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In Memoriam Claude Duthuit (1931-2011)
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To learn more about the growing record of projects undertaken by INA over more than five decades of exploration, go to inadiscover.com.
As you are about to read in the next 100 pages, 2010 was an exciting year for INA and for nautical archaeology research worldwide. It was also a time for reflection and transition.

In 2010, INA founder **Dr. George Bass** and co-director **Dr. Nicolle Hirschfeld**, partnered with INA faculty affiliate **Dr. Harun Özdas** to return to Cape Gelidonya, Turkey, where 50 years earlier Bass initiated the underwater excavation of a Late Bronze Age shipwreck – a watershed moment in the history of archaeology. A watershed moment refers to the place where a river or stream is split into two distinct paths that do not intersect again; such was the case when archaeologists realized that shipwrecks should **and could** be excavated with the same diligence and accuracy afforded land sites. The field of nautical archaeology was born.

One of the key figures of that 1960 field season was **Mr. Claude Duthuit**, who over the next half-century came to be Dr. Bass’ closest friend, a pioneer of underwater excavation techniques, and a loyal supporter of INA. Mr. Duthuit returned dutifully to Cape Gelidonya for the resumption of fieldwork in 2010 but sadly passed away the following spring. Because there are few who knew him better, I encourage readers to turn to Dr. Bass’ tribute in this month’s *INA Quarterly*. Claude’s profound and lasting impact on our field mirrors INA’s long-term commitment to pursuing and supporting the many phases of archaeological research, from survey and excavation to conservation and publication. Claude was larger than life and a powerful presence; his absence is not only a loss for INA but a loss for humankind.

In October 2010 INA also bid farewell to President **Dr. James Delgado**, who left INA after five years to become Director of Maritime Heritage at the National Oceanic and Atmospheric Administration (NOAA). Delgado takes with him to Washington a formidable resume that reflects his many talents as a speaker, museum director, fundraiser, author, and archaeological ambassador. On behalf of everyone at INA, I wish Jim the very best for continued success in preserving, protecting, and publicizing the maritime sites that are one of our most precious cultural resources.

Into the large shoes left empty by Delgado stepped **Dr. Robert Walker**, a loyal and active member of the INA Board for almost a quarter of a century. Walker, who is Texas A&M’s Senior Executive for Development, served as Interim President for six months, and it was his steady hand on the tiller that guided INA smoothly through this recent transition. The new INA leadership brought with it new officers, staffing changes, and five new members of the directorial board; together they are helping to ensure that INA is in the best possible position to attract and sustain support, including donations and grants, to fulfill our mission.

The articles in this issue illustrate the broad geographical and historical spectrum of INA’s research. Our feature is the study of two of the eight breathtakingly well-preserved ships excavated from the Byzantine harbor at
Yenikapi, Turkey by INA Vice President Dr. Cemal Pulak and his team. The conservation of these and two other Yenikapi vessels at INA’s Hethea Nye Wood Conservation Facility in Bodrum is a challenging and costly but hugely important undertaking, since it guarantees that generations to come will be able to see, study, and ponder how Byzantine ships were built.

Other articles reflect the varied aspects of maritime archaeology, from remote survey on land or in deep water, to the careful and comprehensive excavation or in-situ documentation of an underwater site, to the challenges of conserving artifacts from multiple shipwrecks. And virtually all the contributors to this volume come face-to-face with the importance of marrying the physical evidence collected in the field with the historical or archival documents that provide texture and context. My own article is a reminder that there are new opportunities waiting for INA in some pretty fantastic places.

Every year, INA research associates and affiliated faculty share the results of their hard work through presentations at scholarly conferences, public lectures, and in scientific journals and popular articles. In 2010, the Yukon River Steamboat Survey collaborated with friends at Spiegel-TV and National Geographic to produce a documentary film which is expected to be released in late 2011. INA’s web page (www.inadiscover.com) and project blogs have proven effective for communicating the intellectual value, urgency, and real-world challenges of our work. One feature of the current INA web page is a schedule of those lectures that highlight INA’s work and are provided by our sister organization, the Archaeological Institute of America. We are presently exploring additional research tools and options that will make our website even more rewarding for current (and future) INA members.

The fieldwork, conservation, and research INA conducts depends upon a wide network of institutional partners, member organizations, and individual donors and sponsors. To them we say THANK YOU for making our work possible, and for your allegiance in times of transition. When budgets are being slashed all over the country, we appreciate more than ever your support of and commitment to INA. Five decades of fieldwork and analysis since the 1960 Cape Gelidonya excavation have produced the comprehensive Oxford Handbook of Maritime Archaeology (2011), co-edited by past INA president Dr. Donny Hamilton and two graduates of Texas A&M’s Nautical Archaeology Program, Mr. Alexis Catsambis and Dr. Ben Ford.

In the years to come, INA will focus on its core, proven, qualitative strengths: conducting archaeological fieldwork and generating top-tier publications in nautical archaeology. As individuals we come and we go, but the legacy of research and the published word is what transcends time and ensures that INA will endure for many years to come.

We thank you for your support because it makes a difference.
Since 2004, a major construction program has been underway in Istanbul, Turkey, to expand the city’s public transportation system. One of the largest components of the project is the Marmaray rail tunnel, which will connect the European and Asian sides of the city via the deepest submerged tunnel in the world.1 These plans have resulted in a series of major salvage excavations in various parts of the city by the Istanbul Archaeological Museums, the largest of which is in the neighborhood of Yenikapi, located near the southern shore of the old city. Under the directorship of former director of the Istanbul Archaeological Museums Ismail Karamut and current director Zeynep Kızıltan, excavations at the 58,000-m² Yenikapi site have uncovered a vast array of archaeological finds from the city’s history, ranging from an 8,000-year-old Neolithic settlement to classical amphorae and Ottoman paved roads, workshops and cisterns.2 Perhaps the most significant discoveries are from the ancient Theodosian Harbor, one of the main harbors serving the late Roman and Byzantine capital of Constantinople. Archaeological evidence shows that the Theodosian Harbor’s main period of use occurred between the late fourth and 11th centuries C.E. In addition to thousands of artifacts, evidence for harbor installations, and loose ship timbers and ships’ equipment, Byzantine-period finds at Yenikapi include at least 35 shipwrecks.3 Because the shipwrecks were found under the water table, their wooden hulls were extremely well preserved. These shipwrecks represent the largest collection of early medieval vessels ever found in the Mediterranean at a single site.

At the invitation of the Istanbul Archaeological Museums, the project team has been documenting the shipwrecks and related finds from the Yenikapi excavations. Two ships, one an 11th-century merchant ship and the other a small 14th-century ship, have been successfully excavated and recovered. The vessels were found Jahre 1 and 2 in the 2005 and 2006 seasons of excavation.

FIG 1
Map of Constantinople showing the location of the Theodosian Harbor (after Mango 2000, Fig. 4).
Archaeological Museums, Dr. Cemal Pulak, associate professor at Texas A&M University and INA Vice-President, has directed the recording, dismantling, and study of eight of the Yenikapi shipwrecks since July 2005 (Table 1). The ships recorded by Pulak’s team include six merchant vessels dating from between the 7th and 10th or early 11th centuries C.E. and two of the six, 10th-century Byzantine galleys found at the site, the first early medieval galleys ever found. The authors of this article worked on the documentation and dismantling of these ships in Istanbul for 37 months between 2005 and 2008. Four of the 10th-century ships, including two merchant ships (YK 1 and YK 5) and two galleys (YK 2 and YK 4), have been studied by Pulak’s team in Istanbul since 2005; these four ships will be conserved by Istanbul University’s Department of Conservation and Restoration.

Four of the dismantled merchant ships, including a seventh-century merchant vessel (YK 11), an early eighth-century ship (YK 23), a late ninth-century vessel (YK 14), and a late 10th-century ship (YK 24), are now housed at the Nixon Griffis Conservation Laboratory and Hethea Nye Wood Conservation Facility at the Institute of Nautical Archaeology’s Bodrum Research Center, where they are being documented and conserved. Two of these shipwrecks are the topic of Ph.D. dissertations for the authors, both doctoral candidates in the Nautical Archaeology Program at Texas A&M University. Post-excavation recording of these two vessels at INA’s Bodrum Research Center began in the summer of 2009 and has been ongoing since June 2010 under the overall supervision of Cemal Pulak; it is expected to continue into spring 2012. After conservation, the ships will be reassembled and displayed in Istanbul in a planned museum.

Before the Yenikapi excavations, the Theodosian Harbor was known almost exclusively from textual sources. The city of Constantinople (formerly the Greek city of Byzantium) was inaugurated in 330 C.E. by the emperor Constantine as a new capital for the Roman Empire. A period of building expansion occurred over the next century, in which the city’s fortifications were rebuilt, an elaborate water supply system was constructed, and two new artificial harbors were built on the city’s southern shore, along the Sea of Marmara: the Harbor of Julian (later also known as Harbor of Sophia), and the Theodosian Harbor (Fig. 1).

The Theodosian Harbor, or Portus Theodosiacus, was constructed at the mouth of the Lycus River at the site of a deep natural bay to the northwest of the modern Yenikapi ferry terminal. It was built during the reign of Theodosius I (379–394), perhaps around 390; although the precise date of its construction is unknown, it is mentioned in the Notitia urbis Constantinopolitanae, a list of the city’s monuments, in 425. The city’s population, which was in the range of one to a few hundred thousand for much of the period between the fourth and 11th centuries, required a constant importation of food supplies and other goods; most of these supplies
were imported by sea, often over great distances. The presence of two large government-run granaries near the Theodosian Harbor, the Horrea Alexandrina and the Horreum Theodosianum, indicate the association of the harbor with the Egyptian grain trade. After the loss of Egypt and North Africa in the early seventh century, the city probably relied primarily on other, closer sources of foodstuffs, most of which continued to be imported by ship. One of the government grain warehouses was apparently still in use until at least the 10th century, and the city’s grain market and several of the livestock markets were located near the Theodosian Harbor in this period as well. The Theodosian Harbor may also have been used by naval vessels; Theophanes notes that the Byzantine fleet assembled here during the first Arab siege of Constantinople from 674 to 678. The discovery of six late 10th-century rowed galleys, probably warships based on their construction, suggests that the harbor may have continued to serve some military function at a much later date.

Since the harbor’s construction, silts from the Lycus River had begun to accumulate; due to the location of the western mole, this began in the western portion of the harbor and gradually crept eastward, eventually rendering the harbor unusable. By the late 15th century, this alluvial area was being used as gardens, a use which continued until quite recently. However, the 30 merchant ships of fifth- through 11th-century date excavated at the site confirm a sustained commercial activity in the harbor well into the 11th century, later than previously thought by historians; in fact, the majority of the vessels discovered on the site date to after the seventh century C.E. and were found in the center or towards the eastern end of the site. A number of these ships were likely abandoned derelicts, while others, including YK 1, which was found with a cargo of amphoras, were probably sunk in one or more storms in the ninth and 10th centuries.

Excavations at Yenikapi, 2005—2008

The shipwrecks found at Yenikapi are remarkable not only for the number found—this is the largest assembly of ships from one site of the Medieval period—but also for their extensive preservation; collectively, they are the best-preserved fully excavated Byzantine vessels ever discovered. While Yenikapi is not an underwater site, the timbers, found below the water table, were completely waterlogged; they were kept wet throughout the excavation by means of an overhead sprinkler system, which prevented the timbers from drying and becoming distorted. In most cases, the ship hulls retained much of their original form; this is vital information for the later reconstruction of the ships and can be lost once the hull timbers are removed from the ground. In order to record this form, Pulak’s team utilized recording methods which are not feasible for underwater excavation. Prior to dismantling each ship, individual layers were mapped with a total station, a laser-based surveying device which provides three-dimensional coordinates for each point recorded (Fig. 2). When carefully recorded for each timber and imported into Rhinoceros NURBS modeling software, these data provide a 3-D image of the form of the ship in situ; this process was overseen by veteran INA archaeologist and mapping specialist Sheila Matthews. Typically, this recording was done in at least two stages: (1) while the frames and stringers were in place, and (2) again when all timbers except the hull planking had been removed. In the case of YK 11, this recording was done in
Four stages due to the presence of a large number of stringers, ceiling planks, and displaced timbers covering the hull.

Another advantage to fieldwork at a dry site such as Yenikapi is the ability to work with the material in situ for extended periods, rather than within the strict time limits characteristic of underwater excavations. The availability of daylight being the only limit to a work day, far more information could be collected in the recording process. However, because this was a salvage excavation with strict deadlines imposed by the Turkish government, only preliminary data were collected while the ships were in situ, prior to their dismantling.

On-site data collection included in situ photographs (including those for the compilation of photomosaics and preliminary working plans of the ships), measurements for the mapping of each shipwreck, preliminary notes on the ships' construction, in situ 1:1 scale drawings of the ship's planking on clear plastic film after the removal of frames, stringers, and other components above the planking (Fig. 3), and the sampling of wood and other organics in direct association with the shipwrecks. Dismantling the hulls, as opposed to raising the surviving hull in one piece, has some significant advantages as a recovery method due to the fact that a large hull can be removed from a site with little or no heavy equipment (although we used groups of construction workers to move timber boxes), as well as the fact that dismantling a ship reveals numerous construction details which are likely to be missed if the hull remains are removed intact. Once the hull components of each ship were stored in freshwater storage tanks on site, more detailed documentation could begin. At Yenikapi, the drawing and cataloging of three shipwrecks, YK 1, YK 2, and YK 5, was completed between 2006 and 2008 by the INA team, and the documentation of the galley YK 4 is being completed by INA staff archaeologist Orkan Köyağasıoğlu. Timbers from the four ships that will be documented and conserved at INA's Bodrum Research Center were carefully packed in foam-lined wood crates prior to being transported by truck to Bodrum. For many of the large hull planks which had retained their original shape and curvature (some pieces up to 7 m in length were recovered intact), detachable wooden molds were custom-built to preserve the timbers' original shapes during storage and transport.

Post-excavation Research in Bodrum, 2009-Present

Documentation work on the four Yenikapi shipwrecks transported to INA's Bodrum Research Center began in 2009. Because treatment in polyethylene glycol (PEG) can potentially obscure surface details on the timbers, comprehensive recording of each shipwreck's timbers is currently being completed prior to PEG treatment. During this study, the timbers are being kept in freshwater storage tanks with a capacity of 150 m$^3$; a borax/boric acid solution is added to the water as a pesticide. One of these tanks, with a 60-m$^3$ capacity, is also designed as a treatment tank for conserving the timbers in PEG to supplement the laboratory's smaller PEG tanks (approx. 10-m$^3$ capacity), which have been used for the conservation of the Bozburun and Pabuç Burnu ships' hull remains.

The detailed recording of each ship timber is an intensive process and includes a written catalog, measurements, photographs, sketches, and 1:1 scale drawings. The methods used in the recording process are based largely on those developed by Fred van Doorninck and Richard Steffy in their study of Byzantine shipwrecks, particularly

---

**FIG 4**

Rebecca Ingram cataloging a small plank from seventh-century merchantman YK 11; through the use of detachable, custom-built molds, timbers retain their original form while being cataloged just above the waterline in the freshwater storage tanks. September 2010 (M. Jones).
15 Sheila Matthews’ experience in documenting the Şerçe Limanı ship and co-authoring the final publication of its hull remains has been particularly valuable in this respect.

16 Documentation of the larger timbers occurs outdoors in the tanks or in an adjacent work area. We found that post-excavation timber recording is feasible for very large pieces if they can be raised to just above the water level in the tanks; this can usually be accomplished by one or two people, or with additional help from INA staff members. If timbers on custom-built molds are detachable from their storage crates, even large pieces can be raised fairly easily for drawing, cataloging and photography (Fig. 4).

Smaller timbers can be raised on wooden pallets for cataloging outside of the tanks.

The primary records for individual hull timbers are 1:1 scale drawings made on clear plastic film. These are vital to correcting possible errors in the total station records and field records from the excavation and to record additional significant details on the wood, such as tool marks, carpenter’s guide marks used as aids in constructing the ship, damaged areas, the location and type of fastener holes, and evidence for repairs. Completed drawings are scanned to produce high-resolution digital files. This is useful not only for archival purposes but also for combining the information from the drawings with the total station data collected during the excavation; both will be used in the reconstruction of the vessels using Rhinoceros NURBS modeling software. Drawings on plastic film are also well-suited to working directly with the timbers; they are not damaged by water and are easily cleaned, an important consideration since the larger hull timbers are documented just above the water in the tanks and the timbers themselves must be kept constantly wet to avoid damage.

A written catalog of each timber is also kept, which includes various measurements (such as general dimensions and hull fasteners) as well as notes about and sketches of the timber’s significant features, context, and evidence for its function in the hull of the ship. High-resolution photographs of each piece supplement the drawings and written catalog. Finally, sampling of wood for species identification and other organic materials in direct association with the ship timbers is also completed during the recording process for later analysis.

During the recording process, we are also simultaneously beginning some of the preparations for the
timbers’ conservation in PEG, which entails a range of activities. Because the plastic labels used during the excavation to label individual timbers will be damaged by the PEG treatment process, these are replaced by stainless steel labels which are pinned to the timbers with stainless steel wire (stainless steel is not corroded by PEG). Additional labels are also being added where necessary to alleviate confusion in the reconstruction process; for example, labels denoting frame or other timber locations, or port and starboard. Cleaning the timbers is also necessary prior to conservation. Although each timber was cleaned in a preliminary fashion upon excavation, further cleaning is being carried out in the research process to remove iron concretion, pitch and sediment which could complicate the conservation process. Many of the Yenikapi timbers were recovered with large amounts of waterproofing material made from pine pitch still adhering to their surfaces (Fig. 5). This pitch has usually decomposed in the waterlogged depositional environment of the site, so that while it still adheres to the surfaces of the timbers, it can usually be gently flaked or washed off, a procedure which can be time consuming.

2010 Work on YK 11 and YK 14
Rebecca Ingram is studying wreck YK 11, a small merchant vessel excavated in the summer and fall of 2008 (Fig. 6). Ceramics and other artifacts recovered by the Istanbul Archaeological Museums excavation team from the stratigraphic layer containing the ship suggest a seventh-century date for the vessel, which is consistent with the ship’s method of construction. This shipwreck was found at the western end of the harbor, which was one of the first areas to suffer the effects of siltation; fortunately for archaeologists today, the silty mud surrounding the ship fostered an environment that led to the excellent preservation of wood and organic materials. Damage from Teredo navalis and other wood borers in several areas on this wreck reveals that the upper part of the ship was exposed to some extent after sinking, suggesting that the ship may have been abandoned as a derelict.

Despite the shipworm damage, most of the timbers are remarkably well preserved. The ship, built primarily of Turkish pine (*Pinus brutia*), was originally about 12 m in length. Although much smaller, YK 11 exhibits many similarities to the seventh-century vessel found at Yassiada, Turkey. Both ships were built using thin planks edge-joined with unpegged mortise-and-tenon joints (Fig. 7). The original pattern of YK 11’s planking is somewhat obscured by extensive repairs during the life of the ship; however, it appears that edge fastening only continued to the waterline, suggesting a combination of shell- and skeleton-based construction methods. The well-preserved framing of this ship continued an ancient Mediterranean tradition of using alternating paired half-frames and full floors in ship construction; study of this ship may help clarify the framing of the Yassiada ship, which was very poorly preserved. This pattern of framing is seen as early as the late fourth century B.C.E. on the Kyrenia shipwreck and continued into the late eighth or early ninth century C.E. as evidenced by the merchant ships from Yenikapi and into the 10th or 11th century C.E. in the galleys from the site. This framing pattern was used in building ship YK 23 from Yenikapi, a late eighth- or early ninth-century ship excavated in the central portion of the Theodosian Harbor; the planking of YK 23, however, was edge-fastened using regularly spaced wooden dowels called coaks rather than mortise-and-tenon joints, reflecting the gradual adoption of new construction methods.

Michael Jones’ research focuses
Yenikapı shipwrecks studied by Dr. Cemal Pulak and the Institute of Nautical Archaeology.

<table>
<thead>
<tr>
<th>No.</th>
<th>Date</th>
<th>Type</th>
<th>Est. length</th>
<th>Primary wood type(s)</th>
<th>Date of excavation</th>
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<td>YK 1</td>
<td>Late 10\textsuperscript{th} - early 11\textsuperscript{th} century C.E.</td>
<td>Merchantman</td>
<td>10 m</td>
<td><em>Quercus cerris</em></td>
<td>Aug 2005–Jan 2006</td>
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<td>Late 10\textsuperscript{th} - early 11\textsuperscript{th} century C.E.</td>
<td>Rowed galley</td>
<td>30 m</td>
<td><em>Pinus nigra, Platanus orientalis</em></td>
<td>Apr–Aug 2006</td>
</tr>
<tr>
<td>YK 4</td>
<td>Late 10\textsuperscript{th} - early 11\textsuperscript{th} century C.E.</td>
<td>Rowed galley</td>
<td>30 m</td>
<td><em>Pinus nigra, Platanus orientalis</em></td>
<td>Sept 2006–Apr 2007</td>
</tr>
<tr>
<td>YK 5</td>
<td>Late 10\textsuperscript{th} - early 11\textsuperscript{th} century C.E.</td>
<td>Merchantman</td>
<td>14.5 m</td>
<td><em>Quercus cerris</em></td>
<td>Mar–Sept 2006</td>
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<tr>
<td>YK 11</td>
<td>7\textsuperscript{th} century C.E.</td>
<td>Merchantman</td>
<td>12 m</td>
<td><em>Pinus brutia</em></td>
<td>May 2008–Nov 2008</td>
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<tr>
<td>YK 14</td>
<td>Late 9\textsuperscript{th}-early 10\textsuperscript{th} century C.E.</td>
<td>Merchantman</td>
<td>14 m</td>
<td><em>Quercus cerris</em></td>
<td>Apr–Sept 2007</td>
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<td>YK 23</td>
<td>Late 8\textsuperscript{th}-early 9\textsuperscript{th} century C.E.</td>
<td>Merchantman</td>
<td>15 m</td>
<td><em>Quercus cerris</em></td>
<td>Dec 2007–May 2008</td>
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<tr>
<td>YK 24</td>
<td>Late 10\textsuperscript{th} - early 11\textsuperscript{th} century C.E.</td>
<td>Merchantman</td>
<td>9–10 m</td>
<td><em>Quercus cerris</em></td>
<td>Jul–Aug 2007</td>
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</tbody>
</table>

on YK 14, a cargo ship dating to around 900 C.E., which was uncovered in the central area of the Yenikapi excavation (Fig. 8). Like YK 11, YK 14 was also found without a cargo in a stratigraphic layer of gray sand with shell and ceramic inclusions. The almost complete absence of shipworm damage to the ship's timbers suggest that the surviving hull was buried quickly, perhaps the result of a storm. About 11.7 m of the ship's hull survived; it was built primarily of Turkey oak (*Quercus cerris*)\textsuperscript{21} and Sessile oak (*Quercus petraea*), and was originally about 14 m in length and 4 m in beam. YK 14's lower hull planking was edge-joined with regularly-spaced wooden coaks up to the waterline (Fig. 9), while the upper hull was apparently built around pre-erected frames and without edge-fastened hull planking. The design of the ship's frames is also a departure from earlier cargo vessels at the site. Rather than using a pattern of alternating floors and half frames seen on earlier ships, the builders constructed 'L'-shaped floor timbers with 'long arms' oriented in alternating directions down the length of the hull (Fig. 10). This design allows for more standardized and easily fabricated frames, and may also be a precursor to the similar framing pattern used in the skeleton-built Serçe Limanı ship from the early 11\textsuperscript{th} century.\textsuperscript{22} Many of the techniques used in the construction of YK 14 are evident in the design of late 10\textsuperscript{th}- and early 11\textsuperscript{th}-century merchant ships found at Yenikapi, including the ships YK 1, YK 5, and YK 24 recovered by Pulak's team.

