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Spring & Summer 1994

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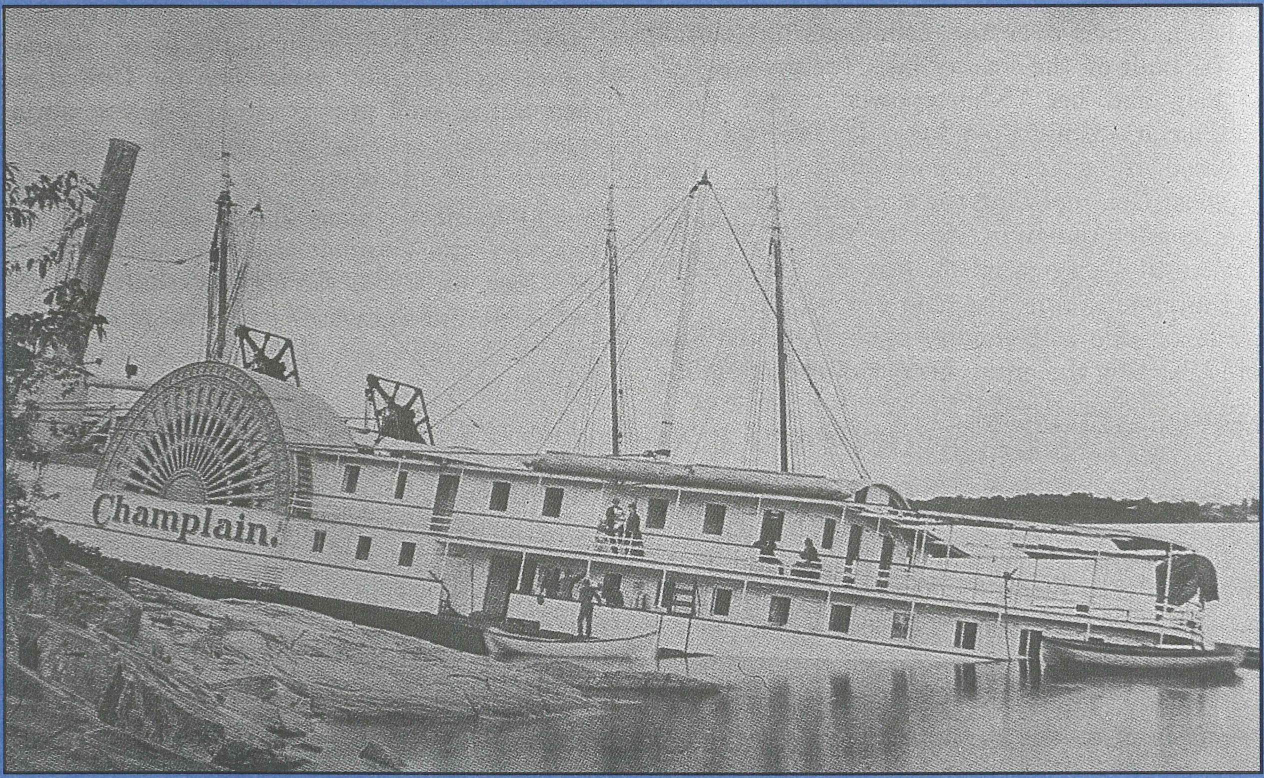

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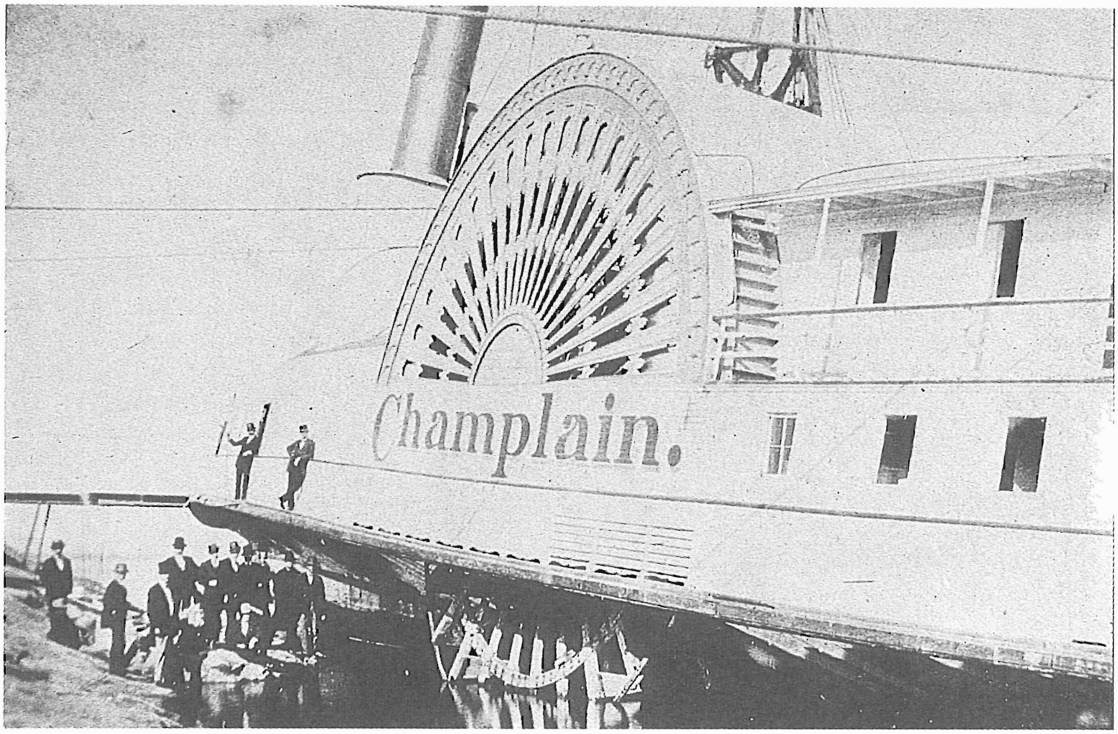
The articles in this issue of the *Quarterly* exemplify the close relationship the Institute enjoys with the students of the Nautical Archaeology Program at Texas A&M University.

On the cover: *An 1875 photograph of the* Champlain II *wrecked on the rocky western shore of Lake Champlain, looking north* (Courtesy University of Vermont Archives).

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



Courtesy University of Vermont Archives

Inspection of the Champlain II *after it had been driven up onto the rocky shore of Steam Mill Point, Lake Champlain, at the southern tip of Split Rock Mountain.*

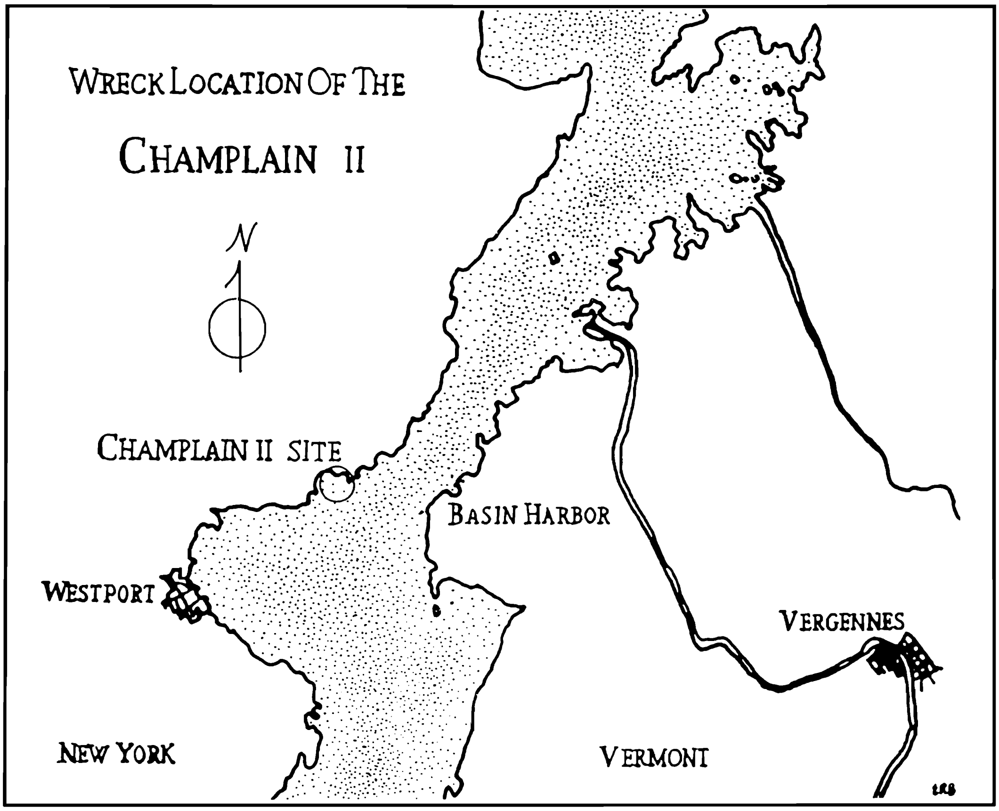
"My God, How Can It Be?" The Wreck of the Steamship *Champlain II*

by Elizabeth Robinson Baldwin

On the night of July 16, 1875, the Lake Champlain paddlewheel steamer *Champlain II* was heading north on the lake from Ticonderoga, New York, under the command of Captain George Rushlow. The steamer had stopped to discharge all but 53 paying passengers and several uncounted ones at Westport, New York. No additional passengers embarked. While at the dock the first pilot, El Rockwell, becketed (strapped down) the wheel at the request of the relief pilot, John Eldredge. Although Rockwell thought Eldredge looked "gruff," he turned the wheel over to him and retired for the evening. Within minutes after Eldredge had taken the wheel, the steamer was rocked by a huge crash.

Although some crew feared they had run over another vessel on the lake, the *Champlain II* had actually been driven into the rocky shoreline of Steam Mill Point, at the southern tip of Split Rock Mountain. Pilot Rockwell rushed back to the pilot house to find Eldredge standing at the wheel, simply staring into space. When Rockwell questioned him Eldredge replied, "Can you account for my being on the mountain?" When the full import of the situation struck him, Eldredge was deeply shaken. "My God, how can it be, I was steering as I always steer, clear of the mountains." Captain Rushlow quickly ordered the engines stopped and the fires under the boilers put out, and the passengers were put ashore by means of a gang plank laid out from the port rail. Miraculously, no lives were lost, no one was seriously injured, all the baggage was saved, and only a small part of the cargo was ruined. During the commotion and landing of the passengers and salvaging of the cargo no one noticed Pilot Eldredge leave the ship and disappear into the woods. He was found days later near the wreck site, claiming not to remember what had happened.

The wreck was well publicized and caused a sensation. Sightseers flocked to the site, and the steamer's owners ran



Map: E. Baldwin

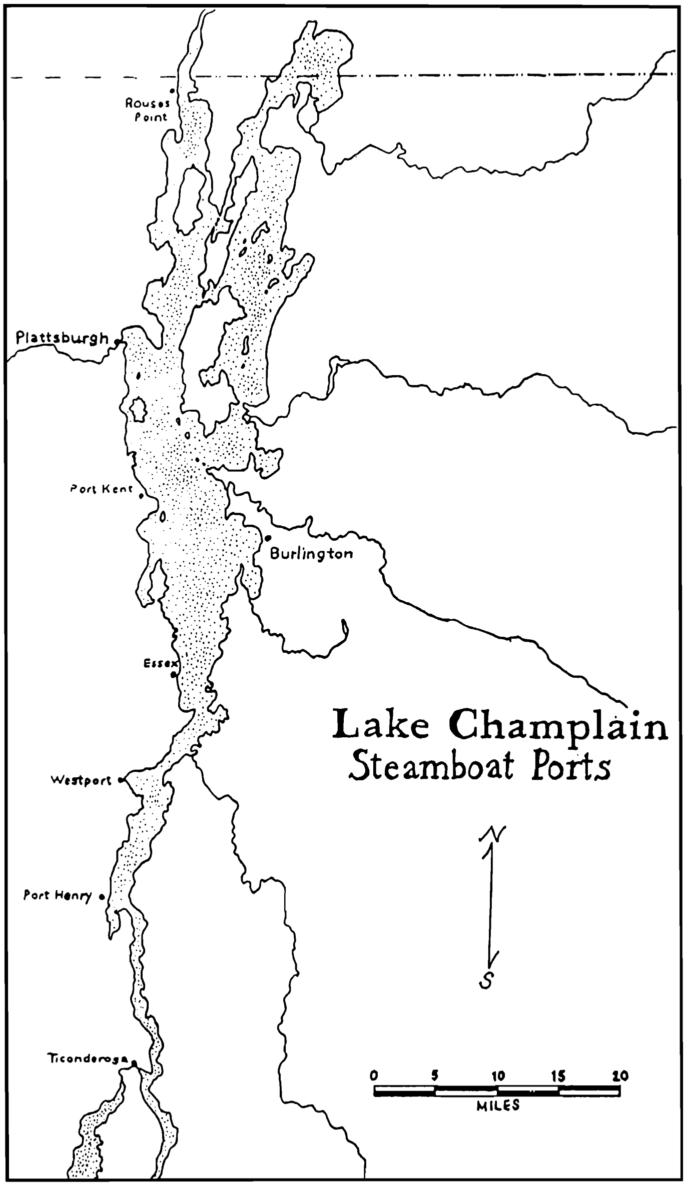
Wreck location of the Champlain II.

excursions to the scene of the disaster. The remains of the *Champlain II* now lie in 15–35 ft (4.57–10.67 m) of water at the southern tip of Split Rock Mountain, on the New York side of Lake Champlain. The site is well known and popular with recreational divers. In the winter of 1993 the Vermont Division for Historic Preservation contacted Art Cohn of the Lake Champlain Maritime Museum, and his research partner, Dr. Kevin Crisman of the Texas A&M University Nautical Archaeology Program. The Division was interested in evaluating the *Champlain II* for possible inclusion in its Historic Underwater Preserve System in Lake Champlain. Dr. Crisman asked me if I would be interested in directing the archaeological recording of the hull during the 1993 Lake Champlain Summer Field School. Having studied other nineteenth-century steamships, I gladly accepted the offer.

The *Champlain II* holds an important place in the development of steamships on Lake Champlain. Although it was on the lake only from 1868 to 1875, the vessel had two distinct service careers. The steamer's changing service illustrates well the intense competition between railroad companies and their insatiable quests for routes to new markets, as well as the struggles of steamship companies to maintain a market share and adapt to changes in transportation technology.

The *Champlain II* began its working life as a railroad car ferry named *Oakes Ames.* The vessel was commissioned by the Burlington Steamboat Company, a wholly owned subsidiary of the Rutland Railroad Company, for the specific purpose of transferring railroad cars between the Rutland Railroad terminus at Burlington and the Montreal and Plattsburgh Railroad terminus at Plattsburgh, New York. The Montreal and Plattsburgh Railroad was also owned by the Rutland Railroad Company. In addition to serving the railroads, the *Oakes Ames* was to ferry passengers between Plattsburgh and Burlington, stopping at Port Kent, New York, along the way.

Champlain II was built in 1868 at Marks Bay in South Burlington, Vermont. Two men were responsible for her construction: Captain Napoleon B. Proctor, an experienced lake captain, and Master Carpenter Orson S. Spear, a well known Lake Champlain shipbuilder and house carpenter. Reports in the *Burlington Free Press* from January through June 1868 indicate that Captain Proctor superintended the construction and maintained a tight veil of secrecy around the vessel, her owners and her intended purpose. The



Map: E. Baldwin

Lake Champlain steamboat ports in the year 1875. All commercial passenger lines made scheduled stops at these ports.

mystery ended on June 3, 1868, when the vessel was launched amidst great fanfare, with Vermont Governor John Page, Director of the Rutland Railroad, and a host of dignitaries attending. Among them was her new namesake, Oakes Ames, a Congressman from Massachusetts and a newly appointed Director of the Rutland Railroad.

The *Oakes Ames* became celebrated in her day for both her strength and her speed. She could carry 12 to 14 fully laden railroad cars at a time on two lengths of tracks that ran the length of the main deck. After initial trials, her engineers estimated her speed would average "between twenty-two and twenty-three miles per hour." The vessel was outfitted with boilers from T.S. Sutherland and Company of Whitehall, New York, located at the southern end of Lake Champlain, and was powered by two independent walking beam engines built by the Fletcher Harrison Company of Hoboken, New Jersey. The boilers were placed well out on the guards (the overhanging portion of the deck along the sides of the vessel), with the two beam engines positioned at the inboard edges of the paddlehousing. One observer, the publisher R.S. Styles, described her "novel and peculiar construction" at length, concluding that she was "a vast floating railroad bridge."

This "vast floating railroad bridge" required a special docking arrangement. Captain Proctor had patented a design for a "Floating Draw Bridge" in 1856, twelve years before the *Oakes Ames* was built. The patent describes a floating dock with a berth for a large steam vessel at one end and a draw bridge equipped with railroad tracks at the other. The draw bridge could be lowered to connect with railway tracks on shore. A steamboat could enter the berth bow first, after which the forward bulwarks would be removed. Freight cars would be pushed across the bridge and dock, over the bow of the vessel and onto the main deck of the steamer. Although the patented bridge had not yet been built, the design and construction of this draw bridge was uppermost in Proctor's mind when he designed the *Oakes Ames*. Proctor's floating dock, with its connecting hinged bridge, was a familiar sight at the end of Maple Street in Burlington for many years after the *Oakes Ames* was launched.

The *Oakes Ames* was successful as a railroad car ferry, operating from August 31, 1868, through March of 1873. During this period the Champlain Transportation Company (CTC), the major passenger steamship operator on the lake, engaged in a contractual agreement with the Rutland Railroad. The CTC made Plattsburgh the terminus for its passenger line service, and coordinated the steamer schedules with the railroad schedule. The agreement provided the Rutland with increased traffic for its rail service, and no appreciable decrease in traffic for the *Oakes Ames*. This profitable period ended on March 1, 1873, however, when a consolidation of railroad property in the Champlain region by the Delaware and Hudson Company eliminated the need for her services.

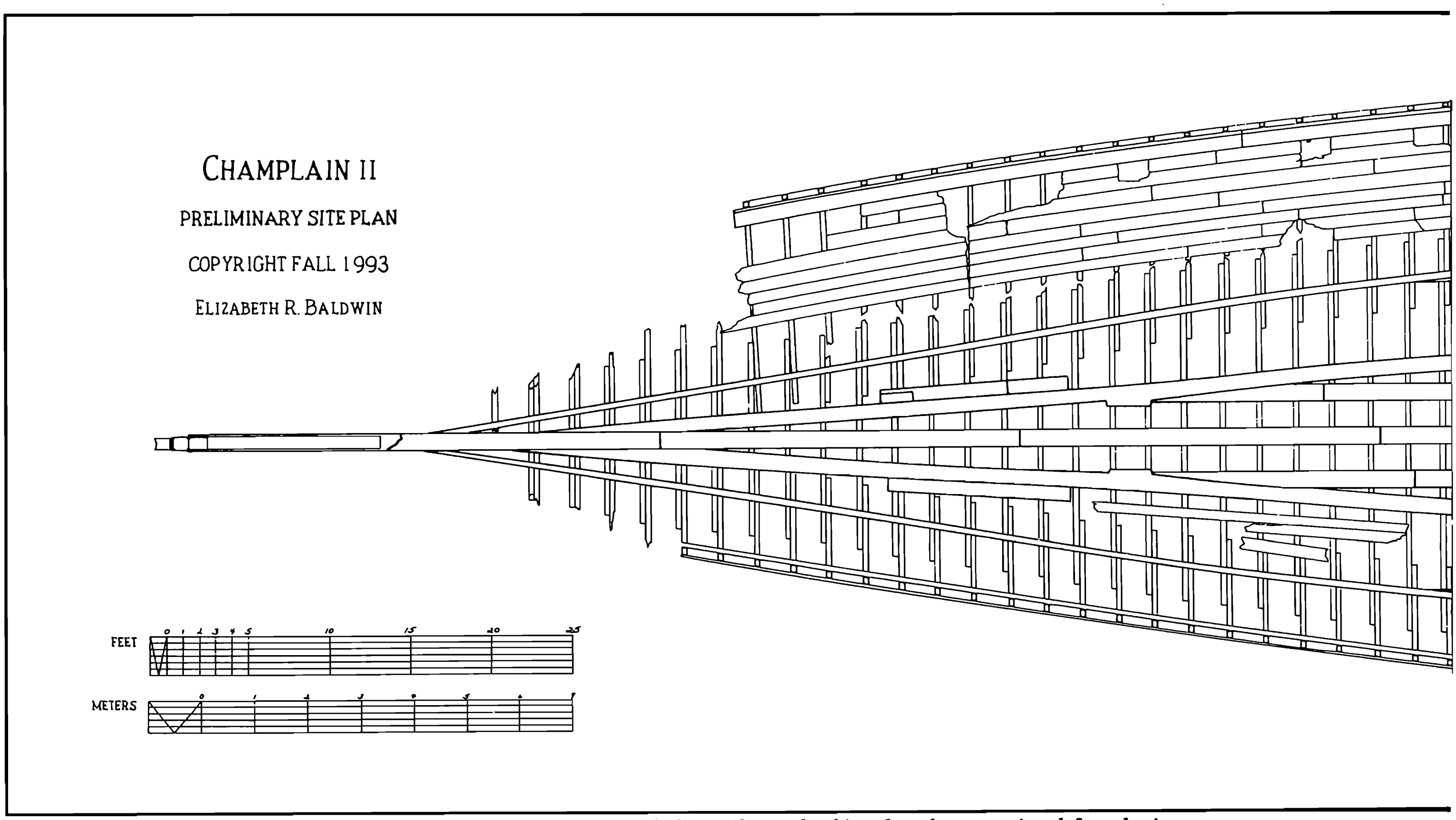
The railroad companies of the late nineteenth century were constantly searching for opportunities to expand. In order to extend the rail lines to reach new markets they leased large portions of track from other lines that linked tracks they built or owned outright. The Delaware and Hudson, wanting to move its Pennsylvania coal north to

Canadian markets, took control of all leases and property of the Rutland Railroad, which of course included the *Oakes Ames*. As the railroad company wanted no competition for the railroad from steamers, the vessel was in turn "sold" in the same year to the CTC, a wholly owned subsidiary of the Delaware and Hudson, for conversion into a passenger steamship.

