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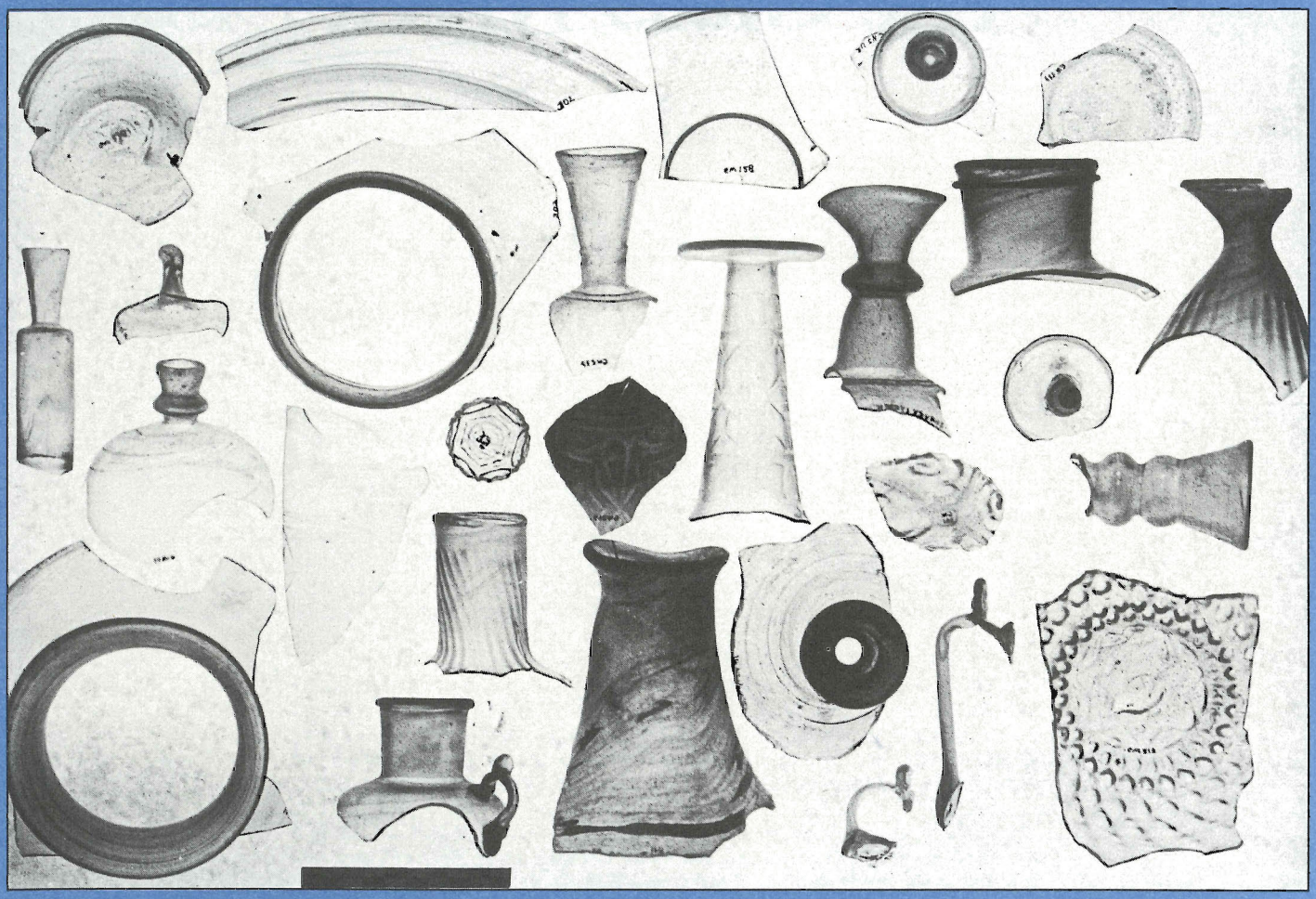


Photo: Don Frey

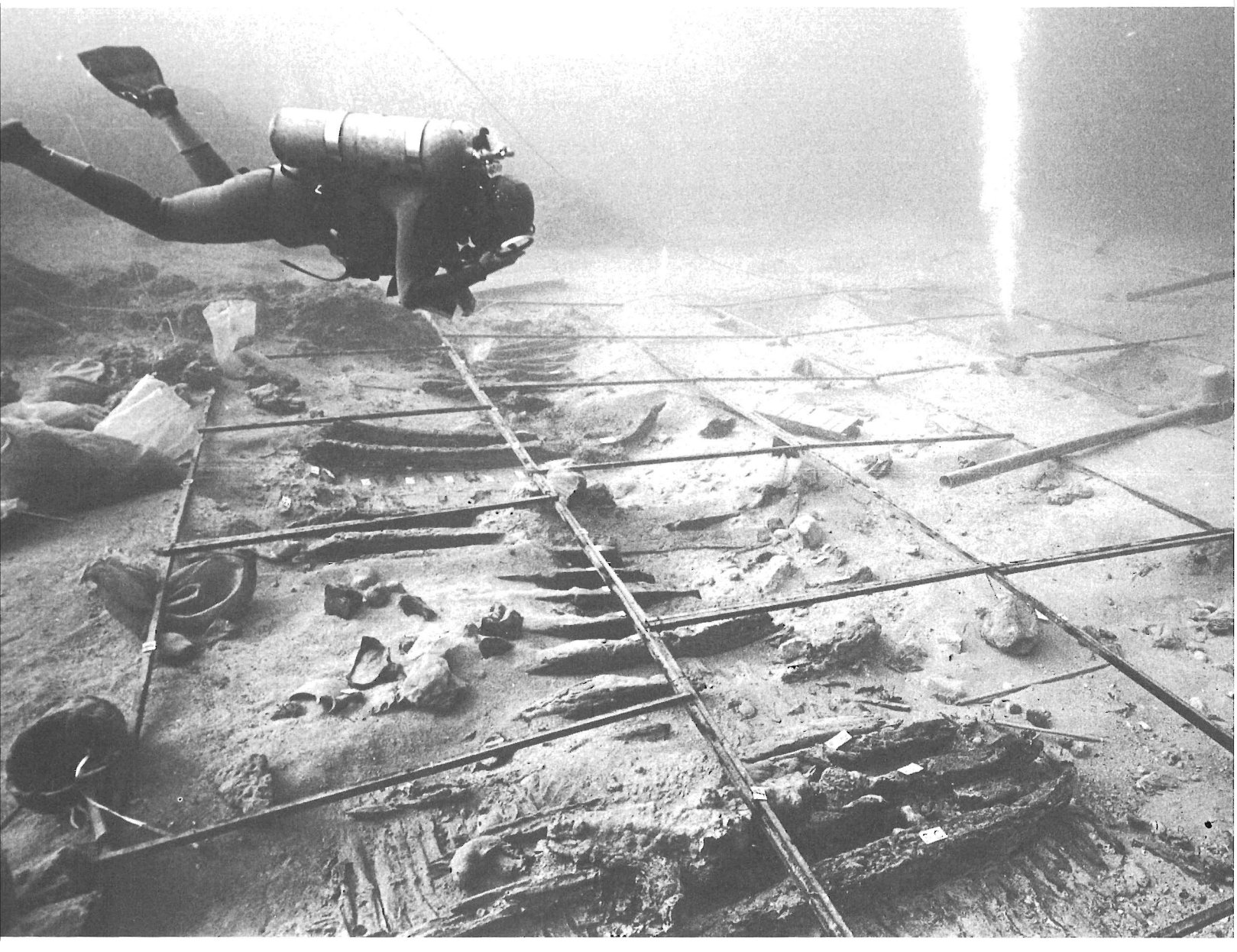
The Glass Wreck: An 11th-Century Merchantman

The Glass Wreck at Serçe Limani

During the summers of 1977 through 1979, the Institute of Nautical Archaeology and Texas A&M University excavated an early 11th-century shipwreck at Serçe Limani, a natural harbor on the Turkish coast directly north of Rhodes. In the early 11th century, the two principal powers in the eastern Mediterranean were the Byzantine Empire, which had dominion over the Balkans and Asia Minor, and the Moslem caliphate of the Fatimids, who ruled from Cairo, a realm that extended from Tunisia to just below the Byzantine city of Antioch in northern Syria. The shipwreck has been closely dated by Fatimid glass weights for weighing coins, the latest of which date to either 1024/25 or possibly 1021/22. The sinking therefore occurred during the third decade of the 11th century, a time of improving Fatimid-Byzantine relations, affirmed by a peace treaty in 1027.

Almost a decade has passed since the shipwreck was excavated. The remains of the ship have been conserved and reconstructed, and considerable progress has been made in the study of many of the other finds. We will soon begin in earnest preparation of the first of several volumes planned for the final report. It seems timely therefore to offer to the readers of the *INA Newsletter* a brief overview of what we have learned to date about the ship, her cargoes, and her last voyage.

Sponsors for the excavation and study of artifacts include INA, National Endowment for the Humanities, National Science Foundation, National Geographic Society, Ashland Oil Inc., Anna C. & Oliver C. Colburn Fund.



Robin Piercy

THE CARGO: Diverse and Partly Unknown

by Frederick van Doorninck, Jr.

During the time of the Serçe Limani ship, governmental control of international trade was relatively moderate, permitting a fluctuation in commodity prices that was often sudden and substantial. Wholesale merchants protected themselves from unexpected changes in prices by dealing in a sometimes remarkable variety of goods, a practice well illustrated by the diversity of cargoes on the Serçe Limani ship.

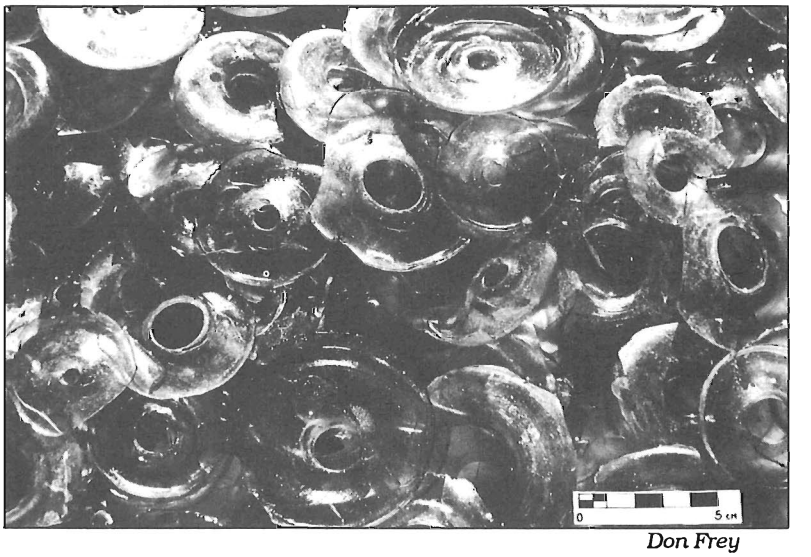
One of the larger cargoes was approximately three metric tons of glass cullet. Two tons of it took the form of chunks of raw glass, while the rest consisted of broken glassware vessels along with some waste glass produced during various stages in the manufacture of glassware. This cullet, which will be described in greater detail in a later part of this article, was stowed within the after quarter of the hold immediately forward of the stern part of the hull. An examination of photographs of the cullet taken when it first was exposed on the wreck site reveals that it tended to occur in compact masses of a somewhat cylindrical shape. We have concluded from this that the cullet had been contained in baskets, most probably of wickerwork, although no actual remains of baskets have been detected.

Forward of the cullet and aft of midships the hold was ballasted with limestone, chalk and beachrock boulders. Included in this ballast were two pairs of small, rotary millstones. The millstones appear to have been unused and were therefore very probably cargo (see C. Runnels, this issue).

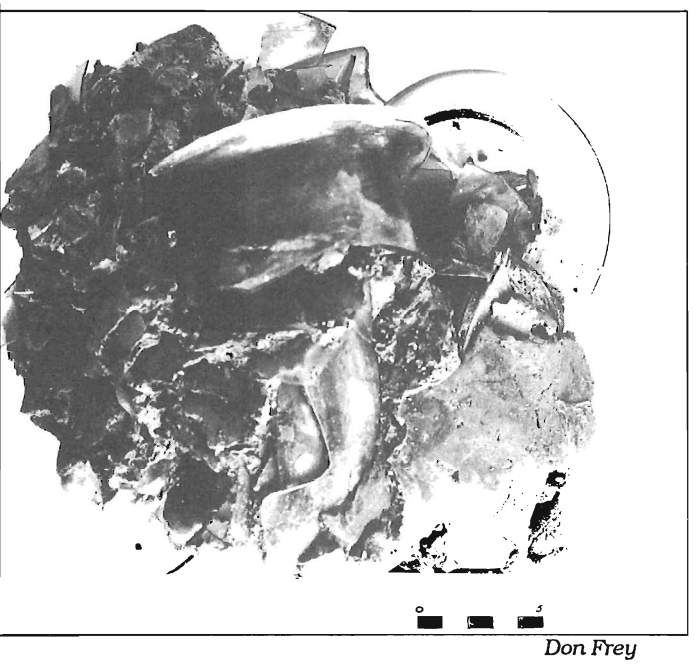
One hundred and ten amphoras were recovered from the wreck. While some of them undoubtedly contained drink and provisions for those on board the ship, the great majority must have been cargo and probably carried wine. Some 50 of the amphoras were stowed within the stern part of the hull and all but a few of the remaining ones were stowed within a small area amidships just forward of the stone-boulder ballast.

Some 80 or more intact glass vessels were on the ship. Many were bottles and tumblers, and most of these were found in the

In addition to large chunks of solid glass, archaeologists were confronted with lumps of heavily concreted glass shards (below). More than a ton of broken glassware (right) and factory waste (below right) had been collected and loaded at a single port for recycling. In medieval times, as today, glass makers added a certain percentage of old, broken glass when making a new batch of glass.



Don Frey



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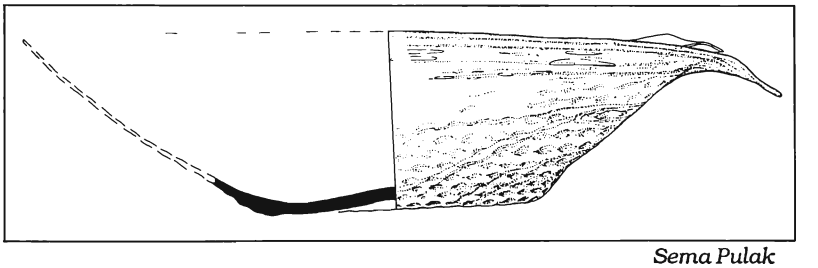


Sema Pulak

It appears that both the intact glassware and the glass cullet were produced at just one locale in the Near East. (Photo: Don Frey)

stern. It was the normal practice in the Mediterranean during that period to ship such fragile cargoes in wickerwork baskets or crates, and fragmentary remains of a wickerwork container were found in close association with some of this intact glassware. Although the wickerwork remnant did not survive excavation, its presence was documented by a photograph.

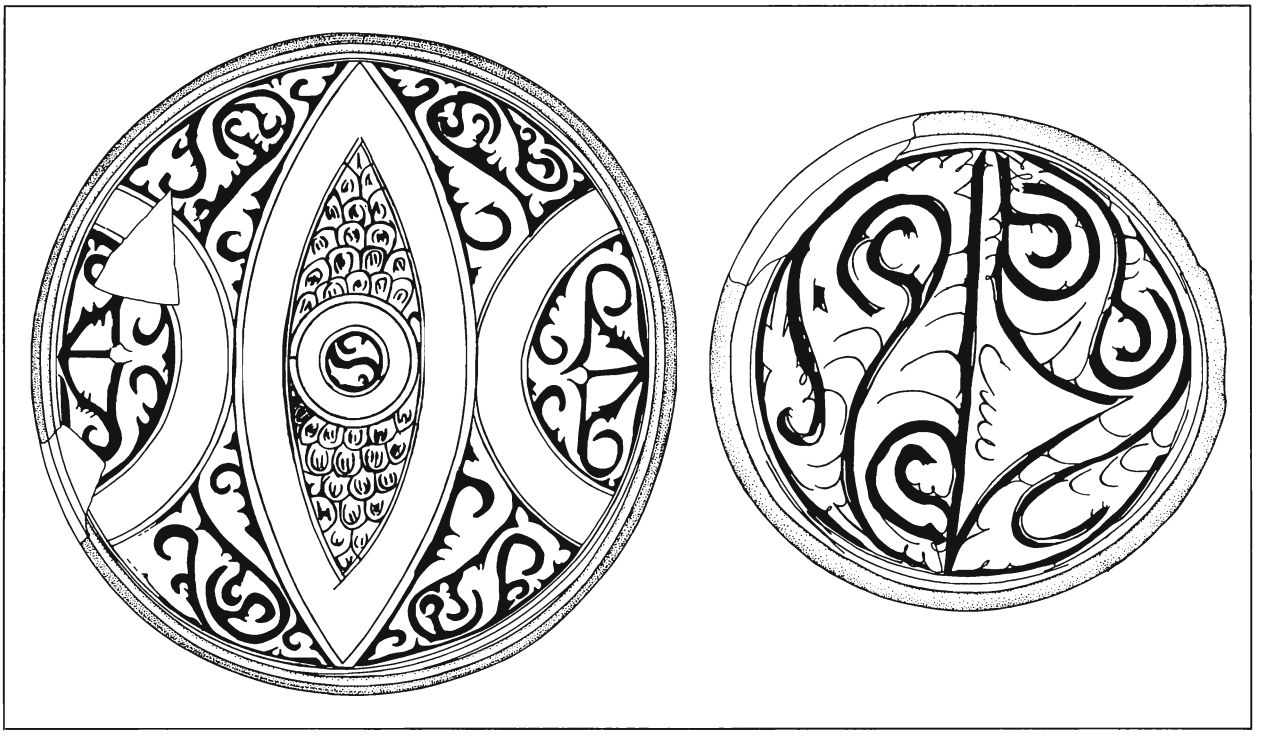
The ship was carrying some small cargoes of fragile ceramic wares that were also probably packed in wickerwork baskets or crates. One of these cargoes consisted of a half dozen thin-walled *gargoulettes* (one-handled jugs with a built-in filter) of white fabric that were found in the stern. They have filters with delicate fretwork and pseudo-Kufic designs characteristic of *gargoulettes* made at that time in Egypt. Another ceramic cargo, stowed with the amphoras amidships, consisted of some three dozen thin-walled cooking pots, several baking dishes, a half dozen two-handled jugs, and a half dozen *gargoulettes*. All of this pottery is made of similar purplish-red fabrics, and the cooking pots and baking dishes have a dark, lead glaze on their interior surface. Although close parallels for these wares have not as yet been found, they would appear to be examples of a general type of ware that was widely used in Syria and Palestine during the period of the Crusades and already produced in Palestine, and quite possibly in Syria, during the time of the Serçe Limani ship.

