The INA Quarterly

Volume 26 • No. 4 Winter 1999

MEMBERSHIP

Institute of Nautical Archaeology
P.O. Drawer HG
College Station, TX 77841-5137

Learn firsthand of the latest discoveries in nautical archaeology. Members receive the *INA Quarterly* and other benefits (see *INA Quarterly* 25.1, 27).

Researcher (students only) $25
Seafarer $40–99
Surveyor $100–249
Diver $250–499
Restorer $500–999
Curator ..... $1,000–$2,499
Excavator $2,500–4,999
Archaeologist $5,000–9,999
Navigator $10,000–24,999
Anchor ..... $25,000 and over

Checks in U.S. currency should be made payable to INA. The portion of any donation in excess of $10.00 is a tax-deductible, charitable contribution.

On the cover: The *ophthalmos* of the Tektaş Burnu ship (TK 7) as it appeared on the seabed. Photo: D. Frey.

INA welcomes requests to reprint *INA Quarterly* articles and illustrations. Articles for publication should be submitted in hard copy and on a 3.25 diskette (Macintosh, DOS, or Windows format acceptable) along with all artwork. Please address all requests and submissions to the Editor, *INA Quarterly*, P.O. Drawer HG, College Station, TX 77841-5137; tel (979) 845-6694, fax (979) 847-9260, e-mail powlrye@texas.net.

The Home Page for INA is at http://nautarch.tamu.edu/ina/

The Institute of Nautical Archaeology is a non-profit scientific and educational organization, incorporated in 1972. Since 1976, INA has been affiliated with Texas A&M University, where INA faculty teach in the Nautical Archaeology Program of the Department of Anthropology. The opinions expressed in *Quarterly* articles are those of the authors, and do not necessarily reflect the views of the Institute.

The *INA Quarterly* was formerly the *INA Newsletter* (vols. 1-18). Editor: Christine A. Powell

The 1999 Excavation Season at Tektaş Burnu, Turkey

Deborah N. Carlson, Assistant Director

Don Frey, Photographs

An exciting new excavation began in the summer of 1999. A team of twenty students and a handful of visiting scholars joined the staff of INA veterans under the direction of Dr. George Bass to begin the excavation of a Classical Greek ship that wrecked nearly 2500 years ago at Tektaş Burnu, Turkey. The wreck was discovered in September 1996 during one of INA's annual surveys for shipwrecks off the Turkish coast. At the time, divers directed by Tufan Turanlı were working along a very rugged and remote stretch of coastline near Tektaş Ada, or "Lone Rock Island," south of Çeşme and west of Sığacık (ancient Teos). The wreck presented itself as a small mound of about sixty amphoras, of two distinct types, lying on a shelf at a depth of between 38 and 43 m.

Three amphoras were raised from the site for identification. On the recommendation of INA Adjunct Professor Dr. Carolyn Koehler, drawings were sent to Dr. Mark Lawall of the University of Manitoba, who specializes in the study of ancient Greek transport amphoras. In July 1997, Dr. Lawall visited the Bodrum Museum of Underwater Archaeology. While there, he confirmed the identification of one of the two amphora types as Mendean (fig. 1), and determined that it was best dated to the third quarter of the fifth century BCE. Dr. Lawall was less certain about the identity of the second amphora type (fig. 2), which he termed pseudo-Samian (based on its resemblance to earlier amphoras from the island of Samos), and dated to the third quarter of the fifth century BCE as well. Lawall pointed out that this type shares certain features with amphoras produced at Klazomenai, which is located very near the Tektaş Burnu wrecksite, in the vicinity of modern Urla. Excavations at Klazomenai have revealed amphora fragments from the late seventh century BCE and a fourth-century BCE amphora workshop and kiln. Future petrographic analysis of the pseudo-Samian amphoras from Tektaş Burnu may enable us to identify their source.

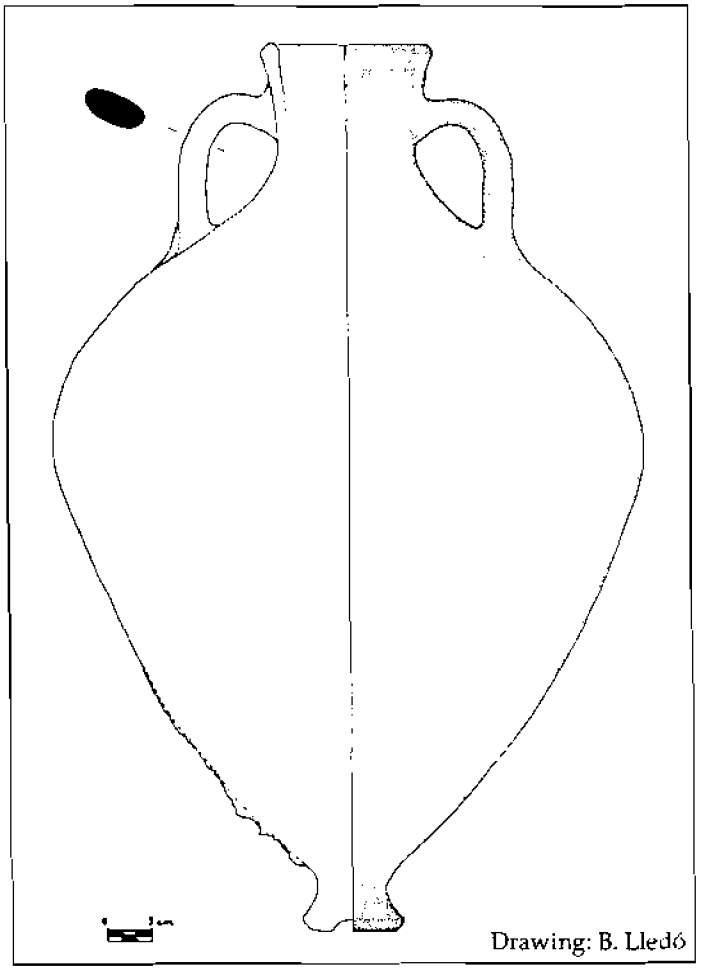


Fig. 1. *Mendean amphora from 1996 survey.*

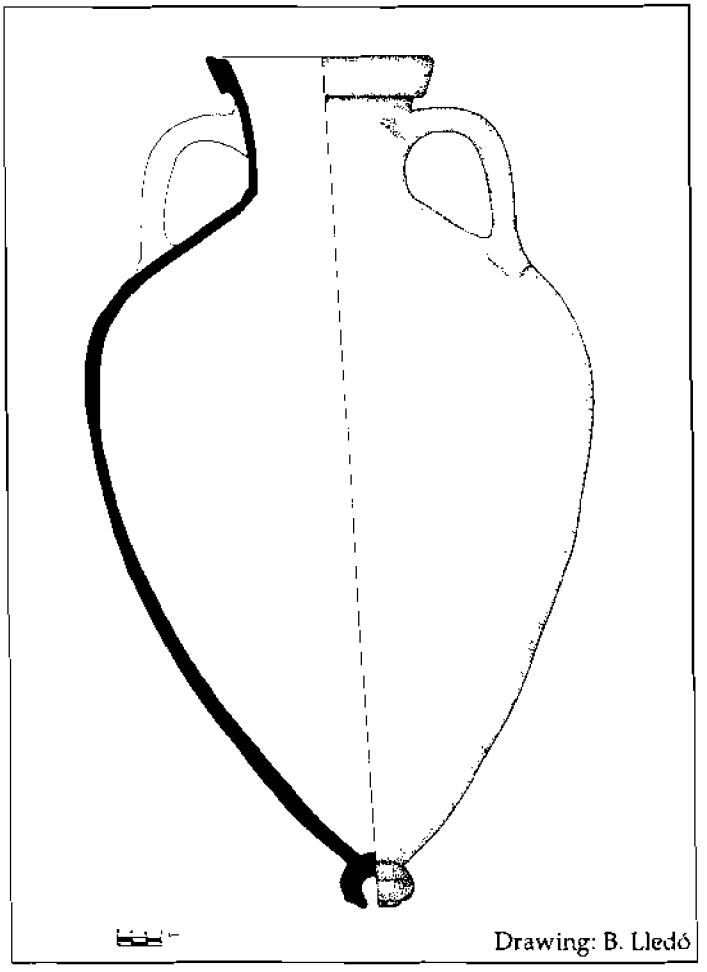


Fig. 2. *Pseudo-Samian amphora from 1996 survey.*

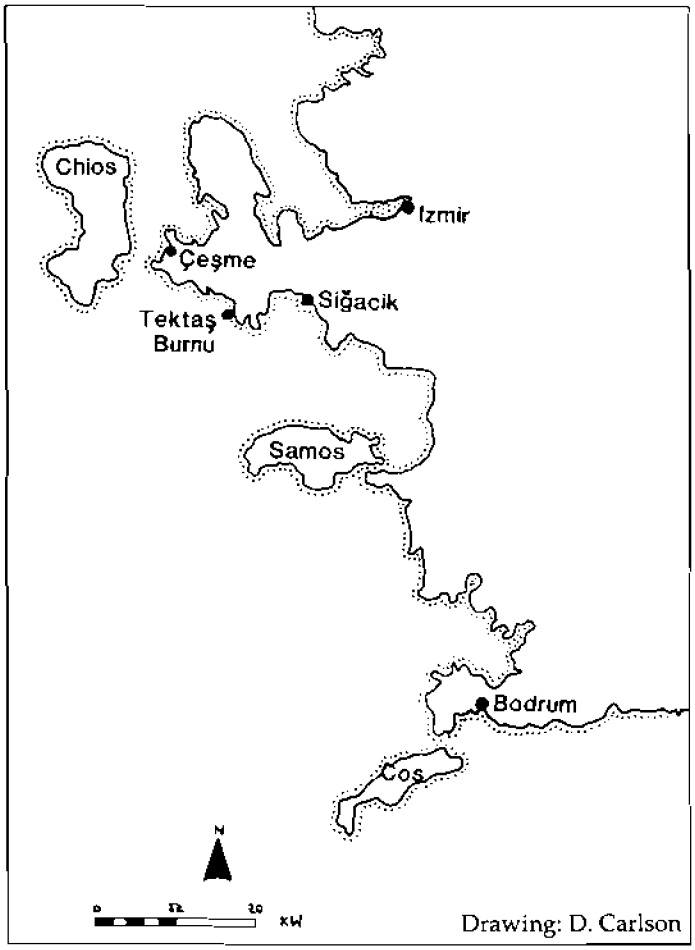


Fig. 3. *The Tektaş Burnu wrecksite.*

In 1999, Turkey installed a new government. This change, coupled with the fact that our excavation permit was a new one, meant that we did not receive our permit until early August. We took advantage of this opportunity to address the logistical difficulties of working and living at Tektaş Burnu, the cape that takes its name from the neighboring island of Tektaş Ada (fig. 3).

Dr. Bass has said that Tektaş Burnu presents the most hostile environment he has worked in during forty years of excavating shipwrecks. The tiny village of Zeytineli, which is the nearest town of any kind, is forty minutes away by boat, a ride that is often accompanied by rough seas. The coastline is barren and the rocks above the wrecksite are jagged and friable; during early visits, we found it difficult, if not impossible, to come ashore on foot. In addition, the site is completely exposed to the prevailing northwesterly winds. Only the small cove behind the cape offers minimal shelter, and it was here that we anchored INA's 65-foot, steel-hulled research vessel *Virazon*, which housed the project's computers and recompression chamber.

In early June, we made several reconnaissance trips to the cape using the research vessel *Saros*, chartered from the Rahmi Koç Industrial Museum in Istanbul through TINA (Turkish Institute of Nautical Archaeology). It was *Saros* that was ultimately capable of lifting our two one-ton generators and placing them on shore where they supplied the various compressors, fresh water makers, lights, and computers. However, while we were busy building a camp on the rocks, we needed a place to house the team, which grew to nearly forty people in mid-July. To this end, we chartered *Artemis*, a 150-foot-long, wooden-hulled US Navy minesweeper built in 1942. What *Artemis* lacked in elegance she made up for in practicality, for her spacious galley allowed 40 of us to dine, work, and hold meetings together. The space also enabled us to receive visiting INA Directors Danielle Feeney, Ayhan Sicimoğlu, Oğuz Aydemir, Gregg and Nancy Cook, Jack and Jean Kelley, Joe and Donna Ballew, Ned and Raynette Boshell, INA Executive Director Jerome Hall, and Donny Hamilton, Head of the Nautical Archaeology Program at Texas A&M University, with his son John.

Fig. 4. *Looking upslope on the Tektaş Burnu wrecksite.*

In early July, the Turkish Ministry of Culture issued a permit authorizing us to prepare the site for excavation, which allowed us to install safety equipment, remove the sand overburden, photograph and map the existing amphoras, and lay a string grid (fig. 4). For the next six weeks, while the construction of a camp and dive platform progressed above the wreck, preparatory work continued on the seabed. By the last week of July, as we prepared to move from *Artemis* into our completed camp (fig. 5), artifacts began to appear in two distinct areas of the wreck: in a sandy river on the upper slope, and farther downslope within the amphora mound. When the excavation permit was issued on August 7, with the summer winding down and the imminent departure of many team members, we focused all our energy on the exploration of these two areas.

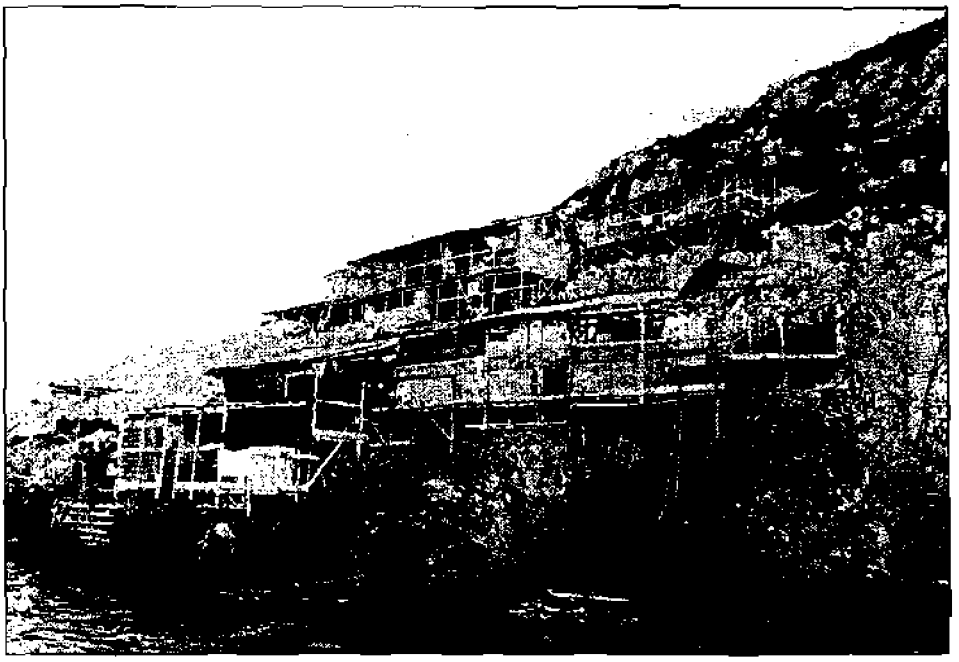


Fig. 5. *The camp at Tektaş Burnu.*

The first objects to appear on the upper slope of the site included a black-glazed *kantharos* (a kind of two-handled Greek drinking cup), a one-handled jug (fig. 6), a *hydria* (water carrier), and a round, handleless oil lamp. These initial discoveries led us to conclude that we were excavating the ship's galley, which one would expect to find in the vessel's stern.