The CTC paid $85,000 for her, and spent another $24,000 to convert her to a passenger vessel by stripping off the rail tracks and adding cabins and passenger furnishings. Because of her original purpose much of the main deck was free of machinery and there was plenty of room for opulence. The vessel was fitted with a main stateroom hall 162 ft (49.39 m) long. The new layout also boasted 41 staterooms, two suites, a dining room capable of seating 115 people, 46 smaller berths, a post office and a barber shop. The name of the vessel was also changed before she was entered into service for the CTC. Senator Oakes Ames had unfortunately become involved in the notorious Credit Mobilier/Union Pacific Railroad Company cash-skimming scandal. His name was most likely an embarrassment to the new owners, but in any case the vessel was renamed *Champlain II,* after an earlier lake steamer.

She was operated by the CTC as a passenger steamer for only one and a half seasons before disaster befell her. Immediately after her refit was completed in May of 1875, the vessel was placed on special charter excursion service and on back-up duty for the line boats. On July 5th of that summer the line boat *Vermont II* broke a piston and was taken out of service. The *Champlain II* replaced her on the night run from Ticonderoga to Plattsburgh. She had been on duty a little over a week when Eldredge drove her onto the rocks.

The loss of the new vessel rocked the financially troubled company, which along with local steamship inspectors launched a thorough investigation into the incident. The entire crew was asked to submit written testimony, and the inspectors interviewed several of the key crew members, including the captain and pilots Rockwell and Eldredge. The investigation revealed that Eldredge had been buying larger than normal quantities of morphine, at that time sold over the counter, from different druggists up and down the lake, and had even had friends, including the *Champlain II's* baggage master, purchase some for him. Co-workers, acquaintances, and even Eldredge's house painter testified that they had seen him in trance-like states. Eldredge himself claimed that the drugs had been for the general use of his family, and that he had never taken any.



Preliminary site plan of the hull remains; the sternpost is at left. Ceiling planking has been omitted for clarity.

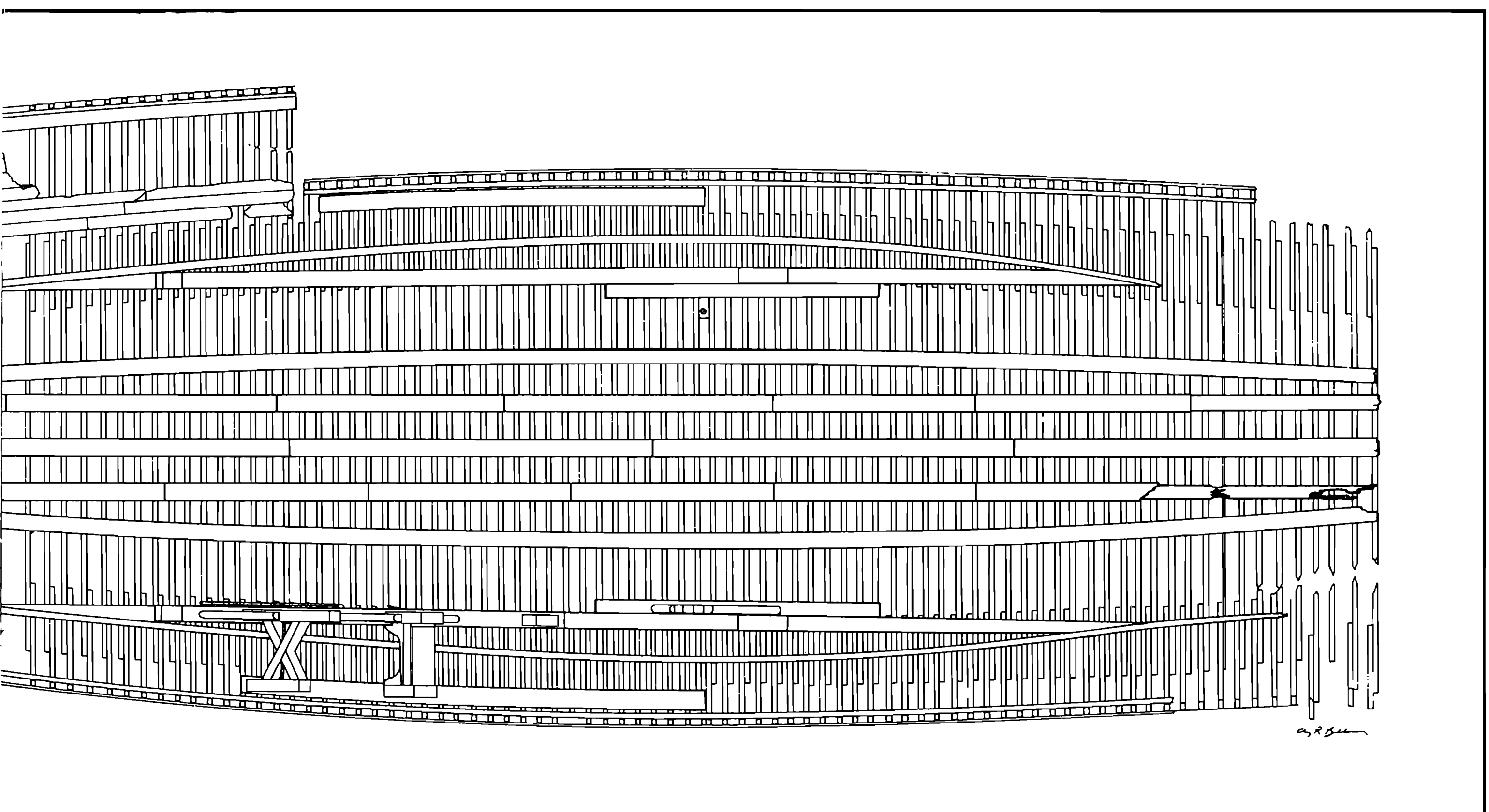
However, the steamship inspectors concluded that Eldredge was addicted to morphine and had most likely lapsed into a drug-induced stupor while at the wheel. His license to pilot any vessel was summarily revoked by the authorities, to which his reply was said to be, "Gentlemen, wait until I ask you for one."

The *Champlain II* had driven about a third of the length of her keel out of the water and had listed to starboard, away from shore. The "back" of the vessel, that is her longitudinal stiffening timbers, had broken in the crash, and the steamer was declared a total loss. The *Champlain II* was subsequently stripped of her two engines (which went into two other Company vessels), boilers, upper works and all salvageable furnishings. The remaining hull was finally towed out into deeper water and allowed to sink.

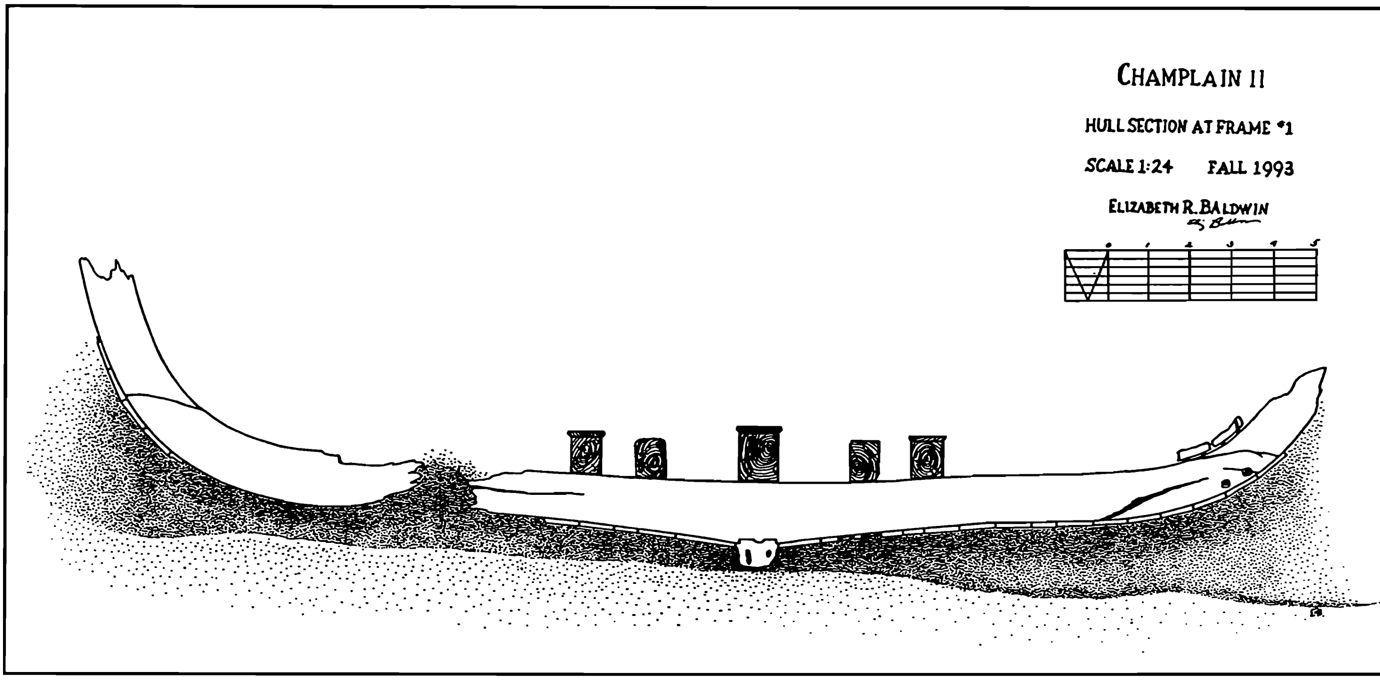
While the story of the wreck of the *Champlain II* is widely known, we know much less about her original construction as a railroad car ferry and about the structural changes made to the hull during her conversion to a passenger steamer. Construction plans showing her original design have not been found. Nor does there exist any record of the structural changes made by shipwrights at the CTC yard in Shelburne, Vermont (besides enthusiastic descriptions of her luxurious appointments).

A brief preliminary survey of the site was made by avocational divers Dennis Breitigan and William Guppy in 1988, who created a simple plan of the wreck. Our initial reconnaissance dive on the hull in 1993 revealed that important information regarding the extent of the hull remains and its unique construction features awaited us. Our field season on this large, well preserved hull lasted from June 6 through July 9, 1993.

The wreck lies in the sheltered cove called Rock Harbor, which is directly across the lake from Basin Harbor, Vermont, where we were based at the Lake Champlain Maritime Museum. Staff and crew loaded their gear into an inflatable Zodiac and were ferried in shifts to the site, at the southern end of Split Rock Mountain. Our crew consisted of graduate students from Texas A&M and the University of Vermont (UVM), undergraduates from UVM, and local volunteer divemasters. Although our mission was only to conduct a general survey of the wreck and assess its condition, we recorded as much of the hull structure as possible within a four week period. We made two dives each per day; each dive lasted between 20 and 45 minutes while the water remained about 40°F; dive times were extended once the water warmed to a balmy 50°F.



Drawing: E. Baldwin



Drawing: E. Baldwin

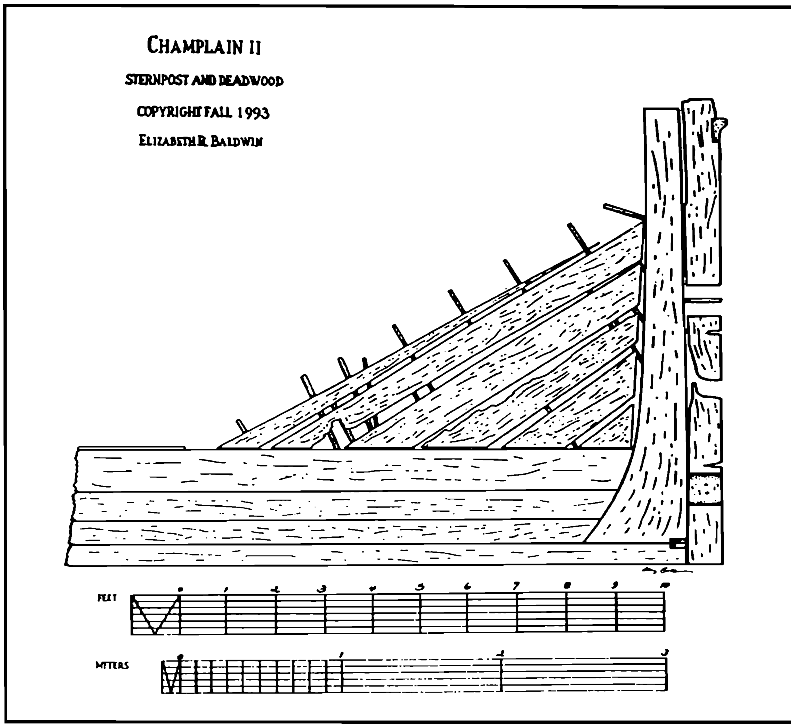
Hull section at Frame 1, looking aft. The starboard portion of the floor timber has broken off. The oak cap timbers are missing from the two inner stringers at this frame section; they commence at F11 and F13, to port and starboard, respectively.

The hull remains lie on a direct north-south axis, with the stern (to the north) lying nearest shore at a depth of about 15 ft (4.67 m). The forward extremity rests in about 35 ft (10.67 m) of water. The entire preserved structure measures 163 ft, 11 in (ca. 50 m) in length. When the *Oakes Ames* was officially enrolled (registered) at the Port of Burlington she measured 244 ft (74.39 m) long, 34 ft 7.7/10ths in (ca. 10.52 m) in breadth, and 9 ft 8.75/10ths in (ca. 2.93 m) in depth. A comparison of the recorded remains with enrollment measurements indicates that a significant portion of the forward end of the vessel is missing: approximately 80 ft (24.39 m), or a little over a third of the total length.

The wreck rests upright on its oak keel, and is firmly settled in the mud. A considerable portion of the starboard side is standing and intact up to the level of the main deck beams. Approximately half of the port side has collapsed away from the hull abaft amidships, a result of the breaking of frames F66 through F101 at the floor timber/futtock join. This section remains a more or less cohesive assembly. The forward-most extremity of the remains marks the point at which the keel and other longitudinal members broke as a result of the crash. Saw marks indicate that the original salvors purposely made a clean saw cut across the hull, leaving the bow section on land to be hauled away and reused. This gave us a convenient opportunity to study the keel and record a section of the hull. The keel is quite shallow, only 7 in (17.78 cm) moulded (high), though it is not clear if this is the original dimension or if portions broke off during the wrecking. There are no rabbets in the keel, as the garboards were butted directly against its moulded faces (sides).

The entire sternpost is standing. It is also of oak and composed of two pieces, the inner, or sternpost proper, and the outer, or false, post. The mortise-and-tenon joint uniting the keel and the sternpost is strengthened by six oak deadwood timbers. The deadwood is stacked at a 45° angle and forms a triangle between the horizontal keelson and the vertical sternpost. Large gaps in the false post were made by salvage divers who at some point cut off the entire rudder, complete with its pintles and gudgeons, and removed it from the site.

A total of 108 pine frames are in place; they were numbered starting with F1, at the forward extent of the remains, through F107 just forward of the sternpost. They are unusual in three ways: first, they are single frames, 16 in (40.64 cm) moulded by 4 in (10.16 cm) sided (wide). Typically, the frames of contemporary lake steamers are not as extremely rectangular as those of the *Champlain II*, but more square in section. The use of single frames along the entire length of the vessel is also uncommon; other lake steamers of the period were built with double frames, especially amidships and/or under the engines. The third irregularity is the spacing of the frames. Amidships the



Drawing: E. Baldwin

View of the port side of the keelson, sternpost and deadwood. Six deadwood timbers remain, although it appears from the protruding drift bolts that there were at least seven originally. The smaller gaps between timbers are due to erosion and deterioration. The large gaps in the outer sternpost were made by the salvage divers who removed the rudder, pintles and gudgeon.

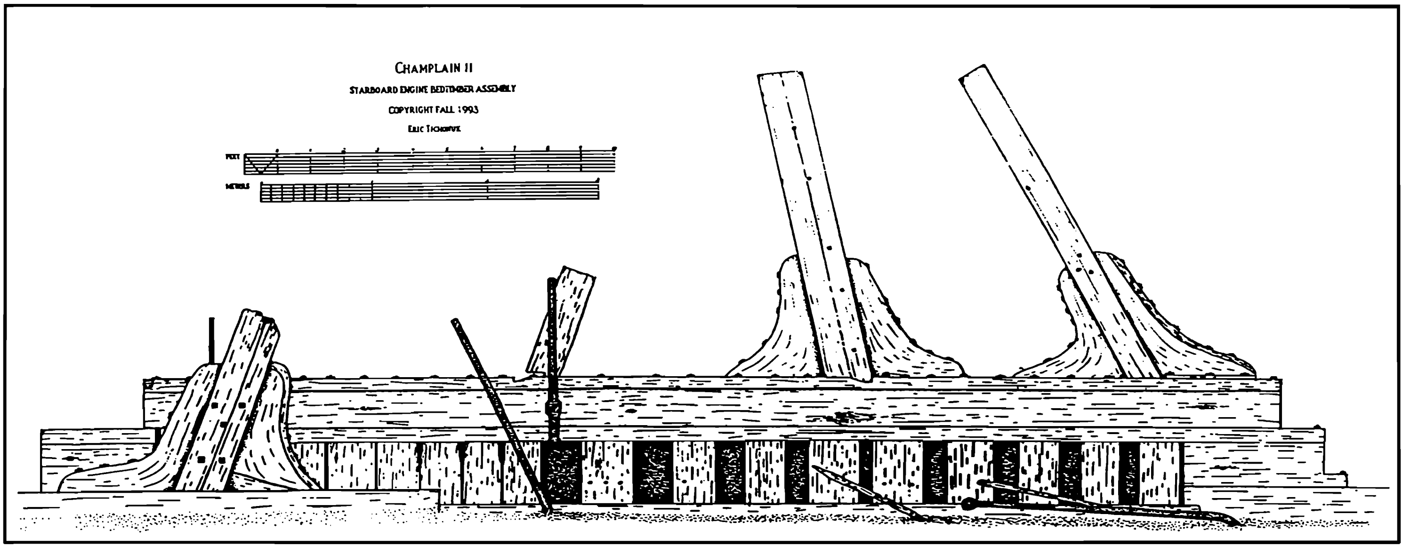
frames are on 12-in (30.5 cm) centers, but toward the stern, and possibly toward the bow, they are on 24- to 26-in (60.96–66.04 cm) centers. Contemporaneous lake steamers usually display consistent frame spacing.

The wreck is dominated visually by five massive longitudinal timbers that run the entire length of the remains. A large central keelson of oak, 14 in (35.56 cm) moulded by 11 in (27.94 cm) sided, is flanked by four large pine stringers, each 13 in (33.02 cm) moulded by 9.5 in (24.13) sided, two on either side. They are all joined to the keelson and provide the hull with integrated longitudinal reinforcement. The inner stringers run parallel to the keelson as far as Frame 80 (F80), where they meet the outer two as the latter arc toward the keelson. The inner stringers are fayed into feather ends at the sides of the outer pair, from F80 through F90, and are fastened to them by 1-inch-diameter iron bolts. The two outer stringers continue their gentle arc and are finally fayed into feather ends at the sides of the keelson from F103 to F107, the last intact frame station. At the turn of the bilge are two more pine stringers, 12 to 14 in (30.5 to 35.56 cm) moulded and 6.5 to 7 in (16.51 to 17.78 cm) sided, one on each side of the vessel. These timbers are smaller than the central longitudinal timbers, but they also run the entire length of the remains, and are fayed into feather ends at the sides of the keelson just forward of the stern deadwood.

The keelson and stringers are each capped by thick planks of oak that are nailed in place. The heads of many fasteners are visible on the top surfaces of the cap timbers, but we recorded surprisingly few mortises or other evidence of stanchions. We had expected that because the main deck had originally borne a considerable amount of weight in the form of up to 14 railroad cars, these longitudinal timbers had provided a base for deck stanchions. But we have evidence of only one small stanchion. Because less weight had to be supported after the 1873 refit, the space was probably made available for storage. We therefore suggest that the cap timbers were either replaced or added during the 1873 refit.

Most of the exterior hull planking is still in place, as is a considerable amount of ceiling planking. The exterior planking strakes of pine average 1 in (2.54 cm) in thickness. There is no ceiling planking atop the floor timbers, but planks of two thicknesses line the sides of the hull from the bilge stringers to the clamp. The lower four strakes of ceiling measure 9 in (22.86 cm) wide by 5.5 in (13.97 cm) thick, while the upper four strakes measure 9 in wide by 2 in (5.08 cm) thick.

Standing approximately amidships are the large support structures for the tall walking beam engines. These engine bedlogs or bedtimbers are longitudinal timbers that begin at F14 and continue, parallel to the keelson, until F82. They are fayed into feather ends at the side of the bilge stringer and fastened with iron bolts. The starboard engine bedlog timbers were recorded in some detail. This wall of timbers extends approximately 6 ft (1.83 m) above the top of the floor timbers and consists of four layers of timbers fastened together with large drift bolts. Thick pieces of pine alternate with two thinner layers of oak. On top of the bed timbers are six of the original eight massive knees that supported the inboard A-frame of the walking beam engine. Portions of three of the four remaining legs of the wooden A-frame are preserved between the knees. In order to stabilize this high A-frame platform, the bed-timbers were bound to the side of the hull by massive



Drawing: E. Tichonuk

Starboard engine bedtimber assembly, looking outboard; the bow is to the left. A portion of the forward-most leg of the A-frame and its knees (at left) are fastened to a small auxiliary stringer located just inboard of, and nested to, the lowest bedtimbers. The platform upon which the two after legs and knees of the A-frame rest is bound to the side of the hull by the support structures.