The ship was also carrying almost four dozen glazed bowls. Although at least two of them had seen use, most of them must have been cargo. Some had been stowed in the stern, most of the others with the amphoras and ceramic cargoes amidships. These bowls are products of the Moslem world, but parallels sufficiently close to suggest specific places of origin have not yet been found. Some of the bowls are examples of splash ware, so called because various colors of glaze were poured or splashed on the interior of the bowl in such a way as to create a decorative design. Conventional chronology would assign a 9th-century date to splash-ware bowls decorated much like those from the Serçe Limani ship. Other bowls are very early examples of sgraffito ware, so called because the decorative designs were carved into the clay. The sgraffito designs on the Serçe Limani bowls are rather deeply carved in what is known as the *champlevé* fashion, a technique conventional chronology maintains did not appear until the 12th century. Clearly the glazed bowls from the Serçe Limani ship will make an important contribution to a much needed reassessment of the chronological development of Islamic glazed wares.

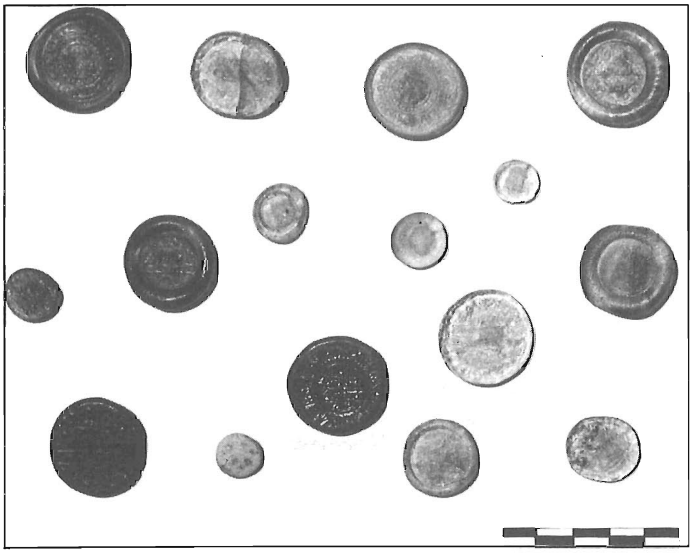
A small cargo that could easily have fit within a single shipping container and some personal possessions were found together immediately forward of the hold in the bow. Both the cargo and personal possessions may very well have belonged to one person. The cargo consisted of a small amount (less than 1 kg was recovered) of the arsenic ore orpiment, over a dozen items of glassware, and possibly some or all of the five glazed bowls and three small amphoras. The most elaborately-decorated intact glassware recovered from the wreck was a part of this cargo, including a matching bottle and tumbler decorated with engraved lions. In addition to one of the glazed bowls, which shows clear signs of extended use, the personal possessions include a couple of glass coin weights, two used cooking pots, and a wickerwork toilet kit containing a scissors, razor, wooden comb and a small number of Byzantine copper coins (the practice of carrying spare change in one's toilet kit when traveling would appear to be an old one). The finding of pork bones in one of the cooking pots suggests that the owner probably was a Christian. That there were other Christians on board is further indicated by the recovery of additional pork bones from other parts of the wreck.

Almost nothing was found within the hull between the small cargo plus personal possessions in the bow and the cargoes of amphoras and ceramics amidships. Only the ship's spare anchors, which had fallen from the deck above, and a half ton of limestone cobbles that had served to ballast the forward half of the hold. Since the ship would have been hopelessly out of trim had there not been cargo in this part of the hold, we must suppose that either the cargo or cargoes here had been unloaded just prior to the ship's sinking

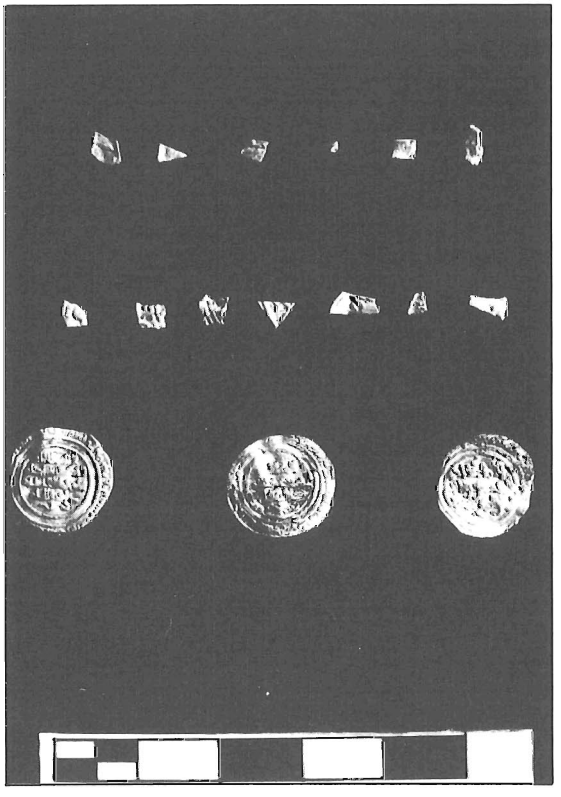
Incised lines in a variety of patterns decorate the interior of glazed bowls from the shipwreck. (Drawing: Netia Piercy)



The ship carried small cargoes of ceramic cooking and table wares that are similar to types from Syria and Palestine. The gargoulettes (center) had filters to keep insects out of their contents. (Photo: Don Frey)



Glass Islamic coin weights (above) securely date the wreck to 1024/5 AD. Three Fatimid quarter dinars and 15 clippings (below) from Islamic gold coins suggest that the ship stopped at a port on the coast of Fatimid Syria. Coin clippings were the "small change" of the ancient world. (Photos: Don Frey)

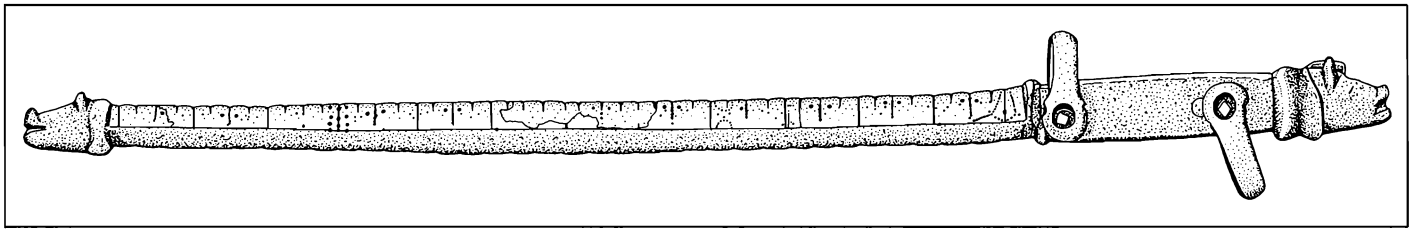


or had been of such a perishable nature that they disappeared in their entirety. In either case, the fact that this part of the hold had been so lightly ballasted suggests that a relatively heavy cargo had been stowed here. We also have slight evidence of the presence of lighter cargoes overlying the boulder and cullet ballast. Although no conscious effort was made to collect organic remains from glassware cullet that had become concreted together into large lumps, when these lumps were broken down to recover the individual fragments of glassware some grape pips and sumac seeds (at first thought to be lentils) were occasionally found within the lumps. Grape pips and sumac seeds were also found together within two amphoras that had come to rest on the seabed just forward of the cullet ballast. This raises the distinct possibility that cargoes of sumac and raisins, and perhaps other perishable products, had been present in the after part of the hold.

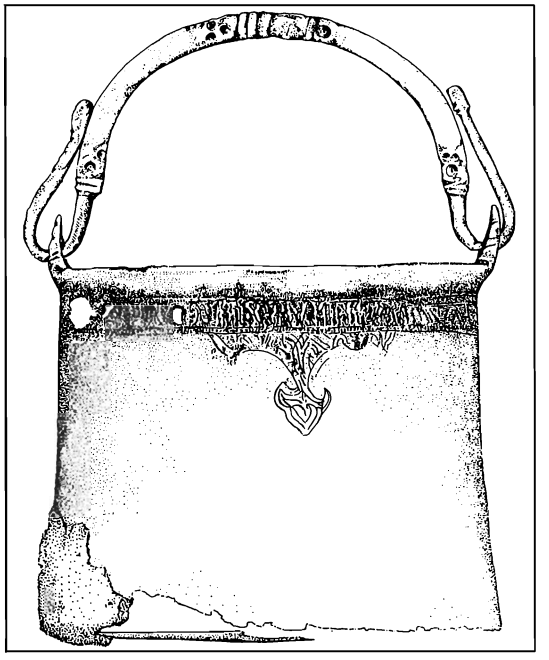
One of the more challenging tasks we face in studying the Serçe Limani shipwreck is that of determining where these diverse cargoes had been put on board the ship. That the ship was involved in commerce with the Fatimid realm is clear. Recovered from the wreck were 16 glass coin weights, all Fatimid issues, two sets of balance-pan weights that appear to be Fatimid, three gold coins, all Fatimid quarter dinars, and 15 clippings from Islamic gold coins. The white *gargoulettes* suggest that the voyage might have begun as far away as Egypt, but if only one port of embarkation was involved, present evidence points to the Fatimid coast of Syria. Both the intact glassware and the glassware cullet appear to have been produced at just one locale within the Moslem world. Lead isotope studies indicate that lead present in some of the glass, as well as in glaze from the glazed bowls, has isotopic ratios identical to lead from northwestern Iran. This would appear to favor a Levantine origin for the glass, as well as for the glazed bowls. The Palestine-Lebanese coast was in Fatimid times, as it was before and after, one of the most important centers for the manufacture and export of glass in the eastern Mediterranean, glass famous for its fine quality and thus particularly desirable even as cullet. The purplish-red ceramic wares were very probably products of this same area, which was also was a major exporter of millstones and renowned for its dried fruits and fine wines. The amphoras on our ship were of Byzantine origin, but as we will see, they were old jars being reused. We might also note that a beautiful gold earring from the wreck is very probably a product of Fatimid Syria. Perhaps analysis of the ship's stone ballast, yet to be undertaken, will help us to pinpoint further the ship's point of departure.

The ship had sailed westward into Byzantine waters, undoubtedly toward some port where glassware was being produced locally. The maritime transport of cullet from a major glass-making center to secondary centers of glassware production made good economic sense. The cullet could be shipped in place of ballast, as was in fact done on our ship, and thus at a low freight rate. Glass factories importing cullet could make due with less-sophisticated furnaces and cut fuel costs, since they did not have to make the glass itself.

What then was our ship's intended destination? Some of the ship's cooking pots and storage jars whose place of manufacture has not yet been determined and the javelins and spears carried on the ship for its defense, which appear to have better Balkan than Near Eastern parallels, may or may not eventually shed some light on this question. In the meantime, it is the amphoras that presently offer the best clue as to where the ship may have been heading.

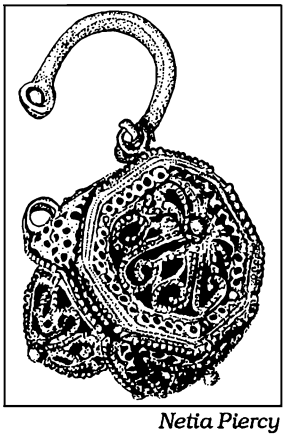


The steelyard was a mainstay of ancient commerce from Roman to medieval times in the Mediterranean. This bronze example from the Glass Wreck bears an upper ring for suspending the steelyard while a balance pan was suspended from a yoke/chain arrangement hung over the boar's "neck." The yoke, chain, balance pan, and weights were also recovered from concreted lumps from the wreck, but it is the system of graduation marked on the long beam scale that may be the most important in determining its origin. (Drawing: Netia Piercy)

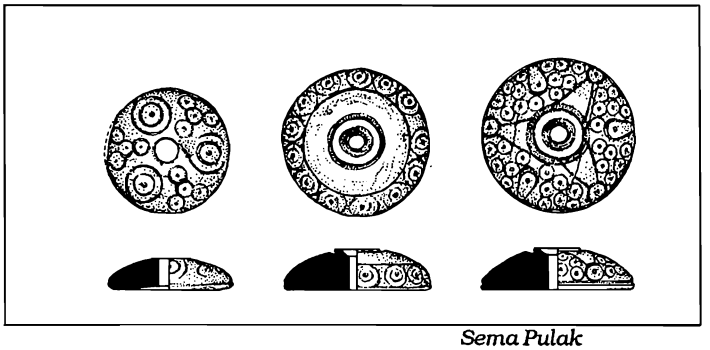


This copper bucket, one of three found on the site, bears an undeciphered Kufic inscription around the rim. (Drawing: Netia Piercy)

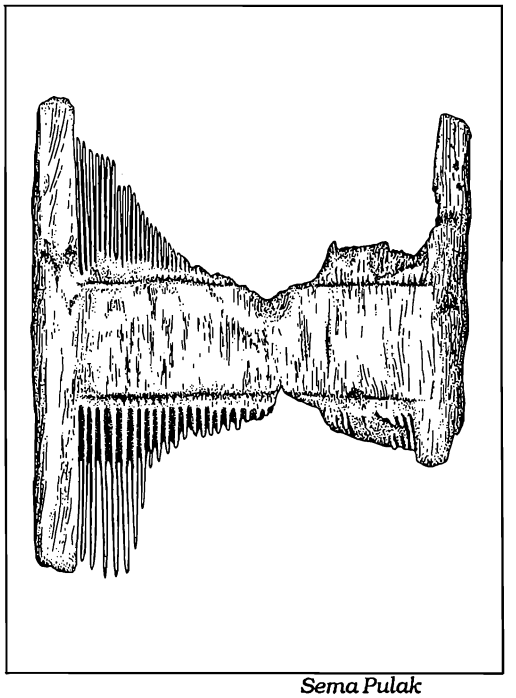
A filigree gold earring, a wooden comb and bone spindle whorls may indicate that a woman was aboard the ship.



Netia Piercy

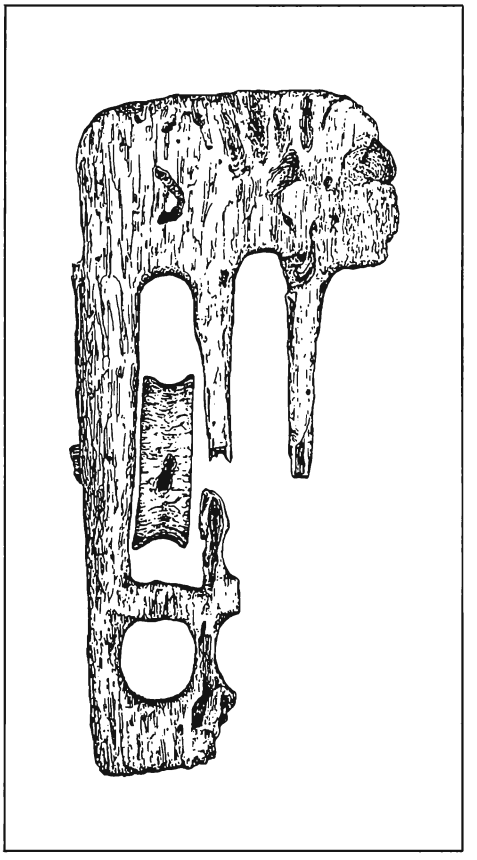


Sema Pulak

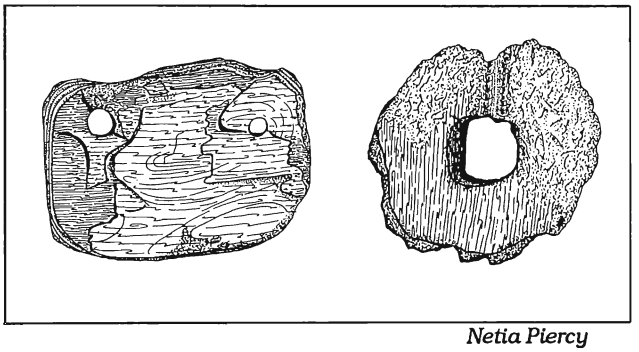


Sema Pulak

Although no traces of the ship's mast were found, Shiela Matthews combined her study of rigging elements like this block and sheave with hull dimensions and concluded that the Serçe Limani ship was probably a two-masted, lateen-rigged vessel.



The ship's crew was well equipped for fishing. Wooden net floats, lead fishing net weights, and a bronze needle for repairing torn nets are only part of the fishing equipment on board.