Conclusion
The Yenikapi shipwrecks are significant for several reasons. The maritime history of Constantinople...
during the late Roman and early medieval period, particularly the period between the 7th and the 11th centuries C.E., represented by these shipwrecks, is still poorly understood. During these years, the Byzantine Empire was under constant threat of attack from a number of groups, including the Persians, Avars, Arabs, Bulgars, Rus, and Slavic tribes. During the seventh century, two-thirds of the empire’s territory was lost, including its richest provinces in Egypt, Syria, and North Africa. Like Rome during the imperial period, Constantinople’s population was sustained in large part by the annonae, a state-subsidized food distribution system, for which grain and other foodstuffs were shipped to the capital by large grain carriers. The loss of Egypt and North Africa in the early seventh century deprived the capital of these major sources of supplies and revenue, which seriously affected Constantinople’s maritime commerce; this was part of a more general decline and simplification of economic activity throughout the empire in the seventh and eighth centuries. However, by the ninth century, the Byzantine Empire and its capital had begun a recovery of much of the land and economic prosperity that had been lost in earlier centuries, a trend which continued in large part until the capture of Constantinople in 1204 during the Fourth Crusade.

Despite the magnitude of social and economic change in this period, contemporary textual sources provide little evidence for some important aspects of Byzantine life, particularly in relation to maritime commerce and technology. Since the underwater excavations at Yassıada in the early 1960s, much of what we know about Byzantine maritime trade and technology has come from archaeological evidence of Byzantine ships and their cargoes. Richard Steffy and Fred van Doorninck’s groundbreaking studies of the hull remains of the 7th-century Yassıada shipwreck and the early 11th-century Serçe Limanı shipwreck established that a major change in ship construction methods occurred between approximately 400 and 1000 C.E., in which the ancient method of shell-first ship construction using edge-fastened hull planking was gradually simplified and evolved into more efficient ‘skeleton-first’ shipbuilding methods which became dominant in the postmedieval world and into modern times. However, understanding the evolution of ship design in the period when skeleton-first construction developed has been particularly problematic due to the relative lack of well preserved, fully excavated ship remains available for study and comparison. The Yenikapı shipwrecks promise to add a great deal of new information toward elucidating this complex process, due both to the large number and varied types of ships discovered at the site and to their exceptional state of preservation.

The Yenikapı ships show that the evolution of Mediterranean shipbuilding in late antiquity was a more complex process than previously thought. Although the use of edge-fastened planking was being abandoned in some vessel types, most notably in the sixth- to ninth-century C.E. shipwrecks discovered at Tantura, Israel, in the capital of the Byzantine Empire the shell-first tradition of shipbuilding with edge-fastened hull planking continued in at least some common vessel types into the 11th century C.E. The reasons for the variation seen in late antique and early medieval Mediterranean shipbuilding are still unclear. Byzantine shipwrights seem to have been adapting to the often harsh economic and political conditions of their times by retaining some aspects of older technology and
traditions while experimenting with or modifying others. Further research on the Yenikapi ships should provide some answers as to how and why these changes took place.

Acknowledgments

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Works Cited


Notes

1 The depth of the tunnel is 56 m below sea level (DLH Marmaray Division Directorate 2004).


5 Asal 2010, 29.

6 Mango 1986, 120—1.


8 Mango 1986, 121.

9 Estimates of Constantinople’s population vary for this period and are based on somewhat fragmentary evidence, but most scholars agree that the city had several hundred thousand inhabitants between the fifth and early seventh centuries and 100,000 or more inhabitants after a low ebb in the seventh/eighth centuries (see, for example, Mango 1986, 120, 128—9; Koder 2002, 110—1; and Magdalino 2007, 18—9).

10 Mango 1986, 121.

11 Magdalino 2000, 213; Mango 1986, 121; Mango 2000, 192, 200—1.


14 Pulak 2007, 203.


17 Wood identification was carried out by Nili Liphschitz of the Institute of Archaeology, The Botanical Laboratories, Tel Aviv University.


21 Liphschitz and Pulak 2009, 168.

22 Bass et al. 2004, 93.


24 See, for example, Kahanov et al. 2004.

25 Wood identification was carried out by Nili Liphschitz of the Institute of Archaeology, The Botanical Laboratories, Tel Aviv University (see also Liphschitz and Pulak 2009).
In early August 2010, INA Director Danielle Feeney, stalwart supporter of so many INA projects, dropped anchor in the small seaside village of Adrasan and picked up the four surviving members of the 1960 expedition to Gelidonya: George and Ann Bass, Claude Duthuit, and Wlademar Illing. Feeney’s yacht, Andrea, brought the reunited team to the sliver of a beach that was home during the long, hot summer a half century earlier, when it was demonstrated that underwater discovery could be archaeology (Fig. 1). The following day, Andrea returned again and this time George, Claude, and Wlady dove on the wreck site (Fig. 2), accompanied by Harun Özdaş (Dokuz Eylül University, Izmir), scientific director of the 2010 project. That visit was the emotional highlight of the 2010 season at Cape Gelidonya, a project catalyzed by the 50th anniversary of the original expedition. But the summer’s most fitting tribute to that benchmark was its contribution to a continuing better understanding of the ship that wrecked at Gelidonya — a result not only of work in the field, but also in laboratories, museum storerooms, and libraries.

The 1960 excavation was revolutionary not only for the development of the methods of underwater archaeology, but also because analysis of the finds led to a radical revision of the accepted paradigm for maritime trade in the Late Bronze Age (ca. 1600–1100 B.C.) eastern Mediterranean. Conventional understanding was that Mycenaens were the driving force, carrying their vases from Greece to be traded in the east. But Bass argued that the objects found on the Gelidonya shipwreck showed that the wreck was Near Eastern in origin. This surprising conclusion led him to re-evaluate the other existing evidence for trade and finally to contend that Mycenaeans
did not hold a monopoly on the trade routes and that it was raw materials, not Mycenaean vases, that were the sought-after items. The Uluburun shipwreck, of course, proved him essentially correct. But no archaeological excavation is ever finished, for new tools of excavation, new methods of analysis, and new discoveries require reconsideration of old finds and theories. Gelidonya 1960 is no exception.

Summary of work
Excavations at Cape Gelidonya were conducted under a permit held by the Antalya Museum, and with the participation of the Bodrum Museum of Underwater Archaeology and the Institute of Nautical Archaeology. Mustafa Demirel (museum director), Mine Bozkurt, and Mustafa Samur represented the Antalya Museum, and Yaşar Yıldız (museum director) and Emre Savaş, the Bodrum Museum. Özdaş and Nicolle Hirschfeld (Trinity University, San Antonio, and INA Research Associate) co-directed the fieldwork. George Bass was the guiding spirit behind the project: he raised most of the necessary funds and participated in the fieldwork, although not as a working diver; in September he supervised photography of the finds raised in 1960, now in the Bodrum Museum. Finally, Cemal Pulak, so vital to the planning of this expedition, joined us for a month and once again demonstrated how good he is at everything, above and under water. The team, averaging about 24 people plus the ships’ crews, lived and operated from three vessels. INA’s Virazon and Millawanda (Fig. 3) had to be taken out of dry-dock and overhauled for this purpose. In lieu of building a camp, we chartered the STS Bodrum, a 36-m wooden sailing-training ship, as a floating dorm and kitchen (Fig. 4).

The fleet left Bodrum in the first week of July, shortly after the excavation permit was approved. Diving commenced 5 July and continued through 25 August. The site lived up to its treacherous reputation of heavy weather and powerful currents — strong enough to shift the ton of steel plates anchoring the telephone booth! But the seamanship of our captains and crews and the determined efforts of the divers made it possible to achieve...
a season of 944 dives, totaling 709 hours of bottom time.

Discoveries
Reconnaissance dives in 1987–89 and 1994 had established that a significant quantity of material remained to be recovered from the wreck site. One of the primary objectives of this summer’s work was to excavate down to bedrock the entire wrecksite as defined in 1960. As before, most of this summer’s finds were made on the Platform (Fig. 5, see also Fig. 10), though objects were also plentiful all around the Boulder and in the flat sandy area immediately north of the Boulder.

In 2010, we raised 350 “lots,” plastic bags of artifacts, as well as larger items, from the site. Ceramics included one complete one-handed jug and the bottom half of another, a handle bearing a characteristically Cypriot mark (Fig. 6), possible Cypriot fine-wares [White Shaved (Fig. 7) and perhaps Bucchero], and the rim fragments and base of a pithos. These not only greatly increased the number of ceramic finds from the wreck, but also gave a clearer picture of the ship’s stern contents, which had always seemed to represent living quarters. About a third of the objects raised are of copper or bronze; identified so far are 15 broken bronze tools and blades, a rim and handle from a small cauldron (Fig. 8), parts of four-handled and bun ingots (Fig. 9), a pin, and several pieces of sheeting from metal vases. Twenty-three lots are identified as tin concretions. In addition we found at least five more pan-balance weights.

Towards the end of the summer, Pulak made a substantial discovery in the storerooms of the Bodrum Museum: seven large wooden crates of never conserved, cleaned or cataloged metal fragments. The contents of these boxes have now been given to the staff of INA’s Nixon Griffis Conservation Laboratory in Bodrum, where
Defining the wreck site

The discovery, in 1988, of two complete stirrup jars 70 m east of the site led to the identification of a trail of artifacts between the point of the ship’s initial impact (against a barely submerged pinnacle of rock, Fig. 10) and its eventual subsidence. In 1994 Don Frey and Murat Tilev found a stone anchor 30 m eastward, further extending the trail of spill in this direction. Thus, this season’s second objective was to define the extent of the wreck site and to search intensively along and beyond the trail of debris.

We were able to clear large bedrock areas to the west, north, and east of the wreck site as defined in 1960 (Fig. 11, note that north is “down” on the map). As a result, we discovered that the wreck area was substantially larger than previously identified, but felt confident we had defined its limits except towards the east. The cliff to the south obviously blocked any scattering of debris in that direction after the wreck settled, but Andrzej Pydyn discovered a complete jug so deeply concreted into the rock face that it took Pulak most of his month on the seabed to chisel it free. It is still too heavily ensconced in concretion to be absolutely certain that it belongs to the wreck, though this appears likely (Figs. 12a-b). If so, it must have fallen from the sinking hull. Pydyn found a few other pieces of pottery in his survey of the cliff, mostly post-Bronze Age. The northern boundary of the site is a low ridge of bedrock that runs roughly parallel to the cliff [datum points G, H, J, K, L]; it would have been an effective barrier against any they are being treated, and will be identified, cataloged, and illustrated along with the finds made in 2010.
movement of objects on the seabed, and nothing was found beyond it. In fact, the bottom currents run east-west or vice versa and it was along these trajectories that objects would have been carried during and after deposition. Nothing was found beyond the Platform and this feature marks the western extent of the wreck site. Only the eastern limit of the wreck site remains undefined. The southern cliff and a large outcrop of the northern ridge converge at this end of the site and the seabed slopes down steeply; we called this part of the site the “Alley”. We found objects from the wreck in this direction as far as we were able to explore efficiently. The currents can be extremely powerful through this funnel and all the objects found in the Alley were either accumulated against natural features or lodged in pockets in the seabed. Below 33 m (about 15 m east/downslope of the eastern end of the Boulder) our efforts were complicated by deep sand overburden. In any case, the diver working in that area found nothing in his deepest exploratory trenches and very little below the natural ledge [near datum point M] against which most of the objects discovered in this area had collected.

It was in the direction of the Alley that the trail of objects was discovered in the 80s. It is not obvious, and it may not be possible, to determine at what point objects spilt from the sinking ship transition to objects carried by currents down from the area where the wreck eventually settled. Indeed, they may overlap. The definition is perhaps only academic, as in either case the artifacts have lost their shipboard context. In 2010 several teams searched intensively along the lane trail of spilled artifacts found in the 1980s and 90s. But we found nothing more. Perhaps this is a matter of visibility rather than fact: the bottom rapidly got too deep for close inspection and, even where the depth was not a challenge, thick layers of concretion covered the boulders.

This was also the case along the cliff bordering the wreck site and in the area of the Boulder. We have already mentioned the jug deeply concreted into the cliff. A substantial portion of another jug had fallen next to the pithos base and it, too, was so completely concreted that it became visible for the first time only this year, after several teams of people had spent weeks working to chisel the pithos free (Fig. 13).

Four areas of the site were not completely finished. Several pithos sherds and fragments of a lamp (?) remain heavily concreted in the fissure (in fact, the eastern extension of Bass’ 1960 “Gully”) from which the pithos base and jug-half were dislodged. In addition, that cavity needs to be thoroughly searched for small items that may have trickled...
down between the containers and settled on the seabed. Similarly, it is possible that small items got lodged under the boulder, which does not lie flat on the seabed; rather, the uneven surfaces of both have created hollow cavities between the two. We explored these as far under the boulder as possible. Perhaps the only way to retrieve any stray objects that might have rolled underneath would be with a water jet. Third, the area underneath the telephone booth and in its immediate vicinity was not completed. Finally, it could be helpful to search along the trail of artifacts discovered in the 1980s using Carolyn. Plans to use this submersible in 2010 were stymied by logistical challenges, but we continue to work on launching it at Gelidonya in the near future.

**Discoveries (laboratory analyses and further research)**

In the course of his work on the Uluburun materials, Pulak has kept an eye toward the Gelidonya artifacts and included samples in relevant analytical studies. Laboratory analyses undertaken by Yuval Goren of samples from the Cape Gelidonya ship’s stone anchor, the ship’s oil lamp, the stirrup jars, and the two pithos bases have identified the stone of the anchor and the clay of the ceramics as Cypriot in origin. Moreover, lead isotope analyses carried out by Zofia Stos of the copper in the Cape Gelidonya cargo shows not only that it came from Cyprus (already
surmised in the 1960s), but locates precisely where on that island it was mined.  

Pulak and Shelley Wachsmann independently identified wood fragments published in 1967 as parts of mortise-and-tenon joints, which Pulak has compared to the joints that held the Uluburun hull together, providing another step in our understanding of the history of hull design.

Further, as part of his doctoral dissertation on the pan-balance weights from the Uluburun shipwreck, Pulak made a new study of the Cape Gelidonya weights, using statistical analyses that give quite different results than those published by Bass in the 1967 report; Pulak is now considering the possibility that the weights are based on a combination of Near Eastern and Mycenaean weighing systems, which could be important for the history of trade.

Finally, Pulak is trying to obtain a more precise date for the wreck with more reliable radiocarbon dating of the brushwood dunnage than was possible in the early 1960s.

These studies are indicative of the contributions that further study of the finds excavated in 1960, 1987–89, 1994, and now in 2010 can make to our understanding of the ship that wrecked at Cape Gelidonya in the late-13th century B.C.E.

Conclusions
In conclusion, 2010’s work revealed a wreck area larger than initially thought, but no further traces of a spill of debris along the proposed route of sinking. The weights recovered in 2010 are potentially important for a recalibration of the weight standards in use on board this vessel, and the mark incised on a terracotta handle adds to the Cypriot inventory of this shipwreck. Although he considered the possibility that the ship was Cypriot in his 1967 excavation report, Bass concluded that the ship was Canaanite. The re-identification of the ship that sank at Gelidonya as Cypriot does not change the view of Near Easterners trading directly with the Aegean because Cyprus was well within the general Near Eastern sphere in the Late Bronze Age. But it is still an important discovery since a Late Bronze Age wreck excavated at Point Iria in Greece seems also to be Cypriot. Perhaps Cyprus played a larger role in maritime trade than previously supposed.

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Fig 13
Marilyn Cassedy chiseling the pithos base. The jug on the left was completely hidden by concretion and its existence unsuspected until this summer. August 2010 (S. Snowden).
Finally but not at all least, thanks to Tuba Ekmekçi and Özlem Doğan for their unstinting efforts on behalf of the expedition.

Bibliography


Notes

3 Goren, pers. comm.
4 Stos 2009, 163–172.
5 Bass 1999.
6 Pulak 1996, 154–277 and Appendix D.
7 Phelps et al. 1999.
For the sixth consecutive year, INA researchers associated with the Yukon River Steamboat Survey (YRS) travelled north to work on the numerous and well-preserved vessels dating from the Klondike Gold Rush. Our 2010 field season involved three distinct projects scattered across 700 km of the Yukon drainage (Fig. 1). In June, Texas A&M M.A. candidate...
Lindsey Thomas led a large team to the site of A.J. Goddard on Lake Laberge, to document this intact vessel’s material culture and construction. Later in the summer, John Pollack and Robyn Woodward organized efforts on several sites between Lake Laberge and Carmacks, and—on the third try—located the hull of the famous Columbian disaster. Finally, Pollack and Woodward led a hull mapping project on Julia B. at the West Dawson “boneyard.”

Phase One—A.J. Goddard Expedition—Lindsey Thomas
The small steamboat A.J. Goddard served the miners and entrepreneurs of the Klondike Gold Rush of 1897/1898. It is the only known surviving example of a small Yukon River sternwheeler, and was discovered in 2008 by the Yukon River Survey team. Sitting upright on the bed of Lake Laberge as a result of an October storm in 1901, the ship and its cargo have not moved since the ship’s abandonment over 100 years ago. Following a successful field season in 2009 during which a basic site plan and preliminary artifact catalog were created, a 14-person team returned to the site of A.J. Goddard for 10 days in June 2010.

The objectives of the 2010 field season were (1) to complete the baseline survey of the wreck site, (2) to create a 3D site plan using multibeam sonar, (3) to locate and record all extant artifacts both on and around the ship, and (4) to recover select artifacts for conservation and display at the Yukon Transportation Museum.

Using the 2009 site plan as a guide, the team focused on recording hull construction features, machinery, steering systems, and hull lines. Due to the vessel’s small size and shallow draft, it was not possible to penetrate the hull to fully document the interior, which was a priority of the 2010 season. However, it was possible to see inside the vessel using a light and the accessibility provided by the 12 hatches. The majority of the interior of the vessel was recorded, though a layer of sediment 10-cm deep inside the hull prohibited the accurate recording of the bottom. The steering system is still intact and was recorded, with the exception of the missing wheelhouse.

Through the support of BlueView Technologies and OceanGate, a tripod-mounted and diver-deployed multibeam sonar unit called the BV 5000 was donated in order to create a 3D site plan (Fig. 2). Over the course of two days, divers set the tripod in 18 different locations to create a detailed point cloud of the vessel’s exterior (Fig. 3). While the sonar image of the ship is useful on a site with limited visibility, an unanticipated but valuable aspect of the sonar unit was its ability to see inside remote sections of the hull. Construction details that were otherwise inaccessible to divers,
such as the spacing of deck beams, were visible and measurable on the computer screen within minutes of the scan. In addition, it is possible to obtain hull lines from the scans of the interior. While there was not enough field time to scan the entire interior of *A.J. Goddard*, it was possible to test the technique and collect valuable data.

When *A.J. Goddard* sank in that fateful October storm, most of the artifacts were scattered around the vessel, though a few still rest on the deck. One hundred artifacts were recorded using trilateration and photography, though more still lie scattered around the site. Of these artifacts, 31 were collected for exhibit at the Yukon Transportation Museum in Whitehorse, including some surprising finds (Fig. 4). A Berliner gramophone and three records were recovered. Berliner records were embossed and did not have paper labels. After cleaning, the songs were *Ma Onliest One*, *Rendevous Waltz*, and *The Harp that Once Thro Tara’s Halls* (Fig. 5).

Other artifacts included clothing, such as a black wool sock and three leather shoes that were worn at the edges. In his report on the sinking, engineer Julius Stockfield recounts removing his shoes and those of the fireman before diving into Lake Laberge. Other artifacts included full bottles of ink and vanilla, many tools, dishes, and elements of steam machinery. Most of the artifacts are currently being conserved at the Yukon Transportation Museum; the gramophone and steam gauges are being conserved by the Canadian Conservation Institute in Ottawa, Ontario.

The 2010 field season filled many gaps in our knowledge about *A.J. Goddard* and the vessels of the Klondike Gold Rush. It has become evident that the hull of *A.J. Goddard* was based on a simple construction design, likely to facilitate its reassembly in the wilderness. The structural components are relatively uniform, with 5-cm (2-in.) angle-iron used for the framing, stanchions, deck beams, and hatch coaming. Much of the machinery and other structural components of the ship, such as the deck plating, could be disassembled into small pieces to facilitate transport over mountain ranges. While the vessel was relatively easy to carry, its small size and weak engines meant that it was not ideally suited for the Yukon River. It eventually began running the ferry service on Lake Laberge instead, which was more suited to the vessel’s size and design.

The vessel’s steam machinery and fixtures were manufactured by companies located as far away as Boston, MA, and Rochester, NY, though they were likely not purchased directly from their original manufacturer as the long shipping time would have thwarted *A.J. Goddard*’s owner’s goal of quickly reaching the Yukon Territory. Of the thousands of vessels that set out for the Yukon in the summer of 1898, *A.J. Goddard* was one of the few that actually made it to Dawson City in time for the gold rush. Its small size and the
speed with which it was outfitted and transported to Dawson were the primary reasons for its success in reaching the gold fields so quickly.

Phase Two—the Yukon River between Lake Laberge and Carmacks—John Pollack and Robyn Woodward

In mid-August, John Pollack, Dr. Robyn Woodward, Jason Sturgis, Donnie Reid, and historian Robert Turner were dropped off by riverboat at the US Bend, north of Lake Laberge, and used large canoes to progressively move a camp north to Carmacks. They were accompanied by Andreas Sawall of Spiegel-TV, whose four-person documentary team continued to film INA's work in the Yukon. Our project involved a traverse of 253 km including the Thirty Mile Section of the Yukon River, noted for deep canyons, sharp bends, and dangerous water. The Thirty Mile was one of the main obstacles along the downstream steamboat route between Whitehorse and the gold fields of Dawson City.

Three sites were visited. The first site, at Shipyard Island, involved the collection of a small amount of supplemental data in the bow of *Evelyn*, a 1908 sternwheeler measuring 39.6 x 8.7 m. The original *Evelyn* was wrecked in the Tanana River shortly after her arrival in the Yukon drainage. The machinery was removed and taken to St. Michael near the mouth of the Yukon River, where a new hull was built. The ship was converted to Canadian registry in 1913, and beached at Shipyard Island and her engines installed in *Keno* in 1922. Our objective was to manually collect data from a “blind spot” between frames 1 to 13, in an area partially obscured during the earlier LIDAR survey (Fig. 6). The documentation of this vessel is now complete.

The second site was the super-sternwheeler, *Klondike 1*, a large (64.1 x 12.8 m) wooden-hulled sternwheel steamboat constructed at Whitehorse in 1926, and wrecked mid-channel in the river. This ship was the largest vessel (in terms of gross tonnage) to operate on the river. Two earlier attempts to document this ship were defeated by current and high water. On this occasion, low river levels exposed most of the hull (Fig. 7). We capitalized on an ideal situation by conducting a total station survey of the main deck, frames, hatches and openings, and longitudinal bulkheads. Also, the team used dry suits to enter half-flooded compartments near the bow and stern. Quantities of machinery were found *in situ* within the holds, including intake and exhaust steam piping, condensers, and a previously undocumented variant of a rudder-and-tiller system. This system features four slave rudders attached to a single master pivot arm without a rudder blade. Amidships the vessel is filled with gravel up to the level of the deck beams.

The hull design of this wreck
provided some insight into the rate of steamboat evolution on the river. *Klondike 1* was replaced by the Whitehorse shipwrights within a year of its loss with *Klondike 2*, now a Parks Canada heritage ship in that town. The general dimensions, superstructure, and machinery of the two vessels were identical, and until the August project on *Klondike 1*, it was believed the hull had been duplicated. However, the hull of *Klondike 1* did not contain the large, water-tight longitudinal bulkheads seen on *Klondike 2*. The builders of *Klondike 2* changed the hull design in an effort to prevent a repetition of the catastrophic flooding that sank *Klondike 1*. This is a late but significant example of the rapid evolution of sternwheel steamboat design and the responsiveness of the shipbuilders on the Yukon River, who quickly adapted to changing conditions and experience.

