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1993: The Year in Review

On the cover: *A diver works amid the last copper ingots and stone anchors to be removed from the Late Bronze Age shipwreck at Uluburun, Turkey. The largest preserved section of the ship's hull lies above the ingots* (Photo: D. Frey).

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

Dear INA Members,

We can all take great pride in the accomplishments of the past year. In this issue we are happy to report still more discoveries at Uluburun, Turkey, in Lake Champlain, and in the library, where research on the Serçe Limanı Glass Wreck material continues. The year was also special in that INA successfully concluded its National Endowment for the Humanities Challenge Grant drive. You should take particular satisfaction in the knowledge that you helped make all of this possible.

Thank you for your assistance to INA. With your support, we can continue a partnership that is creating a World Center for Archaeology and turning our visions into reality.

Special thanks are extended to our major 1993 contributors — INA's Board of Directors and all who gave to the NEH Challenge Grant Drive, and to our many other supporters, listed below.

Sincerely, Robert Vincent

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Photo: C. Pulak

Figure 1. Aerial view of Uluburun from the southwest. Anchored over the wreck site, INA's research vessel Virazon *is visible near the cliff face (right center).*

THE SHIPWRECK AT ULUBURUN: 1993 EXCAVATION CAMPAIGN

by Cemal Pulak, Mr. & Mrs. Ray H. Siegfried II Graduate Fellow

Between May 28 and August 20, 1993, INA completed its tenth, and shortest, excavation campaign on the Late Bronze Age shipwreck at Uluburun (now the preferred spelling of the site), near Kaş in southern Turkey. During the campaign we made 1,908 dives totaling some 607 hours of excavation time under water. This brings the number of dives to 20,556, for a total of 6,006 hours of excavation time on the wreck, more than on any other site in INA's history. (By contrast, the full excavation of the seventh-century Byzantine shipwreck at Yassıada, Turkey [1961–1964], required only 1,224 working hours in 3,533 dives.)

At the end of our four-month 1992 season it was expected that the completion of all areas of excavation and the eventual removal of the remaining bulky artifacts (two stone anchors, a large storage jar or *pithos*, and fifteen copper ingots) could be accomplished with an abbreviated season of just two months. Consequently the "final" campaign was planned for June and July of 1993, with an option for extension into mid-August, after which INA's annual shipwreck survey would commence. The fortuitous discovery of additional hull remains beneath the last copper ingots removed from the wreck, and of bronze artifacts and pottery in areas beyond the site perimeter, however, showed us that the wreck still had much to offer. Even so, it is expected that a campaign of two months' duration in 1994 will bring to a close our work at Uluburun.

Work in 1993 may be divided into the following three categories: excavation in the central part of the site; the excavation, mapping, and recovery of all wreck material between ca. 55 and 61 m (180 and 200 ft) deep; and a systematic metal-detector survey of all areas within and immediately adjacent to the designated site boundaries.

Much of our effort in the area just north and northeast of the large, boulder-like rock outcrop located centrally on the site (grid squares K-P15, L-P16, N-P17, N-P18, N-P19) was devoted to the completion of previously unexcavated areas, the removal and raising of the remaining fifteen copper ingots and two large stone anchors, and the documentation and recovery of the portion of the ship's hull discovered in 1984 that lay upslope of the copper ingots. Excavation progress in these areas was rather slow due to the profusion of beads and other small finds, and the fine sand and sediment in a deep gully just upslope of the boulder-like rock outcrop was found to have preserved many fragments of wood and other organic materials that required great care during excavation. This latter area rewarded us with the majority of the important small finds of the season. Among them are: a blank stone scarab; a faience cylinder seal that is similar to one found in 1992 (see *INA Quarterly* 19.4: 10, fig. 9; Dominique Collon of the Department of Western Asiatic Antiquities in the British Museum, who is studying our cylinder seals for publication, believes both were probably made in the same unidentified workshop somewhere in northern Syria, possibly near Ugarit); a seashell ring, which raises to 23 the number recovered from the wreck; a small bronze zoomorphic weight in the form of a recumbent bull and many other pan-balance weights of hematite, stone, and bronze; and an unidentified circular copper or bronze object encased in a wooden sleeve and presumed to be a pan for a pan-type balance. Also in this area were found many lead fish-net sinkers; beads of agate, faience, and glass; "quarter oxhide" ingots of tin; bronze weapons (KW 4517, fig. 14, p. 12) and tools (KW 4560, fig. 12, p. 10); Cypriot export-type pottery; an intact Canaanite jar (KW 4502, fig. 2) and sherds for many others. Sieving the Canaanite jar's contents revealed chunks of the same yellowish material found previously in other such jars on the wreck and identified as terebinth resin.

Photo: M. Fitzgerald

Figure 3. Peter Kuniholm of Cornell University (front) and Cemal Pulak examine a wood sample's suitability for dendrochronological dating.

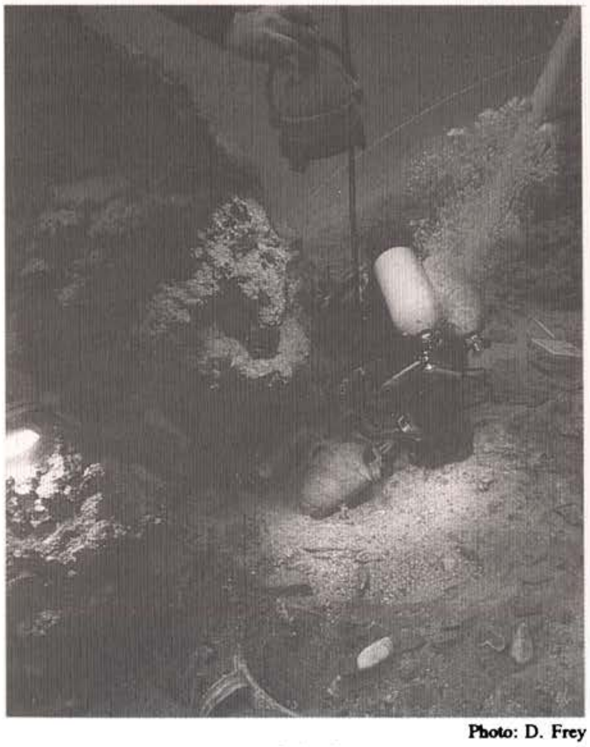
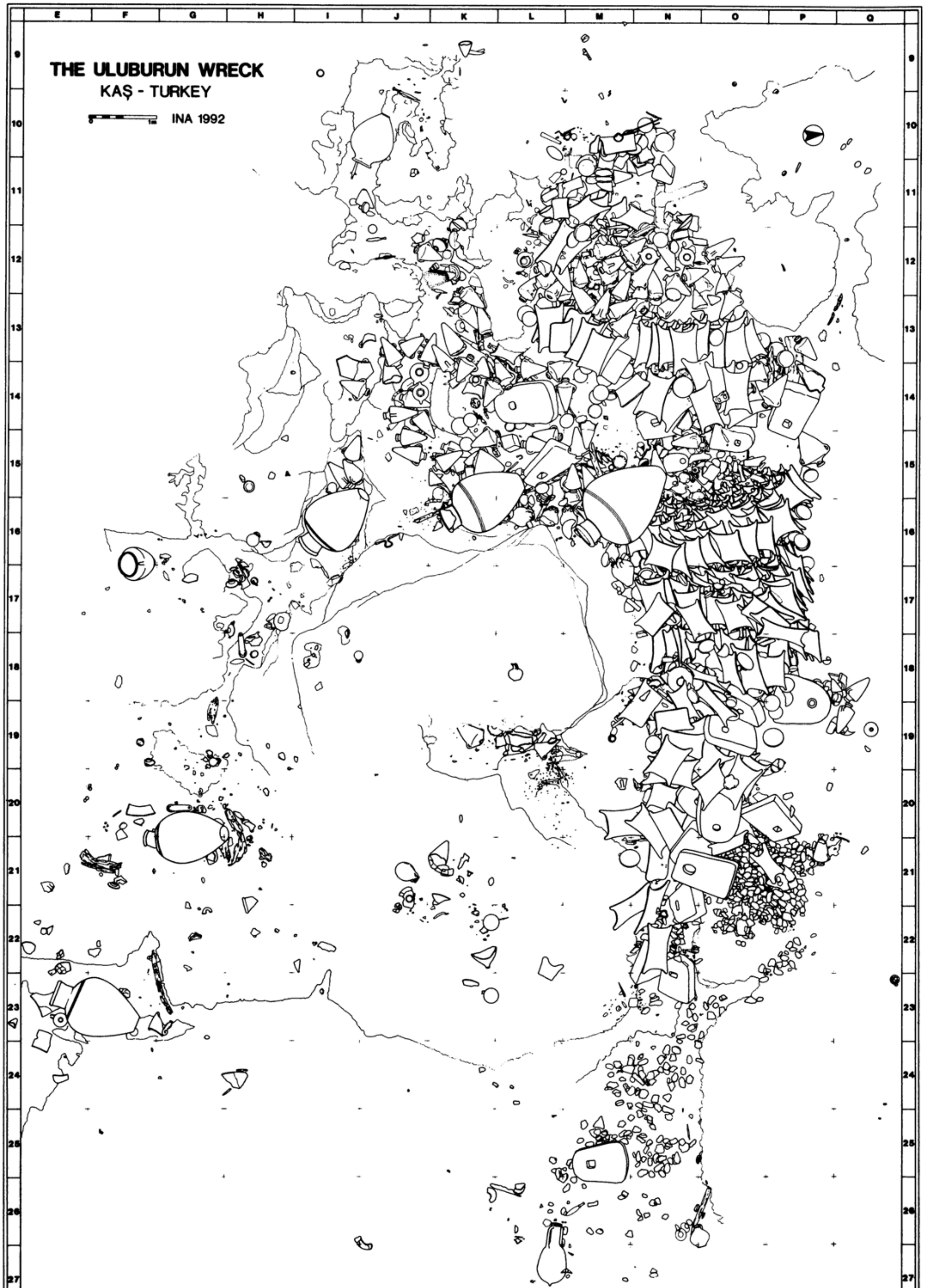


Photo: D. Frey

Figure 2. Excavation of the last intact Canaanite jar (KW 4502) on the wreck. Sieving the jar's contents revealed terebinth resin.

From this area we also excavated and raised a meter-long (3.28 ft) portion of a tree trunk (not a remnant of the hull), possibly of juniper, along with two logs previously identified as either spruce or larch. Eager to have these pieces and pieces from the hull dated more precisely through dendrochronology (tree-ring dating), we were most pleased when Professor Peter Kuniholm visited. He took samples back to the Malcolm and Carolyn Wiener Laboratory for Aegean and Near Eastern Dendrochronology at Cornell University, where he will compare them with his master dendrochronological sequence for the eastern Mediterranean (fig. 3). Results are pending.

Without doubt, the most exciting and rewarding aspect of the 1993 season was the documentation, study, and eventual recovery of the section of hull wood partly uncovered in 1984. During that season a sounding trench was cut in grid squares M-O15 to determine if any of the ship's hull had survived. The sounding revealed a section of the keel, garboard strake (the plank or series of planks adjoining the keel), second strake, and fragments of the third strake on the port side, but only a fragmented portion


THE ULUBURUN WRECK
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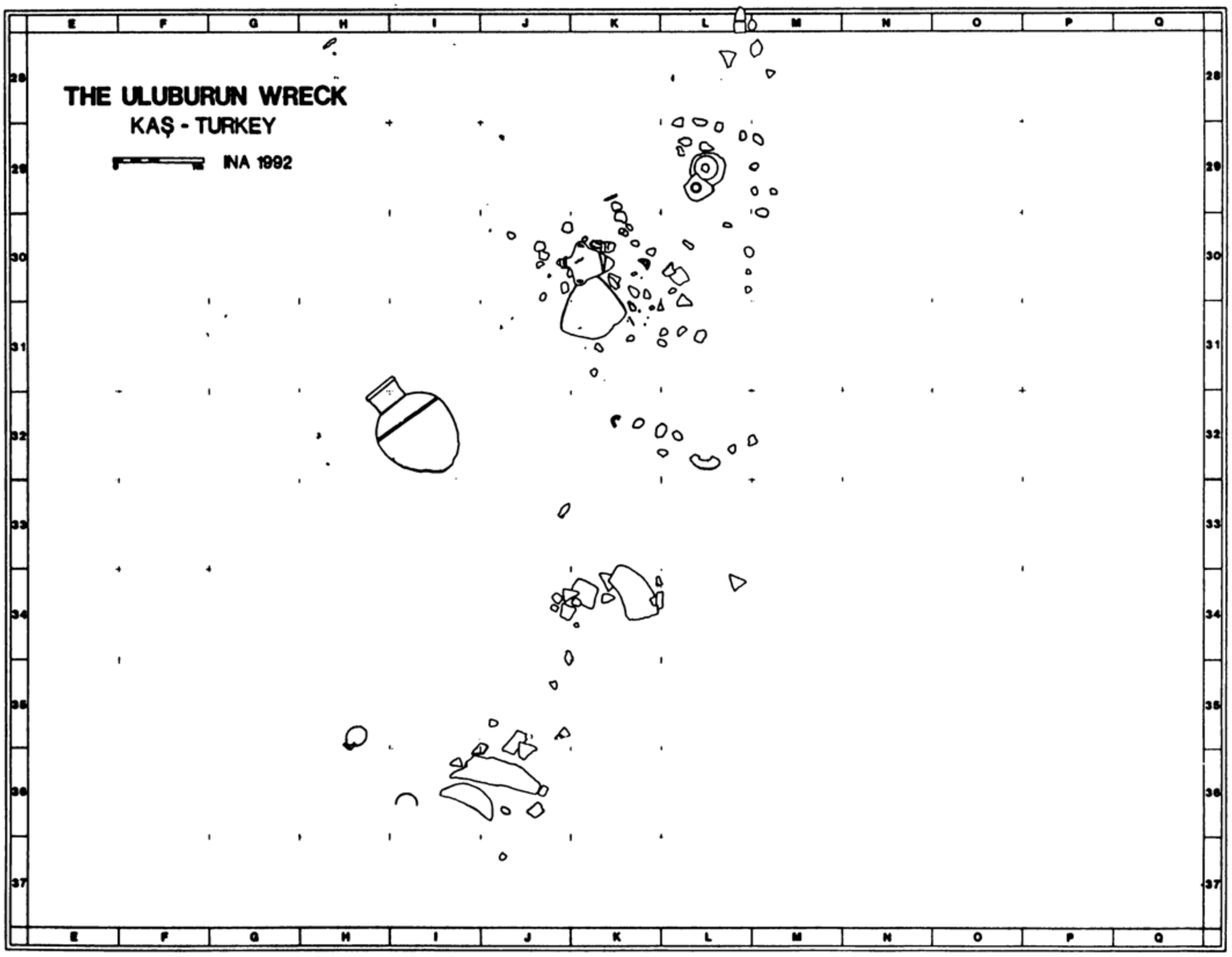
of the garboard strake on the starboard side. In order to protect this important material from damage, we have kept it covered with a protective layer of sand during the excavation and removal of heavy artifacts over the years.