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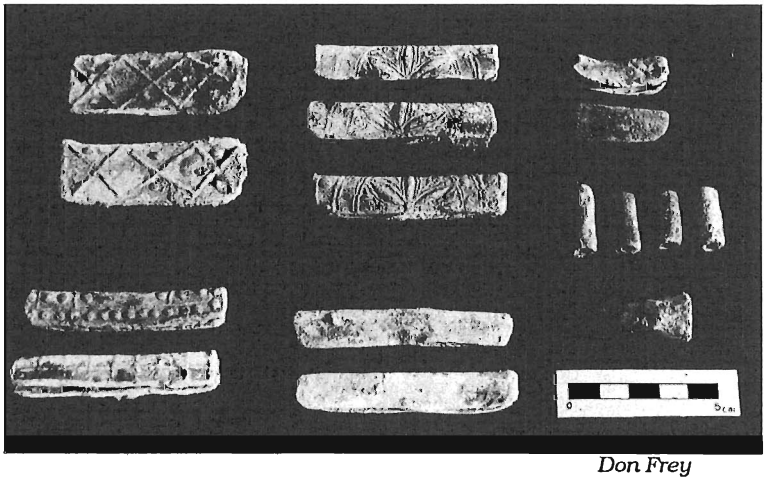

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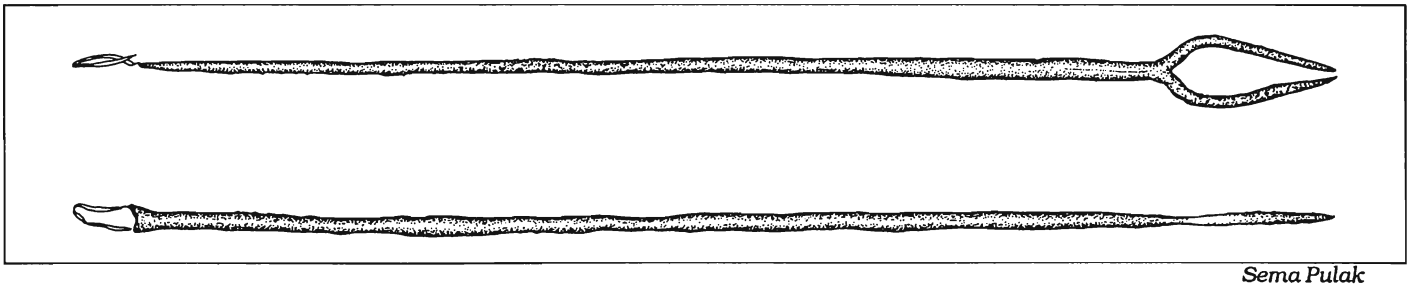


Sema Pulak

The Serçe Limani Glass

by George F. Bass

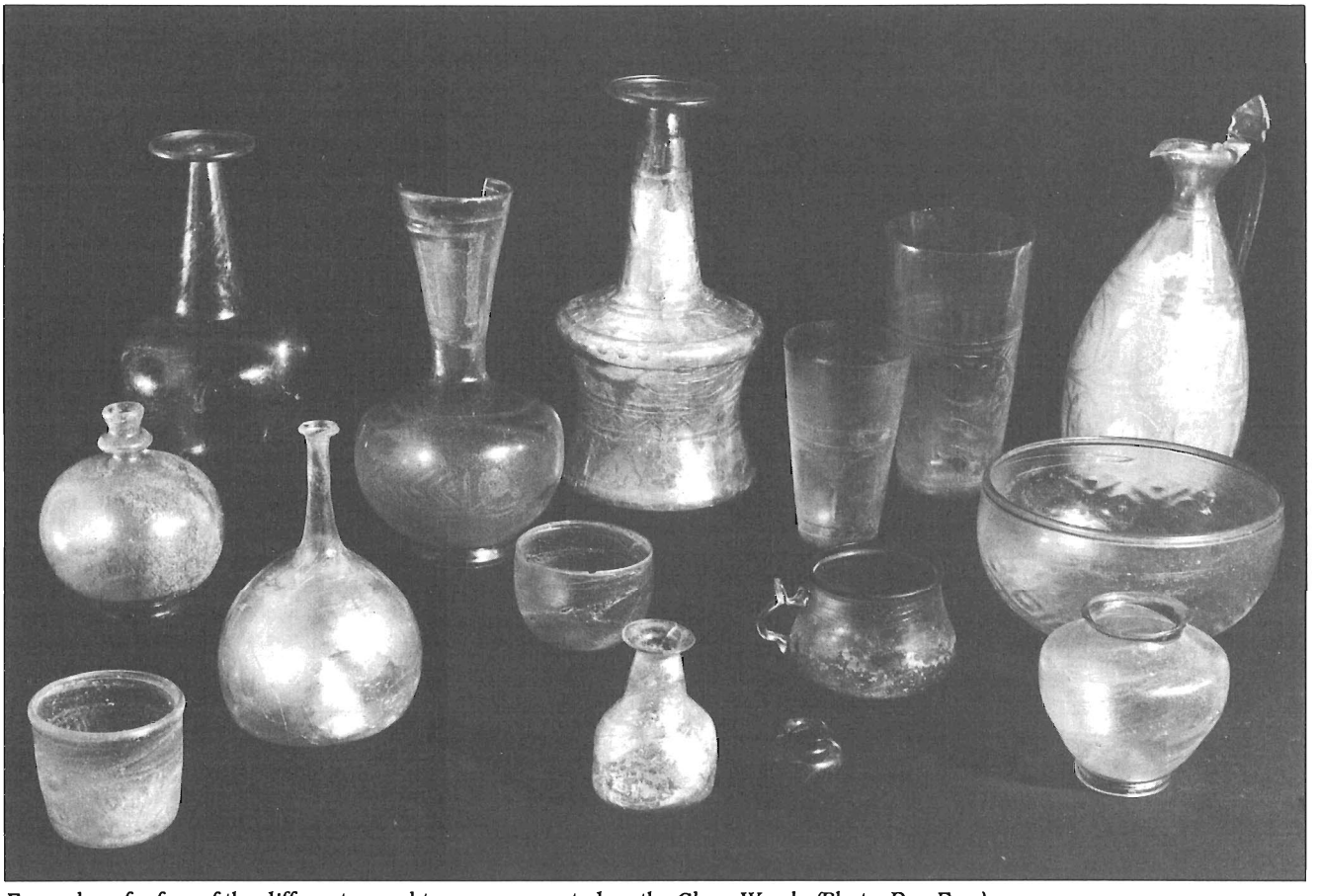
We decided to begin excavations at Serçe Limani in 1977 on the basis of three features noted during a ten-minute dive I made on the site in 1973: a single amphora uncovered and raised to the surface dated the wreck to the 11th century A.D., a period for which we had no firsthand information about hull construction. Because the amphora stood upright and unbroken under the sand, we had reason to believe that the hull of this shipwreck was relatively well preserved under a protective blanket of sediment.

The third feature, chunks of raw glass and the fragments of glass vessels scattered over the seabed, added interest to the site. We thought we might find some more glass, a welcome change from the cargoes of Byzantine amphoras we had excavated during the previous sixteen years.

"Some more glass." We didn't dream that by the conclusion of the excavation, in 1979, we would have brought to light what art historian Marilyn Jenkins calls in Islamic Glass (The Metropolitan Museum of Art, 1986) "the most important find in this medium ever made...revolutionizing our view of a major period of Islamic art history."

We did not dream that we would have more than eighty intact glass vessels—cups and bottles and bowls and beakers in a variety of colors and patterns. Nor did we dream that we would have the fragments of approximately ten thousand other vessels. In addition, there were two tons of raw glass, ready to be melted and fashioned into lamps and ewers and plates and beakers in some unknown glassworks.

But especially we did not dream that more than a decade later we would still have a team of glass-menders, conservators, and illustrators preparing the glass to be studied for our publication of the wreck. And what kind of publication will it be? The rich and famous collection of Islamic glass in the Benaki Museum, Athens, to which most of an entire volume is devoted, comprises only 425 pieces, including fragments. We have in our collection more than 200 different shapes! Joy Kitson-Mim Mack, who is writing her M.A. thesis at Texas A&M on just one of these shapes, the beaker, has cataloged and studied more than 1,200 separate examples from our collection. Margaret Morden wrote her thesis on 250 lamps from the site.



Examples of a few of the different vessel types represented on the Glass Wreck. (Photo: Don Frey)

The glass on these tables represents just a fraction of the glass that is still being sorted and pieced together. To appreciate the task that faces these workers, imagine breaking a thousand glass bottles, bowls and cups, mixing up all the pieces and then trying to put them all back together again. (Photo: Robin Piercy)

The challenge we faced when we began our study in 1979 was mind-boggling: how to make sense of about a million fragments of glass, all scrambled and mostly stuck together in large, concrete-like lumps. We made many false starts during the winter of 1979-80 in the Bodrum Museum of Underwater Archaeology, where director Oguz Alpozen had given us use of the English Tower of the Crusader Castle which houses the museum. There we built tables and shelves and began the job of sorting the fragments by color, pattern, thickness and shape. Once fragments of purple pattern-molded glass with green-threaded rims had been separated from the rest of the shards, for example, we could begin to find joins between fragments of that particular type. And, eventually, we built up entire profiles.

The first year we worked with Texas A&M students, family members, Bodrum volunteers and even a tourist we kidnapped for three cold winter months (Bill Collins seems not to have minded too much; his father, Charles Collins, is now on the INA Board of Directors). Since then we have had up to six Bodrum women spending twelve months a year looking for joins. Fragments which join are held together temporarily with tape, and then placed in styrofoam molds which are cut to fit their curves and support them. Once it seems that no more fragments are to be found for any particular glass vessel, conservator Jane Pannell, or someone under her supervision, actually glues the joins together. In some cases missing fragments are replaced by clear epoxy that is tinted to the same shade as the glass. Each vessel is then drawn with great accuracy by staff illustrator Sema Pulak.

In addition to fairly well-known shapes, new shapes never before seen by modern eyes appear as the glass mending continues. Not only is the glass varied and abundant almost beyond belief, it is also firmly dated to about A.D. 1025 by Islamic weights stamped with the years of the reigns of caliphs of the Fatimid dynasty, and by Byzantine coins of Emperor Basil II. This means that museum curators around the world finally have a base with which to compare and date glass vessels in their collections. "The precise dating and broad scope of this find," Dr. Jenkins states, "are finally making it possible to discuss glass of the Early Medieval period with confidence."

Providing firmly-dated examples of shapes known previously only by undated vessels in museum collections is only one of the benefits of our glass studies. We also are learning about glass manufacture and trade.

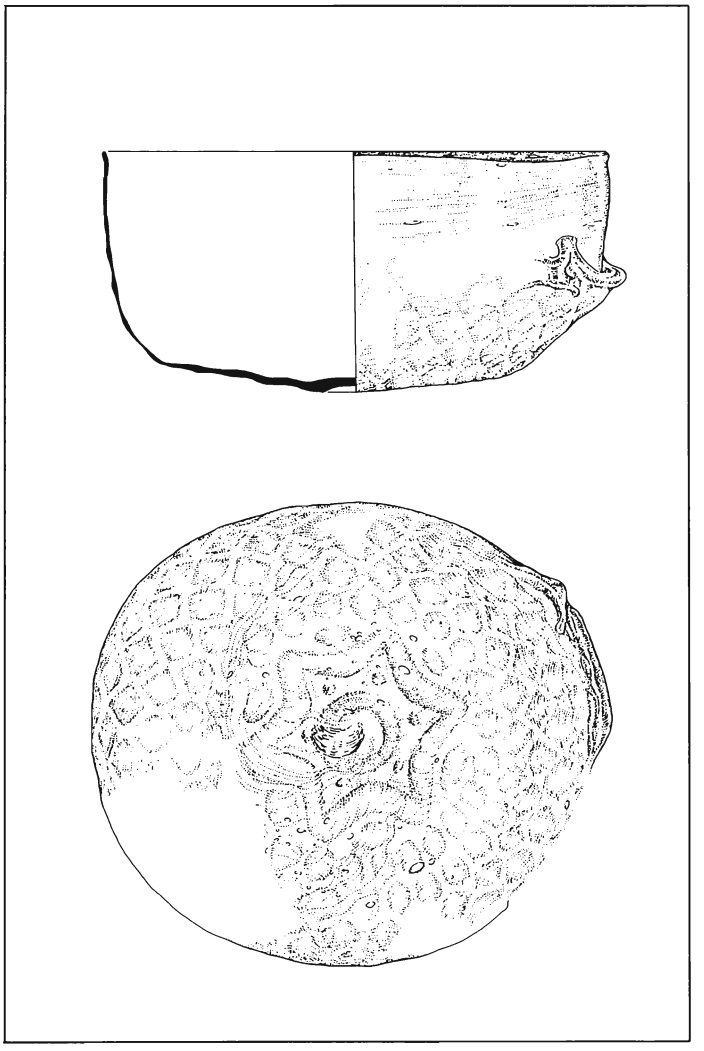
We can now be certain that the glass was not broken as a result of the ship's violent end. Few of the mended vessels have all of their fragments, and some are of such distinctive fabric that it would be impossible for us to have simply overlooked the missing pieces. Further, joining fragments were often found far apart in the ship's cargo hold (we inked onto each shard a number which tells us that shard's find spot on the wreck within 50 centimeters). It seems that the glass was simply shoveled into baskets from a large pile of broken glass and then loaded on board. The glass had been collected for recycling, as today, both from homes (some vessels showed signs of wear on their bases) and from one or more glassworks (some imperfect vessels were discarded before being completed). The 80-odd intact vessels were not found with the

broken glass in the cargo hold, but were found in what seem to be living quarters at the ends of the ship. This suggests that they were ready for sale by one or more merchants on board.

The broken glass and the pieces of raw glass ranging in size from tiny splinters to chunks nearly a foot across were also ready for sale. In Medieval times, as today and in the Classical period, glassmakers added a certain percentage of old, broken glass to the silica, soda or potash, and lime needed for making a new batch of glass.

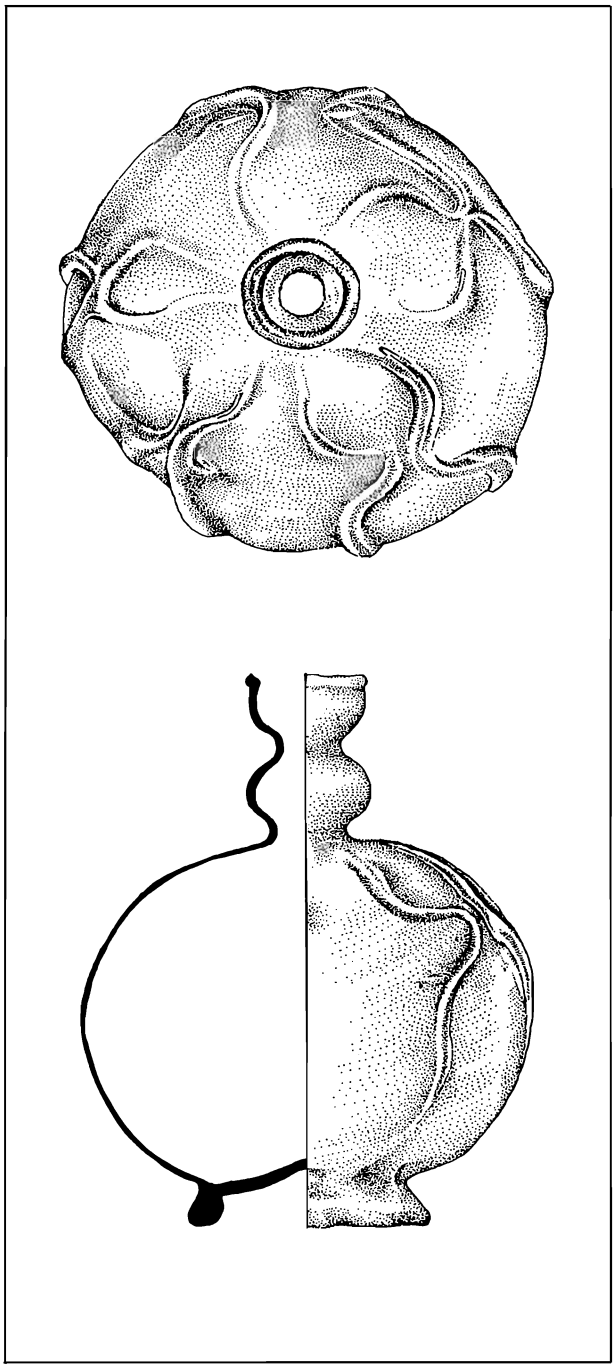
Dr. Robert Brill of the Corning Museum of Glass has shown by chemical analyses that almost all of our glass came from one source, suggesting that it was all picked up at one port. Because the glass does not chemically match the glass from any archaeological excavation, however, that port remains unknown. Lead isotope analysis of the lead content in a few emerald green shards shows the lead to be from northwest Iran, the source of the lead of some of the fishing-net weights also found on the ship, as well as the source of lead in the glaze of Islamic terra-cotta bowls in the cargo. This does not suggest, however, that the glass or weights or pottery were made in Iran, but only that lead was imported from there by craftsmen at our unknown center of manufacture.

Contemporary and nearly contemporary documents describe glass shipments, sometimes giving prices, and in at least one case describing a shipment of broken glass. The study of these documents, continuing chemical analyses, and a study of similar glass found in excavations throughout the Near East will provide our best clues as to the origin and intended destination of our shipwrecked cargo. We feel that a sufficient sample of the Serçe Limani glass has now been mended to allow us to begin our in-depth study of it in the fall of 1989.



This glass bowl with an abnormal bulge in its side, is actually factory waste being shipped for recycling. (Drawing: Sema Pulak)

Gülser Sinaci mends a large bottle pieced together from the broken shards being shipped as cargo. This bottle is probably the largest surviving glass vessel from antiquity. (Photo: Robin Piercy)



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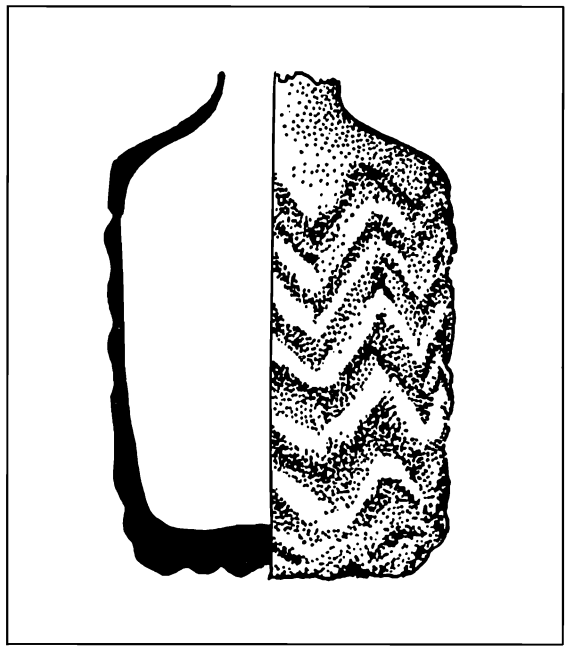

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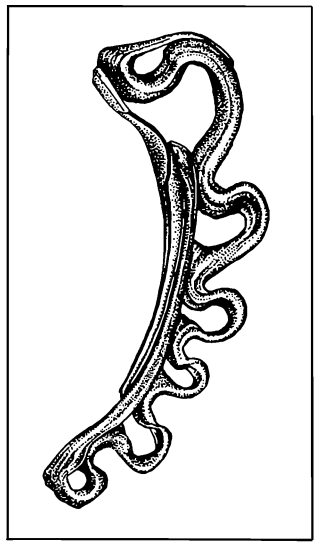

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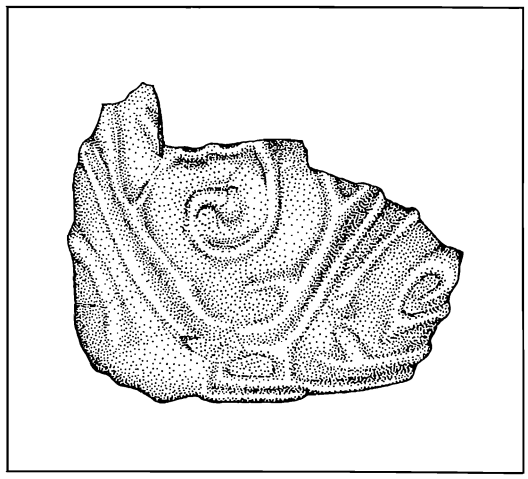


Sema Pulak

An intact decorated flask, a broken "perfume" bottle, the detached handle of a cup, and a shard of patterned glass illustrate the diversity of the glass cargo. More than 200 different shapes are now known from the wreck.