Fig. 6. *One-handled jug (TK 3).*

Within days, Faith Hentschel and Sam Lin uncovered, in the same upper slope area, a white marble disk approximately 14 cm in diameter. This mysterious disk (cover), with a metal spike running through its center, soon became the subject of much discussion; could it be a kind of axle or weight or perhaps the lid of an elegant marble cosmetic box? Then, independently, and almost simultaneously, Troy Nowak and Jeremy Green solved the puzzle: this disk was the ship's *ophthalmos*, or eye, and the lead spike piercing its center would have secured the eye to the bow of the ship. In late August, George Bass, William Murray, and I paid a visit to the Piraeus Archaeological Museum in Greece, where we viewed the six marble eyes that had been excavated from the ship sheds that housed the famed Athenian triremes. The Piraeus eyes are almond-shaped and more naturalistic than the Tektaş Burnu *ophthalmos*, although both seem to have been similarly painted; on the convex side of the Tektaş Burnu *ophthalmos*, you can still see the dark pigment stains of a central circle and a thin dark outer band outlined by faint incised lines. Was the rest of the eye painted on the ship around the marble iris? Perhaps not, if we are to judge from the presence of purely round eyes depicted on black figure pots from the sixth century BCE. Troy Nowak, a graduate student at Texas A&M University, has prepared a scholarly publication of the Tektaş Burnu *ophthalmos*, summarized in the article on pages 10–11.

In the sandy river of the upper slope, artifacts continued to appear throughout the remaining weeks. These included two more lamps and two more black-glazed *kantharoi*, one of which is decorated with stamped motifs typical of Greek pottery from the fifth century BCE.

Farther downslope, within the amphora mound, our team uncovered a lovely table amphora (fig. 8) and a portion of another like it. In both shape and style, this amphora parallels those found at the Rhodian cemeteries of Camirus and Ialysos. Other discoveries in this area included two bone tiles (gaming pieces?), five more lamps (fig. 9), a terra-cotta mortar, and nine one-handled cups, some of which were found nested together (fig. 10). Other interesting discoveries included an ancient kettle, or *chytra*, and a matching cooking pot (fig. 11). Near the pot lay a very fine example of an ancient Greek perfume flask called an *alabastron* (fig. 12). Our *alabastron*, which measures 14 cm in length, appears to have been carved from the same attractive, banded, translucent alabaster for which the vessel type is named. In this same area, we uncovered the two lead cores of a wooden anchor stock, which appear to constitute the earliest evidence of metal-cored wooden anchors. The reader will find more information on the Tektaş Burnu anchor stocks on page 9 in a companion article by Ken Trethewey, who excavated and studied them.

Still farther downslope, at the edge of the shelf, our Turkish commissioners, Harun Özdaş and Gökhan Bozkurtlar, uncovered a pocket of artifacts that included a carinated, third type of *kantharos*. This cluster of objects suggests that the wrecksite may be larger than we originally anticipated. Beyond this point, the seabed drops almost vertically about 15 m,

Fig. 8. *Meghan Ryan inspects table amphora TK 32.*

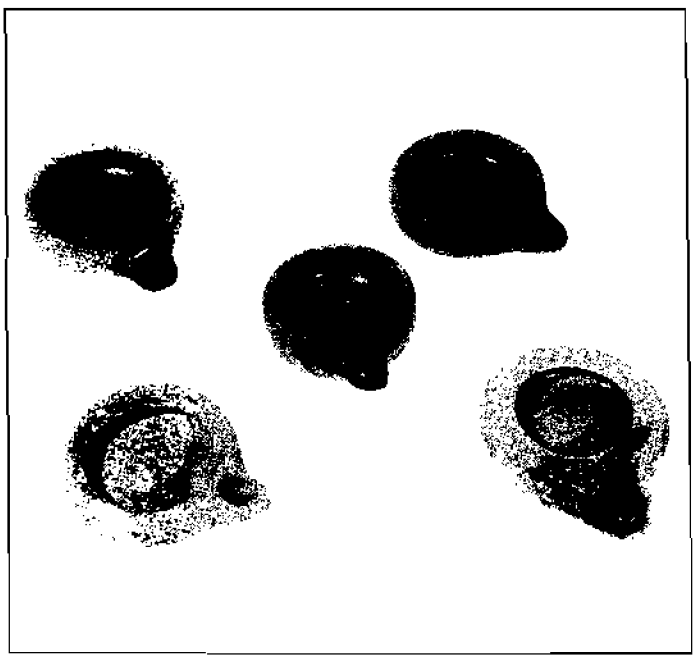


Fig. 9. *Five of eight oil lamps found in 1999.*

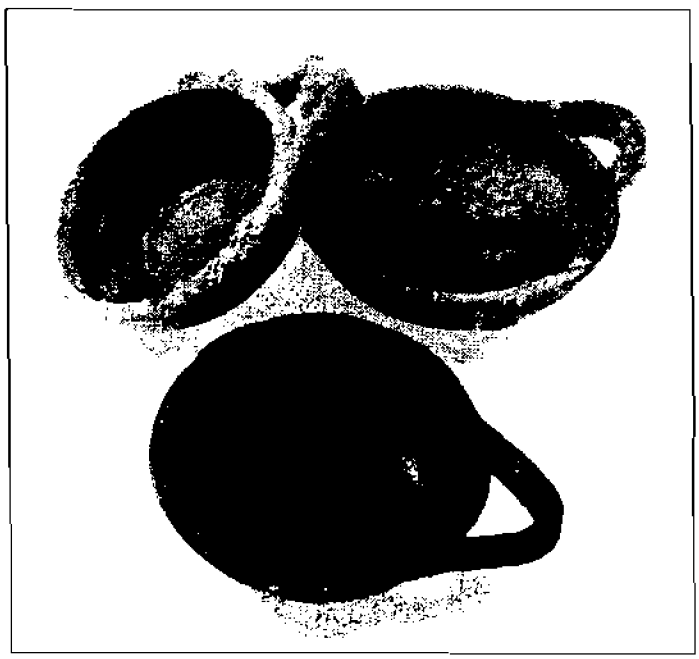


Fig. 10. *Three of nine one-handled cups found in 1999.*

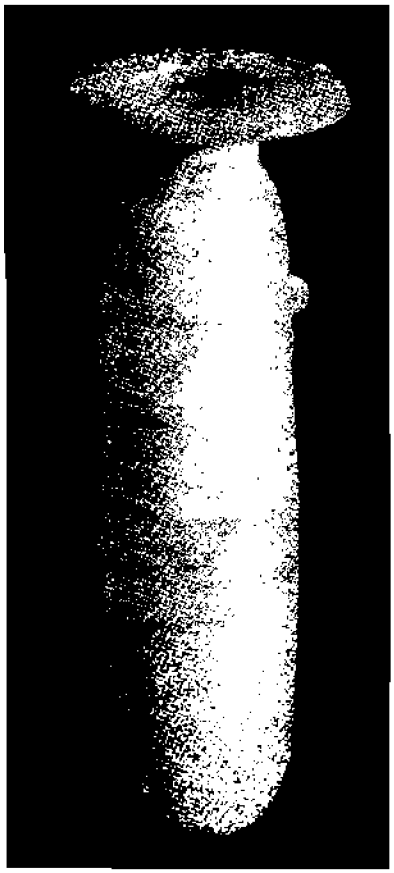


Fig. 11 (left). *Cooking pot TK 51 as it appeared on the seabed.*
Fig. 12 (above). *The perfume flask, or* alabastron, *TK 23.*

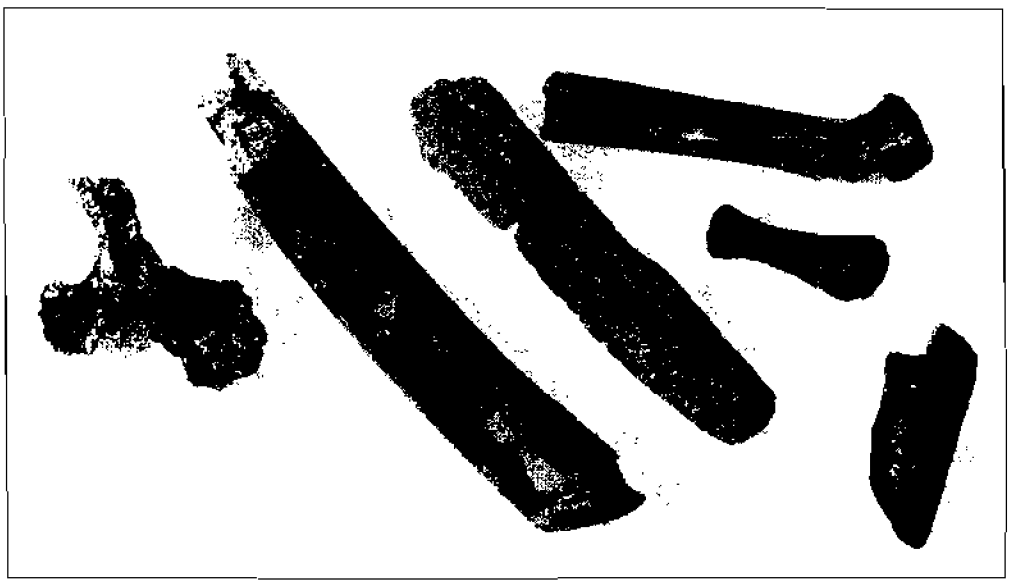


Fig. 13. *Some of the more than 100 cattle bones retrieved from amphora TK 45.*

and one of our goals for the 2000 season will be to explore the deeper waters around the wrecksite to determine if any cargo has tumbled over the edge.

The primary cargo of the ship that wrecked at Tektaş Burnu looks to be just as diverse as the associated artifacts. During the 1999 season, we uncovered two hundred amphoras and raised twenty. Two of these have the swollen neck that is typical of fifth-century amphoras from the island of Chios, which lies northwest of the Tektaş Burnu wrecksite. One of the twenty amphoras is Mendean, from the city of Mende in the Chalkidike of Northern Greece. Mendean wine was one of the most widely-exported and highly-regarded vintages of the Classical world; ancient Greek authors tell us that the wine of Mende was thought to have medicinal, particularly laxative, qualities. Curiously, the Mendean amphora raised for identification during the 1996 survey was filled with a dark resinous pitch, which is currently undergoing analysis.

The majority of the amphoras at Tektaş Burnu are of the so-called pseudo-Samian type that may have originated along the coast of Asia Minor, perhaps suggesting that the ship sank very soon after taking on the bulk of its cargo at a nearby port. While sieving one of the pseudo-Samian amphoras, we discovered that it contained more than one hundred butchered cattle bones, mostly ribs (fig. 13), which may represent cured beef provisions for the crew, or perhaps cargo. The Athenian comic poet Hermippos includes beef ribs from Thessaly among those goods imported into Athens in the middle of the fifth century BCE.

All of the artifacts uncovered during the 1999 campaign were mapped with a photogrammetry system managed by Tufan Turanlı. The provenience of each artifact was recorded on the seabed with calibrated 35mm and digital underwater cameras. Later, on the surface, the digitized images were processed using three-dimensional modeling programs. While Tufan concentrated on the overall site plan, the artifacts were digitally modeled by Berta Lledó in a separate process, and then applied to the mapping points to create a map with accuracy better than 1 in 200. In addition, with the input of INA veterans Faith Hentschel and Sheila Matthews, Berta produced a highly efficient relational database that unites the artifact catalog, team roster, diving log, and a daily journal in a most user-friendly way. Don Frey, who traded in his Nikonos for an underwater video camera, shot much of the video used in the National Geographic Explorer program *Shipwreck Hunters*, which aired twice in late November and featured the Tektaş Burnu excavation.

The acquisition of the Homer and Dorothy Thompson Library for INA's Bodrum headquarters, made possible by the Northwest Friends of INA in Portland, Oregon, enabled us to conduct preliminary research while the excavation was still ongoing. This research has found many parallels for the Tektaş Burnu pottery in the Athenian Agora excavations, which uniformly offer a date between 450 and 435 BCE, precisely the date suggested by Dr. Lawall in his analysis of the Tektaş Burnu amphoras.

What was life like at the time our ship was lost? By 450 BCE, the Aegean was firmly under the control of the Athenian navy, and Athens, receiving regular installments of monetary "tribute" from her allies, had become the cultural center of the Mediterranean world. These were the years that Sophocles and Euripides wrote tragedies, Herodotus and Thucydides chronicled Greek history, Phidias, Polykleitos, and Myron perfected sculptural proportion, and Pericles commissioned the building of the Parthenon on the Acropolis. The hegemony and prosperity of Athens in the third quarter of the fifth century BCE was due in no small part to sea-borne trade, which circulated slaves, grain, timber, silver, copper, oil, and wine around the Mediterranean. While Classical archaeologists are well-versed in the architecture, sculpture, pottery, and coins of fifth-century Greece, we know next to nothing about the ships, crews, and cargoes. Among archaeologists, it is generally considered bad luck to hypothesize about future finds; speculating about the presence of certain artifacts is thought to all but guarantee their absence. It seems only appropriate then, that the following inventory of Athenian imports should appear in the words of their author, Hermippos:

> From Kyrene silphium and ox hide,
> From the Hellespont mackerel and salted fish of
> all kinds,
> From Thessaly salt and ribs of beef,
> From the Syracusans pork and cheese...
> From Egypt papyrus for sails and books,
> Frankincense from Syria, and from lovely Crete
> cypress for the Gods
> From Africa an abundance of ivory,
> From Rhodes raisins and dried figs that bring
> sweet dreams,
> From Euboea pears and plump apples...
> Paphlagonia provides divine acorns
> and shining almonds;
> These are the delights of the banquet.
> Phoenicia furnishes dates and the finest wheat flour,
> And Carthage carpets and colorful cushions.

