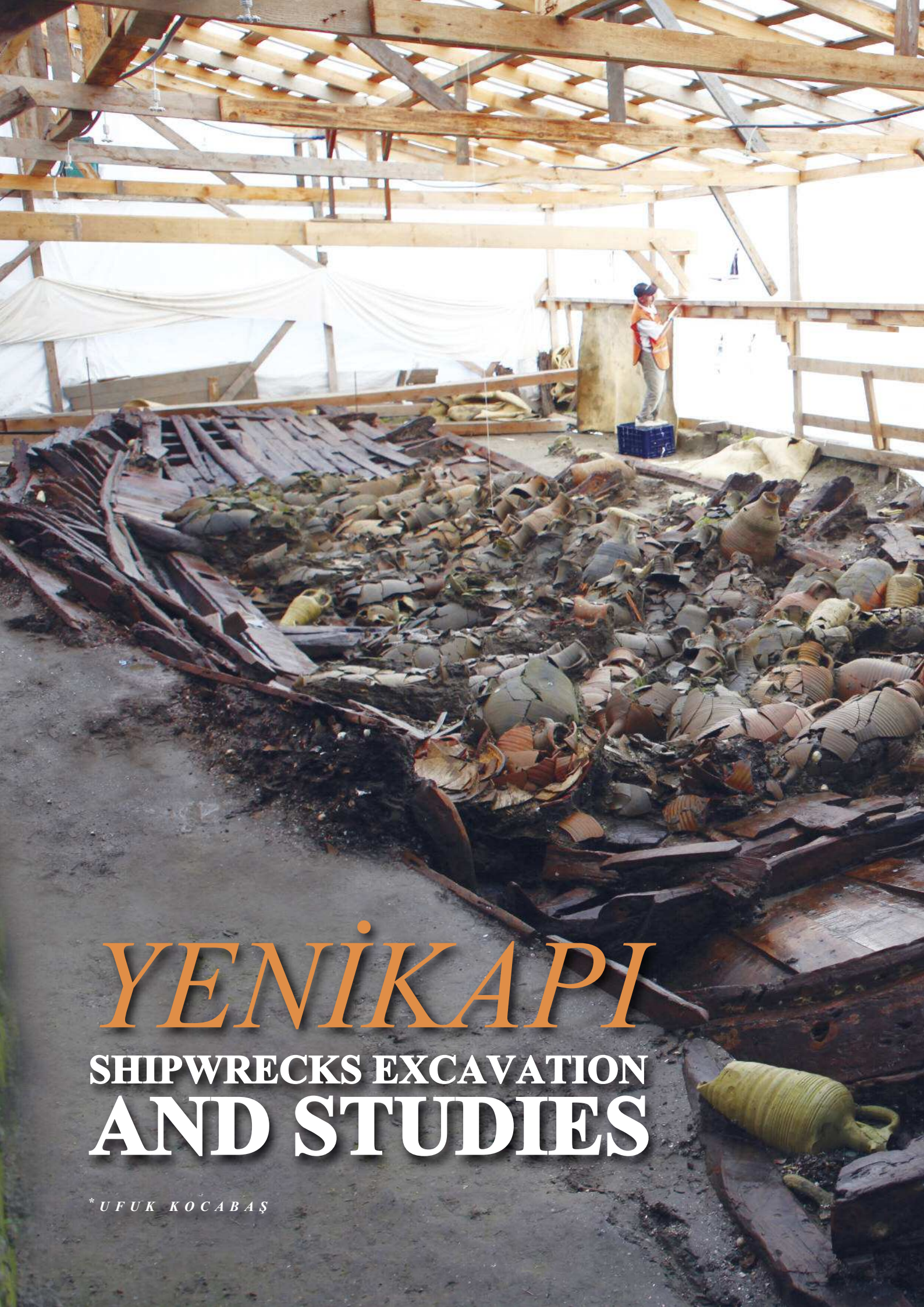
MÜLLER - WIENER 1994 — Müller-Wiener, W., *Die Häfen von Byzantion* - Konstantinupolis - *Istanbul.* Tübingen, Ernst Wasmuth Verlag, 1994.