Our third site involved the ongoing search for the famous wreck of *Columbian*—built in Victoria BC in 1898.9 The fully-loaded vessel measuring 44.7 x 10.2 m, was on its last downstream run of the season when it was destroyed on 25 September 1906 by an explosion and fire. A rifle misfire ignited three tons of blasting powder stored in iron kegs on the bow. Within seconds, the bow of the ship was shattered and kegs were propelled hundreds of feet into the air, to rain down into the river around the ship. The steam-assisted steering gear was inoperable, and only expert handling by the captain and engineer managed to get the ship to shore, where it burned to the waterline. Six crewmen died despite efforts by the ship’s company to get the word of the accident to a telegraph operator some 56 km (35 miles) distant.10 There were notable acts of heroism by the crew and by the captains of other vessels who rushed to the scene of the disaster. After the accident, the hull was moved a short distance downstream into quiet water where the machinery was salvaged, and the site abandoned in 1907.

On two earlier occasions between 2005 and 2008, INA teams sought to determine the vessel’s location. Doug Davidge and Robert Turner believed the hull must rest in shallow water close to the original point of grounding, given that cables had been deployed to moor it during the salvage efforts. Some minor wreckage was located during earlier searches, and by 2008 the search area was narrowed to a 1-km section of the river. Unfortunately a sidescan sonar could not be used at the site in 2008, given the risk of losing the tow fish in the swift, shallow water, and the muddy water from a recent flood prevented drift dives.

In 2009 a historic river navigation chart was found in the Library of Congress by a Yukon staffer. The chart contained a notation on the location of the wreck of *Columbian* that coincided with our search area. Nonetheless the day before we could begin the search in 2010, the Yukon weather changed, and we experienced an 80-km paddle into a headwind, cold rain, and an encounter with two large brown bears. Five years after the initial search, a wet and tired INA team camped on a swampy island in the middle of the river, 1 km above the search area (Fig. 8).

The next day, low water and sharp eyes allowed INA Director Jason Sturgis to locate *Columbian* in shallow water at the head of a side channel (Fig. 9). The hull was
relatively intact below the chines, as were some of the side frames and lower portions of longitudinal bulkheads and keelsons. Hog chains and turnbuckles, engine beds, and a boiler feed pump machinery were observed and an ornate and as-yet unanalyzed white metal drinking mug was recovered during a solitary snorkel inspection of the wreck. The boiler, engines and paddlewheel shaft were missing from the hull.

*Columbian* was one of three wooden-hulled ships constructed in 1898 in Victoria by J. Todd, and it steamed up the West Coast under its own power. Given this delivery route, the hull is expected to display some unique strength features to allow its passage up the West Coast and its survival in the Bering Sea. However, of greater importance may be the cargo of *Columbian*. This large ship made routine runs between Whitehorse and Dawson City. At the time of the disaster, *Columbian* was fully loaded with a crew of approximately 25 men on board, and a substantial number of artifacts may lie scattered downstream in the 700 m-long side channel. The ornate drinking mug is an example of possible discoveries. There is an equal possibility that spring ice and floods will have stripped all loose material and moved it many kilometers downstream, in which case the site will be barren. A thorough mapping and documentation project will be required in August 2011, to determine whether we have a site that will rival or surpass *A.J. Goddard* in material culture.

Phase Three—Hull Documentation of *Julia B.* at West Dawson—John Pollack and Robyn Woodward

Following a crew change, a third team visited the “boneyard” at West Dawson, 530 km to the north of Whitehorse, where seven large sternwheelers lie in close proximity. In 2010 goal was to prepare a detailed plan of a lower Yukon River sternwheel steamboat, *Julia B.* Participants included John Pollack, Dr. Robyn Woodward, Nadine Kopp, M.A. candidate at Eastern Carolina University and Chris Cartellone, Ph.D. candidate at Texas A&M University. *Julia B.* (43.3 x 11.6 m) was built in Ballard, Washington, in 1908 and towed north through the Aleutian Islands and Bering Sea, to St. Michael at the mouth of the river. It was a freight boat, not designed for passengers, but intended to push or tow up to four barges at a time on the lower river from St. Michael to Juneau and Dawson City. This vessel was the 13th largest sternwheel steamboat (by gross tonnage) to operate in the Yukon drainage. Our 2010 survey found a heavily constructed vessel containing a large number of longitudinal bulkheads, machinery and a relatively intact hull except for extensive ice damage.
to port (Fig. 10). Most sternwheel vessels of the era have a single centerline longitudinal bulkhead combined with two truss-built side longitudinal bulkheads to provide hull rigidity fore and aft. *Julia B.*’s hull contains a solid central longitudinal bulkhead comprised of a wall of heavy timbers atop a keelson plus two additional solid side longitudinal bulkheads. Four additional side keelsons support either hold stanchions or combinations of hold stanchions and trusses. Finally, two short truss-built engine girders were noted, for a grand total of nine longitudinal strength members. On the main deck, the remains of one engine, a heavily-constructed three-rudder steering system, the paddle wheel, and two locomotive-style boilers were mapped. A standard chine displayed cocked hat construction, and the boilers were supported by massive transverse carriers.

Two teams of two spent six days on the site (Fig. 11). Draft diagrams were prepared and measurements taken for detailed plans of the hull using both baseline survey and total station techniques. The survey included a plan view, longitudinal and transverse elevations, and lines at the bow and stern.

Three observations are noteworthy. First, the power of the spring ice movement on the Yukon River must be seen to be fully appreciated, and in this case a large vessel was cleaved lengthwise. Second, *Julia B.* is similar to *Seattle No. 3* in stoutness of construction.\(^{15,16}\) Both of these vessels had to endure the Bering Sea, and their hulls contain a number of strength members to ensure they survived. Third, despite the extensive strength features observed within the hull, there were many instances of poor joinery on the vessel, including footlings to support the hog posts or braces. Typical footings are large timbers spanning five to six floors. On *Julia B.*, some of the centerline footlings were assemblies of small pieces of wood spanning only three floors, and merely shimmed together. In retrospect, it is surprising that some of the centerline hog posts did not penetrate the bottom of the hull.

**Summary**

The 2010 accomplishments represent a zenith of activity in the Yukon. No fewer than three graduate students travelled to the north to work with the YRS, and three independent projects were conducted successfully. Foremost was Lindsey Thomas’ technologically advanced and well-publicized assessment of the material culture, construction and history of a small, intact sternwheel steamboat—*A.J. Goddard*—in Lake Laberge. Ms. Thomas’ thesis will be completed in 2011, and all or part of it will be published by the Government of Yukon.

Unseasonably low water allowed a second team to study the great wreck of *Klondike 1* for the first time. Its successor, *Klondike 2*, was launched a year after the sinking and thought to be identical in design. We now know it was not identical, but incorporated additional watertight bulkheads to prevent a repetition of the disaster.

The hull of the most famous shipwreck on the river—*Columbian*—has been discovered in a shallow, side channel that will permit its detailed study. Finally, another large sternwheel steamboat—*Julia B.*—was documented at West Dawson, and will be published as part of the
The successes of this season, when combined with earlier work, have moved the Yukon program forward to the point where a comprehensive monograph or refereed journal article can summarize the various types of sternwheelers used in the north. The shipbuilders of the Pacific Northwest, Alaska and the Yukon were faced with difficult ocean and river conditions, and they built vessels with the intended use, route of delivery of the ships to the Yukon, and expected hazards in mind. With 19 sites studied and five vessels documented in detail by the survey to date, there is abundant archaeological and archival evidence to document the strategies used to build the last great sternwheeler fleet, and its five general classes of vessel. Accordingly, our field goals for 2011 will be to prepare for that publication by gathering missing data from several known sites, examining two reported sites at Rink Rapids, and assessing the wreck of Columbian. Annual papers will continue to be given at the SHA annual conference and published in the ACUA proceedings prior to journal publication in 2012.

Acknowledgments

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Notes

1 Pollack et al. 2009, 287—297 describes the known sternwheel steamboat sites in the Yukon.
2 Davidge et al. 2010, 186 describes the location of A.J. Goddard in June 2008 during an INA project to the Thirty Mile, and his solo confirmation of the vessel later that summer.
3 Daily Klondike Nugget, 14 Oct. 1901.
6 Berton 1972, 275—277.
7 Affleck 2000, 74, 79 notes the vessel was registered as Evelyn and later renamed Norcom.
8 Affleck 2000, 77.
9 Affleck 2000, 73.
10 Graves 1908, 192—216.
11 Affleck 2000, 73.
12 Affleck 2000, 76—77.
13 Adams, 2002, 139—141.
14 Affleck, 2000, 76—77.
15 Pollack et al. 2010.
16 MacKay et al. 2010.
The 2010 field campaign on the frigate Ertuğrul marked the end of INA’s initial three-year excavation plan which was a collaboration with the Municipality of Kushimoto, Japan and the Bodrum Culture and Arts Foundation (BOSAV). The work will continue in 2011 with a study season and in 2012 with further excavation, as part of an educational program for Japanese exchange students.

The 2010 excavation season was held in January and February, with team members, Tuğrul Turanlı, Berta Lledó, Orkan Köyğasıoğlu, İlkyay İvgin, Güzden Varinlioğlu, Yoshuke Nakamura, Toshiyuki Shimano, Hiroshi Enomoto, and 41 local volunteers who worked in the lab assisting with cataloging, photographing, and cleaning artifacts recovered during the excavation.

One question we are often asked is why we excavate in January, the coldest month of the year. Although the water temperatures are quite cold (14 C / 58 F) with an air temperature of 8–9 C / 47 F, there are many advantages to other aspects of the work.

Kushimoto is the southernmost point of Honshu Island, the largest island in the Japanese archipelago. The climate is so temperate as to be almost subtropical. Kushimoto
experiences the highest rain levels during the summer, which coincides with the typhoon season—May to October. During this time large waves and dangerous sea conditions can develop quickly; around the shipwreck which lies off the northeast coast of Oshima Island, just across from Kushimoto, the prevailing winds are N, NE and E. Fishing is the main economic activity in the area and its low season occurs during the winter months. Kushimoto’s other key economic activity is tourism for which the main season is from April to September. Given all of these factors, January and February are the ideal months for archaeological excavation: the wreck site is sheltered by the island; these are the drier months of the year; and the underwater visibility is at its best.

**Background**

As described in detail in previous *INA Annual* articles¹ the frigate *Ertuğrul* traveled from Istanbul to Japan in 11 months. After a three-month-long official visit in Japan representing the Ottoman sultan, the frigate sank on its way home, while still in Japanese waters, the victim of a typhoon that struck on 16 September 1890. The archaeological site of the *Ertuğrul* shipwreck is approximately 200 m off the coast of Oshima Island, which is opposite the southern town of Kushimoto (Figs. 1&2).

The frigate *Ertuğrul* sank immediately after striking the Funagora Rocks and breaking in half. On the seabed, a narrow valley channeled the remains of the ship into a long gully averaging 3 m wide and into a cave at the northern end of the valley, protecting numerous artifacts for the past 120 years.

**Field Work**

During previous campaigns, the main excavation was carried out in a small area at the northern end of the narrow valley. The highlight of the 2010 field season (8 January – 22 February) was the opening of a new area in the cave and the recovery of large concretions from within.

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¹ *INA Annual* articles
Dr. Güzden Varinlioğlu led the effort to make profile sections of the cave and finally completed the mapping of its full contour with the help of Orkan Köyağasıoğlu (Figs. 3&4).

In 2008–2009, we limited the excavation of the cave to those areas nearest the eastern entrance (Cave Areas A, B, and D), owing to the accessibility of the underwater dredge. In 2010, we expanded the excavation to the western end of the cave, Cave Area C, which was surveyed in 2009 but not excavated. A new layout of the dredge connections and a new pump provided the necessary equipment to allow us to access and excavate two new areas: Cave Area C and K (Fig. 5).

An important advantage of the new excavation areas is the existence of an overhead opening which provides natural light for excavating while in other areas (Caves Areas B and D) (Fig. 6).

Cave Areas C and K proved to be very interesting. They have a hard compact sea floor upon which artifacts have become heavily concreted together forming large clusters. Occasionally the divers were able to separate some of the artifacts, but in general, these clusters were brought to the lab, where they were cleaned and the artifacts removed.

By the end of the 2010 season the excavation of these new areas had affected the stability of the large rock located between Cave Areas C and K, requiring that excavation of the loose sand around the rock cease until safety measures could be taken. At present we are considering removing the rock, but its large size, the low ceilings in the cave and the narrow entrance might make it impossible.
One of the large concretions removed from Cave Areas C and K contained an artifact that was not readily identifiable. Further cleaning in the lab during the next few months, in both Japan and Bodrum, Turkey, revealed a complete coffee grinder composed of an iron box and brass hopper. It was manufactured in Wolverhampton, England, sometime after 1879 by T&C Clark company (Fig. 7).

Excavation also continued in the narrow valley as in previous years, especially around large iron concretions in areas Valley A3 and A4.

Orkan Köyağasoğlu undertook the difficult task of raising to the surface a large concretion from this area (Fig. 8). The concretion was separated into three parts, which contained a conglomerate of artifacts, coal and sand that had filled up a large iron container. The leather sole of an officer’s boot was mired in the upper part of the concretion, but was later removed in the lab.

When analyzing the excavation areas and finds, it is important to keep in mind the magnitude of the original vessel: 76 m long (260 ft), 15.5 m in beam (51 ft) and depth of hold of 5.6 m (84 ft). The excavation area in which we had been concentrating our efforts in the last three years was very small in comparison and presumably represents only a percentage of what would have been the total surface of the ship’s original distribution (Fig. 9).

Our detailed analysis of the descriptions of the sinking by local authorities as well as by the survivors in their personal accounts confirms the underwater finds. Surveys of the seabed indicate that there are few remains on the other side
of the large rocks that reach the surface; rather, most of the finds are concentrated in the 2–3 m wide area where we have been working. Large items such as guns, rifles, and other valuable pieces were recovered by the local authorities and returned to the Ottoman Empire. For example, 182 of the 200 rifles on board along with 24 of 40 pistols, 61 swords, 71 bayonets and most of the heavy artillery were recovered and sent to Istanbul. What wasn’t retrieved or lost to the typhoon became interred between the Funagora rocks.

**Highlights**

In the purest of archaeological terms, all artifacts are equally valuable, but among the most exciting discoveries of the 2010 excavation season on the frigate *Ertuğrul* were a handful of gold and silver coins (Fig. 10).

An 1856 Queen Victoria Shield gold sovereign was found by Nakamura in Cave Area C. Sovereigns were first issued in England in 1489 and are still in production. While the coin had at that time a nominal value of one pound sterling or 20 shillings, the sovereign was an official piece of bullion with no mark of value anywhere on the coin itself. Sovereigns minted since 1817 have been produced to a specific standard (weight: 7.9881 g; thickness: 1.52 mm; diameter: 22.05 mm; purity: 22 carat; actual gold content: 7.3224 g). Well-worn or used coins may be marginally less than their manufactured weight and size: the coin from *Ertuğrul* is now 21 mm in diameter, with a weight of 7–8 g, showing little wear after 34 years in circulation and over a century under water. To modern eyes the gold sovereign appears a small coin, but with a face value of £1, it had in 1890, the same purchasing power as £255 in 2010. In the second half of the 19th century, the British sovereign became the foremost coin of international trade, as popular overseas as in England itself.

The obverse features a bust of young Queen Victoria (b 1819—d 1901) and the legend
VICTORIA DEI GRATIA (Victoria by Grace of God) surrounds the bust with the date (1856) at the bottom. The reverse has the Ensigns Armorial of the United Kingdom contained in a plain shield, surmounted by the Royal Crown and encircled with a laurel wreath, with the legend BRITANNIARUM REGINA FID (British Queen, Defender of the Faith) with a rose, thistle and shamrock set under the shield.

Two, one-yen silver crown coins were also recovered from Cave Area C and Cave Area K. Unfortunately they have suffered from corrosion and only some of their original surfaces are recognizable. The first coin has a diameter of 38 mm and weighs 27 grams. Although the exact date of the coins is not assured, based on the dragon design it is possible to say that it was minted after 1874. The Bank of Japan was established in 1870, and modeled its coinage after foreign currencies, especially in the USA and Britain. Gold yens circulated internally, while silver yens were used for foreign trade.

Another small find was an 1890 silver Hong Kong 10-cent coin measuring 17.5 mm in diameter and 1.1 mm in thickness. Although weathering has reduced its weight to approximately 2 g, the coin’s official original weight would have been 2.82 g (0.11).

The obverse shows a coronated Gothic head of Queen Victoria left, with the legend VICTORIA QUEEN; and on the reverse is written HONG-KONG TEN CENTS 1890 around Chinese characters, within a beaded circle, with a dot in center.

A copper (75%) and nickel (25%) five-sen coin from 1889 was found in 2009 in Cave Area D. The official weight was 4.67 grams. The obverse has a number 5 at the center, with the legend JAPAN 1890; the reverse has the Japanese imperial crest of the chrysanthemum at the center, and the legend reads five sen, in English and Japanese.

Two small silver coins in very poor condition, and of similar dimensions were also found in 2009. On one of them are traces of a possible tughra, the calligraphic seal of a sultan, indicating the likelihood of Ottoman origin.

Among other finds were additional fragments of decorated pewter, totaling 15 since 2008. In 2010 a small complete lobe-shaped concave pewter footed tray (8 x 6.5 cm) was recovered from Cave Area K. It is decorated inside with a relief of two bears or dogs playing with a fan (Figs. 12&13).

At the end of the 19th century, pewter was not widely used in Japanese art but with the opening of the Yokohama harbor for international trade, a new array of export items and souvenirs following western tastes was produced to meet demand. Pewter objects were among these, although...
they never eclipsed porcelain products in importance. The influence of the European and North American markets, therefore, created a unique Japanese style at that time.

On the Japanese market, pewter objects were usually produced for the consumption of tea and sake, the most popular items being small saucers for tea cups. The pieces produced for export were mostly decorative and this is also likely the case of the 15 fragments of decorated pewter found so far in the *Ertuğrul* collection.

Following the excavation of this small decorative pewter tray we were granted permission by the municipality to clean and consolidate a larger pewter tray on display for the last 30 years in the local Turkish-Ertuğrul Museum. Conservator İlkyavşin removed a thin layer of marine concretion from the surface of this tray bringing out the beautiful figurative decoration (Fig. 12).

**Finds from the Final Days: The Emperor’s Plates**

It happens during every archaeological field season: the most significant discoveries are often made during the last few days. The 2010 season on *Ertuğrul* was no exception. The last archaeological dive of 2010 took place on 8 February. Nevertheless, one more dive by the Japanese team to close the site occurred on 20 February. The goal was to make a final check for remaining pieces of the permanent anchorage and to retrieve any equipment left behind. Divers also brought to the surface some artifacts found loose on the sea floor in the valley area, specifically two rare white porcelain plate fragments with the imperial emblem.
at the center (Fig. 14).

These two elegant matching fragmentary plates bear the most important motif in Japanese official art: a chrysanthemum blossom, the imperial seal of Japan since medieval times. Under the Meiji Constitution, the 16-petal chrysanthemum was reserved for the Emperor of Japan's exclusive use. Each member of the Imperial family used a slightly modified version of the seal. These plates are decorated with a 12-petal chrysanthemum, as the central motif, which is repeated on the side walls, alongside other painted decoration of which only faint traces survive. The plates may have been a present from an Imperial family member to the Ottoman sultan Abdülhamid II.

Post-Excavation Laboratory Work/Conservation in Kushimoto and Bodrum

All artifacts raised during the 2010 season were registered and photographed in the ERC between 8 January and 22 February. Preparations for wet storage and artifact desalination were overseen by field conservator Ilkay İvgin. On windy or rainy days when dives were not conducted the team worked hard cleaning concretions in the lab (Fig. 15), a process which yielded numerous small nails, officers’ buttons, and other objects of brass, porcelain and glass. Other unidentified metal objects were likely part of the engine room, but their specific nature has not yet been determined.

On 1 February, the exhibit of Ertuğrul artifacts in the Kushimoto Marine Park was officially closed and the artifacts returned to the ERC lab.

The ship’s large copper cooking pot was also brought to the lab where it was cleaned of most of the thin concretions on its surfaces. This iconic piece, the symbol of Ertuğrul, was taken to Turkey for continued treatment in the Nixon Griffis Conservation Laboratory. Once conserved, the cauldron again became the central piece of the Ertuğrul exhibit, this time at the 120th anniversary of the disaster in Mersin, Turkey (Fig. 16).

At the end of February 2010, it was decided to bring many Ertuğrul artifacts to Turkey to complete as much of the conservation process as possible in order to ready them for display, first in Turkey then in Osaka, Japan, and finally in the Kushimoto Ertuğrul Museum.

Among the iron artifacts brought to Bodrum were two cannon balls, weighing 16 kg each, three shrapnel shells, fragments of several iron tools and what may be the fragment of a knife blade.

From February to December 2010 this conservation work in Bodrum continued under the supervision and advice of Kimberly Rash, interim conservator at INA’s Bodrum Research Center, and with the assistance of various team members and students: Hülya Çevik, Dr. Maria Jose Lledó, and conservation student Dilek Ataç, who worked especially hard preparing over 600 pieces for exhibitions in Turkey (Fig. 17).

Conservation of some of the organics like the bone whistle, two small ivory pieces and a few leather soles from officers’ boots took special time and attention, with the end result being quite satisfactory.
**Ertooğrul Shipwreck 120th-Anniversary Celebration Events in Kushimoto, Japan and Mersin, Turkey**

Parallel to the archaeological research, an important mission of this project since its beginning in 2005, with the help of the Kushimoto Municipality in Japan, has been to raise public awareness in Turkey about this important event in the history of the Ottoman Navy.

The existing *Ertooğrul* museum on Oshima Island hosts artifacts from previous surveys and is situated on a walking path that links the museum to the *Ertooğrul* Memorial monument and the lighthouse. This national park and walking area receives about 100,000 visitors per year. The exhibition of some of the *Ertooğrul* artifacts in the Kushimoto Marine Park between April 2009 and February 2010 received approximately 200,000 visitors and helped promote the story of *Ertooğrul* all over Japan.

In 2010, the 120th anniversary of the tragedy, official ceremonies were held on the wreck site on board the Japanese Naval Defense Force Ship *Setoyuki*, and on land a large group of Turkish and Japanese officials presided over events at the *Ertooğrul* memorial on Oshima Island (Fig. 18).

These events were reciprocated in September 2010 by the Mersin Municipality in Turkey, sister city of Kushimoto and home to a sister memorial to the *Ertooğrul* sailors. The centerpiece of these events was the exhibit showcasing the history and excavation of the *Ertooğrul* shipwreck.

In November, this exhibit traveled to Bodrum where it was housed in the main gallery of INA’s Research Center (Fig. 17).

**Reflections**

Again in 2010 the *Ertooğrul* lab in Kushimoto opened its doors to local students and volunteers every afternoon (Fig. 19). About 41 local residents and students participated in the conservation work facilitated by an educational program promoted by the local high school and the cultural department of the local town hall. The history of *Ertooğrul* is part of the academic curriculum of the prefecture and this laboratory component is part of a hands-on internship, especially for high school students (Fig. 20).

At the end of the field season two rooms at the local high school were allocated for dry and wet storage of *Ertooğrul* artifacts. The setting of this new storage area is perfect for our purposes as water is available from an outside hose, the floors are concrete and have level access to an outside open area with drainage that facilitates the changing of the water needed for proper artifact conservation. Finally, its central location provides easy access for our local team members Nakamura, Enomoto, Shimano and Sanakari, who continue monitoring the artifacts and changing the water all year long.

The documentation of the site, conservation, treatment and stabilization of the artifacts provides the material background for the archaeological research and final interpretation. But the archaeological nature of the *Ertooğrul* shipwreck site is far from ideal, for although the site is rich in artifacts, their current location has little relation to their original context. This is because the *Ertooğrul* shipwreck is the result of a disastrous typhoon that battered...

**FIG 18**
120th-anniversary celebrations at the wreck site (Kushimoto Municipality).

**FIG 19**
A volunteer admires one of the porcelain pieces in the ERC, 2010 (B. Lledó).

**FIG 20**
Primary school children receiving their Frigate *Ertooğrul* Lesson in History class in a school in Kyoto (Kushimoto Municipality).
the already old and fragile ship, days after running aground, breaking it into pieces and causing it to sink between the rocks which in turn acted as a funnel and channeled the remains to the deep pockets of the valley beneath. In the case of Ertuğrul, specifically, we are also responsible for respecting, collecting, and reviving a shared social memory that is still alive in two very different cultures. We become closer to its tragedy with each small fragment we raise to the surface.