Reconstructing the Hull

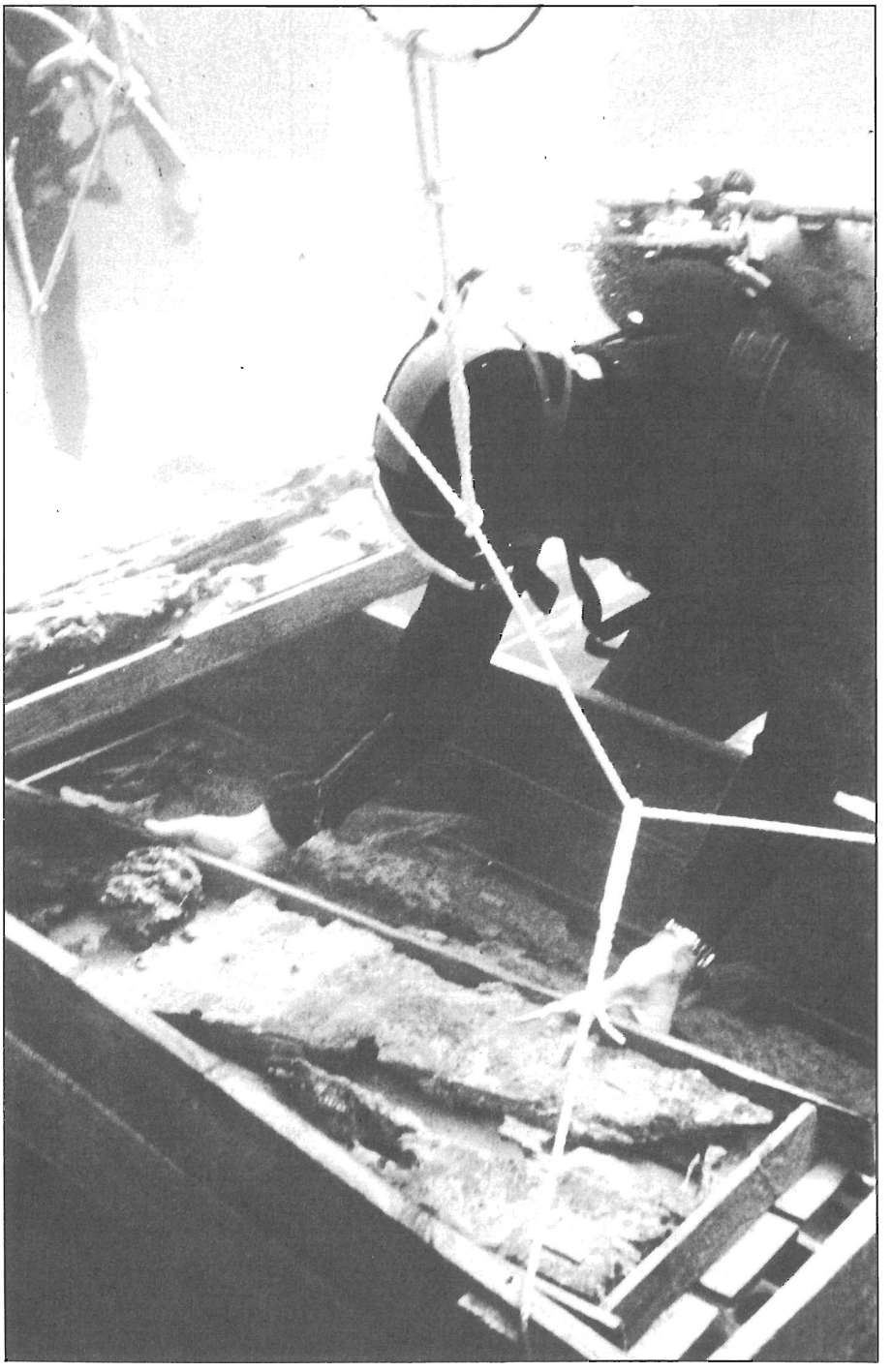
by J. Richard Steffy

Probably not many people got excited when the Serçe Limani vessel was launched. The tubby, lateen-rigged merchantman was neither large, attractive, nor particularly fast, so the event was about as exciting as a new delivery truck coming to town. Nearly a millennium later, however, this little freighter has become somewhat of a celebrity with appearances in newspapers, magazines, television, and now, its very own museum. And why not? It is, after all, the only extant representative of eleventh-century Mediterranean maritime trade, one whose strange design and sparse cargo has posed more questions than it has answered.

Like any other wooden vessel, however, it began as an owner's idea which the master shipwright converted into facts and figures—a 35-ton deepwater vessel with shallow enough draft to navigate shoal harbors and a rig to handle the accompanying lee shores. Sawyers converted trees into tons of timbers and planks which, in turn, carpenters assembled into a broad, boxy hull. Casters and forgers made the anchors, smiths produced thousands of nails and bolts, and there was the work of cordage makers, sailmakers, riggers, caulkers, painters, and others. Many of these people, and probably some of the sailors, passengers, and stevedores who followed, somehow left evidence of their presence on the hull. How well we recreate these processes of building and handling the ship is largely dependent upon the efficiency of our recording and the ingenuity of the reconstructor. But the reconstruction is severely hampered by a subtraction process. We will not have all of the ship to study.

The Serçe Limani vessel probably led a long and active life. It was old enough to have suffered some rotten seams in its bottom planking, and these were cut out and replaced by new planks. What caused the eventual demise of our little trader remains a mystery, but we do have some knowledge of what happened next. The dispersion of sunken ships is a fascinating study, and ours is a fairly typical example. As soon as the hull disappeared beneath the surface, loose gear floated away and some of the rigging must have parted. It settled gently on the seabed, listing slightly to port with its bow pressed into the seabed and its stern perched on a large outcropping of rock.

As time passed, shrouds and halyards let go, masts relaxed, and yards came tumbling to the deck. Nature attacked the intruder with a vengeance as shipworms, decomposition, and currents combined to assault the waterlogged timbers. First deck beams lost their grip on the sides of the hull and, eventually, the deck settled



Reconstruction starts on the sea floor where every piece of wood is labeled. Then the precarious task of bringing it all to the surface begins. Because of the fragile condition of the wood, it is kept in storage tanks of water until conservation can begin. (Photo: Don Frey)

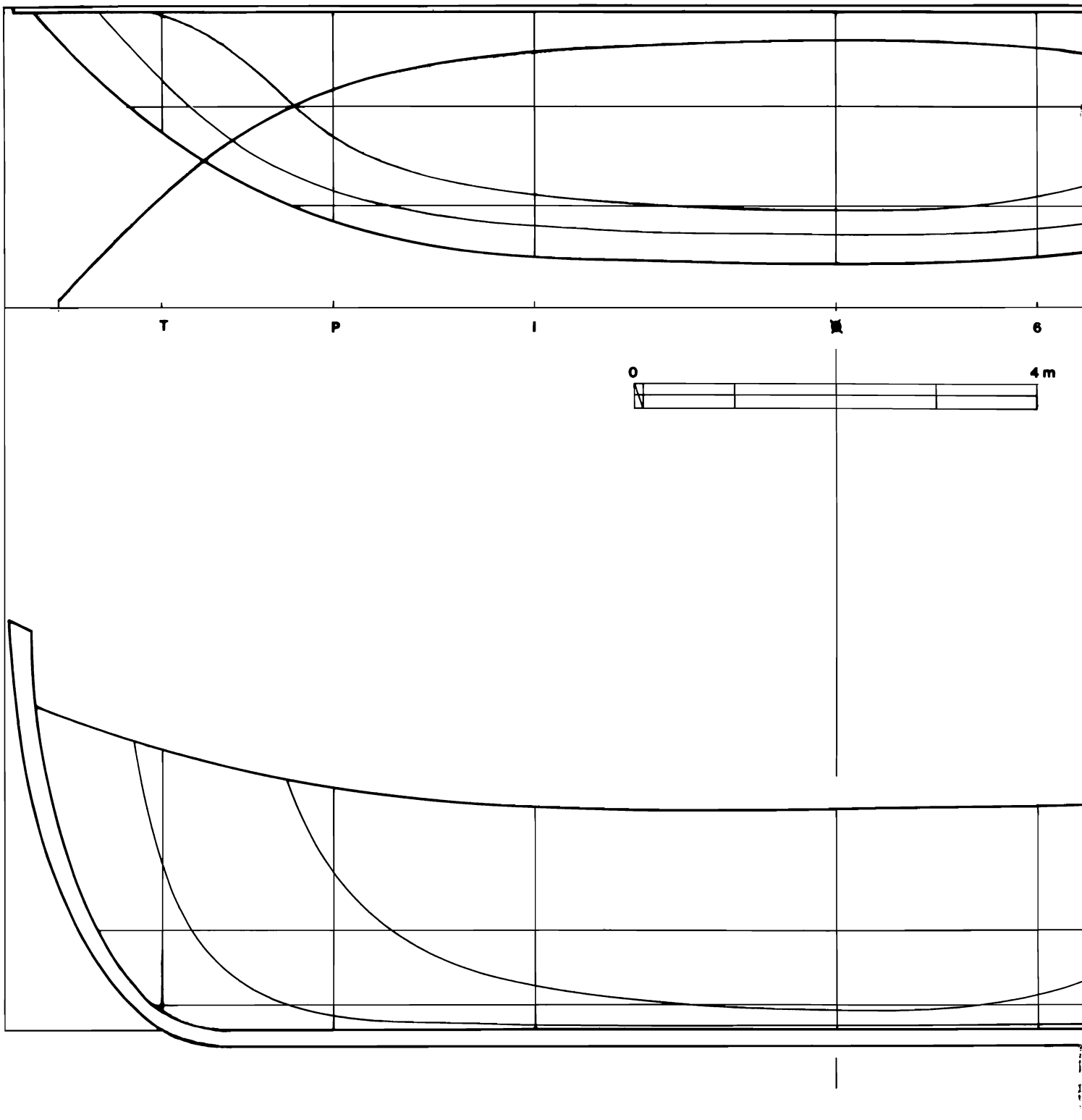
into the hold under the weight of anchors and gear. Masts, or what was left of them, toppled away; the stem released its grip on the bow planking and fell to the seabed. In the stern, too, planking began to pull free of the sternpost, especially on the starboard side, so that now there were big gaps between the sides in both ends of the ship. Without the security provided by beams and posts, the hull sides began leaning outward. It was a slow process at first, but the pace quickened as key fastenings let go, sometimes in fits and starts that projected timber fragments far from their original locations. Eventually the sides of the hull flattened onto the seabed and its bottom, which had been partially suspended by the rock outcropping, did the same thing under the weight of cargo and ballast; the stern still perched atop the rock but the keel now resembled a giant rocker. Teredo and rot continued their attack, destroying most of the bow, starboard side, and the bottom of the stern. But nature often counters her aggression with a little kindness, and now a silting process had begun to cover and protect the flattened timbers. Eventually a truce was reached; twenty percent of the hull was saved from further disintegration by a thick blanket of silt, and the rest disappeared forever. Finally all was still; the lady had died, and only broken pottery marked her solitary grave.

Millions of ships and boats have met a similar fate, although not many of them will ever be found. Of those which are discovered, some are looted for the benefit of a few; the rest are studied for the benefit of all. The Serçe Limani wreck was one of the fortunate ones.

Well-preserved wrecks such as the Kyrenia ship, the *Wasa*, or the *Mary Rose*, are sometimes raised and put on public display. It is an expensive, time-consuming process that is not normally extended to vessels as sparsely preserved as the Serçe Limani merchantman. In such cases, the timbers are often recorded *in situ* and then covered again for the disposition of future generations. In this case, however, the decision was made to raise and preserve the hull remains for a very good reason. This little ship, regardless of the extent of its survival, might supply some valuable information about the dawn of modern naval architecture and its accompanying advances in shipbuilding technology.

From the 4th century B.C. Kyrenia ship and other excavations, it was learned that wooden ships in the classical Mediterranean were built quite differently from those of the later periods of history. Planking was erected before any frames were installed, the contours of the hull being achieved by carefully shaping the planks and constraining them in various ways. Without standing frames to nail the planks against, they had to be held together along their edges with closely spaced mortise-and-tenon joints. Various parts of the framework were inserted only after the planking was completed in the areas they were to occupy. Such vessels had most of their structural integrity contained in the outer shell of planking, the internal structure of frames and longitudinal timbers often serving a secondary role. As time passed, however, internal structures became stronger and less of the hull strength was maintained by the outer planking. By the early 7th century, as determined by

Sheila Matthews painstakingly makes full-size drawings of each face of this piece on clear drawing film. (Photo: Robin Piercy)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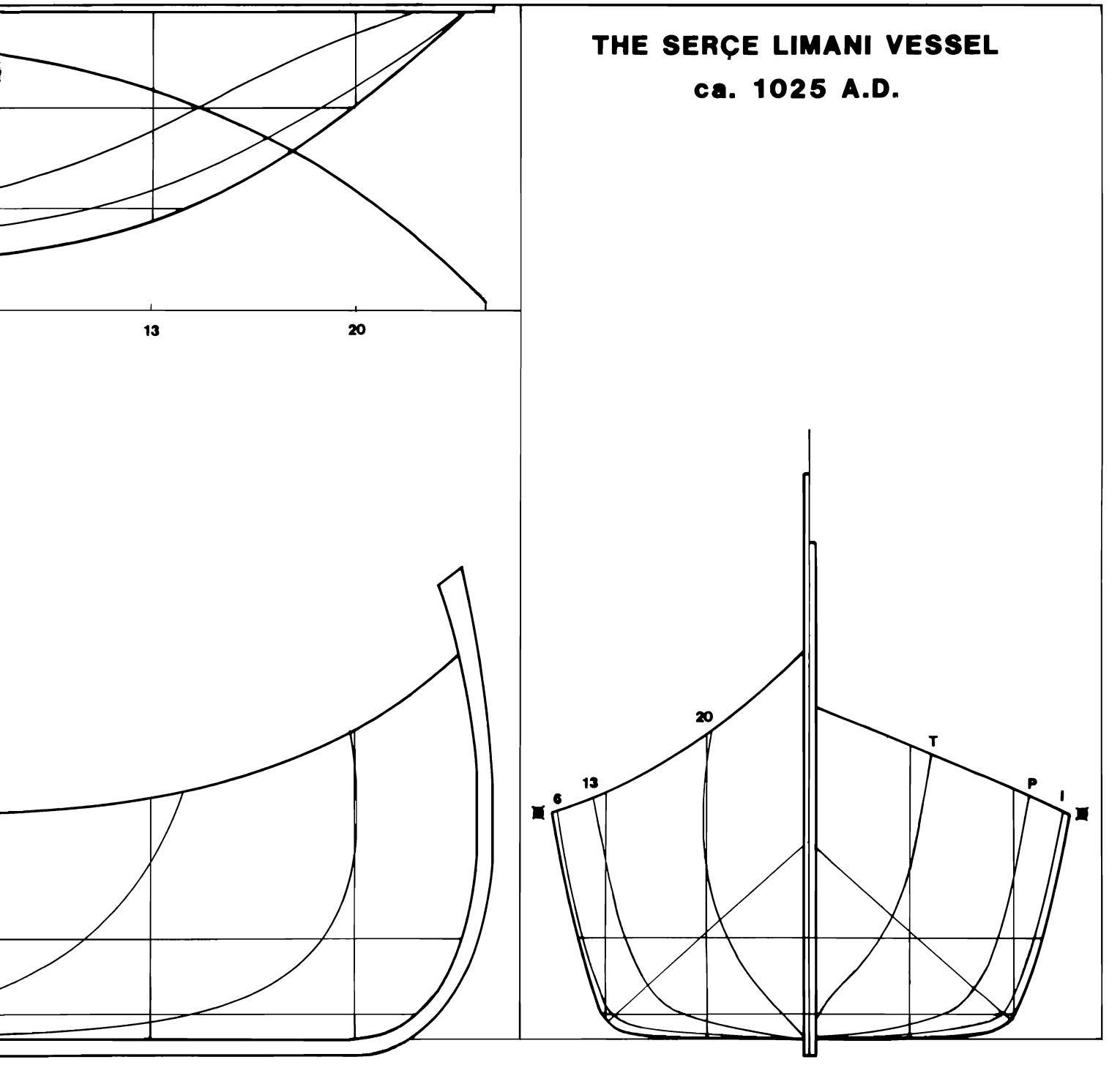
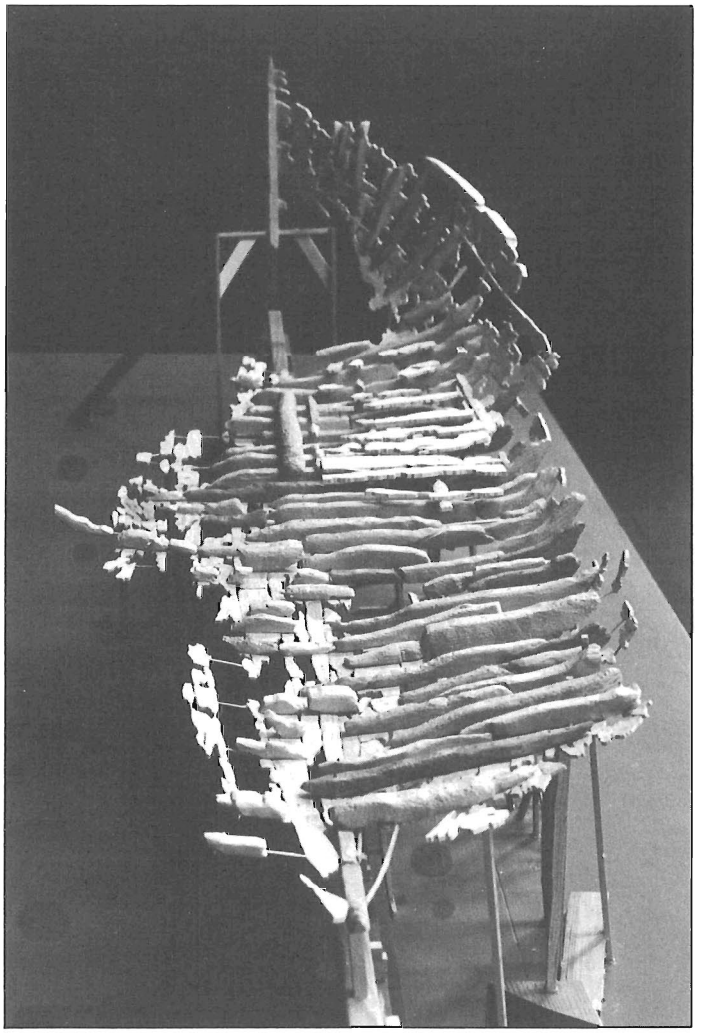