MANGO 1986 — Mango, C., "The Development of Constantinople as an Urban Centre", *The 17th International Byzantine Congress, Major Papers*, Aristide D. Caratzas, New Rochelle, New York, 1986, 117-136.

POMEY – KAHANOV – RIETH 2012 — Pomey, P., Kahanov, Y., Rieth, E., "Transition from Shell to Skeleton in Ancient Mediterranean Ship-Construction: Analysis, Problems, and Future Research", *International Journal of Nautical Archaeology* 41, 2012, 235-314.

PULAK vd. 2013 — Pulak C., Ingram, R., Jones, M., Matthews, S., "Yenikapı Batıkları ve Batıkların Gemi Yapımı Araştırmalarına Katkısı", *Saklı Limandan Hikayeler Yenikapı'nın Batıkları*, (ed.) Z. Kızıltan, G. Baran Çelik, İstanbul, 2013, 22-34.

STEFFY 1994 — Steffy, J.R., *Wooden Ship Building and the Interpretation of Shipwrecks*, College Station, Texas A&M University Press, 1994.



YENİKAPI

SHIPWRECKS EXCAVATION AND STUDIES

*UFUK KOCABAŞ

SUMMARY

Thirty seven shipwrecks dated to Byzantine Period have been discovered in the district of Yenikapı, Istanbul. They were found by the Istanbul Archaeological Museums during a rescue excavation that started in 2004. Considered the largest medieval shipwreck collection in the world, these wrecks have survived due to the sedimentation of the Theodosian Harbour caused by the Lykos Stream. The wrecks provide us with invaluable information on Byzantine period ship typology, shipbuilding technologies, and their constructional evolution.

THEODOSIAN HARBOUR: DISCOVERY, EXCAVATION AND HISTORY

Considered one of the most important cities of the Mediterranean world since its re-foundation as the capital of the Roman Empire in the fourth century AD, Istanbul has been the capital city of three great world empires, and the grandest city of the Republic of Turkey. Istanbul has been the stage for the coexistence and clashes of the occidental and oriental civilisations and different cultures. In the long course of its history, Istanbul has grown beyond the Theodosian walls into a cosmopolitan and gigantic city of 15 million inhabitants. As the old city transformed into a metropolis, one of the biggest problems became transportation. Before the start of construction at ‹sk¸dar, Sirkeci, Sultanahmet and Yenikapı for the Metro and Marmaray projects, designed to resolve many transportation problems, the Directorate of Istanbul Archaeological Museums launched archaeological excavations at these sites .

In the course of these excavations, the most extensive archaeological excavations in the history of Istanbul, the largest medieval harbour of the city has been uncovered at Yenikapı, where a central station will be built **(Fig. 1)**. Known as Portus Theodosiacus (i.e. the Theodosian Harbour) in the written sources, the site has presented us with discoveries deserving of a capital cityís harbour and beyond, with priceless artifacts related with seafaring, trade, and ships of the Byzantine period.

Fig. 1. A view from excavation; one of the stone docks on the front, a shipwreck tent at the back.

* *Assoc. Prof. Dr. Ufuk Kocabaş. Istanbul University Letters Faculty Department of Conservation and Restoration of Artefacts Division of Conservation of Marine Archaeological Objects Ordu Caddesi, Laleli-Fatih, İstanbul-TURKEY.*

The excavations confirmed that the harbour was established in this former cove, and then silted in by the *Lykos* (Bayrampaşa) stream transposing the site to about 300 m from todayís shoreline. Approximately 50 archaeologists and 600 workers had been working on the archaeological salvage excavations at Yenikapı covering a construction area of 58.000 m^2. Istanbul Archaeology Museum has also been collaborating with several national and international universities and institutes which provide scientific support through various disciplines such as nautical archaeology, conservation, osteo-archaeology, archaeo-botany, geology, philology, dendrochronology, prehistory, and anthropology.

