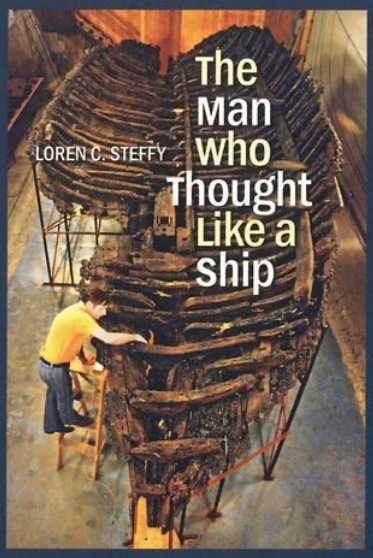

New, in the Ed Rachal Foundation Nautical Archaeology Series

The Man Who Thought like a Ship

LOREN C. STEFFY

The first person ever to reconstruct an ancient ship from its sunken fragments, J. Richard "Dick" Steffy said that ships spoke to him. Steffy's son, Loren, an accomplished journalist, has mined family memories, archives at Texas A&M, his father's papers, and interviews with former colleagues to craft not only a professional biography and adventure story of the highest caliber, but also the first history of a field that continues to harvest important new discoveries from the depths of the world's oceans.
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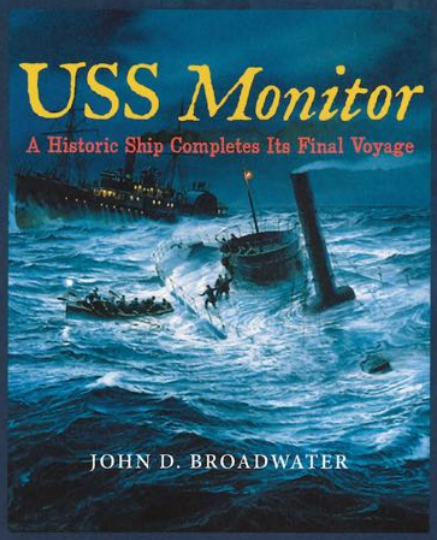

USS *Monitor*

A Historic Ship Completes Its Final Voyage

JOHN D. BROADWATER

Lavish illustrations complement this informative and highly readable account of the more than 100-year-old Civil War armored warship that disappeared under the sea and was excavated and recovered under the auspices of the National Oceanic Atmospheric Administration and the U.S. Navy.
8½x11. 338 pp. 189 color, 161 b&w photos. Bib. Index.
$39.95 cloth

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J. Richard Steffy
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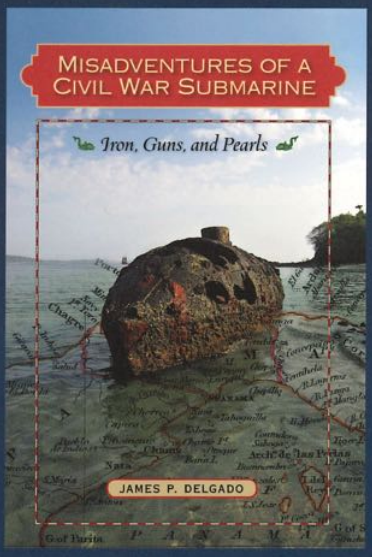
The Porticello Shipwreck
A Mediterranean Merchant Vessel of 415-385 B.C.
$60.00 paper with flaps

Misadventures of a Civil War Submarine

Iron, Guns, and Pearls

JAMES P. DELGADO

In 2001, maritime archaeologist Delgado came upon the hulk of a mysterious iron vessel off Panama's Pacific coast he later determined were the remains of one of the first successful deep-diving submersibles. He tells the story of its inventor Julius Kroehl, who sought to develop his invention for military use during the Civil War.
288 pp. 64 b&w photos. 3 maps. Bib. Index. $34.95 cloth



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The INA quarterly
MAGAZINE OF THE INSTITUTE OF NAUTICAL ARCHAEOLOGY

Where in the World?

THE 2012 FIELD SEASON BEGINS

PHOTOGRAMMETRY
A Legacy of Innovation

SPRING - SUMMER 2012 • Volume 39 • Nos. 1 and 2

INSTITUTE OF Nautical ARCHAEOLOGY

inside INA

A Letter from the President

Let me begin by thanking everyone who participated in our online INA publications survey earlier this year and congratulating INA member Ben Gilbert, who won a signed copy of the 1200-page *Oxford Handbook of Maritime Archaeology*.

While it is clear that a growing number of us are utilizing online media every day (INA now has over 3300 Facebook friends), the results of our survey indicate that the majority of you still prefer to receive the *INA Quarterly* in print form. The immediacy of online information has made it challenging, however, to disseminate the content of four *INA Quarterly* issues in a timely fashion. So, because we value your input but also your time, we are producing two double-issues of the *INA Quarterly* in 2012.

We are also considering producing an e-newsletter supplement (for members only) that would provide timely updates and announcements throughout the year. If you would like to be included on the mailing list please use the *Contact Information Update Form* on the Contact Us page of our website and in the comments section please indicate whether (or not) you would like to receive e-newsletter updates from INA.

Your survey responses also provided helpful feedback about the content of INA publications, and we will be committing future issues to important topics such as the ethical responsibilities, legislative challenges, and the successes and failures of protecting underwater cultural heritage. With this issue we are reviving the practice of reviewing new and recent book titles, and exploring safety issues that concern anyone involved with archaeological diving. Room is also being made to honor the memory of key figures of underwater archaeology, their projects, and their impact on the discipline.

For the Greek historian Thucydides, exact knowledge of the past was fundamental to interpreting the future; put another way, in order to know where you're going you have to know where you've been. In this spirit, our feature for this issue is a retrospective look at the beginnings of underwater shipwreck photography through the eyes of INA pioneer Don Frey and a companion article by Mark Polzer and José Luis Casabán contextualizes just how revolutionary the impact of digital photography has been on our abilities to map large areas under water in relatively little time.

Polzer and Casabán's photogrammetry case-study is a poignant reminder that launching, sustaining, and completing a multi-year excavation like that at Bajo de la Campana represents a major investment of time, labor, resources, and funding. Elsewhere in this volume you will read about some of the many INA projects, big and small, that will be occurring all over the world in the coming months.

Two initiatives which are slated to become major INA projects in the very near future are the shipwreck survey of Tobago by Dr. Kroum Batchvarov, and the excavation of what is presently the oldest known shipwreck in the Indian Ocean, led by a collaborative team of researchers that includes myself, INA archaeologist Sheila Matthews, and INA Associate Director Ken Trethewey.

As we look ahead to an exciting summer full of new discoveries, I urge you to visit the INA website (www.inadiscover.com) and have a look at the various project blogs which will be updated regularly from the field! And, if you have a suggestion or idea for a future *INA Quarterly* article, please feel free to e-mail me directly at dnc@tamu.edu

Your support of INA makes it all possible!

Debbie

Deborah Carlson
INA President

BELOW
Debbie Carlson at Kızılburun in 2011.

For more information check out the Kızılburun Blog pages on the INA website.

PHOTO Donny Hamilton

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Support the Bodrum Library
Donate a book through Amazon.com
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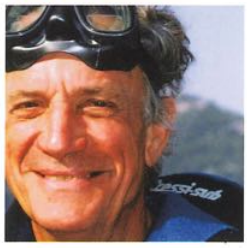

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(Upper image) Jun Kimura wearing the gradiometer harness with GPS antenna, and marking an anomaly using the data logger hanging from his neck. See the article on pages 24-27. PHOTO R. Sasaki
(Lower) Mapping techniques used during the Bajo de la Campana excavation. See the article on pages 13-17. PHOTO P. Baker

The Institute of Nautical Archaeology is a non-profit organization whose mission is to continue the search for the history of civilization by fostering excellence in underwater archaeology.

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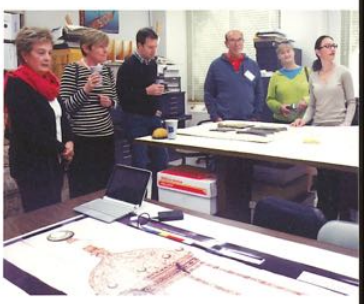
If you are interested in submitting an article for publication please contact the Editor at **inaeditor@inadiscover.com**

ANNUAL BOARD of DIRECTORS' MEETING

The Institute of Nautical Archaeology is governed by a Board of Directors, and their decisions *chart the course* for the future of the organization. There are several committees that provide input and recommendations in areas such as finance, communications and archaeological project selection. The men and women who provide financial support to this institute also donate their time and expertise to guiding the organization, all of which is critical to the continued success of INA. This past November, INA's directors, associate directors, officers & administrators, faculty and students of the Nautical Archaeology Program (NAP) at Texas A&M University, research associates, and other colleagues convened for the annual Board of Directors' Meeting. Having the event in College Station, Texas allowed those in attendance to tour the classrooms and laboratories of NAP and CMAC, including the Conservation Research Laboratory (CRL) where *La Belle* was raised from her home in an enormous vat of polyethylene glycol (PEG).



Touring the labs and classrooms. To see more photos from the 2011 meeting, visit the News & Events section of the INA website.

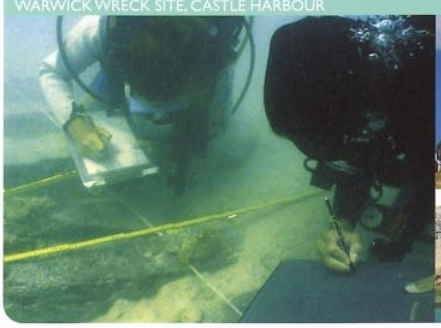
PHOTO **Po Wan**

The meeting also featured presentations on INA's major field projects from 2011, and provided opportunities for directors to interact with the archaeologists and students to whom they lend their support. It was a wonderful time to share our collective passion for unlocking the secrets of the seafaring past through nautical archaeology, while also enjoying the wonderful weather and experiences that College Station and Texas A&M University had to offer.

The 2012 Board of Directors' Meeting

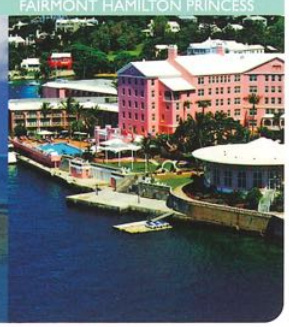
is scheduled for November 8 -10 in Bermuda, home to INA's Warwick and Western Ledge projects. Highlights will include a visit to the National Museum of Bermuda. For more information please contact Tamara Hebert at: thebert@tamu.edu

WARWICK WRECK SITE, CASTLE HARBOUR



NATIONAL MUSEUM OF BERMUDA...
incorporating **Bermuda Maritime Museum**

FAIRMONT HAMILTON PRINCESS



The Mary & Lamar Tooze Library at INA's Bodrum Research Center.

Help FILL THE SHELVES of the Bodrum Library!

Make your donation today through Amazon.com

Did you know that you can help INA by purchasing a book through www.amazon.com? The Mary and Lamar Tooze Library at INA's Bodrum Research Center is staffed by a full-time librarian and is home to more than 10,000 archaeological books and journal volumes, including the Dorothy and Homer Thompson Collection, making it one of the finest research libraries in Turkey.

You can help us maintain the quality of our holdings and enhance the quality of INA's research by donating archaeological titles or purchasing a book that is on INA's Wish List. Simply visit Amazon.com and follow the link in the upper right-hand corner labeled "Wish List." Enter the INA email address (info@inadiscover.com) or "Institute of Nautical Archaeology" to view and select a title. Once purchased, your gift will be sent directly to INA Headquarters where it will be labeled with a bookplate indicating that it is a gift from "Your Name or Organization."

What a great way to make a lasting impression on scholars utilizing the Tooze Library!

Upcoming Conferences...