A simplified version of the Serçe Limani lines drawings

Drawing: Claire Peachey



Models are used as research vehicles in the ship laboratory. By dealing with the object in three dimensions, or by actually repeating a construction process, we usually learn much more than we could by graphic or computer-assisted reconstruction processes. (Photo: Cemal Pulak)

the excavation of the Byzantine ship at Yassi Ada, internal structures were quite advanced and the planking was obviously assuming a less important structural role. Mortise-and-tenon joints had become so small and widely spaced that they seemed insignificant, since now they merely aligned planking seams instead of securely locking them together. Probably by this time some ships were already being built with a few frames erected before the planking was installed, while other builders may have been more inclined to retain older methods. One thing was quite obvious; there was a transition underway from ancient shipbuilding methods to more modern ones. But how, precisely, did that transition take place, and what changes in mathematics, economics, technology, and other factors caused the transition or evolved from it? The Serçe Limani wreck, dated four centuries after the Yassi Ada ship and lacking any mortise-and-tenon joints at all, seemed to hold some of the answers. Clearly it was necessary to raise and preserve the timbers for a far greater scrutiny than they would provide us on the seabed. The chance to reassemble it and make it available to future scholars came with the Turkish government's offer to build a museum featuring medieval seafaring and shipboard life, in which the remains of the hull would form the central theme.

Reconstructions are only as good as the information upon which they are based, and for ships that means a lot of information. Artifactual data, site plans, excavation records, and hundreds of site photographs were assembled and studied. By the end of 1978, most of the wood had been transferred from the site to freshwater storage tanks in the castle in Bodrum, where a preliminary study of the hull remains began. For two months we studied and initially recorded key hull members—those frames, planks, keel pieces, and other timbers which we felt best described the surviving areas. From this initial examination we could make a very basic assessment of hull construction and the condition and extent of its remains, enabling us to plan research, conservation, and the design of the new museum.

This information was taken back to our headquarters at Texas A&M so that research could begin there while Sheila Matthews began the thankless task of making full-size drawings of each surface of every fragment of wood in the tanks in Bodrum. Anyone who has done this type of work will appreciate the seemingly endless effort of placing a sheet of stiff clear plastic on glass positioned directly over the fragment and drawing outlines, tool marks, nails, treenails, impressions made by adjoining timbers, areas of pitch and erosion, as well as every other detail that could be seen on the wet wood. It was a particularly difficult task in winter, when the damp cold of the castle was intensified by the constant need to keep the wood wet, or yet another fragment had to be fished from the depths of the concrete storage tanks. Now and then Sheila had help from a resident staff member or visiting student, but most of our drawings bear her signature. While the drawings were being made, Don Frey made black and white photographs of the same surfaces.

In Texas, the laboratory reconstruction began almost as soon as the wood recording in Turkey. The design of the vessel was unlike any we had seen before, the distribution of surviving hull remains seemed curious at the time, and the amount of cargo was a complete surprise. Ships are usually found with full or nearly full holds, but this wreck did not seem to have enough cargo and ballast to maintain stability. And so, as is frequently the case, we turned to models for the solutions to our problems.

Models are used as research vehicles in the ship laboratory. By dealing with the object in three dimensions, or by actually repeating a construction process in three dimensions, we usually learn much more than we could by graphic or computer-assisted reconstruction processes. Consequently, any large ship project in our laboratory is likely to be developed with a series of models which help to determine design and structural arrangements. In this case it was decided to begin with a model of the site itself in the hope that some of the questions about cargo and hull distribution could be answered. The result was a 1:10 scale model of the shipwreck as it was found on the seabed, with which we could study, even reenact, hull dispersion and relate the cargo to the original hull structure. Such a model would hardly be necessary for a well-preserved wreck or even one with a higher ratio of cargo to surviving hull area, but here it was extremely successful; we now knew enough to proceed with the actual reconstruction.

As Sheila's drawings and Don's photographs arrived in College Station, they were converted to descriptive catalogs and 1:10 scale drawings. From this information 547 key plank and frame fragments were reproduced in wood to the same scale, with all broken and eroded edges, nail locations, and other details accurately duplicated. These were used to build a fragment model, an assembly which permits us to convert the fragments from their seabed state into a three-dimensional orientation. Using the site diorama, wood drawings and catalogs, and a complex reconstruction process which is now taught to nautical archaeology students at Texas A&M, the little model was gradually assembled into the shape illustrated here. The model also supplied valuable informa-

After conservation, the hull fragments were reassembled in the Bodrum Museum. None of the pieces was fastened permanently at first to allow for adjustments as reconstruction progressed. Nail holes in planking fragments were carefully matched with those in the outer surfaces of frames before the planking was tied to the frames with white string. (Photo: Don Frey)

tion for the reassembly of the original hull fragments which was to follow.

From the fragment model it was possible to develop a set of hull lines and structural drawings which, along with the information we learned from the study of the ship, were published in various scholarly and popular mediums.

By now it was 1981 and the hull remains had begun their treatment process in baths of polyethylene glycol in Bodrum. Until that process was completed, hull research could not proceed any further. That does not mean that all was quiet in the ship lab, however, since we always have several projects underway simultaneously. These were the years in which research on the Kyrenia ship's hull was completed, resulting in the publication of that information and the drawings from which *Kyrenia II*, its replica, was built (see *Newsletter 13/3*). The Athlit ram and bow timbers, the *HMS Charon*, the 1st century A.D. Herculaneum boat, and a number of smaller projects were also investigated during this period.

During the summer of 1984, the first Serçe Limani wood was removed from the conservation tanks and cured by reducing its temperature slowly over a long period of time. Later that year the new museum building was completed in Bodrum. Now a more thorough recording and research program could begin, as well as the reassembly of the hull remains. The initial examination of the hull was based on a study of wood fragments which could only be examined on a limited basis because of their extremely fragile, waterlogged state. Some of them were entirely concreted and could not be recorded at all. Once treated and cleaned, however, these fragments were quite stable and could be examined for hours at a time without fear of further deterioration. They could be measured more carefully for curvatures, assembled with adjoining pieces, and studied under oblique light for tool marks and additional fastenings. Consequently, all fragments were examined again. Nails which were missed the first time, details which could not be seen in the waterlogged state, and dimensional changes due to the conservation process were added to the catalogs. In some cases, new drawings were made to better illustrate details. Wood catalogs and drawings must address every possible subject, since we are looking for information about tools, technology, economics, human disciplines, and many other features in addition to the vessel's construction.

As soon as the recording was underway, work began on the reassembly of fragments. Hull parameters were marked on the museum floor, a keel centerline was established, and the location of transverse hull stations noted. Next, temporary scaffolding was made in modules from common framing lumber; keel scaffolds were erected first, then expanded outward in all directions as required to support the assembly of plank and frame fragments. None of the wooden pieces was fastened permanently at first as it is impossible to perfectly reconstruct a ship with drawings and scale models; therefore, the likelihood of some variation from the preliminary reconstruction was expected. By employing flexibility in the supporting system and testing the joins of large areas of the hull, we were, in effect, permitting the ship to tell us how it wanted to go together.

The importance of this standard procedure was illustrated by an error in our original reconstruction of the keel. All of the keel pieces had a slight curvature which, when assembled on the fragment model, produced a curved, or rockered, keel. Even when we made a test assembly of the original keel pieces on the museum floor this seemed to be the case; since all broken ends fit together quite well, they were erected on the scaffolds in this rockered orientation and planks and frames added to them. By the time the fourth strake of portside planking was added, however, we began having trouble fitting the fragments in the after half of the ship. As work progressed, it became evident that the curvatures, in angles and contours too small to be detected on the models and drafting boards, would not go together exactly right. After considerable investigation, we determined that our problem lay in the first fragments assembled—the nine keel pieces. The entire assembly was torn down and the keel pieces laid in a horizontal orientation, even though their broken ends no longer fit together properly. The rest of the structure was then reerected without trouble. Since then it has been determined that the keel, which was originally straight as an arrow, became permanently rockered because the stern of the ship was perched on a rock and the hull, in settling to the seabed, assumed a rockered bottom.

Coarse softwoods, such as the pine of which most of the Serçe Limani hull is made, do not usually bend without cracking in a waterlogged state. Because this hull went through so many distortions during its dispersion, pine planking and frames have broken into many small pieces or cracked badly where they were distorted. But some finer grained hardwoods can bend without telltale cracks when waterlogged. Our elm keel, the only piece of hardwood on the ship, did just that, expressing its final, rather than its original, curvature. Without reassembly of the hull remains, that feature would have been misunderstood forever.

After about two-thirds of the fragments had been properly assembled with temporary attachments, permanent fastening began. In most cases the pieces have been attached to each other with thin, flexible stainless steel rods to permit movement of the hull in the event of serious humidity changes or vibration. In a few cases, treated dowels, toothpicks, or other appropriate fastenings have been used. None of the original fastenings could be reused.

In many cases, trial assemblies of groups of fragments were done in corners of the museum, or details had to be worked out on models and drawings. Now most of the remains have been erected, and the wooden scaffolding is being replaced with more aesthetic permanent steel supports. The keel was placed one meter above the floor to permit interested visitors to study the bottom of the hull. Fred Hocker, a nautical archaeology student with previous training in shipwrightery, spent his past two summers constructing a three-meter-long sectional replica of the starboard side from the middle of the ship aftward. Few hull remains survived in this area. The replica, which was built in a separate area of the castle, has now been installed in its proper place within the reassembly and will eventually be loaded with original cargo and ballast as described elsewhere in this newsletter. Unlike the Kyrenia ship and other well-preserved reconstructions, the Serçe Limani hull remains are not intended to illustrate the complexity or extent of the original construction. Instead, they will serve as a three-dimensional source of information for generations of scholars interested in this form of transitional shipbuilding and, along with cargo and artifactual material, will emphasize to all visitors the importance of archaeological research.

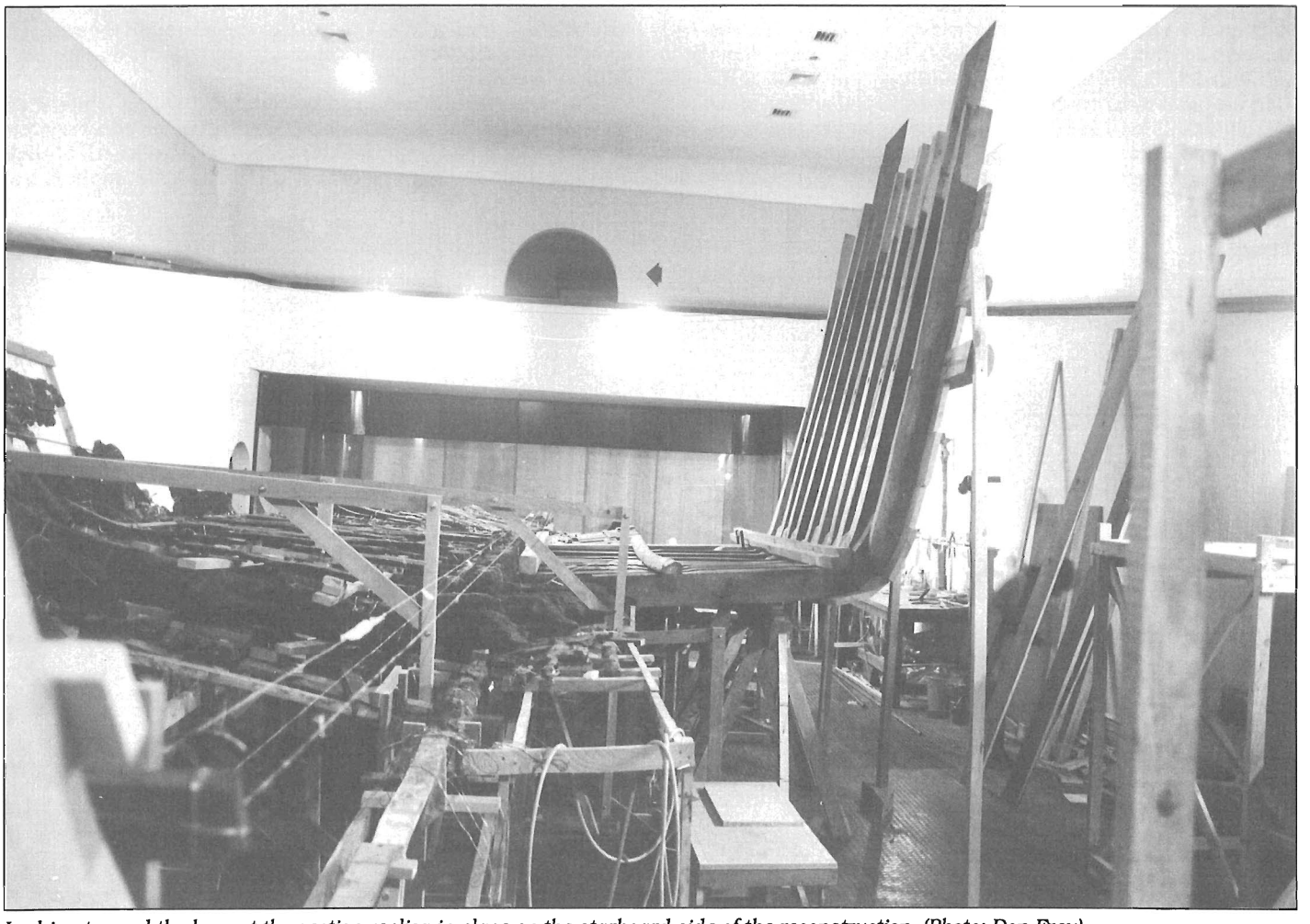
Back in Texas, dozens of final drawings illustrating the details of the vessel's construction are being prepared for an interim report, soon to be published, and an elaborate final report. Research continues in those areas where new questions have been raised or old ones remain unanswered. Details are being worked out on a final research model, complete in every aspect which, when it has terminated its usefulness in the laboratory, will be rigged and sent to Bodrum where it will be placed alongside the reassembly.

The Serçe Limani vessel has added considerably to our knowledge of medieval ship design, construction, and operation. It is most certainly an early example of modern forms of naval architecture, where simple geometric projections and ratios are used to predetermine the rising of the bottom and narrowing of the hull sides. We have detected a unit of measurement, perhaps representing the length of the shipwright's palm or some other favorite dimension, which he might have converted to formal use by marking that unit, and increments or multiples of it, on whatever he used as a measuring device. The frames were spaced in multiples

of this unit, and timbers and planks were rough cut to increments of it.

The shipwright began his task by selecting dozens of trees whose larger branches angled away from the trunks in just the right direction. These formed the knees—naturally grown angles—which described the sharp curvatures at the ends of the keel, the turn of the bilge, and the supports for the juncture of major timbers. The keel was made of elm from three pieces of wood, which were joined together with flat scarfs. The ends of the keel curved sharply into the stem and sternpost, the latter curving gracefully back into the hull. When the keel and posts had been properly set, a pair of midship frames were completely assembled and erected. Afore and abaft of these frames our builders located and erected eight floor timbers, the lower portion of the frames which crossed the bottom of the hull and curved upward for a short distance into one side of the hull or the other. These floor timbers were alternated, one with its knee, or sharply-curving end, on the port side and the next curving to starboard. That seems to be all the frames erected before planking was begun although, as the planking proceeded, temporary braces (called cleats) were erected to control the hull shape. The locations, heights, and angles of these cleats seem to have been selected by a predetermined measurement, although we have yet to prove exactly how that measurement was derived. After four planks described and secured the bottom of the hull, our builders erected a single, broad side plank, after which some additional frames were installed in much of the rest of the hull. Only after the side planking and framing was completed did they install the rest of the planking between the bottom and broad side strakes. A pair of heavy wales, nearly four times as thick as the planking, clamped the hull at and above the waterline, curving into the stem and stern with exceptional steepness.

The vessel was about 50 feet long, 15 feet broad, and carried between 30 and 35 tons of cargo when full loaded. There is evidence that the ship was propelled by two lateen sails, a favorite medieval Mediterranean rig. It had an exceptionally full hold and flat bottom, and its bottom curved into the sides so sharply that the hold was almost rectangular. The small keel and heavy keelson are among the many features that suggest this vessel was designed to navigate shoal harbors, and perhaps river channels, as well as to perform deepwater service. Literary evidence from the tenth and eleventh centuries hints at craft such as this—small, handy little traders which could accompany larger vessels and relay their cargoes into shallow harbors or, when appropriate, operate independently. Research continues on some of these subjects and, hopefully, many more answers will eventually be surrendered by this mysterious little ship.