As expected. the excavations first revealed Ottoman remains. The area between todayís Mustafa Kemal and Namık Kemal Avenues has been known as *Langa Bostanı* (*Langa* vegetable and fruit gardens) since Ottoman period **(Fig. 2)**. *The Langa or Vlanga* was a neighbourhood where the non-Muslim Ottoman population, mostly made up of Jewish families, lived[1]. As the excavations progressed archaeologists uncovered profound Byzantine material beneath the Ottoman remains. Soon after, the site was understood to be the Theodosius Harbour previously known from the literary sources. Named after Byzantine emperor Theodosius I, the harbour was established at the mouth of Lykos stream which includes Zone XII of the city **(Fig. 3).** Although there are doubts regarding the harboursí precise location due to an earlier harbour at the same area, it is commonly accepted that the earlier Eleutherios Harbour, which dates to Konstantin I period (272-337) the precursor to the Theodosius harbour. Petrus Gyllius agrees that the Theodosian Harbour was established at the same location that the Eleutherios Harbour was previously located[2]. Excavations by Istanbul Archaeology Museum supports this idea on the basis of earlier remains and artefacts uncovered at the west end of the site[3].

[1] KÖMÜRCİYAN 1988, 3; İNCİCYAN 1976, 4-5.
[2] GYLLIUS, IV.
[3] ASAL 2007.

Fig. 2. Map of Constantinople and The Harbour of Theodosius that was drawn by a geographer from Florence; Christopher Buondelmonte 14th-15th century.

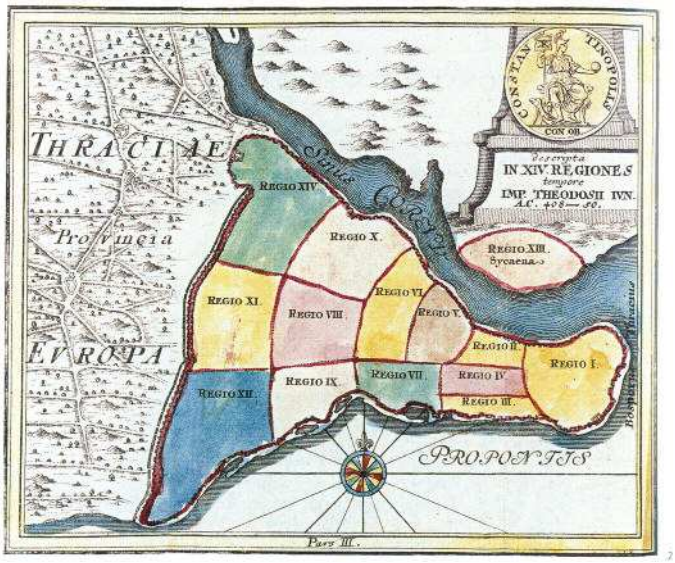


Fig. 3. Map of Constantinople in the era of Theodosius the first that is separated to 14 regions.

Fig. 4. Cleaning and documentation work on largest cargo ship of the excavation site; YK22.

The most telling remain here is a 51 m-long and 4.20 m-wide wall built with ashlar blocks and khurasan mortar. Another diagnostic feature is an exposed 11 m long vaulted structure. Furthermore, breakwater and quay stones exist with two parallel rows of wooden pilings extending 43 m in front of the quay belonged to a pier[4].

According to the textual evidence; the presence of two granaries on the east of harbour; *Horrea Alexandrina and Horrea Theodosiana* indicate this was a commercial harbour, receiving ships loaded with mass cargoes of grain from Alexandria. It is known that the grain trade was active until the Arabic conquest of Egypt on AD 641. Grain ships from Egypt were sailing directly to Constantinople until the reign of ?ustinianos. Due to strong seasonal wind and currents in the Dardanelles strait, the ships had to wait for the safer weather conditions. In order to avoid such delays, granaries were built at Tenedos Island by the emperor ?ustinianos. Thus bigger ships unloaded their cargoes without waiting in the Dardanelles strait while smaller ships were shuttling between Tenedos and the capital. In addition to the grain trade, construction materials such as marble from Proconnesos, tiles, bricks, timbers, and other food supplies were brought to the Theodosian harbour to meet the growing demands of Constantinople[5].