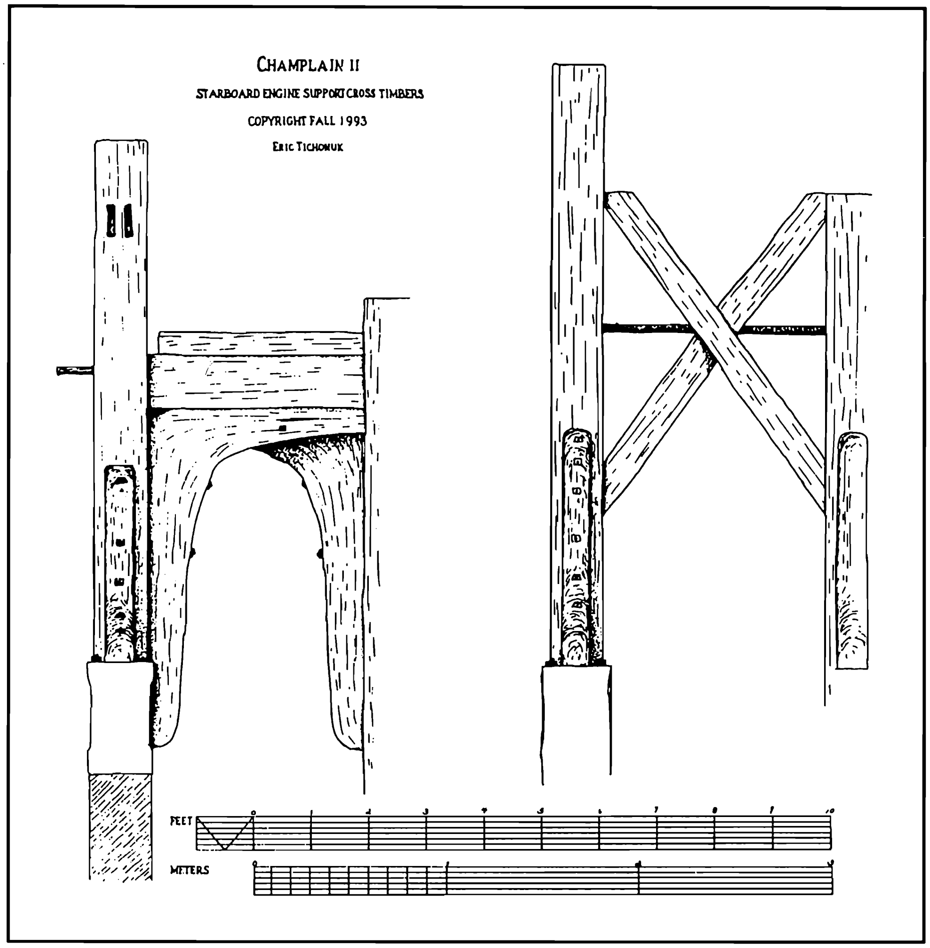
support structures, two of which remain. The forward-most structure is best described as a large arch piece. It is consists of a thick horizontal beam that connected one leg of the A-frame to the side of the hull. To the underside of the horizontal beam are attached the two dagger knees, one at each end and facing each other, that form the arch. The after support structure comprises two cross timbers, in the shape of an X, instead of knees. In addition to strengthening and stabilizing the engine A-frames, these support structures helped to distribute the weight of the lozenge-shaped walking beam on top of the A-frame.

A few other construction features were noted and their basic dimensions recorded. Portions of several deck beams remain in both the collapsed section of the port side and the standing starboard side of the hull. The beam remnants are 4 in (10.16 cm) moulded by 4 in sided, and appear to have been uniformly spaced along the side. Their extremities rest on the clamp and extend inboard approximately 14 in (35.56 cm). The inboard portions obviously were salvaged when the wreck was stripped in 1875. They originally extended outboard to form part of the overhanging portion of the deck known as the guards. Hanging knees on the exterior of the hull supported the deck beams under the guards; only one complete and two partial hanging knees now remain. At several places in the hull, remnants of the hogging truss were found. To prevent the ends of the vessel from hogging, or drooping with respect to the midship area, the *Champlain II* was equipped with a series of tension cables that ran the length of the vessel over iron stanchions positioned on the upper decks. We also noted an iron strap with a loop at one end fastened to the port hull planking. The iron bolts affixing it to the hull pass through the hull planking and the clamp, but not through any framing timbers. As this bolt is located near the engine bedtimbers, it may have been associated with a tension cable that helped stabilize the engine A-frame.

To date, research on steam vessels has typically concentrated on the early development of steam power and technology, and the transition from wooden to metal hulls. Now, the study of the remains of the *Champlain II* is supplementing our meager knowledge of wooden steamboat construction in the late nineteenth century. The construction of the *Champlain II* was unusual in many ways, most notably in the size and placement of the single floor timbers. Such construction irregularities may represent a local building style, or they may reflect construction techniques specific to railroad car ferries.

For these reasons, and because numerous other unusual construction features were only partly documented in 1993, we will return to the *Champlain II* for another week of work in the summer of 1994. The site plan will be completed and a series of hull sections will be recorded to aid in reconstruction. Furthermore, we will gather comparative data on hull construction from the *Adirondack*, a CTC steamer built in 1867 and now lying on the bottom of Shelburne Harbor.

Acknowledgments. The 1993 Field Season was funded by The Lake Champlain Maritime Museum, Texas A&M University, the University of Vermont and the Vermont Division for Historic Preservation. Logistical support was provided by the Institute of Nautical Archaeology. My special thanks are extended to Art Cohn and the staff of the Lake Champlain Maritime Museum who generously shared their time and expertise throughout the project. I would also like to thank my fellow students and the volunteers who put in many cold hours of hard work: John Bratten, Coz Cozzi, Alan Flanigan, Peter Hitchcock, Scott McLaughlin, Stephen Paris and David Robinson of the Nautical Archaeology Program at Texas A&M University; field school students Eric Emery, Elizabeth Keenan, Science Kilner, Scott Mulholland and Nate Wells; and divemasters Pat Beck and Eric Tichonuk. I would especially like to thank Dr. Kevin Crisman and Dr. Fred Hocker for their encouragement and guidance in my thesis research.



Drawing: E. Tichonuk

Bedtimber support structures, looking forward. The forward-most support (the arch) is at left, the after-most (the cross timbers) is at right. In each drawing, the A-frame leg is the vertical timber on the left (inboard), with the side of the hull opposite. The precise manner in which the support structures were anchored to the side of the hull has not yet been determined.

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The Confederate Privateer *Pioneer* and the Development of American Submersible Watercraft

by Richard K. Wills

In Jules Verne's fictional 1869 narrative *Twenty Thousand Leagues under the Sea*, Captain Nemo describes his submarine boat *Nautilus* as "an elongated cylinder with conical ends. It is very much like a cigar in shape.... To steer this boat to starboard or port...I use an ordinary rudder fixed on the back of the sternpost.... I can also make the *Nautilus* rise and sink, and sink and rise, by a vertical movement by means of two inclined planes fastened to its sides...the *Nautilus*, according to this inclination, and under the influence of the screw, either sinks diagonally or rises diagonally as it suits me." At first glance, Verne's *Nautilus* may seem a fantastic product of his fertile imagination. In fact, this fictional ship incorporates some of the basic mechanical principles found in a series of submarine vessels built within the Confederate States of America during the American Civil War. While researching his visionary novel, Verne carefully studied the most recent advances in marine engineering and submersible construction, including the work undertaken by scientists and engineers of the short-lived Confederacy.

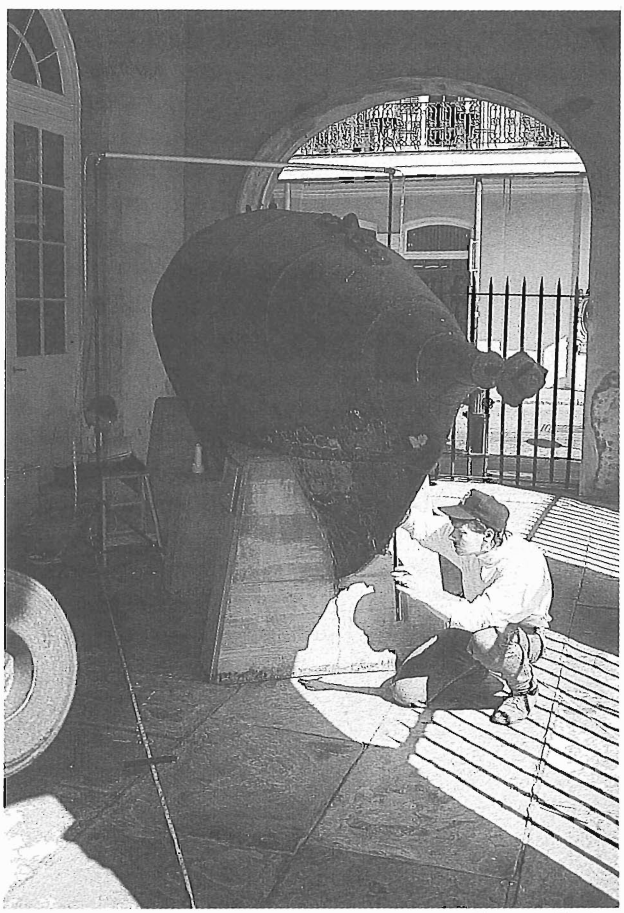


Photo: A. Flanigan

David Robinson measures the hull of the Confederate submarine privateer Pioneer, *now at the Louisiana State Museum in New Orleans.*

The submarines of the Civil War were small, dangerous metal vessels that bear little resemblance to the large and complex vehicles we know today. The Confederate submarines mounted or towed an explosive package called a mine, which was in effect a primitive torpedo (and in this period, the term "torpedo" meant "mine"). In order to detonate the explosive package against the hull of an enemy vessel, a submarine had to tow it into the target's path such that the two would collide, or ram the target with a strong bow spar, upon which the explosive was mounted. Of the three submarine torpedo boats built by the Confederate States, the *Pioneer* alone survives, and today it can be found on exhibit at the Louisiana State Museum in New Orleans' famous French Quarter.

As the first of the three Southern submarines, the *Pioneer* is thought to be the oldest surviving example of an important and distinct tradition of watercraft construction. It may be regarded as a prototype for the *CSS H.L. Hunley*, the submersible destined to cross the elusive and costly threshold of tactical success, as well as a transitional stage between antebellum American submersible vessel designs and the *Hunley*. The legacy of the Confederate submarine boatbuilding program, which culminated in the *Hunley*, was the arrival of the submarine as a grudgingly accepted yet greatly feared weapon of naval warfare. The program therefore contributed significantly to the creation of a new order of seapower and military strategy. Furthermore, the *Pioneer* is historically unique as the product of a private, profit-motivated initiative: it was commissioned by the Confederate government as a submarine privateer.

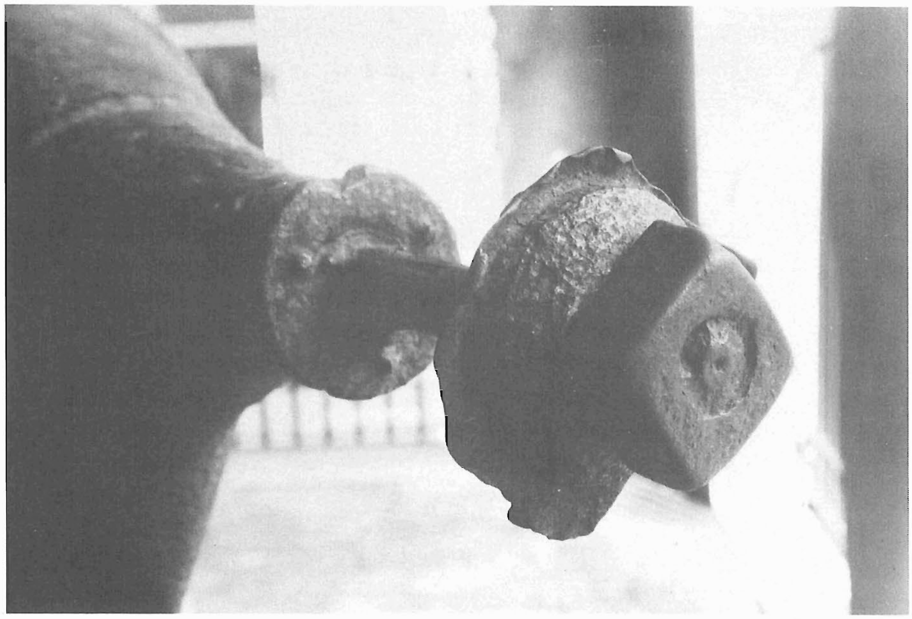


Photo: G. Cook

Detail of the exterior shaft bearing and propeller hub assembly. All four propeller blades have been broken off.

At the Louisiana State Museum the *Pioneer* sits dry on a concrete stand, its eroded bottom filled with cement and its exterior plates worn and discolored. Its rudders are both broken off at the outer shaft bearings, as is the port diving plane. All four propeller blades are broken off at the hub of the shaft, which is bent just aft of where it projects from the bearing. The hatch and conning tower assembly is also gone, along with some of the boat's less durable inner workings. Despite the abuses and neglect it has suffered, however, the *Pioneer* remains in relatively good condition, sheltered now by the Presbytere wing of the museum.

I first became interested in the Confederate submersible initiative in 1991, while researching steam-driven semi-submersible Confederate torpedo boats, or "David boats," for a class in the history of shipbuilding at Texas A&M University. Initially encouraged by Professors Fred Hocker and Kevin Crisman, and Louisiana native and fellow Nautical Archaeology Program student Tina Erwin, I sought and received permission from the Louisiana State Museum to examine the exterior construction details of the *Pioneer*. In February of 1992, a research team consisting of Texas A&M University Nautical Archaeology Program students Alan Flanigan, David Robinson, Juan Vera, and I journeyed to New Orleans to record the hull dimensions of the vessel and take off its lines. During a 1993 recording trip to the Crescent City, Nautical Archaeology Program students Greg Cook, Colin O'Bannon, and I received permission to enter the *Pioneer* and study its interior mechanisms.

Our research team had three goals in mind. First, we wanted to develop an accurate, comprehensive, written and visual record of the boat that would expand the slim body of knowledge of nineteenth-century underwater warfare. Second, we wanted to resolve the recent controversy surrounding the identification of the vessel as the *Pioneer*, as well as the discrepancies that exist between dimensions found in historical documents and modern measurements. Third, we wanted to see the vessel properly recognized for its important contribution to the development of watercraft construction.

As I clambered through the cramped dark interior of this still sturdy boat I could not help but compare the luxurious spaciousness of the fictional Captain Nemo's submarine with the claustrophobic and strictly functional nature of this one. Measuring a mere 19 ft 5 in (5.91 m) in length, 3 ft 2.5 in (98 cm) in beam, and 6 ft 2 in (1.88 m) in depth, the *Pioneer* was constructed in a shape closely resembling that of a fish. Its V-shaped lower hull comprises an iron keel and two rows of riveted boilerplate per side. The overhead deck takes the shape of an inverted U and is also composed of riveted plates. The boat's sharp bottom and rounded deck appear to have been constructed separately and then joined by rivets at the second row of lower plates. The bow and stern castings were then riveted to the hull. All of the *Pioneer*'s plates were lapped toward the stern, testifying to the designers' appreciation of hydrodynamics. The now-missing hatch may have been designed to double as a short conning tower, sealed by means of a rubber-gasket, and probably included round panes of glass through

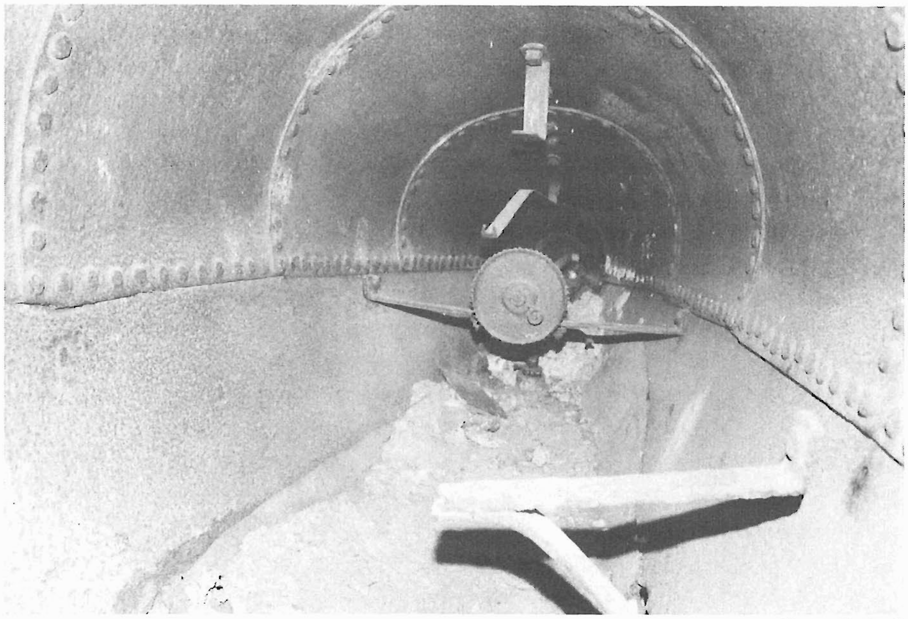


Photo: G. Cook

Interior view of the vessel, looking aft. Note the rivet pattern and the concrete in the bottom. The bracket in the foreground was probably one of a number that supported a longitudinal wooden plank. The two men who turned the now missing crankshaft probably sat on the plank.

which the pilot could see and thus navigate.

The submarine was propelled by means of human muscle power applied to the propeller shaft by cranking, either by hand or by foot. The exact means of propulsion is unknown, as the interior is full of cement to just beneath the top of the first row of plates. The *Pioneer* was steered by means of coordinated bow and stern rudders. Depth was controlled by a pair of forward-mounted diving planes, with the possible assistance of a trimmable ballast tank. Such a ballast tank would now be covered by cement as well. While submerged, the crew's limited air supply was augmented by the use of a rubber tube and float assembly. The lower end of the tube fed into an iron stack and collar located on the deck forward of the hatch. Louisiana State Museum Curator of Science and Technology Tom Czekanski theorizes that the air may have been drawn down the tube by a pump driven by the propeller crankshaft sprocket. A pair of metal lifting and towing straps are still bolted to the deck, and a large socket in the bow indicates that some sort of forward-projecting spar could have been carried. Overall, the *Pioneer*'s construction appears to be simple and well thought out. Although it may seem primitive when compared to modern submarines, in its time it was an advanced, precision-manufactured example of innovative technology.

By the time the *Pioneer*'s keel was laid down in the autumn of 1861, there was an established American tradition of innovative but economical experimentation in underwater warfare. The development of a successful submarine torpedo boat required the maturation of two technologies: 1) underwater explosive-type weapons, and 2) vessels or platforms that could carry and deliver such weapons. David Bushnell's *Turtle* (1775) was the first submarine to engage an enemy warship in combat, albeit unsuccessfully. Of more significance is that it was probably the first watercraft to employ screw-propulsion. This vessel's construction laid the foundation for American submersible design, as well as the future of all propeller-driven watercraft. Robert Fulton, who was first and foremost a scientist of underwater warfare techniques, built and extensively tested the *Nautilus* (1800), which became the standard upon which all future submersible craft design would be based. The subsequent experiments and advancements made by others such as Samuel Colt, Matthew Fontaine Maury, Ross Winans, and Brutus de Villeroi also constituted the American body of knowledge from which the Confederate efforts would spring.

As the "first modern technological war," the American Civil War saw the initial widespread use of ironclad warships, underwater mines (torpedoes), and semi-submersible and submersible towed torpedoes and spar-torpedo rams. Although both sides in the conflict pursued roughly parallel paths in submarine development, the Confederate program was basically a private one, whereas the Northern program received more government support. While the North's efforts were proceeding slowly and proving only marginally successful, there suddenly sprang forth in the newly created Confederate States an intense, profit-driven, private interest in submersible construction. This interest resulted from the combination of a strangling maritime blockade, corporate-sponsored bounties on the Union warships enforcing that blockade, and a flickering but still-remembered American privateering tradition. As a result, Confederate progress in a short time overtook the more Federally sponsored program.

The Confederate submersible boatbuilding program was initially conceived by a group of New Orleans machinists and businessmen inspired by the possibility of collecting prize money for the destruction of enemy vessels of war. The core group consisted of machinists Baxter Watson and James McClintock, lawyer Horace Hunley, and businessmen John Scott, Robbin Barron, and H.J. Leovy. These six men supervised the first vessel's construction at the Leeds Foundry and in the Government Yard in New Orleans, during the winter of 1861–1862. Upon completion they had it towed down the New Basin Canal to Lake Ponchartrain, where they put it through its trials. The boat successfully sank a schooner and two target barges by means of a towed torpedo, and on March 31 the vessel was commissioned as a privateer, with a Letter of Marque issued under the authorization of C. S. Secretary of State Judah P. Benjamin. The Letter of Marque records the vessel's name as the *Pioneer*, the vessel type as a "submarine propeller" armed with a "magazine of powder." The required number of crew is listed as three, with John K. Scott commanding. The *Pioneer* is described in the Letter of Marque as measuring 34 ft (10.36 m) long overall, 4 ft (1.22 m) in beam, drawing 4 ft of water, and weighing 4 tons. It was painted black and had "round conical ends." To obtain the Letter of Marque a surety of $5,000 was posted by Hunley and Leovy. The submarine never saw action, however. Less than a month after the *Pioneer* received its Letter of Marque, New Orleans fell to the U. S. Naval forces under Captain David Farragut. During the city's invasion, Watson scuttled the *Pioneer* in the New Basin Canal near the Lake Ponchartrain entrance. He, McClintock, and Hunley then fled to Mobile, Alabama.

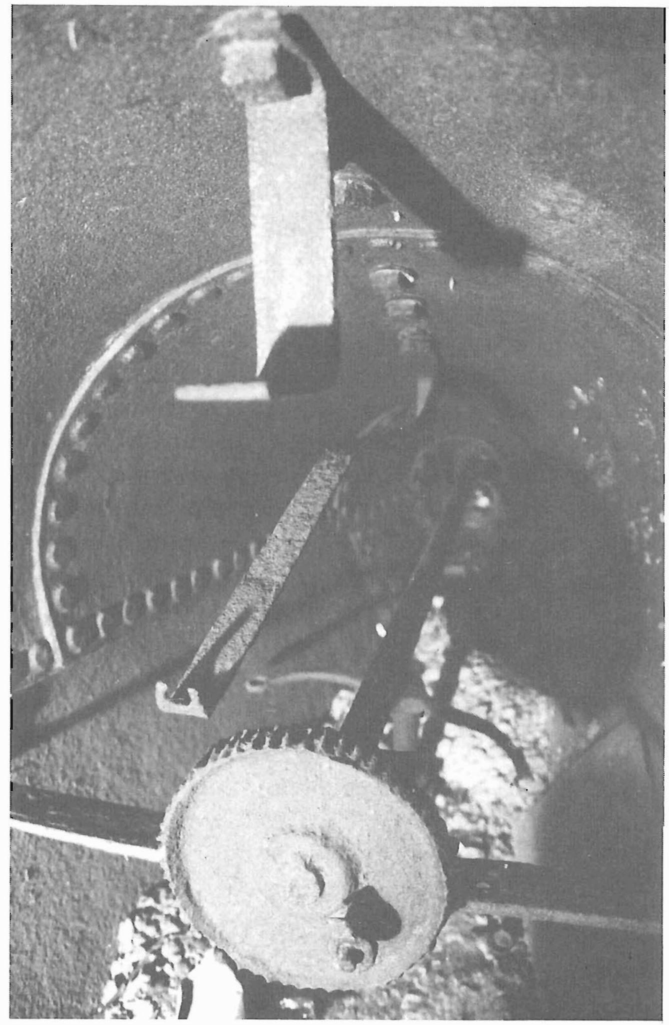


Photo: G. Cook

Detail of the aft end. Surviving propulsion components include the sprocket, sprocket shaft, and its horizontal support. The crankshaft and drive chain are now missing. The two arms of the stern rudder tiller are visible beneath the sprocket shaft. The brackets fastened to the top deck probably supported elements of an air pumping system. An attachment on the forward face of the sprocket suggests that such a pump was somehow driven by the main crankshaft.