Looking toward the bow at the section replica in place on the starboard side of the reconstruction. (Photo: Don Frey)

THE AMPHORAS: Old Jars from the North

by Frederick van Doorninck, Jr.

With possibly two or three exceptions, all of the amphoras from the Serçe Limani ship are Byzantine and belong to well-known amphora types that were in common use during that period. They include 89 piriform amphoras, six very small vessels with a pointed bottom, and six amphoras with a slightly concave bottom (Fig. 1). All three types have been found in South Russia and throughout the Balkans, while examples of the first two types have been found in Syria and examples of the first type in Egypt.

At first, these amphoras left us very puzzled. What were Byzantine amphoras doing as part of the cargo of a ship that apparently had sailed westward from a Fatimid port into Byzantine waters? The answer to this question finally came only three years ago when a detailed study of the amphoras began to reveal that they had not been new at the time of their final voyage.

Evidence of this occurs among the amphoras of all three types but is particularly prevalent among the piriform amphoras, probably because they have the softest fabric and are more easily damaged. At least 64 of the piriform amphoras have rims that had undergone damage before the ship's sinking. Such damage is recognizable because it occurs primarily on the inside of the rim, is in the great majority of cases confined to one or both of the two rim quadrants located between the handles, and in many cases was caused by one or more vertical grooves cut into the rim's inner surface. This damage appears to have occurred as the result of someone prying out a stopper with a pointed object with one hand while holding one of the amphora's handles with the other. In at least four instances, pry damage became so severe that the rim was subsequently carved down to reduce unevenness.

Pre-shipwreck damage to some of the piriform amphoras was of an even greater magnitude. Fifteen are missing a handle (Fig. 2), and two or three were devoid of both handles and the entire neck. Not only were none of these missing parts found during excavation, but in a majority of cases where stumps of handles had remained, it is clear that they had been carved down into rounded knobs, while in one instance where the neck is missing, there is also evidence of the removal of uneven edges through carving (Fig. 3).

One of the amphoras had lost not only both its handles and neck but also all of its exterior surface (Fig. 4). That this surface loss had occurred prior to the shipwreck was revealed by the fact that the surface was gone even where some pitch was adhering to the outside of the amphora. Was this surface deterioration the result of some earlier use? We hope that chemical analysis of the amphora's fabric will yield an answer.

The piriform amphoras had been painted with a white wash when they were made, and one of them had received a new coat of wash after it had been used for an appreciable length of time. The new wash had covered over two graffiti on the amphora and

Figure 1

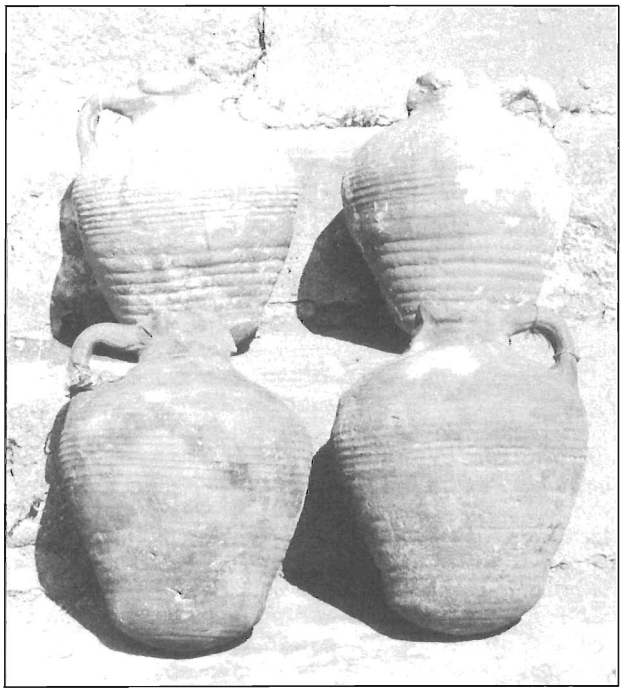


Figure 2

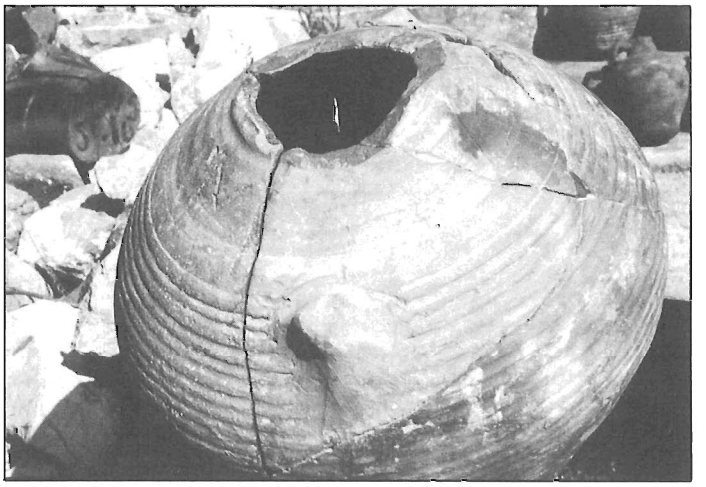


Figure 3

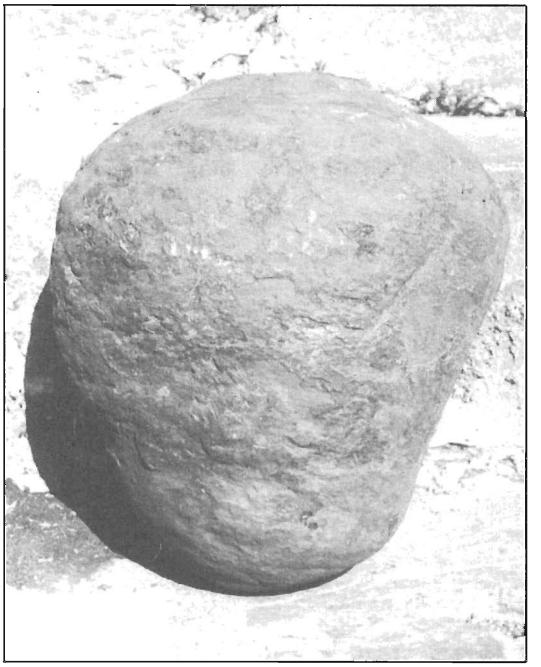


Figure 4

some areas of pry damage on the rim. The amphora's surface underneath the wash is worn and pitted.

It appears clear from the evidence just outlined that many of the amphoras had seen multiple reuse as transport jars. By late medieval times, the amphora was no longer the principle transport container, as it had been in antiquity, and one suspects that such reuse had become a commonplace response to their decreasing availability.

As one might expect, the great majority of these amphoras have graffiti carved on them. The graffiti of greatest interest are those that appear to be marks of ownership of merchants involved in the ship's last voyage. These graffiti tend to be larger and more deeply carved than the others, and amphoras bearing any particular one of these marks appear to have been stowed together on the ship. For example, five amphoras bearing the name Leon (Fig. 5a) were all found together amidships. The most frequent of these marks of ownership is the letter M (Michael?). It appears alone on 25 of the amphoras but also occurs in four cases with one of four other marks joined to its left leg. All four of the latter marks also occur alone at least once on other amphoras. Business associates may be involved here. Another relatively frequent mark of ownership (Fig. 5b) also occurs on a small amphora of unique type on the ship and on some of the cooking pots belonging to the ship's cargo. Very close parallels for some of the marks of ownership, including this one, occur on medieval Bulgarian pottery. This suggests that at least some of the merchants with cargos on the ship may have been from the western Black Sea region and that the ship's destination may have been located somewhere within this general area.

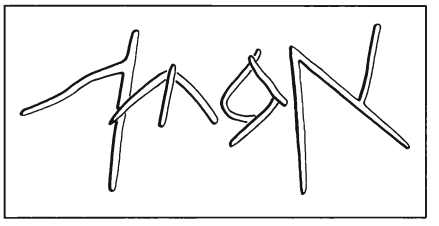


Figure 5a

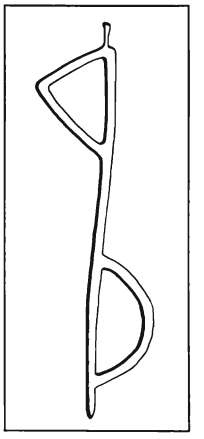


Figure 5b

THE ANCHORS:

A limited technology, A sophisticated design

by Frederick van Doorninck, Jr.

The Serçe Limani ship was carrying eight iron anchors when she sank. Five were spare anchors stacked on the deck between the two masts. The remaining three were bower anchors mounted on the bulwarks in the bow ready for use, two on the port side and one on the starboard side. Perhaps an anchor of like size and design found on the seabed near the wreck is the other starboard bower. If so, it was probably the cause of the ship's untimely end, since its shank had been broken while it was being used.

The anchors have apertures for removable wooden stocks, straight arms that form obtuse angles with the shank, and spade-shaped teeth set at right angles to the arms (Figs. 1 and 2). Anchors of this Y-shaped design were unknown until just two decades ago and when first found were thought possibly to be a type of anchor used primarily by the Arabs. We now know, however, that they were widely used in the Mediterranean and in the Black Sea, and Gerhard Kapitän, the well-known German nautical archaeologist, has recently demonstrated that these anchors in fact represent the last stage in the evolutionary development of the ancient iron anchor in the Mediterranean world.

The earliest iron anchors presently known date to the Hellenistic period. They imitate the ancient wooden anchor in form, having straight arms set at an acute angle with the shank (Fig. 3A). As time went on, however, the arms evolved into a more and more open shape. By the time of Christ, the arms had become lunate in shape (Fig. 3B), by the 4th century, straight and perpendicular to the shank (Fig. 3D), and by the 9th or 10th century, the Y-shaped anchor had begun to appear (Fig. 3E). Kapitän has suggested that one reason for this evolution had been a need to design anchors that broke out from the seabed more easily when lifted. However, our study of the anchors from both the Serçe Limani and the 7th-century Yassi Ada ships has led us to conclude that the primary impetus behind this evolution was a desire to minimize the length of the anchor shank. By increasing the openness of the arms, the shank length could be decreased without at the same time decreasing the distance between the teeth and the stock and consequently the stock's leverage in forcing one of the teeth down into the seabed.

Figure 1

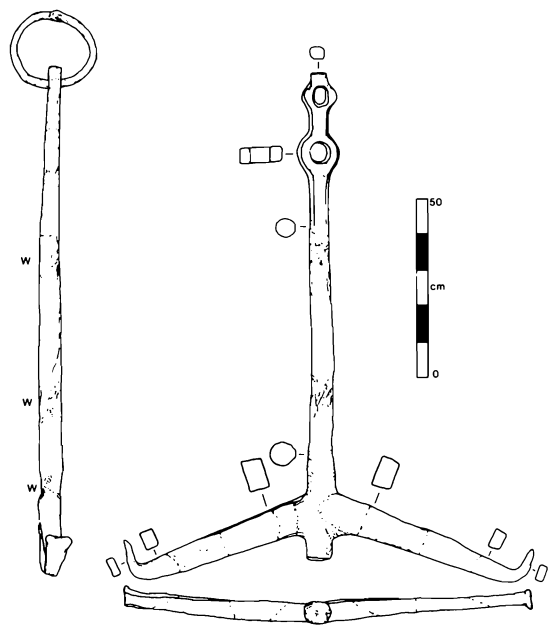
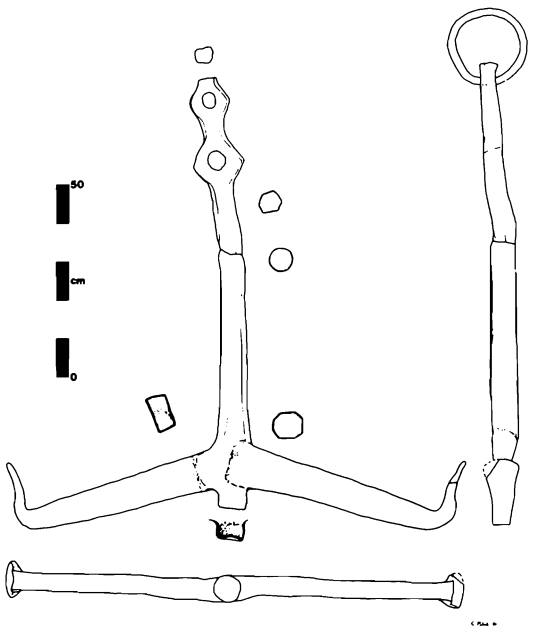


Figure 2



The need to minimize shank length was a consequence of the limited technology generally available for the manufacture of iron anchors in the ancient and medieval Mediterranean world. A closer look at the Serçe Limani anchors will reveal why this was so.

The anchors, which weigh only from some 50 to some 60 kg each, appear normally to have been fabricated from 15 pieces of iron forge-welded together, each piece weighing about 4 to 5 kg. Either arm was made of four pieces; the shank, of six pieces; and the ring, of one piece. As can be seen in Figure 1, the four pieces in either arm were forged together end to end. The middle weld was nothing more than a butt weld, while the other two welds were diagonal scarf welds. The shank pieces were also joined together by diagonal scarf welds. The inner ends of the arms partially overlap the shank on opposite sides, and the three components were welded together through hammering the arm ends against the shank and the shank against the arm ends.

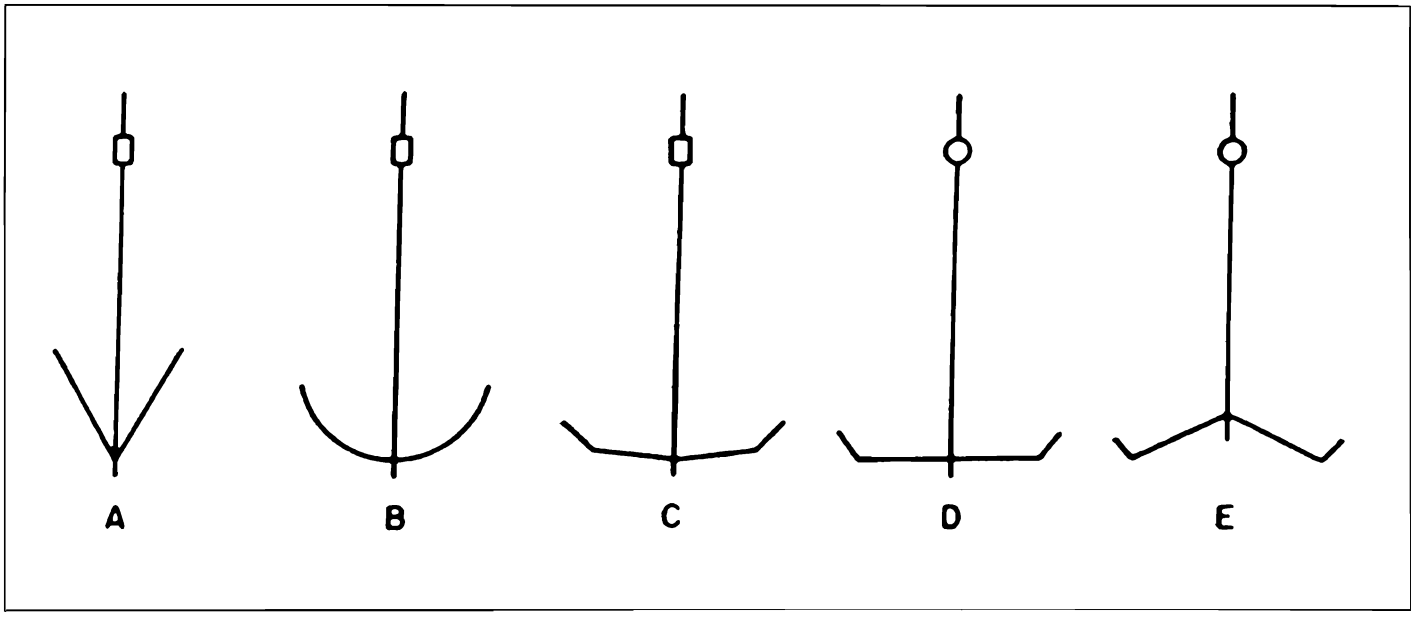
The smaller an anchor's cross-sectional dimensions were made, the easier it was to hand-forge welds that were sound and not likely to break. This is undoubtedly the basic reason why ancient and medieval ships of any particular size carried the thinnest, lightest iron anchors possible. To compensate for anchor lightness, it was normal practice to use a number of anchors simultaneously. Thus, for example, the 7th-century Yassi Ada ship carried four bower anchors ready for use, and it is very likely that the Serçe Limani ship did so as well.

Samples of unoxidized iron from the Serçe Limani anchors have been analyzed at the University of Pennsylvania by Drs. Robert Maddin and Tamara Stech. They report that the anchors were made of a soft bloomery iron that is, however, often rendered brittle by inclusions of slag, creating zones of weakness that made the anchors prone to breakage. Analysis of samples from one of the 7th-century Yassi Ada anchors revealed that the iron of that anchor was of an identical structure.

It is easy to see, then, why the ancient iron anchor underwent the evolution in design that it did. The shorter the thin, brittle shank of an anchor was made, the less chance there was that the shank would break. Even in the case of Y-shaped anchors, however, shanks frequently broke under stress. As has already been noted, the breaking of an anchor shank may even have caused the sinking of the Serçe Limani ship. In any event, it is clear that the shanks of at least three of the ship's anchors had been broken sometime earlier and had then been repaired (Fig. 2). In one instance, the repaired anchor appears to consist of the upper part of one anchor and the lower part of another. In the other two instances, the two parts of the broken anchor were simply forge-welded back together. That it had been possible to retrieve both parts of these anchors when their shank broke was probably due to the normal practice of fastening a buoy line to the bottom of the shank to mark an anchor's location.

The Y-shaped anchor was the evolutionary product of over a millennium of seafaring experience. A strange-looking anchor to modern eyes, it was a sophisticated design in its time, but became outmoded by the advent of an improved iron-making technology toward the end of the medieval period, was replaced by the modern iron anchor with lunate arms and fixed wooden stock, and was totally forgotten. Nautical archaeology is now restoring it to its rightful place in maritime history.