YENİKAPI SHIPWRECKS

37 shipwreck have been uncovered at Yenikapı site. These represent the largest medieval shipwreck collection ever found in a single site. Besides the Yenikapı shipwrecks have survived well as they were buried in the silt brought by the Lycus Stream. The Istanbul Archaeological Museums turned to Istanbul Universityís Department of Conservation of Marine Archaeological Objects to handle the conservation and fieldwork of most of the shipwrecks[6]. Departmentís director Dr. Ufuk Kocabaş and his team of departmentís staff, full time specialists and Istanbul Universityís graduate students have been working for more than seven years at the Yenikapı excavation site to document and raise the shipwrecks **(Fig. 4-5)**.

[4] KIZLTAN 2010; GÖKÇAY 2007.
[5] MÜLLER-WIENER 1998, 18.
[6] The fieldwork of the eight of the Yenikapı shipwrecks were carried out by a team of Texas A&M University led by Dr. Cemal Pulak.

The information on the origins of the shipwrecks is limited. With a goal of ascertaining the geographical regions in which the ships were built, approximately 2800 samples were taken from the ship timbers and analysed at Istanbul Universityís Forestry Faculty by Prof. Dr. Ünal Akkemik[7]. Akkemik reports that most of the ship timbers are of oak, pine, chestnut, and ash trees, all of which are common in the western and northern Anatolian region. The wide distribution of these species throughout the Mediterranean region prevents more precise suggestions for the home ports of the Yenikapı ships.

For the accurate dating of the ships ^{14}C analyses were performed by Oxford Universityís Radiocarbon Acceleration Unit (ORAU). In addition dendrochronological analyses have also been planned for greater dating precision.

[7] AKKEMİK 2008, 201-212.

Fig. 5. Cargo of YK12 shipwreck that consist of amphorae and personal belongings.

Fig. 6. A detail from Total Station work that provides 3D field drawings.

Fig. 7. Parts of the shipwrecks were dismantled and placed in special wooden cases, meanwhile hand drawings in progress.

EXCAVATION, IN SITU DOCUMENTATİON AND LIFTING

The excavation of a shipwreck at the Yenikapı site began with setting up a temporary tent over the wreckage in order to protect waterlogged ship timbers from the drying and damaging effects of direct sunlight. A secondary measure taken for to avoid drying of the waterlogged wood was to install a sprinkler system for round-the-clock misting of the timbers. After carefully removing any sediment from fragile timbers with water and hand-tools, a standard procedure consisting of *in situ* documentation, plan and section drawings, 3d modelling, 1:1 scale acetate drawings, photomosaic micro-site construction, video recording and cataloguing are applied[8] **(Fig. 6)**

After detailed documentation labelled timbers forming the hull structure such as frames, planks, keel, stem or sternposts are gently disassembled **(Fig. 7)**.

[8] ÖZSAİT-KOCABAŞ 2010a; ÖZSAİT-KOCABAŞ 2008, 37-72.

Fig. 8. Planks were placed on the "L" shaped carriers to avoid loss of any part of woods and original curved shape.

Fig. 9. Istanbul University Yenikapı Shipwrecks Project Laboratory near excavation site and preservation pools for the shipwrecks.

Fig. 10. Locating of nails and labelling.

Specially designed mould-like carriers are used to dismantle plank strakes in order to maintain the original angle of hull curvature **(Fig. 8)** Disassembled timbers are placed in separate wooden boxes and transferred to fresh water tanks for the desalination process.

Conservation and reconstruction procedures of the shipwrecks have been carried out at Istanbul Universityís Ship Conservation and Reconstruction Laboratory and the on-site ìIU Yenikapı Shipwrecks Research Centreî **(Fig. 9)** founded with the support of ìIstanbul Metropolitan Municipalityî and ìIstanbul Universityís Scientific Research Projects Unitî[9].

POST EXCAVATION DOCUMENTATION

The first stage of reconstruction work aims to gain a better understanding of the construction techniques of each ship. It is unfortunate that neither detailed description regarding the medieval shipbuilding nor any sketch or plan of a medieval ship exists among the historical sources.