"The UNESCO World Heritage Convention On Its 40th Anniversary"
The World Heritage Convention is the most ratified international treaty for cultural and natural heritage preservation in the world. This year, on its 40th anniversary, the World Heritage Convention celebrates sustainable development and the role of local communities, with conferences and events around the globe.
http://whc.unesco.org/en/40years/

"Living in Changing Island Environments"
8th International Conference on Easter Island and the Pacific
July 8-12, 2012 in Santa Rosa, California, USA
www.farhorizons.com/easterislandconference/index.php

The Nautical Archaeology Society (NAS) 2012 Annual Conference
November 03, 2012 in Santa Rosa, California, USA
Information regarding the event will be posted on the NAS website later this month.
www.nauticalarchaeologysociety.org

"Globalization, Immigration, Transformation"
Society for Historical Archaeology Annual Conference 2013
January 9-12, 2013 in Leicester, Great Britain
A major historical archaeology conference based in the heart of England, but looking at the world, its peoples and the changes they created in the recent past. A website for submitting papers is now online.
www.sha.org

14th International Conference of the European Association of Southeast Asian Archaeologists

Sept 18-21, 2012 in Dublin

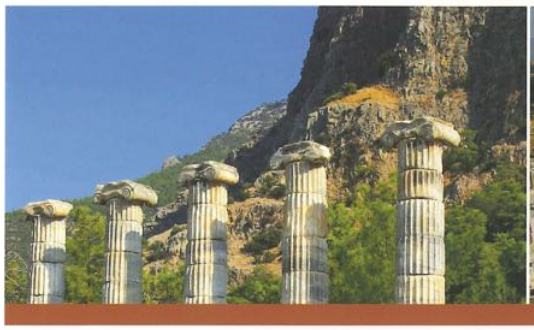
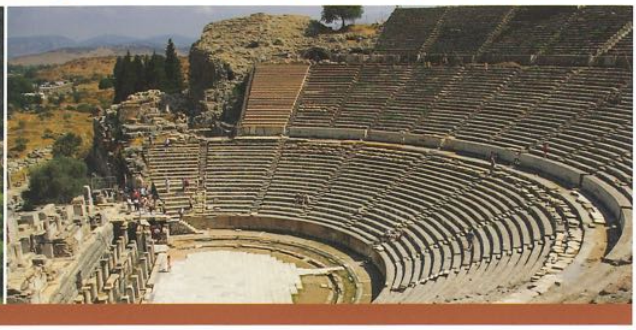
A key session will explore the current work in Southeast Asia that is addressed through maritime themes with the goal being to raise awareness and build networks between colleagues

www.archaeological.org/events/7899

AIA TOURS
ARCHAEOLOGICAL INSTITUTE OF AMERICA

OCTOBER17-26, 2012

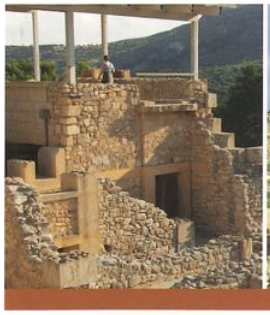
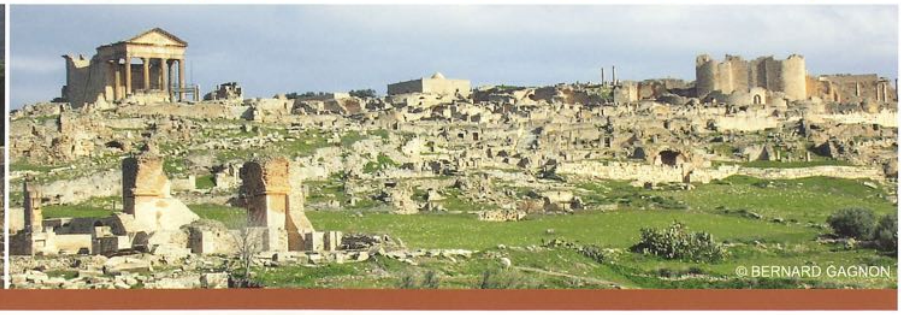
Join lecturer and host Deborah Carlson on an 8-night cruise along Turkey's dazzling azure coast. Cruising this coastline and nearby islands—the intellectual and spiritual home of Western civilization—aboard the 17-cabin private yacht *Callisto* is undoubtedly one of the most gratifying voyages a discerning traveler can experience. Enjoy daily excursions to famous as well as lesser-known (but equally wonderful) archaeological sites, spend time in charming little ports, and marvel at landscapes of spectacular islands and mountainous coastline. Highlights include visits to Ephesus, Priene, Bodrum, Kos, Cnidos, Rhodes, Caunos, Kekova Bay, and Xanthos. Professor Carlson's lectures and informal discussions aboard ship will enrich your travel experiences and help place into context the archaeology and ancient history of the places you visit.


Deborah Carlson, Ph.D. is an Associate Professor in the Nautical Archaeology Program at Texas A&M University, and is the president of the Institute of Nautical Archaeology.

OCTOBER13-29, 2012

What could be more intriguing than a 15-night voyage aboard the 57-cabin, all-suite *Corinthian* II, combining an exploration of practically the entire length of the fabled Mediterranean, especially its lesser-known shores, with the expertise of lecturer and host Shelley Wachsmann and the transcendent joy of music, at what is considered to be the best time of the year? It is also difficult to imagine a more interesting time to be cruising along the southern coast of the Mediterranean. Nautical archaeologist Shelley Wachsmann will serve as our resource on the ancient civilizations whose legacies and monuments we encounter on our journey from Istanbul to Casablanca, such as the magnificent 3rd-century city of Ephesus, Minoan ruins on Crete, stunning Greek and Roman sites at Syracuse, remains of storied Carthage, and the extensive and well-preserved—but seldom-visited—ancient sites of Algeria.


Shelley Wachsmann, Ph.D. Meadows Professor of Biblical Archaeology, on the faculty of the Nautical Archaeology Program at Texas A&M University.

When reserving your spot on either of these fabulous tours, mention that you are an INA supporter and a portion of the proceeds will be directed to INA!

FOR MORE INFORMATION

Please contact the AIA Tours office at (800) 748-6262 or aia@studytours.org with questions and to request a detailed brochure.

Ben Gilbert is a volunteer crew member for *Maryland Dove** and was photographed with his book prize from INA, while posing in front of the vessel during its spring rig-up.

INA Communications Survey

In order to gather the opinions of supporters of the organization, INA launched three surveys this winter, each targeting a specific group: INA Directors, General Membership, and INA Facebook Friends. Our goal is to continue to improve communications and public outreach programs to better serve and inform our members and the general public. To further this goal the Communications Committee sought feedback on the quality and content of INA publications and social media efforts. The results of these surveys will assist us in making informed decisions about how we reach the public, share the results of our work, and increase membership and support for the organization. From the survey results we know that most respondents prefer to receive both print and online communications from the organization. With the help of a grant from the Ed Rachal Foundation, we will continue to publish both the The *INA Annual* and *The INA Quarterly* this year.

Our thanks to all who participated, and congratulations to Ben Gilbert who took part in the survey and was the winning entry in the drawing for a signed copy of the recently released *Oxford Handbook of Maritime Archaeology*. This comprehensive volume draws on many of the distinct and universal aspects of maritime archaeology, bringing them together under four main themes: the research process, ships and shipwrecks, maritime and nautical culture, and issues of preservation and management. Many of the authors are connected to INA including the book's editors Alexis Catsambis, Ben Ford, and Donny L. Hamilton.

* *Maryland Dove* is a replica of a trade vessel from the late 17th century and commemorates the 1634 *Dove* that sailed with Lord Baltimore's colonial expedition to Maryland. www.stmaryscity.org

Gerhard Kapitän

Gerhard Kapitän (1924-2011)

Gerhard Kapitän was a pioneer of nautical research and and is perhaps best known in archaeological circles for his investigation of the Marzememi Church Wreck off the coast of Sicily from 1960 to 1967. An independent scholar, Kapitän researched the maritime traditions and boatbuilding techniques of ancient Mediterranean cultures, writing more than one hundred scientific papers. He undertook highly specialized studies of artifacts such as anchors and transport amphorae. Fittingly he will forever be part of the lexicon of nautical archaeology as a late-Roman Amphora type bears his name.

Kapitän was particularly interested in the beginnings of boat building and seafaring, which eventually led him to ethnographic studies. From 1985 to 2004 he worked on the documentation of traditional watercraft of Sri Lanka, preserving a record of craft that were later swept away by the 2004 tsunami that devastated the area.

"He identified five types of watercraft – Rafts, Vallam, Oru, Angula and Ma-del-paru – with some overlap. Each was divided into sub-types. For instance, he identifies 36 types of oru and 6 types of ma-del-paru. But, he notes, 3 different types of craft used for ma-del fishing, paru, oru and vallam. Classification was based on types of fishing, differences in off-shore sea conditions, and characteristics of beaches, etc. All of which he distilled into a Classification of types, which he considered the ultimate purpose of his research and field work. — Somasiri Devendra

His book, "Records of Traditional Watercraft from South and West Sri Lanka" (prepared for publication by Gerald Grainge and Somasiri Devendra) has been published by NAS as Monograph Series No 2/BAR as No 1931. With this work Kapitan leaves behind a monument to the ancient, traditional vessels of the region, which are now largely displaced by motorized, fiberglass boats.

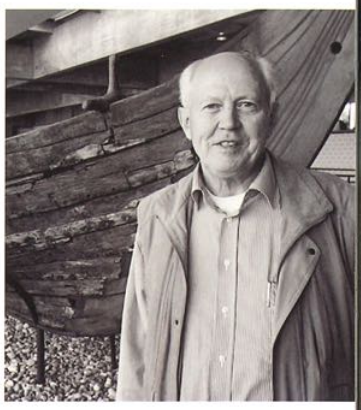
Ole Crumlin-Pedersen (1935-2011)

The late 1950s and early 1960s saw a number of high-visibility projects exploiting the new technology of SCUBA diving to investigate archaeological sites under water. Thanks to good media coverage, popular interest and just enough acceptance by the traditional academic community, the field of maritime or nautical archaeology as we know it today was born. Many of the projects were led by young men, some still students, who appreciated the potential of the new field and were not encumbered by established ideas and conventions. In two cases, the leaders of these early excavations saw a greater vision than one shipwreck site and went on to establish world-leading institutions and research programs in which future generations of nautical archaeologists were trained. INA and Texas A&M formed one of these institutions under George Bass. The other was the National Museum of Denmark with the Viking Ship Museum in Roskilde, which became a major center for the development of maritime archaeology in northern Europe.

The visionary in Denmark was Ole Crumlin-Pedersen, known to his colleagues as either Ole or Crumlin, although he used to introduce himself as "Old Crumbling Pedersen." As a young student in the 1950s, he approached the National Museum of Denmark to chide them for not taking better care of the country's underwater heritage. He encouraged them to investigate a wreck in Roskilde Fjord, near Skuldelev, which was thought to be medieval in date, and he was taken into the team assigned to excavate it. One medieval ship turned out to be five Viking ships, and Ole spent the next decade organizing the conservation, documentation and reassembly of their hulls, while also raising support for the construction of a purpose-built museum to house them in Roskilde. He became its first director as well as the leader of a permanent department at the National Museum dedicated to investigating Denmark's underwater heritage. He later left these posts to lead a full-time research center devoted to maritime archaeology, which employed scholars from around the world. I was one of those fortunate enough to be so employed there from 1999-2003, and had the fascinating challenge of being part of one of the most exciting research environments in Europe.

Ole demanded much of those who worked in Roskilde, and if we asked what he wanted from us, he usually answered "The optimum result!" He had relatively few outside interests other than his family, and was always working on a project or advising others right up to the last days of his life. He pushed us hard every day to live up to the standards he had set, but he also cared very deeply about the welfare of his colleagues. And the relationship, as noted by more than one observer, was less that of a leading researcher overseeing his colleagues and assistants, and more that of a wise father guiding his talented children. Children grow up, however, and so many of the people Ole trained and mentored went on to do other things. Despite personal family tragedies (his wife and one of his sons predeceased him), Ole was always positive in his outlook and believed that things would turn out well. I can see him still looking at me over his half-moon glasses, asking how my book on Danish cog finds is going and if my sons like living in Scandinavia. He is still expecting the optimum result.

— **Fred Hocker**, Ph.D.
Director of Research, *Vasa* Museum



Ole Crumlin-Pedersen
PHOTO **Werner Karrasch**

"Ole Crumlin-Pedersen, born 24th February 1935 in Hellerup, Denmark dedicated his life to maritime cultural heritage, maritime archaeology and old ships. He was a pioneer, who through his professional engagement and an almost unbelievable capacity for work developed an entirely new area of archaeological fieldwork. He changed our view of the world of the past, and gave us new glasses with which to view history. The Viking Ship Museum at Roskilde stands as the most striking trace of what he leaves behind."

—from a tribute by Tinna Damgård-Sørensen, Director of the Viking Ship Museum.

LEFT
Ole with Fred van Doorninck at a symposium held at Texas A&M University in 2007.

Exhibit at the Viking Ship Museum in Roskilde, Denmark.

Four Decades of Underwater
INA THROUGH THE LENS OF DON FREY

A former INA president, vice president, research associate and honorary ambassador, Don Frey has only recently "retired" from the organization he helped build.

A veteran of over 40 years in the field, Don participated in countless expedition dives, capturing some of the seminal moments in nautical archaeology.

BELOW
The iconic Kodachrome film was manufactured from 1935 until 2009.

Imagine being the photographer assigned to take photographs at a remote Turkish excavation site with no chance to see the images until a month after the project finished! Each summer the National Geographic Society gave me forty rolls of Kodachrome color film and I shot most of it under water on the seabed. But since our friends at the Geographic insisted on developing the film in their own laboratory, I never saw a single color picture I had taken until the fall, after they had been processed. And that is how I worked for a decade at INA's Bronze Age shipwreck excavation at Uluburun 30 years ago.

Most of these underwater photographs were taken 160 feet below the surface. At that depth, slowed down by nitrogen narcosis, I had less than 20 minutes to catch the excitement of underwater excavation and record the action, like heavy objects being carried up the slope by divers who had little time or interest in posing for me.

So was I nervous about the quality of my photographs? Yes….very!

My concerns would start the moment the dive was over, when, trapped at the decompression stop for 20 minutes, I questioned what I had done on the seabed. Were my best guesses for light and distance correct? Had I, in the excitement of the moment, 'bracketed' enough in case they weren't? The term 'bracketing' is used by photographers to describe taking identical photographs of the same image, changing only the light or distance settings. For a really good 'photo-op' my own bracketing of distance was a slight variation in that I would take multiple photographs with the same camera setting but move it closer or further from the action.