This group, refusing to let the *Pioneer*'s loss destroy their dream of building a successful submarine torpedo privateer, was then joined in its efforts by engineers Thomas Parks and Thomas Lyons, who provided their machine shops for the construction of a new boat. They also received support from the military in the form of engineers George Dixon and William Alexander, both lieutenants in the Twenty-first Alabama Artillery Regiment. Upon completion this second submarine boat, the name of which is now lost, measured 25 ft (7.62 m) in length, 5 ft (1.52 m) in beam, and 6 ft (1.83) in depth. It was floated (launched) in Mobile Bay and towed off Fort Morgan, with the intention of attacking the Federal fleet, but as the weather turned bad and the sea grew rough, the boat became difficult to manage and sank. No lives were lost in this mishap, but the Confederate submariners had lost another vessel in which they had invested a great deal of time, money, and hope.

Still they would not be discouraged. Financially strapped, they could not afford to machine (plate by plate) another submarine, so Hunley obtained a long cylindrical boiler that the engineers lengthened, deepened, and fitted out for a crew of nine. Although this vessel was designed more economically than its two predecessors, it appears to have incorporated a number of more advanced features, including double ballast tanks with riveted bulkheads, two hatches, remotely jettisonable ballast castings, and a flat overhead deck. The 35-ft-long (10.67 m) boat was powered by a long, hand-cranked shaft requiring the labor of eight sailors; its armament consisted of an explosive torpedo mounted on a 22-ft (6.71 m) spar of yellow pine. Trials produced pleasing results, and the military decided that the boat should be shipped by flatcar to Charleston, South Carolina, for anti-blockade duty under the command of General P.G.T. Beauregard.

In a series of bad luck incidents, the boat was swamped twice and ultimately lost in Charleston Harbor. The first accident killed eight of the nine newly-recruited navy crew members, all save the captain. After the vessel was salvaged, a second incident killed six members of the crew. At this point the military asked that Mobile send people more familiar with the boat to Charleston to take over the vessel's operation. Hunley, Parks, and seven other volunteers answered the call and spent some time putting the boat through "diving and raising" tests. Just when it was finally demonstrated that the vessel merely required experienced hands, the boat suffered yet another terrible disaster. While on a submerged cruise, the usually competent Captain Hunley made a simple error. Seeking to dive by taking on seawater ballast instead of using the diving planes, he opened the forward ballast tank seacocks. While involved with other dive procedures, however, he forgot that the bow was taking on ballast. The stern tanks were taking on no ballast, which of course served to angle the vessel downward. The boat buried its bow in the harbor mud and partially flooded, killing the entire crew. Dixon and Alexander hastened to Charleston, where they buried Hunley, Parks, and the other seven. They then salvaged the boat, which was renamed the *CSS H.L. Hunley* as a memorial.

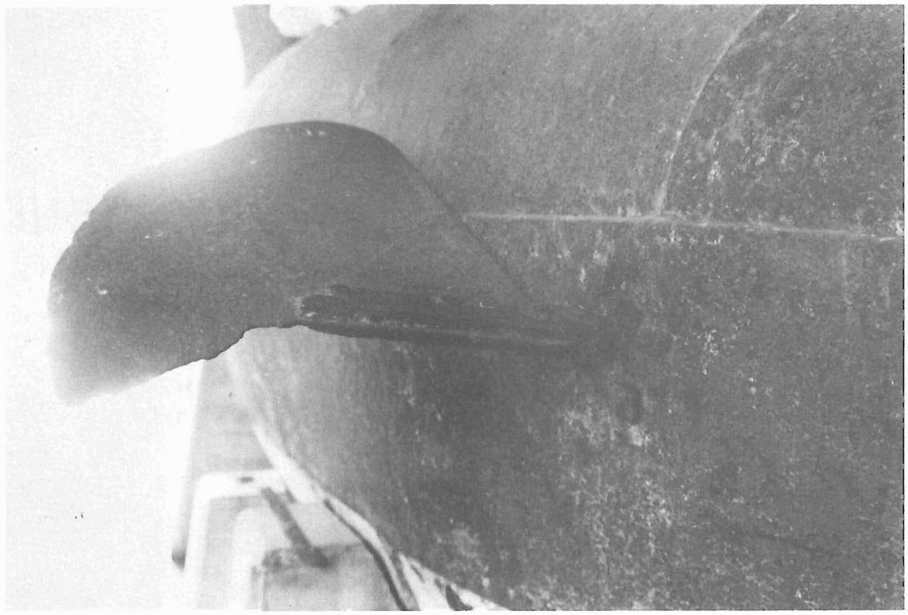


Photo: G. Cook

Detail of the starboard diving plane and plane shaft, looking aft. The forward half of the blade has been broken off. The four through-bolts around the shaft base (three are visible here) hold the interior shaft bearing against the hull. The bearing rested on a bead of India rubber that served as a gasket.

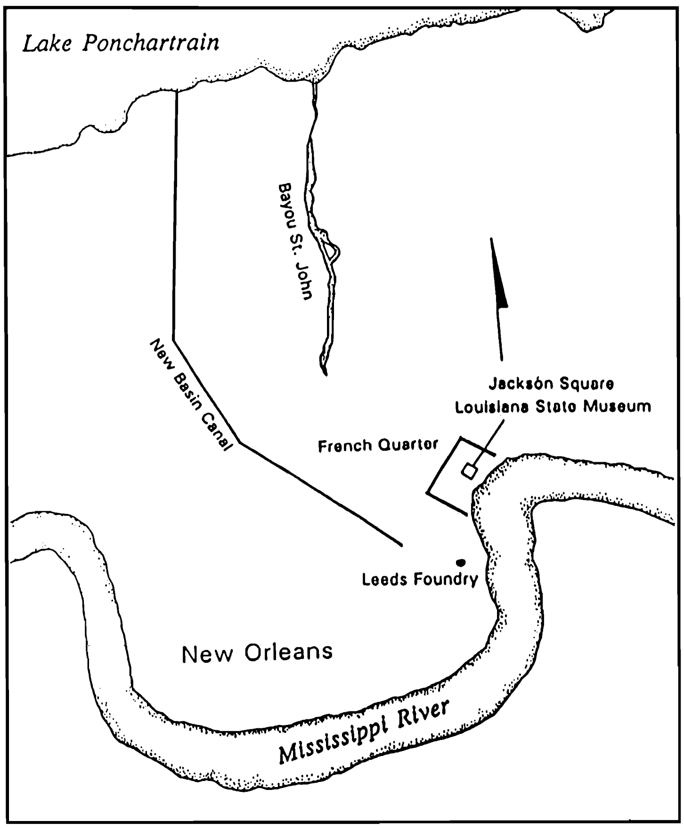
Saddened but undaunted, Dixon and Alexander moved their operations to Battery Marshall, on Sullivan's Island off Charleston. Between November of 1863 and February of the following year, a new volunteer crew often fought foul weather to conduct numerous night cruises in the seas off shore. On February 5, Alexander received transfer orders, and he reluctantly bid Dixon and the crew farewell. It would be the last time William Alexander saw his friends. On the evening of February 17, 1864, about 2.5 miles (ca. 4 km) off Charleston Bar, the *Hunley* observed and made for the steam sloop-of-war *USS Housatonic*, which lay at anchor on blockade duty. The Federal warship's lookout spotted the *Hunley* and voiced warning, causing the *Housatonic*'s chain to be slipped and the engine to be ordered all back full. The defensive action was not timely enough to prevent collision, however. The *Hunley* rammed the Union warship on the starboard stern quarter just abaft the mizzenmast, blowing off most of the stern in a great explosion. The *Housatonic* sank in three minutes.

Although the cost was high and the underlying motives complex, the dream so sought-after by the Confederate submariners had been realized, and on that day the submarine earned its place in the future of naval warfare. But a final toll was exacted, it seems. What happened to *Hunley* following this action is a mystery. Neither it nor its crew returned to Sullivan's Island, even though it had requested a light to which it could steer to port. It has been theorized that the boat swamped or capsized in the heavy night seas, or that it succumbed to structural damage sustained in the collision or explosion. Its fate remains a puzzle.

Perhaps overshadowed by the achievement of the *Hunley*, the *Pioneer* received little attention in the years after its loss. Mention of a submarine boat that could be the *Pioneer* does not appear in the historical record until 1868. In that year, the *New Orleans Picayune* reported that an iron "torpedo boat" of about 2 tons lying on the bank of the New Canal was sold at public auction, "only valuable now for the iron and machinery which is in and about it." No further references to such a vessel are encountered until 1878, when the naval sand dredge *USS*

Valentine discovered a metal submarine boat on the bottom of New Canal, "near New Basin between New Orleans and Lake Ponchartrain." The crew of the *Valentine* grappled the vessel to the surface and then deposited it on the shore of Lake Ponchartrain. In the fall of 1895, we know the submarine was moved from the shore of Lake Ponchartrain to a nearby Spanish Fort and amusement park area on Bayou St. John, where it was propped up on blocks as an exhibit. Then, in 1909, the boat was acquired by the Louisiana State Home for Confederate Soldiers on Bayou St. John, and set into a large cement base as a monument. At this time it was also probably filled with the cement it still holds today. By 1942 the boat had been moved yet again, this time to Jackson Square in the French Quarter, where it was once more set upon concrete supports. In 1957, the boat made the last move in its nomadic journey, across Jackson Square to the Louisiana State Museum's Presbytere.

Lately there has emerged some disagreement as to whether this boat is actually the *Pioneer* or, as one recent theory argues, that there were two derelict submersibles in New Orleans following the Civil War. The embers of controversy have been fanned by three problems in the extant literary evidence. First, the extensive nature of the boat's travels has naturally generated a great deal of confusion. Second, the surviving accounts do not provide us with consistent boat dimensions. Lengths, for example, vary by 4 ft (1.22 m), depths by 2 ft (61 cm). Third, vague and simply inaccurate newspaper articles have been interpreted to suggest that one submarine boat was broken up for scrap and auctioned. Although space limitations do not allow us to retrace the vessel's convoluted course in the years after it was scuttled, problems regarding the accuracy of the auction account and of the boat's dimensions can be somewhat clarified.



Rough map of New Orleans indicating the general areas in which the Pioneer *has resided at various times: Leeds Foundry, the New Basin Canal, Lake Ponchartrain, Bayou St. John, and Jackson Square in the French Quarter* (not to scale).

The theory that two different submarines are represented in the historical record is based upon the contention that, after the *Pioneer* was recovered from the New Canal in 1868, it was auctioned as scrap metal and broken up (thus the second boat now resides in the Louisiana State Museum). These assertions are supported only tenuously by three brief newspaper articles, all of which deal with only a single boat. The first is an auction notice that appeared in the *New Orleans Picayune*'s morning edition for February 15, 1868. The notice stated that a torpedo boat built of iron and weighing 2 tons, which sank in the New Canal during the occupation of the city in 1862, was to be auctioned. The second article appeared in the afternoon edition of the same paper. It relates simply that an iron torpedo boat of 2 tons was sold for $43.00. It does not say that the boat was broken up for scrap, or even that it was moved from the banks of the New Canal.

Thirty-four years later, the third article appeared. The *Cleveland Plain Dealer* printed an error-filled and sensationalistic account of how a Confederate submersible was "sold as scrap" and "carted off from the old Spanish Fort a few miles back from New Orleans." This 1902 article contains at least 12 historical errors in only a few short columns. In fact, it merely conflates the possible breaking up of the boat in 1868 with its location in the Spanish Fort amusement area at the time the article was written. The fact that it appeared in a paper so far removed from New Orleans, and 34 years after the 1868 auction, would seem to have afforded much opportunity for error.

The question of the *Pioneer*'s dimensions is somewhat more straightforward. The recorded measurements of the submarine in the Louisiana State Museum are 19 ft 5 in (5.91 m) long, 3 ft 2.5 in (98 cm) in beam, and 6 ft 2 in (1.88 m) deep. However, three historical accounts relate different dimensions. For the original Letter of Marque, James Scott described the *Pioneer* as 34 ft (10.36 m) long, 4 ft (1.22 m) in beam, 4 ft in depth, and weighing 4 tons. Fifteen years after the war, James McClintock characterized the *Pioneer* as having been "cigar-shaped, 30 ft long, and 4 ft in diameter," and as having weighed "4 tons." Measurements taken by U.S. Navy engineers in 1878 after the submarine was grappled out of the canal also provide it with a length of 30 ft (9.15 m).

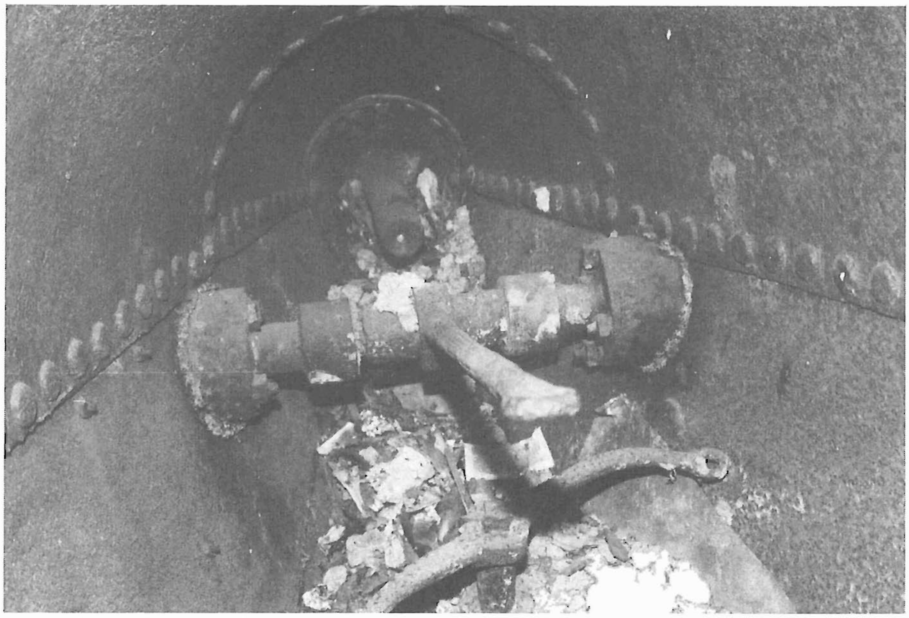


Photo: G. Cook

View of the interior (obscured by tourist litter), looking forward: the bow rudder tiller arms (bottom), the diving plane controls (center), and the bow spar socket projecting inward from the bow extremity.

Why the inconsistencies? First, it appears that the dimensions in the historical literature are rounded off figures, as none includes inches. Second, the beam measurements differ by less than a foot, but clearly they did not include the diving planes. This further suggests that the measurements in general are rough estimates.

But there may be better explanations. The difference of 2 ft (61 cm) in depth between Scott's figure and today's measurement may simply mean that the submarine had an overall depth of about 6 ft (1.83 m), but drew only about 4 ft (1.22 m) of water when lightly ballasted. As for the 10–14 ft (3.05–4.27 m) discrepancies in length, there is also a plausible explanation. Although in tests the *Pioneer* was used only as a towed-torpedo platform, it was probably also capable of being equipped with a bow-mounted spar torpedo. The Louisiana State Museum vessel's deep bow socket definitely could have carried such a spar. Historical documents demonstrate that the concept of the spar torpedo was well known in 1861. In fact it dates to at least as early as Robert Fulton, who in 1810 designed an elaborate spar torpedo assembly for use in naval combat. The spar used on the 35-ft-long (10.67 m) *Hunley* had a length of 22 ft (6.71 m), ca. 63% of the vessel length. Therefore it would not be unreasonable to imagine that the *Pioneer*, with a hull length of about 20 ft (6.1 m), would have been equipped with a spar 10–15 ft (3.05–4.57 m) long. This would have resulted in an overall length of some 30–35 ft (9.15–10.67 m). Moreover, we know that the second submarine built by the New Orleans group was 25 ft (7.62 m) long, 5 ft (1.52 m) in beam, and 6 ft (1.83 m) deep. The length dimension, falling between those of the *Pioneer* and the *Hunley*, does hint at an intermediate design stage. It seems improbable that the second hull in the series was shorter than its predecessor, especially with an increased beam dimension. The boatbuilders were probably more confident with their design, and a larger boat therefore could have been feasible and desirable.

Finally, the principle of Ockham's Razor, which states that "entities are not to be multiplied beyond necessity," is applicable. There is no direct historical evidence that two similar submarines were present in New Orleans early in the 1860s. In fact, it is far more likely that there were no more than two submarines in all of America at such an early stage of their development. But even if this is discounted, it seems quite unlikely that their dimensions nearly matched, and that both would have been scuttled or lost in almost the same location.

Our attempts to establish the identity of this unique vessel have helped illuminate the infancy of submarine vessel design and construction. The *Pioneer* represents a remarkable time in maritime history, when mariners were first trying to find a way to voyage beneath the waves. Yet perhaps more fascinating is the story of a private initiative, conceived partly for personal profit and partly to preserve a way of life, that helped propel seapower doctrine and naval technology into new and uncharted waters. Today, as we continue to explore the past and the future of submarine vessels, the prophetic words of Captain Nemo are still appropriate: "...it will carry you yet into the midst of the marvels of the ocean. Our voyage is only begun."

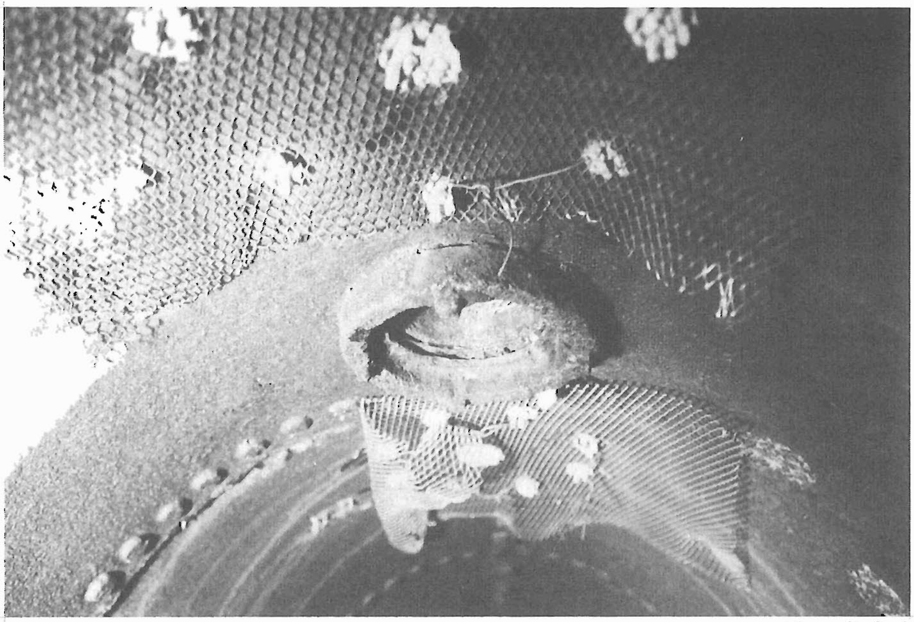


Photo: G. Cook

Interior view of the air stack collar, located on the upper deck just forward of the hatch. The air pumping machinery was probably connected to this collar. The steel mesh and spackling cover holes associated with other mechnanisms.

Acknowledgements. I would like to thank the following individuals and organizations for their contributions of time and resources to the *CSS Pioneer* Recording Project. It is due to their support that the results have been possible: Alan Flanigan, David Robinson, and Juan Vera, who volunteered their time, skills, and experience to the project as part of the 1992 field recording team; Greg Cook, Colin O'Bannon, and Liz Baldwin, who subsequently provided more of the same as part of the 1993 team. This project was truly a group effort, and thanks to the persistence and open mindedness of these dedicated students of the Texas A&M University Nautical Archaeology Program, it was a successful one. Some of the equipment for the project was kindly loaned by Texas A&M University's Ship Reconstruction and Conservation Research Laboratories.

Further thanks go to Deena Bedigian, Tom Czekanski, Jim Sefcik, and the late Larry Tanner, all of the Louisiana State Museum, for granting us permission to undertake this research and for their hospitality; to Vicki Sopher and Sarah S. Shaffer of the Stephen Decatur House Museum, for providing the opportunity to acquire some excellent background history; to Tina Erwin for providing logistical information; to John Bratten for lending his computer expertise; to Karen Galambos for opening her home to the 1993 project team.

Finally I would like to thank Dr. Fred Hocker, Dr. Kevin Crisman, Dr. Shelley Wachsmann, and Dr. William Piston for their encouragement and guidance during the course of this research.

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A PERSONAL LOOK AT SOME TRADITIONAL VESSELS OF BALI AND MADURA, INDONESIA

By Richard D. Herron

From the concerned, yet politely bemused expression on the young fisherman's face, I could tell he was convinced that I must surely have been taken by some kind of tropical madness, probably common to Westerners.

"Come and sit in the shade, sir, or you will find an illness."

I smiled, waved, and indicated that I wanted to take just a couple more photographs. But as the tropical mid-day sun continued to beat down, causing ribbons of heat to rise like smoke from the black volcanic beach sand near the Balinese village of Kusamba, I was soon grateful for the young man's offer of escape to the shade of his palm-thatched awning.