Acknowledgments
We would like to acknowledge and thank INA, Kushimoto Municipality and BOSAV for supporting this project. The continuation of fieldwork and research in 2010 would not have been possible without the financial support of David Koch whom we gratefully thank. Many thanks as well to all project members and volunteers who participated in the project. There was always a long list of experts specializing in different aspects of research (from armament to Japanese art) ready to answer our endless questions about the artifacts, and we thank them dearly, despite not having the space to list them individually. I would also like to thank the Department of Archaeology in the University of Alicante, especially Dr. Lorenzo Abad Casal and Dr. Sonia Gutierrez Lloret, for supporting my research and accepting this topic as my Ph.D. dissertation.

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Notes
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2 Lledó 2010.
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This report summarizes the archaeological fieldwork conducted in 2010 at the Dong Ma Ngua site along Bạch Đằng River in northern Vietnam. The site is a historical battleground related to the Chinese Dynasties’ invasions of Vietnam between the 10th and 13th centuries. The fieldwork follows work conducted in 2009 by the Institute of Nautical Archaeology (INA) at Texas A&M University, the Maritime Archaeology Program (MAP) at Flinders University, and the Vietnamese Institute of Archaeology (IA).1 This report outlines the results of the full excavation at Dong Ma Ngua in 2010 implemented by researchers from the IA, working alongside members of MAP and INA. A number of wooden stakes, believed to have been used as a means of preventing the Chinese fleet from flowing down river during battle, were discovered during the excavation. Some interpretations regarding these stakes are presented in this report. The ultimate goal of this project is to identify the Mongolian fleet of China’s Yuan Dynasty at the battle on the River in 1288.

Site background
As its fifth emperor, Kublai Khan successfully led the great power of the Mongol Empire. During his reign (1260–1294), he dispatched fleets to further the empire’s hegemony, expanding his rule to East and Southeast Asia. Table 1 shows Kublai Khan’s invasions in the region in chronological order. There are two maritime archaeological sites that bear witness to these 13th-century activities: the first is located in the vicinity of the Bạch Đằng River in northern Vietnam (at the time under the reign of Dai Viet, 1054–1804), and the other is located off Takashima
Island in the northwestern region of Kyushu Island, Japan (Fig.1). These are historic naval battle sites where invading Mongolian fleets were defeated by the local people.

The Vietnamese triumph over the Mongol Empire's fleet in 1288 is described in historical sources as follows. After successfully taking the capital (modern Hanoi), the invaders found themselves trapped in the empty city without supplies. They soon abandoned the capital and retreated, but the people of Dai Viet intended to fight a decisive naval battle against the invaders. The Vietnamese forces lay in wait for the fleet to return to China through the estuary of the Bạch Đằng River. Their strategy was to prevent the fleet from reaching the mouth of the river and trap them using hidden wooden stakes that had been driven into the riverbed. Historical records indicate that a number of ships were lost during the battle.

Roughly 700 years later, the battle site was located in the reclaimed lands along the river when a large number of wooden stakes were discovered in the 1950s. The tactic of using hidden stakes to trap fleets on a river occurred sporadically in history as a feature of Chinese naval battle strategy (Table 2). Because at least two battles occurred on the Bạch Đằng River, it has been argued that the stakes discovered in the 1950s may be from a 10th-century battle against the Southern Han Kingdom.

Three sites identified as major stake fields (Yen Giang, Dong Van Muoi, Dong Ma Ngua), are located along the eastern shore of the Bạch Đằng River in the Quang Ninh Province. The Dong Ma Ngua site, discovered in 2009, is about 3 km south of the Yen Giang site, first discovered in 1958. A full excavation at Dong Ma Ngua was conducted in 2010 to explore additional details of the site.

Fieldwork

The 2010 fieldwork at Dong Ma Ngua was conducted between April and May. The site had previously been used as a fish pond, but was drained for survey and excavation. Four permanent data points were established and four trenches were opened but later integrated into one large trench (Fig. 2). The size of the fish pond measures approximately 20 x 15 m. Two additional test trenches were opened in the rice fields around...
Kublai Khan, fifth emperor of the Mongolian Empire, establishes the Yuan Dynasty.
First attack on Japan by the Yuan Dynasty.
Yuan Dynasty conquers the Southern Song Dynasty.
Second attack on Japan by the Yuan Dynasty.
The Yuan and Mongolian force invade Champa (ancient kingdom located in what is currently central and southern Vietnam).
Kublai Khan sends a letter to Dai Viet King to call on him to surrender.
Yuan and Mongolian forces attempt to invade Dai Viet on at least two occasions but are repelled; suffering from fatigue, disease, and a shortage of supplies, the forces withdraw by ship down the Bạch Đằng River.
Dai Viet General Trân Hưng Đạo traps the retreating Yuan/Mongolian fleet by planting iron-tipped stakes around the mouth of the Bạch Đằng River. While small Vietnamese boats challenge the Mongolian fleet, the tide ebbs. Stuck in the river, 100 Mongolian vessels are destroyed and 400 are captured.

**TABLE 1**

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1271</td>
<td>Kublai Khan, fifth emperor of the Mongolian Empire, establishes the Yuan Dynasty.</td>
</tr>
<tr>
<td>1274</td>
<td>First attack on Japan by the Yuan Dynasty.</td>
</tr>
<tr>
<td>1279</td>
<td>Yuan Dynasty conquers the Southern Song Dynasty.</td>
</tr>
<tr>
<td>1281</td>
<td>Second attack on Japan by the Yuan Dynasty.</td>
</tr>
<tr>
<td>1283</td>
<td>The Yuan and Mongolian force invade Champa (ancient kingdom located in what is currently central and southern Vietnam).</td>
</tr>
<tr>
<td>1284</td>
<td>Kublai Khan sends a letter to Dai Viet King to call on him to surrender.</td>
</tr>
<tr>
<td>1285-1288</td>
<td>Yuan and Mongolian forces attempt to invade Dai Viet on at least two occasions but are repelled; suffering from fatigue, disease, and a shortage of supplies, the forces withdraw by ship down the Bạch Đằng River.</td>
</tr>
<tr>
<td>1288</td>
<td>Dai Viet General Trân Hưng Đạo traps the retreating Yuan/Mongolian fleet by planting iron-tipped stakes around the mouth of the Bạch Đằng River. While small Vietnamese boats challenge the Mongolian fleet, the tide ebbs. Stuck in the river, 100 Mongolian vessels are destroyed and 400 are captured.</td>
</tr>
</tbody>
</table>

**TABLE 2**

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>279-280</td>
<td>Chang River (Yangtze River) against Jin; Wu adopts stakes linked together by iron chains on the riverbed.</td>
</tr>
<tr>
<td>933-938</td>
<td>Bạch Đằng River Battle against Southern Han Kingdom; Ngo Quen (Founder of Ngo Dynasty) adopts the tactic.</td>
</tr>
<tr>
<td>1197</td>
<td>Lantau Island, Hong Kong against South Song Dynasty; Lantau Islanders adopts the tactic.</td>
</tr>
<tr>
<td>1288</td>
<td>Bạch Đằng River Battle against the Yuan Dynasty; Trân Hưng Đạo adopts the tactic.</td>
</tr>
</tbody>
</table>
the site to assess soil sediments and enhance our understanding of topographical features. As a result of the excavation, 55 stakes (plus two large wooden pieces) were identified in the fish pond. Moreover, a large number of ceramic pieces currently under analysis by Dr. Le Thi Lien (IA), were identified possibly dating to the 15th century or earlier. A small ceramic coffin, likely dated after the 17th or 18th century, was found in one of the two test trenches (Fig. 3).

Fieldwork included the recording of sediment profiles and detailed descriptions, measurements, and photo-cataloguing of the stakes themselves. Small wood samples were collected from all of these stakes for post-excavation analysis. By using a total station, the team was able to record the positions of the stakes and important topographical features, including concrete irrigation channels, the configuration of the fish pond, and waterways. Recovered artifacts vary but included ceramic sherds, fragments of earthenware tiles, pieces of bricks, remains of wooden stakes, one corroded metal object, and pieces of bone (likely from a mammal and a bird).

Analysis and Interpretation
Fieldwork focussed mainly on detailed recording of the stakes at Dong Ma Ngua to ascertain their specific distribution pattern. The stakes are aligned in columns, extending from west to east. The upper ends of the stakes, which were driven diagonally into the riverbed in two rows, face or cross each other. Similar diagonally-driven stakes were identified in the other stake fields previously identified (Fig. 4). Most of the wooden stakes discovered had been attacked by marine borers and their current condition makes it difficult to determine their original dimensions. However, their original diameters appear to fall into approximate groups of 6, 12, and 20 cm. These estimates can be confirmed by those stakes that still have their bark intact. On the bottom of some stakes was a recess or notch (Fig. 5).

Wood species of the stake specimens recovered in 2009 were analyzed by the Forestry and Forest Products Research Institute in Japan. The five samples that were submitted returned three different taxa: one sample has been identified as *Meliaceae* sp or *Rutaceae* sp, another as *Leguminosae* sp and...
three samples as *Shorea-Shorea* (*Dipterocarpaceae*) sp (Fig. 6 and Table 3). According to Vietnamese researchers, some hardwoods, so-called iron trees, were used for the wooden stakes. There are several hard trees known as iron trees in the area (Table 4). *Shorea-Shorea* sp is an evergreen tree growing widely in Southeast Asia, known as a heavy and hard wood with an absolute density of 0.93 g/cm³. From visible inspection and limited sampling carried out during the 2010 season, it seems there is some consistency in the quality of the woods used for the stakes, but future wood identification analyses will help us refine these preliminary conclusions.

The excavated area shows a change in elevation and sedimentation patterns. The stakes may have been driven into the slope of the old channel shoreline. Based on the profile of the sedimentation recorded during the excavation, the riverbed slopes from east to west. The first few layers appear to have been disturbed by modern activities. A number of ceramics were discovered, mostly from the third and fourth layers. During previous excavations conducted by Vietnamese researchers, such a large number of ceramics was not observed. The stakes, which taper about 20–30 cm from the point, appear to have been driven into the fourth or the fifth layer. The sediment includes a number of thin layers, resulting from riverine deposition processes. The quality of the soils in the different layers changes from top to bottom; from clay, clay with sand, sand, to sandy silt. Some layers were characterized by tiny clam shells, large oyster shells, and degraded plant remains. According to Dr. Doan Dinh Lam from the Institute for Geology of Vietnam, these are the result of typical riverine sedimentation observed in the area; the clay in the upper layer are from slow sedimentation processes with minimal tidal influence. In the lower layers, however, some of the sand

<table>
<thead>
<tr>
<th>TABLE 3</th>
<th>Botanical information</th>
<th>14C date</th>
<th>Calibrated date range</th>
</tr>
</thead>
<tbody>
<tr>
<td>•09.DMN-05 wood <em>Meliaceae</em> or <em>Rutaceae</em></td>
<td>628 ± 27 BP</td>
<td>1280 C.E. (95.4%)</td>
<td>1400 C.E.</td>
</tr>
<tr>
<td>•09.DMN-06 wood <em>Leguminosae</em></td>
<td>577 ± 28 BP</td>
<td>1300 C.E. (95.4%)</td>
<td>1420 C.E.</td>
</tr>
<tr>
<td>•09.DMN-07 wood <em>Shorea-Shorea</em> (<em>Dipterocarpaceae</em>)</td>
<td>664 ± 31 BP</td>
<td>1270 C.E. (95.4%)</td>
<td>1400 C.E.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TABLE 4</th>
<th>Common Name (ironwoods)</th>
<th>Botanical Name</th>
<th>Distribution</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dinh</td>
<td><em>Bignoniaceae</em>—<em>Markhamia indica</em> (Lour.) Pham, H.</td>
<td>North, central and highlands of Vietnam</td>
<td>15–25 m high 60–80 cm diameter</td>
<td></td>
</tr>
<tr>
<td>Lim</td>
<td><em>Caesalpiniaceae</em> (<em>Fabaceae</em> before)—<em>Erythrophloeum fordii</em> Oliver</td>
<td>from Nghe Tinh province to northern Vietnam, also in GuangXi and Guangdong, China</td>
<td>20–25 m high 70–90 cm diameter</td>
<td></td>
</tr>
<tr>
<td>Sen</td>
<td><em>Sapotaceae</em>—<em>Madhuca pasquieri</em> (Dubard) Lam, H.J.</td>
<td>Distributed in central to north Vietnam</td>
<td>20–25 m high 1.2 m diameter</td>
<td></td>
</tr>
<tr>
<td>Tau</td>
<td><em>Dipterocarpaceae</em>—<em>Vatica odorata</em> (Griff.) Symington</td>
<td>Vietnam, Myanmar, Laos, Cambodia, Thailand and Malaysia</td>
<td>30–35 m high 1 m diameter</td>
<td></td>
</tr>
</tbody>
</table>

FIG 6: Samples of the stakes taken from Dong Ma Ngua for wood identification (R. Sasaki).
and sand-silt layer are much thicker, which is consistent with the original riverbed into which the stakes were driven.

Two test trenches were opened west and northwest of Dong Ma Ngua to determine whether these areas were originally a deeper part of the channel. Apart from the coffin, neither cultural remains nor organic and shell remains were identified there and the quality of the sediment is consistent.

Summary
The 2010 fieldwork at Dong Ma Ngua has contributed to a better understanding of the stakes’ placement pattern, their usage, and the past landscape of the area. It is clear that stakes were intentionally inserted in specific narrow areas, and not simply placed between natural barriers such as high ground and river rocks. On the final day in the field, preliminary results were presented at a meeting attended by the Director of the Institute of Archaeology in Hanoi, the Previous Minister of the Ministry of Culture, Sports, and Tourism, the Representative of Regional Communist Party, officials from the District, the Province and the Commune. The purpose of this meeting was to draw the public’s attention and raise interest for wider support. We also hope to raise awareness of the need to conserve the recovered artifacts and manage the site responsibly. As conservation facilities are not available in Hanoi, a proper method of conservation for excavated organic materials is a primary concern. At present, first-aid conservation using Kathon CG is being proposed.

The 2011 Survey
The 2011 survey will target the area of high ground along the ancient Kenh River. The area has been reclaimed and can hardly be seen on the map. The Kenh River is one of the three major channels that used to connect the Bạch Đằng River and the Chanh River to other small streams. The higher ground in this area is called “Shipwreck place,” making this particular area relevant for an intensive survey by coring and remote sensing equipment in order to identify possible ship remains.

References


Notes
1 Sasaki and Kimura 2010
2 Kimura 2006
3 Le 2005, published as an internal report for the IA, translated into English for this project.
4 Le et al. 2011.
5 Nguyen Thi Mai Huong (IA), personal communication, 2009; also referred to Vietnam Forest Trees, Agricultural Publishing House.
In November 1619, a powerful hurricane formed in the Atlantic (Fig. 1). It threatened the fledgling Bermuda colony and all the ships anchored at the island's natural harbors. One of these was *Warwick*, an English magazine ship destined for the colony at Jamestown, Virginia. The ship had just delivered Captain Nathaniel Butler, the newly elected Commander and Governor of Bermuda, and Mr. John Dutton, the new bailiff of the Warwick Tribe (Fig. 2).

*Warwick*’s captain was faced with a difficult choice. He could depart prematurely and attempt to ride out the storm in the open ocean, or seek shelter in Castle Harbor and hope that the ship’s mooring cables were stronger than the wind. Under Butler’s orders, the crew of *Warwick* dropped anchors behind the harbor’s tall cliffs and secured the ship. The captain’s decision would strand some 40 colonists and deprive the Jamestown colony of desperately-needed supplies and
On 20 November, the hurricane landed. A fierce northwesterly ripped through Bermuda. At King's Anchorage, Warwick broke free of all her moorings and was torn apart on the reef and rocks. Some of her supplies were rescued. Her cannons were raised and used to bolster the island’s defenses. Regardless, the loss of the ship was a devastating blow to her owner, Sir Robert Rich, the second Earl of Warwick, as well as the Virginia and Somers Island Company and their individual investors.

2010 Excavation
More than 390 years later, Warwick has a new story to tell. Between 19 June and 23 July 2010, the Institute of Nautical Archaeology (INA) and the Center of Maritime Archaeology and Conservation (CMAC) at Texas A&M University, with the collaboration of the National Museum of Bermuda (NMB) and the National Geographic Society (NGS) conducted the first field season of excavation of the galleon Warwick. The staff included project directors Piotr Bojakowski and Dr. Katie Custer Bojakowski, Dr. Kevin Crisman and Dr. Jonathan Adams; Carlos Cabrera, John Eastlund, Mike Gilbart, and Doug Inglis, all graduate students in the Nautical Archaeology Program at Texas A&M University. Volunteers included Leah Crisman, Patrick Dresch, and Bermudians James Davidson, Zoe Brady, Piers Kermode, and Tristan Kermode.

During the 2010 field season, the partially buried section of early 17th-century Warwick’s hull was successfully excavated and recorded (Fig. 3). Constituting roughly a 10-m by 5-m rectangle, the extant structure represented the very stern portion of the starboard hull, from the turn of the bilge to just above the orlop deck. It comprised ceiling planks, stringers (with one serving as a shelf clamp), lodging knees and two types of deck beams supporting the deck, framing timbers, and outer planks in two distinct layers covered with sheathing.1

The Hull Remains
The first elements uncovered during the survey were the nine ceiling planks, which followed an alternating pattern with the stringers. The stringers were considerably more robust than the ceiling planking. They were also visibly chamfered along both edges. Amalgamating the preliminary findings of the survey with past research conducted by Adams, these heavy fore-and-aft stringers appeared to be installed at pre-determined intervals along the inside of Warwick’s hull.2 Only after they were secured in place, with what may have been treenails, were the ceiling planks of more irregular widths tightly fitted into the spaces between the stringers. Interestingly, such a solution to the planking of the interior of the vessel is consistent with the technology discovered on the 16th-century Tudor warship, Mary Rose.3 The internal structure of Warwick deviates from that of the contemporaneous and better-known English shipwreck from Bermuda, Sea Venture. While the system of stringers on the latter was restricted to the footwales or sleepers, the function of which was to run on each side of the keelson at the level of the floor’s wrongheads (rungheds) the regularly-spaced stringers of the former spanned the entire hold of the ship.5 Of the three stringers, the uppermost one also served as a shelf clamp on which the lodging knees and two types of beams were placed.
The exposed section of the hull included 29 framing timbers (Fig. 4). These comprised the floor timber’s wrongheads and well-preserved first, second, and third futtocks. Although the framing timbers showed distinct overlapping between the futtocks, the arrangement was rather loose and the elements did not appear to be horizontally fastened to each other. All the timbers were fastened directly to the outer planks with treenails, which were tightly spaced, oftentimes in pairs, with two to four treenails per futtock-plank intersection. Additionally, no chocks or scarfs were detected, and the lower futtocks were simply butted up against the upper ones, often with a significant gap between the timbers. The framing was
regular and corresponded to the typical English three-arc system that dictated the hull form from the 16th to the 18th century. In addition, the evidence from Warwick resembles the framing arrangement known only from the “Navy Board” models.

Fifteen strakes constituted the first layer of external planking. Two of the upper planks were significantly more narrow and thick and have been identified as the ship’s wales. Unlike other planks, which seemed to be butt joined, the top wale also exhibited a nicely-preserved diagonal scarf. The second layer of external planking, also referred to as the doubling, was only visible at the aft most end of the stern and labeled according to the corresponding first layer of planking. Furthermore, there was direct evidence of a third layer of planking, functioning as wooden sheathing, most likely constituting a sacrificial layer. The frames were fastened to the first layer of outer planking with treenails while the doubling seems to have been fastened to the first layer using iron spikes. The sheathing was secured to the doubling with small, regularly-spaced tacks (Fig. 5). Finally, the spaces between each layer of planking were tightly packed with caulking material that appears to be a mixture of animal hair and rosin.

Using original drawings with marked positions of the consecutive knees as well as the direct evidence of beam notches cut into the shelf clamp, it was determined that the first type of beam was lodged on the shelf clamp and supported from both sides by the knees. The second type of smaller beam, most likely the ledges, was placed between the first type. These were fitted into the shallow notches carved in the knees. The arrangement of large knees, beams, and ledges produced a sturdy support for the deck. Although the limited nature of the excavation during the first season prohibits defining which deck the structure represents, everything points towards the first deck or orlop deck that most likely would have served as the gun deck.

Significant Artifacts
A section of one of the outer planks was covered with a circular metal concretion of what appears to be an iron grenade (Fig. 6). The object was tentatively identified during 1979–80 salvage work carried out by Teddy Tucker as a cannonball lodged in the hull. This has been refuted, however, based on the position of the object below the suspected waterline, its small size, the hollow inner cavity, and the fact that it was only concreted to the plank but did not penetrate it.

Within the midship section of the wreck, lodged between the ceiling and floor timbers, was a fragment of a barrel stave. Wooden barrels were standard cargo containers for transporting provisions and water. The historic records indicate that wooden barrels of beer were recovered in 1620 and Tucker found the remnants of several wooden barrels and boxes. Another wooden artifact was a fragment of block, likely representing an element of the running rigging of the vessel (Fig. 7). The block was characterized by longitudinal grains and beveled edges, and complemented other rigging elements previously found on Warwick. In addition to wooden artifacts, the excavation produced a
distinctive ceramic sherd identified as stoneware. It was grayish-tan in color and had evidence of glaze, which deteriorated underwater.

Lodged under one of the frames was a small and extremely fragile piece of wood resembling a ruler. Upon close examination, the object has tentatively been identified as a mathematical instrument generally referred to as a Plain Scale or a Gunter’s Scale (Fig. 8). This precision instrument was inscribed with three sets of logarithms laid on straight lines to facilitate the resolution of numerous navigational problems, such as converting rhumb lines into miles of longitude, without resorting to laborious calculations by hand. The Gunter’s Scale found on Warwick was used in conjunction with a pair of dividers, the ends of which were inserted into silver plugs that are still preserved on the artifact but highly corroded.

Conclusion
Warwick is a prime example of the early 17th-century multipurpose ships that played a fundamental role in creating a lifeline between England and English settlements in North America. Warwick, and ships like her, carried the financial interest of small businessmen and large investors. These ships also carried the settlers that would make their permanent homes in Bermuda and America. Besides its economic and civic importance during the 17th century, the “magazine” ship Warwick provides a plethora of new data to modern nautical archaeology. Warwick has begun to teach us more about the Island’s history as well as that of the Atlantic world, and it is a lesson we look forward to continuing.

References


**Notes**

1 Bojakowski and Bojakowski 2011, 47–9.
2 Adams 2003, 123; Jonathan Adams, pers. comm.
3 Marsden 2003; Marsden 2009.
5 Manwayring 1972, 95–6.
6 Anderson 1953, 139.
7 Jonathan Adams, pers. comm.
8 Cajori 1920, 188–192.
Harbour Island

The 2010 season of the Harbour Island Archaeological Survey (HIAS) supplemented work begun in 2009 aimed at collecting archaeological data and investigating historical material in the National Archives of the Bahamas. The project is ultimately geared toward understanding the nature of maritime communities by comparing the Harbour Island archaeological assemblage with other British sites from the same period. In 2010, six new properties were surveyed by the author and field archaeologist Catherine Sincich. The sites were concentrated in an area identified as the heart of the early 18th-century settlement as well as properties settled at the time of Dunmore Town’s official founding in 1791.

Historical Sketch

The maritime nature of the colony at Harbour Island extends back beyond the initial British settlement of the area to the exploitation of the islands by colonists from Bermuda. When the first Anglo-Bahamians arrived in the depopulated islands, they relied on the natural bounty of both sea and land as well as on trade with other colonies. They fished, caught turtles and seals, raked salt, and harvested tropical hardwoods. Over time, piracy and privateering, shipbuilding, wrecking (maritime salvage), and fruit growing cycled through their economic repertoire as well. Many patterns of maritime life endured at Harbour Island from the earliest days in the late-17th century through the 19th, and some even into the present.