The present information on nautical life of the period is limited to a small number of iconographic examples and literary sources vaguely referring to some of the ship types. The lack of sufficient historical evidence dictates a need for detailed examination of each shipwreck.

Therefore digital reconstructions showing the possible original hull and rigging have been made on the basis of the careful examination of surviving remains **(Fig. 10)**. Using digital reconstructions, the original dimensions of a shipwreck, such as draught, overall length, length at the waterline, breadth, depth, etc. may be estimated with some certainty.

[9] KOCABAŞ — ÖZSAİT-KOCABAŞ — KILIÇ 2012.

Fig. 11. A digitizer called Faro Arm provides 3D drawings of the shipwrecks.

Detailed recording of the surviving ship timbers are made with a 3-D digitizer called, *FaroArm* are made. This technology has been used in the field of archaeology for the first time in Turkey by Istanbul Universityís Project team **(Fig. 11)**. Ascertainable details of each timber, such as fastenings, joints, angles, tool marks, corrosion stains, etc. are all recorded using the laser scanner. Each digitized timber can then be used to create 3-D images of ship timbers[10].

GENERAL CHARACTERİSTİCS OF THE YENİKAPI SHİPWRECKS

The Yenikapı shipwrecks provide us with invaluable information on shipbuilding technologies and shipbuilding evolution over time. The ongoing research of shipbuilding experts from Istanbul University reveal a broad range of shipbuilding techniques from traditional shell-based approaches to skeleton-based approaches as well as a mixed construction technique of the transitional period combining both approaches. Research has shown that the planks of some shipís hulls were edge-joined with coaks, while planks of other ships show characteristics of the transitional period, locked in place with wooden pegs. In a third group of ships, probably of skeleton-based construction, no evidence of edge-fasteners were found in the joining of the planking. Use of diverse construction techniques in some ships dating from the same period suggests the presence of local differences and a non-linear progression of approaches[11]. Progress in scientific research on the Yenikapı shipwrecks will certainly contribute to discussions of shipbuilding processes, revealing many technical details that have been previously unknown.

[10] ÖZSAİT-KOCABAŞ 2011a.
[11] ÖZSAİT-KOCABAŞ 2011a.

Fig. 12. In situ position of YK12 with her cargo which is exceptional.

According to the initial results, in shipwrecks YK 34 and YK 35 the planks of the hull were fastened with wooden dowels using locking pins whereas in YK 22 the planks were fastened without using any locking pins.

In the excavation area of Yenikapı, a majority of the shipwrecks are those which were edge-fastened using dowels. Shipwrecks YK 3, YK 6, YK 7, YK 8, YK 9, YK 12, YK 13, YK 15, YK 16, YK 18 and YK 20 are considered to have been built using mixed construction techniques of the transitional period.

The excavations have also yielded three shipwrecks without any edge fastenings between planks. There is evidence that shipwrecks YK 17, YK 27 and YK 29 were built using the skeleton-based construction techniques.

CARGO SHIPS

According to the preliminary evaluations, Yenikapı shipwrecks can be divided in two groups. The first group is represented by cargo ships in various dimensions dating from the fifth to the tenth centuries. These ships have flat bottom sections and rounded hulls and likely carried one sail, probably a lateen rig, placed near the bow. On the basis of their relatively small sizes most of the ships would have been used over short distances. It is possible that some ships would have functioned as fishing vessels

Fig. 13. Cleaning work on YK34. Remaining pillars of a pier has been paled on the shipwreck.

At least four of the cargo ships were found with the cargoes intact **(Fig. 12-13)**. The reason for the sinking of these four ships remains unclear. The rest of the ships were found without cargoes, anchors, or rigging equipment and were probably abandoned in the harbour after a long period of service[12].

GALLEYS

Six galleys or oared vessels constitute the second group of Yenikapı shipwrecks. There were no original examples of this type prior to the Yenikapı excavations and the information on this type of Medieval vessel was limited to scanty literary evidence. These first archaeological examples of medieval galleys exhibit quite different hull forms than the cargo ships.