After I neatly deposited my perspiration-soaked rucksack, assorted camera gear, and myself beneath the awning, my congenial host and I exchanged introductions and the necessary pleasantries. With the required etiquette soon out of the way, the young fisherman commented on the fact that I was photographing only boats, and that he was curious about why I was so fascinated with these *jukung*. I explained that I was a doctoral student in the Nautical Archaeology Program at Texas A&M University, and that I had come to Indonesia to do field research regarding traditional sailing craft. But unfortunately, because I could stay only three weeks, I had to limit considerably the geographical range of my fieldwork. The reason I chose to study the craft of Bali and Madura, I continued, was because I felt that the traditional vessels of these islands were some of the most likely to disappear soon. I also knew that the recent, heavy impact of tourism on Bali, for example, has caused many fishermen to abandon their traditional vocation in favor of more lucrative jobs catering to tourists. Also, with the almost frantic, government-supported push for modernization, many traditional vessels are either no longer built or have undergone such drastic design changes, to accommodate motors and other modern introductions, that they bear little resemblance to their traditional

Photo: R.D. Herron

With her sail set, a Balinese jukung pelasan *is nearly ready to get under way. The port-side rudder will remain raised until the canoe is clear of the shallows. The outrigger floats are connected to the hull with graceful upward-curving booms and down-turned* cedik. *Note the extremely short mast, and the sail's upper spar positioned inside the bow.*

counterparts. This seems to be particularly true for Madura.

The young fisherman agreed that many changes had occurred just within the past few years, and he appreciated the importance of understanding his country's maritime legacy. He had no idea, however, that many construction features of vessels built on Bali and Madura have an ancestry of nearly 4,000 years; he was plainly very impressed by this fact.

For over an hour we sat discussing the nomenclature and various features of different Balinese vessel types. We talked about the fact that Balinese canoes are identified by certain common characteristics. Differences, however, include several, sometimes subtle, variations in design relative to where the vessel was built and how it was intended to be used. For example, the double outrigger canoes found at Sanur, and elsewhere along the southern coast, are usually built with a rounded or oval-shaped splashboard on the bows, whereas those built in the areas roughly northward of Serangang Island, as well as several examples at Kusamba, are usually equipped with a splashboard shaped like a square box. Depending on how they are used, canoes such as the *jukung pemencaran*, used for fishing with a throw net, may have only a single outrigger, or they may have no outrigger at all, enabling vessels such as the *sampan jaring* to negotiate narrow, shallow waterways. Furthermore, canoes can vary in the artistic design of their bow and stern decorations. All of these variations aside, however, the shape of the outrigger is one of the main characteristics commonly used to distinguish Balinese outrigger canoes from those built elsewhere in Asia and the Pacific.

As our conversation continued, I remembered that in 1920 James Hornell, whose monumental work on Oceanic canoes remains the standard reference source on the subject, observed that Balinese canoes are distinguished by the gracefully upward-curving *cedik* of the outrigger, a piece that joins the boom (*bayungan*) and the float (*katir*). Regarding the antiquity of this feature, G. Adrian Horridge, a contemporary authority on Indonesian vessels, argues that the use of the curvilinear *cedik* may have come to Bali via Madura, and was then further developed in southern Bali during this century. Although several Balinese boatbuilders assured me personally that the curved *cedik* is indeed an ancient form unique to their island, I believe that Horridge is correct, because photographic evidence from the early part of this century indicates that the majority of Balinese canoe outriggers were fitted with almost rectilinear *cedik*.

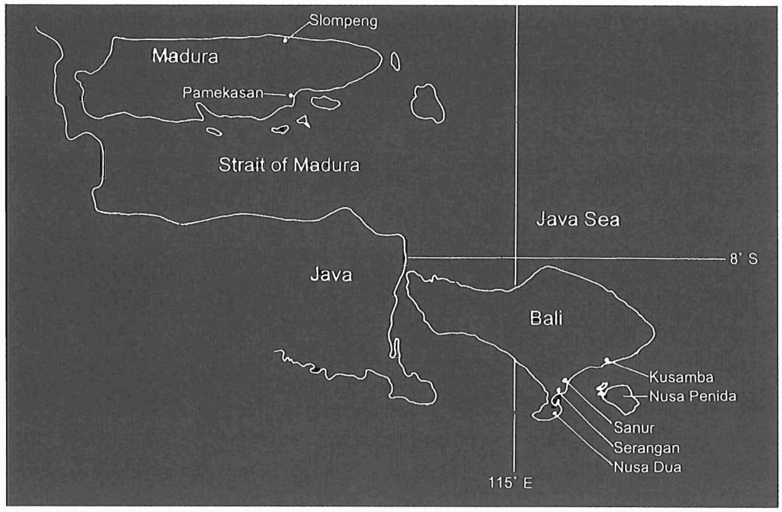

Photo: R.D. Herron

The islands of Bali and Madura, located just off the eastern coast of Java and approximately 8° south of the equator.

Another distinction of Balinese canoes, and one associated with less controversy, is where the rudder is positioned. On Bali the rudder is always on the port side of the stern, whereas on most other islands it may appear on either side. Also, with Hinduism as their dominant religion, the Balinese commonly decorate the bows of their *jukung* with the head of the god Gajah, whose stylized countenance provides safety and fortune for the sailor and his vessel.

Most Balinese outrigger canoes are built using the traditional five-part method of hull construction. Geographically, these five-part canoe types range from the Comores Islands near Madagascar, to Indonesia and as far eastward as Hawaii. The construction of these types of vessels begins with the selection of a tree suitable for a dugout. On Bali, as well as Madura and elsewhere, specialists will still occasionally be on hand during the felling of the tree in order to hew out the log slightly and roughly shape it before it reaches the boat yard. This is done largely to help prevent the wood from splitting as it dries. The preferred boat building material comes from the *belalu* tree (*Albizzia falcata*) and the *kayu suren* (*Cedrella sureni*). But trees of suitable size are becoming increasingly scarce and, as a result, increasingly expensive. To reduce construction costs, boatbuilders try to purchase solid logs and shape them themselves. Today, however, bargaining for solid logs is difficult because the owner of the tree usually cuts and shapes the log himself, so that he can sell the left-over wood.

Once obtained, and depending on the available funds of the expected buyer, these roughly shaped logs are allowed to season for approximately one month under the protective cover of palm-thatched awnings before any further construction is carried out. Considering that, from a Western viewpoint, the daily religious observances followed by the Balinese encompass almost every aspect of their lives, it is interesting that this stage of hull construction apparently has no associated ceremony or ritual. When asked about this, both boatbuilders and fishermen alluded to the idea that a roughly shaped log does not yet exist in the *rohani*, or spiritual realm. Horridge explains that once a tree is cut down, it has no spirit or life-force until made into a canoe. As I continued to press my young fisherman host for more information about boat construction, I also asked him about this spiritual side of canoe building and the associated ceremonies. After thinking for a moment, he suddenly stood, as if an idea had just occurred to him, and said that I needed to talk with Pak Murje.

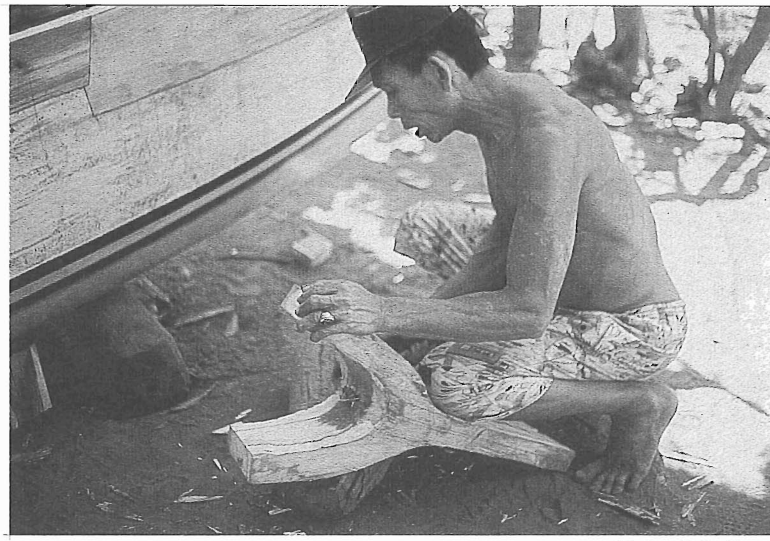

Photo: R.D. Herron

Pak Murje, one of the oldest living traditional boatbuilders on Bali, works on a fork-shaped kanti *for an older* jukung.

After winding along several narrow, dusty paths of the village, we eventually arrived at the boat yard of Pak Agung Akan Murje, allegedly one of the oldest living boatbuilders in Kusamba. After being introduced to Pak Murje, I, in true Western form, enthusiastically proceeded to bombard him with questions about construction techniques and ceremonies. Accustomed to the open, congenial nature typical of most Balinese, I was surprised when the best answers I could elicit from this unexpectedly taciturn gentleman were only occasional grunts — which he absolutely forbade me to tape record. Realizing that I was probably being considered a rude foreign buffoon, I quickly changed my approach. After saying good-bye to the young fisherman, and expressing my gratitude for his hospitality, I spent the remainder of the day quietly sitting and merely watching the skilled craftsmanship demonstrated by Pak Murje as he made repairs to an older *jukung*.

Just after daybreak the following day I returned to the boat yard and patiently waited for Pak Murje to appear. When he did so, he was plainly surprised to see me. I greeted him, and he grunted. By mid-morning, however, he had undoubtedly realized the extent of my tenacity and disappeared into his house, where I feared he might stay until I left. To my relief, he soon returned with two cups of tea, sat down beside me, and began trying to answer my earlier questions.

With him speaking mostly Balinese, and I Bahasa Indonesia, much of the information conveyed was through sign language and drawings. When I tried to ask what, if any, ceremonies took place at the outset of canoe construction, Pak Murje gently took me by the arm and led me to a rudimental-shaped log that had not yet been fully adzed out. With brackish-looking water from a small ceramic bowl sitting on the ground nearby, he silently sprinkled both my hands, handed me an adze, and allowed me to hew out some of the wood. I am uncertain whether this was actually a legitimate preconstruction ritual, routinely followed by all boatbuilders, or if it was merely something Pak Murje invented on the spot to placate me. In either case, I must have been performing the task rather abysmally because, after only a few strokes, he good-naturedly took the adze from my hands, obviously to prevent me from doing any further harm.

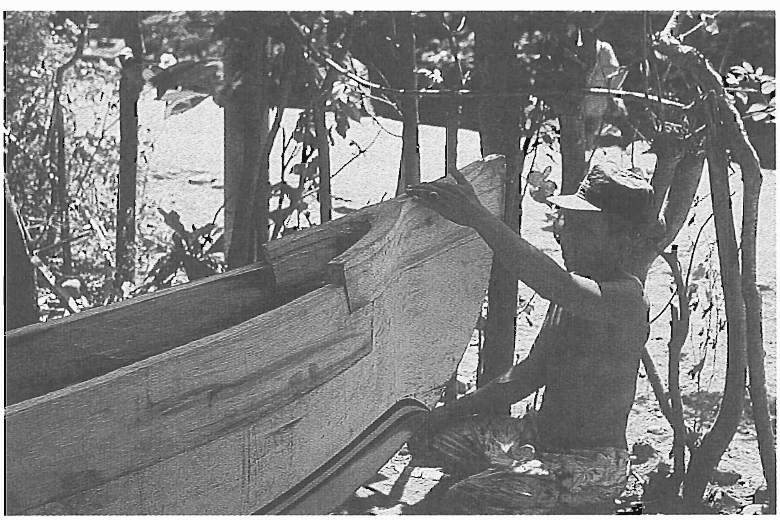

Photo: R.D. Herron

Pak Murje fits a fork-shaped kanti *to the stern of an older* jukung.

Photo: R.D. Herron

The partially painted bow decoration of this Balinese jukung pelasan *represents the head of the god* Gajah, *who protects the fisherman and his vessel. Stylistic variations of figureheads can indicate the age of a vessel and where it was built. A protruding eye is visible under the curved splashboard. The* jukung *is held level by a log in the sand under the* cedik*'s pointed end. The forward ends of the two floats can be seen to the right.*

Regardless of the possible religious observances, the actual construction of Indonesian *jukung* adheres closely to a rigorous system of proportions, and is not merely a haphazard method of building by eye. Handed down from generation to generation, use of this system of proportions involves dimensions taken from the builder's own body. Pak Murje indicated on the log he allowed me briefly to adze that the interior longitudinal dimension would be three times the length of his outstretched arms, plus three times the width of his open hand at both ends of the hull. Interestingly, the older *jukung* he was repairing had an interior length of nearly 6.36 m (21 ft 2 in), approximately 8 cm (3 1/8 in) longer than Murje's intended *jukung*, suggesting an original builder who was slightly larger in stature. Thus, no two vessels are identical.

Horridge calculates that the ideal thickness of a canoe's sides is 3.5 cm (1 3/4 in), and 8 cm (3 1/8 in) at the bottom. I noted a variation of nearly half a centimeter in the top thickness of several *jukung*. Variations in bottom thickness remain undetermined because I had no means to measure accurately this dimension. These measurements, however, were taken from older craft and, therefore, may indicate wear and subsequent repairs. Nevertheless, variations obviously occur. What is most important is the manner by which the builder uses the system of proportions.

The hull is internally divided into six equal sections, where transverse bars called *sendang* are usually placed. The mast is positioned such that the distance from the interior surface of the bow to the forward surface of the mast is one-sixth of the internal length of the hull. From this fractional distance the boatbuilder determines the length and placement of the fore and aft outrigger booms, as well as the length of the mast itself.

With this rather intricately developed system of proportions in mind, the boatbuilder begins by hollowing out the seasoned log, with the naturally occurring narrower end designated as the bow. Once this procedure is completed, or nearly so, two hardwood planks, which will serve as sheer strakes, are then fitted to the top of the dugout — one for each side of the hull. The thickness of these sawn planks is approximately one-quarter less than that of the uppermost edges of the dugout. This leaves a shelf-like surface inboard, upon which flat, transverse pieces (*dolos*) are fitted to provide internal support for the two strakes. A brace and bit is used to bore holes of approximately 1 cm (3/8 in) diameter into the top edge of the hull, about 1 hand-width apart. Their positions are then marked along the bottom edge of the sheer strake, into which corresponding holes are likewise bored. Hardwood dowels are temporarily placed in these holes, and the sheer strake is placed on top of them. An ingeniously conceived, sharp-pointed tool (today usually made of metal and in a variety of shapes) is then run along the upper edge of the dugout such that the tool's sharp point scores a line along the strake, near its bottom edge, that follows the contour of the dugout's upper edge. An experienced craftsman can achieve a similar but slightly less accurate result by holding a straightedge between his middle finger and index finger, and the stub of a pencil between his index finger and thumb. While the straightedge is run along the top edge of the dugout, the pencil marks the strake. By then removing the strake and carving along the mark, whether made by a sharp tool or a pencil, the boatbuilder can fit the strake to the dugout log almost perfectly. After both strakes have been properly shaped, and thin, paper-like strips of material made from tree bark have been positioned so that they will be sandwiched between the dugout and the strakes, the latter are firmly driven home with a large wooden mallet. The dowels are then secured with hardwood pins driven from inside the hull.

After the strakes are secured, the wishbone-shaped stem and stern elements are added. These solid pieces of timber are usually made from the naturally occurring forks of the *belalu* tree — the same type of wood as used for the hull. The name for these pieces varies throughout Indonesia. At Sanur they are called *kanti*, but I have also heard them called *ketua kuat* (strong head) and *sayap kuat* (strong wing). The *kanti* are carved and positioned so that the two arms of the fork lie flush with the sheer stakes, and the third arm extends outward, forming the end of the hull. Once in place, these *kanti* provide valuable strength for the vessel. Occasionally, canoes are built without a proper *kanti* in the stern and, therefore, cannot accurately be called *jukung*. Pak Murje informed me, however, that all Balinese canoes invariably have a *kanti* in the bows.

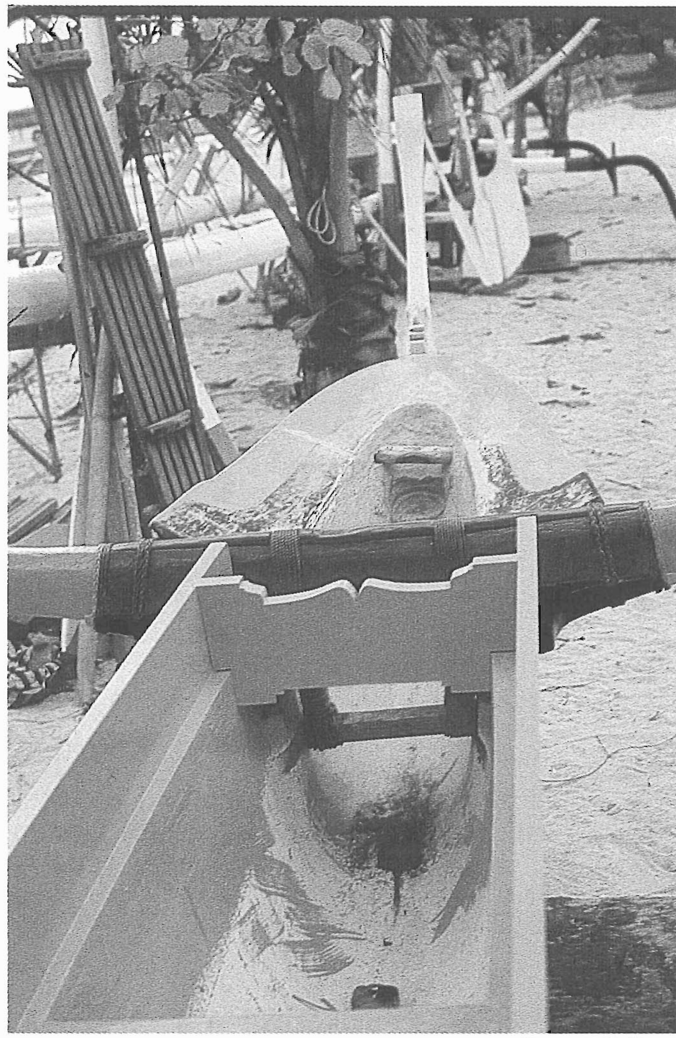

Photo: R.D. Herron

In southern Bali the splashboards in the bow are rounded. A flat, athwartship dolos *supports the sheer strakes. The* layang-layang, *hidden in this view behind the* dolos, *supports the outrigger boom. The lowest transverse member visible here is the* sendang, *to which the outrigger boom is lashed. The rectangular mast step in the bottom of the hull is just visible (bottom center).*

Considering this construction method, that of attaching two side strakes and two end pieces to a dugout, one can understand why these vessels are classified as five-part canoes. The only major difference from those built nearly 4,000 years ago is that dowels, instead of lashings, are used to fasten the strakes and end pieces to the dugout. Today the only lashing or, more accurately in this case, lacing on Balinese *jukung* is found at the forward ends of the bamboo floats, where flat wooden plates are laced on to prevent water from flowing through the hollow, tube-like floats.

Variations in the internal supports, however, are myriad and most are fairly modern. Like the ancient five-part canoes, Balinese *jukung* still depend largely on compression to hold the vessel together. As previously mentioned, round wooden bars (*sendang*) are placed athwartships relative to the six internal divisions of the hull. Not all vessels, however, are fully fitted out with six *sendang*, and, at least in Kusamba, some *sendang* are rectangular rather than round. Nevertheless, at least one *sendang* will be placed in the bow and another in the stern. These are usually positioned with their extremities beneath carved lugs that help hold them in place. The fore and aft outrigger booms (*bayungan*) are then lashed to the *sen-*

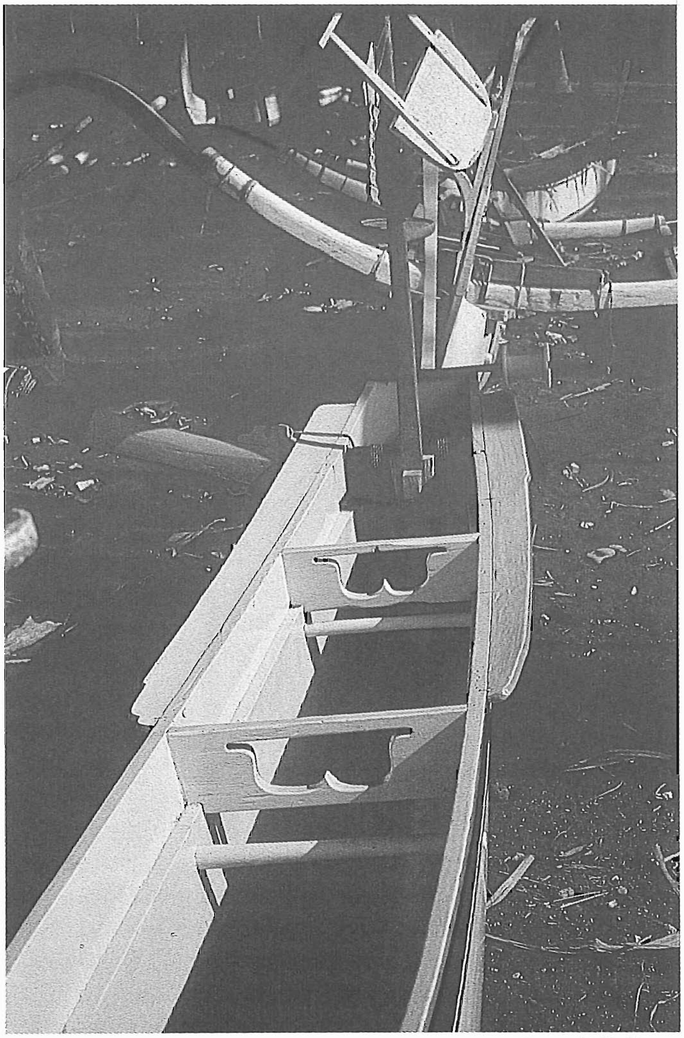

Photo: R.D. Herron

Near the Balinese village of Kusamba, as well as the coastal area roughly northwest of the island of Serangan, vessels often have rectangular splashboards. Holes, frequently intricate in design, are sometimes cut in the dolos. *Lashing is run through them to secure the* dolos *to the* sendang *below.*

dang. Along the inside of the hull, the flat *dolos* (transverse pieces) that support the sheer strakes are occasionally lashed to *sendang* positioned below them. Drilled in each side of the hull are holes in which the ends of these *sendang* are placed. The ends of the protruding *sendang* are cut off flush with the outside surface of the hull, but they are still visible. This is a modern and structurally weak method of construction. Depending on the size of the canoe and the amount of stress the outrigger booms are expected to exert on the *sendang*, those at the bow and stern also may be inserted through holes in the hull rather than held in place by lugs.

The mast is seated in a rectangular step carved out of the solid bottom of the dugout. The dimensions of the mast are determined by the system of proportions previously discussed, and usually the mast is stepped immediately aft the forward outrigger boom, which provides longitudinal support.