Dunmore Town was officially founded by John Murray, Earl of Dunmore in 1791, but the area had been settled for over a century. Murray, who was Governor of the Bahamas from 1787 to 1796, arrived in the islands with the loyalists at the end of the American Revolution. Most of the newcomers, who brought with them their entire households including slaves, settled on previously uninhabited islands. Some did make their homes in older communities, including at Harbour Island, where traditional Island modes of life predominated.

In Nassau, the seat of government, there were political tensions between older residents who resented having their way of life disrupted so severely, and the loyalists. The newcomers saw themselves as champions of improvement, bent on dragging...
the islands into the modern world whether they wanted it or not. They saw the maritime focus of older residents on logging, salt raking, wrecking and turtle hunting as an impediment to progress. Harbour Island mostly escaped these tensions, but was not exempt from changes wrought in the broader political arena. This community had benefited greatly from trade with the American colonies before the revolution, and there was a period of adjustment before minds turned to the profits to be made growing food for the expanding population on New Providence.

The 19th century saw a cycle of boom and bust at Harbour Island. Shipbuilding and food production were both important, and related, industries. The vessels produced in the island’s shipyards were used in the carrying trade as well as for wrecking and sometimes smuggling. In the first half of the 19th century, local shipwrights mostly produced one-masted vessels under 50 tons, with a few larger two-masters capable of venturing further in the open ocean. Vessels grew in size later in the century, and by the early 1900s, island shipwrights produced ships as large as 360 tons (though not without difficulty).

Shipbuilding techniques influenced local building from the early days of the settlement, as most carpenters learned their trade building hulls rather than houses. Wrecking, or salvage, was another trade practiced since the earliest days and linked closely to shipbuilding. Bahamians staked out various areas where wrecks were common to wait for inevitable groundings and founderings as well as keeping watch on local navigational hazards, so that they could lay claim both to cargoes and to the vessels themselves. New ships were commonly outfitted with timbers, spars and equipment from salvaged vessels.

In 1850, Governor John Gregory required wreckers to license their ships, and to declare recovered goods to authorities in Nassau before they could sell them in the local markets. These new regulations altered the informal system of consortship and shares by which the wrecking crews had operated previously. In the new system, outside parties had more control and it was easier to impose duties and taxes. Wrecking continued to be a profitable enterprise, however, and Harbour Islanders were well known for their expertise, with the “king” of the Bahamian wreckers, Captain John Buck Saunders, Sr., a Harbour Islander himself. His famous schooner, Galvanic, was locally built.

In 1837, Harbour Island was made an official port of entry for the Bahamas. This development had an immediate positive influence on the economy. For a short time (until a new regulation in 1840), locals were able to declare wrecked goods at home. In the long term, the island’s new status facilitated imports and exports, which in turn helped stimulate a fruit boom in the mid-19th century. Islanders were able to sell produce cultivated on Eleuthera abroad (mostly along the Atlantic coast of America). As can be expected in an island economy, the boom stimulated other maritime developments. It created a rise in the demand for more small vessels for the carrying trade, as well as fast sailing schooners that could transport perishable fruit quickly to distant markets. Eleutheron pineapples were traded as far away as England, transported on locally-built vessels. The ability to ship directly from the island also encouraged the development of sugar mills and canneries, which likewise sold their produce abroad from island-built vessels in the late-19th and early-20th centuries.

All of these developments occurred against the backdrop of another important social change—the abolition of the slave trade in 1808 and eventual emancipation of all enslaved blacks in 1834. In the Bahamas, newly-emancipated slaves were forced into a four-year apprenticeship program, which kept them beholden to their old masters. Many wound up deeply indebted by truck and sharecropping systems. At the time of emancipation, many Harbour Island households had small slave holdings (<20), and most slaves served as domestic servants (37%), mariners (17%), and field laborers (17%), or were not formally employed (29%). While the community was nearly equally split between blacks and whites at mid-century, it is more difficult to claim that it was racially integrated. Whites tended to live closer to the bay, and the poorer blacks on the margins of the community. Church services were segregated, and efforts by five black church members to protest this practice in 1885 were to no avail.

Blacks and whites alike on
Harbour Island were tied in to a lifestyle that relied heavily on maritime elements. Even those not directly involved in shipping, shipbuilding, and wrecking relied on maritime transportation for the flow of people, goods, and information on and off the island. They also relied heavily on natural maritime resources, supplementing their diets with locally-obtained fish and shellfish. Despite the various social and economic developments of the late-18th and 19th centuries, the community retained its maritime nature.

2010 Field Season
The goal of the 2010 HIAS field season was to survey properties in the town to acquire a larger material sample and increase the area of investigation. The field season ran from 21 August to 4 September 2010. The methods employed mirrored those used in 2009: we roughly mapped each property using hand tapes, and dug shovel tests (ST) at 3-m intervals along straight transects. Transect placement was influenced by a number of factors: accessibility, avoidance of known modern disturbances, and site coverage. Where possible, transects crossed the largest available stretch of a site. As seen in 2009, most soil deposits are relatively shallow, and the lack of clear stratigraphy means that the artifacts themselves, along with the historical record, are the best dating tools. On one property investigated this season (The Duke Street Higgs House—DHH), our test pit hit bedrock at a depth of only 12 cm. The items recovered this season were similar to those collected in the previous year, with a great deal of faunal material (mostly fish) and shell, as well as historic and modern artifacts including ceramics, glass, metal fragments, brick, plaster, pipe fragments, and charcoal. Materials collected were catalogued in the field, and are undergoing further analysis and conservation at Texas A&M University.

Yellowbird
The Yellowbird property is owned by Mr. Joe Farell, and is located on Murray Street near where it intersects with King Street, on the hill overlooking the harbor. The property dates to the 18th century and was granted to Richard Thompson in the original 1791 land grant. A modern addition and a pool take up much of the property, with much of the rest covered by concrete pavers. The wall that surrounds the property appears to be early, but much of the ground is covered with palm trees and other landscaping. We laid our transect along a short strip of land between the western edge of the pool area and the wall. We placed four shovel tests and recovered some historical material from them, though the matrix was primarily grey sandy fill being transformed by the palms and other trees in the yard (Fig. 1).

Methodist House
This property belongs to the Methodist Church. The house likely dates to the early 19th century and is used to house the resident minister. We had one afternoon to survey the property as the minister at the time, Rev. Marie Neilly, was leaving the island for another post that day. We nevertheless managed to place six test pits on two transects in the north yard (Fig. 2).

We laid our first transect running south-north across the north yard, leading from the side door of the house, and dug four trenches. The test pits became deeper as we moved...
north across the yard, progressing from 22 to 43 cm. Transect Two ran east-west parallel to a detached building, 3 m east of the midpoint between ST 003 and ST 004. I expanded ST 005 to 50 x 33 cm to recover a ferrous metal bar lodged in the side of the unit. The test pits on this transect were 41 cm (ST 005) and 43 cm deep (ST 006). We found a large amount of material in all pits, mostly dating to the 19th century. Glass predominates, followed by bone, metal fragments, and plaster. Most of the identifiable ceramic types were 19th-century, transfer-printed pearlware and whiteware. As with other Harbour Island sites, there was very little redware or stoneware represented. One particularly notable artifact is an as-yet unidentified bone tool with concave indentations (possible finger holds) and traces of red pigment or staining on one end (Fig. 3).

We also mapped a number of limestone blocks that may belong to the foundation of an earlier building or outbuilding, located just north (and somewhat east) of the standing outbuilding. ST 005, just north of this location, produced a large amount of material, including many faunal remains (some burned) and an intriguing 21-cm long ferrous bar, leading us to hypothesize that the area may have been part of an outdoor kitchen.

Old Barry House
The third property we surveyed was also the largest, consisting of two parcels from the 1791 land grants and located directly across the street from the harbor itself. This intersection is within sight of the modern fishermen’s dock (the location of the older town dock), placing the area directly in the heart of the old town. On the first lot stands the foundation of an old house and a building that used to be a tailor shop and laundry. According to the property owner Mr. Pat Barry, the property had once housed a hog pen, chicken coup, and vegetable garden; at the time of our fieldwork, the building was home to a large hive of bees. The tailor shop, built in 1958 with timbers from an old Nassau church, was constructed by means of the traditional local method of nailing tar-paper to the boards and covering them with plaster. The house has been in the Barry family since the early-20th century, but the building may predate their occupation. The foundation exhibits some methods of construction seen on another early property, being built of tree-stump posts notched to receive scarfed frames, and surrounded by large limestone blocks (Fig. 4). Mortises and notches received support timbers for the floor.

We ran our first transect between the house and the edge of King Street, in an area Mr. Barry indicated had primarily been used as a flower bed during their occupation (Fig. 5). A low rise running along the edge of the street indicated the presence of an earlier fence, and a ring of stones around an indentation in the soil indicated another feature that we did not investigate as it did not intersect with any of our six planned trenches.

The rear lot served as a depot for gravel, and also hosted several large dilapidated trucks. A fence runs along the edge of the lot, so we set a second transect along the small open area between the trucks and the fence, opening an additional six shovel tests (Fig. 6). Both areas of the site contained relatively large...
amounts of historic material, some clearly dating to the earlier-18th century. Several artifacts of note recovered from the gravel depot yard include pieces of a pewter brooch, some lead shot, and the top of a c.1950s candy dish.

**Java House**

Java House was built around the turn of the 19th century, using construction typical of the period—the basement was dug into the limestone bedrock, and the excavated stone used to build up the walls of the foundation and the house itself (Fig. 7). Since the summer of 2009, the house has been undergoing historically-informed restoration and renovation by its owner, Jem Clarke. In 2010, the foundation of the house was exposed, and much of the yard covered in construction debris, landscaping gravel, and soil removed during excavation of the one-foot-thick cellar walls.

We established two short transects in areas where the ground surface was exposed and accessible—one along a temporary fence separating the property from the neighboring (and newly reconstructed) Java Cottage, and one strip running from the rear of the house towards the back of the lot, where workers uncovered the remains of an outdoor toilet in 2009 (Figs. 8&9). They cleared the area and installed a new concrete water tank.

We placed three shovel tests on Transect 1, with depths ranging between 41 and 44 cm, with four more on Transect 2 for a total of seven. Depths ranged from 66 to 70 cm, and stratigraphy was heavily influenced by the ongoing construction, with mixed layers of fill and the natural soil in the upper levels of the units closest to the house. The non-fill layers were similar in color and composition to the rest of the property.

Most of the site was covered with a layer of gravel which contained crushed shell and some small whole shells, and it seems likely that similar materials recovered in the pits (especially whole small clam shells) originated in this landscaping fill. Despite the construction disturbance, the property was very rich in 19th-century historic material. ST 007, closest to the edge of the privy, contained over 560 artifacts (including faunal remains, and discounting charcoal).
Along with materials more typical of the other Harbour Island sites we have investigated, we also found a pressing iron, a fork, and several sections of decorated bone (a handle and a button). We also observed a ship’s knee that had been discarded from the interior of the house.

**Duke Street Higgs House**

The area between Duke and Princess streets is colloquially referred to as “the bottom,” and is considered by locals to be the oldest part of town though this is not supported by the historical record. The Duke Street Higgs House is a property owned by the Higgs family (Carl and Brenda), located between Duke and Pitt streets, behind Bay Street (Fig. 10). The plot was not granted in 1791, but assigned in 1836 to an ex-slave mariner by the name of Chatham Albury.\(^\text{18}\) The existing house was built in the 1920s and inhabited at that time by David Thomas Higgs and his wife, Adelaide Mather. The remnants of an outside kitchen are also on the property.

We placed one transect of four shovel tests along the length of the yard in front of the house. The units were all relatively shallow, with the deepest reaching 37 cm. ST 004 hit bedrock at 20 cm in the deepest corner, and 12 cm in the shallowest. Even the deeper units hit the sterile brown layer of degraded limestone at just 8 cm above bedrock. Of the little material recovered from this site, most artifacts were 20\(^{th}\) century in date. Due to these factors, we decided not to pursue further survey of this property.

**Conclusion**

The 2010 season represented the second and final field season of the Harbour Island Archaeological Survey. Analysis and conservation of the artifacts recovered from this season is ongoing, and should be complete by summer 2011. Once the data from both seasons have been compiled, I will compare the Harbour Island material to assemblages from other contemporaneous British colonial sites and try to determine if, and how, maritime communities differed in their material culture. This question is at the heart of my research, as such differences relate to the relationship between identity, both of the community and its individual inhabitants, and the maritime environment.
Acknowledgements
I would like to acknowledge the generous support provided by the Institute of Nautical Archaeology, the Department of Anthropology at Texas A&M, and Dr. Kevin Crisman. I would also like to thank the Antiquities, Monuments, and Museums Corporation of the Bahamas for providing the permits to carry out this research, the landowners who granted permission to survey their property, and the staff of the National Archive of the Bahamas for research assistance. Special thanks also to my field assistant, Catherine Sincich.

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The Greco-Roman city of Thmuis was a major economic hub, naval center and capital located along the Mendesian branch of the Nile in Egypt. The ancient city is now a degraded tell, outside the modern villages of Timai el-Amdid and Kafr el-Amir Abdulla Ibn Salam. Two consecutive summers of fieldwork at Tell el-Timai by the University of Hawaii and the Institute of Nautical Archaeology (INA) at Texas A&M University, revealed the location of one of ancient Thmuis' riverine harbors and a defunct channel of the Nile. Geophysical survey, coring, and excavation were employed to locate and explore the layout of the harbor, and to trace the former waterways of the region.

While Egyptian harbors have experienced a wave of interest over the last decade, very little is actually known about the physical interface between man and river. Recent studies in the Nile Delta have unveiled the Nilotic harbor and provided a foundation for the study of the Egyptian maritime cultural landscape. The primary goals of the Tell el-Timai harbor project are to determine: (a) when and how the harbor was constructed and when it fell out of use, (b) the function of the harbor (commercial or temple-related), and (c) the ancient hydrology of the region.

Background

The Egyptian city of Ta-mawy ("new land"), known to the Greeks as Thmuis, is located amidst the salt-ridden soils of the Eastern Nile Delta within the Dakhliya province. Today, the modern villages of Timai el-Amdid and Kafr el-Amir Abdulla Ibn Salam encroach upon the northeast and northwest limits of the tell; the latter is perhaps a development of the medieval Arab suburb of Thmuis. The tell itself stretches more than 1 km in breadth and lies 400 m (quarter of a mile) south of Tell el-Roba, or ancient Mendes. The likelihood that these tells were a single landform during antiquity is high; however, in recent times the expansion of surrounding farmlands has separated the settlement into two tells.

The city of Thmuis is documented in historical texts beginning in the fifth century B.C.E. to the ninth century C.E. Herodotus (484–430 B.C.E.) provides the earliest literary reference to Thmuis as a settlement in the Nome of the Calasaries. Here too is the first mention of the Mendesian River, a tributary of the Sebennytic branch of the Nile, which opened onto the Mediterranean. In the fourth century B.C.E., the Mendesian branch of the Nile began to shift, contributing to the decline of the city of Mendes. By Claudius
Ptolemy’s time (90–168 C.E.), the majority of Mendes’ inhabitants had migrated southwards to Thmuis. Thmuis appears to have supplanted Mendes as capital of the Mendesian Nome, and was a production and distribution center of the popular perfume, Unguentum Mendesium.

Josephus (37–95 C.E.) alludes to Thmuis’ role as a naval center. He relates that the ships of the Roman emperor Titus (39–81 C.E.), departed from the coast of Alexandria and sailed as far as Thmuis, where they disembarked and continued overland to Jerusalem. Centuries later, Ammianus Marcellinus (353–378 C.E.) relates that the settlement was one of the most important Egyptian towns of his time. At the beginning of the fourth century B.C.E. the city became an Episcopal See and remained a stronghold for Christianity throughout the Coptic period up until the arrival of the Arabs. During the first centuries of Islam under the Umayyad and Abbasid dynasties, Arab sources reveal that Thmuis retained a role as an administrative division (Kura). However, by the time of the Fatimid Caliphs in the 10th century C.E. the city had been abandoned.

The recent history of Tell Timai is marked by intermittent exploration by looters, archaeologists and farmers, who remove the phosphate-rich mud brick (sebakhin) from the tell to use as fertilizer. Swiss Egyptologist Edouard Naville directed the first systematic exploration of the tell in 1892 for the Egypt Exploration Fund. His discovery of a burnt storage house in the southwest extremity of the tell revealed the second largest cache of papyri ever discovered in the Nile Delta. Not far away, a group of mosaics was discovered in the early-20th century. Two of these portray a Ptolemaic queen, perhaps Arsinoe II, with the prow of a ship atop her head (Fig. 1). The Mendes Stele, discovered at Mendes in 1871, was erected by Ptolemy II Philadelphus (309–246 B.C.E.). In this important text, the king commemorates the deification of his wife Queen Arsinoe II at Mendes.

Therefore, it is possible that these mosaics, perhaps crafted at Thmuis by local artisans, represented tribute to the queen’s importance in the Mendesian Nome. The most curious aspect of these masterpieces is, of course, the symbol of the ship; certainly a symbol of maritime importance, but for whom exactly? Some scholars believe the women featured in the mosaics are not Arsinoe but are personifications of the great naval city, Alexandria. However, considering the maritime role of Thmuis it seems reasonable to suggest that these two mosaics were intended to signify not the maritime importance of Alexandria, but rather that of Thmuis. Either way, the two mosaics discovered at Thmuis are a poignant reminder that we are dealing with the remains of a once-great maritime center with important royal connections (vel sim) that signify at the very least, an awareness and perhaps an involvement in maritime affairs.

**Findings**

During the summers of 2009 and 2010, the University of Hawaii and INA began the exploration of a potential harbor at Tell el-Timai. Earlier explorers of the site had proposed that the northern limit of the tell revealed traces of one of Thmuis’ ancient harbors, including the remains of a limestone quay-like structure and a fine-silt depression reminiscent of a harbor basin.
Modern records of the tell indicate that the potential harbor district experienced intense sebakheen harvesting activity during the mid-20th century by local farmers. This activity severely altered the landscape and potentially created a harbor-like depression in this region of the tell.

Excavation of the possible ‘quay’ that was located during a preliminary investigation by New York University in the 1960s revealed, instead, the foundations of a Ptolemaic temple built atop an earlier mud brick structure (Fig. 2). The foundation is composed of re-used and well-worn limestone blocks from the quarry of Tura in Cairo. These blocks were dovetailed into position to form three casemate rooms that were filled with limestone debris and minimal pottery. Dating of the ceramics found within the structure indicates construction sometime during the first century B.C.E.

Although our excavation revealed a temple and not a quay, geophysical survey provided clues for the location of a potential harbor. In 2010, Tomasz Herbich from the Polish Center of Mediterranean Archaeology completed a magnetometer survey of the fine-silt basin situated east of the Ptolemaic temple (Fig. 3). His survey revealed a network of buildings surrounding the beginning of a rectangular basin devoid of architecture (Fig. 4).
While the survey did not reveal the overall extent of the enigmatic basin, the dimensions appear to be smaller than the three harbors discovered at nearby Mendes. Initially it was thought that the function of the harbor was related to the small temple located near its western shore. Excavation of both features, however, suggest otherwise. The areas in and around the potential harbor revealed three phases of settlement spanning from the fourth through late-first centuries B.C.E. Ceramics discovered within the basin in 2010 indicate that the harbor was in use between the third and mid-second centuries B.C.E. Destruction deposits and burnt ceramics unearthed in the quarters surrounding the harbor basin (see grids N and O on Fig. 2) indicate a tumultuous event around the mid-second century B.C.E. which destroyed this area and perhaps decommissioned the harbor. Following the destruction, these quarters were immediately filled in with debris, presumably to accommodate a new phase of construction and the limestone temple was subsequently built in the late-first century B.C.E. Unfortunately, all strata above this level were removed in recent times by local farmers.

Excavation of the harbor basin revealed sloping deposits presumably related to the destruction fill discovered in the nearby quarters (Fig. 5). These deposits included pottery, Hellenistic amphora fragments from the Aegean, dozens of votive figurines, stone, metal fragments, Mediterranean and Nilotic shells, fish and animal bone, a decapitated human skull, and a ballista ball. A similar ballista ball was discovered in the excavation of a nearby mud brick structure (Fig. 6). These anti-personnel projectiles were launched from the smallest caliber of stone throwers, compact in design so that they could be used in urban conflict or aboard small warships or freighters, perhaps moored in the harbor or river. Small projectiles like these would have been used to target marines, deck crews or shore personnel when used in naval siege warfare or combat between ships.

Ptolemaic history of the third and second centuries B.C.E. is replete with invasions and naval battles waged against the Seleucid Empire. Shortly after the death of Alexander the Great (323 B.C.E.) and the subsequent Wars of the Successors, the Seleucid Empire emerged alongside Macedon and the Ptolemaic Empire as one
of the three great kingdoms in the Mediterranean. Centered in Syria and Mesopotamia, the Seleucids were the foremost rivals of Ptolemaic military and economic interests in the Aegean and Asia Minor. What followed were six Syrian Wars between the reigns of Ptolemy II (285–246 B.C.E.) and Ptolemy IV (180–145 B.C.E.) that ultimately resulted in the erosion of Ptolemaic hegemony over the Mediterranean and Aegean. On the home front during the late-third century through the second century B.C.E., Egypt was consumed by a nationalistic fervor and the cities of the Nile Delta were involved in local revolts against the Ptolemaic administration. The evidence of destruction layers and ballistae from this period suggests that Thmuis may have been caught up in these skirmishes.

Tracing the defunct waterways that fed the region of Tell el-Timai is problematic as the topography of the ancient eastern Nile Delta was highly dynamic. Beginning in the seventh century B.C.E., the Mendesian River began a period of increased flow. The prevalence of East Greek and Phoenician wares at Mendes dated to the seventh through fourth centuries B.C.E. indicates lively commerce between Mendes and the Aegean and Levantine coasts. Although the evidence of this trade tapers off at Mendes around the fourth century B.C.E., perhaps due to the shifting course of the Mendesian River, it reappears shortly thereafter at Thmuis. Rhodian amphora fragments dated to the third through second centuries B.C.E. were unearthed in preliminary investigations of the harbor area at Tell el-Timai. These wares suggest that Thmuis assumed the role of ‘international emporium’ and maintained on a smaller scale the foreign trade first established by Mendes in the seventh century B.C.E. By Claudius Ptolemy’s time (90–168 C.E.) the Mendesian River had partially silted up and the Busiritic branch, which lay further to the east, dominated the landscape.

In the late 1990s, an Egyptian team from Mansoura University conducted a geophysical survey around the archaeological sites of Mendes and Tell el-Timai. Their findings revealed traces of two defunct branches of the Mendesian Nile. One flowed up to a kilometer west of Thmuis and Mendes. The other passed further to the east (Fig. 7). This geophysical survey also identified a manmade canal that flowed along the western limits of Thmuis and Mendes and connected them with the western branch of the

FIG 7 Location of the waterways proposed by Taha in the 1990s. March 2010 (V. Morriss after Taha 1998).
To substantiate their findings, a series of 21 cores were taken with a handheld coring auger in 2010; three within the purported harbor basin and 18 along the western limits of the tell (Fig. 8 & 9). The cores, which consist of silts, clays and fluvial sands, conform to the 1998 study, and confirm the presence of a major waterway that once flowed west of ancient Thmuis (Fig. 10). The remains of this waterway lie beneath the modern village of Kafr el-Amir and the surrounding farmlands. Future coring and radio carbon dating to the east, the west, and between the sites of Mendes and Tell el-Timai is expected to locate additional waterways and better characterize the courses of the river throughout antiquity.