Bracketing distance settings was actually unnecessary in the early days of underwater photography because for the 1960 Cape Gelidonya excavation George Bass's underwater camera was a Rollei Reflex camera in a custom housing. The special attribute of the Rollei was that it had a second lens which projected the image on a large glass screen at the top for accurate focusing. The primary camera lens was geared to that second lens so that the image it projected on the film would also be in focus.

My Nikonos camera was much more compact and had other advantages but since I couldn't see if my image was sharp, bracketing the distance was advisable. When the action on the seabed was not happening too fast, I also reset the camera aperture for both increased and decreased light intensities. And, for each aperture setting, I would again bracket the distance by getting closer or further from my subject.

So this bracketing burned nine frames on a single subject! But the only thing that really mattered was getting the best picture possible. After all, the film was free and there was no reason to come up with any of the 36 frames unused. On every dive I wanted to start with a fresh roll to be ready for whatever there was to photograph.

And for some exceptional underwater activity or moment or discovery—perhaps never to be repeated—I did also worry whether the camera would malfunction or flood! This did sometimes happen, because my Nikonos camera was rated to only 150 feet and was being opened and shut (plus compressed and decompressed) twice a day, six days a week, for a ten-week season!

But I have to say that the Nikonos cameras were truly ingenious and usually reliable! The first prototype, called the Calypso Amphibious Camera, was invented in 1952 by a Belgian, Jean de Woutersk, a member of Jacques Cousteau's team. Until that point the only way to take a camera underwater was in a waterproof box, which had both a window and some sort of leak proof mechanism to externally trigger it and advance the film. The Calypso's 'box' was the camera's body itself, cleverly designed so that the camera's mechanism and a set of lenses fit into it, both sealed by o-rings. One of the great advantages of this camera and

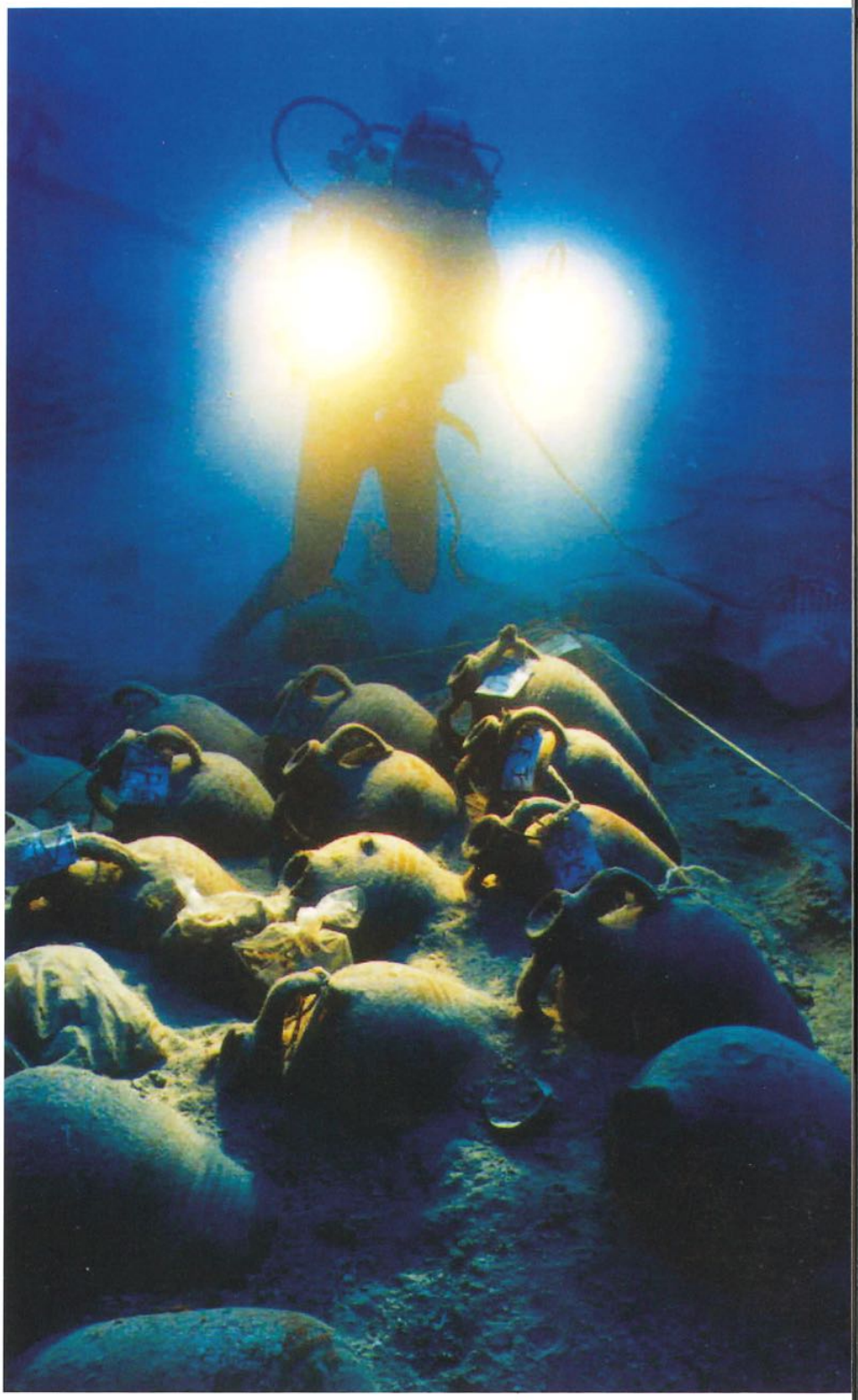
Photography

its later 'Nikonos' variations was the fact that it could be held, triggered and rewound in one hand, leaving the other hand free for buoyancy compensation or holding lights on the object being photographed.

Nikon took yet another great step forward when they designed a 15 mm underwater wide angle lens. The lens cost over $1000 but was worth every penny because this wide angle (almost a fish eye) allowed me to get much closer to whatever I was photographing. This reduced the silt filled water between the subject and my camera! And at close distances this wide angle lens was much more forgiving as far as distance settings were concerned. I soon found that if I set the distance to about five feet almost all my photographs were in sharp focus.

For natural light the other setting—the lens aperture—was also not a great problem since 150 feet below the surface bright sunshine or a cloudy sky above made little difference. So I usually just used one setting for the light and distance and it worked most of the time.

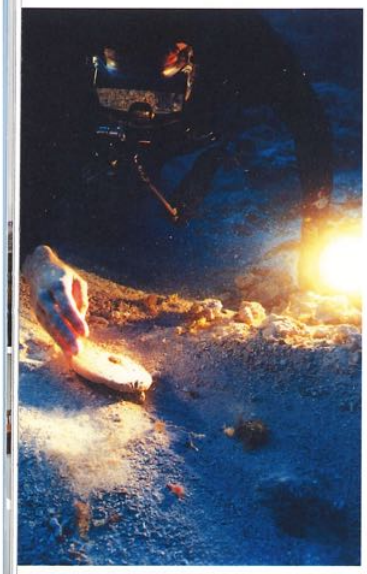
But this changed when I acquired a set of strobes passed on to me by Frank Beddor, an amateur underwater photographer. The illumination intensity they provided now depended on the distance they were from my subject. In strobe photography I also never got to see how my subject was illuminated and instead had to imagine it with all the subtleties of color and shadows. In addition, badly positioned strobes could illuminate silt in the water that was otherwise barely visible. To work around this my strobes came with long extension arms to provide illumination above the object so the silt would not reflect back into the camera. But all this



FROM TOP LEFT
Don's early "Nikonos" camera, a 15mm wide angle lens that was "worth every penny," and a Subal underwater housing for Nikon digital cameras.

The unique positioning of the lights—held here by Murat Tilev—pointing towards the camera, meant there were no reflections from the silt and there were beautiful shadows, as seen in this image from the Bozburun shipwreck site.

Through the lens of Don Frey (continued)



More outstanding images captured by Don Frey.

Ken Trethewey uncovering one of the ship's marble eyes, or *ophthalmoi*, from the Tektaş Burnu site (top) and Feyyas Subay raising a nearly intact wine pitcher from a 6th-century BC shipwreck at Pabuç Burnu.

turned my single, one-handed Nikonos into a large unwieldy underwater lobster!

In 1994 the lighting situation changed dramatically for me when a professional team of filmmakers came to Uluburun to make a documentary about our Bronze Age shipwreck. Their equipment included two 1000-watt underwater lights powered from the surface by heavy duty electric cables. It was my good luck that the film crew encouraged me to move in and out of their filming as part of the action! After they placed their lights I was free to swim around the site and more often than not discover a beautiful picture just waiting for one click on my Nikonos! This mostly occurred when I was facing the lights because this meant there were no reflections from the silt, but there were beautiful shadows not visible from behind the strobes.

It was my great fortune that one of the INA Directors, Jack Kelley, appreciated what the lights had added to my photography and bought the lamps from the film crew for me! In the years that followed, I made hundreds of dives with these lights manufactured by BIRNS —often being held dramatically by Murat Tilev— and captured many of the signature images that are still featured in INA publications and on the website.

As the new millennium approached I began working with digital Nikon cameras in custom housings designed for them. With the auto-focus and auto-aperture features I could concentrate more on different poses and no longer had to wait for the Geographic to process my films! Instead I easily passed my long, cold decompression time looking at the images I had taken. Those images got even better, because I could check them out while on the seabed, and make small corrections to get the optimum photograph.

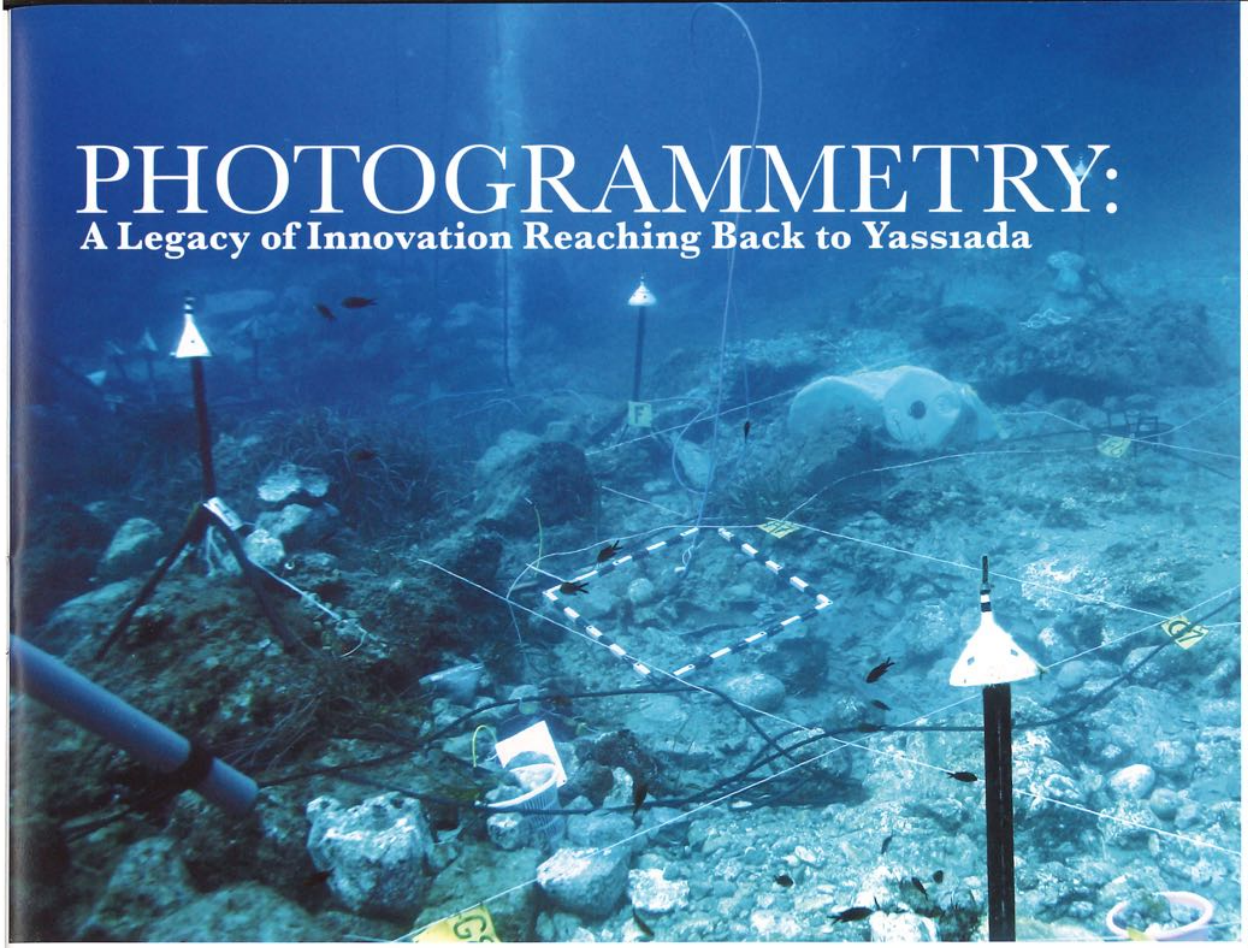
All these remarks are difficult to appreciate in our current era of digital *point and click* photography because these new cameras, even working with limited light, eliminate most of the distance and aperture guess work. Above water an amateur photographer can really compete with the professionals if he just has a good eye, takes a lot of pictures and then keeps the few that are the best. Today this is also true under water because most digital camera manufacturers now mass-produce inexpensive housings small enough to fit in the front pocket of a buoyancy compensator! So although I struggled a bit in the Nikonos era, I do consider myself lucky because at that time I was given the exclusive privilege of being the only diver who was allowed to take expedition cameras under water.