Associated with the mast is an important structural member called a *layang-layang*. This flat board is attached to the hull and has a square or rectangular center-hole that receives the mast, thus serving as a kind of mast partner. In addition, two smaller square holes are cut near the forward edge of the *layang-layang*. Lashing passes through these holes, around the *sendang*, and over the forward outrigger boom that sits atop the *layang-layang*. As wind fills the sail, and the leeward outrigger float is pushed downward into the water, nearly equal but opposite forces from the mast and the outrigger boom are exerted on the *layang-layang*. In this way much of the load is transferred from the mast to the outrigger boom rather than along the length of the hull.

The *penyankilang* in the stern is similar to the *layang-layang* and is lashed to the aft outrigger boom in the same manner as the *layang-layang* is lashed to the forward boom. A square hole near the center of this thick, flat board receives the rudder-support post.

Balinese canoes are frequently fitted out with *tungkoh* or, as some fishermen pronounce it, *tengah korsi* (literally "center seat"). The ends of these rectangular pieces of wood are secured to the edges of the hull with dovetail joints. Not only do they help strengthen the hull, but they also serve as seats for the fisherman, or as platforms for a kind of split-bamboo decking that can be later rolled up and removed.

Both the fore and aft outrigger booms, as previously described, are attached to the hull with only simple, but strong, lashings. Originally these lashings were made from rattan, but today only cheap nylon rope is used. When the boat is not in service, the booms can be removed to prevent them from rotting in the humid environment. The *cedik* is attached to the boom by means of a lashing wound over a scarf joint secured by a wooden peg or tenon. The opposite end of the *cedik* is carved down to a point that fits into a hole drilled through the upper surface of the float (*katir*). Thus positioned, the bamboo float is then lashed to the *cedik*.

An important engineering feature of these composite outriggers, in contrast to outriggers made from a single piece of wood, is that they tend to act in a manner similar to that of a woven wicker chair. The stress loads taken in a heavy sea are more evenly distributed along the entire length of the outrigger and not concentrated in a single area. Furthermore, with their high-curving arch, the *cedik*

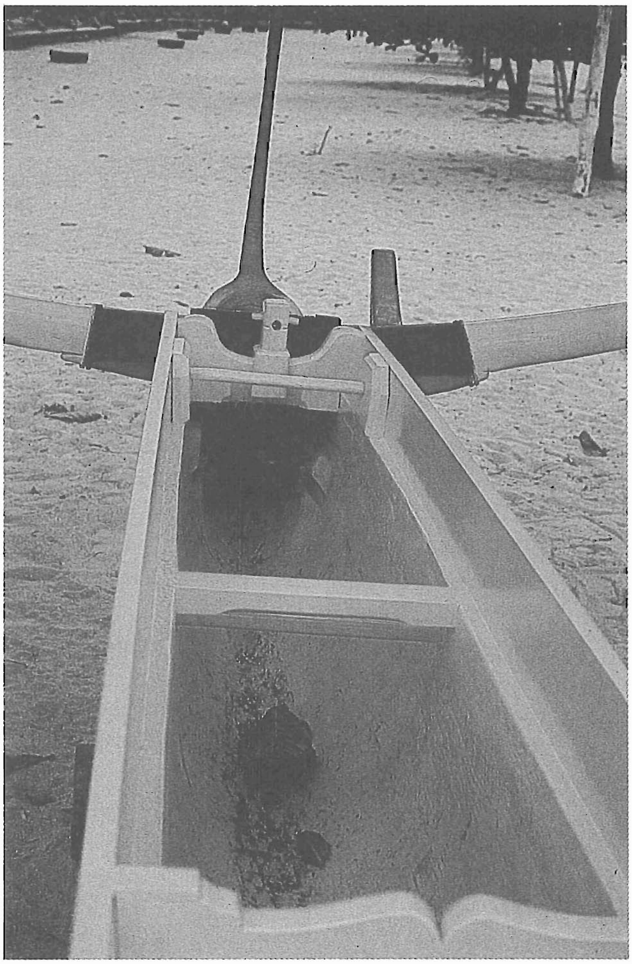

Photo: R.D. Herron

The narrow, flat thwarts, or tungkoh, *of this Balinese* jukung pelasan *serve as seats for the fisherman, or as platforms for loose bamboo decking.*

are less likely to be swamped by waves, and the optimal positioning of the floats is maintained. Exactly how the floats are positioned is apparently determined by the individual sailor. Nevertheless, all floats project out farther from the bow than they do from the stern, and the forward extremities are farther apart from one another than are those aft. This provides longitudinal stability in a heavy following wind, and helps the sailor control the weather helm by preventing the forward float ends from plowing into the sea. Variations of as much as 10 cm (3 7/8 in) may occur in the positioning of the floats. Frequently, one sees floats with several holes for the *cedik*, indicating the need for adjustments.

The origin of the simple yet very sophisticated Balinese *jukung* rig is unclear, and to describe the rig fully is an entire study unto itself. In general, Balinese canoes are fitted with a triangular sail held between two spars. The upper spar is supported forward of its point of balance by a rope looped through the head of the characteristically short mast. Both the upper spar and lower spar, or boom, intersect at the tack of the sail, and are commonly secured by wedging them into the bows of the canoe. The only lines used to control the sail are the sheet, attached to the boom, and a brace- or vang-like top line, which also serves as a backstay, running from the upper spar. In operation the sail is moved by rotating the boom and upper spar around the mast, which serves as a pivot for the upper spar. This type of rig is well suited to these vessels because, in combination with the floats, it permits a canoe to be steered without use of the rudder.

The large, heavy *jukung* rudder (*pancer*), nevertheless, plays an integral part in controlling the vessel, and also acts as a kind of leeboard. The stock and part of the blade

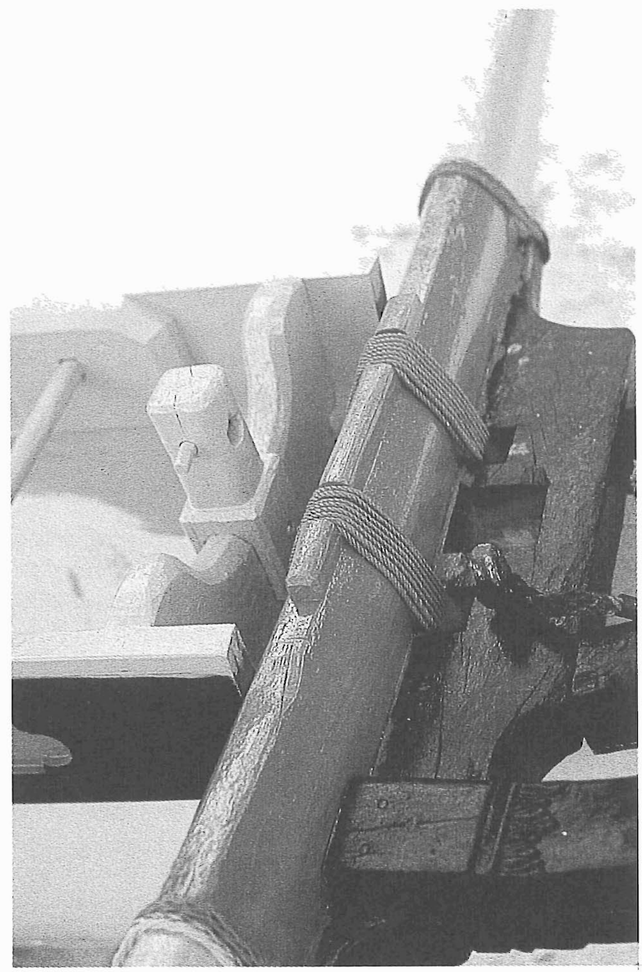

Photo: R.D. Herron

On a Balinese jukung pelasan *the aft outrigger boom is lashed to the thick, flat* penyankilang. *The empty, central square hole will receive the rudder-support post. Note the decorative carving on the fore-and-aft member at lower left.*

of the *pancer* is made from a single piece of wood. The remainder of the blade is fashioned from a second piece of wood, and is attached with dowels. A slightly rounded or rectangular hole cut in the rudder's loom serves to hold the tiller loosely in place. The aft end of the tiller is cross-pinned to prevent it from sliding forward. Just below the tiller, the rudder stock is lashed to the port side of the rudder-support post (*tunguan*). By pulling the tiller forward, and pivoting the rudder stock on its lashings, the blade can be brought out of the water to prevent it from scraping along a shallow sea bottom. Because of its shape, one may initially think that this type of rudder was directly influenced by the Portuguese. In reality, the Balinese *pancer* has a Southeast-Asian ancestry dating to about the sixth century B.C.

As time and money became increasingly limited I realized that, although I was able to achieve many of my research goals concerning Balinese vessels, much would have to be left undone if I were to travel to Madura and study the vessels there, as originally planned. Studying the watercraft of Madura is important because many of the vessels from this island exhibit design features and construction techniques that are not only related to but, I believe, predate those used by the Balinese. One example is the upward-curving booms and *cedik*, which Hornell suggested as being Balinese in origin. Photographic evidence, as previously discussed, suggests otherwise, as did several Madurese boatbuilders who, with unabashed pride, informed me that this feature did not originate on Bali. Several builders even laughed outright at the suggestion. They did, however, agree that the Balinese have developed it into a distinctive form.

Although individual construction rituals and ceremonies may vary slightly between the Hindu Balinese and the Muslim boatbuilders of Madura, the construction of both Balinese and Madurese vessels are generally based on the traditional five-part hull canoe design. Moreover, as with the *jukung* of Bali, the design of traditional Madurese canoes varies from village to village. Although difficult to get to, the villages along the isolated northern coast of Madura are excellent locations to observe traditional watercraft. At Slompeng and at a few other villages, the double-outrigger, five-part canoe called a *jukung polangan* is still built.

Like the Balinese *jukung pelasan*, the *jukung polangan* also is used in trolling for fish. The Madurese vessel, however, displays several interesting variations with respect to her outriggers. The forward outrigger consists of two booms, each attached directly to a float. The inboard ends of the booms pass through a bamboo- or wooden-log tube (*kolong*) that is positioned laterally across the hull and fastened to the sides of the canoe. The *kolong*, like the *layang-layang* of the *jukung pelasan*, helps hold the booms in place yet allows for some flexibility, thus reducing the chance of breakage from stress in a heavy sea. The aft outrigger booms are also positioned inside a *kolong*, but their upward-curving outboard ends are not attached to the floats. Instead, a *cedik*, or *tencil*, is pegged and lashed to

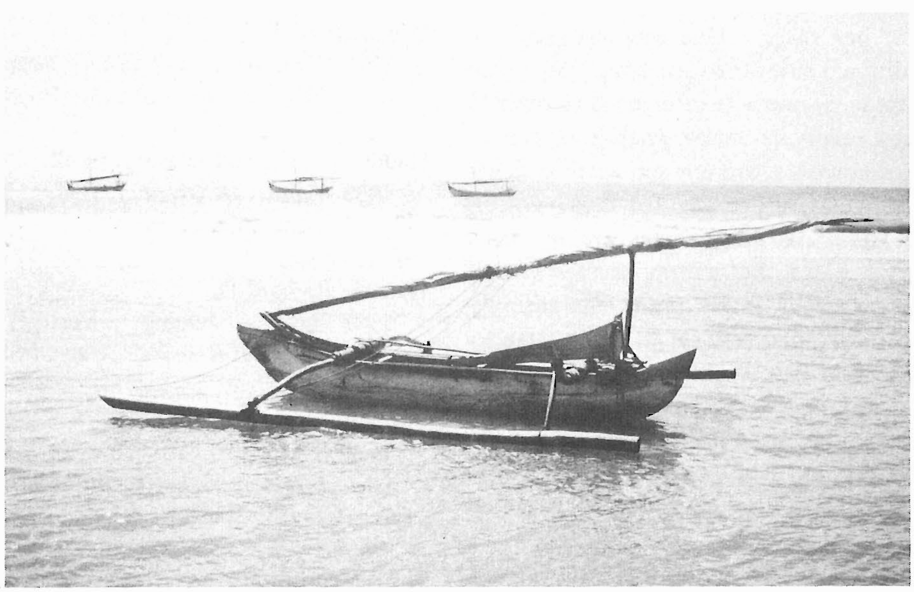

Photo: R.D. Herron

A jukung polangan *near Slompeng, Madura. Note the fore and aft outrigger booms positioned in the* kolong. *Only the aft outrigger has a* cedik; *the upward curve of the aft outrigger boom helps keep trolling lines separate.*

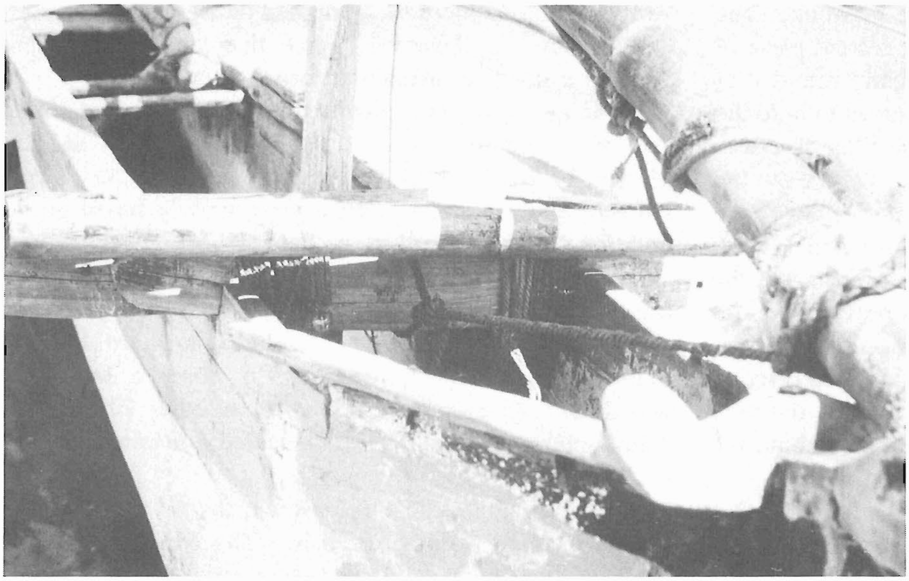

Photo: R.D. Herron

The bow of a Madurese prahu polangan. *Note the two-part boom, normally positioned within a* kolong, *and the additional side strakes.*

the underside of each boom, and the boom ends extend outward beyond the *cedik*. The extension of the boom is used to keep the fishing lines separated when trolling.

The *prahu polangan*, also found at Slompeng, is an interesting variation on the *jukung polangan*. Although the *prahu polangan* exhibits many of the same construction techniques as the *jukung*, the reason she is considered a *prahu* rather than a *jukung* is because her sail is raised on a halyard, traditionally uncommon for a *jukung*, but most importantly because of the two or three side strakes used to increase the height of her sheer. One obvious reason a builder might use additional side strakes is simply to create a larger vessel, and the term *prahu* is often used to refer to watercraft larger than a relatively simple *jukung*, or canoe. Many *prahu polangan*, however, are not appreciably larger than *jukung*. This suggests, especially for those vessels built today, that the additional side strakes are not used simply to create a larger vessel, but a *large-enough* vessel. Timber suitable for a dugout is becoming increasingly scarce. Boatbuilders often must rely on younger, smaller trees for their dugouts, and then build up the sides of the smaller dugout with additional strakes to produce a vessel of sufficient size. Thus the term *prahu* is not simply a reference to large vessels, but is a qualifier word, used in conjunction with another, denoting the use or construction of a vessel type.

Strikingly, more vessels of the *prahu* type than *jukung* are being built in Madura, particularly along the island's northern coast. The rather generic, motorized *prahu besar* (or "big boat") are becoming an increasingly common sight, as are the outriggerless, plank--hulled *prahu jaring*. Whatever the economic or environmental reasons for this change in native boat building, change is definitely occurring.

My research in Indonesia reminded me that nothing remains static. Certainly nothing cultural has ever been exempt from the forces of change or modernization. Like anything else, Indonesian watercraft have been changing and will continue to do so. In fact in one respect, the term *traditional* is only limited in its usefulness. The vessels built today, of course, are not replicas of those constructed thousands of years ago. But fortunately, they have retained enough of their structural ancestry to allow us to study firsthand at least some of the ancient methods of Austronesian construction. How many more years the *jukung* of Bali and Madura will be built and sailed is difficult to predict, but by the end of this decade most, if not all, will probably cease to exist. It is therefore imperative that we understand as much as we can today about these and other traditional types of Indonesian vessels. If we fail, vast amounts of information concerning this aspect of the world's wooden boats will likely be forever lost to the miasma of history.

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A Quest for Simplicity

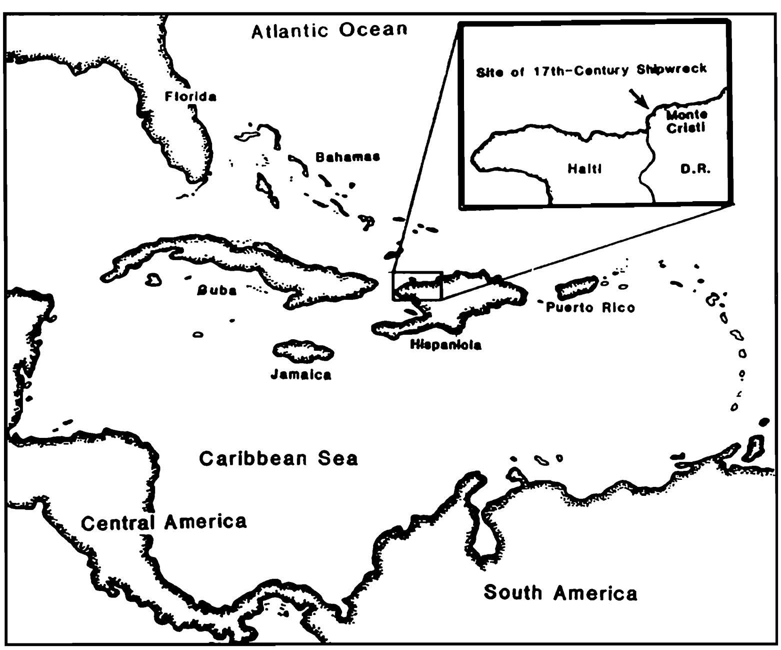
Musings on the Seventeenth-Century "Pipe Wreck" in Monte Cristi Bay, Dominican Republic

by Jerome Lynn Hall

William of Ockham was a fourteenth-century English philosopher who posited the idea that assumptions must never be multiplied beyond necessity. So popular is this aphorism that it has come to be known as Ockham's Razor. There are a number of expressions that restate this maxim: "keep it simple;" "common things occur commonly;" "don't make a mountain out of a mole hill." No matter which saying best conveys the message, the underlying premise is an intelligible challenge to give consideration to that which is obvious.

Talk to any nautical archaeologist and he or she will tell you that there is very little about a shipwreck that is, at first, obvious. In fact, the opposite is usually true. Wreck sites, by their very nature, are most often jumbled masses of wood, metal, and scattered cargo. Between the stages of excavation and museum display lie a number of challenges: artifacts must be measured, drawn, photographed, and conserved, and at some point the archaeologist must stand back and ask, "What does all of this mean?" Herein lies the most challenging part of any research project — interpretation.

For three years now, a small contingent of Texas A&M University Nautical Archaeology Program students, along with volunteers from Earthwatch®, a non-profit organization based in Watertown, Massachusetts, have pooled their physical, emotional, and intellectual resources to excavate the extant hull and cargo of a shipwreck site that is known simply as the "Pipe Wreck" (see *INA Quarterly* 19.2: 3-7). Each summer these dedicated individuals map, excavate, record, and conserve the thousands of artifacts that have, amazingly, survived repeated onslaughts of inclement weather, souvenir seekers, and treasure hunters. Located on the north coast of Hispaniola (fig. 1), the site represents the remains of a northern European merchant vessel. Where it came from is uncertain; where it was headed and for whom the cargo was intended is unknown; when and how it sank remain mysteries.



Map: J.L. Hall

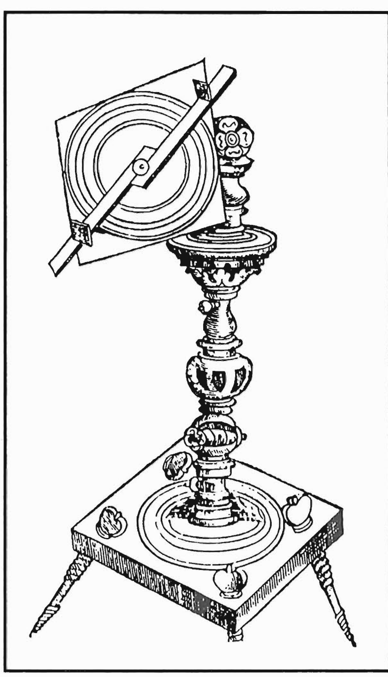
Fig. 1. Location of the Monte Cristi wreck on the north coast, Dominican Republic.

The interpretive stage of a project tests one's ability to synthesize information. It is the point at which the researcher translates raw data into hypothesis, a concept those familiar with the scientific method know as an "educated guess." "Can this hypothesis withstand careful scrutiny and testing? Would anyone replicating the work or reviewing the data arrive at the same hypothesis?" It is at this juncture too that one of science's dark specters o'ershadows the researcher: through either ignorance or vanity or both, one is tempted at some juncture to depart from Ockham's Razor.

Courtesy PIMA Archives.

Fig. 2. The copper-alloy object, with sequentially numbered gear-like "teeth."