**Discussion**

Nile Delta cities that became emporia of bustling trade or capitals with naval fleets were presumably equipped with harbor installations, such as moorages, customs facilities, and warehouses for storage. Unfortunately, the evidence at hand for Egyptian riverine harbors is minimal. A harbor is a safe haven for watercraft to moor, as well as load and unload their cargoes by using dock facilities such as quays or wharves. These were places at which tolls and duties were collected, imports and exports were exchanged, watercraft were repaired and maintained, and imperial fleets were stationed. Often, however, harbors were simply places to beach vessels upon a firm shore or ‘hard.’ Lucy Blue’s investigations at the Roman-Islamic port of Myos Hormos along the Red Sea coast revealed a ‘hard’ consisting of an amphora foundation covered with packed sediment. Similarly, recent work at the eastern harbor at Mendes suggests the presence of a ‘hard’ where vessels were beached and unloaded. Such rudimentary installations were both practical and efficient in the riverine and lagoon environments of the Nile Delta. Apart from the permanent harbors and portages found along the seacoast and at the river port of Schedia in Lake Mareotis, the use of stone for mooring facilities is quite rare in the Nile Delta. The fluctuating conditions of the river often negated the construction benefits of permanent stone moorings. Rather, the meandering nature and seasonality of the Nile often led to the establishment of multiple harbors within a city. Recent work at nearby Mendes has uncovered the locations of three harbors. As the Nile shifted course, harbor basins silted up and became inaccessible to the river, and new ones were adopted. It is well-documented that the Egyptians organized dredging operations to counteract siltation in the various waterways of the Nile. Such operations were presumably
employed in riverine harbors. Evidence, however, from the two eastern harbors at Mendes suggest that any such efforts to control silation were ultimately futile once the river changed course. Hundreds of terracotta votive figurines discovered in Mendes’ smaller eastern harbor, reflect a last desperate attempt to restore the failing waters of the Mendesian River, which began its final ebb during the first century B.C.E. The ceramic evidence and the multitude of votive figurines (Fig. 11) from the northern harbor of Thmuis suggest that it too might have witnessed a similar scenario.

Conclusion
According to the preliminary findings from Thmuis and Mendes, the harbors of the Nile Delta did not always conform to the typical harbor design. Rather, these riverine portages were adapted to and at the mercy of the ephemeral conditions of the Nilotic landscape. Beginning in the fourth century B.C.E., the demise of the Mendesian branch of the Nile marked a decline for the Pharaonic city of Mendes. With Mendes effectively cut off from the river, Thmuis emerged as the primary emporium of the Mendesian Nome. Thmuis’ northern harbor, already established by the third century B.C.E., appears to have maintained some fraction of Mendes’ former trade with the Aegean. However, in the mid-second century B.C.E., the harbor area and its facilities were destroyed in what might have been a local revolt against the Ptolemaic administration. The area appears to have been rebuilt later, perhaps concurrent with the construction of the limestone temple during the late-first century B.C.E. While the city of Thmuis is documented in historical texts beginning in the fifth century B.C.E. until the ninth century C.E., very little is known about the topography of the surrounding landscape. The loss of the Mendesian River and the appearance of a more easterly Busiritic branch during the first century B.C.E. reflect major hydrological changes which certainly played a part in the decline of the harbors at Mendes, and perhaps also Thmuis. Due to the highly dynamic nature of this region of the Nile Delta, geophysical survey and coring are the only absolute methods for locating and tracing the evolution of the defunct waterways of the Nile. An understanding of the hydrology around Thmuis will provide clues to understanding how the inhabitants of this Greco-Roman city adapted to their transient maritime environment. Initial coring along the western limits of Tell el-Timai in 2010 confirmed the location of a waterway that once flowed west of ancient Thmuis. Additional coring and subsequent radiocarbon dating of sediments will be imperative to delineating the ancient waterways that passed through the landscape. Reconstructing the riverine environment of Thmuis will play an integral role in understanding how the citizens of this Greco-Roman city perceived, utilized, and interacted with their maritime space.

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Beginning in the fall of 2009, I had the great pleasure of leading the brilliant team of highly-skilled conservation technicians at INA’s Bodrum Research Center. The women and men working for the center, through their diverse contributions, continue to put their heart and soul into keeping INA at the forefront of the field. At a time when the laboratory needed leadership, I was offered the opportunity to step in as interim head of conservation and gratefully took on the responsibility. I was warmly welcomed as part of the family and immediately began to organize different tasks in order of urgency as well as to delegate various responsibilities as they fit into the staff’s daily schedules. In addition to managing the everyday daily operation of the lab, I made it a priority to address a backlog of objects in various stages of treatment, from numerous INA excavations and surveys.
As I had the most experience with the conservation and replication of iron objects, I turned my attention first to the large collection of metallic artifacts from the 9th-century Bozburun shipwreck. Stored for over 10 years following the completion of the excavation, these concretions represented a daunting task due to their numbers alone. Covering the original metallic surface was a dense outer shell of concretion, which develops over time as the submerged iron corrodes and reacts with the chlorides in the seawater. Due to such a long immersion, the iron disappears completely leaving a cavity in its place, while the remaining shell serves as a natural mold from which a replica can be cast. This technique, pioneered by Dr. Fred van Doornick and Michael Katzev in the replication of tools from the 7th-century Yassi Ada shipwreck, remains the standard for treating iron concretions to this day. Since the general appearance and shape of heavily concreted objects rarely offers clear indication of the artifacts within, the first step in working with them was to build on the existing relationship with the staff of the radiography department at Bodrum’s Özel Hospital who allowed us to use their high-powered digital x-ray machine at no expense to INA. After radiography, we were able to identify which of the concretions were legitimate artifacts, evidenced by the ghostly outline of the obscured objects, and which could be discarded as a deceptive conglomerate of sand and sea rock. The viable concretions held an array of the ship’s fasteners and tools which proved important to understanding how the ship was constructed as well as how it functioned.

Easily the most time-consuming project from the Bozburun assemblage was the casting and reconstruction of one of the ship’s anchors. While the casting process itself was not complicated, it required the better part of three months to reconstruct the broken pieces into the cruciform-shaped anchor which would have once been key to the functioning of the vessel. After producing an x-ray, the inner cavities were cleaned of sand and iron dust, then epoxy resin was poured inside and allowed to harden. The dense concretion encasing the anchor was then removed using pneumatic tools, which added further to the time needed to address an already large undertaking (Fig. 1). The hardened epoxy replica represents an accurate facsimile of an object that would have otherwise been lost. I also advised the staff about the casting process so that they could continue working on the numerous smaller concretions following my departure. Together, we were able to recreate over 150 iron objects from Bozburun, and dozens of others from the Kızılburun and Tektaş Burnu shipwrecks, discovering a number of hand tools and an anchor as well as creating much-needed space in the laboratory’s wet storage facility.

Occasionally, there are iron artifacts that survive in their original metallic state despite having been deposited in sea water. Following radiography, one such object was identified among the Kızılburun concretions. A solid iron double axe could clearly be seen in the x-ray, and its state of preservation...
After removing concretion from one face, the axe’s metal surface is exposed after 2000 years on the seabed (K. Rash).

FIG 3

necessitated a completely different treatment strategy (Fig. 2). Due to the presumed age of the axe, passive removal of all remaining soluble salts was deemed the safest means of conservation. It was placed in a bath of 2% sodium hydroxide, and the salt levels in the solution were measured continually. Periodically, the solution was refreshed, and over time it was possible to observe the steady decline of salts within the iron. After one year of desalination produced only minor changes in the salinity levels, I decided that the concretion was hindering progress, and carefully removed the shell from one face of the axe, leaving the other face intact (Fig. 3). The object was placed once again in solution and will continue to desalinate until it can be displayed safely.

The most pressing matters involved the continuation of treatment for organics from the different projects. Timbers and fragments from both Bozburun and Pabuç Burnu had been undergoing the lengthy polyethylene glycol (PEG) treatment process and were approaching a finish point. Over the months while the last of the PEG was being added incrementally to the tanks, it was not unusual to experience certain setbacks from equipment failure that could only be overcome by a team effort. As the standard treatment for waterlogged wood, PEG is reliable but needs constant supervision: it must be heated in order to be sufficiently liquefied to impregnate the wood, and the solution must be circulated to ensure a uniform concentration. We were constantly negotiating issues from failing heating elements and beleaguered pumps, but our largest concern occurred during the spring of 2010 when one of the treatment tanks developed a leak, and a stream of PEG poured onto the laboratory floor. Over the course of that week, everyone worked together to transfer all of the timbers and remaining solution to an empty tank, which we thankfully had in reserve (Fig. 4). Being too little now to cover the timbers in the new tank, the old solution was supplemented with another batch of PEG, which had to be heated and mixed at the same concentration as the existing solution before being added.

Used PEG was dried into manageable blocks, weighing 15 kg each, so that they might easily be reused for subsequent treatments. Molten PEG was poured into a heavy duty plastic-lined bin, and once the PEG was sufficiently dry, it was removed from the bin and wrapped and secured in plastic. Storage of the blocks in a cool dry room, will prevent them from becoming liquefied once more and will ensure they are ready for use as the time approaches for the treatment of the organic material from both the Kızılburun and Yenikapi sites, the latter of which produced copious amounts of well-preserved wooden timbers.

In addition to the larger timbers being treated with PEG, there were many more degraded small wood fragments needing attention. Experiments had been conducted with more fragile remains using sugar with successful results so it was decided to treat many of the Tektaş Burnu and degraded Bozburun wood with a sugar solution. The concentration was measured weekly to ensure that it was gradually reaching 70%, and a periodic addition of biocide was needed to discourage any detrimental biological growth within the treatment vat. This method proved to be a cheaper and much faster way to stabilize wood when compared to PEG, and it allows for a more natural color of the treated wood. Although not ideal for larger timbers, due to its inability to impregnate dense woods, the use of sugar was deemed suitable for the very sparse remains of the Tektaş Burnu ship.

Inherent to most shipwreck assemblages is a large collection of broken ceramic vessels. In 2010, the fragments from the Archaic Pabuç Burnu amphoras were steadily cleaned and numbered before being spread out over most of the area of
the lab in search of joints between the shattered pots. The team made remarkable progress in sorting the fragments into piles of recognizable fabrics and worked swiftly toward the realization of several amphoras in seemingly no time at all. The talented women employed at the BRC have the intrinsic ability to spot the metaphorical needle in the haystack, and I very much admire their skill, born from years of experience. Edith Trnka, the conservator overseeing the care of the artifacts from the Uluburun shipwreck, continues to work toward the completion of all materials from this extraordinary site. Edith spent the year attending to the desalination and stabilization of the remaining glass ingots, all in differing states of preservation, as well as finishing the restoration of the last of the wreck’s amphoras and tin ingots. This tremendous assortment of priceless objects requires constant supervision, and Edith is invaluable to the staff in ensuring that the artifacts, both on display and in storage, receive the necessary attention in order to maintain their stability for the long term.

INA research associates Berta Lledó and Tufan Turanlı have been raising material from the 19th-century Ottoman frigate Ertuğrul and were granted permission to bring a portion of the objects back from Japan to Bodrum for conservation. I had the pleasure of working closely with Berta and advising on the preservation of various objects, including copper, iron, leather and wood, which differ greatly from the other shipwreck material INA has recovered in Turkey not only in age but also in degree of preservation. Having worked with a similar object from the 19th-century Mardi Gras shipwreck assemblage at the Conservation Research Laboratory at Texas A&M, I was able to identify one mystery artifact as a coffee grinder. We also reassembled the broken segments of the grinder’s iron handle and replicated it so that a sturdy epoxy facsimile can be used for display (Fig. 5). Working together, we were able to establish a conservation plan for the objects that remain in Japan awaiting treatment.

The summer of 2010 witnessed the return to Cape Gelidonya, marking the 50th anniversary of the landmark excavation which put nautical archaeology on the map as a legitimate scientific endeavor. I was lucky enough to be included as part of the 2010 excavation team, in addition to taking on the role of project conservator. At the end of the season, the artifacts were returned to the laboratory where desalination began and in due course these objects will add to the knowledge gained from previous excavation and survey campaigns at the site. Throughout the year, in addition to managing the laboratory staff and overseeing certain conservation projects, I was called upon to direct tours of the exhibit halls within the Museum of Underwater Archaeology, where the shipwrecks excavated by INA during the last 50 years are displayed. This opportunity enabled me to share and elaborate upon INA’s work with friends of the Institute, international scholars and students of archaeology. Along with public outreach, I provided instruction and education to the many conservation interns and students who volunteered their time at the center to help our staff with ongoing projects, from ceramics to metals and organics.

Departing Bodrum in the spring of 2011 with a heavy heart, not only would I miss the extraordinary
abundance of waterlogged material to be conserved, but I would be leaving behind a new family and turning the page on the most enjoyable chapter of my life to date. The Bodrum Research Center became my home, and while the capable staff certainly has the ability and the tools to continue their work without me, I will always feel that my time there was too short. It was a rare opportunity as a student of the Nautical Archaeology Program at Texas A&M University where I studied these very shipwrecks in a classroom to become the individual responsible for the preservation of the material from them. I look forward to following the progress of the Bodrum Research Center’s future endeavors, believing strongly in the scholars, students and staff connected to it as I continue to support INA’s goals and vision.

Further Reading


Mersa/Wadi Gawasis: Port of the Pharaohs to Punt

In 2010, an INA research grant provided invaluable support for the continued excavation, documentation and preservation of the world’s oldest seagoing ship remains. INA Research Associate Cheryl Ward and Mohamed Abd el-Maguid, now Director of Antiquities for Alexandria in the Supreme Council of Antiquities, returned to Mersa/Wadi Gawasis, near Safaga, Egypt. Beginning in January 2005, excavation of the site under the direction of Kathryn Bard (Boston University) and Rodolfo Fattovich (University of Naples Insitut d’Orientale) produced complete and reworked ship timbers as well as thousands of wood fragments from the ancient disassembly of ships following substantial sea journeys.

Mersa/Wadi Gawasis is the modern name of the ancient pharaonic port of S’ww on the Red Sea, about 24 km (14 mi) south of Safaga. Ancient activities at Gawasis focused on the assembly, and later, disassembly of ‘seagoing ship kits’ by thousands of men on an intermittent basis. These seagoing ships, built in Nile dockyards of imported cedar of Lebanon, were carried in pieces across 145 km (90 mi) of the Eastern Desert to the shore of the Red Sea at S’ww.

The site is complex, with a number of living and work areas, including two ceremonial areas with shrines, a camping area for tents, food processing locations, and also a series of galleries, or long rooms cut into an ancient uplifted coral reef (Fig. 1 & 2). When the ancient Egyptians began to use the site, a brackish lagoon lined with mangroves and up to 10 m deep extended about a kilometer from the sea into this protected area. The galleries they carved out gave them dry climate-controlled spaces for work and storage of materials.
FIG 1
Panoramic view of the ancient fossil reef from the now-dry lagoon (E. Selby).

FIG 2
The galleries shown in detail here (Caves 2–5) are carved into the base of the fossil reef. Ship timbers were cleaned and then recycled throughout the site as ramps, walkways, and architectural supports (BU/UNOIO plan).
Primary use of the site and its major construction features date to the Middle Kingdom (2022–1650 B.C.E.); most artifacts belong to the Twelfth Dynasty (2022–1784 B.C.E.).

Our INA-funded project objectives were to create a plan for conserving and curating maritime artifacts from Gawasis, to continue excavation and documentation of new finds, and to review documentation for finds excavated in the two previous seasons. With the help of Chiara Zazzaro and the cooperation of the dig team, all objectives were accomplished and more. In addition to reviewing drawings, photographs, and descriptions of ship and boat components and debitage from the dismantling process, each individual component was examined again. Rainer Gerisch, project botanist, also provided significant assistance by identifying hundreds of wood samples to species level.

The major focus of our work was to plan for the stabilization and preservation of the wooden finds. The galleries provide relatively stable environments protected from light, animals, and rapid changes in temperature and humidity. We wondered if we could use them for timber storage after the floors were cleared and excavated, and as a result called in Howard Wellman, a professional conservator who worked for INA-Egypt in Alexandria as well as on the Sadana Island shipwreck excavation.

Howard visited the site and made specific suggestions for a conservation plan. These suggestions formed the core of a funded grant proposal to our long-time institutional colleagues at the American Research Center in Egypt for an Antiquities Endowment Fund conservation grant administered through USAID of c. $25,000 to establish secure storage and curation facilities within the ancient galleries at Gawasis during the 2010-2011 season. Conservation plans include creating individual micro-environments for the major timbers with impermeable “envelopes” and oxygen scavengers, testing methods for conserving brittle and fragile coils of rope covering the floor of one gallery, and achieving safer storage for all finds in an ancient work space now re-purposed for storing the archaeological remains of maritime artifacts.

Super-sized Egyptian ships
The maritime team (in this case Ward, Zazzarro, and Abdelmaguid) at Gawasis dealt with all artifacts related to ships and seafaring, and also made inroads on the documentation and analysis of some intriguing finds outside the entrance to Cave/gallery 6 and in Cave/gallery 3.

In 2005, a pair of steering oar blades were among the earliest finds. At about 2 m in length and 50 cm maximum width, the blades originally were attached to a loom by mortise-and-tenon joints. Analogies with tomb reliefs, tomb paintings, and ship models but most specifically the Deir el Bahri Punt relief of large ships suggest that the entire steering oar was about 5 m long, a length we found appropriate for the reconstruction of Min of the Desert, a 20-m-long vessel.

But outside Cave/gallery 6, a pair of blades with a similar pattern dwarfs the first set. Each is roughly double the size of the earlier finds, suggesting an overall length of at least 8 m which would be appropriate for a hull 30 m or longer (Fig. 3). Other Egyptian vessels include the rivercraft from Dashur (about 10 m long) and the buried 'ship kits' at Khufu’s pyramid, one of which has been reassembled into a 43-m-long craft. Transport of large stone monuments in the Middle Kingdom and later required large vessels, and their successful designs have features shared with the seafaring hull timbers, so 30 m is not an unreasonable length even for ships sailing nearly 4,000 years ago.

A segment of a hull plank just over a meter long and 22.5 cm (about half a cubit) (Fig. 4) thick with a maximum width of 52 cm can be reconstructed today as a knife-shaped plank similar to a complete example excavated in 2006. Its original width would have been close to 60 cm, and removal of some of the tenons still in the re-worked piece showed that they were a full cubit long (45 cm) when hammered into mortises for the first time. A number of fastenings found on the floor of Cave/gallery 3 nearby can now be explained as broken examples of these super-sized fastenings. The massive dimensions of these components reinforce what we have learned at Gawasis: the ancient Egyptians were masterful seafarers even before 2000 B.C.

Future work at Gawasis
Excavation at Gawasis is planned to continue through 2012-13 with the clearance of three additional galleries and continued conservation work.
The two blades of an immense steering oar were heavily attacked by shipworm while in use, and being used as an entry ramp for gallery six, some 3,800 years ago didn’t help their preservation. Still, the 4-m-long blades caused our jaws to drop when we realized they belonged to steering oars twice the size of those already excavated at the site.

FIG 4
Plank segment T64 is about 30% of a hull plank from an Egyptian ship that sailed the Red Sea about 3800 years ago. Standing on its edge, the outside curvature of the hull at the waterline is visible; this plank touched the keel. Team members Dr. Mohamed Abd el-Maguid, Cheryl Ward, and Chiara Zazzaro recorded this piece in January, 2010.

and curation of maritime finds. INA’s support was invaluable in documenting existing and new finds in 2009-10 and in planning the conservation grant that provided a successful route to significantly improved storage and preservation of these remains from some of the world’s oldest seagoing ships, and I am grateful for the Institute’s support.

Acknowledgments
The Supreme Council of Antiquities, project directors Kathryn Bard and Rodolfo Fattovich, and maritime team members Mohamed Abd El-Maguid, Chiara Zazzaro, and Howard Wellman are all appreciated deeply for their contributions. Funding from the Institute of Nautical Archaeology made it possible for the maritime team to be on site in 2009/10.

Further reading


Introduction
Since 2008, INA research associates Bradley Krueger and Carrie Sowden have been diving in Lake Erie to investigate the remains of Anthony Wayne, one of the earliest examples of a side-wheel steamboat on the Great Lakes (Fig. 1). Anthony Wayne was transporting passengers and cargo from Toledo to Buffalo on 28 April 1850 when it suffered a boiler explosion and sank. The site was discovered in fall 2006 by shipwreck enthusiast Tom Kowalczk and examined by the Cleveland Underwater Explorers (CLUE) the following spring. Announcement of the discovery prompted the formation of the Anthony Wayne Shipwreck Survey, a collaboration of archaeologists and volunteers from the Great Lakes Historical Society, Texas A&M University, and CLUE. The survey team conducted a site assessment in the summer of 2008 and returned for limited excavation in 2009. With fieldwork completed, the 2010 season focused on archival research in order to better understand Anthony Wayne’s operational history and place the archaeological data into a historical context.

History of Anthony Wayne
Anthony Wayne was built by Samuel Hubbell in Perrysburg, Ohio, in 1837 for the Perrysburgh & Miami Steamship Company. Helmed by veteran lake captain Amos Pratt, Anthony Wayne measured 47.7 m (156 ft 6 in) in length, 7.9 m (25 ft 9 in) in beam, 3.3 m (10 ft 10 in) in depth at the hold, and was registered with a 354-t capacity. Designed to carry passengers along the southern Lake Erie shore, the steamer could accommodate several hundred travelers and was outfitted with 20 lavish staterooms, gentlemen’s and ladies’ cabins on the boiler deck, and steerage quarters. In addition to passengers, Anthony Wayne was capable of carrying approximately 1,500 barrels of freight below decks.
After ten years of service on the Lakes, time had taken its toll on *Anthony Wayne* and the dilapidated steamer was sold to Charles D. Howard of Detroit. Howard and his business partner, Captain E. C. Gore, refurbished the vessel in 1848 making improvements to the hull, rebuilding the upper decks, and adding a new propulsion system. Four new boilers were installed along with the horizontal, high pressure engine recovered from the steamboat *Columbus*, which had been wrecked earlier that season. Under the command of Gore, *Anthony Wayne* made its return in the spring of 1849 and serviced the Toledo-Buffalo shipping line for the remainder of its career.

While making its way to Buffalo, disaster befell the steamer just after 12:30 am on 28 April 1850 when the vessel's two starboard boilers suddenly exploded. The blast destroyed the engine room and caused irreparable damage to both the hull and superstructure, causing *Anthony Wayne* to sink to the bottom of Lake Erie within 15 to 20 minutes. During the sinking, the upper cabins tore free of the hull and survivors used this piece of wreckage as a life raft. Despite efforts by Captain Gore and his officers to coordinate lifesaving of those on board, 38 people lost their lives or were reported missing as a result of the disaster.

**Previous Investigations**

Two Ohio residents, shipwreck hunters Kellogg Roloaf and Matthew Vance, claimed to have found the wreckage of *Anthony Wayne* with side-scan sonar in 1988. The pair described the site as "pretty broken up... the sidewheels are above the mudline. So is the bow. Everything else is anywhere from the mudline to 10 ft below the mud." Driven by the belief that the steamer carried over $100,000 in gold and silver coins at the time it sank, the two petitioned the State of Ohio for a permit to salvage the wreck. Their request was denied in 1992 after state legislation was approved to protect historically significant shipwrecks from salvage and looting. Disappointed over the ruling, the two refused to release the coordinates for the wreck and the location of the site remained a mystery.

*Anthony Wayne* was rediscovered in September 2006 by Tom Kowalczk just over 11 km (approximately seven miles) north of Vermilion, Ohio. The shipwreck, which lies in 13.7 m (45 ft) of water, was visited by CLUE divers the following spring and proved to be an old steamboat broken into two parts: the midship section, complete with two large standing paddlewheels; and the bow section. Given the location of the wreck, propulsion features, and preliminary dimensions, Kowalczk and CLUE concluded that they had indeed found *Anthony Wayne*.

**Site Description**

The wreck of *Anthony Wayne* lies upright on the relatively flat lake bottom and is situated in two areas, with the bow lying approximately 22.9 m (75 ft) to the southeast of the midships section (Fig. 2). The sections of wreckage are nearly aligned with one another, with the bow section slightly skewed to starboard. Both bow and midships are mostly buried in gelatinous sediment with no architectural elements or debris field visible between the two areas of wreckage.

The midship portion of the wreck is the larger and more complete of the two sections. Each of the
steamer’s two large paddlewheels, located on either side of the vessel, measures 7.9 m (26 ft) in diameter. With the bottom portion of the wreck entombed in mud, only the upper halves of the paddlewheels are exposed. The majority of the buckets (i.e. paddles) are either broken or missing, while most of the arms, originally totaling 60 on each wheel, are still in place. The buckets that do remain are attached to the arms with both iron through-bolts and U-bolts.