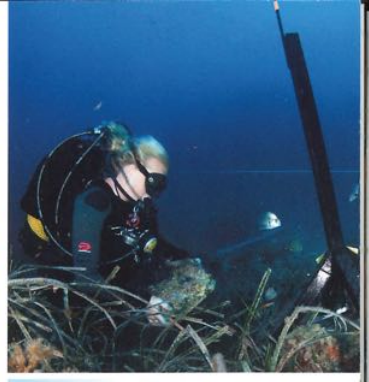
Hand in hand with these developments in digital photography came incredible advances when reels of underwater movie film were eliminated in favor of digital video cameras. My own first experience with underwater video happened when two Turkish friends, Nurdan and Özcan Arca, decided to produce a documentary about our Bozburun shipwreck excavation and I became their videographer. Digital video cameras had been out for only a few years and housings for them had to be custom made. The one Özcan had made for me had a few problems but it worked well enough so that after a few dives with it I became an addict.

In underwater video it was my own motion that could make all the difference, whether I was interacting with some diver's activity or an object at rest on the seabed. In the 1970s I took several courses in modern dance. In my 'improv' classes we were taught how to spontaneously choreograph movements that complemented those of our partner, and I have always felt that dancing and 'improv' added another dimension to my underwater video. Mind you this 'choreography' could be quite difficult while gasping for air with both hands too occupied to inflate my BC, as I struggled to accompany a diver ballooning a precious artifact to the surface. Being underwater certainly added a layer of adventure and complexity to any task, and I do miss the adventure!

—**Donald A. Frey**, Ph.D.

PHOTOGRAMMETRY:
A Legacy of Innovation Reaching Back to Yassıada





Mapping the Shipwreck Site at Bajo de la Campana

by **Mark E. Polzer and José Luis Casabán**

Arguably the most important thing archaeologists do when excavating a site is document the precise position and orientation of features and artifacts that they discover there. To excavate a site is to destroy it, and unless every possible bit of information about the site and its archaeological content is recorded before being dug, airlifted, removed, or otherwise altered, then that information and what it might reveal about the site and its material remains are lost forever. This is as true under water as it is on land.

During INA's recently completed excavation of a Phoenician shipwreck at Bajo de la Campana, Spain (see *INA Quarterly*, vol. 38, issue 1–2, pages 16–19), where we mapped the site primarily with photogrammetry, we benefited from a legacy of methodological and technical development that spans decades of fieldwork and innovation by INA archaeologists, affiliates and others. Just as they have done for so many other aspects of underwater archaeology, INA affiliates have pioneered numerous mapping techniques and their application to submerged shipwreck sites.

The mapping system we employed at Bajo de la Campana consisted of a rope grid placed over the excavation area and a network of datums, or control points, strategically placed around the site. The grid effectively divided the excavation area into a matrix of 2 m squares labeled by columns and numbered by rows. Each grid square was subdivided so that non-diagnostic fragments uncovered during excavation could be assigned to an area 50 cm x 50 cm by subdividing each grid square into sixteenths. All complete or diagnostic objects, however, were mapped much more precisely using photogrammetry and the computer software PhotoModeler®. The datums provided a set of known points that PhotoModeler could use to locate, in three-dimensional space, the position of any object within the control point network.

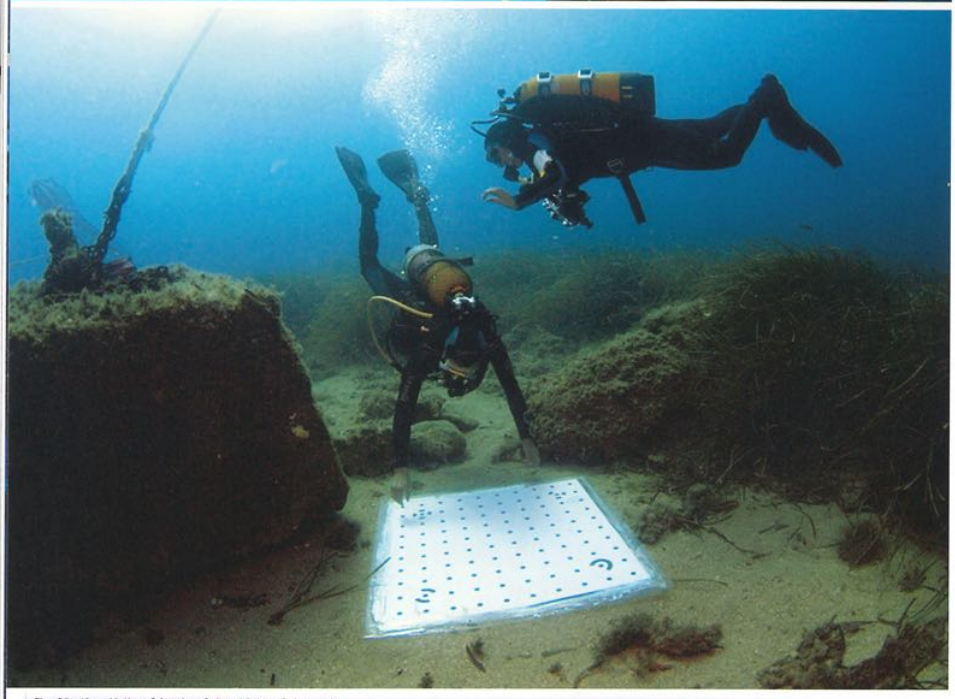
We used meter-tape measurements and a linear computer program called WEB (developed originally for the *Mary Rose* excavation) to trilaterate the relative locations of the control points, and then estab-

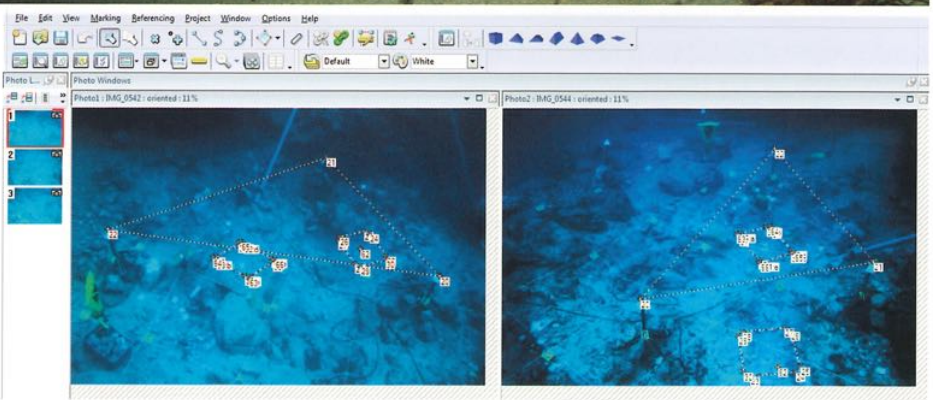
ABOVE
The Bajo de la Campana excavation site, with site grid, datum towers, and graduated meter frame used for mapping.
PHOTO **S.H. Snowden**

A diver holds one end of a meter tape on a datum tower while another (off camera) measures the distances from it to all the other control points.
PHOTO **S.H. Snowden**

Divers take a GPS reading at one of the datum towers.
PHOTO **P. Baker**

Photogrammetry (continued)



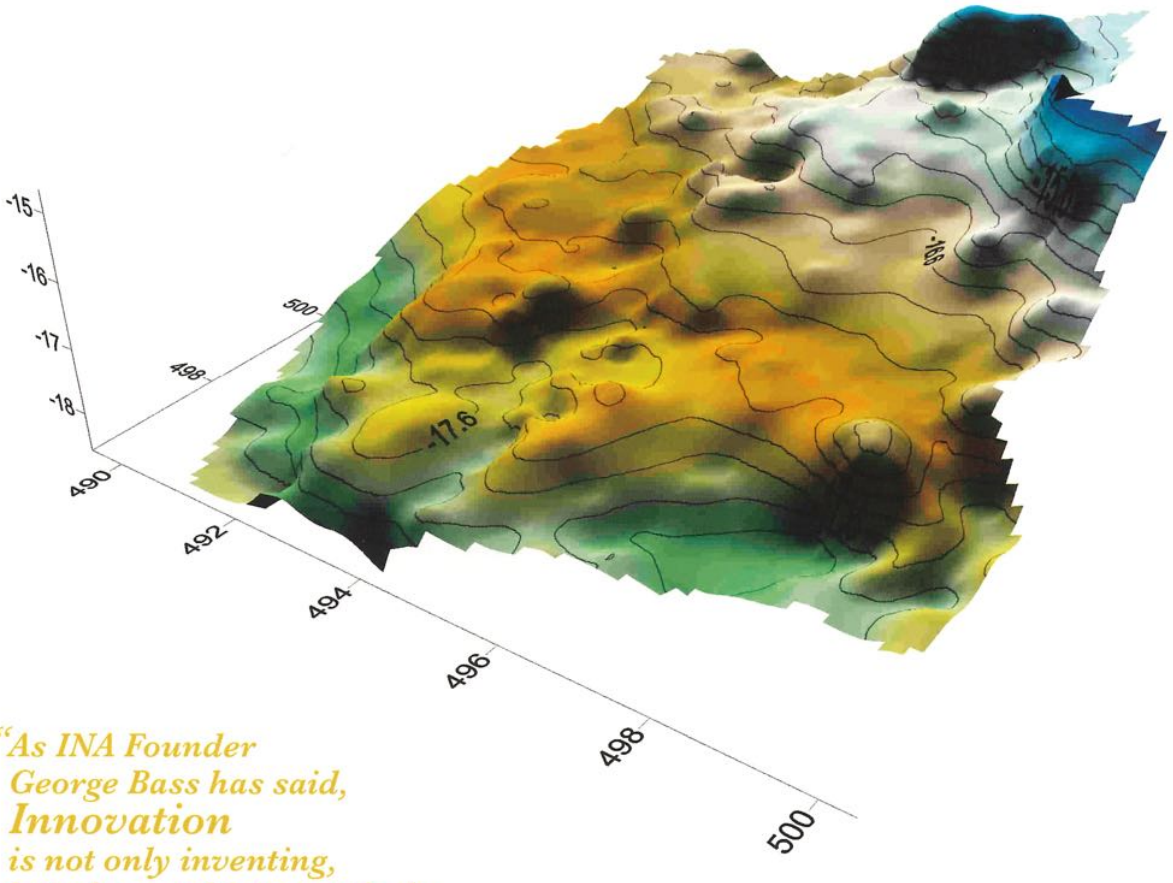


lished their true global positions using a GPS unit in an underwater housing connected to a receiver floating on the surface above. With the control network established, artifact mapping was then a fairly simple matter. Our designated site mapper would take a series of photographs under water using a calibrated camera. The photographs were taken from differing lines of sight, but each one included the object of interest and at least three common control points. Once back at the expedition house, the pictures were downloaded onto the computer and processed with PhotoModeler.

Instead of having pairs of divers measuring multiple distances underwater with meter tapes, a single person could replicate this work in the virtual world of digital photographs, allowing the rest of the team to dedicate more valuable bottom time to excavation.

As artifact locations were plotted successfully, their coordinates were exported to the drafting program AutoCAD® and marked on the digital site plan. Three-dimensional models of the objects were also drawn with AutoCAD and overlaid on their corresponding points. In this way, we created both 2- and 3-dimensional plans of the wreck site. In much the same way, we covered sections of the site at a time with hundreds of small, white ceramic tiles, which we mapped with PhotoModeler and combined in AutoCAD to produce a digital terrain model of the seabed.

Our mapping method was basically the same as what was used at Pabuç Burnu, Turkey, which was the first INA excavation to rely solely on photogrammetry for site mapping. The system, however, was pioneered during INA's previous excavation of a Classical shipwreck at Tektaş Burnu. Expedition team members mapped artifacts using direct tape measurements from datum points, while a dedicated diver mapped the site in parallel using digital photographs and PhotoModeler. In this way, the photogrammetry results could be compared to manual measurements for accuracy, and benefits such as reduced



"As INA Founder George Bass has said, ***Innovation*** *is not only inventing, but also working creatively to apply existing technology in new ways to solve underwater problems."*

time mapping under water could be quantified. The system proved extremely successful, providing both greater accuracy and efficiency. It was estimated that divers using this method of photogrammetry spent as little as one-quarter of the bottom time that they would have otherwise mapping by direct measurements.