Figure 3



A Medieval Arsenal

by Joseph K. Schwarzer, II

In addition to the cargo of glass and amphoras, the remains of many iron objects were recovered from the Serçe Limani shipwreck. Unlike lead or bronze, iron deteriorates rapidly in sea water. As the iron dissolves, an electrolytic reaction occurs, and a rock-hard shell of calcium carbonate is deposited around the object. Eventually, the metal completely rusts away leaving a cavity which corresponds to the exact dimensions of the original artifact. Archaeologists recover and desalt these lumpy concretions (essentially negative molds), then break them open for cleaning before filling the cavities with liquid epoxy. After the epoxy hardens, the calcium carbonate shell is removed to reveal a plastic facsimile of the original object. Since 1981, this process has yielded a remarkable range of artifacts including unique assemblages of weapons and tools from the 11th century Glass Wreck.

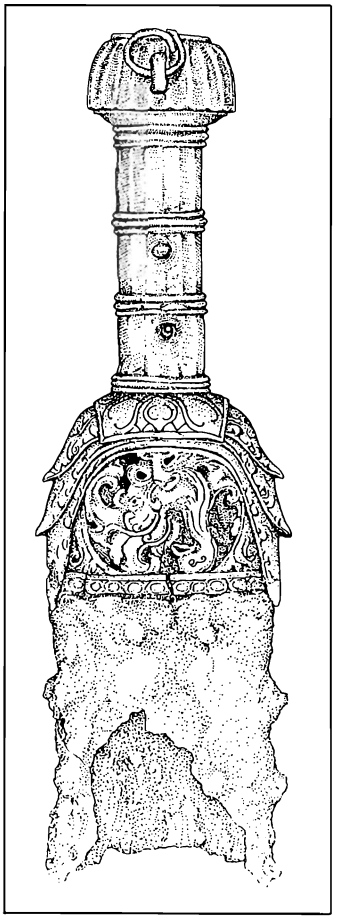
Weapons

Fifty javelins, twelve spears, and fragments of two or three swords were recovered from the site. Assembled in the early 11th century A.D. and preserved in an undisturbed archaeological context, this arsenal is an important discovery. Aside from furnishing data pertaining to patterns of trade and general economic systems of the Eastern Mediterranean, a comprehensive analysis of this armament should provide more precise chronological and typological controls for the study of medieval weapons as a whole.

The typological range and corresponding function of medieval pole arms have attracted limited scholarly interest and continue to be poorly understood. Of the 62 examples recovered from Serçe Limani, there are at least ten distinct variations, two of which have never before been recorded in any Western medieval context. Observations made in the course of conservation suggest that the total ensemble may have been divided into specific units ranging from pairs of javelins to groups including one or two spears and five to seven javelins.

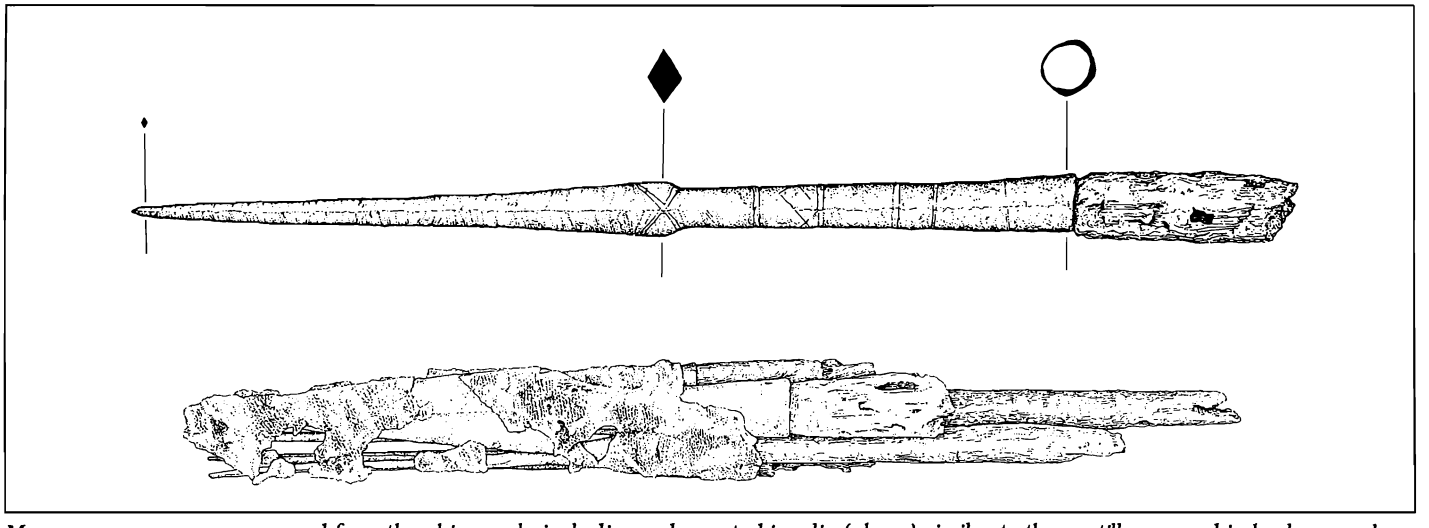
Does this reflect purposeful arrangement or an accident of deposition? How do the weapons relate to the site: are they cargo or ship's stores? If they represent the armament of the vessel, does the ordering of weaponry reflect the number and status of crew members or the presence of men-at-arms? The resolution of these questions will provide a new perspective on the logistics of early medieval maritime trade.

The edged weapons from Serçe Limani present a very different problem. Unfortunately, the remains of these weapons are so fragmentary that it is quite impossible to determine the exact number of swords which were on board. Although none of the blades and only one bronze hilt survived, the concreted remains of scabbards indicate at least two or three swords on the ship. Two of the blades were clearly straight and double edged. However, the remains of a third suggest a curved blade. If so, this would be the earliest of its type yet discovered in a medieval context.

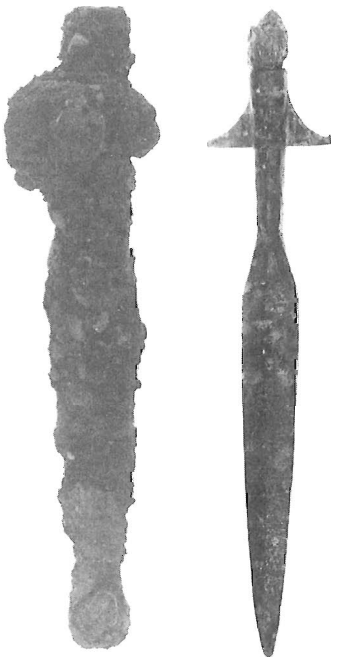


The hamsa bird that decorates this bronze sword hilt has parallels in India, but may be an Islamic adaptation of the motif. (Drawing: Sema Pulak)

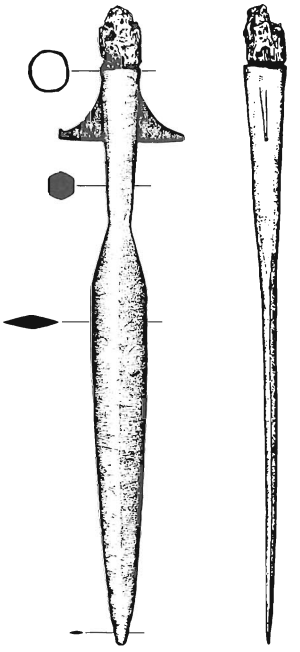
Similarly, the bronze hilt recovered from the site in 1977 is a unique find requiring precise morphological and iconographical analysis. The large pommel, compartmentalized grip, and solid arched guard of this hilt are design elements which denote a close affiliation with late Roman types and continued to be used in the East and West well into the 15th century. Nevertheless, the exact source and development of this hilt form is not clearly understood.



Many weapons were recovered from the shipwreck, including a decorated javelin (above) similar to those still wrapped in burlap nearly one thousand years old (below). (Drawings: Sema Pulak)



Meticulous conservation of the concreted lump (far left) reveals a large boar spear (left). Drawings like those on the right enable scholars to compare the weapons with finds from other locations. (Photos: Joe Schwarzer, Drawings: Sema Pulak)



Technical examinations (lead isotope, PIXE analysis, etc.) indicate a Near Eastern origin, but flanged quillions and the overall decorative schema clearly reflect an oriental aesthetic. The representation, on both sides of the guard, of a fantastic bird, the hamsa, is ultimately derived from an Indian artistic tradition. The motif had already reached the West by the eighth century A.D. and the image, or its generic equivalent, continues to appear in manuscript illumination well into the 13th century. However, the exact meaning of the adopted image is difficult to ascertain as the iconographical/iconological characteristics of hamsa, peacock, and phoenix become increasingly interfused. As a result, the origin of the hilt is debatable. It may have been created by an Indian artisan (or a craftsman thoroughly familiar with Indian motifs) working in Caucasia or Byzantium sometime in the early 11th century A.D. Alternatively, the weapon may have been fashioned in India or Malaysia from raw materials imported from the West and, subsequently, shipped back to the West via Oman.

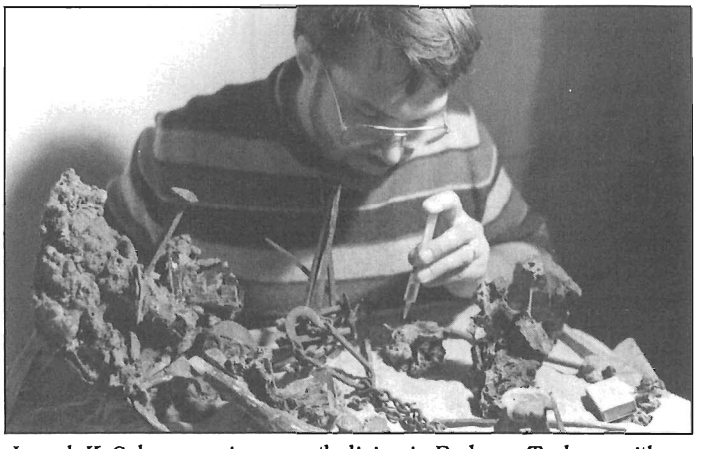
As a whole, the weapons from Serçe Limani reflect a remarkably international range of influences. The winged spears are clearly based on Western European types which may have reached the Aegean over trade routes stretching from Prague and Krakow to the shores of the Caspian and Black Seas. Other pole arms, such as a massive spear sheathed in a wooden scabbard, have no Western equivalent. Similarly, the remains of sword blades from the site suggest traditional Mediterranean types; however, the bronze hilt clearly denotes a confluence of East and West.

A Basket of Hardware

Unlike the weapons, the majority of which were individual finds, most of the tools from Serçe Limani have been recovered from a single, large concretion. Raised in 1978, this conglomeration of nails and implements retains the oval shape of a wicker basket, traces of which are preserved on the lower exterior surfaces of the rock-like mass. Due to the density of the concretion, x-ray examination proved impractical. Consequently, since 1983, discovery and casting of individual objects has been painstakingly slow.

Working from the top down, each successive level of the concretion has been carefully dissected. In some cases, the hollow impression left by objects are surrounded by powdery oxides and are extremely delicate. In other instances, a thick shell of calcium carbonate must be cracked with a pneumatic air chisel and disassembled. In fact, the conservation of this concretion resembles a miniature excavation. The nature and location of each artifact is learned through systematic physical examination, and each discovery presents a technical and analytical challenge as the replica plastic objects are created.

Thus far, finds include a set of drill bits, chisels, a rasp, dozens of nails, a bronze steelyard, a yoke and chain of the steelyard, two combination claw hammer/pry bar tools, two small deep, bronze weighing pans, a lead-filled bronze counter-balance weight, and, most recently, a padlock and key. After we finish casting the artifacts, we hope to reassemble all the finds in such a manner as to duplicate their original position in the basket. More importantly, however, individual study of each implement will provide new information on levels of technology, and perhaps patterns of trade, which existed one thousand years ago.



Joseph K. Schwarzer is currently living in Bodrum, Turkey, with his wife Melanie and two sons. Joe received an American Research Institute in Turkey fellowship to support his continued conservation and research efforts on the Serçe Limani tools and weapons.

The "Gaming Pieces"

by Ken Cassavoy

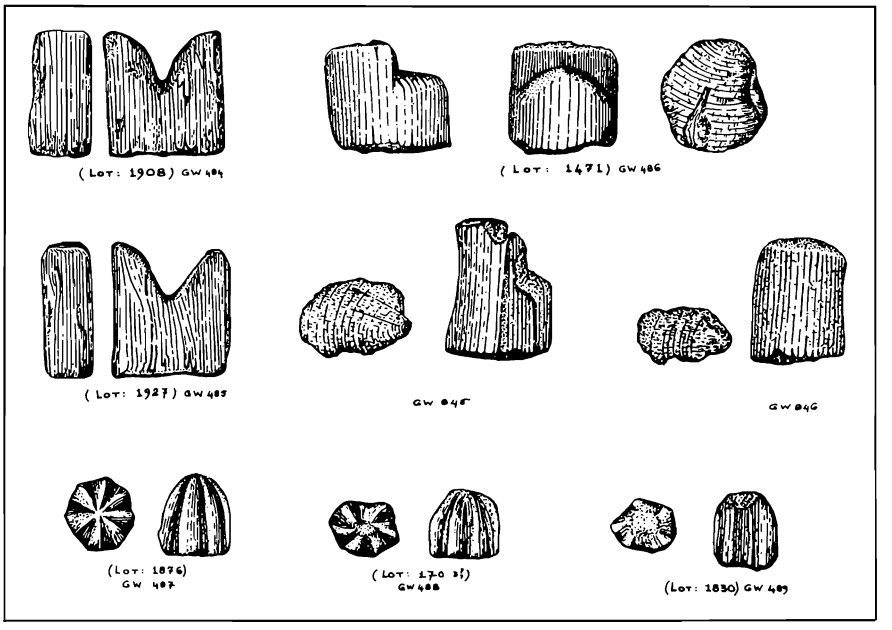
During the course of the excavation of the Glass Wreck, tens of thousands of individual artifacts were recovered from the site. Among these were eight Medieval chessmen, a round gaming tableman, and a bronze cube resembling a die (single dice) which were grouped for study into a "gaming piece" category of finds. As a group, they represent just one small piece in the massive archaeological puzzle of the Glass Wreck. Yet, independently, these ten simple objects have provided valuable information concerning both the vessel and the crew who sailed in her.

The Chess and Backgammon Pieces

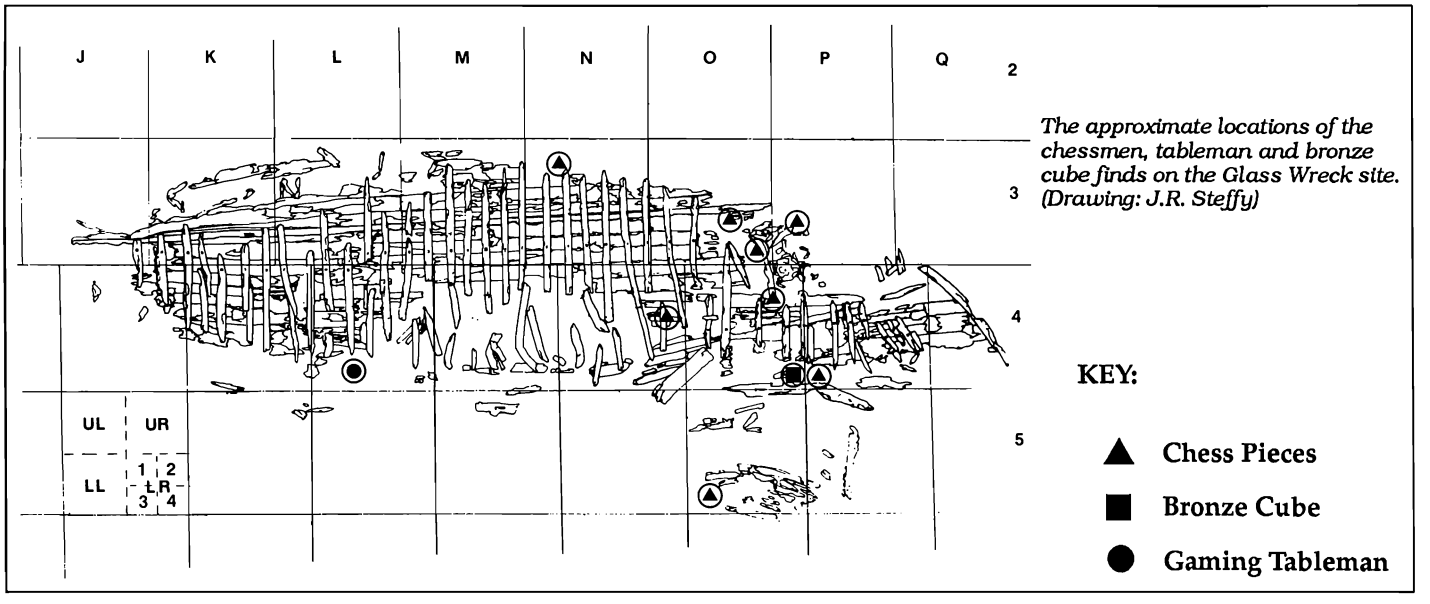
The eight chess pieces found on the Glass Wreck are of Islamic design and include a *Shaw* (now referred to as King), a *Firz* (Minister—now Queen), two *Rukh* (Chariot—now Rook), one *Fara* (Horse—now Knight), and three *Baidaq* (Foot soldier—now Pawn). The only piece not represented in the Glass Wreck set is a *Fil* (Elephant—now Bishop). These simple wooden chessmen undoubtedly were carved and shaped very quickly, probably from materials at hand and apparently using just a knife or simple carving tool and a small file. They are of a very basic nonrepresentational design which had been in widespread use around the Mediterranean for centuries before the ship sank. Islamic concern about the use of images clearly was a major factor in the creation of these abstract shapes to represent the kings, elephants, horses and other figures used in the game at that time.

The bone gaming tableman found on the Glass Wreck is round with concentric grooves cut into the sides and top. It is similar in shape and appearance to a modern checkers or backgammon tableman. This simple standard form of tableman has been in existence since at least early Roman times and used interchangeably for various games. There can be no certainty of the specific game in which the tableman was used; however, in the opinion of those who have studied the history of games extensively, the Glass Wreck tableman most probably would have come from a backgammon set.