Certain elements of Anthony Wayne’s hull can be seen above the lake bottom. Five frames on the port side and four to starboard protrude from the murky bottom and rise from the outboard side of the vessel’s wooden hogging truss. The diagonal truss timbers, which longitudinally strengthened the sides of the hull, run forward on either side of the vessel before disappearing beneath the mud. Only on the port side are there visible remains of exterior planking attached to the frames. The planks measure 2.5 cm (1 in) in thickness and are secured to the frames with iron nails.

The paddlewheels are connected together by two robust iron drive shafts. Connected to the port and starboard shafts are two iron cranks fastened to the vessel’s pitman arm. Also present on the starboard driveshaft are twocams and their respective frames. Two cam-rods are connected to each cam and run forward into the mud, parallel to the pitman arm. On the port side of the vessel, immediately forward of the driveshaft, is a freestanding feed-water pump secured to a tall vertical timber. There are connections situated on the base of the pump intake, but none of the associated pipes survive. Forward of the pump is the feed-water cylinder that stands alone near where the pitman arm disappears into the mud.

The bow remnants of Anthony Wayne are scant, only 3 m (10 ft) in length, but exhibit interesting features. The exposed wreckage is triangular in shape and mainly consists of the cap-rail, spindles, and rail-shoe. While the upper rail is detached from the lower base, some of the spindles remain suspended from the cap-rail. The cap is fitted with a rectangular notch and an iron eyebolt on each side to allow a cable or line to pass through; a third iron eyebolt is found on the cap’s breast-hook. Protruding from the front of the bow are two sturdy catheads that were used to raise and lower the steamer’s anchors, each having a tackle situated on the outer side. Abaft the apex of the rail are two tall riding bits that are attached to a beam running athwartships; these are the structural supports for the vessel’s cathead timbers and would have been used in towing or heavy lifting operations. Finally, beneath the catheads and off to the sides, two large wooden anchor stocks with an iron band barely protrude from the soft mud.

A high degree of biofouling is evident on the site, with zebra and quagga mussels attached to several areas of the wreck. These mussel clusters are so thick in some areas that they obscure all surface detail, such as the basin of the feed-water pump and the rivets atop the pitman arm. A thick layer of abandoned mussel shells can be found around the midship section, indicating that Anthony Wayne has been a victim of these invasive species for several years.

Also present on site is a very long PVC pipe that is clearly intrusive. The pipe, which is approximately 7.6 cm (3 in) in diameter, crosses the port hogging truss forward of the hogging post. Estimated at 12.2 m (40 ft) in length, most of the pipe is buried, with the inboard end terminating just forward of the feed-water heater.

2008 Field Season
The 2008 field season lasted four weeks between 9 June and 9 July. The Great Lakes Historical Society, located on the shores of Lake Erie in Vermilion, served as base of operations for the duration of the project. The objectives for the 2008 season consisted of three primary goals after the completion of an initial site assessment: 1) map the entire site including main wreckage components and associate debris; 2) obtain detailed measurements and sketches of architectural and mechanical features of the wreck; and 3) conduct systematic probing between the midship and bow sections in order to see how much, if any, of the steamer’s hull was buried beneath the lake bottom.

The majority of the field season was spent on the first two objectives, site mapping and construction/machinery details. Given the upright nature of the wreck, mapping was accomplished using trilateration from a baseline located along the center of the vessel. One team focused on this task, while another team sketched and measured construction features of the paddlewheels, hogging trusses, drive shafts, cranks, pitman arm, machinery, and the bow section. To supplement these data, underwater video and photographs were also taken, but the limited visibility on site, which averaged between 0.3 to 1.5 m (1 to 5 ft), significantly restricted their use.

The last objective called for systematic probing to be carried
out between the two sections of wreckage, where no visible remains are present, in order to ascertain the extent of potentially buried hull structure. Four lines were established between the bow and midships, two on the port side and two on starboard. The lines nearest the edges were fixed to the hogging posts and ran to the extreme ends of the bow railing on either side, while the inboard lines attached between the middle of the drive shafts and the middle of the bow railing. Tests were conducted along each line, including the baseline, in intervals of 1.5 m (5 ft). A 3-m (10-ft) section of 0.64-cm (quarter-inch) copper pipe was used to conduct 78 probe tests over the course of three full dives. Of these, 48 tests yielded positive hits, while the remaining 30 encountered no sub-surface material. Positive tests ranged from depths between 0.9 m and 3 m (3 ft and 10 ft) beneath the lake bottom. On average, the more shallow positive hits occurred closer to midships, whereas the deeper hits were located in the intermediate zone between the two sections of wreckage.

Analysis of the exposed portions of the vessel’s drive system dates the vessel to the pre-1850s. The presence of a single pitman arm suggests that the steamer had only one horizontally mounted engine, the same type reportedly installed during Anthony Wayne’s 1848 rebuild. The probe data confirmed that a significant amount of material existed buried on site, but the state of these components remained a mystery.

2009 Field Season

The Anthony Wayne Shipwreck Survey resumed field investigations in the summer of 2009 and ran for approximately six weeks, running from 1 July to 18 August. The objectives of the 2009 season were strongly influenced by the results of the probe testing conducted the previous year and focused on (1) investigating the buried elements of the wreck, which included uncovering elements of the vessel’s port-side hull, (2) locating the horizontal steam engine, and (3) investigating the stern section of the site, where no visible remains are present. To meet the first two objectives, concentrated excavation was required at two locations of the midships section, while the third objective was to be carried out with remote sensing equipment.

The first objective of the season was to open an exploratory test unit on the port side of the wreck, just forward of the hogging post (Fig. 3). The goal was to follow the hogging truss timber forward into the mud and move inboard toward the centerline of the vessel in order to locate any elements of the hull (i.e. frames, planking, etc.). This would allow archaeologists to record the shape of the hull at this location, observe construction details, and assess the overall degree of preservation of buried components. Two weeks were spent conducting systematic excavations in this area. The only structural element encountered was the hogging truss timber and no other hull remains were discovered. The truss timber crossed the test unit longitudinally and continued downward into the mud through the forward wall. Prolonged burial has significantly aided the preservation of the wood, as it was still incredibly sturdy and exhibited no signs of flaking or severe degradation. No fasteners were discovered nor were any fastener holes observed. To ensure the continued preservation of the uncovered timber, the test unit was back-filled prior to the end of the field season.

The second objective of the season involved opening a second test unit for the purposes of locating and documenting Anthony Wayne’s steam engine. The steamer was deemed a total loss following its 1850 boiler explosion and no reports were found to indicate the engine was salvaged, suggesting that it should still be on site. Uncovering the engine would allow us to study its assembly and preservation, and record all details and features.

Three weeks were spent excavating this test unit with an induction dredge system. Sediment removal commenced around the visible portion of the pitman arm and proceeded forward and down until met with other components. Excavation in this area resulted in the uncovering of Anthony Wayne’s intact horizontal steam engine. Working down the pitman arm’s forward end quickly exposed the crosshead linkage, attached to the engine’s piston. The piston ran forward and ended at the engine’s cylinder, atop of which sat four large steam valve levers. The entire upper half of the engine was uncovered from the piston to its forward end. In terms of preservation, the engine’s iron pieces exhibited light surface corrosion and some pitting, while brass components appeared like new. The crew spent several dives documenting the engine assembly, which included recording measurements, completing sketching, and taking photographs of all exposed elements. Once documentation ended, the test unit was thoroughly back-filled.

Anthony Wayne’s engine is a remarkable and rare find, as it is one
of the earliest marine engines to be discovered on the Great Lakes. Operationally, the arrangement works as follows. Four steam valves are situated atop the engine and are opened and closed by four corresponding levers. The levers are lifted by two crescent-shaped lifting arms, known as wipers, which oscillate back and forth, allowing steam to enter one end of the cylinder while being expelled out the other. The wipers were attached to a semi-rotating shaft which is manipulated by two cam-rods. As the cams rotate on the drive shaft, the surrounding cam frame moves back and forth, thus moving the cam-rods in a similar fashion. The amount of steam entering the engine from the boilers is controlled by the throttle, in this case a 35-cm (12-in) long ‘S’-shaped crank just starboard of the cylinder. Located on the aft-face of the cylinder, the engine’s oiler consists of a small globe with attached funnel and lever, and was used to lubricate the piston and cylinder head, allowing the system to run smoothly. These components comprised the vast majority of material encountered in Test Unit #2. Other finds included three iron nails, two pieces of wood, and a small shard of blue glass.

With the engine thoroughly documented, the last phase of the 2009 season included a short remote sensing survey of the wreck’s stern section. With no visible remains aft of the paddlewheels, it was decided to explore this area to see how much, if any, archaeological material had survived. The team had temporary access to an Imagenex DF 1030 sub-bottom profiler, a device that emits high-frequency sound waves into the lake’s uppermost layers in order to glimpse buried material. To ensure the sub-bottom profiler maintained...
a level position in the water column, the device was attached to a wooden sled and towed transversely across the stern section of the wreck. Each transect was spaced approximately 7.6 m (25 ft) apart starting at the wreck and working away from it in a northwesterly direction. The collected data confirmed that hull material is buried in this area as much as 15.2 m (50 ft) abaft the paddlewheels. The remains in this area, which measure approximately 7.6 m (25 ft) transversely across the wreck, are buried under 1.1 m (3.5 ft) of sediment.

2010 Research Season

Since very little is known of Anthony Wayne aside from its violent sinking, it was necessary to consult historical documents to learn details of the steamer’s construction and operational history. Utilizing the library facilities at Texas A&M to access 13 years of historical newspapers from all over the Great Lakes region, Krueger sought out newspapers from some of the major cities that Anthony Wayne visited, including Buffalo, Cleveland, Sandusky, Toledo, Monroe, Detroit, and Milwaukee (Fig. 4). Microfilmed copies of these periodicals were sent to College Station through Texas A&M’s inter-library loan system. For a period of four months, Krueger spent hundreds of hours carefully examining each roll of microfilm. When information on the steamer was encountered, a high-resolution PDF was made of each article and then cataloged by date.

The results of this endeavor proved very successful. In total, over 130 scans were made of articles specifically referencing Anthony Wayne. Information fell into three distinct categories: 1) building and launch; 2) career and advertising; and 3) the sinking. Additionally, details about other steamboats operating alongside Anthony Wayne were also collected, in addition to information pertaining to the transportation industry of the Great Lakes. The total number of PDFs created during this research season exceeded well over 700 separate files, information that is vital to the forthcoming comparative analyses between Anthony Wayne and other steamboats of the mid-19th century.

First, information was found with regard to the building and launching of Anthony Wayne. Certain details, such as basic vessel dimensions and the original name of the vessel (Representative) were discovered during the earlier field seasons. One of the most significant finds of this year, however, was a short article published in the Milwaukee Sentinel newspaper that bulleted several facts about the steamer. The article indicated that the entire cost of the steamer was $70,000, and of that $18,000 was used to purchase the original steam engine. The same article also listed scantlings related to the engine, such as its total weight of 127 t, and the space required on deck and in the hold (15.2 m and 4.9 m respectively). The details featured in this article aided greatly to understanding the economy of steamboat construction and outfitting, as well as the onboard spatial requirements needed for early steam machinery.

Most of the material encountered centered on the operational history of Anthony Wayne. Arrival and departure information posted in newspapers all around the Great Lakes traced the shipping routes serviced by the steamer (Fig. 5). While the Toledo-Buffalo line was
its most frequent route, research showed that Anthony Wayne spent several seasons on Lake Michigan transporting people and goods from Buffalo to the far ports of Milwaukee and Chicago. Over the course of the steamer’s 13-year career, advertisements described the vessel as “fast,” “splendid” and “a first-class boat” (Fig. 6). One interesting fact was that the ship participated in a steamboat monopoly for the first seven years of its career. This monopoly, known as the Steamboat Combination, was a collection of steamboat owners that sought to maximize profits by fixing passenger and cargo rates, and controlling the number of steamers operating in any given season. The monopoly was very unpopular with the public, however, and ceased to exist by the late 1840s.

The third category of information involved details from the sinking of Anthony Wayne. Personal accounts from both passengers and crew told the story of the steamer’s untimely demise and efforts by survivors to stay alive in the moments following the catastrophe. Through their testimony we learn of the damage sustained by the vessel in the explosion, including the destruction of the main cabin, the bar, and the forward deck. Once it became evident that the vessel was in peril, individuals threw doors, mattresses, and even a coffin into the water to serve as flotation devices. During the sinking, the ship was dismasted and the upper cabins were ripped away from the hull, explaining their absence from the wreck site. Information in this category was especially valuable as it not only allowed for the re-creation of events on that fateful night, but significantly aided in the interpretation of Anthony Wayne's archaeological remains.

With the archival research concluded, additional investigation consisted of amassing information on early North American steam engines, boilers, and drive systems, and examining why these machines occasionally failed. In the case of Anthony Wayne, no official determination was made for why its boilers exploded, and although these elements were not discovered on the wreck site, understanding this phenomenon is significant for the study and interpretation of the remaining archaeological material. It was learned that the most commonly-cited reasons for boiler explosions included insufficient water levels, poor construction or materials, and the engineer’s inexperience or ignorance of the engine. Unfortunately, excavations did not uncover the boilers or their connecting pipes, thereby preventing a more detailed analysis.

**2010 Public Outreach**

A significant component of the Anthony Wayne Shipwreck Survey has been public outreach and education, a priority of the Great Lakes Historical Society, Texas A&M, and INA. In 2010, Krueger presented an interim report on the Survey’s progress at the annual conferences of the Society for Historical Archaeology and the Society for American Archaeology. Sowden gave a presentation on Anthony Wayne to the Cleveland West Shore Delta Gamma Alumnae Group in early May, and featured the site in several of her educational talks on Lake Erie shipwrecks (Fig. 7). Finally, Krueger produced two articles that outlined the project and discussed finds from the two field seasons.4

**Analysis**

While many aspects of Anthony Wayne are compelling, the drive system is by far its most notable feature. What is particularly interesting is that its arrangement is standard for an early 19th-century western river steamboat. Steamers that navigated the waters of the Mississippi, Ohio, and Missouri rivers were lightly built and shallow drafted to better avoid sand bars, snags, and fluctuating water levels. To this end, horizontal engines were typically utilized, as they were light weight, compact, and simple in design. This design, which became typical starting in the late 1830s, was considered to be very efficient and underwent very little change until after the Civil War.

On the Great Lakes, however, vertical walking beam engines were more prominent in similarly styled steamers. These larger, heavier engines were thought to better stabilize the deeper drafted vessels, and their low-pressure cylinders were considered to be significantly safer than the high-pressure varieties found in horizontal engines. As widespread as vertical engines were on the Lakes, there were advantages to employing a horizontal engine. Vertical engines extended up through the hurricane deck, where cabins were often located, whereas horizontal engines were completely housed upon the main deck, allowing for more passenger accommodations on the upper decks. Secondly, horizontal engines were lighter and took up less space than their vertical counterparts, meaning steamers could carry greater amounts of cargo and thereby increase profits. The regional popularity or prevalence of horizontal and vertical engines would constitute an interesting case study for future research.
Regarding *Anthony Wayne*, the fact that its engine is representative of a style from the late 1830s corresponds to the historical record. The steamer received this engine from an earlier vessel, the steamboat *Columbus*, during the 1848 refurbishment. *Columbus* was built in 1835 at Huron, Ohio, and while the particulars of its drive system are not known, it was widely reported that its engine was recovered and placed into *Anthony Wayne* following its foundering in the spring of 1848. The engine uncovered during the 2009 field season of the *Anthony Wayne* Shipwreck Survey is believed to be the one originally placed in *Columbus* and predates the construction of *Anthony Wayne* by two years. Study of this unique maritime relic is incredibly important in that engines are usually salvaged following sinking events, leaving archaeologists to rely primarily on historical data for their understanding of early steam engines. The excavation of *Anthony Wayne*’s engine, from the four complete steam levers to the intact globe-shaped oiler, provided a rare opportunity to observe the physical characteristic of a maritime engine in a remarkable state of preservation, the style of which and the arrangement of the drive system, closely resembles historical descriptions and images of similarly typed vessels. To date, *Anthony Wayne*’s engine is believed to be one of the oldest remaining steam engines on all the Great Lakes.

**Conclusions**

Following the 2010 research season, the *Anthony Wayne* Shipwreck Survey officially drew to a close. The last remaining aspect to be completed is the final report of
archaeological and historical findings, the culmination of which will be Krueger’s M.A. thesis in the Nautical Archaeology Program at Texas A&M. This project was significant on many fronts, from understanding early steamboat architecture and machinery to learning the details of a prominent 19th-century shipping industry. Both Krueger and Sowden will continue educating the public about Anthony Wayne, Great Lakes maritime history, and the importance of submerged cultural heritage.

Acknowledgments
This project would not have been possible without the generous support of the Great Lakes Historical Society, the Peachman Lake Erie Shipwreck Research Center, the Cleveland Underwater Explorers, the Institute of Nautical Archaeology, the Ohio Council of Skin & Scuba Divers, and the Center for Maritime Archaeology & Conservation at Texas A&M University. Additional thanks should be paid to Carrie Sowden, Chris Gillcrist, Tom Kowalczk, Kevin Crisman, Jim Delgado, and several enthusiastic volunteers who helped make the last three years such a success.

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Notes
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INA in Sri Lanka
Pearl of the Indian Ocean

Two years ago, I was seated in an internet café near Çeşme, Turkey with my good friend and INA colleague Sheila Matthews, conducting triage on dozens of e-mail messages that had accumulated since our last day off from the Kızılburun shipwreck excavation one week before. The Friday day off was designed to provide our tired bodies with a break from the intense and potentially dangerous absorption of nitrogen that comes with decompression diving twice per day. But shopping for groceries, camp and excavation supplies, and fuel for the outboard motors in less than eight hours leaves precious little time to actually relax, so 45 minutes in an air-conditioned internet café takes on the significance of a spa treatment.

One of the e-mail messages I read that day was from Dr. Sanjyot Mehendale, an archaeologist at the University of California at Berkeley who conducts research on the Silk Road and Buddhism in places like Afghanistan, Uzbekistan, and Sri Lanka. Dr. Mehendale told me that her collaborators in the Department of Archaeology had found what appeared to be an ancient shipwreck off the southern coast of Sri Lanka at Godavaya (Fig. 1). Intrigued, I read the message aloud to Sheila—who has traveled extensively in India and South Asia—and watched as her eyes filled with curiosity at the mention of glass ingots and ceramic pots that had been dated tentatively to the third or second century B.C.E, a date that would make any clearly-associated ship the oldest ever found in the Indian Ocean. Dr. Mehendale’s introductory e-mail went on to explain that, in discussions between her and her colleagues about choosing an institutional partner for their project, “Texas A&M’s Nautical Archaeology Program and Institute of Nautical Archaeology were the first that came to mind.”

Anxious to learn more about the archaeological and logistical details of the shipwreck, I invited Dr. Mehendale and her senior colleague, Dr. Osmund
Bopearachchi, to visit College Station and tour the INA/NAP facilities. Dr. Bopearachchi is a numismatist specializing in the ancient coinage of India and Bactria (modern Afghanistan, Uzbekistan and Tajikistan); he is a dual citizen of Sri Lanka and France and a Director of Research at the Centre National de la Recherche Scientifique (CNRS) in Paris. Since Dr. Bopearachchi was serving as a visiting professor in the Department of Religious Studies at Yale University during the spring 2010 semester, he and Mehendale visited Texas A&M University in March; during their short stay he also generously agreed to give a public lecture on maritime trade in the Indian Ocean.

At our March meeting I learned that the Godavaya wreck had been discovered in 2003, when a local fisherman found a small stone quern or bench and showed it to officials from the Department of Archaeology. Similar stone objects are known from ancient Buddhist temples on the island, and the inscriptions carved on them can be dated paleographically to the third or second century B.C.E. (Fig. 2). In 2008, divers from the Department of Archaeology and the Maritime Archaeology Unit (MAU) of the Central Cultural Fund (CCF) conducted a brief exploration of the site, taking preliminary measurements, capturing some video footage of the area and raising artifacts that included ceramic bowls and a hemispherical blue glass ingot (Fig. 3). The CCF was established in 1980 with input from UNESCO for the purpose of restoring and preserving religious and cultural monuments on Sri Lanka.

The three of us also discussed some of the practical, logistical, and safety challenges of working under water in Sri Lanka, including the absence of a recompression chamber anywhere on the island, and the need for reliable dive gear, compressors, and excavation equipment. The construction of a massive port in nearby Hambantota lends some urgency to the excavation, with reports of large boulders appearing suddenly on top of and around the wrecksite. And of course we spent many hours brainstorming about where we could get the necessary funding to make a thorough archaeological exploration of the Godavaya underwater site.

In the fall we submitted research funding applications to the National Oceanic and Atmospheric Administration (NOAA) and the National Endowment for the Humanities (NEH), then planned a winter dive trip to tropical Sri Lanka—known as Taprobane to the ancient Greeks and Romans, Serendib to the Arabs (the source of ‘serendipity’), and Ceylon to the British (and the rest of the world), until 1972.

Knowing not only that Sheila Matthews has seen and excavated more shipwrecks than I have but also that she has a genuine fondness for the climate, culture, and cuisine of Southeast Asia, it seemed only sensible to invite her to be a part of my first visit to Sri Lanka. In the end, our busy schedules afforded us only one week to make

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**FIG 2**
An inscribed stone quern or bench in the museum at Tissamaharama (R. Muthucumarana and courtesy of the Director General of the Department of Archaeology, Sri Lanka).

**FIG 3**
A hemispherical glass ingot from the Godavaya shipwreck and now in the Maritime Archaeology Museum in Galle (Director General of the Department of Archaeology, Sri Lanka).
the trip, returning on Christmas Eve! Convening in Houston on 16 December, Sheila and I spent many of our in-flight hours discussing how best to utilize our limited time on the island and on the wreck. We arrived in Colombo on 18 December and overnighted in nearby Negombo, where we met Dr. Mehendale. Departing the next day, we collected Dr. Bopearachchi at the start of our eight-hour drive southward to Hambantota, the largest city near the small fishing village of Godavaya.

The route from Colombo to Hambantota is a coastal one, with lush tropical forests spilling right down onto the beach. Our hosts Bopearachchi and Mehendale spent hours answering our endless questions about the Sinhalese way of life, and never missed an opportunity for us to experience it first-hand, with impromptu roadside stops for a refreshing drink of coconut milk served out of the husk and prepared by a tiny machete-wielding woman (Fig. 4). In Ambalangoda we saw (and purchased!) some of the brightly-painted and captivating wooden masks hand carved from the Strychnine tree (*Nux vomica*) which are a conspicuous feature of Sinhalese festivals and ceremonial dances. In Matara we saw the stilt fishermen atop their precarious perches hoping to catch mackerel and other small fish in the shallow reefs below. Amidst all this natural beauty were poignant reminders of the overwhelming destruction and loss of life that occurred six years earlier when a devastating tsunami struck this island (and many others) the day after Christmas.

About halfway between Colombo and Hambantota is Galle (Fig. 5), a charming and scenic town originally settled by the Portuguese but resettled in the 17th century by the Dutch, who built an enormous fort that still carries the emblem of the Dutch East India Trading Company (VOC). Within the walls of the 130-acre fort are numerous historic buildings, homes, temples, shops, a resort hotel, and the Maritime Archaeology Museum (Fig. 6), in a setting that is pleasantly reminiscent of the Museum of Underwater Archaeology in Bodrum, Turkey. The Galle maritime museum was established in the late 1990s following an intensive multi-year survey of Galle harbor co-directed by long-time INA Research Associate Jeremy Green of the Western Australia Maritime Museum.1 This survey succeeded in locating the wrecks of VOC ships *Avondster* (1659) and *Hercules* (1661), multiple 19th-century iron steamship wrecks, and numerous Arab-Indian stone anchors.2

Our stop in Galle gave us the opportunity to experience the museum and its attractive setting, tour the modest conservation facilities, and examine some of the artifacts raised from the Godavaya shipwreck which are among the objects on display. We also had the pleasure of meeting Mr. Sanath Karunarathne of the Department of Archaeology and Mr. Rasika Muthucumarana of the Maritime Archaeology Unit, both of whom were closely involved in the earliest
investigations of the site and would be our dive buddies in the coming days. Circumstances dictated that our visit to Galle was regrettably short, but we scheduled a group meeting in Hambantota for the next morning, which brought us one step closer to diving on the shipwreck we had come a great distance to see.