Despite the later than expected arrival of our 1999 excavation permit, we are excited about the progress made in just a few short weeks. With the alleviation of many of the site's logistical problems and the construction of a magnificent camp and dive platform, which was achieved through the untiring efforts of Robin Piercy, we are ready and anxiously waiting to greet the 2000 season at Tektaş Burnu.

Acknowledgments: The 1999 season at Tektaş Burnu was made possible through the generous financial support of the Directors and members of the Institute of Nautical Archaeology, Texas A&M University, the National Endowment for the Humanities, the National Geographic Society, and Turkish Airlines (THY). It was a pleasure to work with *National Geographic Explorer* producer Leslie Schwerin, cameraman Jerry Risius, and photographer Courtney Platt. Leslie and Jerry had scarcely left Tektaş Burnu when Jerry was rushed back to Turkey to document the aftermath of the devastating earthquake that occurred on August 17. That this INA project was able to follow on the heels of the Bozburun Byzantine Shipwreck Excavation is due in no small part to the maintenance efforts of Murat Tilev, who worked hard to ensure that all of our equipment was running all of the time, and Tufan Turanlı, who supervised the annual overhaul and painting of *Virazon*. Compliments to our Head Conservator Asaf Oron and his assistants Laura Pretsell, Sabine Westerhuis, and Meghan Ryan, who, faced with the prospect of a less-than-desirable conservation facility, joined forces to build a highly efficient one. Kudos to Diving Safety Officer Bill Charlton and Assistant Divemasters Dan Davis and Ken Trethewey for seeing us through more than 1800 logged dives without incident. Warmest thanks to our cook, Angie Mitchell, who prepared the most appealing meals (often under the most unappealing conditions) and never served the same dish twice. I would like to extend my special thanks to George Bass, for offering me the opportunity of a lifetime, and Sheila Matthews; if I met with any success as an Assistant Director, it is largely because she took me by the hand and showed me the ropes.

An Interesting Anchor from the Tektaş Burnu Shipwreck

Ken Trethewey

INA archaeologists excavating the classical Greek shipwreck at Tektaş Burnu, Turkey, last summer discovered and raised two large bars of lead, the well-preserved remains of one of the ship's anchors. The heavy bars had originally been the lead cores of a wooden stock designed to turn one of the anchor's hooks into the seabed and hold it there. Many similar artifacts have been discovered in the Mediterranean and Black Seas, but very few of them have come from datable contexts, since anchors are lost much more frequently by themselves than along with the ships that carry them. The Tektaş Burnu anchor, however, comes from a fairly securely datable shipwreck, and it provides new insight into the evolutionary development of ancient anchors.

Scholars largely agree that early simple stone anchors were followed by stone anchors fitted with wooden spikes or hooks to improve their ability to grip the seabed. This form in turn seems to have evolved into an anchor made predominantly of wood, but with a stone stock to add mass and ensure the proper orientation of the anchor on the bottom. Later these stone stocks were replaced by denser, less breakable lead ones. The earliest lead stocks were of the type found at Tektaş Burnu, a type defined by the wooden outer shell of the stock into which molten lead was poured. Though none of the wood from the Tektaş Burnu anchor survives, it is clear that the lead bars were originally poured into a wooden stock mold. The notches in their edges, their trapezoidal sectional shape, and their casting bolts (small nail-like protrusions formed when the molten lead flowed into holes drilled in the mold) all demonstrate that the craftsman took pains to secure the heavy cores within their wooden casing so that they would not break through the bottom or sides of the stock when the anchor struck the seabed. Later lead anchor stocks had no casing of wood; they were cast in molds of sand or other materials, and these molds were not retained. More efficient anchors made of iron ultimately replaced the bulky wooden anchors with their heavy stocks.

Though the general evolution of the ancient anchor seems fairly clear, it has been more difficult to establish firm dates for each of the types. Anchors with lead-filled wooden stocks were until recently often thought to have first appeared during the fourth century BCE, as that is the date of the Kyrenia shipwreck, for long the earliest datable context for lead stock cores. Later it was thought that the cores found on the Porticello shipwreck demonstrated that this type of anchor existed as early as the end of the fifth century, a hypothesis that was confirmed by the discovery of the anchor discovered during the Ma'agan Michael excavation largely confirmed that view. In fact, the Ma'agan Michael anchor was until now the earliest secure evidence for the change from stone anchor stocks to lead. The Tektaş Burnu cores now appear to show that anchors with lead-filled stocks existed considerably earlier, by the third quarter of the fifth century BCE.

Photo: D. Frey

The lead anchor stock cores from the Tektaş Burnu shipwreck are the earliest examples known of this anchor design.

A Marble *Ophthalmos* from Tektaş Burnu

Troy J. Nowak

The tradition of decorating a ship's bow with eyes is one of the most widespread customs practiced by seafarers from antiquity to the present. Eyes can be seen today adorning the bows of ships from Portugal, Malta, Greece, India, and the Far East. In their present form, they appear painted on a ship's timbers or as worked components fashioned from metal or wood. These eyes serve a prophylactic function similar to that of eyes depicted on ships throughout antiquity. Archaeological finds of naturalistic marble eyes from the Piraeus attest to eyes, *ophthalmoi*, taking the form of decorated marble appliqués once affixed to the bows of ancient Greek warships. Documentation of similar *ophthalmoi* can be found in entries from the contemporary Naval Inventories that list them as "missing" or "broken." Evidence for the use of marble *ophthalmoi* on ancient Greek merchantmen has only recently come to light. The Institute of Nautical Archaeology's 1999 excavation of the Classical Greek merchantman at Tektaş Burnu yielded a small marble disc believed to be an *ophthalmos*. This is not only the first known example of an *ophthalmos* from a shipwreck site, but also our earliest archaeological example of this decorative element.

The Tektaş *ophthalmos* is a marble disc about 14 cm in diameter with a roughly finished inner face (fig. 1). Its outer face is convex, polished and decorated with a dark concentric design (fig. 2). A lead fastener pierces the center of the disc, once affixing it to the ship that sank at Tektaş Burnu.

The *ophthalmos* was uncovered in the upper layer of the site in what is believed to be the vessel's bow section. Its outer face was exposed amidst a concentration of scattered wood fragments and copper fasteners. If these are remains of the ship's hull, their position within the artifact assemblage suggests they represent the inboard collapse of the ship's starboard side. Artifact scatter and bottom topography indicate that the ship settled listing to port. This may explain the concentration of structural elements in the upper reaches of the site as well as the upright position of the *ophthalmos*. Future excavation and analysis should refine this hypothesis.

This unique object proves that the tradition of affixing a painted marble appliqué to the bows of Greek ships applied to warships and merchantmen alike. Study of the representational evidence for *ophthalmoi* in the Archaic and Classical periods shows that the most common depictions of merchantmen's *ophthalmoi* are circular. An Attic black-figure *oinochoe* (wine pitcher) and an Attic black-figure cup, both dating to c. 510 BCE, best illustrate this feature. They depict merchant vessels with circular eyes painted with a concentric pattern similar to that of the Tektaş *ophthalmos* (fig. 3). This same pattern is also visible on the central portion of eyes depicted on warships of the late sixth and fifth centuries BCE and on the naturalistic marble examples from the Piraeus. Based on the available evidence, it seems likely that the Tektaş Burnu ship had simple circular *ophthalmoi* adorning its bow. Further excavation should yield new evidence to shed light on this enigmatic object.

Acknowledgements: I would like to thank George F. Bass, Director of the Tektaş Burnu shipwreck excavation, and Deborah Carlson, Assistant Director, for suggesting that I publish this exciting find.

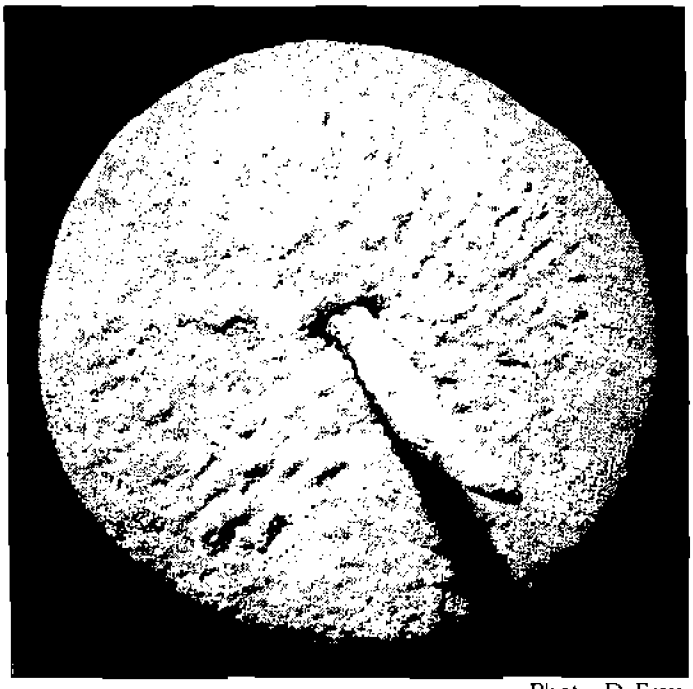


Photo: D. Frey

Fig. 1. *The Tektaş Burnu* ophthalmos, *inner face.*

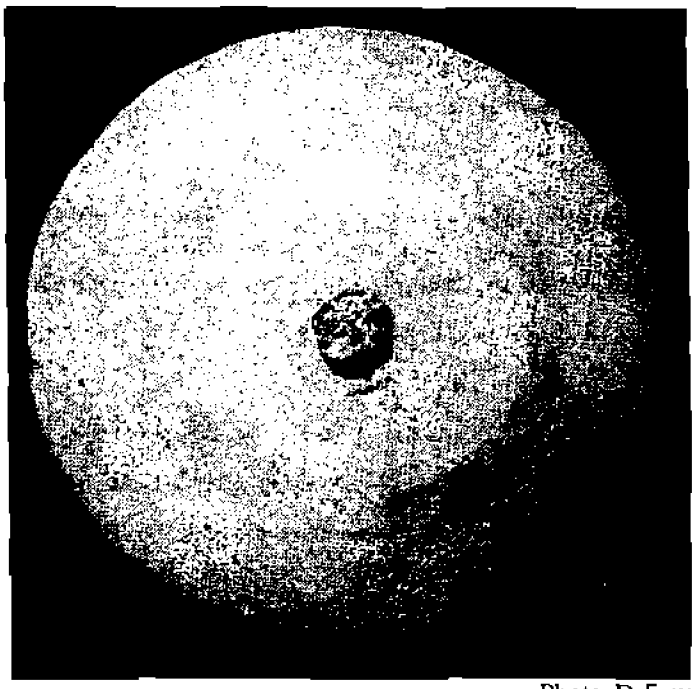


Photo: D. Frey

Fig. 2. *The Tektaş Burnu* ophthalmos, *outer face.*

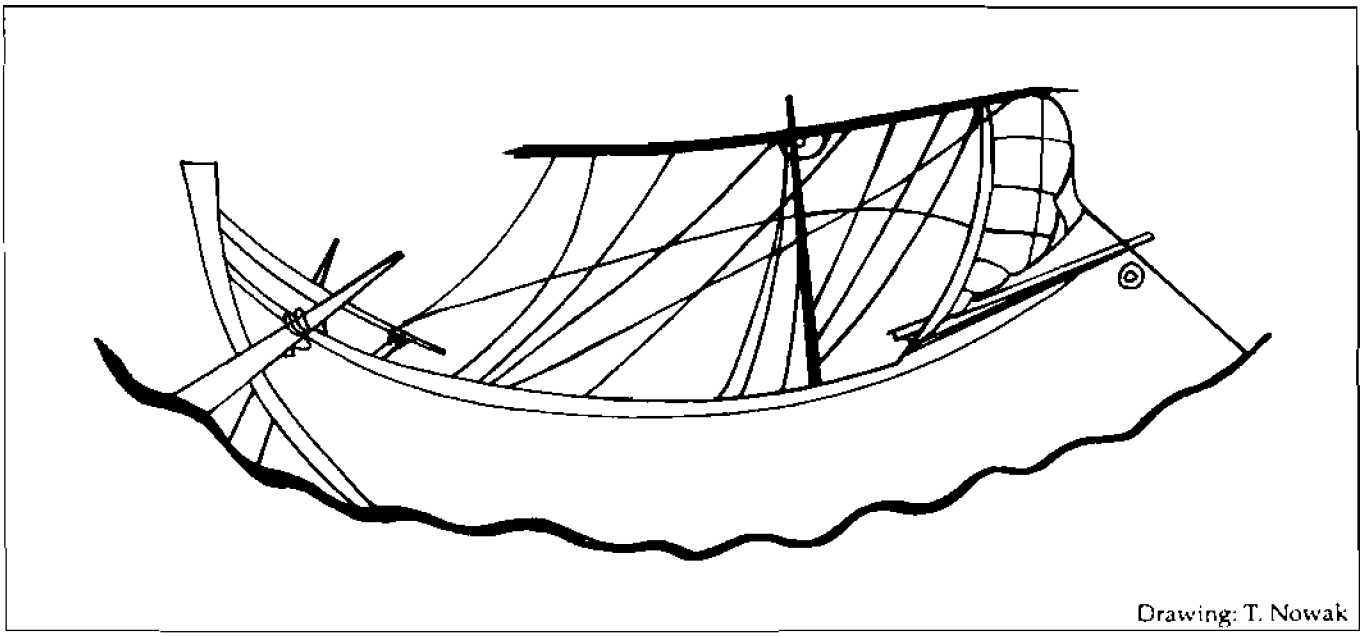


Fig. 3. *Merchantman under sail with a circular* ophthalmos *set high on its bow, c. 510 BCE (after Casson, 1971.* Ships and Seamanship in the Ancient World. *Princeton, fig. 91).*

Suggested Readings

Filgueiras, O.L.
1989 "Some Vestiges of Old Ritual Practice in Portuguese Local Boats." In *Tropis III, Proceedings of the Third International Symposium on Ship Construction in Antiquity*, ed. H. Tzalas, Athens: 149–166.

Hornell, J.
1923 "The Significance of the Oculus in Boat Decoration." In *The Origins and Ethnographical Significance of Indian Boat Designs, Memoirs of the Asiatic Society of Bengal* 7: 247–256.