Based on a cursory evaluation of the remains in 1984 and 1989, we learned that the Uluburun ship was constructed in the same "shell-first," edge-joined-plank technique found in Graeco-Roman ships. In contrast to the present-day "skeleton-first" construction technique, whereby the ship's planking is formed around and fastened to the pre-erected skeleton of the vessel, the ancients used the "shell-first" method. This was demonstrated conclusively for the first time through the excavation and detailed study of the late-fourth century B.C. merchantman discovered near Kyrenia, Cyprus. The Kyrenia ship remained the earliest well documented example of a ship built by this method until the discovery of our Late Bronze Age shipwreck at Uluburun. Except for the larger-sized mortise-and-tenon joints used for the edge-fastening of the planks on the Uluburun ship, the joinery method is virtually the same as that seen on the Kyrenia hull. We thus have dated the use of this construction method to about a thousand years earlier than previously known! Details regarding other key elements such as the keel and frames, however, would remain unknown until the wood was fully excavated and studied in succeeding campaigns.

It was therefore with much anticipation that we set about excavating, recording, and raising the hull remains in 1993. When completely exposed, the remnants were found to be fairly well preserved over an area measuring some 1.8 m (ca. 5.9 ft) along the keel by 1 m (3.28 ft) in width (figs. 4, 5). After being completely drawn in plan and sectional views and studied *in situ*, the keel and strakes were placed in separate, custom-built wooden trays for raising and eventual transportation to the Bodrum Museum of Underwater Archaeology, where they will receive conservation and more study. The trays were carried under water from the site to the shallows near shore, where they were then lifted to the surface (fig. 6). This precaution was taken to prevent damage that could have occurred



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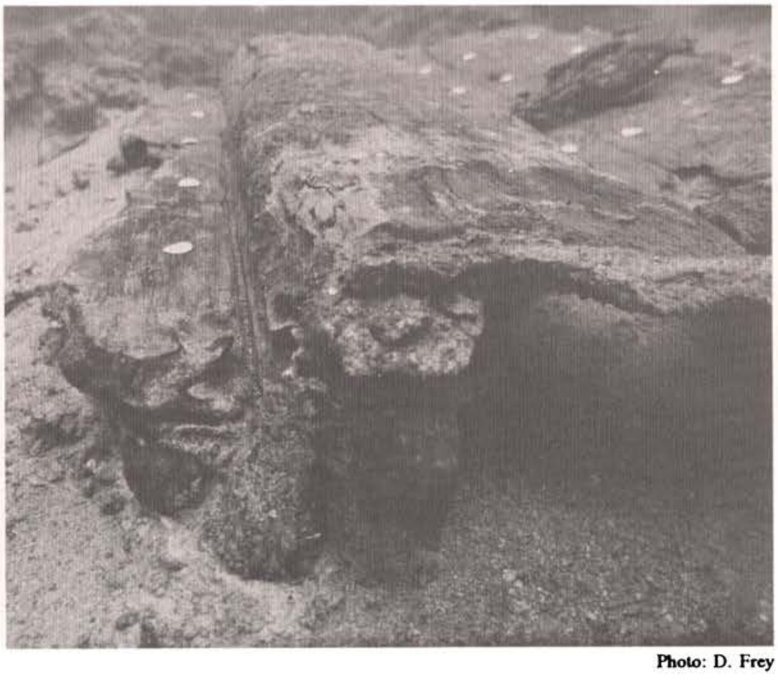

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if divers had ascended from the wreck directly to the surface with the trays.

Soon after we began to clear the wood we were excited to discover that we were confronted with an unexpected and hitherto unknown structural configuration: in spite of detailed examinations of the hull remains, both under water and on the surface, no evidence for any framing has emerged. At this time we reason that perhaps the preserved section is not wide enough, or perhaps long enough, to include frames or bulkheads or evidence for securing such elements to the planking, especially if they were not affixed to the first few strakes they spanned. But this is not the only intriguing construction feature (fig. 5). Upon raising the keel we found that it is wider (sided 28 cm = 11 in) than it is high (molded 22 cm = 8.66 in), although the latter dimension is based only upon what appears to be the finished surface of a knot in the keel, and so may not be the original molded dimension. According to what we know so far, the lower surface of this timber originally protruded beyond the outer planking surface by only a few centimeters. It would have served as the ship's spine, and to protect the planks and support the ship when beached or hauled ashore. Unlike keels of later sailing ships, however, it would have done little to help the ship hold course or point nearer the wind under sail. In other words, it appears that we have a rudimentary keel, perhaps more of a keel plank than a keel in the traditional sense. Not only will this exciting discovery allow us to understand better the evolution of ship construction technology, but also to consider its possible implications for sailing capabilities and the nature of trade in the Late Bronze Age.

During the excavation of the hull remains, a number of fascinating artifacts came to light nearby. A group of bronze objects had concreted into a mass along with wood, bone, and ivory artifacts. Several are indicative of shipboard fishing during the journey. Among these are a bronze harpoon (KW 4254, fig. 7), a netting needle for repairing torn fish nets (the second recovered from the site)

Figure 4 (Upper left). Plan view of the hull remains first discovered in 1984. The white dots mark the locations of pegs that secure the mortise-and-tenon joints (upslope [west] is toward the top of the photo). Figure 5 (Left). Sectional view of the keel and part of a garboard strake, looking upslope.

and several fishhooks. In the same concreted deposit was an ivory cosmetic or unguent spoon with a handle in the form of a feminine forearm with a clenched hand (KW 4246, fig. 8), a bone tube that may possibly have served as the spoon's case (KW 4251, fig. 7), a partly worked long bone of unknown purpose (KW 4255, fig. 7), and a nearly complete tortoise carapace (KW 4250, fig. 7) that probably was used as a sounding box for a musical instrument such as a lute or lyre. On the southern side of the keel or keel plank lay a small limestone anchor (KW 4418, fig. 9) similar to one raised in 1989 (KW 2339). Weighing 25.9 and 21.9 kg (ca. 57 and 48 lb), respectively, they were probably anchors for the ship's boat, but they could have served as hawser weights or lead (rhymes with reed) sinkers for large fish nets. (A lead sinker is a weight affixed to the leading and/or trailing bottom corner of a fish net and to which the net marker buoy is also attached.) The much larger anchors being carried on the ship appear to be sandstone.

Photo: D. Frey

Figure 6. Divers walk trays of hull wood to the shallows for lifting to the surface.

Photo: D. Frey

Figure 7 (Above). The concreted mass of wood, bone, ivory, and bronze objects found near the hull wood: the bone tube (beneath and left of brush); the worked long bone (one end visible below and right of brush); the harpoon (overlying the long bone); and tortoise carapace fragments (left of bone tube and behind long bone). Figure 8 (Below). The cosmetic or unguent spoon of ivory (length ca. 9.8 cm).

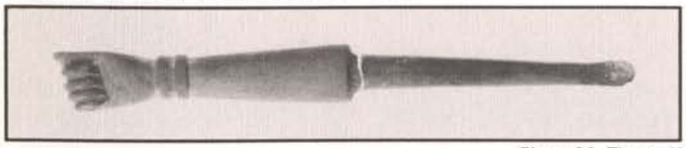

Photo: M. Fitzgerald

The third and fourth rows of copper ingots (in N–P17, N–P18) had served as a barrier that prevented small artifacts originally located in the aft portion of the vessel from rolling down the steep slope upon which the ship eventually came to rest. The excavation of the last copper ingots on the wreck therefore revealed many objects, as had the removal of the second row of ingots in 1992. The freeing of these heavily concreted ingots required meticulous chiselling, during which the appearance of unknown artifacts in the encrustation and among the ingots had to be anticipated at all times. This newly cleared area yielded many beads of agate, faience, glass, and ostrich eggshell. Other finds include Cypriot ceramic export wares (White-Shaved juglets and milk-bowls); disk-shaped glass ingots colored cobalt-blue and turquoise; assorted pan-balance weights; lentoid agate beads, perhaps intended as seal blanks; a bronze adze

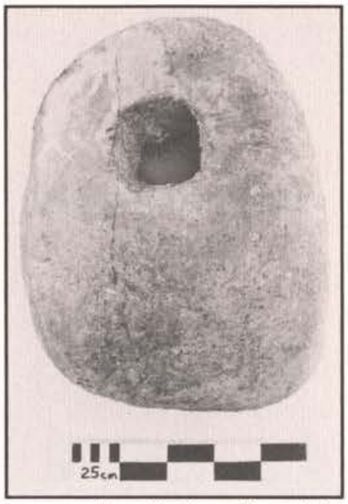

Photo: E. Greene, P. van Alfen

Figure 9. The small limestone anchor of 25.9 kg.

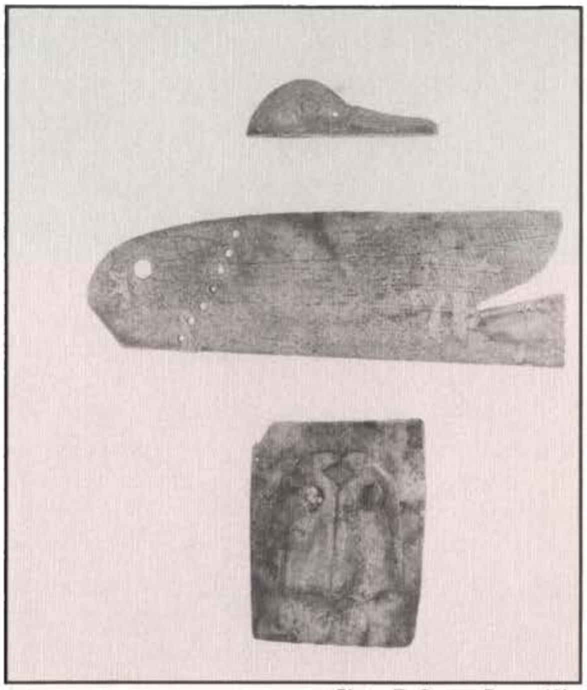

Photo: E. Greene, P. van Alfen

Figure 10. A head and feet of the two duck-shaped cosmetic containers found in 1992. The wing (length 14 cm) belongs to KW 2818.

blade, a knife, tools, and fishhooks; fragments of a lead (?) pendant; and tin ingots.

Just downslope of the copper ingots (N-P19), around and beneath the remaining two stone anchors, were many glass ingots, some of which had to be excavated and removed before the anchors could be raised. Most glass ingots here (as elsewhere) were cobalt-blue in color, but a considerable quantity of turquoise-colored ingots were also recovered. Also discovered was a purple glass ingot fragment of the same color as a unique purple ingot found in 1992. Whether this fragment is part of the first ingot or is from a yet undiscovered second ingot of this unusual color has not been determined. One perplexing aspect of the glass ingots found here and in numerous other places on the site is the occurrence of beautifully preserved ingots alongside others that have hydrolyzed totally, so that they have no mechanical integrity and their original color is no longer discernible. The large number of hydrolyzed glass ingots was another reason for the generally slow pace of excavation. Extremely fragile, they had to be encased in a protective "jacket" and freed with utmost care before raising.

Photo: D. Frey

Figure 11. Thorny burnet (dunnage) at right, and remains of several disarticulated strakes and the keel found beneath the last copper ingots removed from the wreck.

The sandy area immediately downslope of the stone anchors (N-P19 and N-P20), mostly excavated in 1992, yielded additional small artifacts that included more glass ingots, a variety of beads, seashell buttons or beads, and additional components of the two duck-shaped ivory cosmetic containers recovered in 1992 (fig. 10): a wing belonging to container KW 2818 (see *INA Quarterly* 19.4: 5, fig. 2), as well as a head, neck, and feet. Apparently all these artifacts rolled down from their original positions higher up on the slope.

With the removal of the last 15 copper ingots from the wreck — for a total of 354 on the wreck — large quantities of dunnage were exposed, comprising primarily thorny burnet (a low, thorny shrub ubiquitous to the Mediterranean) but also grasses and oak leaves. To our delight we encountered beneath this material more remnants of the ship's hull, though they are poorly preserved. This portion of the ship came to rest on bedrock, not on sand that could have cushioned and protected the wood. Thus the hull suffered distortion and damage from the weight of the copper ingots that pressed it against the uneven rocks jutting from the seabed. Nevertheless, it was immediately apparent that new hull information was available. In addition to the keel or keel plank, there are at least six strakes in evidence on the starboard side. Large wooden pieces rounded in section and placed perpendicular to the keel or keel plank appeared at first to be the remains of poorly preserved irregular frames, but after all of the readily identifiable dunnage had been removed, closer exami-

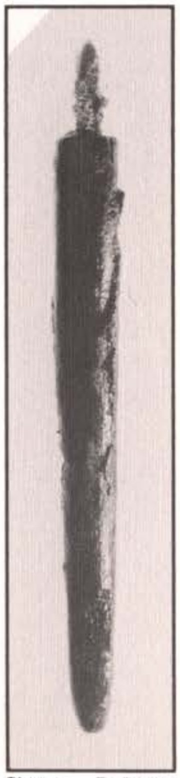

Photo: E. Greene P. van Alfen

Figure 12. Small chisel (KW 4560) with wood handle (overall length 19.5 cm).

nation of these pieces revealed that none was fastened in any way to the keel (or keel plank) or the planking. Consequently, they are probably large branches (dunnage) that were placed under the brushwood for additional protection of the planks from the heavy metal ingots.

As remnants from the only Bronze Age seagoing ship known to date in the Mediterranean, all of these pieces of wood deserve thorough scrutiny. But because they were found to be in such a poor state of preservation, their removal promised to result in extensive damage and the loss of unique information. Accordingly, we decided to leave the wood in place until we could study and understand it as much as possible — a task not easily performed while fighting the judgement-clouding effects of nitrogen narcosis at a depth of about 49 m (160 ft). We estimated that an additional six to eight weeks would be required to complete this task, far more time than was left to us in 1993. This was the primary factor in our decision to push the completion date of the excavation into 1994. At the end of the season we carefully covered all the hull remains with a thick layer of fine sand to protect them from the elements.

In order to locate artifacts we might have missed in prior seasons, we initiated a comprehensive, systematic metal-detector search of the approximately 450 square meters of site area and another 200 square meters around it. We found an abundance of modern metallic trash including nuts, bolts, wire, hose clamps, nails, and various objects lost overboard from the *Virazon* during our ten seasons on the wreck site (this in spite of our care to avoid contaminating the site in anticipation of an eventual metal-detector survey), as well as pre-excavation modern refuse including WWII shrapnel. Ancient contaminants such as net and fish-line sinkers, anchors and anchor fragments, metal vessels, and even a small sounding lead were also found.

The discovery during the survey of only a single artifact — a necked adze — within the site boundaries demonstrated that the site has been excavated methodically and completely over the years. It had fallen into a crevice in a rock ledge and had become totally sealed by encrustation. Concretion deposits are usually chiselled open during excavation in search of such objects, but this adze was missed because the concretion was thought to be bedrock. Two similar necked adzes were recovered during the 1985 campaign, all three belonging to a type found mostly in Egypt and, to a lesser degree, south Palestine.

To our surprise, the metal detector led us to ceramic objects as well. This enhanced capability to locate wreck material benefitted us significantly in the deeper parts of the site. We recovered half of a *pithos* and other pottery fragments that had slid down the slope to depths of ca. 58-61 m (190-200 ft). As these remnants were few and lay under about 50-90 cm (ca. 2-3 ft) of sand, their discovery by airlifting alone would have been extremely slow, labor intensive, and dangerous for divers working at such extreme depths.