The groundwork for this innovation and improvement was laid during INA's excavation of the Byzantine shipwreck at Yassıada, Turkey, from 1961 to 1964, which proved to be a virtual-underwater laboratory for developing and proving different means of mapping artifacts and hull remains. Early on, the team mapped much of the site with plane tables, marking the first time these were used for underwater surveying. The technique, though, was time consuming and required at least three divers working in close coordination.These and other drawbacks led the team to look for better and more efficient ways to map the site. For recording areas of the wreck that contained many artifacts, the team instead used mapping frames, which they assembled over each area of interest. They also pioneered the now standard practice of placing meter grids directly over the wreck, both for orienting divers to specific work areas and for locating and sketching objects.

Ultimately, though, they needed a more detailed and accurate method of mapping when it came time to record the wreck's hull remains. It was then that the team turned to photogrammetry, adapting the method used for aerial surveying to conditions under water. The system they devised was

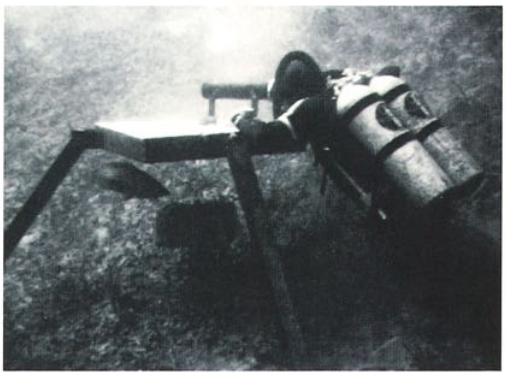
ABOVE
3D surface contour map of the seafloor in 2009 at the Bajo de la Campana shipwreck site.
IMAGE **J.L. Casabán**

FACING PAGE
José Casabán photographing a small object in situ using a graduated meter grid.
PHOTO **P. Baker**

Divers calibrating the underwater mapping camera at our anchorage just off the site at Bajo de la Campana.
PHOTO **P. Baker**

Screen shot from the PhotoModeler program during processing of mapped points.
IMAGE **J.L. Casabán**

BELOW
Mapping by plane table at Yassıada.
PHOTO **H. Greer**
(INA Archives)



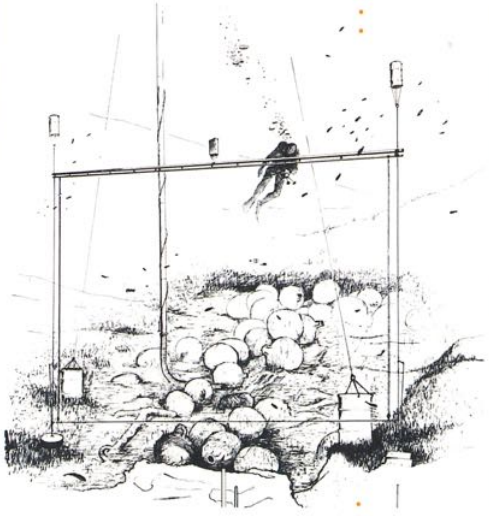
"INA's excavation of the Byzantine shipwreck at Yassıada... proved to be a virtual underwater laboratory for developing and proving different means of mapping artifacts and hull remains."

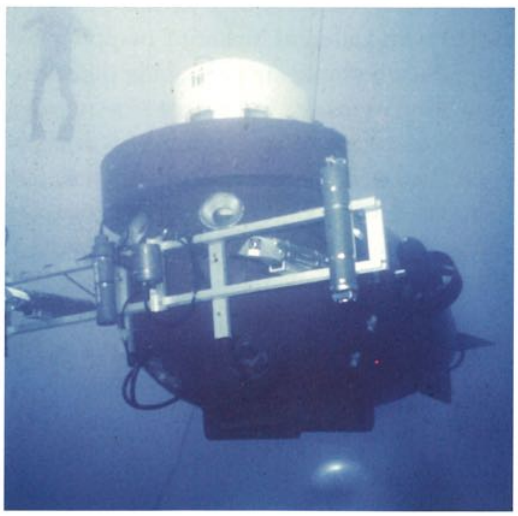
"step-frame" mapping. They constructed two 4-meter-high photographic towers, each fitted with a 2-meter-square wire grid at their base, from which they took sequential and overlapping pictures to form stereo pairs that gave a three-dimensional image of the wreck when viewed through a Zeiss stereoscope. The towers were moved across the wreck site on a series of metal frames that stepped down the sloping seabed—hence the name. Through continuous tweaking, the use of corrective lenses, and working out ingenious techniques to correct for parallax, scale distortion, and other problems, they developed a system that worked extremely well and allowed for quick and accurate mapping of the wreck. During their final field season, the team even experimented with mapping photogrammetrically from *Asherah*, the first submarine designed and built for archaeology (another INA innovation).

When INA excavated the so-called Glass Wreck at Serçe Limanı during the late 1970s, many of these same surveying techniques were used. However, excavators were faced with the daunting task of mapping hundreds of thousands of fragments of broken glass, pottery, and other artifacts. It was here that INA first implemented the "lots" system for mapping non-diagnostic fragments relative to the site grid (a system commonly used on terrestrial excavations and now standard INA practice), rather than trying to map each piece individually.

But it was the advent of computers and their application to archaeology that truly allowed mapping—especially photogrammetry—to come into its own. At Bozburun, Turkey, where INA excavated a Byzantine shipwreck, the team used direct tape measurements and WEB to map artifacts and hull timbers for the first time. Since such measurements do not have to be coplanar, i.e., horizontal, time-consuming plumb line measurements are not required. This simplification is only possible because computers are able to process large amounts of measurement data through iterative calculations to find best-fit solutions for the points being surveyed; a computation that would be unsolvable without the speed of computer processing.

As computer and digital technologies race forward at breakneck speeds, processors are becoming faster, data storage devices larger, optics better, and the portability of computers and digital SLR cameras ever more convenient, even to locales beneath the sea. And so, as we have seen, on INA's next field project at Tektaş Burnu (1999-2001), photogrammetry truly came into its own. Freed of the limitations of older film cameras and lenses, and equipped with ever more powerful computer programs, photogrammetry is delivering highly accurate and more diagnostic results quicker and easier than ever, allowing excavators to focus more of their efforts under water on excavation and other tasks.





BELOW (left to right) Illustration of the stereophotogrammetry used to map parts of the site at Yassıada. DRAWING **E.J. Ryan**

Measuring parallax on a pair of stereo photographs using a Zeiss stereoscope. PHOTO **G.F. Bass**

Asherah was the first submersible built specifically for archaeological research

As INA Founder George Bass has said, innovation is not only inventing, but also working creatively to apply existing technology in new ways to solve underwater problems. It was such innovation that allowed INA to be the first to reconstruct on paper an ancient ship's hull from thousands of wood fragments mapped on the seabed; to sort a million or more broken glass shards and reconstitute the world's largest collection of medieval Islamic glassware; to map the wreck sites of Archaic and Classical Greek ships in the Aegean, and an Iron Age Phoenician shipwreck on the far side of the Mediterranean. What the next leap forward in photogrammetry and digital mapping will be no one can say for sure, but the possibilities seem truly limitless. Undoubtedly, INA will be there, in the forefront, leading and innovating as it always has, from Yassıada to Bajo de la Campana and beyond.

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José Luis Casabán is a Nautical Archaeology Program PhD student at Texas A&M University and an INA Research Associate.

Further reading:

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INA projects

In conjunction with Texas A&M University's Nautical Archaeology Program, the University of Udine, Tidewater Atlantic Research, the University of Zadar, and other partner organizations and institutions, this year INA will conduct 20 archaeological projects around the globe in the United States, Canada, Bermuda, Turkey, Spain, Italy, Tobago, Ukraine, Japan, Jamaica, the West Indies, and Brazil. Eleven of the projects are ongoing, while nine are new initiatives.

*New projects are marked with an asterisk**

ITALY

Anaxum Project*
Directed by Filipe Castro & Massimo Capulli
(Texas A&M University & University of Udine)
The aim of this 2012 project is to survey and record the remains of a Roman bridge over the Stella River (ancient Anaxum) and inspect a number of anomalies detected in a survey conducted in 2011 with a team from the University of Trieste.

BERMUDA

Bermuda Sloop Survey*
Directed by Gordon Watts
(Tidewater Atlantic Research, Inc.)
Inundated areas once occupied by Bermuda Island and Sloop Marsh will be surveyed in an effort to identify the Bermuda sloop that was possibly lost in the vicinity. This was one of the most popular vessel types in the western Atlantic in the 18th century.

BRAZIL

Brazilian Stranded Shipwrecks*
Directed by Rodrigo de Oliveira Torres
(Texas A&M University)
The Rio Grande do Sul coast comprises a 640 km shoreline of a nearly uninterrupted, poorly populated, sand beach, dotted with stranded shipwrecks from various periods of southwestern Atlantic seafaring. This project will study the formation processes in highly dynamic shipwreck sites in southern Brazil.

TURKEY

Burgaz Harbors Project*
Directed by Elizabeth S. Greene (Brock University) and Numan Tuna (Middle East Technical University)
This collaborative project will explore the four harbors associated with the Archaic and Classical maritime site of Burgaz, on the Datça Peninsula, Turkey. The project aims to investigate the development and changing maritime landscape of the harbors and their association with the settlement through its history.

USA - Virginia

City Point Shipwreck Survey
Directed by Joshua Daniel
(Tidewater Atlantic Research, Inc.)
This survey project continues after preliminary analysis of data collected during the 2011 field season tentatively identified 37 wrecks in the tidal flats east of City Point on the James River. Vessels have been disposed of here since the Civil War era, although older wrecks may also be present.

USA - Texas

***Denbigh* Phase IV**
Directed by J. Barto Arnold (INA)
The 2010-11 activities will concentrate on research, analysis, and reporting on the excavation and documentation of *Denbigh*, a Civil War blockade-runner lost at Galveston, Texas in 1865. Following five summers of fieldwork, we now proceed with and concentrate on publication.

SPAIN

Finisterre Project*
Dircted by Miguel San Claudio, José Luis Casabán, Filipe Castro (Texas A&M University)
Finisterre is a small village in the NW of the Iberian Peninsula. One of the most important clusters of shipwrecks to be found there dates to 1596, when a large naval fleet (Padilla's Fleet) was caught in a storm.

JAPAN

Frigate *Ertuğrul*
Directed by Tufan Turanlı and Berta Lledó (INA)
In 2012 the research and conservation of the artifacts from this 1890 Ottoman shipwreck will continue in "The Ertugrul Center." The archaeological team will also participate in the preparation of a new museum that will house these remains.

ITALY

The Immortal Fausto: the Life, Works, and Ships of the Venetian Humanist Vettor Fausto (1490-1546)
Directed by Lilia Campana (Texas A&M University)
An ongoing assessment and study of rare Venetian manuscripts dating from 1500 to 1620. This season continues with detailed study on Vettor Fausto's technical innovations in Venetian naval architecture.

CROATIA

Gnalić Project*
Directed by Filipe Castro (Texas A&M University) and Irena Radić (University of Zadar)
The Gnalić shipwreck site includes the remains of a late-16th century merchantman, perhaps the Venetian round ship *Gagiana*, lost in the area in 1583. This is a tremendously important site for the history of the Eastern Mediterranean in the late 16th century.

SRI LANKA

Excavation of an Ancient Shipwreck at Godavaya
Directed by Deborah Carlson (Texas A&M University), Osmund Bopearachchi (CNRS-Paris), and Sanjyot Mehendale (University of California at Berkeley)
Excavation begins this year following the preliminary assessment of the site which indicated a cargo of raw

and finished materials that includes glass ingots, stone querns, ceramics, and large quantities of iron. Radiocarbon analysis of wood samples from the site points to a date in the first century BC.

TURKEY

Analysis of Artifacts from the Kızılburun Shipwreck
Directed by Deborah Carlson (INA/TAMU)
Since the raising of the remaining six column drums from the Kizilburun shipwreck in 2011, our efforts turn toward the conservation, analysis, and study of thousands of artifacts raised from the site since the excavation began in 2005. In addition, during the summer of 2012 a team of French archaeologists and architects who have been studying the architectural remains of the Temple of Apollo at Claros will visit Bodrum to examine the column drums that were destined for the Apollo temple.

UKRAINE

The Novy Svet Wreck: The Search for Hull Timbers in the Bay of Sudak
Directed by John Albertson (Texas A&M University)
For the 2012 season, the eastern end of the bay will be assessed to determine future survey techniques to be employed in the search of vessels lost in the bay.

SPAIN

Patacho of Pedro Diaz*
Directed by George Schwarz
(US Naval History & Heritage Command)
The discovery and subsequent analysis of the patacho of Pedro Diaz, an example of a little-known but ubiquitous Iberian Age of Exploration work vessel is poised to answer many questions regarding Iberian ship construction and operation during this period.

JAMAICA

Pirates of Port Royal*
Directed by Chad M. Gulseth (Texas A&M University)
After Captain Bartholomew Roberts was killed and his crew captured by the British Royal Navy, a hurricane struck Port Royal in August 1722. Two of Roberts' vessels were lost. One vessel has since been located. In the summer of 2012, the remains of *Ranger* will be documented and a survey will be conducted to locate Roberts' flagship *Royal Fortune*.