1970 "The Prow of the Ship: Sanctuary of the Tutelary Deity." In *Water Transport: Origins and Early Evolution*, second edition. London: 271–289.

Saatoglu-Paliadele, C.
1980 "Marble eyes from Piraeus." *Archaiologike Ephemeris* 1978: 119–135, pls. 40–41.

News & Notes

Recent A&M Graduates

The *INA Quarterly* would like to congratulate the following graduates from the Nautical Archaeology Program at Texas A&M University who received Master of Arts degrees in the last year: Alan Thomas Flanigan and David Stewart Robinson (Spring 1999); Thanos Aronis Webb (Summer 1999); Kendra Quinn and Athena Trakadas (Fall 1999).

Request for Contributions

The *INA Quarterly* always welcomes contributions from INA members concerning nautical archaeology. Please address inquiries or manuscripts to the Editor at the address shown on page 2, or by e-mail to powlrye@texas.net. *INA Quarterly* submission guidelines for manuscripts were published in the Winter 1995 issue volume 22.4, page 22.

The 1999 Excavation Season at the Presumable *Nossa Senhora dos Mártires* Site

Filipe Castro

On September 14, 1606, after a nine month voyage from Cochim, India, and a three month stop in the Azores, the Portuguese East Indiaman *Nossa Senhora dos Mártires* arrived in sight of Lisbon. A heavy storm forced Captain Manuel Barreto Rolim to drop anchor off Cascais, a small village a few miles from Lisbon. Here the Indiaman *Salvação*, another returning *nau* from the 1605 fleet, was already struggling with the southerly gale. Dangerously dragging her anchors in the direction of the beach, *Salvação* was too heavy to be towed against the wind by the galley that was sent to help. The next day, after seeing *Salvação* run aground on the Cascais beach, Rolim decided to head for the mouth of the Tagus River hoping to escape the tempest in the calmer waters of the estuary (fig. 1).

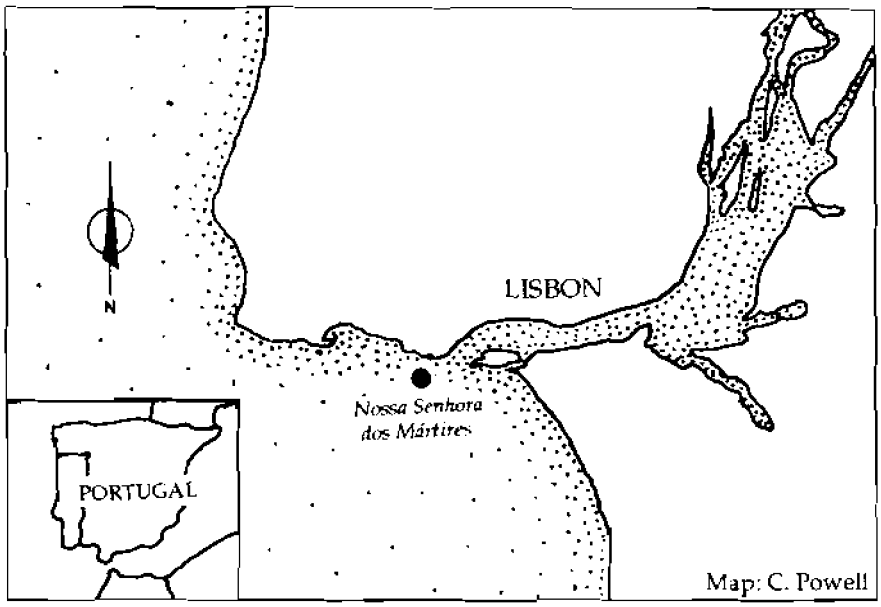


Fig. 1. *The Tagus mouth and the location of the fortress of São Julião da Barra.*

However, getting past the sandbars was not easy. Two large sandbanks narrowed the entrances, making the waters run dangerously fast in both the northern and the southern channel. Rolim headed for the northern canal. By the early seventeenth century, this was already considered too narrow and shallow for laying anchor, and too crooked for any galley to tow a large vessel. In the middle of the passage, *Mártires* lost her headway and the *nau* was dragged to a submerged rock. She sank in front of the São Julião da Barra fortress in a matter of hours; soon afterwards she was broken up into such small pieces that witnesses commented it looked as if she had sunk long ago.

Photo: J. Pessoa

Fig. 2. *Chinese glazed earthenware jar from the late sixteenth or early seventeenth century.*

Her main cargo of pepper, which had been stored loose in small holds, spilled out upon wrecking, forming a black tide that extended for leagues along the coast and the Tagus estuary. A large amount of pepper was saved and put to dry by the king's officers. The population also salvaged a notable quantity, as it was impossible for the soldiers to stop the locals who, despite the dreadful weather conditions, went to sea every night in small craft to salvage what they could.

During the subsequent summers, the officers of King Felipe III of Spain—who was also King Felipe II of Portugal—may have salvaged a great part of the cargo from the shallow waters, and they certainly rescued cables, anchors, and guns.

Just as with many other wrecks that occurred at this dangerous channel, *Nossa Senhora dos Mártires* was soon forgotten. The tsunami that followed the earthquake of 1755 probably rolled heavy rocks over its remains. A codfish trawler wrecked near the site in 1966, covering a large area with other debris.

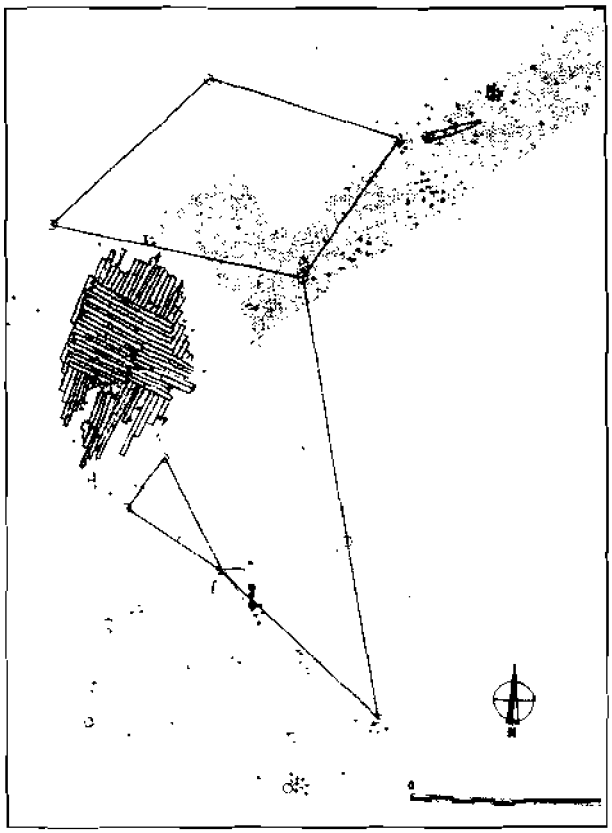
Stories of treasure around the fortress of São Julião da Barra were certainly transmitted through generations, and the spread of scuba diving from the early 1950s heightened interest in the area. In the late 1970s, archaeological surveys were carried out by avocational archaeologists, but no governmental action was taken to protect the site. As a result, the area was heavily looted by sports divers during the 1980s.

In 1993, the Museu Nacional de Arqueologia sponsored a survey of the site under the direction of Dr. Francisco Alves and identified two main areas of archaeological interest. One—designated as SJB2—consisted of

the remains of a wooden hull with shards of Ming porcelain and Chinese earthenware dating from the late sixteenth or early seventeenth centuries (fig. 2). Based on information from the Museu Nacional de Arqueologia's shipwreck archives, *Nossa Senhora dos Mártires* seemed the most likely identity for this wreck.

In 1996 and 1997, excavations were conducted on the SJB2 site under the direction of Dr. Alves and myself. The wooden hull was recorded, and an area of approximately 100 square meters was excavated (fig. 3). We recovered many artifacts from directly below a ubiquitous layer of peppercorns. These items included three astrolabes and two dividers, several sounding leads, as well as porcelain, stoneware, earthenware, brass, copper, pewter, and silver and gold objects. Among the organic materials, many peach pits were recovered along with ropes, fabrics, leather, and straw, this later found between seven stacked porcelain dishes. Several of these artifacts were exhibited in the Portuguese pavilion at EXPO '98, the World Exposition held in Lisbon during the summer of 1998.

A historical investigation led by the team of the Portuguese Pavilion at EXPO '98 brought to light information about the lives of some of *Mártires'* crew and passengers. Among them were Aires de Saldanha, seventeenth vice-regent in India (1600-1605), who died just before reaching the Azores on his return trip to the regency, and Manuel Barreto Rolim, who was trying to make a fortune in the India trade after being disinherited by his father because of an unwanted marriage. Another was the cabin boy Cristóvão de Abreu, who survived this shipwreck and the wrecks of several other *naus* namely *Nossa Senhora da Oliveira* in 1610, *Nossa Senhora de Belém* in 1635, and *S. Bento* in 1642. He then died at sea in 1645 while returning from India as boatswain of the *nau S. Lourenço*. No less interesting is the story of Father Francisco Rodrigues, a Jesuit priest who lost his life while coming from Japan to see the Pope on matters concerning the future of the whole Japanese Jesuit mission. These and other stories have been published in the catalogue of the Portuguese pavilion at EXPO '98: *Nossa Senhora dos Mártires, The last voyage*.



Drawing: CNANS

Fig. 3. *Site plan of the preserved portions of* Nossa Senhora dos Mártires *after the 1996/7 field season.*

Photo: G. Garcia

Fig. 4. *Armando Sousa and Paulão Camargo raising garboard T1W.*

In the summer of 1999, INA and the Instituto Português de Arqueologia through its Centro Nacional de Arqueologia Náutica e Subaquática sponsored an excavation season on the SJB2 site, aiming at what is perhaps the most exciting part of this wreck: its hull remains (fig. 4). A section of the bottom immediately before the midship frames was preserved, including a section of the keel, eleven frames, and some of the planking. Construction marks carved on the surfaces of the floor timbers allowed us not only to understand the method used by the shipwright to conceive the hull shape, but even to reconstruct some of the hull dimensions with a high degree of certainty. It was a large *nau* with a keel close to 27.72 m in length (91 ft or 18 *rumos*, the unit then used in Portugal), and an overall length of about 38.25 m). The hull structure had been built with cork

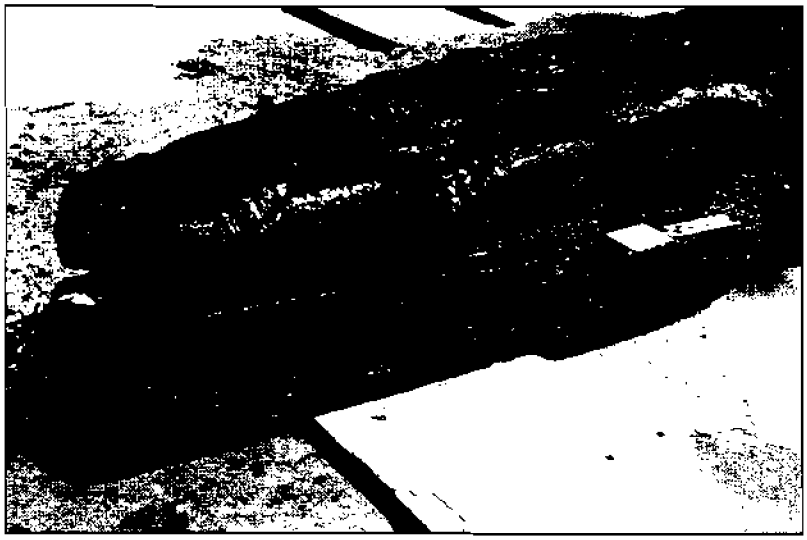


Photo: F. Castro

Fig. 5 (above). *Futtock B8E showing the filler piece spiked to the side of the timber. Most contemporary written sources mention the lack of suitable timber for the construction of such large ships.*

Fig. 6 (right). *The keel begins its ascent from* Nossa Senhora dos Mártires, *guided by two archaeologists.*

Fig. 7 (below). *An archaeologist brings the keel section to the surface.*

Photo: G. Garcia

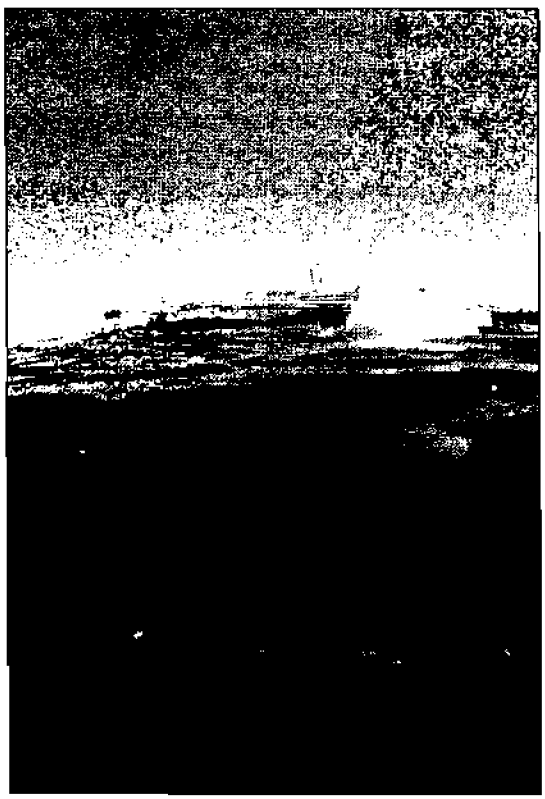


Photo: G. Garcia

oak (*Quercus suber*), and the small size of the trees that were used forced the shipwrights to assemble large structural pieces from several small timbers (fig. 5). The hull planking was cut from umbrella pine (*Pinus pinea*), with strakes almost 11 cm thick. These were caulked with a string of lead, which was inserted between the planks during construction. Two thick layers of oakum were pressed into the seam, against the lead string, and were then protected from the outside with a strip of lead. This protective strip was nailed to the outer surface of the planks using short tacks with wide circular heads.

The 1999 excavation season lasted two months. The first month entailed intense underwater work to record some important construction details and to raise most of the remaining structure (figs. 6 and 7). Unfortunately, the wood remains had been heavily damaged by the rough sea conditions since the 1997 excavation season. Most of the second month of the 1999 season was spent recording the timbers and preparing an exhibition of the artifact collection for Lisbon's Naval Museum (figs. 8 and 9).