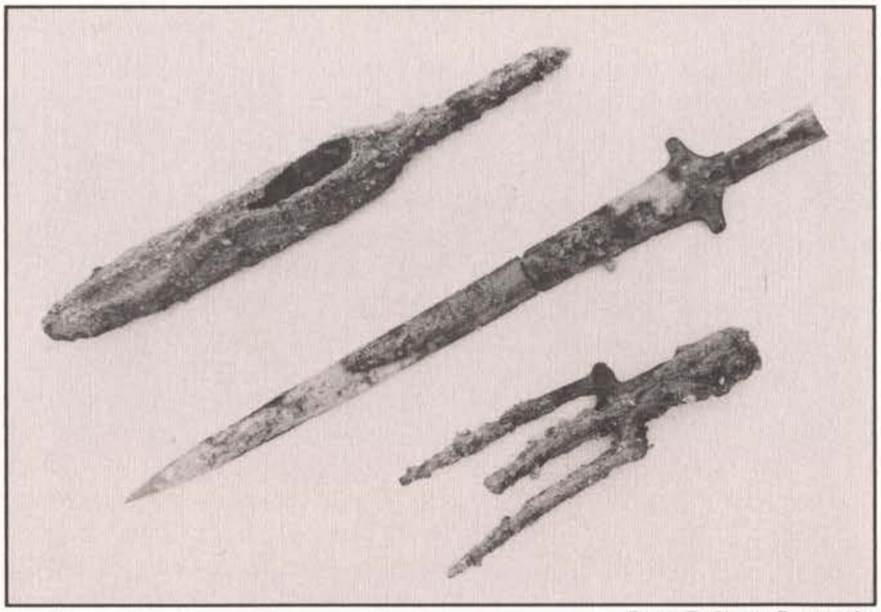

Photo: E. Greene, P. van Alfen

Figure 13. A bronze spearhead or dagger (KW 4217), the Mycenaean sword (KW 4193), and the trident (KW 4160) (preserved sword length ca. 51 cm).

After the conclusion of the metal-detector survey within the wreck boundaries, the search was expanded to include adjacent peripheral areas. Our efforts were handsomely rewarded by the discovery, in a deep sand pocket just upslope of the site (K8-9) at a depth of only 42.5 m (140 ft), of a unique bronze trident for fishing (KW 4160, fig. 13), a spearhead or tanged dagger (KW 4217, fig. 13) and a Mycenaean sword (KW 4193, fig. 13). The sword is very similar to, but slightly longer than, the one found just 2 m (ca. 6.5 ft) downslope in 1985. As with the first sword, the pommel, or end piece, of the new sword is also broken off and missing. This is unfortunate, as the pommel is the key to distinguishing fourteenth-century Mycenaean swords from those of the thirteenth century. Careful examination of preserved structural details on the two sword handles, however, make us fairly confident that

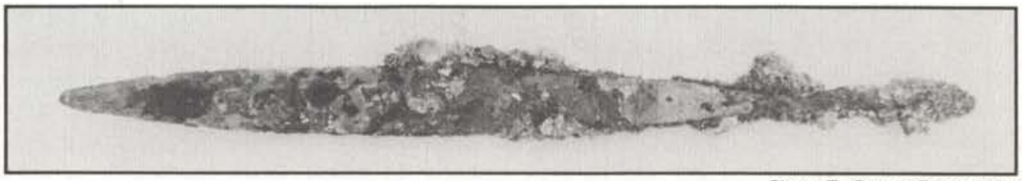

Photo: E. Greene, P. van Alfen

Figure 14. A tanged dagger (KW 4517) of Canaanite type not previously noted on the site (length ca. 31 cm).

both of these weapons are of the fourteenth-century type.

Preliminary study of the ship's cargo and the personal effects of those on board suggests that the ship was sailing from somewhere on the Syro-Palestinian coast, perhaps embarking from Ugarit in northern Syria for a destination somewhere to the west of Uluburun, before being dashed against the rocky promontory. The two Mycenaean swords, however, together with the Mycenaean knives, chisels, nearly two dozen pieces of pottery, jewelry (beads of quartz, faience, amber, and glass pendant beads), a cloak pin of bronze, and the personal seal of a merchant, point to a near-certain Mycenaean presence aboard the ship, if only as a passenger or passengers. On the other hand, the recovery from the wreck of at least five spears of a type that, when found on the Greek mainland is termed a "northern type," and a ceremonial stone mace or "axe" for which the best parallel, albeit of bronze, comes from the Danube region (see *INA Newsletter* 17.4: 11, fig. 6; *INA Quarterly* 20.3: 13), suggest an Aegean connection extending all the way into the northern Balkans or Black Sea basin.

With a final, eleventh campaign of two months' duration in 1994 we hope to complete the excavations at Uluburun. We can then direct our energies to the conservation, restoration, documentation, study, and final publication of this most magnificent site. The new Kaş - Uluburun Shipwreck Exhibit Hall, currently under construction at the Bodrum Museum of Underwater Archaeology, ultimately will house all materials recovered from the wreck.

Acknowledgements. As in previous years, the project was generously funded by the INA Board of Directors, Texas A&M University, and the Institute for Aegean Prehistory. The fuel needed for the project was donated by Shell of Turkey, Ltd., while Cressi-sub of Italy gave us significant concessions towards the purchase of their diving equipment. By taking us on an aerial tour in their private plane, Toni and Maria Pia Bassani of Milan turned five years of dreaming into the reality of observing and documenting Uluburun from the air.

Under the overall directorship of George F. Bass, the 1993 team comprised Cemal Pulak, co-director; INA staff Donald A. Frey, Robin C.M. Piercy, Tufan Turanlı, Murat Tilev; INA staff archaeologist Sheila Matthews; INA counsel James A. Goold; hyperbaric specialists David Perlman, M.D., and Tom Sutton, P.A. The excavation would not have been possible without the enthusiastic and diligent participation of volunteer archaeologists and art historians Dr. Faith Hentschel, Jerry Lyon, and Dr. Patricia Sibella; Nautical Archaeology Program students Peter van Alfen, William Charlton, Michael Fitzgerald, Elizabeth Greene, Roxani Margariti, Brendan McDermott, Claire Peachey, Matthew Pridemore, Edward Rogers, David Stewart, and Mark Smith. Harun Özdaş of the Bodrum Museum of Underwater Archaeology represented the General Directorate for Monuments and Museums of the Turkish Ministry of Culture. Back in Bodrum, Uluburun finds continued to be conserved under the guidance of INA staff conservator Jane Yıldırım by Gökhan Özağaçlı, Güneş Özbay, and Gülser Sınacı, with Suzanne Biehl, and student volunteers Stacey Hild, Barbara van Meir, and Tuba Tetik. INA staff members Selma Karan, Sheila Matthews, and Sema Pulak continued to prepare object drawings for final publication.

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Weight, Money, and Weight-Money:
The Scales and Weights from Serçe Limanı

by Fred Hocker, Sarah W. & George O. Yamini Faculty Fellow

When INA excavated the eleventh-century shipwreck at Serçe Limanı between 1977 and 1979, the most readily apparent components of the site were the major cargos of glass (both raw and scrap) and wine (represented by over a hundred amphoras), as well as the hull itself. In the succeeding years, much of the research on the excavated material has been devoted to the reconstruction of the hull remains, piecing together the hundreds of thousands of glass fragments, and the intensive study of the weight and capacity systems detectable in the amphoras. But these large groups of artifacts only tell part of the story of this medieval trading voyage. The ship was well equipped with anchors, with tools for repair and foraging, weapons for defense against pirates, money for purchasing commodities and supplies, nets for catching fish, and pots for cooking; the crew and merchants aboard left behind their own possessions, such as knives, a chess set, combs, even a sewing kit. All of these small finds have been the subject of extensive study over the last 15 years, and a large number of scholars have been involved in the process of testing, sampling, and analyzing hundreds of artifacts of clay, metal, bone, glass, and wood. One group of finds, the weights and scales used to measure commodities and coin, have revealed some surprising aspects of Mediterranean trade in the eleventh century, and have provided some clues to the idiosyncratic personality of their owner.

Measurement is essential to the conduct of trade. While some finished products and raw materials may be sold by count, this is impractical or impossible for the vast majority of commercial goods. For these goods, quantities are expressed in units of length, area, volume, or weight. For convenience, some dimensional quantities and count may also be expressed with acceptable accuracy by weight; thus one may buy wire by either a linear or a weight unit, and modern nails are often sold by weight if sold in quantity. Weight is also relatively easy to measure and verify. In many periods, not only merchandise but also the money used to purchase it was commonly weighed to assess value. This was especially true where coins could be easily altered, where change was made by cutting up coins of larger denomination, and where money issued by several different authorities was in mixed circulation. It should come as no surprise, then, that the Serçe Limanı ship or the merchants travelling aboard it were equipped with a variety of devices for measuring weight: a steelyard, at least three equal-arm balances, two sets of metal pan-balance weights, as well as a number of glass coin weights (the latter are being studied by Dr. Michael Bates of the American Numismatic Society).

The Steelyard

The steelyard beam, its counterpoise (counterweight), and the assembly of iron load-hooks, chains, and shackle (figs. 1-5), were all recovered from a large basket of mixed implements found at the foot of the sternpost. Other items in the basket included a wide variety of carpenter's tools,

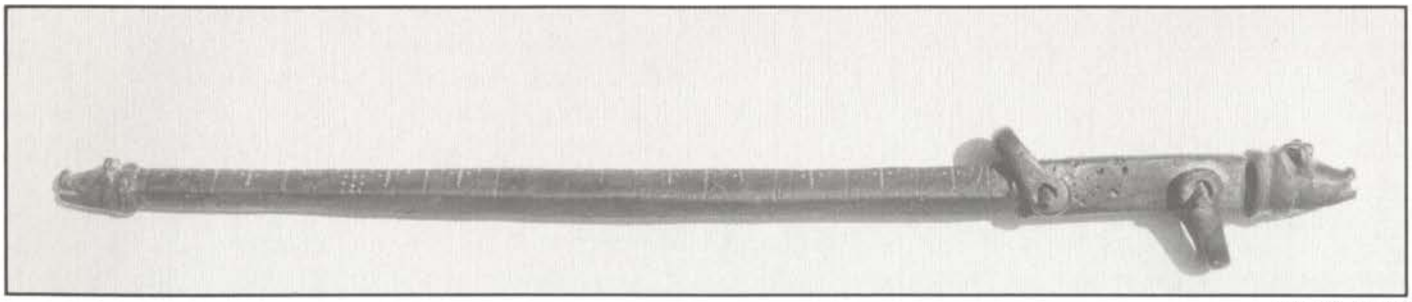
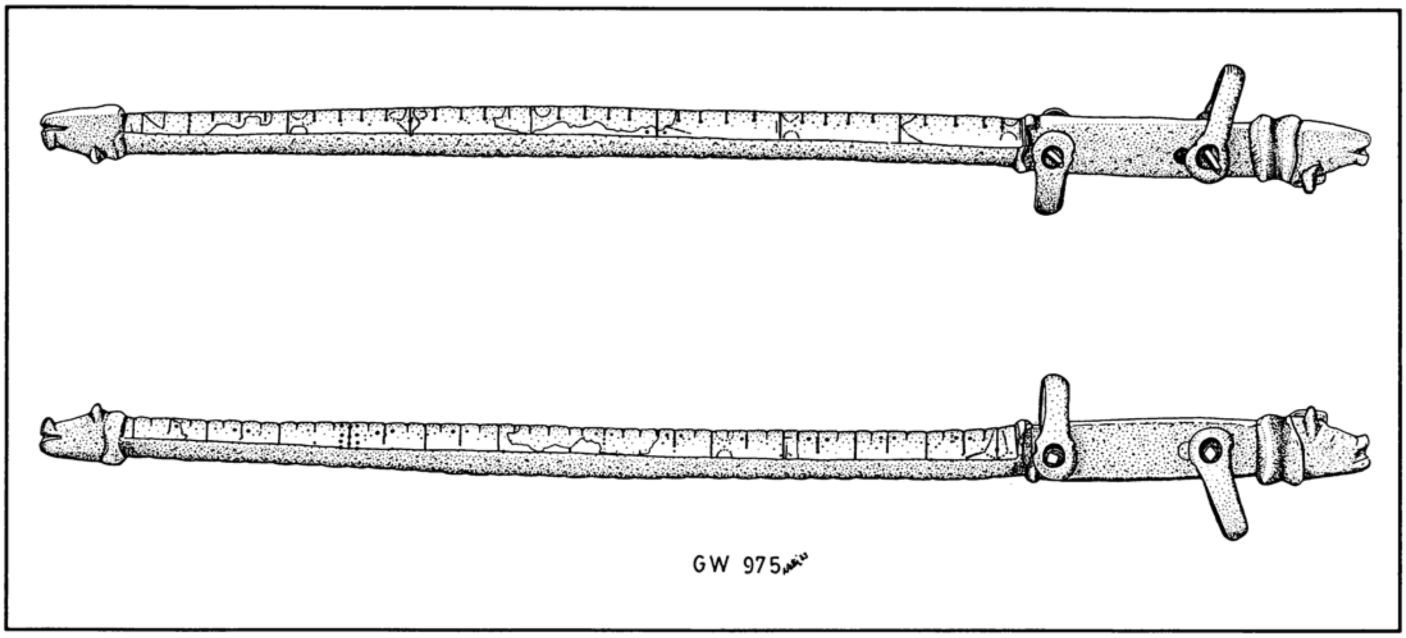


Photo: F. Hocker

Figure 1. The Serçe Limanı steelyard beam (GW 975) (length ca. 41.2 cm).



Drawing: N. Piercy

Figure 2. Both scales of the Serçe Limanı steelyard beam.

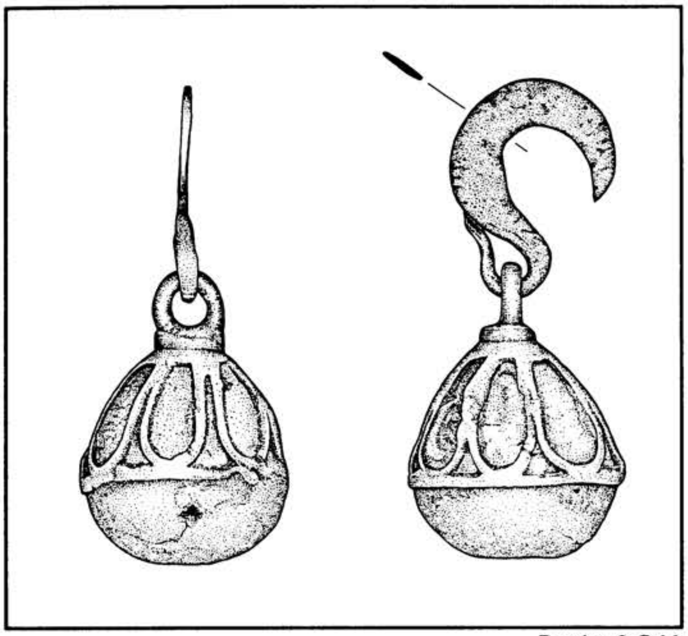
new and used nails, a lock, and the pans for a fine balance. The steelyard was found in association with its gear, lying near the top of the jumbled contents of the basket.