In considering the possible passengers and crew of the Glass Wreck, a study of the history of chess, chess pieces, and backgammon has been useful. The form of the pieces and the views of medieval societies concerning various games allows us to propose that the person who possessed the Glass Wreck chess set was Islamic or closely associated with Islamic society. A study of the movement of the game of chess in and through social levels, al-



The chessmen from the Glass Wreck. Top: rook, queen (3 views). Middle: rook, king, knight. Bottom: three pawns. (Drawings by Netia Piercy)



The approximate locations of the chessmen, tableman and bronze cube finds on the Glass Wreck site. (Drawing: J.R. Steffy)

GAMING TABLEMAN

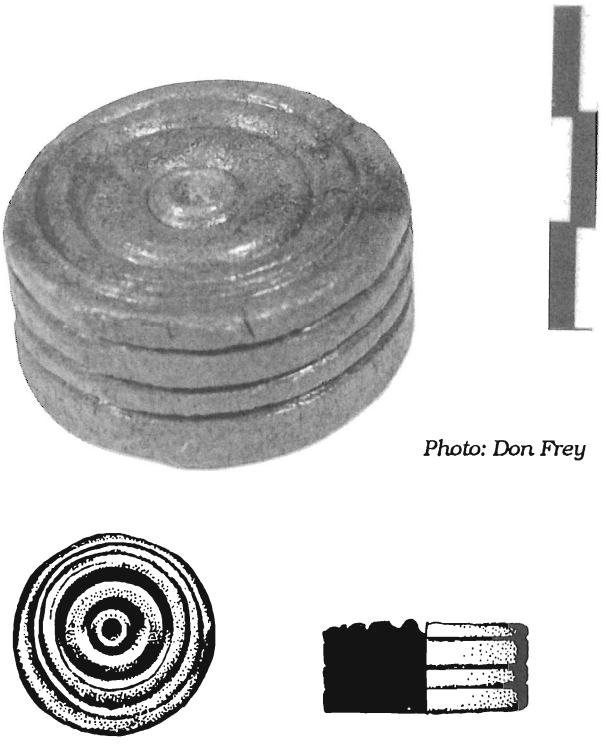


Photo: Don Frey

Left: superior view. Right: profile view. Drawings: Netia Piercy

lows us to suggest also that the owner of the chessmen was more likely to have been an officer of the ship or perhaps a passenger. On the other hand, the owner of the backgammon piece was probably a simple member of the crew.

In terms of the vessel itself, since the gaming pieces were undoubtedly personal possessions, the general area where the chessmen were recovered almost certainly represents a living area on the ship. With an understanding of the established accommodation practices on ships, and because the owner was more likely to be an officer or a passenger, we can suggest that the general area of the chessmen finds is likely at the stern of the vessel. At the same time, it is probable that the area in which the backgammon table was found is another living area, in this case for regular crew members. These suggestions are more certain in relation to the chessmen with all eight pieces found in one general area, less certain in terms of the single backgammon tableman. On a different level, one explanation for the somewhat problematical pattern of dispersal of the chessmen in the stern area provides us with a reasonable basis for the suggestion that the Glass Wreck had at least a partial deck. Perhaps the pieces were loosely stored and some floated out through the open hatches or undecked areas while others remained trapped beneath a deck and eventually settled to the bottom in the distribution pattern recorded during the excavation.

The shape and design of the Glass Wreck backgammon tableman is essentially universal and timeless. The chessmen fall into a very different category. They are the most precisely-dated chessmen from the first five or six centuries of the game's existence, and they are very unusual pieces. Unlike most extant chessmen of the period, they are simple and carry no apparent decoration. Just as the Serçe Limani ship probably represents a simple, average working vessel of its time, the Glass Wreck chess pieces are perhaps more truly representative of 11th-century chessmen than any other existing pieces.

The Bronze Cube

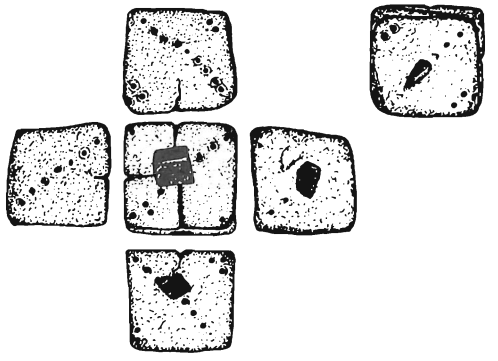
The cube-shaped bronze piece has a series of small holes, similar to pips on dice, on each of its six faces. These small holes vary from a maximum of fourteen on one face to a minimum of five on another. Larger indentations are present on four of the six faces. The cube was found inside the remnants of a wood casing which appeared to have been just large enough to accommodate the cube itself. The cube weighs approximately 42.6 grams.

The dice-like appearance of the bronze cube and its location in the stern area of the wreck, near one of the chess pieces, made the original grouping with the gaming pieces a reasonable one. However, the pip pattern on the cube does not bear any resemblance to those on dice used in any game during the period of history. Other objects found in close association support the more likely identification of the cube as a weight. Within a meter or so around the cube were found six glass weights, five metal weights, a counterbalance, and a large number of other objects related to commercial activities. Although it is still under study, a possible relationship between this weight and the North African *miskal* (or *miscal*, *mitqal*, etc.) unit of weight and/or the Islamic *dinar* unit of currency has already been suggested.

The "gaming pieces" from the Glass Wreck demonstrate how important a single category of simple finds can be in the interpretation of an excavated shipwreck. If these ten small objects had been the only artifacts found on the site we could still draw important conclusions about the Glass Wreck and those who sailed in her in A.D. 1025.

Beyond what they can tell us archaeologically, the gaming pieces almost inevitably draw us closer to the people who sailed on the final voyage of this doomed vessel. We establish a direct link with these 11th-century seamen as they take a break from their duties to play chess and backgammon, games which are still popular today, nearly a millennium after the shipwreck occurred. The Glass Wreck becomes less of a failed Medieval commercial venture and more of a timeless, personal tragedy—an involving story of a small merchant trader and her crew.

THE BRONZE CUBE



Exploded view. Drawings by Netia Piercy

Further Reading:

For chess, backgammon and the history of games:

- **Bell, R.C.,** *Board and Table Games from Many Civilizations* **(London 1979).**
- **Murray, H.J.R.,** *A Short History of Chess* **(Oxford 1963).**
- **Wilkinson, C.K., "Chessmen and Chess,"** *Metropolitan Museum of Art Bulletin* **(1943) pp. 3-11.**

The Rotary Querns

by Curtis Runnels

Among the many interesting artifacts found with the cargo of the wreck are two rotary querns (handmills), each consisting of a set of two disk-shaped stones. In use, one stone lay flat on the ground and the other was placed upon it. The upper stone was held in place by a central spindle, and it was turned by means of a vertical wooden handle. These handmills were used to grind grain for making bread or porridge. The grain was passed through the spindle-hole from above, and, once between the revolving stones, it was moved to the outer edge by the motion of the stones and it emerged as finely pulverized flour.

Rotary querns are first known among the Romans in the Western Mediterranean in the second through the first centuries B.C. They were invented shortly before that time, probably in Britain. They continued in use down to modern times when they fell out of use as everyday household equipment with the advent of the industrial-scale steel roller mill.

Finds of querns in the eastern Mediterranean world are rare in any period, and almost nothing is known of Byzantine querns. The two querns on the Serçe Limani shipwreck are especially valuable, therefore, as they are well preserved and can be dated with precision. The querns are not small tools: each stone could reach 0.57 m in diameter and weigh up to 37 kg. The smallest stone weighed 20 kg. They are carefully worked, with slots for handles and collars to help funnel the grain past the spindle. They were probably expensive, by Medieval standards, and were intended to last for generations. Used for the grinding of grain by the crew, they must have been an important part of the ship's equipment. Querns may also have made up part of the cargo, as they were especially useful as ballast along the keel. Large numbers of millstones used as ballast have been found on shipwrecks from classical antiquity. They are mentioned also in the transactions of the Jewish merchants in Medieval Cairo in connection with ships' cargos.

The Serçe Limani querns are interesting because they tell us something about the ship's equipment. The finding of Medieval querns allows us to fill in a missing chapter on the history of technology, for they bridge the gap from ancient Roman querns to modern querns, showing us the form and the techniques employed in the eleventh century. The Serçe querns show an important change from their ancient Roman counterparts. Namely, they were designed to be used with a peddle and a "bridge-tree" arrangement, which permitted the user to adjust the space between the two stones, and thus to control the fineness of the flour that was ground.

In addition to the technical refinements, we are also interested in the raw materials used to make the querns. If the source of the millstone could be identified, it would probably tell us something of the route taken by the ship before it sank. By allowing us to identify the sources of craft products that are mentioned in Medieval documents, it would undoubtedly aid us in reconstructing the small-scale reality of Medieval trading networks.

The grayish-white stone used for their manufacture may be described as a vesicular, silicified, rhyolitic tuff. Its vesicular texture makes it very rough, yet light in weight. The tuff, which is mostly a volcanic glass, is quite hard, and this too would have been useful for a quern. Unfortunately, the sources of this raw material are unknown. A proper survey in the eastern Mediterranean of such sources for the Medieval period has yet to be carried out. Outcrops of similar rock in this volcanically active region are likely to be distributed widely throughout western Turkey and the Levant.

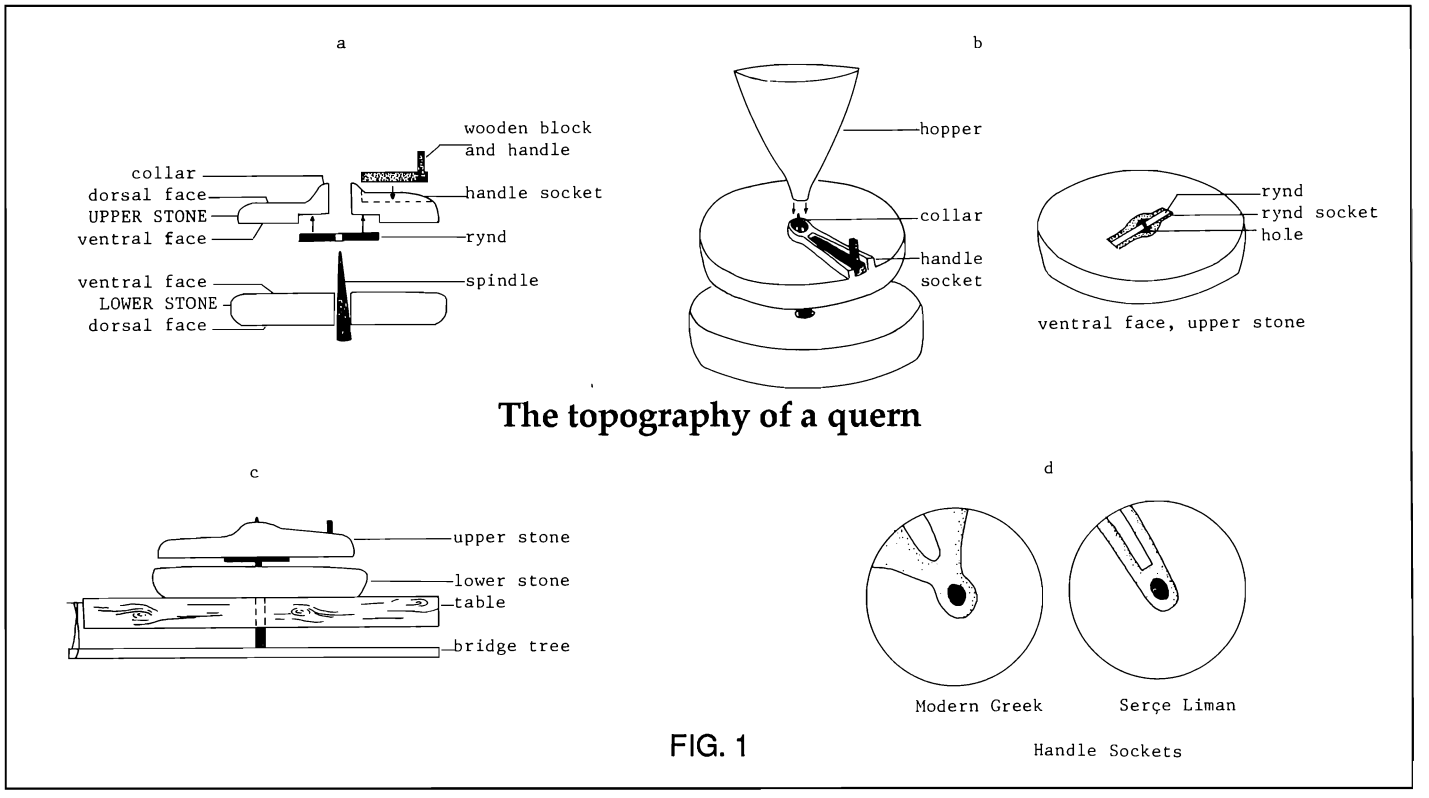
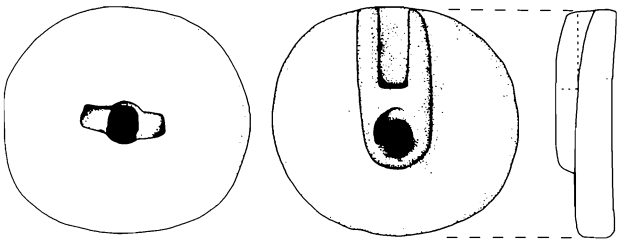


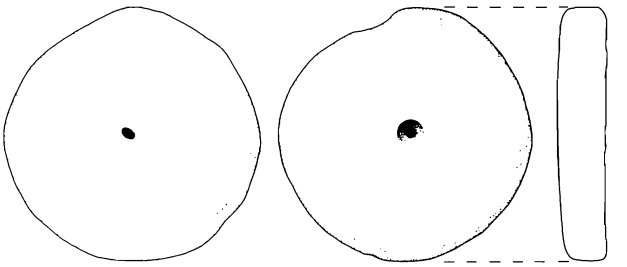
FIG. 1

The Serçe Limani Querns



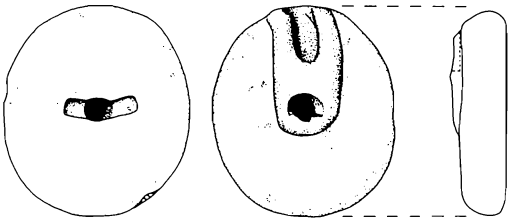
Q 1
UPPER STONE
FIG. 2

The largest and best made of the querns. Note the large socket for a handle, and the cutting on the bottom of the stone (left) for the rynd.



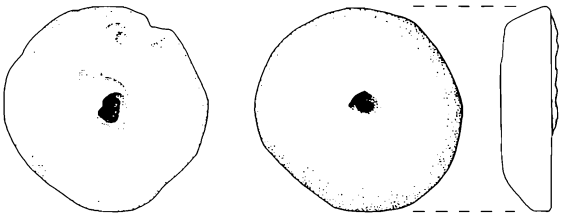
Q 1
LOWER STONE
FIG. 3

The lower stone for the larger quern pair bears a hole for the bridge tree.



Q 2
UPPER STONE
FIG. 4

The smaller Serçe Limani quern is not as well made as the larger example.



Q 2
LOWER STONE
FIG. 5

The lower stone for the smaller quern also has a perforation for the bridge tree.

One intriguing possibility is that the source of the Serçe querns may have been located on the Aegean island of Melos. This island is famous as a source of obsidian, a black volcanic glass used for the manufacture of sharp cutting tools. Obsidian began to be exported from Melos to the mainland of Greece 13,000 years ago, and it has been found in the Indiana University excavations at Franchthi Cave in the Argolid. Quern quarries of much later date are known from Melos. In Medieval times, querns, along with millstones for water mills and windmills, were exported to all parts of the Aegean. The earliest evidence for rotary querns manufactured from the distinctive Melian stone are found on mainland Greek sites of the 13th and 14th centuries A.D. The Melian stone and the material used for the Serçe querns is very similar, and an analysis of thin sections from the Serçe querns shows that the querns may be from the Melian quarries, but this identification is based on only two small samples and cannot be considered definitive. If the querns are really from Melos then they would be the earliest examples of querns from that island. This would not mean that the Serçe Limani ship went to Melos to pick them up. The documents of Medieval merchants in Cairo show that querns in small numbers could be picked up at many transshipment points along the ship's route.

We do not know if the querns were part of the ship's equipment or of the cargo. Modern experiments have shown that an hour or more of grinding each day may have been necessary to supply bread to a crew of five or six sailors. The querns were probably used to grind grain carried on the ship, for it is easier to store and preserve grain than flour, in order to supply the sailors with their daily bread. The presence of two querns is explained by assuming that one was a spare in case anything happened to the first. It is interesting that the larger and better-made quern showed signs of wear on its grinding surfaces, but the smaller "spare" quern showed no signs of use. There is a problem, however, with this interpretation. Despite the exceptional state of preservation of metal artifacts from the wreck, no traces were found of the handles or the spindles that would have been necessary to operate the querns. Unless these parts were wood, which has decayed, we must conclude that the querns had not been fitted out for use, and were part of the cargo. Fortunately, we do not have to accept this hypothesis. Modern day querns sometimes have metal handles and spindles, but as often as not they have wooden fittings, and it is safe to conclude that expensive metal parts would not have been used where wood could have been used. The lack of fittings for the Serçe querns need not trouble us, and in the final analysis I think that the querns were everyday tools used aboard the ship.

Further Reading:

For the interesting documents of the Medieval merchants in Cairo, see:

- **S. Goitein, 1967, *A Mediterranean Society*. Los Angeles and Berkeley.**

For the Franchthi Cave Excavations, and Melian obsidian, see:

- **T.W. Jacobsen, 1976, "17,000 years of Greek prehistory," *Scientific American* 234:76-87.**

For more details on milling technology in ancient Greece, see:

- **L.A. Moritz, 1958, *Grain-Mills and Flour in Classical Antiquity*. Oxford.**
- **C. Runnels and P. Murray, 1983, "Milling in ancient Greece," *Archaeology* 36(6):62-75.**

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