The extent of future work on this wreck site will depend on the results of the ongoing study of the information recovered this season. We hope that the data will allow the reconstruction of part of the midship section and the hull's overall length. We also hope to reconstruct the rules that were used to narrow and raise the bottom of the ship in the direction of its extremities. The hull reconstruction, the analyses being performed on the artifacts, and the historical information assembled will hopefully shed more light on the history of this wreck and the Portuguese East India trade.

Acknowledgements. The author wants to express his gratitude for the support of the Portuguese Navy, especially the Direcção de Faróis, without which none of the field seasons would have been possible.

Suggested Readings

Castro, Filipe
1998 "Underwater Archaeology in Portugal: Policies, Budgets, and Results." *INA Quarterly* 25.4, 16–18.

Luz Alfonso, Simonetta, Ed.
1998 *Nossa Senhora dos Mártires, the Last Voyage.* Lisbon: Verbo.

Phillips, Carla Rahn
1986 *Six Galleons for the King of Spain: Imperial Defence in the Early Seventeenth Century.* Baltimore: John Hopkins University Press.

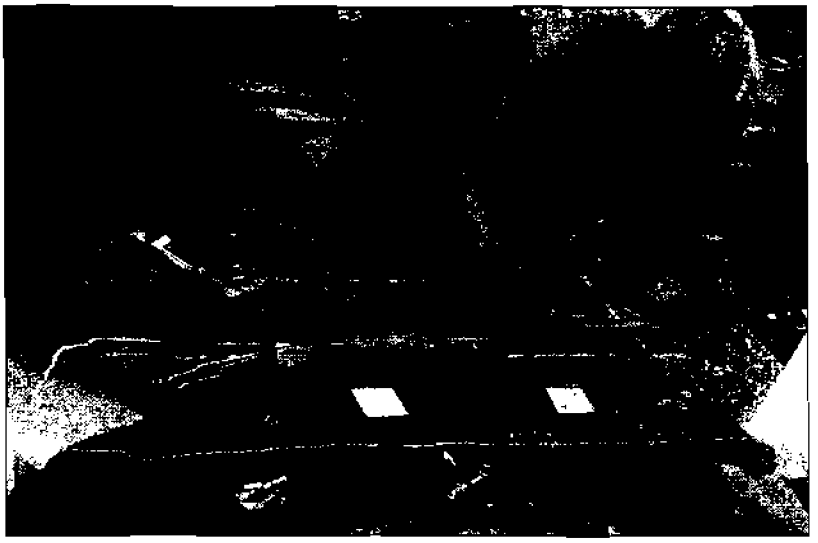


Photo: F. Castro

Fig. 8. *Mikkel Thomsen draws the east side of floor C5 in the CNANS warehouse.*

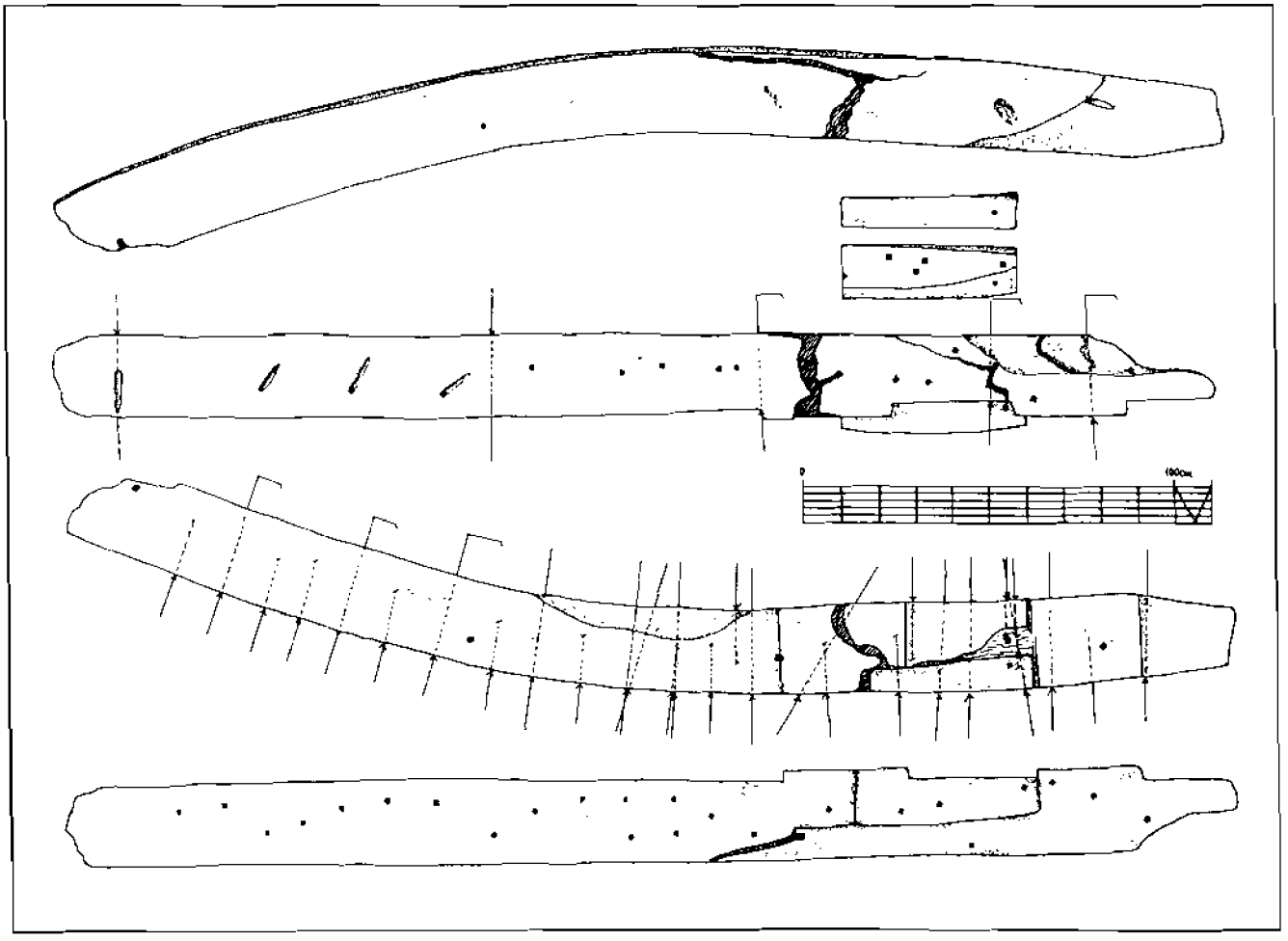


Fig. 9. *Futtock C5 was carefully drawn to preserve its diagnostic features.*

Hull Construction of the Late Bronze Age Shipwreck at Uluburun

Cemal Pulak

From 1984 to 1994, the Institute of Nautical Archaeology excavated one of the world's most exciting archaeological sites. A Late Bronze Age shipwreck at Uluburun opened a window into ancient commerce by providing an enormous collection of trade goods from the period. The ship apparently sank shortly after 1305 BCE, when the last datable ring on a dendrochronologically dated piece of cedar dunnage or firewood was laid down. One important aspect of this shipwreck is the preservation of parts of its hull, which provide unique insights into Late Bronze Age shipbuilding.

Investigation of the site showed that the ancient ship had come to rest on the seabed in approximately an east-west orientation. The western end was uppermost on the sloping seabed, with the wreck listing about 15 degrees to starboard. At the west end, the stern rested at approximately 44 m depth with the bow at 52 m. Excavators found artifacts and cargo scattered down the slope to at least 60 m. Since so much of the cargo perished, estimates of the ship's size are speculative. However, it appears that the length was about 15 m and the total capacity at least 20 tons, based on the recovered remains.

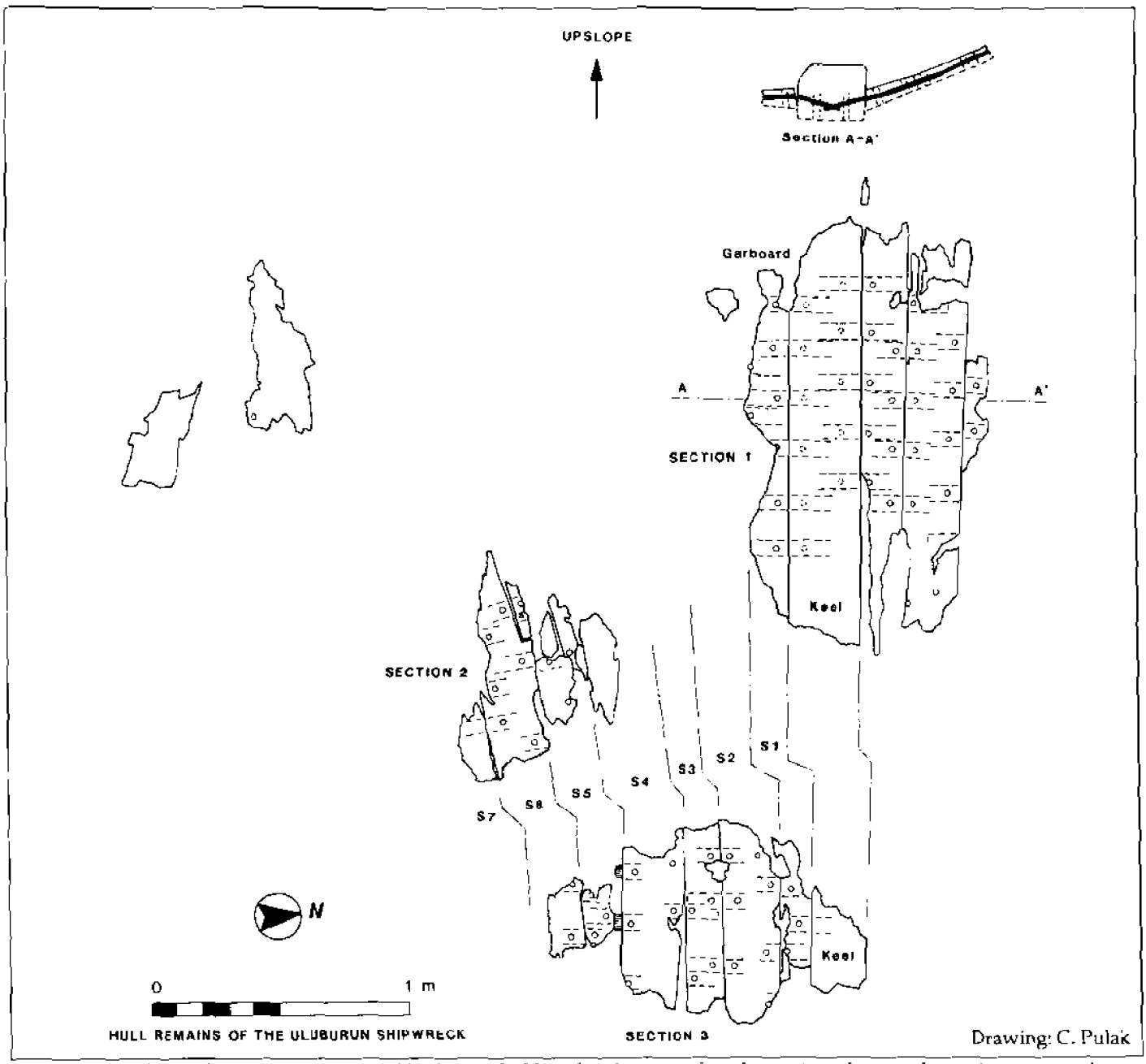


Fig. 1. *The Uluburun hull sections discussed in the article. Note that they were found on a steep slope, so the sections appear shorter in length when projected on a horizontal plane, as here.*

The hull remains

We found the scanty hull remains in four distinct sections, although one of these consisted of only a few scraps of planking (fig. 1). The first and largest section was preserved by the weight of the ship's eight stone anchors forcing the keel and planking into the relatively flat sand high on the slope. This first section of Uluburun hull remains measured approximately 1.8 m by 1 m (fig. 1). These were well preserved on their inboard surfaces, but badly eroded on the outside. Included were a 1.7 m section of the keel, port garboard (the plank or strake joining the keel), and second strake. Besides these two full width-strakes, there were fragments of the third port strake. On the starboard side of the keel, only fragments of the garboard remained.

The smaller second and third hull sections were preserved under the second and third rows of copper ingots, respectively. The copper created a toxic environment that discouraged marine life that would otherwise have attacked the wood. The wood from these sections is stained green and heavily distorted by the ingots, but otherwise well preserved.

Peter I. Kuniholm of the Malcolm Weiner Laboratory for Aegean and Near Eastern Dendrochronology at Cornell University identified the wood species in the ship, and Werner Schoch of the Swiss Federal Forestry Research Institute in Zürich confirmed the identifications. These analyses revealed that the hull was built of cedar (*Cedrus* sp.) instead of fir (*Abies* sp.), as previously believed. This new identification is not at all surprising when one considers that Bronze Age sources often mention cedar as the most preferred timber for building ships. The physical and mechanical attributes of cedar are well suited for shipbuilding. It is easily worked and has little dulling effect on tools, shrinkage is minimal, seasoning is achieved without significant distortion, and it is more resistant to decay in salt water than most other woods.

Excavators have also tentatively identified the remains of bulwark fencing (fig. 2) as evidenced by five well-rounded stakes in a row several meters to starboard of the hull. Only one is fully preserved. It is 1.7 m long and nearly 7 cm in diameter. Each stake was sharpened, with the points all oriented towards the keel. Perpendicular to and laying on the stakes were closely spaced parallel withies. This almost certainly is a wicker work weather fence similar to those on all the Syrian ships depicted in nearly contemporary Egyptian tomb paintings. Odysseus used similar wicker fencing to keep the waves out of the boat he built to leave Calypso's island.

There was no evidence of framing. It is possible that the preserved hull section was too small to contain evidence of such structural elements, or that frames or bulkheads were attached higher up the hull. However, the absence of these elements in the first few strakes either side of the keel may indicate that there were fewer internal supports than in later vessels. If, in fact, there were few supports, how was the hull held together?

Joinery used in construction

Ships today are constructed by erecting a skeleton of framing and then attaching the planking to this framework. In contrast to this "skeleton-based" approach, ancient shipbuilders used a "shell-based" method. This entailed edge-joining the planks with mortise-and-tenon joints that were then locked in place with wooden pegs. These were driven from inside the hull through the tenons to form a rigid shell. The framing was only added later to reinforce the hull. On examining the hull sections, we discovered that the Uluburun ship used this shell-based method known from Greek and Roman ships of more than a millennium later. Indeed, it is the oldest ship currently known to have been built this way.