The unequal-arm balance in various forms has been in use in the Mediterranean since at least Roman times and remains common in local markets there; when Gökhan Özağaçlı and I wanted to measure the weight of a medieval anchor in the Bodrum Museum of Underwater Archaeology, we went up to the local vegetable market and borrowed a steelyard from one of the vendors. Unlike the equal-arm balance, with which an unknown weight is balanced against an equal weight of known amount, the steelyard uses the principle of leverage to balance the unknown weight against a single known weight that is moved toward or away from the fulcrum along a graduated scale. The farther from the fulcrum the counterpoise is moved along the beam, the greater the weight it will balance.

The essential components of the steelyard are a beam incorporating one or more fulcra, a means of suspending the beam at the fulcra, a movable counterpoise, and a means of suspending the load from the beam. The beam is normally a straight bar of bronze with a little more than half its length covered by the graduated scales. The counterpoise may be a simple lump of lead or bronze, but is often decorated or cast in the form of a portrait bust; its suspension hook is normally hammered out thin and flat to allow the weight to hang on the thinnest possible bearing edge, so that its position on the scale can be accurately determined. In the Byzantine period, the load gear usually consisted of two or three hooks on chains attached to a free-swinging shackle suspended from a knife-edged yoke riding in a groove at the end of the beam nearest the fulcrum (fig.4). Some balances have a pan in addition to the hooks and chains, and there is some evidence, in the form of iron pan remains found in the same tool basket in which the beam was found, that the Serçe Limanı steelyard was so-equipped.

As with the equal-arm balance, one of the keys to steelyard accuracy is minimal friction in the suspension apparatus as well as minimal inertia in the beam. In the Byzantine period, an efficient system of iron knife-edged fulcrum pins projecting from the sides of the beam and bearing on metal suspension shackles was in common use; this can be seen on modern steelyards as well. Accuracy also depends on the location and uniform spacing of the scale markings, which can be derived mathematically or calibrated empirically. The former requires an understanding of the physical principles involved, and theoretical aspects of equilibrium and the operation and calibration of balances were the subject of much scientific enquiry in the Middle Ages; a number of relevant texts and commentaries have survived in both Greek and Arabic. In practice, these discussions and texts were largely academic, as most steelyards were no doubt calibrated empirically by weighing known or standardized quantities and marking the scale appropriately. Because the relationship between distance from the fulcrum and weight is linear, it is not necessary to calibrate the graduation of every scale on every beam.

Two points can be ascertained on a scale and the desired divisions interpolated. As with all weighing systems, the possibility of cheating is ever present (the simplest expedient for the seller being to shave weight off his counterpoise after calibration), and so regulation of some sort is desirable, although there is no evidence on the Serçe Limanı steelyard of any kind of control or certification stamp.



Drawing: S. Pulak

Figure 3. The counterpoise (GW 1283) (maximum diameter 7.6 cm).

In size, form, marking, and materials, the Serçe Limanı steelyard is fairly typical of those from the Byzantine world. It falls into a relatively large group of medieval steelyards that are between 35 and 45 cm long. Nearly all of these balances begin with 0 or 1 λίτρα (*litra*, the Byzantine pound) on the lightest scale, and most have maximum capacities of 35 to 60 *litrai* (11–19 kg). The animal-head finials, astragals (raised convex rings), and design of the load gear are actually quite similar to those of the large steelyard from the seventh-century Yassıada wreck, and the Greek letters used to denote the markings at 5-*litrai* intervals can be seen on nearly all medieval steelyards in the eastern Mediterranean, even those of Arab origin. The bronze and iron used in its manufacture are also typical, although the manner in which the beam is made is unusual, if not unique. Rather than a single casting filed to shape, the beam was cast in two pieces and joined by means of a soldered mortise and tenon at the astragal between the scale and the fulcrum bar. The joint is not a repair, as the mortise in the fulcrum bar is part of the original casting.

This steelyard is equipped with two fulcra and is marked with two corresponding scales, the first reading from 1 to 13 units subdivided into quarters, and the second from 15 to 51 units without subdivisions. The gap of two units between the scales is a bit unusual, although there are examples of steelyards with small gaps, usually of a *litra* or less, between scales. A two-*litrai* gap is excessive and potentially inconvenient, but doubtless results from an alteration of the steelyard at some point in its working life. Apparently, the owner was not satisfied with the capacity of the balance and had it changed. This involved moving the fulcrum for the higher capacity scale closer to the load collar, filing off the corresponding original scale markings (the remains of which can still be seen in places), and re-calibrating the scale.

The unit of weight on this steelyard, presumably one *litra*, is something of a puzzle. As the instrument is apparently complete, with load gear and counterpoise, it is theoretically possible to calculate the absolute value of the unit for which it was calibrated. There is some room for variation here, as we do not know the original weight of some of the components (the iron load gear is now represented only by an epoxy casting, and the counterpoise is damaged), but we can at least come close to a minimum. With the existing weights of beam and counterpoise, and a reconstructed weight for the load gear, the "pound" for the lighter scale is 550 g, that for the heavier scale approximately 590.5 g (by comparison, the pound in common use today weighs 454 g). The discrepancy between the scales, of approximately

Photo: F. Hocker

Figure 4. The yoke, free-swinging shackle, and chains (GW 1282) (preserved overall length ca. 33.5 cm).

7.5 per cent, is not the result of weight loss in the beam or counterpoise, nor can it be attributed to an inaccurate reconstruction of the weight of the load gear. It is instead due to an inherent error in the graduation of the beam, probably resulting from the alteration of the heavy scale. At a *litra* of 590.5 g, the maximum capacity of the steelyard is about 30 kg. Although the original marks on the heavy scale are all but obliterated, it is possible to estimate the original capacity before alteration; calculation reveals that the heavy scale began at 12 *litrai* and had a maximum capacity of 40 or 41 *litrai* (22-22.5 kg).

It seems apparent that the original "pound" or *litra* for which the Serçe Limanı steelyard was calibrated was something more than 550 g, but probably not more than 650 g. Unfortunately, a *litra* in this range does not seem to correspond to any common medieval weight standard of Byzantine, Islamic, Balkan, or Italian usage, even though the steelyard and its markings are clearly Byzantine in nature. The Byzantine *litra*, the standard commercial unit of the period, ranged between approximately 312 and 324 g in the eleventh century and was ultimately derived from the Roman pound of only slightly more. It is possible that the steelyard represents an as yet unknown Byzantine unit, or a unit in use in a peripheral area, such as the Balkans.

Another possibility that must be considered is that the counterpoise is not original to this steelyard. It is considerably larger than the counterpoises found with other medieval steelyards of similar dimensions and capacities, and the maximum load of ca. 30 kg seems excessive for the relatively light suspension and load gear. In addition, the other weights on board the ship seem to be based on common standards, with the large set of disc weights clearly derived from a *litra* of 318 g or a bit more (see below). In order for the steelyard to weigh in Byzantine *litrai*, the counterpoise should weigh approximately 1 kg — a little more than half of its actual weight.

If the original counterpoise is indeed missing, how can any merchant have tolerated the use of an oversized counterpoise, one so oversized that the error was easily detectable? This counterpoise is clearly intended for use with a steelyard, and was found in close proximity to the beam, so it is difficult to dispute their association. Could the provenience of the Serçe Limanı counterpoise be misleading? Is it possible that the steelyard and its associated gear were not being carried as usable implements, but as scrap, due in part to the loss of the counterpoise, and that the counterpoise was also scrap carried in the same basket? This seems far-fetched.

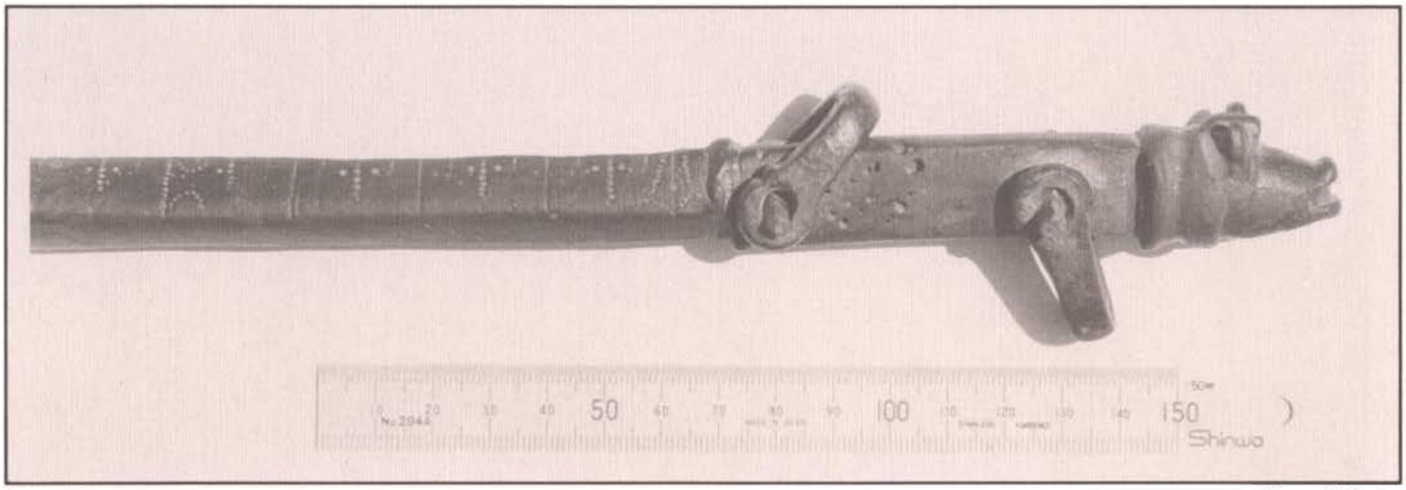


Photo: F. Hocker

Figure 5. Detail of the steelyard.

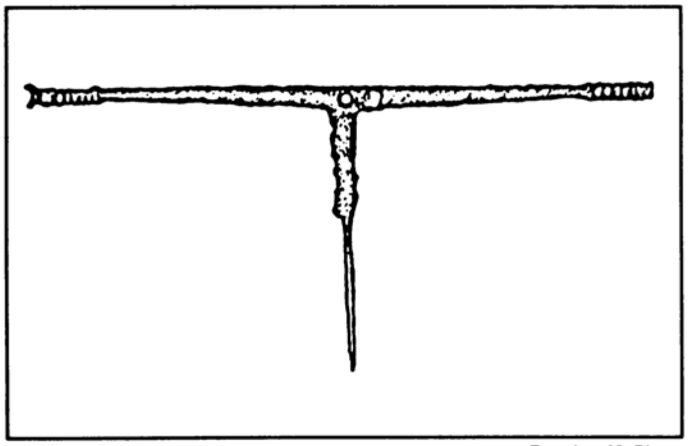
A final possibility is that the counterpoise has lost considerable weight, up to 250 g, and was intended to increase the capacity of the instrument by doubling (a practice not unknown in the Middle Ages; double pounds were sometimes called "royal pounds"), so that a reading of 10 *litrai* would signify an actual weight of 20 *litrai*. The moving of the heavy fulcrum and re-cutting of the relevant scale demonstrate the owner's desire for increased capacity, so another alteration to increase capacity further is not out of the question. Amphoras exceeding 50 *litrai* were quite common in this period, and several of the amphoras carried on the ship's last voyage weighed when full considerably more than 51 Byzantine pounds but less than 102 pounds. Perhaps even more significant is Fred van Doorninck's study that shows that the amphoras on the wreck were carefully manufactured in standardized sizes graduated *by weight* (see "Giving Good Weight in Eleventh-Century Byzantium: The Metrology of the Glass Wreck Amphoras," *INA Quarterly* 20.2: 8–12). A steelyard too small to weigh the common seagoing cargoes of the day would be of limited use on the ship.

If the last scenario is accurate, then our steelyard had a long and colorful career behind it before the ship sank. Fabricated in a Byzantine workshop and calibrated to the standard pound of the day, it originally had a capacity of approximately 40 *litrai*. At some point, the owner had need of a larger instrument and had it altered, possibly doing the work himself, so that it could weigh up to 51 *litrai*, presumably with the original counterpoise. Even this was not enough, and the original counterpoise was replaced to double the capacity, to 102 *litrai*. Could the last alteration be directly related to the instrument's employment on a merchant ship carrying amphoras and other bulk goods?

The Equal-arm Balances

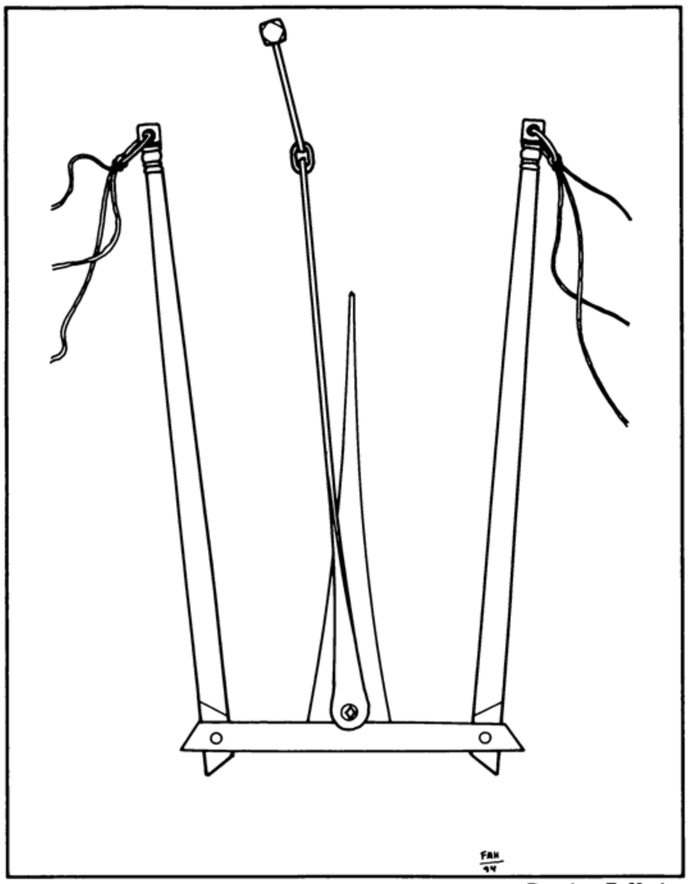
The beam of a fine balance (fig. 6) was found approximately 1 m downslope from the basket of mixed implements, not far from a concentration of barrel-shaped weights, but the pans were found, crushed, in the basket itself. It is likely that the beam originally lay in the basket in its own container (probably a wooden box) with the pans and was thrown or washed downslope during or after the wreck. The arms of a large folding balance were found over 2 m apart, between 8 and 9 m downslope from the after part of the keel. A fragment of a third balance beam lay over 2 m farther downslope.

The equal-arm balance is the oldest and simplest of weighing devices. The essential components of the balance are a beam, a means of suspending it on a free central fulcrum, a means of suspending the known and unknown weights from the ends of the beam, and a set of masses of



Drawing: N. Piercy

Figure 6. The fine balance (GW 455) (beam length 15.7 cm).



Drawing: F. Hocker

Figure 7. Reconstruction of the folding balance (GW 522, 523), folded up. Only the two arms were recovered (original open length ca. 50 cm).

known weight, commonly called, simply, weights. A refinement added in Roman times was a vertical indicator, attached to the beam, which made it easier to determine when the beam was exactly horizontal. The accuracy of the instrument depends primarily on how closely the pan weights match their theoretical standard, but the precision of the balance depends on the construction of the balance itself, with knife-edged fulcrum pins offering the same advantages that they do in the steelyard. A well made balance of the Middle Ages was capable of distinguishing values (that is, producing a visible movement of the beam) of less than 0.1 g, considerably smaller than the smallest weights in common use.