I know. I did. In fact, I have many times. A perfect example was my hypothesis regarding an unidentified artifact excavated during the 1992 season of the Monte Cristi Shipwreck Project (fig. 2). Shaped like an oversized chess pawn, the copper-alloy object stands 30.8 cm tall. Two "collars," one at the top and the other at the bottom of the column-like body, are both notched such that a series of "teeth" — eight on the top and sixteen on the bottom — are created. The teeth are stamped sequentially with from zero to eight dots on the top collar, and in the same sequence repeated twice on the bottom collar. After months of consulting museum collections, libraries, and various specialists, I happened across a single illustration that inspired a working hypothesis (fig. 3). Could our artifact possibly be a component of a cosmolabe, a little-known astronomical and mathematical device invented in the sixteenth century? How this instrument was used is ill understood, but two points are clear. First, a contemporary drawing indicates that it was mounted in a gimbaled chair on the sterncastle of a ship, presumably allowing the navigator to determine latitude (fig. 4). I had my doubts that such was the nature of our artifact, but there was no disputing a keen resemblance between it and the object in the lithograph. Besides, nothing else had turned up and I was intrigued by what I perceived to be a type of computational device. Still, something bothered me, which brings us to point number two: the cosmolabe was a contrivance that, according to the scant literary evidence, proved un-



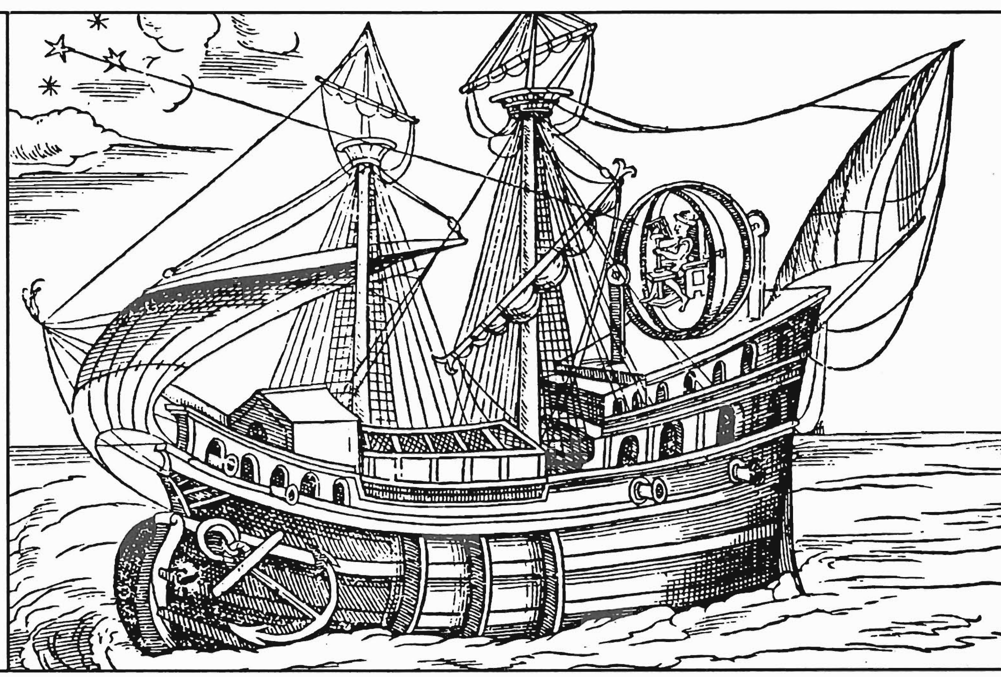


Fig. 3 (left). A portion of a cosmolabe, a sixteenth-century navigational device invented by Jacques Besson (after Randier 1980: 79). Fig. 4 (right). A navigator seated in a gimbaled chair and using a cosmolabe (after Randier 1980: 79).

Fig. 5 (right). The artifact is, more than likely, a portion of a chandelier column. The notches between the numbered teeth received similarly numbered candle arms.

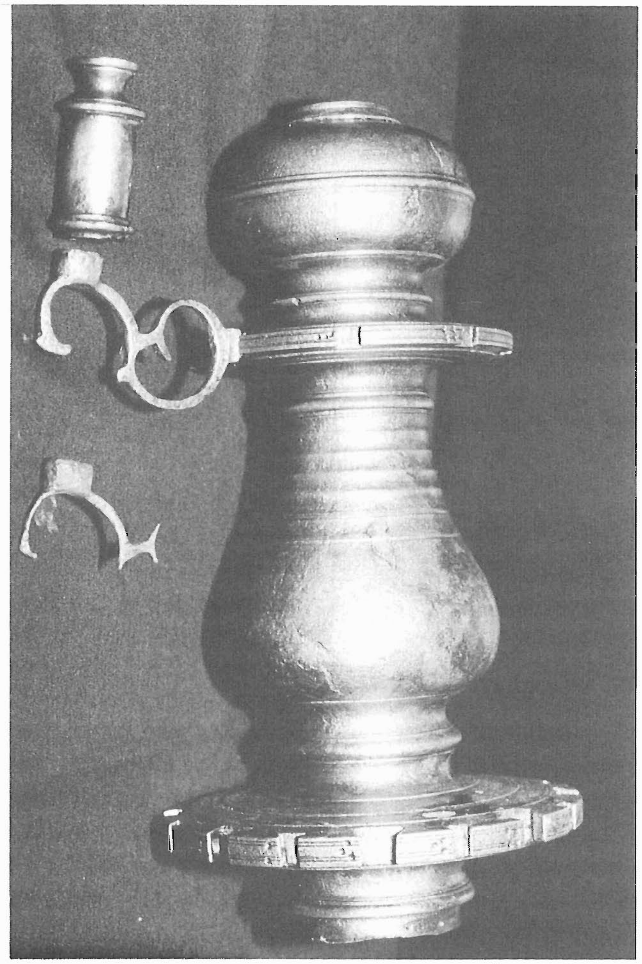
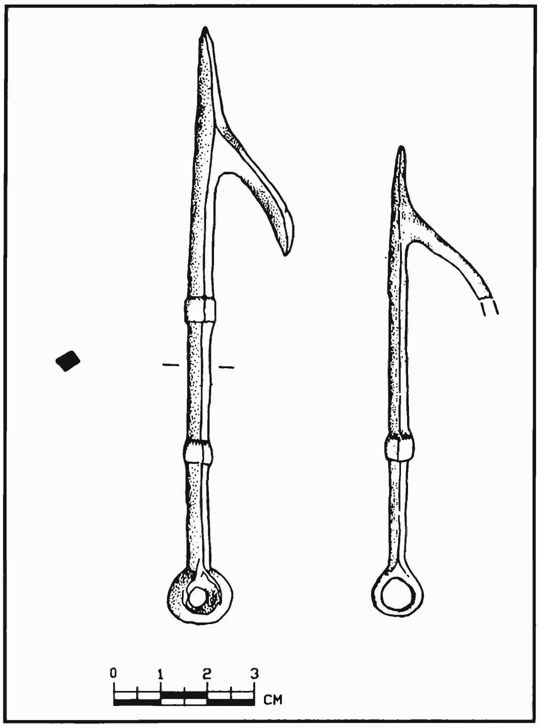


Photo: L.R. Martin

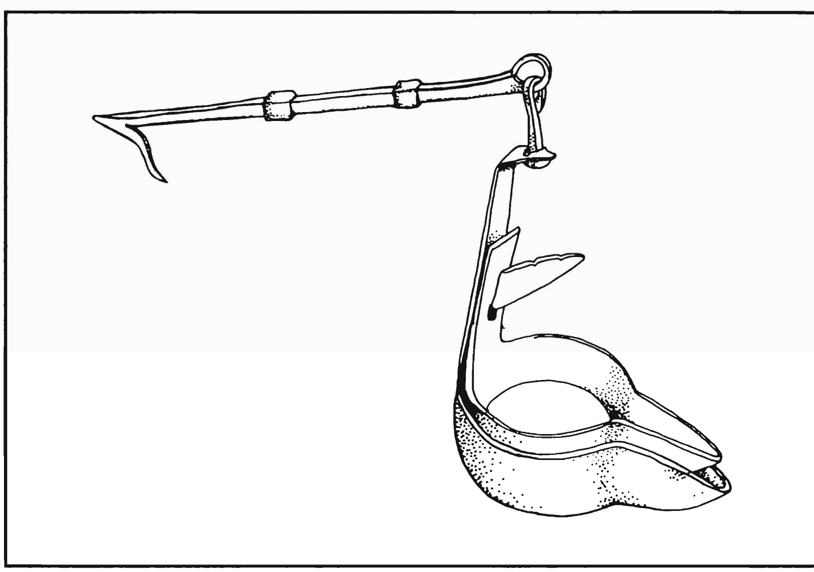
successful as a navigational instrument. If this was indeed true, then what was such a device from the sixteenth century doing on a ship that positively sailed in the seventeenth century?



Drawing: A. Roberts

Fig. 6. Pan-lamp brackets, shaped like fish hooks or harpoons.

About the time I was beginning to believe in my initial hypothesis, Francis Tejeda, director of the *Fortaleza Ozama* Conservation Laboratory in Santo Domingo, discovered a curved, copper-alloy artifact that had been recovered from our site approximately 12 years previous. The object had three small dots stamped into one of its ends and fit perfectly into one of the sequentially-numbered notches of our column. This suggested that the artifact is, more than likely, a portion of a chandelier column (fig. 5). I recalled that a professor at the Oceanographic Institute from which I received my master's degree had a plaque over his desk that read: "Oh, the tragedy of science; to destroy a beautiful hypothesis with an ugly fact!"

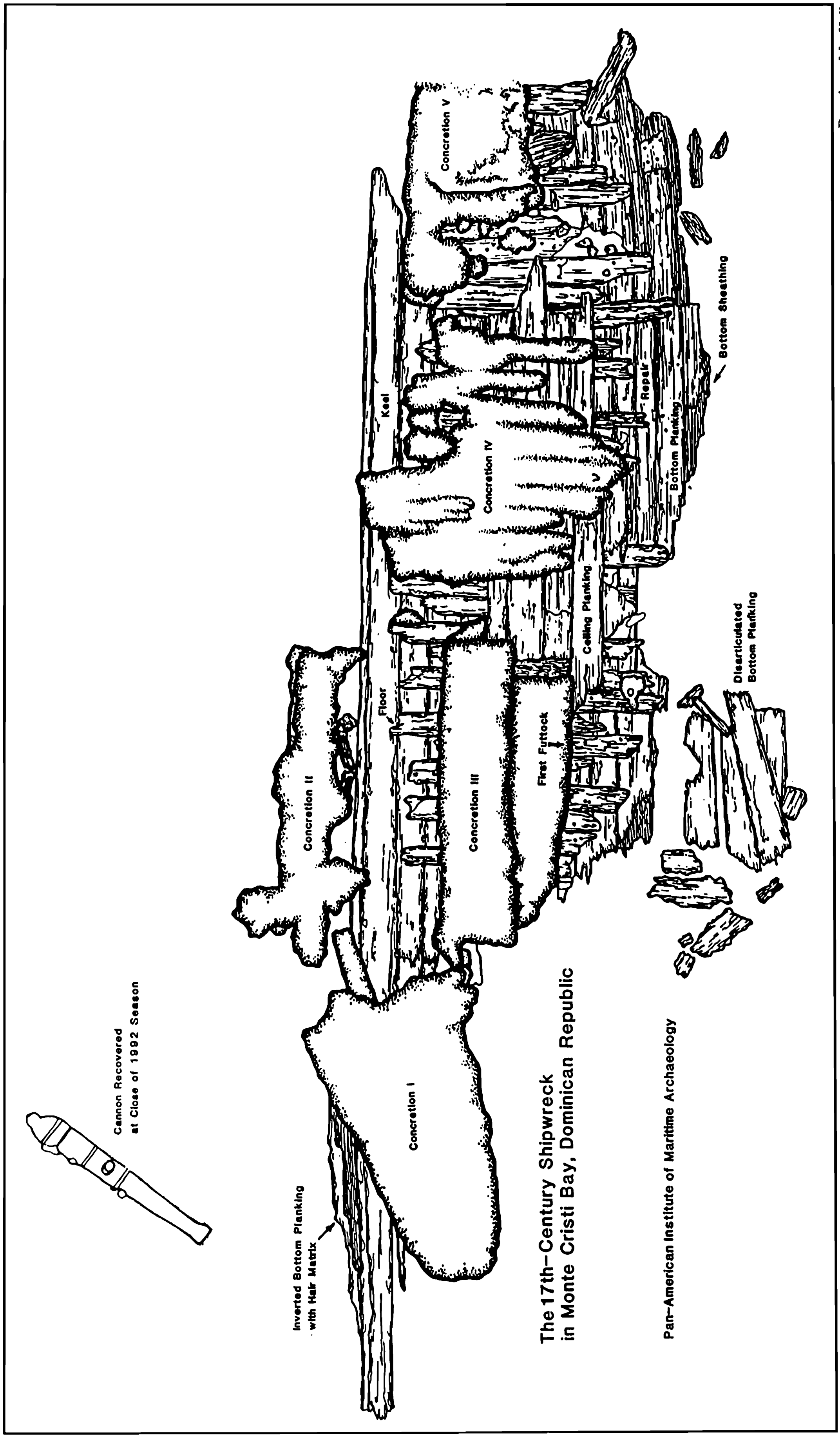


Drawing: J.L. Hall

Fig. 7. Pan-lamp bracket suspending an oil lamp (after Woodhead et al. 1984: 30, fig. 29).

Keeping Ockham's Razor in mind, what then were we to make of the two artifacts depicted in figure 6? Fishhooks? Harpoons? Those were the possibilities that first came to my mind and others versed in the material culture of the seventeenth century. As I was trying to determine the type of knot a sailor would have used on these hooks or harpoons while angling for large pelagic fish, what I can only describe as "blind luck" led me to the drawing in figure 7. The objects are, in fact, "pan-lamp brackets," simple devices for hanging oil lamps from chair backs or wooden beams.

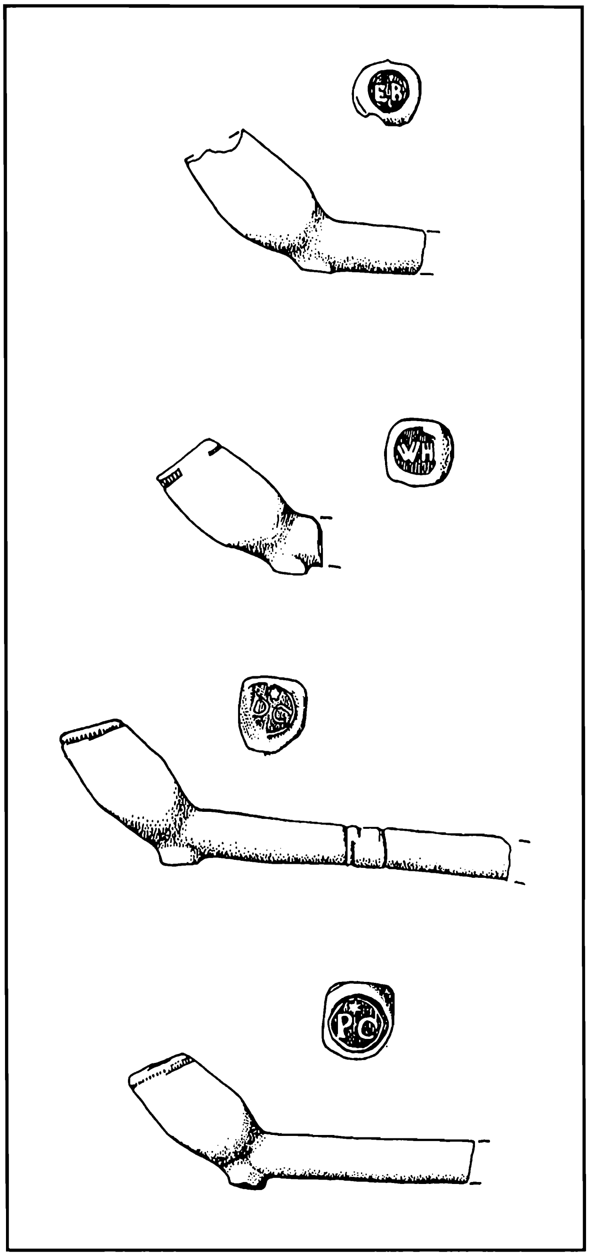
No aspect of this study is easily explained. While there are several hypotheses that address the issue of the ship's origin, the purpose of its voyage, and the circumstances surrounding its loss, no single explanation stands above the rest. The cosmopolitan nature of the cargo and the temporal range for the ship's destruction conjure up a plethora of scenarios for every aspect of the vessel's history. Was it of Dutch or English origin? Was its destination a Dutch or an English settlement? Did it rip its hull open on the coral reef that rises to within a few meters of the surface



Drawing: J.L. Hall

near the site, or was it sunk by the Spanish for trespassing in territorial waters? Even the extant hull is somewhat puzzling; and were the five large concretions that delimit the site a cargo of iron, simply ballast, or both?

Fortunately, certain items of the ship's cargo present fewer problems. These include Dutch pipes, three-legged kettles, and some details of the ship's construction, including the origin of the wood used. I have spent the past eight years studying the more than 25,000 pipe fragments that have been raised from the wreck, the majority of which have been recovered in the past three years. It is, clearly, the largest collection of clay tobacco smoking pipes ever to be recovered from a submerged site; by project completion — tentatively scheduled for 1997 — it is certain to surpass the more than 50,000 fragments excavated from the Anglo-American settlement at Jamestown, Virginia. Approximately 2,000 of the Monte Cristi fragments represent pipe bowls and stems, many of which bear distinguishable maker's marks. To date, we have observed seven such marks.



Drawings: A. Roberts

*Fig. 8. Top to bottom: the heelstamps "EB" (of Edward Bird); "WH" probably of William Hendricks; "D*C" (unknown); and "P*C" (also unknown).*

Four of these stamps bear the pipemaker's initials, and three exhibit marks of a "botanical" nature. During the seventeenth century, European pipemakers commonly stamped their initials into the heels of their pipes as a symbol of quality that also served as a form of advertising. One of the most prolific of the seventeenth-century Amsterdam manufacturers was an expatriated Englishman named Edward Bird, who arrived in Amsterdam sometime between 1624 and 1628. Why he chose to settle in Holland is unknown, but history documents well that during this time a number of English, fleeing persecution in their native country, emigrated to Amsterdam. Many quickly succeeded as potters and pipemakers, among other trade occupations. While Bird most likely started as a laborer in someone else's shop, by 1638 he and his wife were on their way to success, a fact well attested in the archaeological record of Europe and North America. Bird's pipes are often the most frequently found pipes on seventeenth-century archaeological sites across Holland and on Dutch-American sites in the northeastern United States, particularly in New York (fig. 8). His wares were also trade items favored by Native Americans.

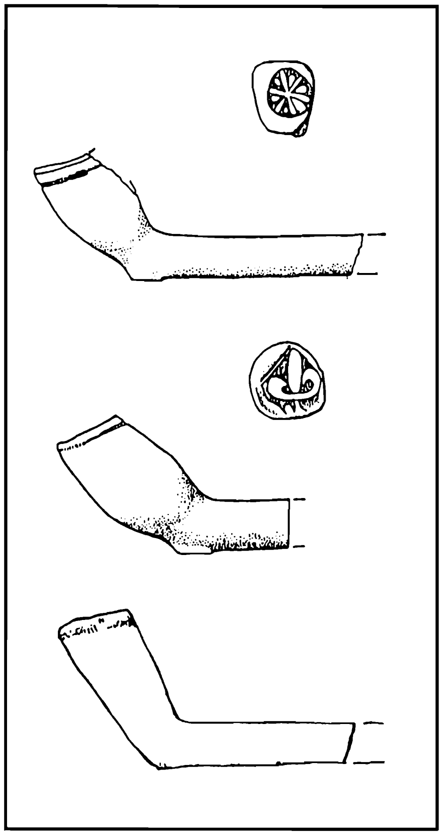
If the archaeologist fails to illuminate the lives or, at the very least, the lifeways of a people, then he or she has, in my opinion, failed. Upon conclusion of the excavation phase of a project, the principal investigator and his staff and crew have done nothing more than produce a pile of artifacts. Ceramics, organic materials, and even precious metals are merely trinkets destined to collect dust in a museum display case unless care is taken to conserve, study, and publish them and their historical significance. Edward Bird and other pipemakers of his time have helped us avoid such ignominy. The numerous historical documents that have allowed us brief glimpses into his life paint a picture of an industrious young soldier who built an empire that stretched from Amsterdam to New Netherland (modern-day New York). His life, although successful, was also tempered with tragedy: church rolls show that he buried 10 of his first 11 children in their infancy, a sober reminder of just how difficult life in seventeenth-century Europe could be, even among the middle and upper classes.

We also know that Bird had a friend by the name of

William Hendricks, another expatriated Englishman. Hendricks was born in Nottingham in 1599, and is considered by at least one scholar of seventeenth-century pipemaking to be the "third most important name in the Amsterdam pipe industry" (Duco 1981: 401). Records from the city of Amsterdam indicate that during his lifetime Hendricks was a sheet metal worker, a potter, and a pipemaker. His association with Bird is well documented in a seventeenth-century court case, and some have speculated that Bird fired his pipes in Hendricks' kiln (De Roever 1987: 56; John McCashion, personal communication 1991). Hendricks died in Amsterdam in 1669 or 1670 (Duco 1981: 309). What makes all of this so relevant to our work is the fact that we consistently excavate pipes from the wreck that bear heelstamps with the initials "WH" (fig. 8).

Pipes that exhibit rouletting around the stems are the most intricately decorated examples from the shipwreck. They bear "D*C" and "P*C" heelstamps that have yet to be identified, but several clues have emerged that may help narrow the possibilities (fig. 8). Paul Huey, Senior Scientist of Archaeology at the New York State Office of Parks, Recreation, and Historic Preservation, has stated that an elevated star positioned between initials on a heelstamp may stand for the phrase "the son of." While there has been no identification to date of a Dutch pipemaker with the initials "D*C," researchers are currently investigating the possibility that "P*C" represents Pieter Claess or Paulus Claesszoon, both of whom were Amsterdam pipemakers. Claess, the son of pipemaker Claus Pieterzoon, was 22 years old in 1651 and apparently manufactured his wares at least until 1654. Records indicate that Claesszoon was 52 years of age in 1651, which means both men were contemporaries of Bird and Hendricks. We do not know if Claess or Claesszoon had any sons. If they did, there is no indication that they worked with their fathers or carried on their family businesses.

A heelstamp bearing the very popular Tudor Rose is also present in the Monte Cristi collection (fig. 9). This five-petalled flower originated in England where, during the reign of Elizabeth (1588-1603), the European pipemaking industry was born. Among the emigrants who fled England to Holland in search of economic and religious freedom were a number of Protestant pipemakers who were advocates of the House of Tudor. Some adopted the symbol as their trademark, a statement of identity in a foreign land. Omwake (1969: 131) suggests that it is the oldest of all Dutch pipe marks, first adopted in 1617 by one Willem Barentsz, founder of the pipemaking industry in Holland. Solecki (1950: 32) states that the mark was "in vogue during the latter half of the seventeenth century," and according to de Mello (1983: 270), it was rivalled only by the seemingly ubiquitous "EB."