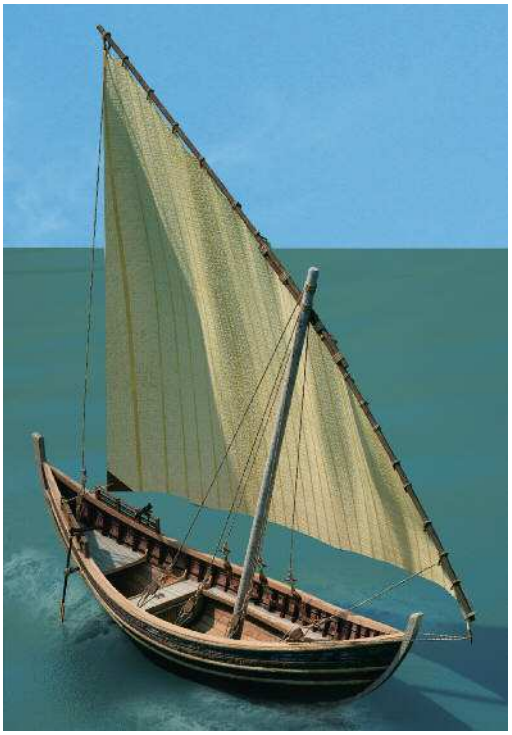
They are approximately 28 meters long and narrow. These hull designs must have provided greater speed and manoeuvrability[13]. The Yenikapı galley type vessels can be associated with the ìgaleaî mentioned in Byzantine texts and these would have served the Byzantine navy as scout vessels escorting ìdromonsî, the main type of warship of the empire[14]. **(Fig. 14).**

Fig. 14. YK16; a combat vessel that called Galley (Galea)

[12] ÖZSAİT-KOCABAŞ 2010b; ÖZSAİT-KOCABAŞ 2011b, 137–148; KOCABAŞ 2012, 1-5.
[13] ÖZSAİT-KOCABAŞ - KOCABAŞ 2008, 97-186.
[14] SAKELLIADES 1997, 47-54; PRYOR - JEFFREYS 2006; PULAK 2007, 128-141.

CONSERVATION

Due to a thick layer of muddy sediment, the Yenikapı shipwrecks were found in a relatively good state of preservation in comparison with other wrecks found underwater in Mediterranean region. However, regardless of their fair condition, it is unwise to store or display any waterlogged ship timber without conservation and restoration procedures as natural drying will result in irreparable damage to the ships. Biological and taphonomic activity has resulted in differing levels of degradation on the cell structure of the timbers during the course of many centuries and must be counteracted through conservation processes.



The conservation procedure begins immediately as the wrecks are brought to day light. In order to avoid cracks and shrinkage on waterlogged timbers due to drying out, a temporary tent with a sprinkler system is set on the wreck site to maintain high relative humidity at site during the fieldwork. The ship timbers removed from the site are kept in fresh water tanks and thereby desalination procedure is started.The levels of degradation, the causes of degradation, and maximum water contents are identified via ESEM (Environmental Scanning Electron Microscope), XRF (X-ray Fluorescence), XRD (X-ray diffraction), ICP-MS (Inductive Kapling Plasma) analyses. After this stage the iron compounds on timbers are removed by chemical and mechanical methods **(Fig. 15)**. The most crucial stage of the conservation procedure is the impregnation of chemicals into the cell structure of the wood to replace water in the cell structure and provides mechanical strength. A synthetic resin, Polyethylene Glycol (PEG) and Kauramin (melamin formaldehid) solution are chosen as the impregnation chemical for Yenikapı wrecks in accordance with industry standards **(Fig.16-17)**. Following this lengthy procedure, drying techniques will be applied and reassembly of ship timbers for the future public exhibitions will be possible[15].

[15] KOCABAŞ 2010, 23-33.

Fig. 15. Chemical and mechanical cleaning on keel before conservation.

Fig. 16. Woods are being conservated by using Kauramin method.

Fig. 17. PEG solution is being poured into the conservation tank.