The Serçe Limanı fine balance is reasonably typical of small balances from Byzantine sites. Small pans were normally suspended by silk thread, and one of the hemispherical pans bears stains that may be from fine cord. Such balances were typically used to measure precious metals, coins, and some expensive commodities sold in small quantities. The unusually deep pans may also have

Photo: D. Frey

Figure 8. Some of the disc weights (note the inscribed concentric circles).

been useful for weighing powdered or granular substances, perhaps even liquids. Fine balances of this size and the weights that accompanied them are common finds on medieval sites (including graves) in northern Europe, but medieval Byzantine fine balances, while widely distributed, are comparatively rare. A balance of this size is capable of great accuracy, on the order of a twentieth of a gram.

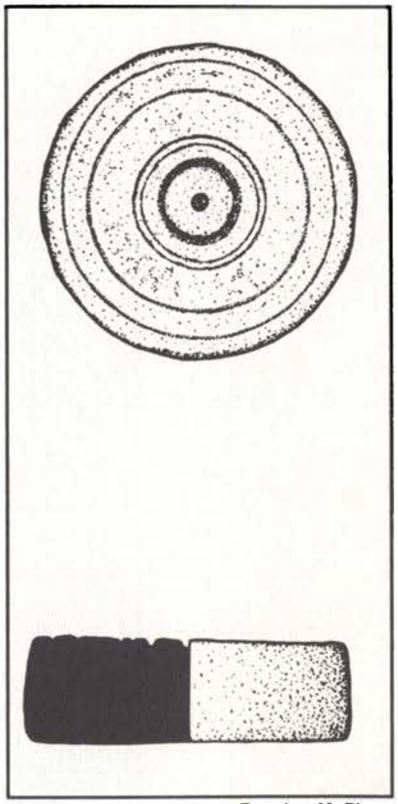
A balance for weighing money and small goods was an individual possession, and was normally kept on the person and protected carefully. Small balances such as the Serçe Limanı example were easily transported with their weights, normally in a fitted wooden case, but larger instruments for heavier loads could be unwieldy. The folding balance represents the most common medieval solution to the problem. The arms are hinged to the central section of the beam, which also carried the fulcrum pin and vertical indicator, and could be folded into a narrow, elongated package (fig. 7). This innovation first appeared in Persia or Mesopotamia in the early Middle Ages and spread as far as Scandinavia by the end of the ninth century. Such balances were ideal for weighing groups of coins, as medieval illustrations show. The Serçe Limanı balance represents one of the largest known examples, with a reconstructed beam length of at least 45 cm.

A folding balance is less accurate than a comparable fixed-arm balance, as the arms must be heavier, and there is a minute but unavoidable amount of slop in the joints, especially as the balance wears with age. The reduced accuracy is less significant when weighing silver, due to its lower value per unit of weight, and it is therefore not surprising that folding balances are most common in northern Europe between the eighth century, when gold coinage was abandoned, and the thirteenth century, when it was re-introduced. The use of a folding balance on the Serçe Limanı ship, especially a balance of such great size (and presumably minimal accuracy), suggests either that its primary use was for weighing commodities of relatively low value, or that the owner felt no need for extreme accuracy.

The Weights

The large number of metal weights (all but one are of bronze) found on the wreck fall into two easily distinguished groups: 15 discs and 14 barrels. The former (figs. 8, 9), ranging between 20.64 and 469.4 g in preserved mass appear to represent only six different denominations, with as many as four examples of one denomination, and seem to be a collection assembled from several sets or partial sets with distinctly different styles of decoration. Much the same is true of the barrel-shaped weights, ranging in preserved mass from 3.06 to 170.5 g; there are at least seven and perhaps eight different sizes (figs. 10, 11). Each of these groups has something very interesting to tell us about the type of commerce in which the ship was engaged, and even throws some light on the personality of the owner, who was probably the man who owned the steelyard.

The disc weights are typically Byzantine in proportion and decoration, and allowing for slight loss of mass due to corrosion, fit readily into a normal progression of Byzantine ounces, with representatives of 1, 2, 3, 6, 12 and 18 ounces in the set. This combination is all that is needed to weigh any number of whole ounces up to the total weight of the group, 71 ounces (almost 6 *litrai*, or 1.88 kg). This progression is most commonly found in groups



Drawing: N. Piercy

Figure 9. A six-ounce disc weight (GW 494) (preserved mass 153.55 g).

of weights used in systems based on the 12-ounce pound, such as the Romano-Byzantine *litra*. According to the preserved mass of our weights, this *litra* weighed at least 318.5 g, and was probably nearer 320-322 g. This is quite similar to the value of the *litra* derived independently by Fred van Doorninck from the capacity weights of the amphoras on the wreck. It shows that even in the eleventh century there was still a great deal of consistency in Byzantine weights, and that the *litra* was still very near its original Roman value of approximately 327 g. Earlier studies of Byzantine weights and coins suggested that the *litra* had declined to as low as 318-319 g by this time, but the Serçe Limanı finds show that merchants were successfully "holding the line" against this trend to a greater degree than formerly suspected.

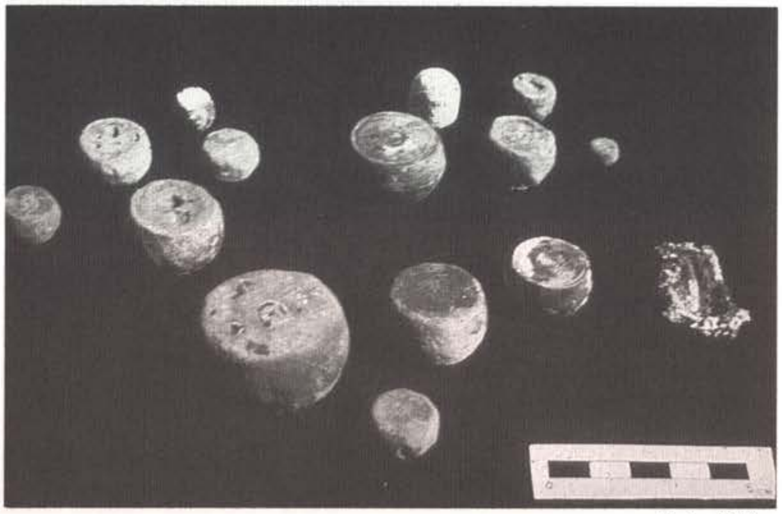
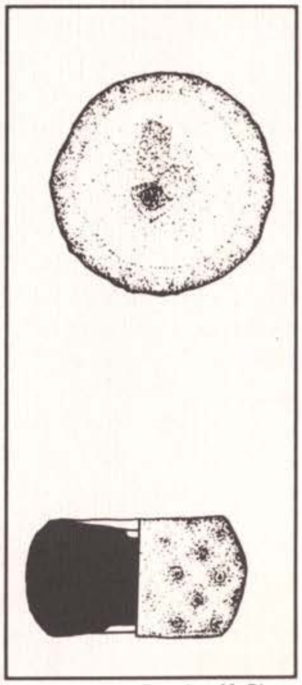


Photo: D. Frey

Figure 10. Some of the barrel weights.

The barrel weights are actually faceted, rather than biconical (with two important exceptions). This shape is considered typical of Fatimid Islamic metal weights, and the dimensional proportions of our weights indicate that they were probably made in Palestine rather than Egypt. Determining the denominations of these slightly smaller weights is not as easy as it is for the discs, as the barrel weights do not fall as clearly into groups on the basis of preserved dimensions and mass. There is also the problem of the Islamic weight system itself. Unlike the Byzantine ounce, which was based on the weight used for precious metal and was directly linked to the weights of coins, the Islamic dirhem had two theoretical weights, one for silver (2.96 g), derived from the gold dinar standard, and one for non-precious commodities (3.125 g). The difference is slight but significant. The Serçe Limanı weights are too corroded to allow clear attribution to one standard or the other, but there is the distinct possibility that weights based on both standards have been combined in this very motley group. There is also some confusion about the denominations due to the apparent mixture of two different weight systems, one based on units of 10, which is more typical of Islamic weights, and one based on units of 12, which is consistent with the Byzantine system. Could it be that the latter are from an Islamic region on the Byzantine frontier, such as Syria, where a 12-unit system allowed easier interchange with Greek merchants to the north?



Drawing: N. Piercy

Figure 11. A typical barrel weight (GW 516) from the wreck, probably a 24- or 25-dirhem weight (preserved mass 70.28 g).

Two of the barrel weights are smoothly biconical, not faceted. They resemble late Roman/early Byzantine weights of similar form quite closely, right down to the decorative rings turned in their upper faces. They also do not fit into the dirhem system very cleanly, as they are slightly over weight. In fact they are very nearly the proper masses for a 10- and a 20 dinar-weight. The problem is that the biconical form was not typically used for dinars; rectangular or octagonal forms were preferred, probably so that dinar and dirhem weights could be easily distinguished. Could these two weights be old Byzantine weights added to a set of Islamic weights precisely because they were so close to a good dinar multiple? A similar practice was common earlier in the Islamic world. Before the Fatimid caliphs began issuing their own dinar and dirhem weights, Abbasid rulers simply validated existing Byzantine weights and reissued them.

Use and Ownership

The people on board the Serçe Limanı ship were well prepared to conduct commerce in both Byzantine and Islamic centers of trade. Heavy goods, such as amphoras, could be weighed with the steelyard, while fine goods and coinage could be weighed with the equal-arm balances and their associated weights. The available weights could even accommodate the dichotomy of the Islamic weight system:

the commercial standard, represented by at least some of the bronze barrel weights, is complemented by the glass coin weights (which are all Fatimid issues for dinars and dirhems [fig. 12]), and by the Byzantine-style barrel weights, which represent the monetary standard. Byzantine coins, since they were the basis of the commercial weight system, could be weighed with the same weights as fine goods. It may seem a bit odd that no Byzantine coin weights were found, but in a unitary weight system, in which coins were weighed in the aggregate, they were superfluous.

Photo: D. Frey

Figure 12. Two of the 16 glass coin weights of Fatimid issue found on the wreck.

Medieval gold and silver coins were not money in the modern sense, but merely a convenient format for the transportation and exchange of bullion. In medieval Arabic, the word for payment had the literal meaning of "weighing." While medieval copper coinage might be accepted at face value, the value of gold and silver coinage depended directly on its precious metal content. This in turn depended on the fineness (purity) and total weight of the coin. The best coinage was struck from fine (pure) metal, but in many of the economies of medieval Europe, debasement was a common method of raising revenue, such that coinage was frequently recalled and reissued. Fineness could be assayed by use of the "balance of wisdom," as it is called in Arabic sources (a water balance, i.e., a means of measuring specific gravity), but the device was hardly portable and in practice the merchant was forced to rely on the honesty of the issuing authority and his own shrewdness. In the markets of northern Europe, debasement and the proliferation of regional or independent mints kept merchants on their toes. Fortunately for the merchants on board the Serçe Limanı ship, the eastern Mediterranean was dominated by a small number of issues, Byzantine *nomismata* and Fatimid dinars, which were themselves relatively stable until well after A.D. 1025, about the time the ship sank.

Even where the currency was fine and stable, however, wear and deliberate defacement reduced the total weight of coins, and the inevitable variation in weight of hand-struck coinage made weighing necessary. Long-term wear of coinage could also prompt issuing authorities to lower the weight of new coins slightly, so that they would match the existing, worn coins in circulation. In addition, change was sometimes made by clipping pieces off of coins. In fact, 15 cut gold dinar fragments were recovered from this wreck. These fragments were not simple fractions of whole coins, such as halves and quarters (four complete quarter-dinars were also found on the wreck), but irregular bits, and thus depended purely on their bullion content for their value.

In this sort of "weight-money" economy, it behooves the merchant to protect himself from loss by verifying the value of currency. Coins could be weighed and verified by bankers and money changers in most larger commercial centers, but a traveling merchant had to have his own means of weighing, and he had to be familiar with the fineness of the issues with which he might be paid. The weight of individual coins could be checked with a fine balance and a set of official coin weights, which were often made of glass. Yet this was tedious and impractical, and money for large transactions was normally weighed in bulk. In such transactions, the value of the group was expressed as its total weight, rather than as the number of coins. Transactions recorded in medieval documents show that groups of gold coins were described in terms of both the number of coins involved and their value by weight in "standard" gold coins. For example, in 1050–1051, a merchant in Tunisia sent to Egypt a purse containing 53½ coins valued at only 49 23/24 dinars.

A final issue to be resolved is ownership of the Serçe Limanı weighing equipment. Was it personal property of one or more merchants, or was it part of the ship's equipment? The evidence strongly favors the latter. All of the weights and weighing implements were found quite far aft, in an area that also produced carpenter's and foraging tools, coins, locks, and some weapons. All of these items can be associated more easily with the ship than with individuals. The stern is also the traditional stowage area for a variety of shipboard property, such as valuables (money) and bosun's stores, both the steelyard and the pans for the fine balance were found in the basket that also contained a large selection of carpenter's tools, a lock, and a quantity of new and used iron nails. The nails are the same size as those used in the construction and repair of the ship, and the tool assemblage is similar to other shipboard tool kits from Mediterranean wrecks. It is therefore most likely that the tools are part of the ship's equipment, and perhaps by association, so is the steelyard.

The large, folding balance was found farther down slope, broken and scattered, and is less clearly associated with the ship's equipment. Folding balances were developed precisely because they were personal possessions and had to be easily transportable, so it is possible, even likely, that it belonged to an individual. It is also possible that its owner had ties with the ship, perhaps as captain or owner; a medium-sized balance was needed to fill the gap in capacity between the steelyard and the fine balance. Moreover, the folding balance is of the correct size for use with the disc weights and was probably the most effective means of weighing money. If the folding balance is not associated with the ship and its equipment, then perhaps the balance of slightly smaller size represented by the beam fragment is.

The pan weights themselves tell an interesting story. That the barrel weights were used with the fine balance and coin weights, as well as with a quantity of coins, can be argued on the basis of provenience. Provenience is of less help with the disc weights; they were more tightly concentrated on the site (suggesting a more robust container) and farther removed from the tool basket, although other elements of ship's equipment, notably a large felling ax, were nearby. The heterogenous nature of both sets, with large numbers of extra weights culled from partial sets, suggests that both were owned or collected by the same individual. They also hint at a personal interest in weights that goes beyond the utilitarian. The inclusion of weights of different standards within each set parallels the minimal concern for accuracy evident in the alteration of the steelyard and its consequently incompatible scales. This inconsistency, which is also seen in the relatively wide range of pounds nominally conforming to the same standard in a given period, is a reflection of the personal level at which business was done in the centuries before the changing structure of medieval trade made more consistent standards necessary. It also seems to me to reflect the personality of the merchant who owned the weighing equipment. Maximum capacity was his primary goal, not accuracy.