Unpegged mortise-and-tenon joints were found in Khufu's funerary boat at Giza (ca. 2565 BCE) and Senusret III's boats (ca. 1855 BCE) at Dashur. Without pegs to lock adjacent planks to one another, they offered considerably less longitudinal support for the planking than did their pegged counterparts. The tenons served primarily to align the planks during construction. Ligatures were used to hold the planks together. As late as the fifth century BCE, Herodotus observed Egyptian shipwrights attaching short planks with long, closely set tenons. They caulked the planks from the inside using papyrus fibers, which presumably would have been held in place by the ligatures used to bind the planks together. Although the Egyptians used pegged mortise-and-tenon joints as early as the Third Dynasty (ca. 2680–2610 BCE) for furniture, we have no evidence of their use in shipbuilding. However, we also have no physical remains of Egyptian seagoing vessels, which could have used such construction.

Until the discovery of the Uluburun ship, the oldest completely-documented vessel with pegged mortise-and-tenon joints was the Kyrenia ship of the late fourth century BCE found off northern Cyprus. However, it seems likely that such construction was previously used in the seventh-century Mazarrón, Spain, shipwreck, the late sixth-century Jules Verne 7 ship at Marseilles, France, the late fifth-century Ma'agan Michael shipwreck near Haifa, Israel, and the late fifth- or early fourth-century Porticello shipwreck in the Straits of Messina, Italy.

We do not know when and where mortise-and-tenon joints were first used in ship construction. Possibly, this technique developed on the Levantine littoral and spread westward. It may be more than coincidence that the Romans called this type of joint "Phoenician." The two earliest ships known to have used pegged mortise-and-tenon joints were both built somewhere along the Syro-Palestinian coast or on Cyprus. The first was the Uluburun ship; the other is the Cape Gelidonya shipwreck (ca. 1200 BCE),

excavated on the southern Turkish coast by George Bass in 1960. Recent examination of drawings and photographs from that ship have confirmed the use of this style of construction. More exact answers about the origin of this technique may have to await the discovery and excavation of additional Bronze Age vessels.

Keel remains

One of the most striking features of the Uluburun ship was its keel (fig. 2). Traditional keels project well below the exterior surface of the planking. This assists the ship to hold course and tack closer to the wind in adverse weather. In contrast, the Uluburun keel projected no more than two centimeters beneath the hull. The flat top of the keel was ten centimeters higher than the interior surface of the garboards. In most ancient Mediterranean hulls, the inside surface of the keel is at the same level as the garboards.

The excavators originally assumed that the keel projected well below the exterior planking, and that the keel had settled on the bottom above its original position. However, further study showed that the garboards had been fastened to the keel near its bottom surface. The keel was originally wider (sided 28 cm) than it was high (molded 22 cm), although the height had to be reconstructed with information from a small, well-preserved knot in the worm-eaten keel's exterior. It appears that the keel narrowed by about a quarter of its maximum width towards the bow, based on a 50 cm length of the keel preserved in the third hull section.

This keel would have served as an effective spine for the ship, provided protection to the bottom planking, and supported the vessel when beached. The Uluburun keel is more massive than a simple plank but was not a true keel projecting below the hull. This design will help us to understand the technological and navigational capabilities of Bronze Age seagoing ships. This, in turn, will assist us in understanding how those capabilities favored certain maritime trade routes.

The keel or keel plank of the seventh-century BCE shipwreck at Mazarrón, Spain, was somewhat similar in proportion of its sectional dimensions, although its interior surface was at the level of the garboards. As such, it appears to represent the next logical step in the development of the keel, a configuration similar to that of the Uluburun ship, but now pushed to the outside of the hull.

Construction of the planking

The second section of hull is extensively eroded but includes an important construction feature not attested elsewhere. This is either a flat scarf or a drop strake. As runs of planks curve in toward the stem and diminish in width, those that become impractically narrow are discontinued (dropped) and their ends cut square to prevent splitting. In the first hull section, the garboard noticeably tapers towards the bow. In the third section this tapering becomes even more pronounced. Therefore, the drop strake possibility for the feature in the second section seems most likely. There is one well-preserved mortise-and-tenon joint at the scarf or drop strake, and a vestige of a second. Bronze Age seafarers were apparently not worried about the strength of such joints, since the heavy copper ingots were placed directly above the joints. There was only a patch of dunnage (thorny burnet, *Sarcopoterium spinosum*) between the ingots and planks to protect them.

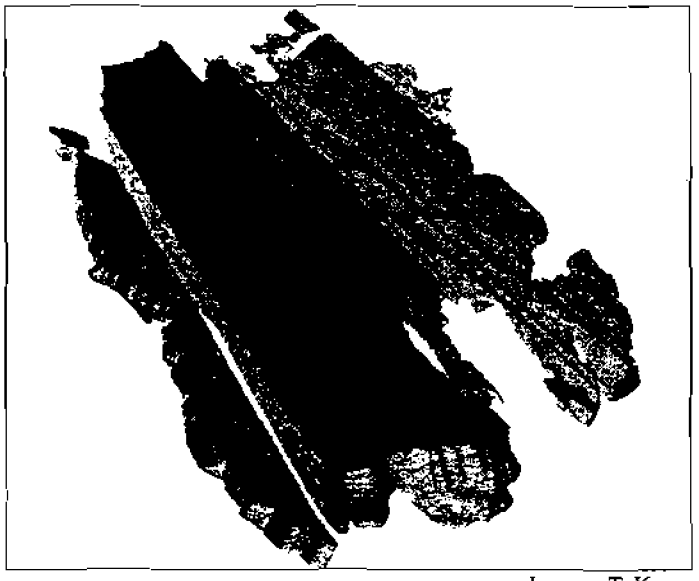


Image: T. Kang

Fig. 2. *This computer reconstruction of the keel shows how it projected internally, rather than externally.*

The garboards were fastened to the keel with pegged mortise-and-tenon joints. The edges of the garboard adjoining the keel were approximately 10 cm in thickness while the opposite edge was about 6–6.5 cm. We found no metal fasteners, treenails, or ligature fastenings anywhere in the hull. It appears that the pegged joints were the exclusive means for holding the ship together. The builders drove all the pegs completely through the planks from the interior of the hull and then sawed them even with the surfaces. The oak pegs, averaging 2.2 cm in diameter at their inboard face, are tapered and multi-faceted, with one well-preserved peg displaying about twelve facets.

Spacing and size of the joints

The Uluburun ship had joints that were spaced further apart than those found in Greek and Roman ships of similar size. The joints were extraordinarily robust, with the mortices extending from one plank edge to within 1.5–2 cm of the opposite edge. This is about twice as long as the tenons in Greco-Roman ships of similar length, and is considerably longer than is required to resist shear forces

on the joints. The long tenons functioned as frames within the planks, providing extra stiffening. This intra-planking framework compensated for the lack or paucity of external frames in the hull. The oak tenons were much harder than the cedar of the planks. The use of such tenons embedded in very thick strakes would have provided a substantial measure of lateral rigidity.

As shipbuilders began relying on a sturdy external framework to provide lateral rigidity, it was no longer necessary to use such long tenons or thick planks. Thinner planks simplified construction and allowed more precise shaping of the hull. However, the resulting flexibility also affected water tightness. Therefore, the joints needed to be placed at closer intervals. This explains the difference between the construction of the Uluburun ship and those built in Classical or Roman times.

One-half of a preserved Uluburun tenon is approximately 15 cm long and 6.2 cm wide, suggesting a length of about 30 cm for the complete tenon (fig. 3). When compared with the only surviving tenon fragment from the Cape Gelidonya ship (fig. 4), a relatively constant ratio of 1.2–1.3 was observed between the lengths, widths, thicknesses, and peg hole diameters of the two tenons. These two tenons are remarkably similar in shape, featuring the same taper in both width and thickness, and beveling at the narrower extremities, but the Cape Gelidonya tenon is 17–23 percent smaller than those from Uluburun. If one assumes that the tenons and ship were of proportional size, then since the Uluburun ship was approximately 15 m in length, the Cape Gelidonya ship would be 11.5–12.5 m. That would be somewhat larger than the previously estimated size of that ship.

Classical ships used joints that were evenly spaced and staggered from one edge to the other. The Uluburun mortises are paired, and each is cut immediately next to the nearest joint in the opposite edge. In fact, the Uluburun paired mortises are so close together that they sometimes overlap, and occasionally a tenon was cut into or damaged when the mortise was cut from the opposite edge. This seems to be a conscious attempt to extend an internal "frame" of paired tenons up the sides of the hull planking.

In most ships of the Classical period, the joints were spaced fairly equally and their locations along adjacent seams were staggered. This would seem to strengthen the plank by reducing the distance between tenons, rather than pairing them immediately next to each other as was done in the Uluburun wreck. However, it is the uncut wood between mortises that resists tensile stresses and prevents the plank from splitting. The resistance of the plank to such forces is proportional to the distance between the two adjacent joints. In a Classical hull, the short mortises on the opposite edge do not compromise the area between the mortises on the closer edge. Therefore, it is best to stagger the mortises and space them evenly. The situation is otherwise when the mortises extend almost across the plank as in the Uluburun wreck. Then, the best way to maximize the distance between mortises is to place each pair side by side. This nearly doubles the effective wood area and strengthens the resistance to splitting.

It is notable that the spacing of joints in the Uluburun ship varies with the width of the plank. The spacing increases from about 20 cm amidships to 25 cm in the narrower planks toward the bow. By placing the joints further apart, the ship builders could maintain the same uncut wood area between joints. This indicates that the shipwrights were indeed concerned with maintaining the resistance of the planks to splitting.

Lateral stiffening

Although there is no direct evidence of framework or other structures to provide additional lateral stiffening, there may be evidence of a standing beam or through beam. Near the first hull section, we found one large timber that

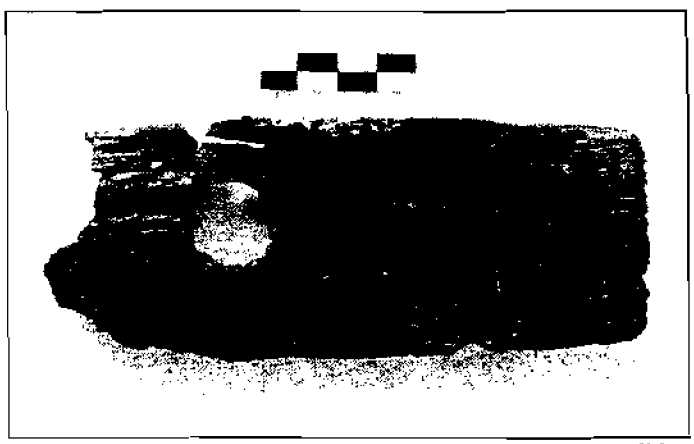


Photo: INA

Fig. 3. *A partially preserved tenon from the Uluburun shipwreck, showing the peg hole.*

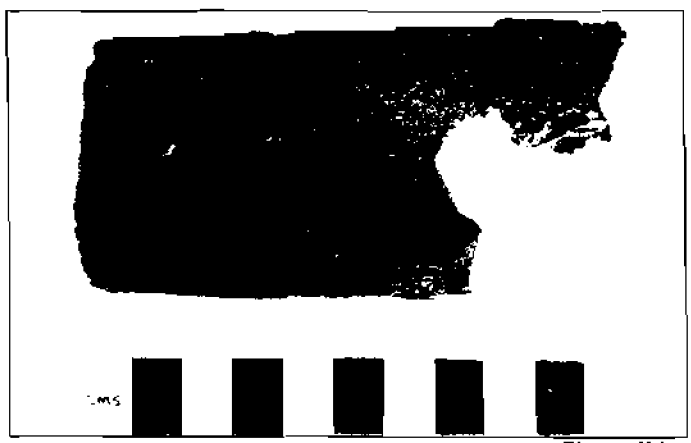


Photo: INA

Fig. 4. *The surviving tenon from the Cape Gelidonya shipwreck was similar to the larger Uluburun tenons.*

lacks any evidence indicating how or whether it was attached to the ship. Unfortunately, this heavy oval timber, curved at one end, is so poorly preserved that its ultimate function is unclear.

Some lateral support was provided by placing freshly cut branches of up to 5 cm in diameter athwartships from either side of the hull toward the keel (fig. 5). The cargo was then placed above these cushioning branches. This would assist the hull in distributing the weight of the eleven tons of metal ingots in the ship's final cargo.

Some scholars have argued that a frameless or sparsely framed hull would have to carry cargo on deck to evenly distribute the weight throughout the hull. This is the way an architectural arch bears the load of a building. However, the Uluburun ship was probably only partly decked, and the cargo was placed directly on the hull planking with only minor cushioning. According to the inverted arch theory, this would force apart the planks. Obviously, the Uluburun shipbuilders and mariners were not concerned about this prospect.