CONCLUSION

Thirty-seven shipwrecks uncovered during the Yenikapı archaeological excavations, dating from 5th to 10th centuries, constitute the largest medieval shipwreck collection ever found in a single site. The temporal differences exhibited by the shipwrecks provide a unique opportunity to understand the development of shipbuilding traditions and technologies in the Mediterranean region. Although the results are preliminary, there are many construction details which do not exist in the present literature. Widely discussed and debated subjects in the field of nautical archaeology; transition from shell-based to skeleton-based shipbuilding techniques and possible reasons behind this transition, are being reviewed based on the new evidence from the Yenikapı excavations.

Our ultimate goal is to make Istanbul own the largest ancient shipwreck collection in the world. No doubt, this collection will attract numerous Turkish and foreign visitors and will contribute to the national economy when displayed in a museum to be founded in the future, adding new value to the cultural heritage of Turkey.

ACKNOWLEDGEMENTS

I would like to express my sincere thanks to Zeynep Kızıltan, the director of Istanbul Archaeological Museums, vice director Rahmi Asal; Sırrı Çömlekçi, Mehmet Ali Polat and Emre Öncü, the field directors of Yenikapı salvage excavation for their continuous support during all stages of our work on Yenikapı shipwrecks excavation. Besides, I would like to thank Dr. Işıl Özsait-Kocabaş; project assistants Evren Türkmenoğlu, Taner Güler, Namık Kılıç and all İÜ Yenikapı staff for their teamwork since 2006.

This Project is supported by Istanbul Universityís Scientific Research Projects Unit. Project numbers: 2294, 3907, 7381, 12765.

BIBLIOGRAPHY

AKKEMİK 2008 — Akkemik, Ü., "VII. Identification of Timbers From Yenikapı 12 Shipwreck/ VII. Yenikapı 12 Batığı Ahşaplarının Cins/Tür Teşhisleri", *Yenikapı Shipwrecks*, *Volume 1: Old Shipwrecks of New Gate 1 /Yenikapı Batıkları, Cilt 1: Yenikapının Eski Gemileri 1,* (ed.) U. Kocabaş, Istanbul 2008, 201-211.

ASAL 2007 — Asal, R., "İstanbul'un Ticareti ve Theodosius Limanı", *Gün Işığında: İstanbul'un 8000 Yılı. Marmaray, Metro ve Sultanahmet Kazıları*, (ed.) A. Karamani-Pekin, İstanbul 2007, 180-189.

GÖKÇAY 2007 — Gökçay, M., "Yenikapı Kazılarında Ortaya Çıkarılan Mimari Buluntular", Gün Işığında: İstanbul'un 8000 Yılı. Marmaray, Metro ve Sultanahmet Kazıları, (ed.) A. Karamani-Pekin, İstanbul 2007, 167-179.

GYLLIUS — Gyllius, P., *İstanbul'un Tarihi Eserleri*, çev. E. Özbay, İstanbul 1997.

İNCİCYAN 1976 — İncicyan, P.G., *18. Asırda İstanbul*, İstanbul 1976.

KILILTAN 2008 — Kızıltan, Z., "Marmaray-Metro Projeleri Kapsamında Yapılan Yenikapı, Sirkeci ve Üsküdar Kazıları / Excavations at Yenikapı, Sirkeci and Üsküdar within Marmaray and Metro Projects", *İstanbul + Marmaray – Metro Kurtarma Kazıları Sempozyumu Bildiriler Kitabı*, 5-6 Mayıs 2008 / Archaeological Museums, Proceedings of the 1st Symposium on Marmaray-Metro Salvage Excavations 5th-6th May *2008,* (ed.) U. Kocabaş, Istanbul 2010, 1-16.

KOCABAŞ 2010 — Kocabas, U. (ed.), *İstanbul Arkeoloji Müzeleri Marmaray – Metro Kurtarma Kazıları Sempozyumu Bildiriler Kitabı*, 5-6 Mayıs 2008 / Istanbul Archaeological Museums, *Proceedings of the 1st Symposium on Marmaray-Metro Salvage Excavations* 5th-6th May 2008, Istanbul 2010.

KOCABAŞ 2012 — Kocabaş, U., "The Latest Link in the Long Tradition of Maritime Archaeology in Turkey: The Yenikapı Shipwrecks", *European Journal of Archaeology*, 15 (1), 2012, 1–15.