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Relics of the Revolution

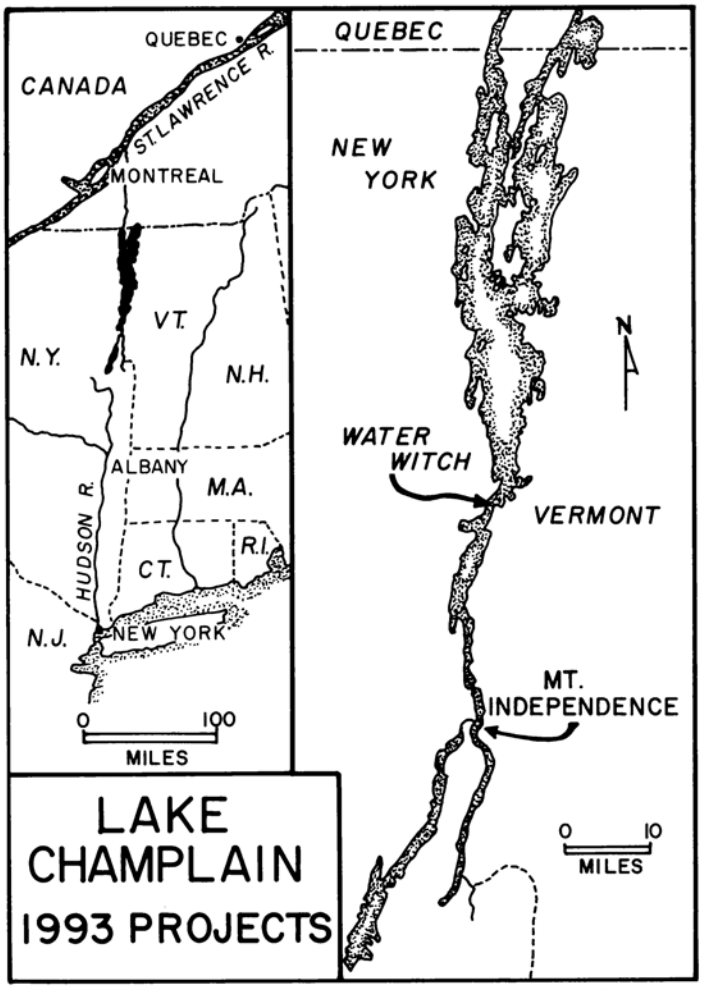
and

A Schooner Called *Water Witch*

The 1993 Field Season on Lake Champlain

by Kevin Crisman

Way back in 1981, during my first week as an M.A. student in the Texas A&M Nautical Archaeology Program, I composed a letter to my friend Arthur Cohn in Vermont. What we needed, I wrote, was a realistic plan of archaeological research for Lake Champlain. Our successes of the previous two years — the recording of the earliest known wreck of a steamboat in 1980 and the discovery of a sunken War of 1812 ship in 1981 — were a good start, but we needed to systematize our approach. Lake Champlain was clearly the perfect place to study the history of American ships and inland navigation: what we now needed to do was find a wreck of every significant vessel type and from every major period in the lake's history. The data we gleaned from these wreck studies could then be turned into books on the nautical archaeology of Lake Champlain, books that would describe 300 years of shipbuilding, warfare, commerce, and everyday life. Above all, I said, we had to be realistic about what we were attempting to do. The fieldwork, research, analysis, and publication of all these wrecks could possibly take as long as *five years* to complete.

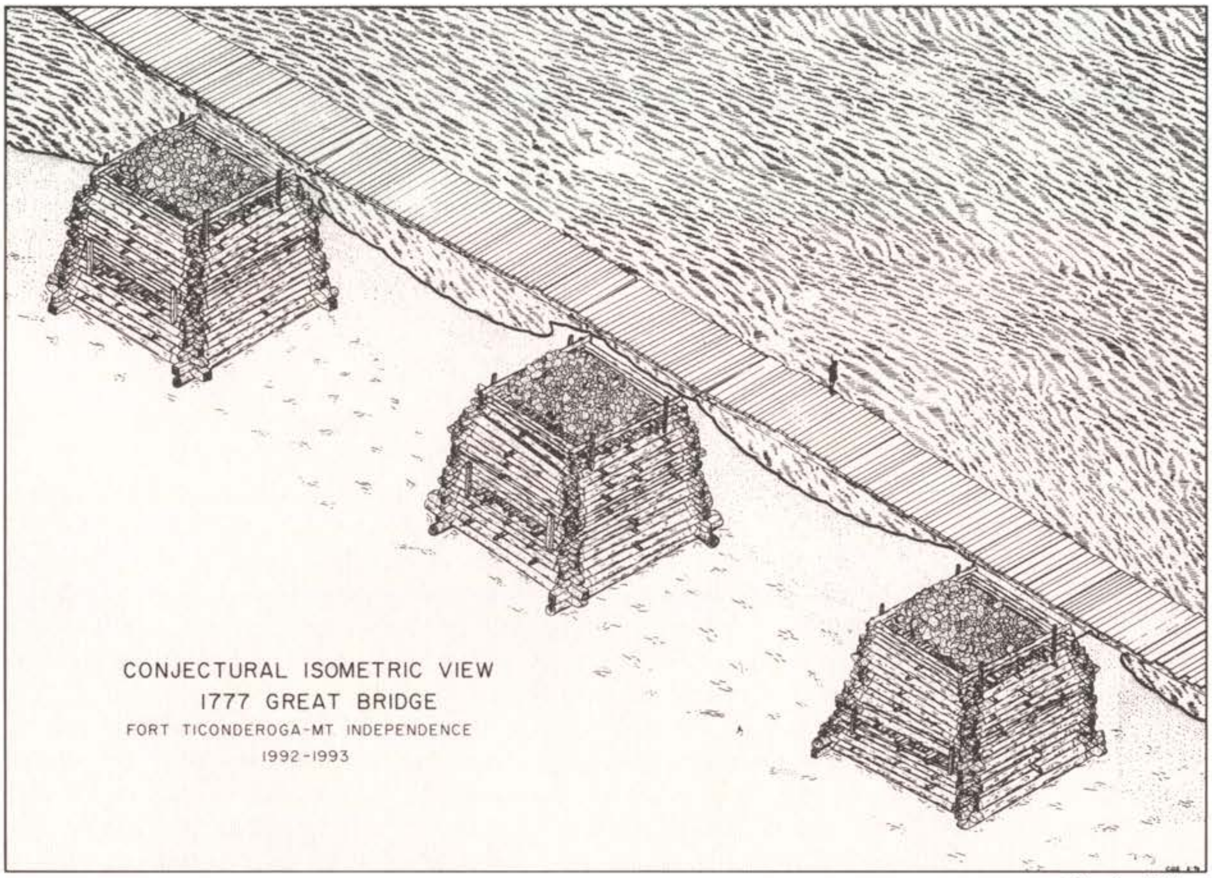


Map: K. Crisman

Locations of 1993 Lake Champlain projects.

Like economic planners in the former Soviet Union, Art and I have watched our "5 year" plan extend into a "10 year" plan, and onward into a "15 year" plan. Were we naive in 1981? Yes, hopelessly. Would we do any of it differently? I don't think so. It has been an incredible 14 years of astounding underwater finds, hard work, and generous dollops of good luck. In this time we have documented prehistoric dugout canoes, colonial bateaux, a British sloop from the French and Indian War, Benedict Arnold's flagship from the Revolutionary War, a 20-gun U.S. Navy brig from the War of 1812, sailing canal boats, steamboats, a floating drydock, and the only known wreck of a horizontal-treadwheel horse ferry. The lake has been, for us, a cornucopia of beautifully-preserved and unique wrecks.

In recent years the work on Lake Champlain has moved to a new level of productivity and sophistication, thanks in large measure to the participation of the Institute of Nautical Archaeology and Texas A&M University. And 1993 was our best year yet, for with the assistance of a team of graduate students from the Nautical Archaeology Program we completed three very ambitious projects: the recovery



Drawing: J. Cozzi

Reconstruction of the floating bridge between Fort Ticonderoga and Mount Independence.

and conservation of Revolutionary War artifacts from the waters around Mount Independence, the *in situ* recording of the steamboat-turned-schooner *Water Witch*, and a preliminary study of the sidewheel steamship *Champlain*. Our work on the *Champlain* will be described by project field director Liz Baldwin in Volume 21.1 of the *Quarterly*.

Mount Independence — Artifacts of the American Revolution

During the perilous years 1776 and 1777 the future of America's war for independence rested in large measure upon the twin defensive works of Fort Ticonderoga and Mount Independence near the southern end of Lake Champlain. Here the American army was expected to stop an imminent British invasion from Canada, an invasion that threatened to split the rebelling colonies in two and force them to surrender. Earthwork gun batteries were placed to repel boats filled with redcoats; barracks, hospitals, magazines, and other buildings were constructed to house American troops and war materials; and a floating bridge was extended across the lake to assist the movement of soldiers and munitions between fortifications. By the spring of 1777 the defenses seemed ready.

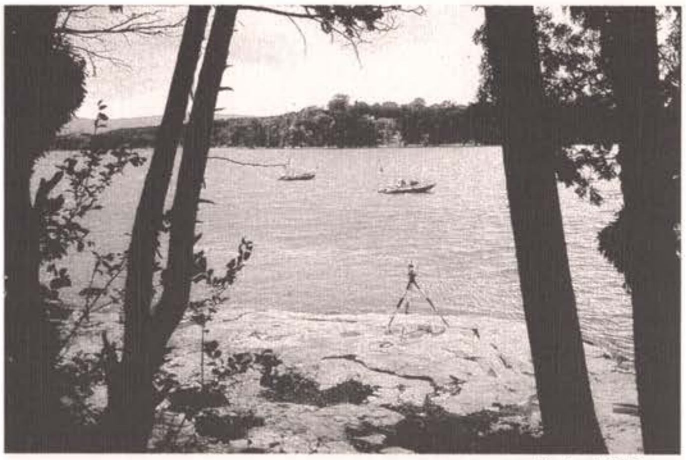


Photo: K. Crisman

View across the lake to Fort Ticonderoga, along the path of the floating "great bridge."

The strength of Ticonderoga and Mount Independence was illusory, however, for through mismanagement and faulty intelligence there were not nearly enough men to

Photo: S. Paris

Photo: K. Crisman

Nautical Archaeology Program students David Robinson, Peter Hitchcock, and Joe Cozzi watch as the 12-pounder cannon is lifted from the lakebottom.

stem the British tide; the American troops on hand were poorly equipped and riddled with sickness. When the superior British army under General John Burgoyne began surrounding the two fortifications in early July, 1777, the commanding American General Arthur St. Clair decided that there was nothing to be gained, and a whole army to be lost, by trying to resist a siege. On the night of July 5-6 his army decamped in the darkness, abandoning everything and fleeing southward on foot and by boat. It may have looked disgraceful, but St. Clair's retreat saved the army to fight another day, and fight it did, capturing all of Burgoyne's army a few months later at the Battle of Saratoga. It was perhaps the greatest single American victory of the war.

Cohn and I first surveyed the waters between Ticonderoga and Mount Independence in 1983, finding the caissons that had anchored the floating bridge and a few scattered artifacts. These were entered on the Vermont state archaeological inventory and the site was monitored until 1991, when a relic-hunter from Indiana was arrested and convicted for mining artifacts from the lakebottom. The state decided that it had to take further steps to study and protect the site, a goal that coincided nicely with our interest in returning to investigate this historic waterfront. The work began in 1992 with intensive surveys that revealed an iron cannon, mortar bombs, bar shot, entrenching tools, and a complete musket. Recording of the bridge caissons was also undertaken at this time (see *INA Quarterly* 19.4: 17-21).

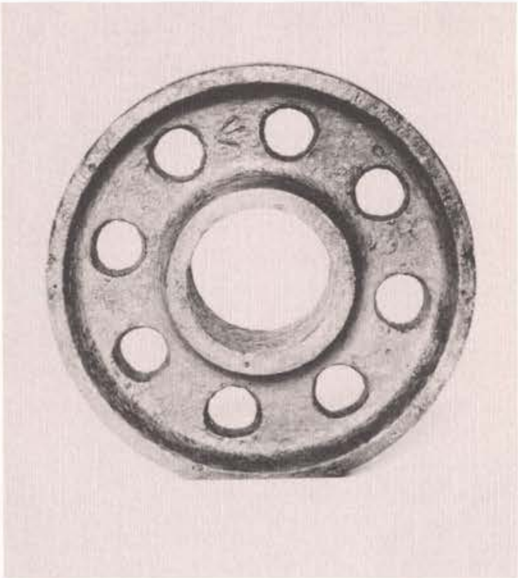
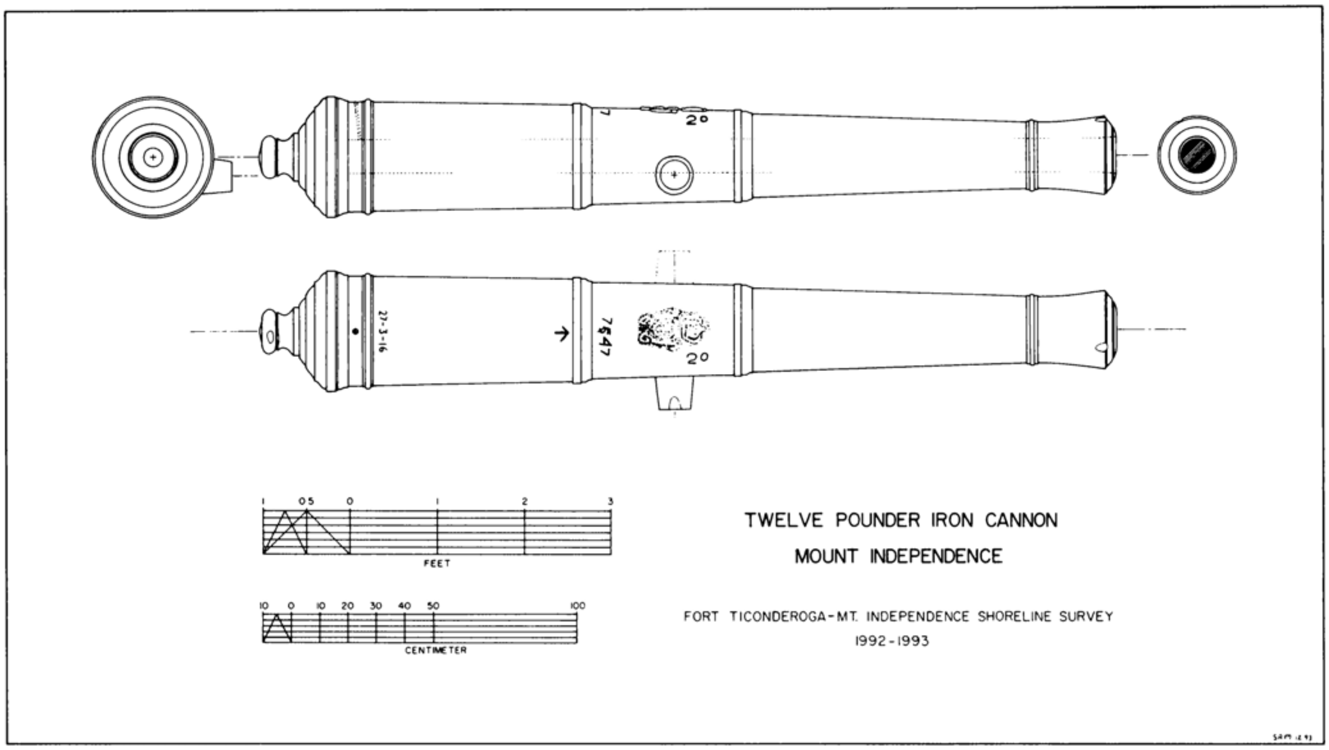


Photo: D. Robinson

The cast-iron gun carriage wheel (diameter ca. 47 cm = 18.75 inches).