TOBAGO

Tobago 1677 Shipwrecks Project*
Directed by Kroum Batchvarov (University of Connecticut) and John McManamon (Loyola University Chicago)
In 1677 a French squadron assisted by a large detachment of troops attempted to wrest control of Tobago from the powerful Dutch West Indies Company. A multi-phased archaeological investigation of the sunken vessels from the battle will begin this summer.

BERMUDA

Excavation of the Galleon *Warwick*
Piotr Bojakowski and Katie Custer-Bojakowski
(Texas A&M University)
The excavation of *Warwick* will continue in 2012. *Warwick* is not only a prime example of late 16th-century warships, but also of the early 17th-century magazine ships that played a fundamental role in supplying English settlements in North America. *Warwick* wrecked while at anchorage in Castle Harbour, Bermuda during a hurricane in 1619.

USA - Lake Ontario

War of 1812 Shipwrecks Project
Directed by Ben Ford (Indiana University of Pennsylvania)
The identification and location of the wrecks of three American warships: *Mohawk*, an unnamed 75-foot gunboat, and *Lady of the Lake* will significantly increase the database of American War of 1812 vessels on the Great Lakes in time for the bicentennial of the war.

TURKEY

Yenikapı: Documenting the Seventh and Ninth-Century Shipwrecks Excavated from the Theodosian Harbor at Yenikapı
Directed by Rebecca Ingram & Michael Jones
(Texas A&M University)
Through careful documentation of two of the site's Byzantine-era ships, dating to the 7th and 9th centuries AD, the investigators hope to understand how the vessels were designed, built, and used by Byzantine shipwrights and seafarers during a period which saw major changes in maritime trade and technology.

CANADA

Yukon River Steamboat Survey
Directed by John Pollack (INA),
Robyn Woodward, Project Archaeologist (INA)
Involves a three-week, late fall project to: locate and catalogue *Glendora* and *Mona*; conduct a detailed assessment of the complex stern of *Victorian* at West Dawson; and conduct a detailed assessment of *Columbian* upstream of Carcross.

These INA projects would not be possible without the generous support of donors, sponsors, partners, benefactors and friends who have supported the fieldwork, excavation and analysis represented in the 2012 projects.

Where in the world?
2012

Adriatic to Africa

The RPM Nautical Foundation 2012 Field Season

BELOW
A 4th-century B.C. wreck site off the coast of Albania.

One of three warship rams discovered on the seafloor near the Egadi Islands.

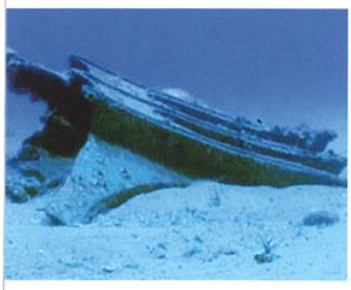
LOWER RIGHT
Map of 2012 RPMNF projects.

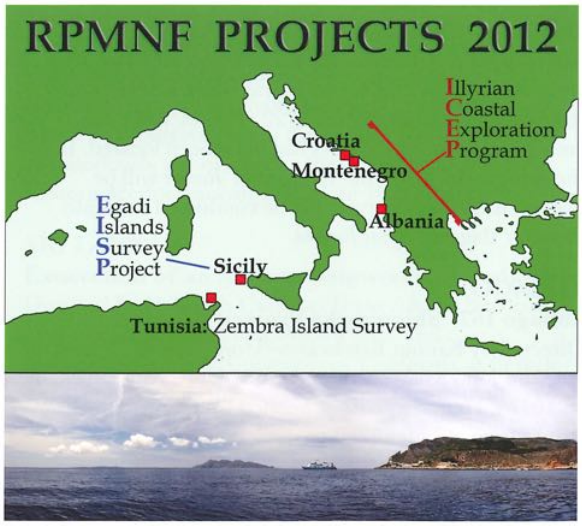
PHOTOS
Courtesy of RPMNF

The upcoming 2012 field season includes the continuation of ongoing projects as well as ventures into new areas. In Sicily, RPMNF and the Soprintendenza del Mare will conduct the eighth season of the Egadi Islands Survey Project (EISP). After confirming the battle zone last season for the Battle of the Egadi Islands in 241 BC, this year's work will focus on mapping and collecting artifacts from the battle event. Last year three warship rams and four bronze helmets were collected. At least four helmets and hundreds of amphoras still remain on the seafloor, and with the majority of the sector not yet explored the potential for finds is great. These finds not only provide the only confirmed ancient naval battle site, but also provide some of the best contextualized weapon and armor finds for the 3rd century BC. A planned collaboration with the University of Nottingham and the Australian Centre for Field Robotics will see cutting-edge AUV recording of the site in order to detect small finds on the seafloor.

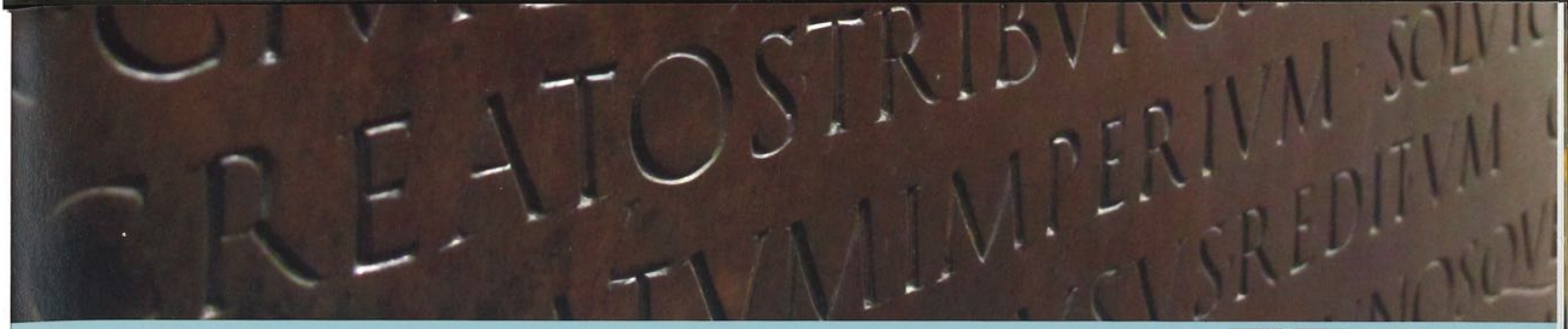
As part of the ongoing Illyrian Coastal Exploration Program (ICEP), the coastal surveys in Albania and Montenegro will continue this year. With five ancient wrecks found last season, which included an interesting 4th-century BC wreck of Corinthian material in Montenegro, prospective discoveries this year are likely. The first year of a maritime archaeological field school will be conducted in Albania this season, a joint venture between representatives from the University of Southampton (Peter Campbell), University of Washington (Derek Smith), University of Transylvania, Albanian Center for Marine Research, and RPMNF. In Montenegro, cooperative efforts and support will be realized between ICEP and the Montenegrin Maritime Archaeological Research Project conducted by the University of Southampton. In addition to research along the Albanian and Montenegrin coasts, this will be the first field season of work in Croatia. A project planned in partnership with the International Centre for Underwater Archaeology in Zadar will begin near the southern Croatian border.

Other inaugural projects for the 2012 field season include the Zembra Island Survey in Tunisia. This planned joint project with the Institut National du Patrimoine will survey the seafloor around Zembra island and over to the nearby western side of Cap Bon. This area is interesting due to it being the transit route between Carthage and the central and eastern Mediterranean. Another research project to be initiated in conjunction with all the survey projects will be a comprehensive amphora analysis for newly and formerly discovered sites. This research effort is in conjunction with Peter Campbell, a graduate student at the University of Southampton, and will include students and professors from the University of Southampton, Bologna University. Samples from the amphoras will be taken to ascertain the origin of the clays used in their manufacture, an independent dating assessment through thermoluminescence, and DNA samples in order to exactly determine their contents. This will result in an exhaustive database that will benefit archaeologists and provide opportunities for students.





Jeffrey Royal, Ph.D.
Director, RPM Nautical Foundation



Kızılburun in Lyon

In summer 2011, INA completed the excavation of a ship that sank at Kızılburun, Turkey, very probably in the first century B.C. while transporting 60 tons of newly quarried white marble from Proconnesus Island in the Sea of Marmara. Some marble pieces in the Kızılburun cargo had been roughly carved into basins, blocks, and headstones, but the heaviest pieces were eight unfluted column drums and a single Doric column capital. Preliminary metrological study of the drums' dimensions, the ship's route and the date of its sinking suggest that the column parts were almost certainly destined for the façade of the Temple of Apollo at Claros.

In January 2012 I had the distinct pleasure of participating in a two-day symposium dedicated to the ongoing excavation, analysis, and interpretation of finds from the Temple of Apollo at Claros. The opportunity to join a group of the world's leading archaeologists, historians, and epigraphers to discuss the most provocative aspects of one of the ancient world's greatest oracular temples comes along once in a lifetime. Nearly two dozen scholars presented papers devoted to various aspects of the site including the development of the sanctuary, the architecture of the temple, the nature of the cult, the operation of the oracle, the inscriptions, votive offerings and small finds.

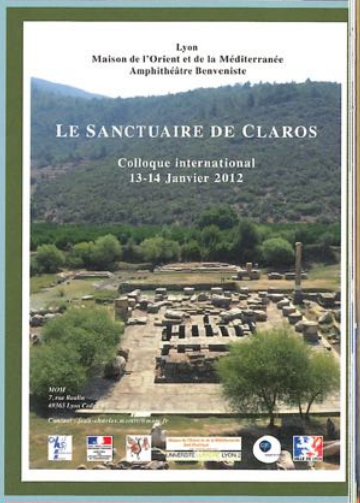
What made the Claros colloquium doubly enchanting is that it was held at the Maison de l'Orient et de la Méditerranée in Lyon, France. Just two hours from Paris and an hour from the French Alps, Lyon is the birthplace of modern French cuisine. The most traditional dining venues in Lyon are the *bouchons*, or family taverns that serve hot, hearty meals which almost always involve homemade sausages. And lest anyone worry about going thirsty, the official marker of Lyon's Bouchon Association is a red-nosed marionette with wine glass in hand – a poignant reminder that the vineyards of Beaujolais lie just north of the city.

In the 15th century Lyon was an important textile center, as evidenced by numerous Renaissance buildings and homes still standing in Vieux Lyon (the old city); many of these structures are still connected by a fascinating network of *traboules* or passageways used by silk weavers to move their goods in inclement weather. The *traboules* proved equally important for members of the French Resistance during World War II.

At the time of the Kızılburun shipwreck, modern Lyon was ancient Lugdunum, capital of the Roman province of Gaul and named after the Celtic god Lugus. Adjacent to the two first-century BC theaters in modern Lyon is the Musée Gallo-Romain, which is home to fantastic artifacts including a Roman water pump carved from a single block of oak and an incredible 500-pound bronze sheet inscribed with the text of a speech made by the Emperor Claudius in AD 48. Incidentally, among the thousands of important antiquities in The Louvre are several headstones of white Proconnesian marble from Smyrna (modern Izmir) which are contemporaneous, sculpted versions of the roughly-finished grave stelai excavated from the Kızılburun shipwreck.

One of the discussion points that arose following my presentation on the Doric column recovered at Kızılburun and destined for the Temple of Apollo at Claros concerned the source of the lost column: was this a communal civic act or an individual benefaction? While we are not in a position at present to answer this question, it is one of many driving collaborative research efforts between myself, French archaeologists Didier Laroche and Jean-Charles Moretti, and Claros excavation director Nuran Şahin; my sincere thanks to all of them for their hospitality, collegiality, and generosity.

—**Deborah Carlson**, Ph.D., Kızılburun Archaeological Director



FROM TOP
TOP: *Tabula Claudiana*, a bronze tablet, inscribed with a speech delivered by the Emperor Claudius.

One of several sculpted headstones from Smyrna, now in the Louvre.

The cover from the Claros symposium program.

The official marker of Lyon's Bouchon Association.

PHOTOS **D. Carlson**

TECHNOLOGY Today

New Capabilities in Wood Conservation

Donny L. Hamilton, Ph.D.

The Conservation Research Laboratory (CRL), directed by Dr. Donny L. Hamilton, is one of the oldest continuously operated conservation laboratories that deals primarily with archaeological material from shipwrecks and other underwater sites. Operating under the Center for Maritime Archaeology and Conservation (CMAC), CRL plays an important role in the Nautical Archaeology Program at Texas A&M University (TAMU), and works closely with all of the excavation projects of the TAMU-affiliated Institute of Nautical Archaeology. In fact, TAMU students are a big part of the work done at CRL. It is a great place to gain practical experience in conservation science.