KOCABAŞ – ÖZSAİT-KOCABAŞ –KILIÇ 2012 — Kocabaş, U., Özsait-Kocabaş, I., Kılıç, N., "The Yenikapı Shipwrecks: Dismantling Methods and First Step to Conservation", *11th ICOM International Conference on Wet Organic Archaeological Materials (ICOM-WOAM),* (eds.) K. Straetkvern, E. Williams, 2012, 303-312.

KÖMÜRCİYAN 1988 — Kömürciyan, E.Ç., *İstanbul Tarihi, XVII. Asırda İstanbul*, İstanbul 1988.

MÜLLER-WIENER 1998 — Müller-Wiener, W., *Bizans'tan Osmanlı'ya İstanbul Limanı*, İstanbul 1998.

ÖZSAİT-KOCABAŞ 2008 — Özsait-Kocabaş, I., "III. Documentation: Reading The Timber / III. Belgeleme: Ahşabı Okumak", Yenikapı Shipwrecks, Volume 1: Old Shipwrecks of New Gate 1 /*Yenikapı Batıkları*, Cilt 1:Yenikapının Eski Gemileri 1, (ed.) U. Kocabaş, Istanbul 2008, 37-72.

ÖZSAİT-KOCABAŞ 2010a — Özsait-Kocabaş, I., "Yenikapı Batıklarında In Situ Belgeleme/ In Situ Recording of Yenikapı Shipwrecks", *İstanbul Arkeoloji Müzeleri Marmaray– Metro Kurtarma Kazıları Sempozyumu Bildiriler Kitabı*, 5-6 Mayıs 2008 /*Archaeological Museums, Proceedings of the 1st Symposium on Marmaray-Metro Salvage Excavations* 5th-6th May *2008*, (ed.) U. Kocabaş, Istanbul 2010, 35-51.

ÖZSAİT-KOCABAŞ 2010b — Özsait-Kocabaş 2010b, I., *Yenikapı 12 Batığı: Yapım Tekniği ve Rekonstrüksiyon Önerisi*. Yayınlanmamış Doktora Tezi, İstanbul Üniversitesi, İstanbul

ÖZSAİT-KOCABAŞ 2011a — Özsait-Kocabaş, I., "Yenikapı Batıklarının Akdeniz Gemi Yapım Teknolojisindeki Yeri", *Arkeoloji ve Sanat Dergisi*, 2011a, 136, 137–48.

ÖZSAİT-KOCABAŞ 2011b — Özsait-Kocabaş, I., "Akdeniz Gemi Yapım Geleneğinde Bir Ortaçağ Teknesi: Yenikapı 12 Batığı", *Özsait Armağanı, Mehmet ve Nesrin Özsait Onuruna Sunulan Makaleler,* (ed.) H. Şahin, E. Konyar, G. Ergin, Antalya 2011b, 345-351.

ÖZSAİT-KOCABAŞ –KOCABAŞ 2008 — Özsait-Kocabaş, I., Kocabaş, U., "V. Technological and Constructional Features of Yenikapı Shipwrecks: A Preliminary Evaluation/ V. Yenikapı Batıklarında Teknoloji ve Konstrüksiyon Özellikleri: Bir Ön Değerlendirme", *Yenikapı Shipwrecks, Volume 1: Old Shipwrecks of New Gate 1 /Yenikapı Batıkları, Cilt 1:Yenikapının Eski Gemileri 1,* (ed.) U. Kocabaş,Istanbul 2008, 97–185.

PRYOR – JEFFREYS 2006 — Pryor, J.H., Jeffreys, E.M., *The Age of the ΔΡΟΜΩΝ,* Leiden & Boston 2006.

PULAK 2007 — Pulak, C., "Yenikapı Batıkları: Fırtınanın Armağanı" *ArkeoAtlas* 6, 2007, 128-141.

SAKELLIADES 1997 — Sakelliades, V., "Byzantine Naval Power", *Journeys on the Seas of Byzantium*, (ed) D. Zafiropoulou, Athens 1997, 47-54.