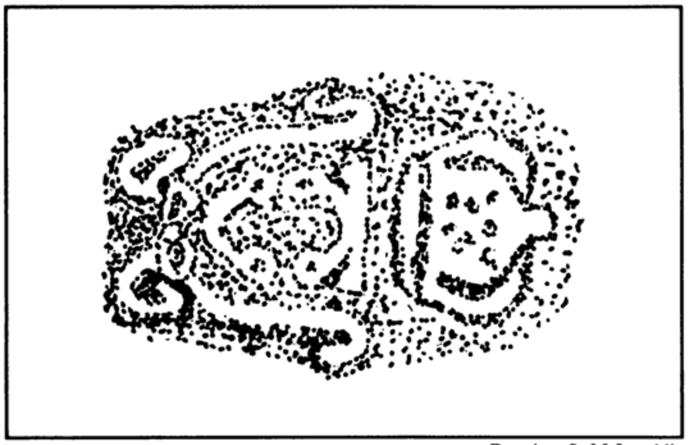
The results of the 1992 study so impressed the Vermont Legislature that it passed a special one-time appropriation to continue the survey in 1993, and to recover and conserve all of the finds for display in Vermont museums. It was a tall order: complete a survey in the black, muddy water conditions around the Mount, as well as build a conservation facility from scratch and treat all of the artifacts in just a few months. Fortunately, we had strong allies in the form of eight highly trained and hard-working graduate students from the Texas A&M Nautical Archaeology Program, as well as a group of enthusiastic undergraduates from the University of Vermont. With this crew and a sprinkling of experienced Lake Champlain-area divers and volunteers, much would be accomplished in three busy weeks, from June 14 to July 1.

We employed the same diver search techniques in 1993 that we had depended upon during the previous year, which included examining the bottom visually (visibility sometimes extended up to several inches!), by touch, and most effectively, with hand-held metal detectors. Sections of lake floor were surveyed with anchors and guide tapes to allow



Drawing: S. McLaughlin

The 12-pounder cast-iron cannon (above) and detail of the unidentified crest on the barrel (below).



Drawing: S. McLaughlin

thorough, overlapping linear or circular search patterns. All surveyed areas and finds were mapped by using transits to triangulate the locations of buoys or a stadia rod. The going was slow, but the relatively warm water and shallow depths (averaging 3 m [10 ft] to no more than 7.62 m [25 ft]) permitted long dives of up to three hours.

Whenever we encountered a cluster of artifacts with a metal detector, survey markers were placed over the find and a diver gently removed the overlying mud by hand. Once the full extent of a feature was uncovered, the snail's-pace process of plotting the location of each artifact began. One of the biggest problems we had to deal with in this regard was seeing the numbers on the measuring tapes and writing them on the clipboard in next-to-zero visibility. Nautical Archaeology Program student David Robinson spent two days mapping a scatter of grenades, mortar bombs, and cannon shot that was about 2.43 m (8 ft) in diameter; his carefully measured underwater drawing of the entire feature was about 3 inches in diameter, with numbers each the size of a flea's hind leg. Asked why he worked in such a small scale, Dave reported that it seemed large enough underwater when he was holding a clipboard, flashlight, and pencil 1 inch away from the faceplate of his mask!

The high point of the field work came on June 28, when "feature 1," the 12-pounder cannon discovered in 1992, and a cast-iron gun carriage wheel were hoisted from the water by a crane parked on the deck of the Lake Champlain Transportation Company ferry *Vermont IV*, which voyaged down to Mount Independence specially for the occasion. Also on hand was the Lake Champlain Maritime Museum's replica Revolutionary War gunboat *Philadelphia II*, which fired a series of salutes from her muzzle-loading swivel guns as the cannon rose above the surface. It was a memorable day for everyone involved.

The cannon, after cleaning, clearly exhibits the broad arrow and British weight stamps on its breech, but the crest on the barrel, which indicates the country of origin, has not yet been identified. One of the cannon's trunnions had been knocked off with a heavy tool and was found nearby on the lake bottom; removing a trunnion was a common way to render a gun unusable when abandoning it.

There was even more excitement. The 12-pounder was surrounded on the lakebottom by 36 8-inch mortar bombs. Were they, we wondered, filled with gunpowder, and if so, was it still dry? The possibility of the bombs still being dry inside after all this time seemed remote, but getting blown up by Revolutionary War ordnance was definitely not on our "to do" list for the 1993 season. I selected a few sample bombs from the pile, and Art Cohn and Nautical Archaeology Program student John Bratten lifted them one-by-one into the inflatable boat, then gingerly scraped away the corrosion around the fuse holes and pried out the wooden plugs. Some of the bombs gave a little hiss when the plug came loose as 200-year-old air escaped; remarkably, they were perfectly dry inside. Fortunately, all the bombs that we recovered contained no powder, and apparently they never had.

Overall, the amount of material we encountered on the lakebottom in 1993 was considerably more than we had expected to find, and together with the finds from 1992 comprised a large and varied collection of Revolutionary-War-era ordnance and tools. Recovered pieces of cast-iron shot included 42 round shot (for guns firing 4- to 24-pound shot), 41 bar shot for use against a ship's rigging (for guns firing 6- to 24-pound shot), 26 mortar bombs (6- and 8-inch diameter), and several hundred smaller swivel and grape shot. Much of the grapeshot came from two rectangular wooden shot boxes that were found lying side-by-side on the bottom. Four hand grenades and a lead musket ball rounded out the collection of munitions. Other weaponry included three bayonets, and the musket found in 1992 which, during conservation, was found to have "Pomeroy," the name of a Connecticut gunsmith, stamped on its lock plate.

Tools found on the site consisted mostly of entrenching spades (a total of 18, with many different styles of manufacture), two shovels, two picks, two axes, and a file. Objects relating to the daily life of the troops at Mount Independence included a brass skillet and many pieces of cast-iron cooking pots, leather shoe fragments, ceramic shards, whole and broken dark-green-glass alcohol bottles, clay pipe stems, a deer antler, and animal bone fragments.

Out in deeper water, not far from one of the bridge caissons, Nautical Archaeology Program student Joe Cozzi located the partly-buried remains of a flat-bottomed scow, a common vessel type on inland waters but one that is seldom studied by archaeologists. Test excavations around the sides of the vessel permitted Cozzi to record its construction details and reconstruct its appearance, but no

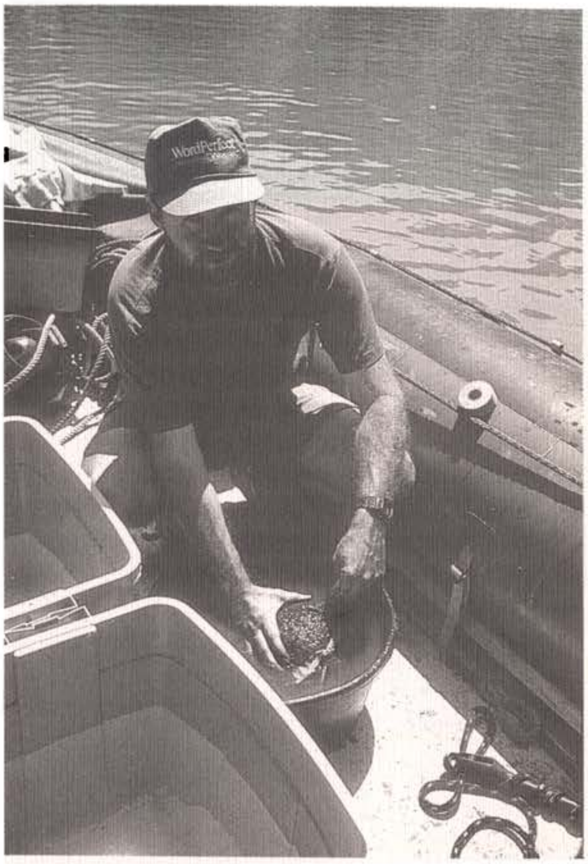


Photo: A. Cohn

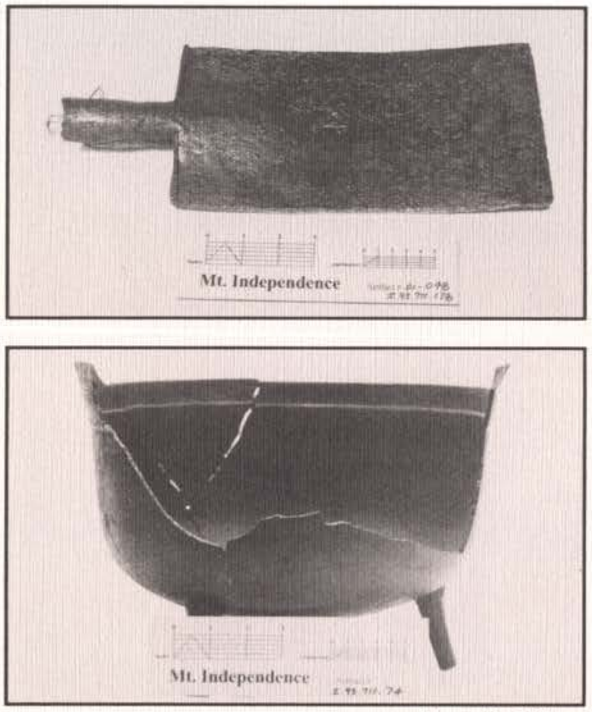
Photo: D. Robinson

Top: John Bratten opens the first of the mortar bombs, none of which contained powder (bottom).

diagnostic artifacts were found that would permit us to date the craft. Nevertheless, the scow's location near the bridge, in an area that saw much ferrying activity during the 1776-1777 period, strongly suggests that it may be of Revolutionary War vintage.

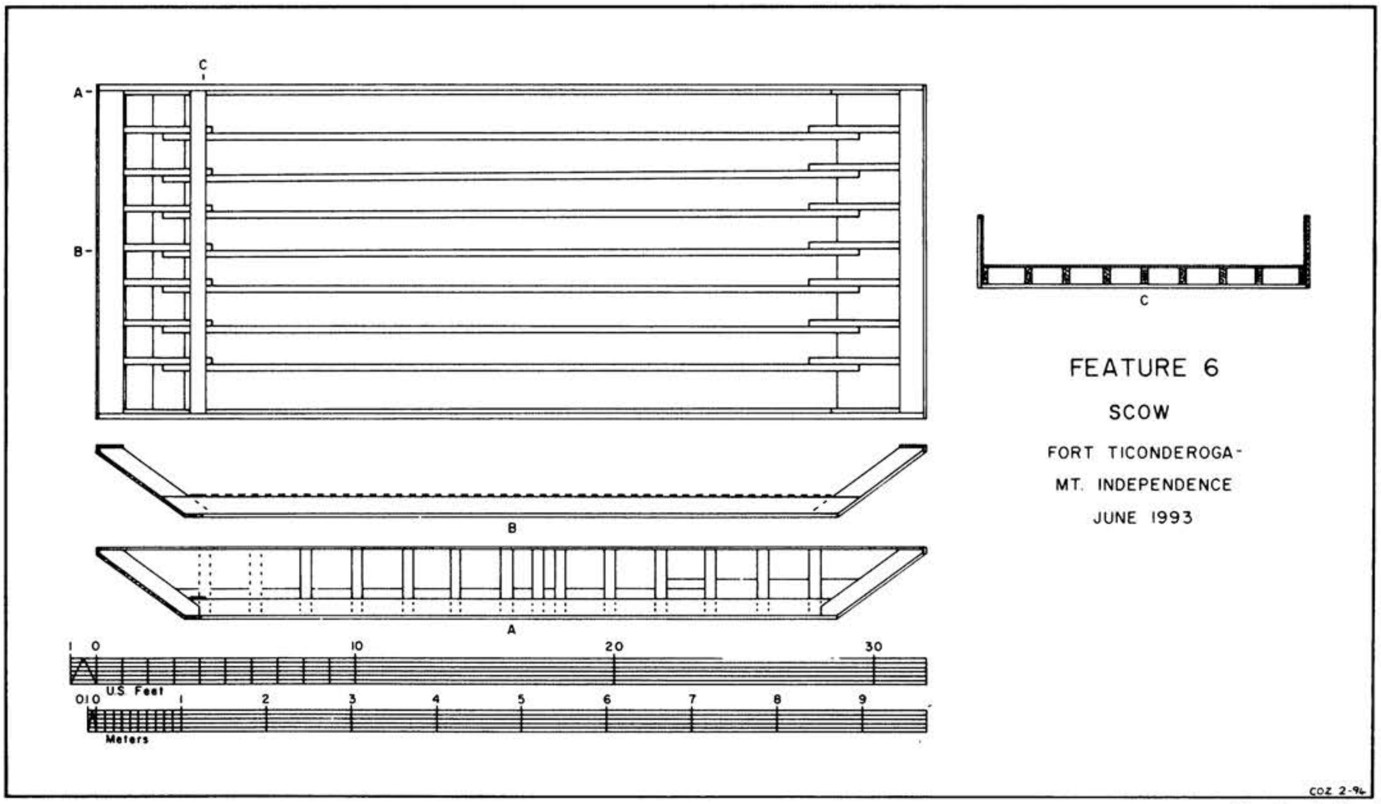
Locating, mapping, and recovering these materials was the relatively easy part of the process; John Bratten's task of building a conservation lab from scratch and getting it into full operation in just a few weeks was one of the truly impressive feats of the 1993 season. When John arrived at the Lake Champlain Maritime Museum in late May the "lab" consisted of a few stakes pounded into the ground near the museum's boatbuilding shed. As the foundation was poured and carpenters erected the walls and roof of the lab, John ranged over the Vermont countryside, scrounging parts from junkyards, borrowing equipment, and negotiating for tools and chemicals. By the end of June artifacts were bubbling away in electrolysis vats, field school students and local volunteers were cleaning and scraping, and the conservation process was in full swing. John worked until the end of August, and then Dave Robinson took over the direction of the lab; by the end of October nearly all of the finds had been conserved and were ready for exhibit.