Drawings: A. Roberts

Fig. 9. Top to bottom: heelstamps in the form of the Tudor Rose; the fleur-de-lis*; an imitation of Native American pipe forms, known as a funnel elbow-angled pipe.*

A less frequently encountered heelstamp from the Pipe Wreck is that of a *fleur-de-lis*, or "lily flower," centered in a diamond (fig. 9). The *fleur-de-lis*, a heraldic symbol popularized by French kings, predates the practice of pipe manufacturing in both Holland and England (Omwake 1969: 133-134). This heelstamp stamp is common on Dutch pipes of the seventeenth century, and it also enjoyed great popularity as a stem design on garishly decorated Dutch pipes, especially those from Gouda. It has been known to occur as a heelstamp on pipes recovered from English sites in North America, but Omwake (1969: 134) is quick to add that in each instance, the "English origin has been obscured by questionable circumstances."

Perhaps the most interesting group of pipes — and one that I think will tell us more about the voyage of this ship than perhaps any other collection of artifacts — represents a lesser known type descriptively referred to as a "funnel elbow-angled" design (fig. 9). They are occasionally called "trade pipes," "export pipes," or "Dutch bowls," and are most commonly recovered from Native American sites in the northeastern United States. Among researchers, this type has earned the nickname "trade pipe" for the simple reason that, although manufactured in Amsterdam, they were intended for export to the Americas. In fact they seldom, if ever, occur in Europe. Because many of the earliest excavated forms that are known to have been produced in Europe, and specifically Amsterdam, bear heelstamps with the initials "EB," Edward Bird has rightly been implicated as the innovative capitalist behind the manufacture and marketing of this type of pipe. Funnel elbow-angled pipes are clear imitations of Native American pipes and occur commonly on Onondaga, Mohawk, Oneida, Seneca, Wampanoag, and Susquehannock sites (Huey 1988: 786).

There is no record of this type from French-American, Scandinavian, British, or Dutch sites. This pipe form may well be the *kasioten* described in a letter written by Jeremias van Rensselaer at Fort Orange (Albany, New York) to pipemaker Robert Vastrick of Amsterdam. In the letter, written in 1658, van Rensselaer describes four cases of pipes, three of which he had sold for nine beavers apiece. He comments that the fourth case could have been sold had there been shipped in it "some of those curved, English pipes...for they are not looking for large *kasioten* alone" (Huey 1988: 456). "They" most probably refers to Native Americans, and Huey suggests that the "curved, English pipes" may be bulbous-bowled forms manufactured by Edward Bird.

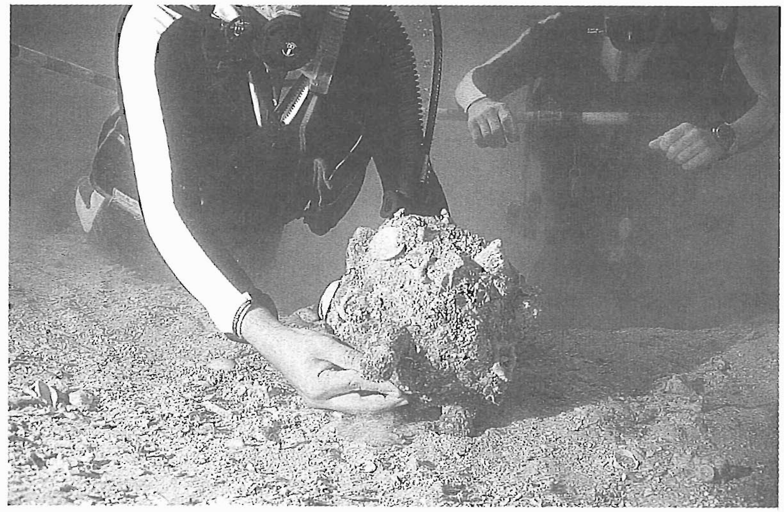
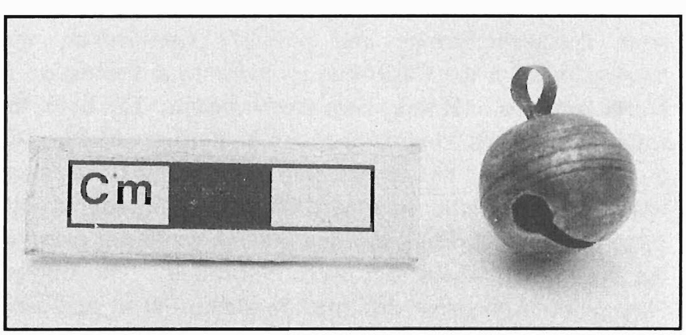


Photo: P. Borrell

Fig. 11. Archaeologists recovering a three-legged kettle.

Numerous other artifacts that appear commonly on Native American contact sites have been recovered from the Monte Cristi shipwreck, including glass beads, bone or ivory comb fragments, brass thimbles, a hawk's bell (fig. 10), and three-legged iron kettles. While not exclusively trade goods, as these items were in great demand within the European-American frontier colonies, their presence on the site does raise the possibility of a cargo shipment designated for barter with Native Americans.

The most interesting of these objects are the three-legged kettles (fig. 11). We have excavated two such artifacts, but a site map drawn and provided by the late Mr. Duke Long — an American who, along with a group of Dominicans, visited the site in 1980 — indicates that four were recovered prior to our work on the wreck. The cultural importance of these vessels is evident in their frequent occurrence in seventeenth-century Native American burials, which seems to emphasize their utility both in life and the afterworld. Tin, iron, copper, and brass kettles are commonly found on sites from this period, and it is known that, as trade items, each had a specific value. Tin kettles were the most highly prized, and those made of iron were preferred over brass. In certain instances, however, Native Americans regarded iron kettles as too heavy to carry around, and opted for the lighter brass kettles that also served as a source of metal from which ornaments could be made. European settlers also valued these all-purpose utensils for baking, roasting, and boiling, the predominant methods of cooking in the seventeenth-century European-American household. Boiling required little fuel and less attention.



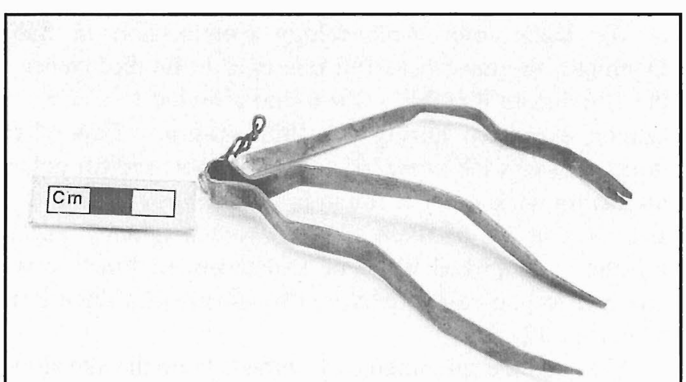
Courtesy PIMA Archives

Fig. 10. A hawk's bell. Such European-made bells were favored trade items, as indicated by their common occurrence on Native American sites. They appear as early as Columbus' first voyage to the New World.

In addition to the chandelier column and the pan-lamp brackets described earlier, several other objects associated with lighting have been recovered from the site. A brass candlestick holder that is, according to the representatives of the Underwater Archaeology Commission in Santo Domingo, the most beautiful one ever to be discovered in the Dominican Republic, was found accreted to a cast iron cannon excavated during the 1992 season. Two of the three pairs of wick tweezers — instruments used for pulling up a lamp wick — were found in the vicinity, leading us to suspect that all of these objects were originally packed together. A forked blade of undetermined function was attached to one pair of tweezers by means of a thick brass wire (fig. 12).

Although the assemblage of artifacts from the site allows a unique study of colonial trade items, the primary importance of the shipwreck lies in the fact that it represents one of just a handful of seventeenth-century vessels wrecked in the New World for which we have detailed hull information. Even though the Caribbean basin, like the Mediterranean, is a vast repository of shipwrecks, it is most unfortunate that much of the work has been and is still conducted by salvage groups who care little for the historic value of artifacts and less for the integrity of ship structures. A detailed study of the Monte Cristi hull is in progress, and preliminary work suggests it is of English design. Moreover, analyses conducted by the Dutch Dendrochronology Center in Amsterdam, The Netherlands, indicate that the ship was constructed with oak from England. Therefore, at this point we are reasonably confident that the ship itself was English.

The dendrochronolgy data also indicate that the wood used to build the ship was felled sometime between October 1642 and March 1643. One of about a dozen Spanish *ocho reales*, or "pieces of eight," from the wreck (fig. 13) establishes a *terminus post quem* (the date after which the vessel must have been lost) of 1652. The large collection of clay tobacco smoking pipes are of Amsterdam manufacture, and six of the seven identifiable heel stamps fit well into a temporal range of 1645–1665. The pipes are characteristic of, and in some cases identical to, those from Dutch-American contact sites of the northeastern United States, specifically those in New York state. If the unidentified copper-alloy object is, in fact, a component of a chandelier, as I now believe it is, then for whom was it intended? Surely someone of considerable wealth. Fine, tin-glazed delftware ceramics and imported Venetian glass vessels were also high quality cargoes for which wealthy colonists would have paid handsomely. Still, much of the cargo, and specifically the clay pipes, would have found their way to Native American settlements via a European-American *entrepôt*.



Courtesy PIMA Archives

Fig. 12. Copper-alloy wick tweezers with a forked blade wired to them.

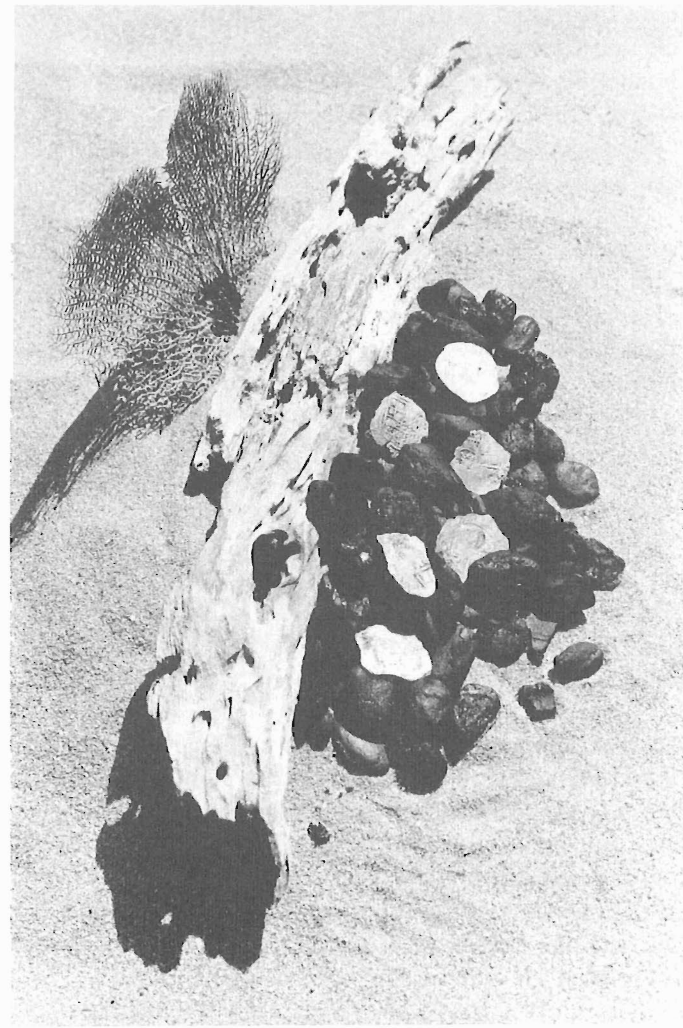


Photo: L. Sanders

Fig. 13. Examples of the "pieces of eight" found on the site. One allows the wreck to be dated no earlier than 1652.

So what would William of Ockham think of all this? What is the prudent hypothesis? What is the simplest, most obvious theory? It would appear that the ship, traveling from northern Europe and possibly Amsterdam, was passing through the Caribbean *en route* to a destination in North America. Of this, I am fairly certain. But here, the equation becomes complicated with numerous variables. In the latter half of the seventeenth century, the Caribbean basin and the Atlantic seaboard of North America was the stage upon which European sea powers acted out many of the disputes in which they were embroiled. The English Navigation Acts were designed to strike out at and limit Dutch seaborne commerce, and although their effectiveness is argued by historians, all would concur that the Dutch-Anglo Wars of the second half of the seventeenth century were one result. Was our ship a captured English vessel in the service of the Dutch West India Company, traveling from Fort Amsterdam on the island of Curaçao to the settlement of Fort Orange on the Hudson River? The possibility of an English-built ship carrying a preponderance of Dutch-manufactured goods is best explained by such a hypothesis. Of course, we cannot discount the influence of piracy in the Caribbean during the seventeenth century. An idea that occurred to us early in excavation of the site, that the vessel may have been engaged in illicit trade with the inhabitants of the north coast of Hispaniola — specifically the *boucaniers*, or "buccaneers" — is still viable.

Acknowledgements. Without the corporate sponsorship of Continental Airlines, Igloo Coolers, Coleman Outdoor Products, the Institute of Nautical Archaeology (INA), the Pan-American Institute of Maritime Archaeology (PIMA), Earthwatch®, and all the Earthcorp volunteers, this work could not have been carried out. My deepest gratitude is expressed to Don Pedro Borrell, Secretary of the *Comisión de Rescate Arqueológico Submarino*, and Francis Tejeda, Director of the *Fortaleza Ozama* Conservation Laboratory for their assistance. I am especially indebted to Texas A&M University Nautical Archaeology Program graduates Lillian Ray Martin and Sam Turner, and Program students Rich Wills, Rahilla Abbas, Barbara van Meir, Colin O'Bannon, and Ralph Pedersen, with whom it was my great pleasure to work. The late Duke Long, cartographer for the *N.S. Concepción* project, and Henry Taylor, numismatist and conservator for the *N.S. Concepción* project, have both been indispensable sources of information; their hard work and advice are greatly appreciated. Dr. Ronald Halbert, President of PIMA and one of the two attending physicians on the project, has kept us both well and sane. Paul Huey, Senior Scientist at the New York State Office of Parks, Recreation, and Historic Preservation, and the late John McCashion, have not only provided a veritable library of information, but have also offered tremendous encouragement and guidance. For these contributions, and these people, I am truly grateful.

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IN THE FIELD

INA would like to express its deep appreciation to all of the supporters of the projects listed below. Such work would not be possible without you.

Uluburun & Cape Gelidonya, Turkey
INA archaeologists plan to complete the excavation of the Bronze Age Shipwreck at Uluburun during the 1994 campaign (June 15–August 15). Three primary tasks await the team. One is the excavation around the upslope edge of the large boulder near the center of the site. This area is densely packed with artifacts. Another major task will be the recording and raising of the hull wood discovered last year. Cemal Pulak, co-director with George Bass, also hopes to map the site's topography.

INA staff members Don Frey, Robin Piercy, Tufan Turanlı, Sheila Matthews, and Murat Tilev will rejoin the expedition. Archaeologists Faith Hentschel, Nicolle Hirshfeld, Lillian Ray Martin and Patricia Sibella, and hyperbaric specialists David Perlman, physician, and Tom Sutton, P.A., will return to Uluburun for the final season, as will Texas A&M University Nautical Archaeology Program students Michael Fitzgerald, Brendan McDermott, Stephen Paris, Edward Rogers, and Mark Smith.

Prior to the season at Uluburun, another short survey will be conducted at Cape Gelidonya by Cemal Pulak and INA staff members Don Frey, Tufan Turanlı, Murat Tilev, and Tom Sutton.

Bodrum, Turkey
In the Bodrum Museum of Underwater Archaeology, Frederick van Doorninck's research on the capacities of the eleventh-century Glass Wreck amphoras continues, as does work on the glass from that same wreck. Frederick Hocker, assisted by Nautical Archaeology Program students Stefan Claesson, Tommi Mäkelä, and Taras Pevny, will build a partial replica of the seventh-century Yassıada vessel in the former Bronze Age Hall. Other Nautical Archaeology Program students working in Bodrum are Peter van Alfen, who will begin a study of amphoras from the Yassıada wreck; Barbara van Meir, who will study artifacts raised during past INA surveys along the Turkish coast; and Claire Peachey, who will co-instruct a conservation intership (see News & Notes).

Lake Champlain, Vermont
Kevin Crisman, recipient of a grant from the Texas A&M University College of Liberal Arts Program to Enhance Scholarly and Creative Activities, will conduct a sonar and ROV (remove operated vehicle) search for the *Troy*. If found, this earliest known sailing canal schooner, which sank in 1824, will fill many gaps in our knowledge of the early commercial history of Lake Champlain.

Elsewhere on the lake, Nautical Archaeology Program student Elizabeth Baldwin, assisted by fellow Program student Scott McLaughlin, will direct the second season of the *Champlain II* Project in August (see pp. 3–11 above).

The Dominican Republic
Nautical Archaeology Program Ph.D. candidate Jerome Lynn Hall will be directing the fourth season of excavations on the seventeenth-century "Pipe Wreck" (see pp. 29–37 above). He will be assisted by fellow Program students Elizabeth Baldwin (through July), Kyra Bowling, James Coggeshall, Tina Erwin, David Johnson, Anne Lessmann, and Richard Wills, who will co-direct the project.

Red Sea Survey, Egypt
INA Research Associates Cheryl and Douglas Haldane will conduct an underwater survey of the Egyptian Red Sea coast. Nautical Archaeology Program students Peter van Alfen, Elizabeth Green, and Colin O'Bannon will assist.

St. Ann's Bay, Jamaica
Nautical Archaeology Program student Greg Cook, a Junior Fulbright Scholar, continues to excavate and research an eighteenth-century shipwreck in St. Ann's Bay. He is being aided by fellow Program student Clive Chapman.

Pensacola Bay, Florida
Nautical Archaeology Program Ph.D. candidate John Bratten, and fellow Program student Michael Scafuri, will conserve artifacts from the wreck in Pensacola Bay of an early Spanish galleon that is now being excavated by Roger C. Smith, Florida state underwater archaeologist and Nautical Archaeology Program graduate.

The Canary Islands, Texas, Greece, and Holland
Nautical Archaeology Program students Brett Phaneuf, Peter Hitchcock, and Program graduate Sam Turner will be studying possible Roman and post-medieval seafaring in the Canary Islands area. Program students Layne Hendrick and Brian Jordan will survey a steamboat wrecksite in Texas; David Stewart will work at Pylos, Greece, and on Crete; Mason McDaniel will continue his work with the Dutch government in Holland.

News & Notes

New President at INA

After 5 1/2 years at INA, President Robert "Chip" Vincent has accepted a position with the American Research Center in Egypt. Based in Cairo, he will direct, in conjunction with the Egyptian government, a major project designed to restore selected monuments, survey and document unknown monuments, and assist in the preservation of the national archives. We wish him and his family well in their new venture.

Frederick M. Hocker, Sara W. and George O. Yamini Faculty Fellow, has been appointed interim president by the Institute's Executive Committee. Associated with INA since 1984 and a Ph.D. graduate of the Nautical Archaeology Program, Dr. Hocker has extensive experience with the Institute's activities around the world. He has worked in Port Royal, Jamaica; he spent three summers in Bodrum, Turkey, working on the reconstruction of the eleventh-century Serçe Limanı ship and studying the tools aboard it; shipwreck excavation and recording projects have been conducted under his directorship in South Carolina and Holland.

INA Receives NEH Conservation Grant

INA is pleased to announce it has received a grant from the National Endowment for the Humanities (NEH) to conduct an internship program in the conservation of archaeological artifacts from submerged sites, to take place in July and August in Bodrum, Turkey. Five students from conservation programs in the U.S. and England will be instructed by freelance conservator Claire Dean of Dean & Associates, and conservator and Nautical Archaeology Program student Claire Peachey, with assistance from INA conservator Jane Pannell-Yıldırım. The program will cover all aspects of this specialized field of conservation, from pre-excavation planning to dry storage and display.

The laboratory will be busy this summer, with two visiting conservators from Egypt and two students from England working under the direction of Pannell-Yıldırım.

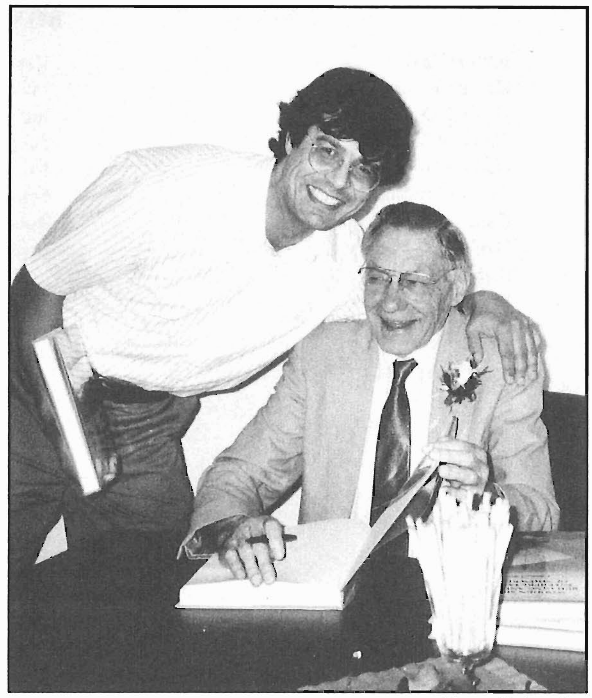

Photo: K. Bowling

Cemal Pulak congratulates J.Richard Steffy on the publication of his new book, Wooden Ship Building and the Interpretation of Shipwrecks.

Steffy Book Published

On May 10, 1994, J. Richard Steffy, Sara W. and George O. Yamini Professor of Nautical Archaeology, Emeritus, signed copies of his new book at a book signing hosted by the Nautical Archaeology Program and INA. Entitled *Wooden Ship Building and the Interpretation of Shipwrecks* and published by Texas A&M University Press, the book will be a standard reference for nautical archaeologists, ship reconstruction specialists, and students of shipbuilding technology. It is available to members of the Institute at a substantial discount (see enclosed flyer or contact the Institute). Professor Steffy continues to prepare for publication the final reports on the hulls of the Kyrenia and Serçe Limanı ships.

INA-Egypt Newsletter Available

The Institute's new regional center in Egypt, INA-Egypt, has published the first issue of its English-Arabic newsletter, *El Bahri* ("of the sea"). A reconnaissance of the Sharm el Sheikh area and news of INA-Egypt's activities are included. Persons interested in receiving a copy may write to Cheryl Haldane, *El Bahri*, c/o INA at P.O. Drawer HG, College Station, TX, 77841.

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