Our first meeting with the local archaeologists and divers who knew the Godavaya wreck (and even the fisherman responsible for finding it!) was incredibly educational, for it was from them that we learned the logistical specifics and gained a real sense of what would be required to launch a project involving multiple divers conducting repetitive dives over many weeks (Fig. 7). We learned, for example, that the depth of the wreck is approximately 33 m (110 ft), that it is some 30 minutes by boat from the tiny fishing village of Godavaya, and that the wind and current become so strong in the afternoon that they customarily dive only in the morning; for our shortened schedule this meant that we would have only two opportunities to dive on the wreck, so Sheila and I charged our batteries, prepped our cameras, and sharpened our pencils!

In the next 48 hours we safely completed two dives on the Godavaya shipwreck, and despite snapping copious digital photographs which we later consulted and contemplated, our time was too short and the site too complex to allow us to draw informed conclusions about the date or nature of the wreck. Visibility on the wreck was about 9 m (30 ft) and the seabed was fairly flat except for a blanket of marine debris caused in large part by the 2004 tsunami. The site as it has been defined by local archaeologists (who have dived on it the most) is situated between several large rocky areas; its most conspicuous feature is a central mound that is presumed to be the shipwreck (Fig. 8). Sheila and I observed what appeared to be numerous flat, thin pieces of metal interspersed with sections of wood which lacked any discernible features that would permit their identification as hull timbers. Nearby we saw additional examples of the glass ingots, stone benches and ceramic bowls already raised from the site, scattered on the seabed between the central mound and an outcrop of rocks to the south. While collecting wood samples on our second dive, Sheila
located what appeared to be a heavily-concreted section of chain at the edge of the central mound.

It is difficult to be certain about the relationship of the material we examined on the seabed, but it seems probable that either we are dealing with two separate shipwreck events (one ancient and one historic) or we may be looking at a colonial ship that was transporting ancient objects — either of which is still interesting from the point of view of maritime commerce.

What our new friends failed to describe in sufficient detail was the thrill that awaited us each day as we returned to the tiny fishing village at Godavaya, where the huts come right down onto the beach, which is covered with small open fishing boats each about 5 m long.

As we returned to the beach, we had to describe in sufficient detail what we saw in the tiny fishing village at Godavaya, where the huts come right down onto the beach, which is covered with small open fishing boats each about 5 m long.

Scott Art

As if sensing our unfamiliarity with the landscape, history, and archaeology of Sri Lanka, our hosts made every effort to ensure that we saw as many meaningful places as possible in the little time left to us. In the small museum opposite the incredible restored Buddhist stupa at Tissamaharama, which was the ancient capital of the Kalinga Kingdom in the third century B.C.E., we saw some of the comparable inscribed stone benches which are associated with the Buddhist monastery, though their precise function remains unknown.

FIG. 8
A preliminary site plan of the Godavaya wrecksite (R. Muthucumarana and courtesy of the Maritime Archaeology Unit [MAU]).
remains of a quarry, temple, and monastery dating from the second century C.E.3 Smaller diagnostic finds such as imported Persian and Chinese pottery, Roman coins, beads, bangles and stamped bricks attest to the scope and vitality of Godavaya’s commercial network.

Underwater exploration during the 1990s focused on the remains of the ancient harbor, which include a jetty of stone pillars and a large medieval stone anchor found nearby.

These preliminary finds suggest that Godavaya served as an important transshipment point for eastern goods destined for western markets, such as Chinese silk and pottery. In addition, the evidence provides valuable insight into long-distance trade in antiquity and the “international” contacts between Mediterranean and south Asian traders. As far as the links between East and West are concerned, the organization of trade is well documented from the conquest of Egypt by the Roman emperor Augustus in 30 B.C.E. onwards. Political control of Egypt gave rise to a very profitable use of the Red Sea to sail to India to procure raw materials, spices and fashionable luxury goods. To make use of the system of monsoons, the ships that sailed to India would have left Egypt in July, utilizing the south-west monsoons, to reach the gulf of Aden and proceed eastward to the western Indian ports of Barygaza and/or Muziris (in Kerala). All the seaports connected to this trading network are noted in an exceptionally important document known as the Periplus of the Erythraean Sea, probably written ca. 70 C.E., a manual for merchants who traded with the East.4 The Roman author Pliny, who perished in the eruption of Mt. Vesuvius in 79 C.E., reckoned that India absorbed at least 50 million sesterces in trade with Rome.5 The ancient geographer Strabo alludes to the early use of the monsoon winds by westerners after an Indian sailor, shipwrecked in 116 B.C.E. off the coast of Egypt, is said to have revealed the secret use of the monsoon in exchange for his return back home.6 Thus, while the majority of the textual and archaeological evidence for maritime trade between East and West dates from the beginning of the Roman Empire, links between the two regions must have existed centuries earlier.7 The Godavaya shipwreck excavation promises to yield the kind of direct archaeological evidence that can enhance significantly our understanding of Sri Lanka’s role in the ancient maritime trade of the Indian Ocean.

On 23 December we left Hambantota reluctantly for the long drive back to Colombo to catch our midnight flight to the United States. Returning via a different, interior route afforded us additional opportunities to experience this rich and fascinating island. In Udawalawe we paid a visit (and an enthusiastic donation) to the superb elephant transit home, where as many as 30 orphaned juvenile elephants are being prepared for reintroduction into the wild (of a nearby national park). We stopped for lunch in rainy Ratnapura, which lies at the foot of Adam’s Peak and is famous for the rubies and sapphires that are mined there, but we were most impressed by the numerous rice paddies and large, lush plantations dedicated to tea, rubber, mango and papaya. As we neared the commercial capital of Colombo, the traffic became horrendously bad. Though not obvious to us at first, the heavy traffic was the result of
the same Christmas holiday bustle that was occurring all over the world, which served as a poignant reminder that Sri Lanka is home not only to Buddhists and Hindus, but also Muslims and Christians—a reflection of the many cultures that have stopped on this unique island over the centuries and found it difficult or impossible to leave! And like those before us, INA archaeologists will be spending Christmas in Sri Lanka for some years to come, for armed with the financial support of a Collaborative Research Grant from NEH, we intend to return in 2012 to begin unraveling the history of the Godavaya shipwreck.

Acknowledgments
This preliminary research project would not have been possible without the initiative and enthusiasm of Drs. Sanjyot Mehendale and Osmund Bopearachchi, or the financial support of the Institute of Nautical Archaeology and the Sara W. & George O. Yamini Professorship in Nautical Archaeology at Texas A&M University. Our thanks to Dr. Senerath Dissanayaka, Director General of Antiquities for permission to examine the wrecksite, and to our colleagues in the Department of Archaeology and Maritime Archaeology Unit for their warm hospitality: Sanath Karunarathne, Rasika Muthucumarana, A.M.A Dayananda, and K.D. Palitha Weerasinghe. Jeremy Green and Oliver Kessler were readily available to answer questions and provide background information which proved extremely useful, and Sheila Matthews was characteristically delightful and capable as a travel companion and dive buddy.

References and Further Reading


Notes
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Surrounded by total darkness, at approximately 130 m, the Baltic Sea hides an intriguing secret, one that archaeologists and oceanographers have been working hard to reveal over the last few years. The almost completely intact Ghost Wreck rests proudly upright on a cold and barren sea floor (Fig. 1&2). Amazingly, after almost four centuries her bow sprit still projects...
out from a complete hull, deck planking is continuous, anchors still hang from the rails, and two of the masts continue to reach toward the heavens. This excellent preservation is due to the environmental conditions found in the Baltic Sea. The lack of organisms like *Teredo navalis* and frigid water arguably make the Baltic Sea the best location in the world for the survival and recovery of wooden ships. Cold temperatures, low salinity, and nominal oxygen concentrations prevent wood boring organisms, the leading cause of damage or decay of wooden ships in a salt water environment, from attacking the ship. This almost lifeless environment is an effective means of protecting and preserving archaeological mysteries like the Ghost Wreck. Ideal preservation conditions mean many other wrecks are also lying below almost as they sailed these dark waters centuries ago. The preservation potential of the Baltic in combination with its extensive use as a transportation corridor increases the likelihood of finding important wrecks in the area.

**Discovery**

The Ghost Wreck was first discovered in 2003. A joint expedition between Deep Sea Productions and MMT (Marin Mätteknik) located an exceptionally well preserved shipwreck, about 30 nautical miles east of the island of Gotska Sandön while searching for a downed DC-3 Swedish reconnaissance plane. The plane had been shot down in 1952 by the Soviet Union and had been unaccounted for ever since.

The wreck was discovered using basic 500 kHz side-scan sonar. The processed sonar images showed a snub-nosed wooden wreck with two standing masts, a prominently pointing bowsprit, and an unusually high stern section. Surveyors knew right away that they had something special. Design features of the wreck suggested it was quite old and of a type and size that possibly made it one of the most important vessels of 16th- and 17th-century Europe.

Dr. Johan Rönnby (Södertörn University) and Dr. John Adams (University of Southampton) would later be the first to call it a fluyt. In an effort to retrieve as much data as possible from the wreck, 

**Importance of the Fluyt**

In the same way *Vasa* is and was a remarkable example of a 17th-century Dutch designed warship, the Ghost would have been completely unremarkable during its day. The type and design was so numerous and abundant it filled the ports and sea lanes of the Baltic and beyond. The Fluyt was the semi-truck of the sea. It existed as a reliable, cheap, and profitable means to transport cargo. What makes it remarkable was how successful and innovative the design was.

—Dr. Fred Hocker  
INA Research Associate

*Vasa* Museum
two separate ship-mounted multi-beam 300-kHz and 90-kHz echo sounders were activated to scan the wreck. The bathymetric data gathered proved to be unsatisfactory for research because the energy of the signal was absorbed by both the waterlogged wooden ship and the seafloor, making the return data almost impossible to process. A closer look and more innovative approach were needed if the group would be able to investigate the wreck further.

Assembling the research team, MMT and Deep Sea revisited the site in 2006, armed with remotely operated vehicles (ROVs) and two preeminent maritime archaeologists and historians of the Baltic, Drs. Ronnby and Adams. What they saw was a completely intact 17th-century ship, a ghost from the past in a state of preservation that exceeded even *Vasa*. Wooden sculptures, sea chests, ladders, and blocks littered the sea floor. Elaborate carvings adorned the ship, while the rudder stood in place and anchors were still at the ready. Aided by international news coverage, what they found had ignited keen interest in the archaeological community and prompted the formation of an international research group.

**The Dutch Fluyt**

The fluyt was pragmatic and easy to sail. Light on crew, the vessel was heavy on cargo. It was the most important commercial ship developed by the Dutch toward the end of the 16th century. The fluyt served mainly as a cargo mover, but could also be outfitted for patrol and naval warfare. It was inexpensive to build, cheap to operate, of dependable design, and very adaptable. These traits not only made it the most popular ship of its day, but also changed the way ships were built. This innovative design makes having a complete example of this vessel type so important (Figs. 3&4).

During the 17th century, Dutch-built fluyts were among the most valuable tools of a new global Dutch economy. Trade with East India and the developing New World market provided Amsterdam and other port cities in the Netherlands with a great amount of wealth and power. Baltic trade was also important and by the middle of the 17th century, thousands of Dutch merchant ships visited the Baltic every year. Ships transported and sold manufactured goods from western Europe, spices from East India, dried fish, salt, and cloth to the northern countries of the Baltic. On the return voyage the fluyts were loaded with raw materials like timber, iron, chalk, and grain. The Ghost Wreck itself was well suited for the of timber trade; it has a low loading hatch on the stern section of vessel. Low, if not under the waterline, it enabled the crew to load long timbers into the bowels of the ship while in port by ballasting the ship heavy to the bow.

Shipbuilding is one of the reasons why the Dutch were instrumental in leading the way in the industrialization of Europe during the 19th century. At the very vanguard of this international trade and communication movement, the everyday fluyt slowly made its way across the oceans and seas of the world, spreading Dutch influence and power.

**2008 Roundtable and Expedition**


*FIG 4 below*

Drawing of port side (N. Eriksson).
In late 2008 the first major expedition to the Ghost Wreck set out from the Island of Gotland. On board MMT’s Franklin, a research team prepared to begin the remote survey of the Ghost Wreck. ROVs were loaded, multi-beam warmed up and steerable side-scan in place. Most ambitious was a small lawnmower-sized ROV which the crew and researchers hoped would be able to penetrate the wreck.

The first order of business was to video survey the ship and surrounding site using the Sub-Fighter ROV. The dark green brackish water of the Baltic presented some real challenges for filming. Extra lighting had to be rigged using three aluminum ladders and a custom-built cage. This structure provided a platform for the lights and allowed the rig to be placed directly on top of the wreck. When it was complete the light ramp generated 50,000 lumens and night became day under water.

As a result of this video survey, the expedition was able to identify some amazing details on the Ghost Wreck. In one brief moment when the cameras on the light rig and large ROV were lined up above the deck, the view into the aft cabin window from the small ROV revealed that the cabin was littered with sea chests, an overturned table, and sleeping bunks. The group also retrieved a section of planking and sleeping bunks. The group was determined to record the location of the wreckage properly and raise a piece of sculpture from the sea floor. They identified the plank as Scots Pine from the Island of Gotland and dated the wood to the middle of the 1630s. Chemical analysis by Yvonne Fors showed sulfur present in the wood, but at minimal levels. Testing performed by the author showed the waterlogged wood to be borderline class II (185–400% water) and III (185–400% water). All three separate analyses indicate that the wood from the wreck is remarkably stable after having been submerged for 400 years.

**Report of the 2010 Expedition**

In 2010 the research group returned to the site of the Ghost Wreck led by Dr. Johan Rönnby’s newly-founded Maritime Archaeological Research Institute at Södertörn University. MARIS teamed up with MMT/Deep Sea Productions to continue the survey with new technology. Learning from the hardships of the 2008 expedition, the group was determined to record the site properly and raise a piece of sculpture from the sea floor. They came prepared with three ROVs, including a micro-ROV for wreck penetration, state-of-the-art HD cameras, custom lifting claw and basket, as well as an ROV-mounted multibeam sonar system.

The platform for all of this technology was a newly-converted survey vessel, Icebeam and its state-of-the-art technology, fresh from a job for a trans-Baltic pipeline (Fig. 5). For the first few days, ROVs scoured the wreck with HD video beamed directly to the archaeologists on the survey ship so they could monitor and direct the survey. Unlike the 2008 expedition, the light rig and ROVs worked in unison, due to Icebeam’s dynamic positioning system and experienced ROV pilots. The ship was able to maintain a steady position in space that was measured in sub-meters while the ROV pilots maneuvered with pinpoint accuracy (Fig. 6).

An accurate site boundary was determined and several new construction details and artifacts were located, the largest of which was the main mast top, complete with intact trestle-trees, a first for a ship of this age according to Dr. Fred Hocker (Vasa Museum). This part of the rigging was isolated some 100 m from the starboard side of the wreck.

Dr. Hocker also noted the way in which the spars and blocks lay on the deck and seafloor. With better video and lighting, the team was able to deduce the location of most of the spars and Dr. Hocker’s observation pointed to the crew’s last moments at sea on the Ghost Wreck. The main and fore yards appear to have been set against each other in a v-pattern; such an arrangement in sailing terms is called heaving to. This technique was used to slow a ship’s forward progress and steady it in strong winds. Because of the opposing arrangement of the sails, the wind pushes each of them in separate directions, effectively bringing the ship to a stop with a slow drift. The crew may have been...
in trouble and tried to stabilize the vessel in order to abandon ship. It is also possible they were trying to ride out bad weather. Either way, the Ghost Wreck was not under normal sail when it sank. Beyond rigging details, the visual survey revealed the layout of the ship's galley, permitted a better look into the stern cabin, and divulged one very interesting clue as to the name of the vessel. Ships of the 17th century did not have their name written across the stern in large letters. Instead, the practice was to have a design on the transom that symbolized the name of the vessel. The stern of the Ghost Wreck is very elaborate: floral carvings surround the tiller port, the tiller is capped with three sculpted roses. Other decorative sculptures, as well as the transom itself were found all over the sea floor aft of the vessel, left behind once the iron fittings which attached them to ship corroded. One carving appears to be the body of a large fowl and sits just off the stern, its position indicating it was originally on the transom. Our Ghost Wreck, therefore, may have been named Swan.

Lifting the “Hoekman”

Once the visual survey was complete, researchers and crew set about lifting a well-preserved sculpture, the “Hoekman,” Dutch for “Corner Man.” During the era of the Ghost Wreck, Dutch-built ships often had corner figures on the transom stern. These sculptures often represented important figures from the ship’s country of origin or the shipping company itself. The wreck had both “Hoekmans” intact and on the sea floor so Drs. Rönby and Hocker chose to raise the sculpture they believed had the greatest chance of being recovered without damage to the artifact.

A specially designed hook and basket had been built in-house by MMT, based on laser measurements taken during the 2008 expedition. The plan was to use the claw in conjunction with the ROVs to grab the sculpture and then lower it into the basket for the final lift topside. It turned out that the basket was too small for the sculpture and an alternate plan had to be developed by MMT’s pilots and crew.

The main concern was that damage could be done to the delicate remnants of the paint on the sculpture. Paintings on Vasa’s mast were lost during its removal from the water. The air/water interface that was to blame with Vasa now threatened the “Hoekman.” Luckily, two certified tech divers were amongst Icebeam’s crew and a plan was hatched to employ them to protect the sculpture from damage while still in the water (Fig. 7&8). After successfully grabbing and securing the “Hoekman”, crane operators slowly raised the sculpture to a depth of around 10 m. At this point the divers entered the water and used line with plastic wrap to encase the artifact in a protective layer which would guard it against damage at the critical air/water interface. The operation went like clockwork and the “Hoekman” saw the light of day for the first time in over 350 years.

Dutch conservators Laura Koehler and Gerd Schreurs (Rijksdienst voor Cultureel Erfgoed, Department of Ship Archaeology, Lelystad), were onboard Icebeam to receive and prepare the artifact for transport (Fig. 9). The final destination for the sculpture was Lelystad, Holland but for the time being the conservators wrapped the Hoekman in plastic, secured it in a crate and transported it to a temporary holding tank in Stockholm (Fig. 10).

3D Imaging of the Wreck

One major goal of the expedition was to develop an accurate multi-beam scan of the wreck for future analysis. To accomplish this goal, MMT deployed a single transducer Reson 7125 multi-beam echo sounder mounted under a sub-Atlantic Mohican ROV. It recorded over 6 million reference points to form a 3D model of the wreck.
(Figs. 11&12). To the technicians’ surprise, the beams penetrated the deck of the Ghost Wreck making it possible to collect accurate measurements of the outer hull, the captain's quarters, the holds and the forecastle.

The hull is 27 m long with a maximum breadth of 8 m and is curved lengthwise with the stern standing about twice as high as the midship deck (Fig. 13). The vessel was built using a carvel technique with three wales and aft of the midsection there is a chain wale for shrouds. Numerous small scuppers run the length of the ship.

The bow is blunt without a beak head, and the bowsprit is in place positioned just starboard of the centerline. Both the cat heads are in place and between them a slightly curved timber that is probably part of a small balustrade, which was also used as a belaying rail or pin rack.

The stern is round with a counter on top. The transom has fallen off and this seems to have caused the hull sides to bend slightly outwards. A tiller port is present in a typical oval shape with floral carved borders and the tiller is still attached to the rudder. The top of the rudder is decorated with three flowers arranged in a triangular pattern. A so-called buss painted by van de Velde in 1650 has an almost identical decorative scheme.

To either side of and below the

**Initial assessment of the Hoekman was done by Emma Hocker (Texas A&M graduate and Vasa conservator); recorded as follows.**

**Description:** The sculpture is in the form of a standing male figure in a cloak and broad-brimmed hat, about 171 cm long and ca 45—50 cm thick, and weighing ca 150—200 kg (Fig. 1). The style of the clothing suggests mid-17th century, which is in keeping with constructional details evident in the wreck. It is of pine and carved from the centre of a trunk (the tree rings can clearly be seen in cross-section). It was the port cornerpost of the transom, and the figure looks inwards towards the centreline. It is referred to within the project as the “Hoekman,” which is Dutch for “corner man.”

**Condition:** The sculpture is covered in a layer of smooth mud and algae, about 1—2 mm thick. As this provides protection to the surface, no attempt was made to remove it during examination. In the field, the Dutch conservators made a very preliminary examination to check for pigments but stopped the moment traces were suspected, with the intention to continue the cleaning under laboratory conditions. The wood is somewhat eroded probably from its life in service and from surface abrasion while exposed to the slight current on the sea bottom. The facial features and figure's right arm no longer remain, but more protected areas such as the details of the hair are still quite crisp in form, and details of the style of clothing are still evident. A pin was pushed into the wood to assess condition. In general, the pin could be inserted about 2 mm into the surface before the wood resisted, suggesting that below this depth the wood is in reasonable condition. There were some areas where the pin sank between 5—9 mm, but these were often carved areas sitting proud where bacterial decay could proceed from three directions. In one place on the torso, the pin was inserted 20 mm, but as this was also one of the thickest parts of the sculpture, it may be that the wood is sapwood. This was an exception however. The overall results of the pin test place the wood into de Jong's Class III classification, a hard core beneath a thin deteriorated surface layer and a likely moisture content of <185% (according to De Jong, 1977). Taking core samples to establish water content is unnecessary. The conservation laboratory in Lelystad has extensive experience of waterlogged wood condition assessment and conservation, and the conservators there can, no doubt, assess the wood according to their experience.
tiller port, are four openings, two of which are cabin windows. These apertures are all surrounded by floral carvings. The two closest to the sternpost are hawse holes. Further below on the starboard side are a larger square and slightly smaller openings with nailed down hatches. These were most likely for loading timber and ballast.

The rudder is on the port side of the sternpost and there are clear traces of the pintle and gudgeon assemblies. It appears that the rudder was partly lifted when the ship hit bottom, which explains its present position to one side of the sternpost.

The ship has three masts: main, mizzen, and foremast. The bases of the fore and main masts are still in place. The mizzen mast had been dislodged due to the fact it was not stepped as deeply in the hull. On the port side of the deck are many parts of the rig, including blocks and deadeyes; a large pile of debris likely has some sail remains in it.

There are three hatches on the main deck, two before the mainmast and a smaller one further aft. Directly aft of the mainmast there are three knights with sculpted males (Fig. 14). Two of the knights are connected by a rider with belaying pins still in place. One more knight further aft has a large block fastened to it and sits at a slight angle. Near the stern there is a large windlass which runs from one side of the vessel to the other.

Stocked anchors hang on the port and starboard sides just behind the bow (Fig. 15). The stocks are wooden, the arms are V-shaped and the flukes are triangular. In construction the anchors appear much like those from Vasa. In front of the poop deck is a pump drilled from an unfinished timber; directly to its starboard side is a hole which appears to be the remnants of a second pump.

Surrounding the ship is a debris field which contains many artifacts that presumably fell from the ship during its sinking or subsequent decay. No human remains have yet been observed and there has been no ship’s boat found, leading to theories that the ship’s crew may have escaped.

Whatever their fate, the crew of the Ghost Wreck left behind a unique and extraordinary example of 17th-century Dutch shipbuilding. The research team and crew of Icebeam used the synergy of several disciplines and individuals with a high degree of technical expertise to survey this remarkable ship.

The Ghost Wreck expedition stands at the vanguard of a new era of maritime archaeology, not in replacing divers, but rather extending the range and depth of their abilities, while applying the proven methods upon which the field was founded.

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FIG 11
Midship cross section generated from multibeam. (MMT/Ghost wreck project).

FIG 12
Stern cross-section from Multi-Beam data (MMT/Ghost wreck project).
References


FIG 13 top
ROV view of stern section (Deep Sea Productions/Ghost wreck project).

FIG 14 middle
ROV Photo of knight near the mainmast (Deep Sea Productions/Ghost wreck project).

FIG 15 bottom
ROV investigating anchor (Deep Sea Productions/Ghost wreck project).
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