The Mount Independence study is now in the research and writing phase, with both interim and final reports in various stages of completion. Nautical



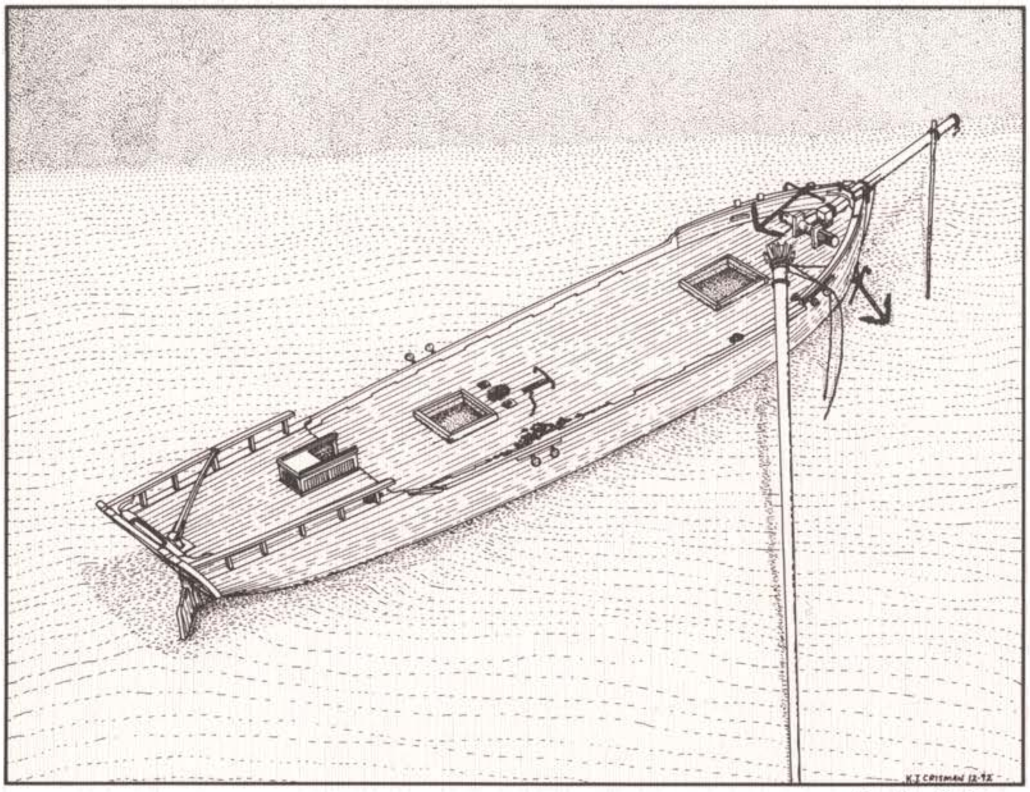
Photos: D. Robinson

An entrenching spade (top) and a cast-iron cooking pot.



Drawing: J. Cozzi

Reconstruction of the scow that may date to the Revolutionary War period.



Drawing: K. Crisman

Reconstruction of the schooner Water Witch, *lost in 1866.*

Archaeology Program student Scott McLaughlin has undertaken the study of the entire artifact collection for his Master's thesis, and over the next few years these artifacts and story they tell of the desperate summer of 1777 will be featured in articles, books, and other publications, as well as in museum exhibits around the state of Vermont.

Schooner in Fourteen Fathoms — the Water Witch *Project*

The second major accomplishment of the 1993 season began on July 6 and continued until July 16. This was the recording of *Water Witch*, an 80-foot-long (24.39 m) schooner that sank in 14 fathoms of dark and very cold (if relatively clear) water near Diamond Island, in the central part of the lake. This project differed a great deal from the preceding work at Mount Independence.

Water Witch had a long and varied career that makes her beautifully-preserved hull of particular interest to nautical archaeologists. She was launched in 1832 as a steamboat by veteran steamer captain Jehaziel Sherman. In her first three years she navigated Champlain's waters as a passenger-and-freight carrier that competed with the reigning steamboat monopoly on the lake, the Champlain Transportation Company. Sherman's challenge was not an entirely noble cause, however, because his chief purpose in running an opposition boat seems to have been to force the monopoly to buy out his operation at a fat profit. The Transportation Company finally did so in 1835 and, due to an over-abundance of steamers on the lake, removed *Water Witch*'s engine and boiler and converted her into a centerboard-equipped merchant schooner. She sailed in this capacity for three decades until she was knocked over by a squall and sank with a load of iron ore in April of 1866. According to all accounts the sinking was nearly instantaneous. The captain's infant daughter drowned in the after cabin during this tragedy.

Art Cohn and I conducted a preliminary and very brief survey of *Water Witch* during a stormy week in May of 1990, and planned to continue the study when time and funding permitted. In 1993, with special assistance from then-INA Board Chairman Ray H. Siegfried II and the Lake Champlain Basin Program, we scheduled a two-week project to document the external appearance of the wreck and take off her lines — record her three-dimensional shape — and thereby gain a better idea of the hull form of this early lake steamer. Our goals were extremely ambitious given the time we had, the depth and the dark conditions on the wreck, as well as the unpredictable weather that can so easily disrupt a dive schedule on this part of the lake. Nevertheless, we had several factors working in our favor, including use of the research vessel *Neptune*, commanded by experienced lake captain Fred Fayette, and a small but crack crew of eight Nautical Archaeology Program students and local divers. We were also fortunate to have the valuable assistance of the Nautical Archaeology Program's ship expert, Dr. Fred Hocker.

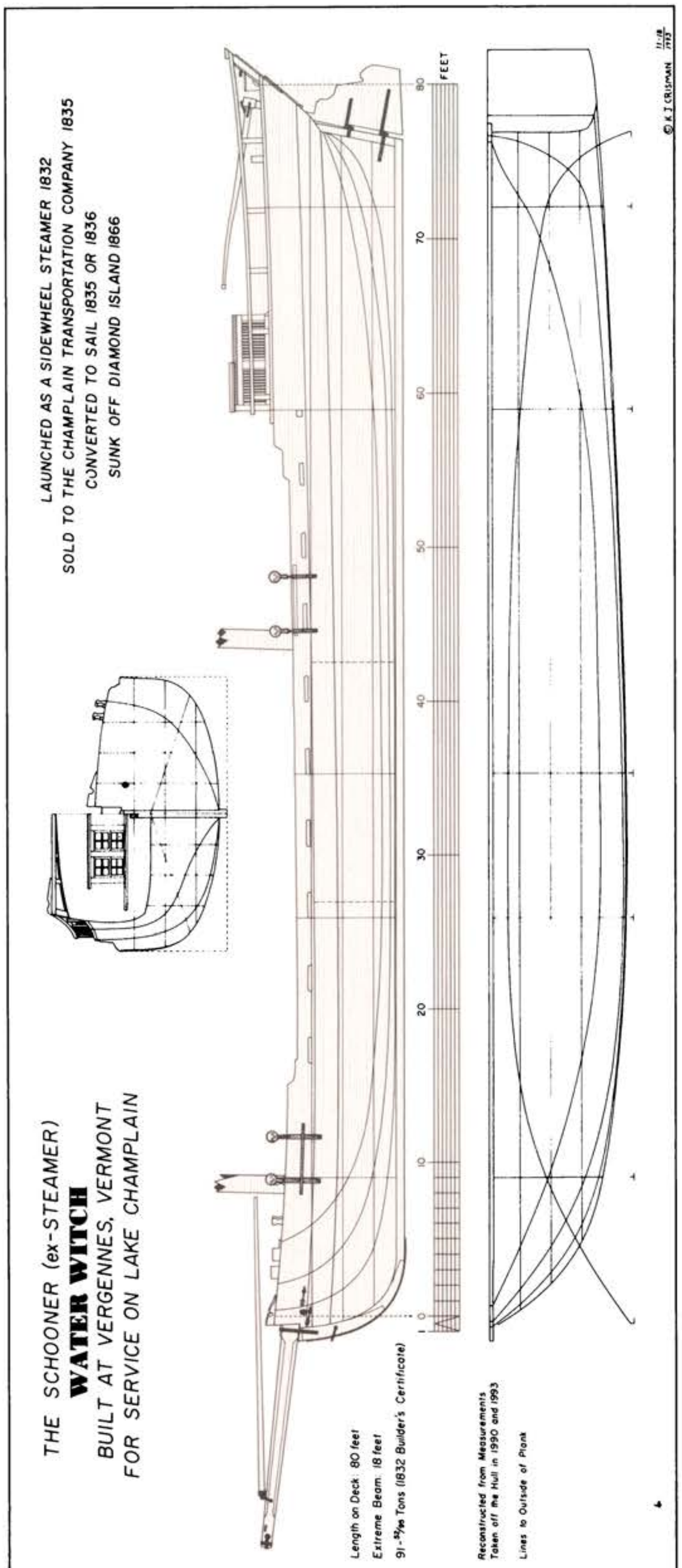
Water Witch is perhaps the prettiest vessel that I have yet had the privilege of recording, but she is a most haunting wreck to visit. She sits upright on the bottom in perpetually dim, grey-green light, her sides rising high and dark above the smooth, silty lakebottom. Whenever we descended upon the wreck, one of the first objects to appear in the beams of our dive lights was the bowsprit, extending out into inky blackness. At the schooner's bow could be seen two folding-stock anchors, one lying on the bottom off the starboard side, the other still ready for deployment on the port side of the deck. In the center of the bow sits a wooden windlass for raising the anchors, its drums worn from years of reeling in anchor chain. Two open hatches on the main deck provided access to a hold now filled with chunks of iron ore and covered over with a thick layer of silt.

At the after end of the schooner the quarterdeck rises above the level of the main deck, and is surrounded by a low open railing. A flashlight-assisted peek into the open companionway revealed the stern cabin, complete with a cast-iron wood-burning stove, reeded panelling painted white, and what appears to be the remains of bunks and storage lockers. About 9 m (30 ft) off the starboard quarter of *Water Witch* lies the schooner's small boat, dragged to the bottom by a towrope that has long since fallen to pieces and drifted away.

We did not, unfortunately, have much time for sight-seeing on *Water Witch*. The project schedule allowed for only one dive per diver per day, and each diver descended with a long list of measurements and sketches to record in just a few short minutes on the wreck, which lay at a depth of 84 ft (25.6 m). During the 10 days of diving the dimensions of endposts, rails, spars, scuppers, planking, hatches, the companionway, tiller, and rudder were carefully taken, along with hull offsets, video footage, and several rolls of color slides. The recording of the schooner's three-dimensional shape was greatly assisted by our use of an electronic angle-measuring device, called a goniometer, devised by Joe Cozzi.

All in all, it was a nip-and-tuck race to see if we could complete all of our objectives on time, but the weather held, all of the divers did an exemplary job of getting the required information, and on the last day we recorded the final, essential measurements necessary to reconstruct the lines of *Water Witch* on paper. In 14 years of archaeological work on the lake, this was probably the most productive project we have ever run in terms of the amount of data collected per dive.

What did we learn about the vessel? The reconstructed lines of *Water Witch* show a long, lean hull with a length-to-beam ratio of 4.44:1, a sharp entrance, a relatively full midship section with slack bilges, and a long, gracefully tapering run. Above all *Water Witch* was a shallow vessel, with a rabbet-to-sheer height of only 6.5 ft (1.98 m) amidships; she could not have drawn much more than 4 ft (1.21 m) of water even when heavily laden with iron ore. The weight of her final cargo probably did not leave much



freeboard, and it is no surprise that she swamped and went to the bottom as quickly as she did.

The conversion of *Water Witch* from a steamer to a schooner was thorough, and we found little evidence of her earlier career on the outside of her hull. Her original U.S. Government enrollment documents indicate that the vessel had no masts or bowsprit when she was built; these were all added after 1835. Fred Hocker noted that the opening cut for the bowsprit showed clear evidence of being a later modification. The centerboard case in her hold was also a later addition, designed to improve the schooner's lateral resistance and stability. Remnants of the vessel's steamboat past may lie in the hold, beneath the iron ore, in the form of engine mounts and sister keelsons designed to distribute the weight of the engine and boiler over the length of the hull.

What was evident to us was *Water Witch*'s advanced age at the time she sank. Small fillets of wood had been inserted in many places in the main deck and at the sides to replace sections of rotten planking, and the corners where the rails meet the deck had strips of copper flashing tacked down over seams to prevent water from leaking into the hold. She was an old vessel, clearly in the twilight of her career, when that gust of wind heeled her over in 1866 and the water gushed into the hold. By a strange coincidence the shore nearest the wreck is Fort Cassin Point, the very place where *Water Witch* was built and launched in 1832.

Acknowledgements. The 1993 field season on Lake Champlain was sponsored by the Institute of Nautical Archaeology, Texas A&M University, the Lake Champlain Maritime Museum, the Vermont Division for Historic Preservation, the University of Vermont, and the Lake Champlain Basin Program. A special thank you is due to Mr. Ray H. Siegfried II for his help. Thanks also to Texas A&M graduate students Elizabeth Baldwin, John Bratten, Joseph Cozzi, Alan Flanigan, Peter Hitchcock, Scott McLaughlin, Stephen Paris, and David Robinson. The staff of the Lake Champlain Maritime Museum contributed greatly to the smooth running of the summer's fieldwork activity.

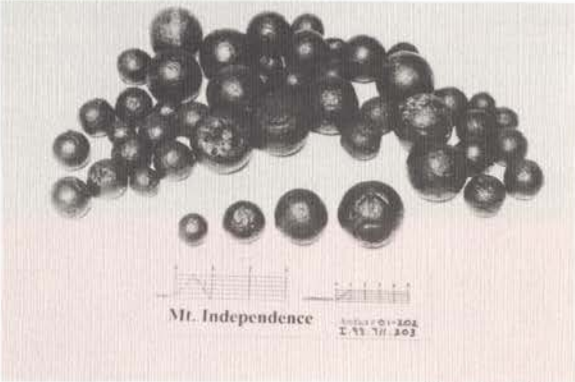


Photo: D. Robinson

Photo: D. Robinson

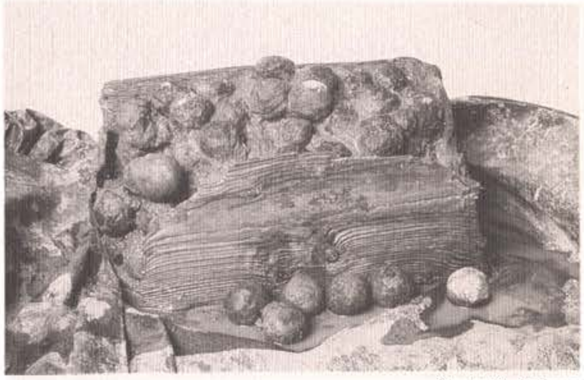


Photo: K. Crisman

Cannon balls and grapeshot (top), bar shot (middle), and a shot box (bottom).

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News & Notes

Fulbright Scholar Program

Council for International Exchange of Scholars
Washington, D.C.

Fulbright Scholar Awards for U.S. Faculty and Professionals
1995 – 1996 Competition

Fulbright opportunities are available for university lecturing or advanced research in nearly 140 countries. Funding is provided by the United States Information Agency, on behalf of the U.S. government, and cooperating governments and host institutions abroad.

Awards range from two months to a full academic year, and many assignments are flexible to the needs of the grantee. Openings exist in almost every area of the humanities, social sciences, natural and applied sciences, the arts, and professional fields such as business, journalism, and law. Applications are encouraged from professionals outside academe, as well as from faculty at all types of institutions.

Basic eligibility requirements for a Fulbright Scholar award are U.S. citizenship and the Ph.D. or comparable professional qualifications. For lecturing awards, university or college teaching experience is expected. Language skills are needed for some countries, but most lecturing assignments are in English.

A SINGLE DEADLINE OF AUGUST 1, 1994, exists for research or lecturing grants to all world areas. Other deadlines are in place for special programs. For further information and application materials, contact:

Council for International Exchange of Scholars
3007 Tilden Street, N.W., Suite 5M
Box GNEWS
Washington, D.C. 20002-3009
Bitnet (application requests only): CIES1@GWUVM.GWU.EDU. Telephone: 202-686-7877

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Archaeology Projects\Interpretive Research
Division of Research Programs, Room 318
1100 Pennsylvania Avenue, NW
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