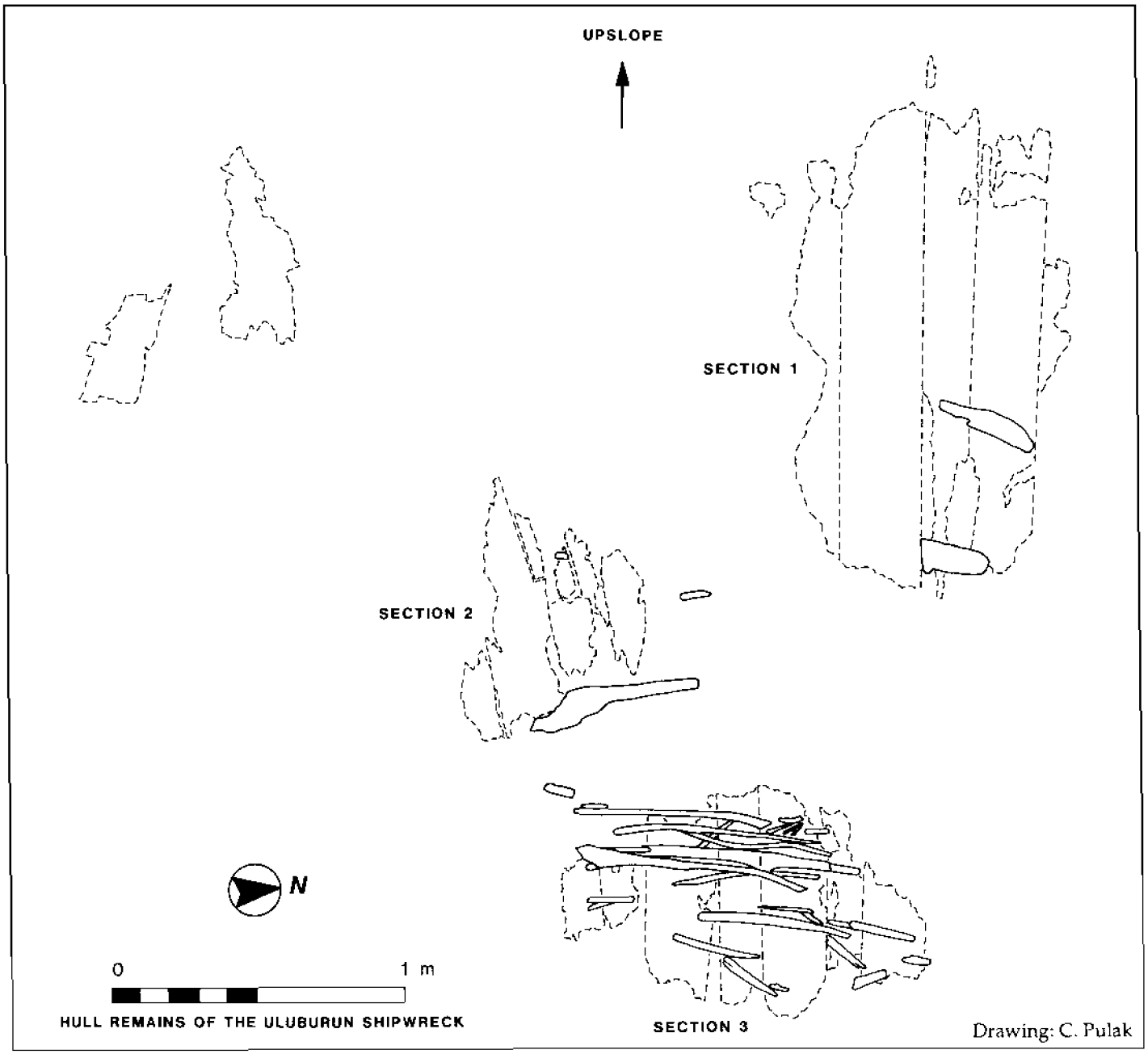


Fig. 5. *Branches were laid crosswise on the bottom of the Uluburun hull to cushion the copper ingots in the cargo.*

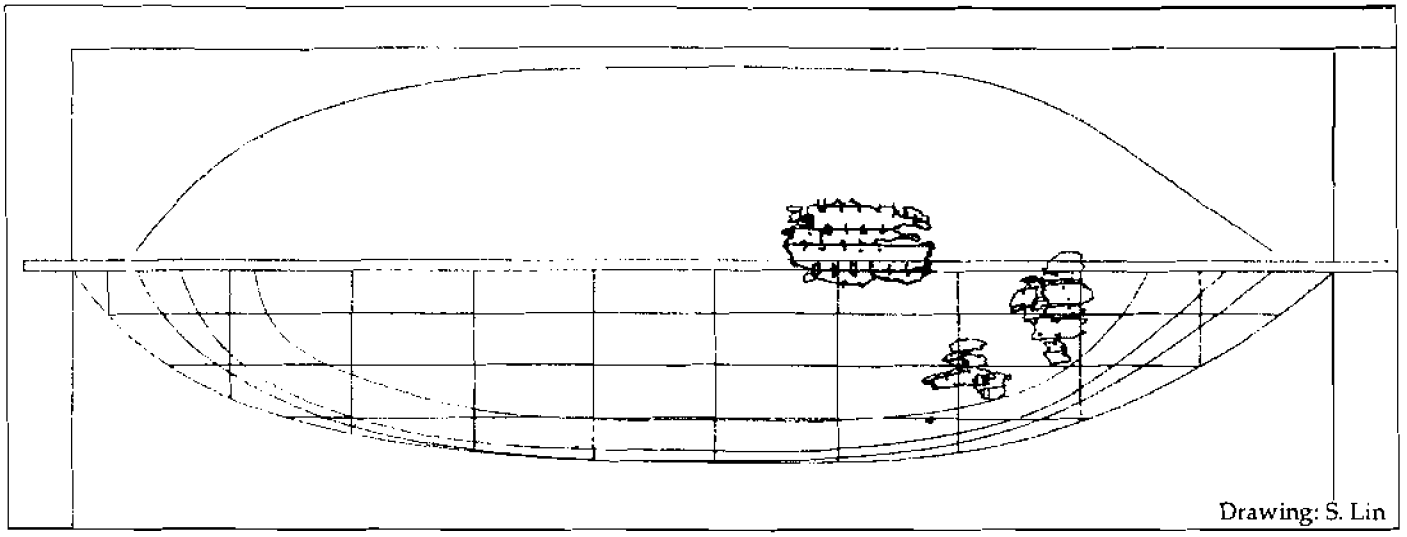


Fig. 6. *Reconstructed lines of the Uluburun ship, showing the position of the remains found during excavation.*

Possible applications of the Uluburun discoveries

The Uluburun hull (fig. 6) provides a firm basis for comparing an actual Late Bronze Age ship with contemporary ship representations and models. For example, there is a detailed portrait of Egyptian seagoing ships on Queen Hatshepsut's (ca. 1460 BCE) mortuary temple at Deir el Bahri. These long and slender ships are shown in profile. A line marks the seam between the hull planking and the central timber that terminates in a projecting stem and sternpost. This may indicate a keel that projects below the planking at the extremities of the hull, but that disappears almost entirely amidships.

These ships resemble carved boat models from the tombs of Amenhotep II (ca. 1400 BCE) and Tutankhamun (ca. 1330 BCE). These confirm a popular New Kingdom hull design with a spine or backbone timber that protrudes below the hull only near the ends. Although these models are solid and show no internal features, they are complemented by a hollow clay boat model from Byblos. This has a molded central member running the full length of the hull and projecting outward at bow and stern. As with the other models, the longitudinal member appears to be flush with the exterior hull amidships. The model probably represents a somewhat foreshortened version of an Egyptian hull. This model also shows the protruding ends of four through beams. Two of these are concealed beneath the partial decks fore and aft. The other two cross the open hold amidships.

Models from the Late Bronze Age Aegean suggest that a similar internal keel configuration was used elsewhere in the eastern Mediterranean. A clay ship model from a late Late Cypriot I-II (ca. 1450–1225 BCE) tomb shows a molded strip on the interior center line with no indication of a keel on the exterior. A late Helladic IIIB (thirteenth century BCE) model fragment from Tiryns, Greece, has a similar internal strip. Two small Late Helladic IIIB models from Tanagra, Greece, have a keel and frames (or other lateral timbers such as beams) marked in paint on their interior.

Therefore, the Uluburun shipwreck confirms the evidence from contemporary artistic representations that at least some seagoing ships were equipped with centerline timbers that projected into the hull instead of externally. These timbers provided vital longitudinal strength. All these indications suggest that there was no conspicuous use of traditional framing during the Late Bronze Age. Instead, shipbuilders used robust mortise-and-tenon joinery or ligatures to hold their planking together (although the use of widely spaced frames or bulkheads, in conjunction with through-beams, is possible).

Study of the Uluburun ship has allowed us to push back by more than half a millennium the first known use of the pegged mortise-and-tenon shell-based construction technique. This will provide many opportunities to compare shipbuilding techniques in the Late Bronze Age with later Greco-Roman ships of comparable size.

Suggested Reading

Pulak, Cemal

1999 "The Late Bronze Age Shipwreck at Uluburun: Aspects of Hull Construction." *The Point Iria Wreck: Interconnections in the Mediterranean ca. 1200 BC. Proceedings of the International Conference, Island of Spetses, 19 September 1998.* Eds. William Phelps, Yannos Lolos and Yannis Vichos. Athens. Hellenic Institute of Marine Archaeology (HIMA).

Conservation in the Bodrum Museum of Underwater Archaeology, Turkey, 1998–99

Kathy Hall

Life in the conservation lab in Turkey is always stimulating, and the past year was no exception. Together with colleagues of various nationalities, we worked on many of the incredible artifacts excavated by INA in Turkey.

Work in the laboratory focused on the conservation of material from the Late Bronze Age (ca. 1300 BCE) Uluburun shipwreck. After eleven seasons of summer excavation, there is still a large amount of material to be treated. Dr. George Bass estimates that for every month of underwater excavation, two years of conservation and research are required before publication. However, we are beginning to see the completion of conservation for some major categories of artifacts. In the meantime, we continue to work through the material from this amazing shipwreck, eliciting information from every artifact, and learning a little more about the ship and its cargo every week.

This year, we focused on two main areas: desalinating and drying artifacts still in wet storage, and mending the cargo of amphoras from the thousands of pieces of broken pottery recovered from the site. Examples of artifacts desalinated and dried this year include twenty-two of the twenty-four stone anchors (which also included two small anchors restored earlier) from the shipwreck. We now begin a project to remove masses of marine concretion from the anchor surfaces, in order to recover evidence of which tools were used to shape them, how much they weighed, and signs of use wear. This will help us to understand these artifacts. For example, why were there so many anchors on the ship? Information will also come from an ongoing project to identify the source of the stone used for the anchors.

Photo: INA

Fig 1. *Stone anchor with marine concretion.*

The concretion seen on the anchors is of the type found on most of the artifacts from Uluburun (fig. 1). It is a hard, calcareous, cement-like material, precipitated onto artifacts from calcium carbonate rich seawater. On wreck sites, precipitation can be triggered by changes in the pH of seawater caused, for example, by metal artifacts corroding underwater. For the anchors, concretion removal is carried out by skilled Turkish technicians using small pneumatic chisels running on compressed air. Working all summer long under fragrant mimosa trees, they sound like a group of monster bees. It takes a skilled pair of hands and eyes to distinguish between concretion and stone, and we are lucky in our dedicated technicians, some of whom have been with INA for a very long time. In the summertime, the technicians are joined by Turkish and foreign interns, who volunteer their time for the chance to learn about archaeological conservation. Several of our Turkish interns are planning to apply to university conservation programs, having been inspired by INA.

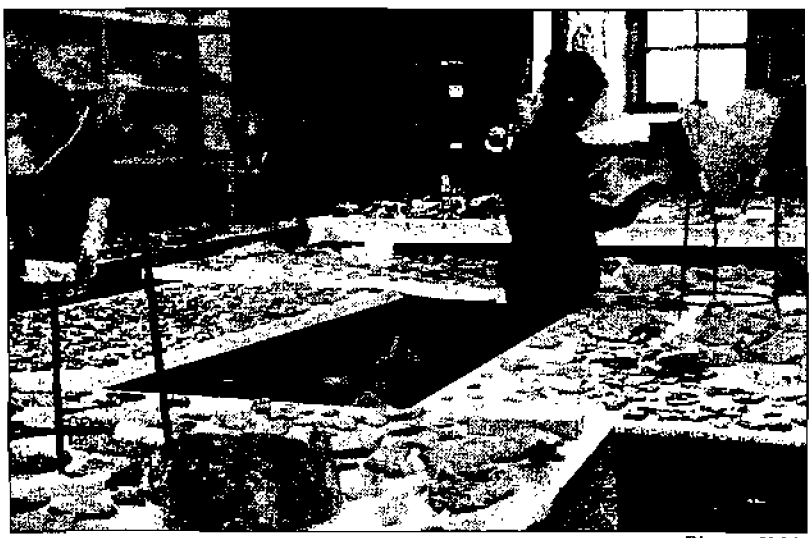


Photo: INA

Fig 2. *Gülser Sinacı working with amphora sherds.*

The interns and technicians work together on cleaning many of the copper oxhide ingots from the wreck. This year we found pomegranate seeds, a silver bar, glass beads, agate beads, and beads made of ostrich eggshell scattered across the surfaces of ingots. We also found many more of the intriguing signs chiseled into the ingot surfaces which are being studied by Nicolle Hirshfeld and Patricia Sibella.

Over the past year, many people worked hard on mending the cargo of amphoras from Uluburun (fig. 2). Visitors often ask *why* we are mending them all! This is a good question; we do not usually mend every broken amphora we find on excavations. However, one of the unique things we are finding about Uluburun amphoras is that they come in many different shapes and sizes, and are made of different types of clay. Why do they differ so much? The answer to this question may well be an important key to understanding the wreck. In addition, this is one of the largest existing groups of amphoras from this period, and, as such, is a unique resource for statistically evaluating Late Bronze Age capacities.

Interns who are used to working on ceramics from land excavations are often amazed at how fragile the artifacts from Uluburun are. You might not expect pottery to deteriorate underwater, but we are finding that many of the amphora pieces have become soft and crumbly. Other pieces may be very brittle. Often, we have to strengthen the pieces with polymer resin before they can be joined together or even handled. This lack of durability is partly because they were fired at much lower temperatures than the ceramics we find on later shipwrecks.

Many of the amphoras we are mending are composed of sherds recovered from forty or more different places on the shipwreck site. First we have to locate those pieces in a sea of amphora sherds. It is like struggling to find the pieces of a plain brown jigsaw puzzle, after it has been scrambled together with many other such puzzles. Fragments are adhered together with a glue that we make ourselves, using beads of an acrylic resin. In this way, we know exactly what we are adding to the artifacts. Most importantly, we also know that, if need be, we can remove it again easily. Often, when the amphora is mended, there are a few pieces missing. If these lost areas are critical, to ensure that the amphora is strong enough for permanent storage, the missing spaces are filled in using plaster of Paris and afterwards painted in a neutral tone (fig. 3).

Photo: INA

Fig 3. *Reconstructed Uluburun amphora.*

Our other big focus at the moment is the new Uluburun exhibit, due to open in July 2000. The exhibit hall building is long since finished, as is the largest room with the replica of the ship and the mock-up of the artifacts on the sea floor. Together with the museum, we are working on the final gallery, where the Uluburun finds will be displayed. We help to advise on display cases so that they are the safest possible for the artifacts. Everyone is aware that these are the oldest and most fragile artifacts ever to go on display in the museum. We are also helping to select specific artifacts for display. In addition, with all the recent tectonic activity in Turkey (including tremors in Bodrum) we are planning to make the display as earthquake-proof as possible!

In addition to the above, and looking forward to the day when we are finished with our work on the Uluburun artifacts, we are mindful of our responsibility to leave the museum with a usable archive. This year, we helped to design a new storage depot for the Uluburun objects. We also worked on packing up artifacts for final storage, including the many bronze tools. For these, several Turkish interns helped to create storage boxes from inert, long-lasting materials. The tools are clearly visible to reduce handling and they are held firmly in the boxes in polyethylene foam cut-outs with fragile edges protected.