FACING PAGE

(clockwise from upper left) *La Belle* rises out of her PEG filled tank for a viewing by INA Directors last November. PHOTO **Po Wan**

The freeze drier is installed at the Conservation Research Laboratory. PHOTO **Po Wan**

La Belle has been removed from the vat and disassembled. The hull will be freeze dried in batches and is scheduled to be delivered to the Bob Bullock Texas State History Museum in Austin, Texas by August 2013. PHOTO **CRL**

Any research center conducting shipwreck excavations or waterlogged wood conservation has to have adequate conservation facilities to stabilize the wood. When wood is submerged in water, over time, all the soluble sugars, starches, and organic acids leach away. Then the cellulose of the cells starts breaking down, and finally the lignin starts to deteriorate. Over the centuries the water content continues to increase and it is the water that maintains the overall shape of the wood. If not treated, the surface tension of the water collapses the wood as the water evaporates. For more than four decades, the most common conservation process has used polyethylene glycol (PEG) to replace the water and to bulk the cells to prevent them from collapsing when the wood dries.

There have been a lot of changes in the Institute of Nautical Archaeology (INA)'s conservation abilities since the 1970s when Robin Piercy was setting up PEG vats in the Museum of Underwater Archaeology in Bodrum, Turkey to conserve the wood remains of the Bronze Age shipwreck from Cape Gelidonya. I was doing the same thing at the Texas Archaeological Research Laboratory at The University of Texas at Austin conserving the keel of one of the ships of the 1554 Spanish Plate Fleet wrecked on the Texas coast. When I joined the Nautical Archaeology Program faculty in 1978 and established the Conservation Research Laboratory (CRL), wood conservation was a low priority. There was a major shift in INA's conservation priorities in 2004, when as INA President I approved the completion of the Nixon Griffis Conservation Laboratory at INA's Bodrum Research Center (BRC), which allowed INA to move most of its conservation activities from the Museum of Underwater Archaeology (housed within a Crusader castle) to its own conservation laboratory. Now the wood from the Kızılburun shipwreck and the ships Dr. Cemal Pulak excavated at Yenikapı are being conserved at the Hethea Nye Wood Conservation Facility at the Nixon Griffis Conservation Laboratory. INA now has the ability to conserve waterlogged wood on a large scale.

There was a similar, but much more dramatic improvement in the wood conservation abilities of CRL in College Station, Texas. In 1995 the Texas Historical Commission discovered La Salle's ship, *La Belle*, which sank in Matagorda Bay in 1686. Since CRL is a well-established conservation laboratory with staff who have extensive experience in shipwreck conservation, CRL was awarded a contract to conserve the artifacts and hull remains recovered during the 1996-97 excavation seasons. When the disassembled wood components were delivered to CRL in a series of vats in 1997, the dirt and sea life were removed, along with the wooden treenails and the remains of all iron fasteners. Instead, epoxy fasteners were inserted into the different holes in order to reassemble the ship. Following that process, every plank, the frames, and the keel were documented.

The excavation of *La Belle* was a high-profile project, and because it was carried out inside a drained cofferdam and thus visible to the public, it was decided that conservation of the ship should not then be an out-of-sight, out-of-mind process within a dark brown sea of PEG. The solution was to construct what is probably the largest wood conservation vat in the world where the ship is being conserved by submergence in PEG. The finished concrete vat is 60 feet long, 20 feet wide, and 12 feet deep, with a large steel lifting frame that can be raised and lowered with four large winches. If filled to capacity, the vat holds 86,000 gallons of liquid. Importantly, the reassembled hull can be lifted out of its PEG bath at any time for viewing or documentation.

The original intent was to conserve *La Belle* by the widely accepted two-step PEG treatment. The first step was to slowly increase the low molecular weight PEG (200) concentration to 30% to ensure that the PEG penetrated the dense interior wood. In the second stage, the vat was to be drained and replaced with 20% high molecular weight PEG (3350) and slowly raised to a concentration of 70%. One reason for making this decision was the offer from a major chemical company to supply us with all the PEG at no cost. However by the time the treatment

started, the company could no long afford to supply us with the required PEG, but allowed us to purchase it at manufacturer's cost. Unfortunately by the time we reached the required 30% PEG 200, the price of PEG had increased substantially, and when the cost of the PEG 3350 was calculated, the expense was more than $1 million. Obviously something had to be done to reduce the cost. This situation underscores the importance of flexibility in conservation, for changing circumstances mean that it is not always possible to carry through a specific plan.

Back in the early conservation planning of *La Belle*, freeze drying was considered, but at the time was a more expensive option than the two-bath PEG treatment. Yet, given the current circumstances, it has become more economical to switch processes. In freeze-drying, water in the wood freezes and then over time converts to a gas, leaving the wood without distorting it. If we were going to undertake this change, it was the ideal time, since freeze-drying requires a pretreatment of 18 to 20% low molecular PEG. The first step of the two-bath PEG treatment is essentially the same, so all we had to do was dilute the PEG 200 bath that the wood was in at the time and then let the wood soak in a shallow vat of PEG 3350 (35-38%) to provide additional stability and more mechanical strength to the deteriorated wood.

SP Industries was contracted to build a freeze drier that is 40 feet long, 8 feet in diameter, and cost approximately half a million dollars once a steel building was constructed over it. This not only saved about half the cost of the PEG 3350, it also cut off a year or more from the conservation time table. Now CRL has the world's largest freeze drier devoted to the conservation of waterlogged ship's wood, as well as the largest PEG conservation vat.

Since CRL does extensive contract conservation projects, we will be able to conserve ship remains from other projects at a competitive rate. Already, we have been contacted about conserving the wood from several planned projects once *La Belle* is completed in August 2013. Presently there is no conservation laboratory in the United States that can compete with the wood conservation capabilities of CRL.

Donny L. Hamilton
Professor of Anthropology
Abell Chair in Nautical Archaeology,
Yamini Family Chair in Liberal Arts

The ARCHAEOLOGY of Battle

MAGNETIC SURVEY OF BACH DANG IN VIETNAM

FACING PAGE
Dave Ross (left) and John Pollack, with the Total Station, surrounded by a group of Vietnamese children, and our interpreter Minh.
PHOTO **R. Sasaki**

A worker walks down a path between two inundated rice paddies.
PHOTO **V. Morriss**

Veronica Morriss surveying with the gradiometer.
PHOTO **D. Inglis**

In the 13th century, the Khans of Mongolia forged the largest empire in the world using a combination of cunning diplomatic tactics and military force based on swift and brutal cavalry units. Their seemingly unstoppable conquest of the world ultimately collapsed upon the high seas in Asia. An ingenious strategy devised by Vietnamese General Tran Hung Dao in AD 1288 turned the tide of war by luring a massive Mongol and Chinese fleet into a trap along the Bach Dang River. Vietnamese forces had secretly buried thousands of sharpened wooden stakes beneath the waves. When the tide ebbed, the Mongol fleet found that they were surrounded by a barricade of stakes which immobilized their vessels. Legends tell us that the greatly outnumbered Vietnamese forces fell upon the fleet and destroyed over 400 ships during this battle on the Bach Dang River. Today, General Tran Hung Dao is still venerated as a national hero who maintained the independence of Vietnam.

ARCHAEOLOGY OF THE BATTLE

The mighty Bach Dang River has shifted course over the last seven centuries, and the construction of dykes along the river has completely altered the landscape. Regions where river channels once ran have been converted into flat rice fields. In the 1950s, some 700 years after the battle, farmers started finding large wooden stakes buried in their rice paddies and Vietnamese archaeologists determined that these were the same stakes used to trap the Mongol fleet. Further investigations revealed numerous stake fields in the region, however, no other types of artifacts related to the invasion were identified.

An international research team was formed in 2008 to undertake a large-scale survey, with members from INA, the Maritime Archaeology Program at Flinders University, as well as members from Southampton University and the Institute of Archaeology at Hanoi. The results of the initial surveys have been published in the 2008, 2009 and 2010 editions of the *INA Annual*, and the Bach Dang research blog can be viewed on the INA website at www.inadiscover.com.

Archaeology provides unique insight into how humans adapt to and view their natural environment. In a sense, a ship is a tool that shows how well humans understand the forces of nature – the wind, waves, and other physical processes. At Bach Dang, it is the strategic use of land, as well as the river and the tides, which best demonstrates how our ancestors understood the natural world. We discovered that the Vietnamese used both the natural barriers (such as small islands and rocky shoals) and artificial barriers (the wooden stakes) to block the Mongol fleet and it was this knowledge that changed the course of history.

The objective for the 2011 field season was to test several geophysical survey methods, and determine which would be most helpful in recreating the ancient environment and locating diagnostic artifacts, including buried ships and stake yards. These methods included 1) collecting sediment cores to reconstruct the ancient landscape, 2) using Ground Penetrating Radar (GPR) to look for buried features and to analyze sedimentary profiles, 3) conducting a gradiometer survey to find magnetic anomalies, and 4) using side scan sonar systems to search for exposed stakes and ship remains in the region's ponds and canals. We used a Total Station to record the survey area so that we could incorporate all of the data into a Geographic Information System (GIS) map for integrated analysis. While the majority of the data we collected during the survey in 2011 are still being analyzed, a portion of the results from the gradiometer survey are available.

MAGNETIC SURVEY METHODS

A gradiometer is a device that measures anomalies in the earth's magnetic field. It has two cesium sensors that identify magnetic fluctuations caused by buried iron, such as nails in the hull of an ancient ship, or materials that have been heated, such as bricks or pottery. In this case, having two heads is better than one. The two sensors can filter out "real" anomalies from the background noise caused by the soil, solar flares and other sources of magnetic interference. Another advantage is that gradiometers can precisely detect minute signatures and the orientation of anomalies.

The gradiometer is heavy, awkward and uncomfortable to carry. Our survey team affectionately called it "The Rack of Pain." The cesium sensors are mounted on the end of a long unwieldy counterweighted boom, and are connected to a computer that hangs from the operator's neck. A Global Positioning System (GPS) antenna mounted on a pack frame constantly tells the computer where the operator is standing, and how quickly he or she is moving. The whole kit is powered by a pair of surprisingly heavy batteries, and in total weighs some 50 pounds.

To survey the area, we walked back and forth in parallel lines spaced a few meters apart. The whole process is very similar to mowing a lawn, though instead of cutting grass, a swath of data is collected. The GPS sent signals to indictate if we were walking in a straight line or veering off course. While surveying rice paddies, it is almost impossible to stay on course. The fields provide a difficult environment in which to maneuver. Some were inundated, and we risked sinking up to our knees in mud. Others were dry, but had been turned with a mattock, so the large dirt clods would shift and roll underfoot. It is a wonder that no one twisted an ankle. There were always farmers working nearby and their tools often interfered with our sensors. We in turn had to be very careful not to trample their rice plants.

The gradiometer emits an audible signal to help "visualize" the magnetic fields in the area being surveyed. When the device senses a strong magnetic field, the pitch rises; when the field weakens, the pitch lowers. By listening to the signal, and sweeping the sensors back and forth, the shape and strength of a magnetic anomaly can be "pictured." Back in the lab, data uploaded from the sensors and the GPS were used to create a map of the magnetic hot spots in the survey area.

INTERPRETING THE DATA

Our search covered a wide area, and we identified over 100 magnetic anomalies (designated by an "M" followed by numbers in sequence). Finding anomalies is the easy part – interpreting them is much more complicated.

MAGNETIC SURVEY OF BACH DANG continued...

FACING PAGE
Magnetic anomolies in the West Field of Dong Ma Ngua
IMAGE **J. B. Pelletier**

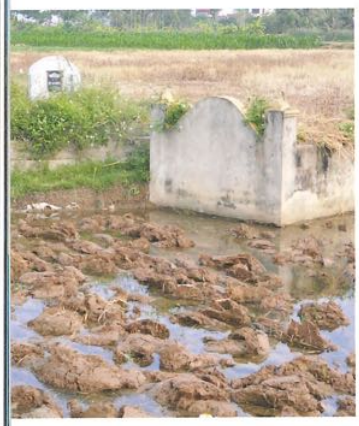
Many anomalies corresponded to piles of discarded material, old graves, or infrastructure; if these disturbances were above ground we could easily eliminate them as potential shipwrecks. However, this still left a wide variety of anomalies, large and small, that we needed to investigate. We explored a few strong, peculiar signatures while we were in the field. One small test pit yielded some 19th or early-20th century ceramics and an iron nail; another test pit showed that the anomaly was caused by a strange pocket of iron-rich soil. We were also able to identify anomalies associated with trash pits and a possible burial. Further exploration was inhibited because we did not have permission for a full excavation, and we could not process all of our magnetic data in the field.

The main question facing us was, "What would the magnetic signature of a shipwreck or stake yard look like – particularly after 700 years of decay?" The gradiometer senses changes in magnetic field strength, but cannot provide more information about what causes those changes. A pile of iron bolts buried several meters deep will give off the same signature as a nail just under the surface. The magnetic signature created by a shipwreck is the product of several factors: how much of the vessel has survived, how much iron was used in the construction, how extensively the iron has corroded, and how deep it is buried.

BELOW
Modern graves in a inundated field.
PHOTO **R. Sasaki**

Doug Inglis walking through the rice field.
PHOTO **V. Morriss**

We have developed a model for the signature of a buried Mongol vessel based on existing data. Our primary challenge was to estimate how much iron would remain per square meter of soil. It is probable that most portable iron objects, such as helmets and swords, would have been recovered after the battle. It is even possible that the iron fasteners would have been salvaged from the hull. Legend has it that the fleet was destroyed by fire ships, so hull remains may be limited to a small portion of the vessel.