Several qualified conservators worked with us as interns this year. Amandina Anastassiades came from Canada, and experimented with new materials to fill lost areas in glass ingots. She is now researching techniques for the treatment of composite objects of wood and bronze, a tricky problem since the treatments for the two different materials are usually incompatible. Gaby Kienitz also came from Canada, compared treatments for glass and faience beads, and looked at treatments for textile fibers from Uluburun. Edith Trnka, the Austrian conservator for the site of Ephesus, studied the conservation of material from underwater excavation with us. Asaf Oron, INA Associate Conservator, treated some of the material from the Middle Byzantine shipwreck INA excavated in 1995–98 at Bozburun, including the bronze steelyard.

We also worked with two colleagues from the American INSTAP (The Institute for Aegean Prehistory) Study Center on Crete. This institution donated the time of their illustrator Doublas Fulman and photographer Kathy May to us for a month, for work towards the final Uluburun publication. We hope to work with them again next year.

In addition, many scholars visited the lab to study Uluburun material. These included Dr. David Reese, an expert on animal bones from excavations, and Dr. Andreas Hauptmann from Bochum, Germany, who sampled copper ingots and bronze tools. Dr. Unsal Yalcin, also of Bochum, will be working on the study and provenancing of orpiment found on the Uluburun wreck and the eleventh-century CE Serçe Limanı (Glass) wreck excavated by INA in 1977–79, as well as that from another eleventh-century shipwreck found during INA's 1984 shipwreck survey. In addition, Edward Rogers began a study of the glass ingots for the final publication, Dillon Gorham took pollen samples, and Dr. Robert Blanchette, of the University of Minnesota, looked at copper pseudomorphs of wood structures. As conservators, we are particularly excited about this last project, which will enable identification of the various woods used in hafting tools and handles from tiny samples, even when the wood has long since decomposed. This is done by looking at the microscopic impressions of wood cellular structures preserved in metal corrosion products.

On a personal note, we said good-bye to a long-term technician, Birgül Akbülüt. Güle güle Birgül! We'll miss you! And "Hoş geldiniz" to a new arrival—Esra Altinanıt Göksu's baby, Elif, born September 6, 1999.

INA Egypt Update

Douglas Haldane

Between July 1 and December 31, 1999, INA-Egypt, with USAID support through the Institute for International Education Development Training 2 Project, ran a six-month training program in wet-artifact conservation. The course was held in the Alexandria Conservation Laboratory for Submerged Antiquities and was designed to assist the Supreme Council of Antiquities (SCA) nationwide in addressing conservation problems relating to the rising ground water in Egypt.

The curriculum was divided into three subjects: 1. Glass/Ceramic/Stone; 2. Ferrous and Non-Ferrous Metals; 3. Organics. Each subject was given twice for a month each. About ten students from all over Egypt attended each course. In all, the program reached about 65% of the permanent SCA conservation staff. The students were selected through interviews in their home laboratories and course assignments were made according to the type of materials they handled (or preferred training in) and the amount of their previous experience. With the objective that each lab would have at least one person trained in each artifact category, we gave preference to the least experienced. The course materials were created in English and translated into Arabic. Someone was present throughout the course for simultaneous translation to assist in comprehension. In addition to the course manuals, which included photocopies of the overheads, the students took away books relating to their subject and a conservation tool set.

In other areas, INA-Egypt was granted permission by the SCA in March 1999 to create a conservation reference library/storeroom in the sixth building in the Alexandria Laboratory. The library facility will complete the laboratory complex in the National Maritime Museum.

In November 1999, the SCA granted INA-Egypt permission to renovate Qait Bey fortress as a nautical archaeological museum. Qait Bey fortress commands the entrance to Alexandria's Eastern Harbor and sits atop the foundations of the Pharos Lighthouse, one of the ancient Seven Wonders of the World. The objectives of the renovation are:

1. To restore the fortress, as closely as possible to its late-fifteenth century condition;

2. Excavate where possible to explore and define the Pharos site;

3. Install the equipment necessary to maintain a modern, innovative museum to the degree that this does not conflict with objective #1.

The first exhibit will be a joint project between INA and Jean-Yves Empereur of the Center for Alexandrian Studies on the history of the Pharos and Qait Bey. The second scheduled exhibit will be the Sadana Island Shipwreck.

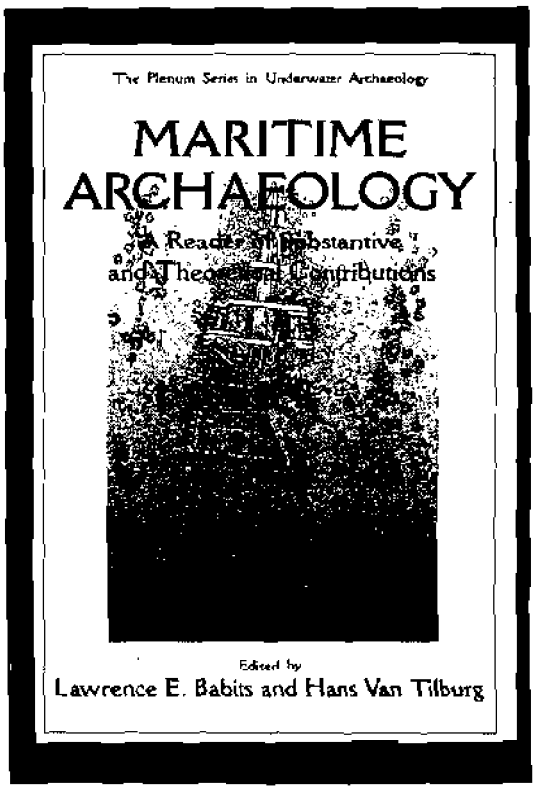
INA-Egypt has also been fortunate to receive permission for three shipwreck surveys in 2000 at: Agami, west of Alexandria; the islands of the Straits of Gubal, Red Sea (between the Sinai and Eastern Desert: July - August); and Umm al-Rakham to Marsa Matrouh (September/October). The survey team members will be predominately Egyptian and from the newly-created SCA Department of Underwater Antiquities. The surveys are part of a strategy that INA-Egypt has recently initiated to explore and document shipwrecks along the entirety of Egypt's Mediterranean and Red Sea coastlines on an annual, incremental basis.

Just Released

The Plenum Series in Underwater Archaeology

J. Barto Arnold III has recently become General Editor of a series of nautical archaeology texts from the Plenum Press of New York and London. The series is intended to meet the increased interest of the public in our discipline. It hopes to provide materials for three distinct audiences: the academic student of archaeology, the professional archaeologist, and the avocational diver who wishes to participate in professional surveys or excavations. The first three books in the series show this range of potential audiences.

Maritime Archeology
Lawrence E. Babits and Hans Van Tilburg, eds.



This first book of the Plenum Series is a collection of forty-eight articles intended as a textbook for a university course in nautical archaeology on either the undergraduate or graduate level. The focus is not on "how to excavate a shipwreck," but on the history and theory of the discipline. Although nautical archaeology is a subdiscipline of archaeology, many of the students and avocationals who explore underwater sites lack grounding in archaeological theory. This book hopes to fill that gap in knowledge.

The articles do not stand alone without an interpretive context. Drs. Babits and Van Tilburg have provided an extensive framework of introductory and bibliographical material for each topic. The characteristic perspective of the volume stems from the "new archaeology" of Lewis H. Binford and his associates. This school insists that archaeological projects such as surveys and excavations should be approached on the same systematic basis as any other scientific research.

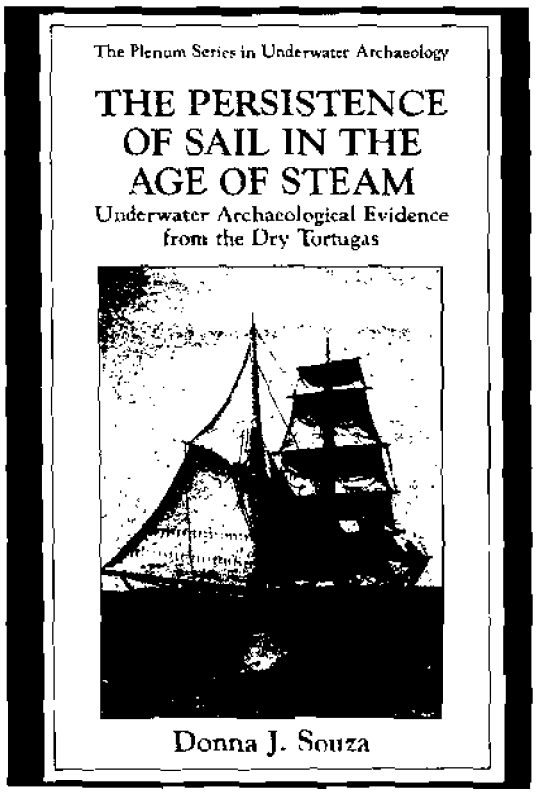
The book touches on most of the major issues in the field, such as the conflict between archaeology and treasure-hunting, and the proper role (if any) of sport divers in maritime archaeology. Many of the articles illustrate how proper research should begin with a careful design that takes into account the processes of maritime site formation and the realities of survey or excavation in a hostile environment. There are examples of properly executed research design from all over the world and from each of the past four decades. Older articles are included to provide an overview of the history of the discipline, and the editors are careful to warn that they may not represent the best contemporary practice. All in all, the book represents an excellent detailed introduction to maritime archaeology.

1998 ISBN: 0-306-45843-8, 590 pages, 87 illustrations, references, bibliography, 2 appendices, index, hardback.

The Persistence of Sail in the Age of Steam
Donna J. Souza

The second book in the Plenum Series in Underwater Archaeology, in contrast to the first, focuses on a single archaeological project. Dry Tortugas National Park in Florida preserves one of the largest collections of shipwrecks in North America. Over two hundred ships have wrecked or stranded on the Tortugas reefs since the sixteenth century. The Pulaski Reef in the northeast corner of the Dry Tortugas has seen twenty-one catastrophes since 1839. One of these (possibly the 1892 wreck of the Brigantine *Shannon*) was the primary subject of the Pulaski Site exploration directed by Dr. Souza.

The bulk of the book describes the remains found on the Pulaski Site. Because it was within a national park, the wreck could not be removed from its final resting place. At most, artifacts could be briefly raised for photography before being returned to the site. The lion's share of study and recording had to be done in situ, 19–24 feet underwater. It is a tribute to the careful work of the archaeological team that so much data could be collected through this nonde-



structive approach. The book is not a bare catalogue of finds. It includes interpretive material, including drawings and photographs of contemporary ships and marine equipment, to enable the reader to place the Pulaski Site in its historical and economic context.

This is not just an excavation report. The book includes a historical account of the impact of the Dry Tortugas on navigation. However, the author's chief interest is given in the title. Dr. Souza is concerned with how and why sailing vessels continued to compete with steam-driven vessels for some applications well into the twentieth century (as late as 1910, American shipbuilders produced more sailing ships than steamships). Part of the answer was the development of steam auxiliary equipment to allow smaller, less-expensive crews the means to handle sails and cargo. Another part was the perception of sailing ships as less risky than steamships. Dr. Souza uses the Pulaski Site to illustrate both of these factors.

1998 ISBN: 0–306–45843–8, 189 pages, 51 illustrations, references, bibliography, 9 appendices, glossary, index, hardback.

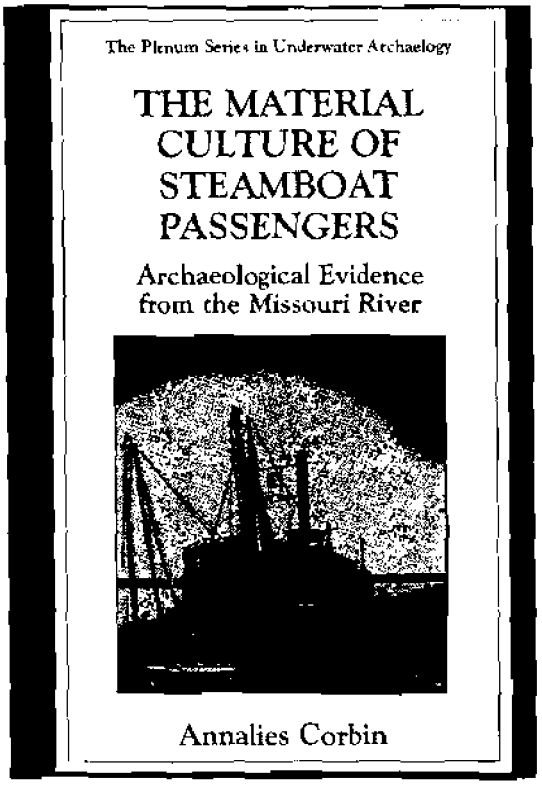
The Material Culture of Steamboat Passengers
Annalies Corbin

Most of us imagine the westward expansion of the United States to have occurred exclusively by wagon train. In fact, water transport played an important role. Beginning in 1860, Fort Benton, Montana, served as the world's innermost port, the place farthest from ocean or sea regularly served by watercraft. Thousands of passengers and thousands of tons of freight made the 3,300 mile voyage up the Missouri River from St. Louis to Fort Benton, which was only 624 miles from the nearest navigable route down the Columbia River to the Pacific. This newest book in the Plenum series was originally a Master's thesis at the University of Idaho discussing this trade.

After a historical introduction, the largest section of the book is devoted to the artifacts found in the only two Missouri River packets excavated to date, *Arabia* and *Bertrand*. Ms. Corbin focuses on several boxes found in the cargo holds with contents that could be identified with a particular traveler or family of travelers. These give a vivid picture of what the pioneers may have carried with them as they headed west in the 1850s and 60s. We are not left to take the author's conclusions on faith; a series of appendices list all of the artifacts found on the two steamboats. There is also a rich selection of photographs throughout the book.

A further appendix may be the most valuable feature of the book for maritime historians and archaeologists, as it provides an alphabetical listing of over six hundred Missouri River steamboats. A paragraph on each vessel describes its history and ultimate fate. Since a majority of them foundered somewhere along the river, they provide a major potential resource for future exploration and research. Actually, this list represents only part of a database of over 1400 nineteenth-century vessels that Corbin has so far identified in her ongoing research on inland river travel. *The Material Culture of Steamboat Passengers* thus represents an important milestone in a developing field where historical and nautical archaeology intersect.

2000 ISBN: 0–306–46168–4, 237 pages, 66 illustrations, references, bibliography, 8 appendices, index, hardback.



Vol. 26 Index

Author Index

Subject Index

Books: Reviews and Just Released

INSTITUTE OF NAUTICAL ARCHAEOLOGY