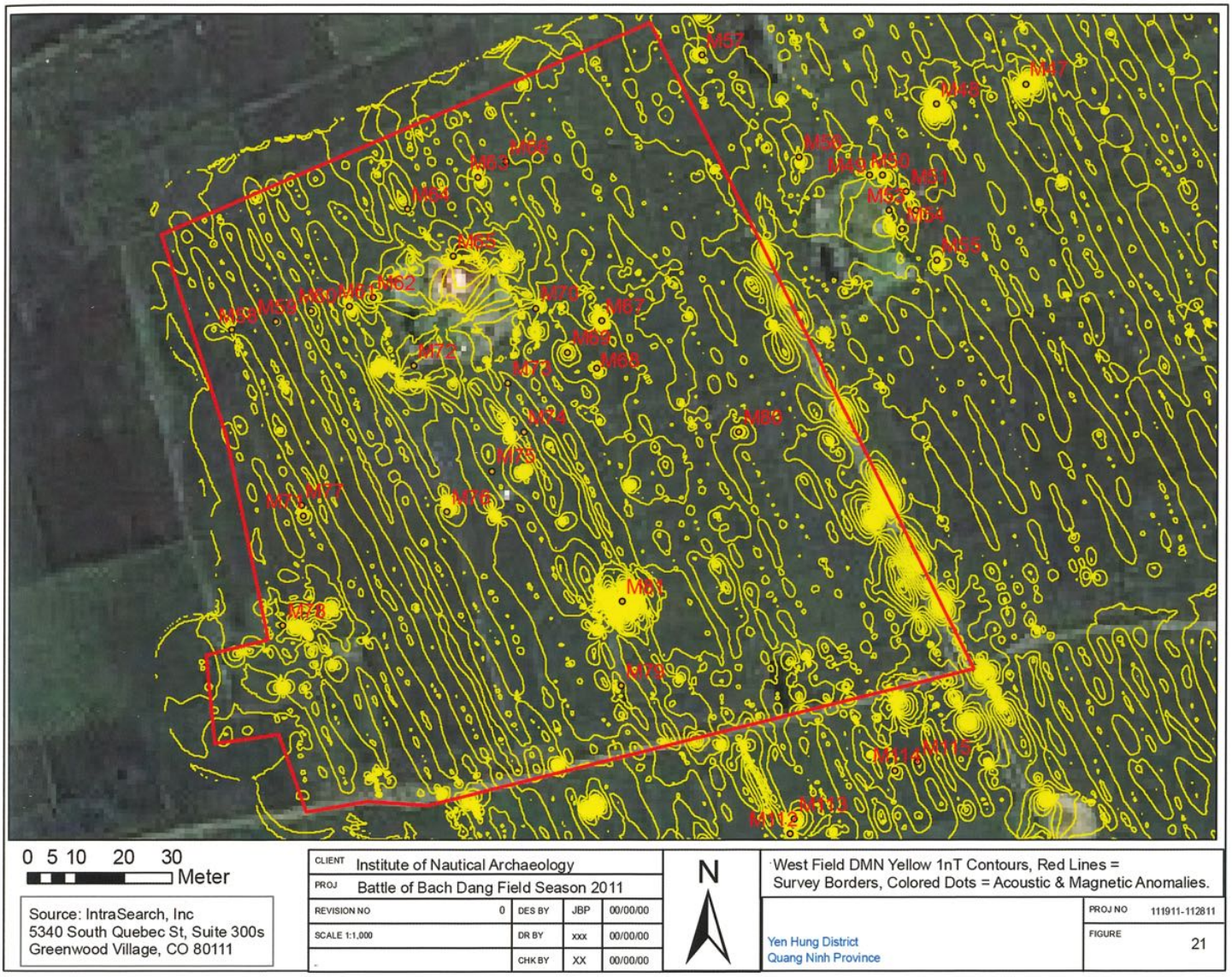


If we assume that only a small portion of the hull survives – maybe four or five strakes on a side – then we can estimate the amount of iron fasteners in a ship's wooden hull based on our understanding of Chinese ship construction from sites including the Shinan and Quanzhou shipwrecks, and the Takashima site from Japan. Compared to Western built ships, Chinese shipwrights used an enormous quantity of iron fasteners to attach multiple layers of planking. Nails averaged 20 to 35 cm in length and 0.8 to 1.5 cm in section. The first layer was held together with these large nails driven diagonally at intervals of 12 to 20 cm; additional layers were attached with smaller nails. However, over the last 700 years, those nails would have corroded in the damp river sediments, losing 60 to 80% of their mass. Considering corrosion, a shipwreck should emit a signature similar to 120 to 400 g of iron in a one-meter area. This assumption leads us to believe that a partially extant, deeply buried shipwreck will produce a diffused, low amplitude anomaly spread over a large area. We can disregard small, high amplitude anomalies which are probably trash or graves.

RESULTS FROM WEST FIELD OF DONG MA NGUA

An area approximately 560 m wide and 1000 m long was partitioned into smaller blocks in preparation for survey. This 1.73 hectare area, known as the West Field of Dong Ma Ngua (DMN) was home to 24 anomalies identified during the magnetic survey. Most (19) of the anomolies are associated with the modern graves that surround the large burial mound, situated in the northeast corner of the field.

We found two areas with anomalous magnetic responses that require further investigation. The first is adjacent to the burial mound and consists of a series of five magnetic anomalies from M58 to M62. These anomalies all have low amplitude deflections, relatively short durations and simple magnetic signatures. This means that we would normally classify them as graves. However, all of the anomalies are neatly aligned east to west and are regularly spaced 7 to 8 m apart. No other anomalies display this linear nature and consistent spacing. Anomaly M58 was detected for a distance of 10 m. At a depth of roughly 5 m, 6.22 kg of metal would create a similar signature to M58. This quantity of iron is very close to our estimates for a shipwreck. The adjacent anomalies



M59 and M60 have less iron, but were perhaps once part of a larger mass. The only other anomaly in the West Field of DMN that has characteristics remotely similar to a buried vessel is M78, located in the southwest corner. M78 has a duration of 15 m and a relatively complex pattern of magnetic centers with a somewhat rectangular distribution. Both patterns are fairly mysterious, and not easily interpreted. Another survey with tight coverage will help us define their shape and strength; however, test excavation is the only certain way to determine what they are. It is our hope that as we continue to refine our survey methods, we will uncover more clues to the lost history of the Bach Dang River and its famous battlefield.

Randall Sasaki, M.A., *INA Research Associate*
Jun Kimura, Ph.D., *INA Research Associate*
Veronica Morriss, *Ph.D. student, Nautical Archaeology Program, Texas A&M University*
Doug Inglis, *Ph.D. student, Nautical Archaeology Program, Texas A&M University*

ACKNOWLEDGMENTS
Our thanks for the generous contributions from Claude and Barbara Duthuit, as well as other INA members. We would like to thank Dr. Le Thi Lien from the Institute of Archaeology at Hanoi, who has been a partner of the project from the very beginning. We also appreciate all of those who participated in this field season. Last but not least, we express our appreciation to the people of Vietnam who have allowed us to investigate their national heritage.

The Oldest Known Ship in the Indian Ocean

LOGISTICS FOR AN UPCOMING INA EXCAVATION

INA Associate Director Ken Trethewey (left) with Osmund Bopearachchi of the Centre National de la Recherche Scientifique (CNRS). PHOTO **A. De Saxcé**

In December of 2010, INA President Deborah Carlson and INA Archaeologist Sheila Matthews traveled to the south coast of Sri Lanka to investigate a shipwreck that had been discovered by fishermen several years earlier (see *INA Annual*: 2010 Projects and Research, pages 89–95) and brought to the attention of Dr. Sanjyot Mehendale of the University of California at Berkeley and Dr. Osmund Bopearachchi of the Centre National de la Recherche Scientifique (CNRS) in Paris.That trip laid the groundwork for further exploration by establishing relations with local archaeologists, recovering artifacts and samples for dating analysis, and initiating a logistical assessment of the area with an eye toward future excavation of that particular shipwreck.

Preliminary results of the dating analyses suggested a date in the second or first century BC, which would make the Godavaya wreck the earliest known shipwreck in the Indian Ocean. However, large amounts of iron on the site seemed inconsistent with such a date and suggested the wreck might be dated to a later period.

FACING PAGE (from Top) Sri Lankan diver drawing and measuring the site area. PHOTO **S. Matthews**

View entering harbour of Hambantota PHOTO **S. Matthews**

The vacant government buidling that will be INA headquarters in Sri Lanka during this project. PHOTO **K. Trethewey**

Leaving the fishing village for last day at the dive site. PHOTO **S. Matthews**

Ceramic pot in situ PHOTO **S. Matthews**

Godavaya temple stupa PHOTO **K. Trethewey**

The day after Christmas, 2011, Sheila and I embarked upon a second trip to Sri Lanka to take more samples for dating, and to look into housing, conservation facilities, and the vessels, compressors, recompression chamber, and other heavy equipment required for excavation. Again Sanjyot and Osmund were gracious hosts, with Osmund conscientiously showing us the sites, introducing us to the necessary people, translating, arranging transportation, and entertaining us indefatigably. We were also joined by Ariane de Saxcé, one of Osmund's students from the University of Sorbonne in Paris.

The shipwreck lies about 15 minutes by small boat from a new harbor being built by the Chinese near Hambantota, and about 30 minutes from the fishing harbor in the heart of town. The seas are fairly calm in the mornings in December, but grow rougher as the day progresses. Surface currents are strong. The monsoon season in the region dictates that the best time for diving operations would be February through May.

The wreck lies at 34-35 m, and visibility was 5-10 m. Artifacts are scattered quite widely on the seabed; with 15 minutes of vigorous hand fanning, and moving farther out from the central pile every time I uncovered more ceramics, I could not find the edge of the scatter.

Having collected additional samples and surveyed the wreck site, we turned our attention to the main things we would need if we decided to come back in order to launch a full excavation: a place to live, work and store artifacts during excavation, a ship or barge to support our operations on the seabed, a recompression chamber, compressors for airlifts and filling cylinders, and so on. INA has all of the necessary ships and equipment in Turkey, but how much of that can be feasibly transported to Sri Lanka?

As on so many occasions, Osmund's contacts on the island proved invaluable. He was able to secure the use of a large government building, currently vacant, a few short blocks from Hambantota harbor. Its proportions are ample enough for housing any size team we might deploy, along with mapping and conservation areas, and the location is nearly perfect. One of the many local fishermen with a fishing boat in Hambantota could be hired to transport the team from the harbor to the site each day, and to deliver oxygen cylinders, fuel, etc. when required. We looked at other possibilities for housing and work space, and even considered our usual method of building a camp, but we could not beat the price of this completely adequate and very convenient option: free.

The question of a ship or barge from which to operate above the site remained. Ideally it needed to be large enough to accommodate 20 or so people, along with a chamber, airlift compressors, diving equipment, a cylinder filling station, and the decompression stop equipment. And the small issue of all that necessary heavy equipment remained as well. So we departed Hambantota for the capital, Colombo, in hopes of scouting the large harbor there for a suitable ship, before our flight back home.

Osmund got us an appointment with a professional marine salvage company, and it quickly

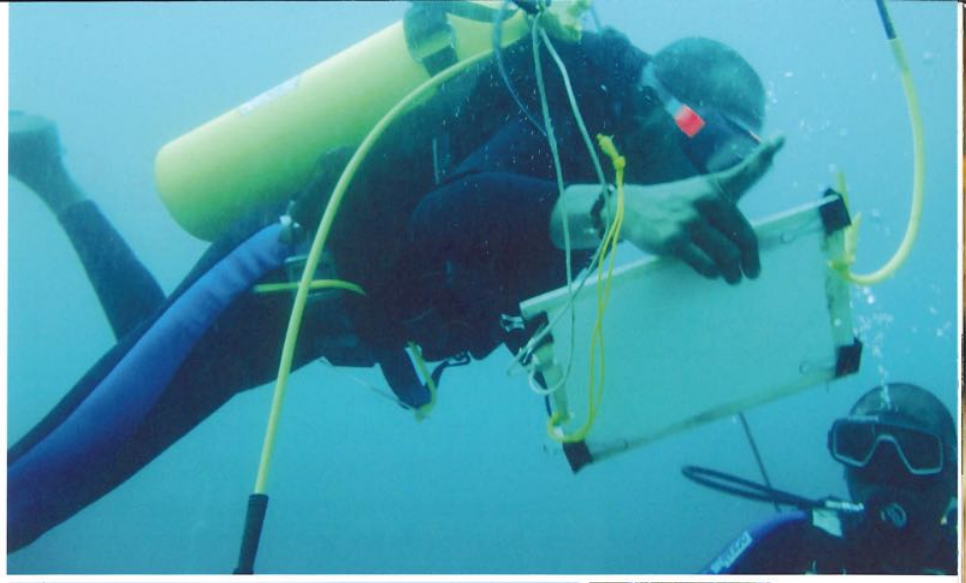
became evident that they indeed have all of the equipment we need, including ships and crews, recompression chambers, and compressors. Of course, renting all that we will need at their listed daily rates would soon burst our budget, but there is always hope that we will be able to negotiate a non-profit rate.

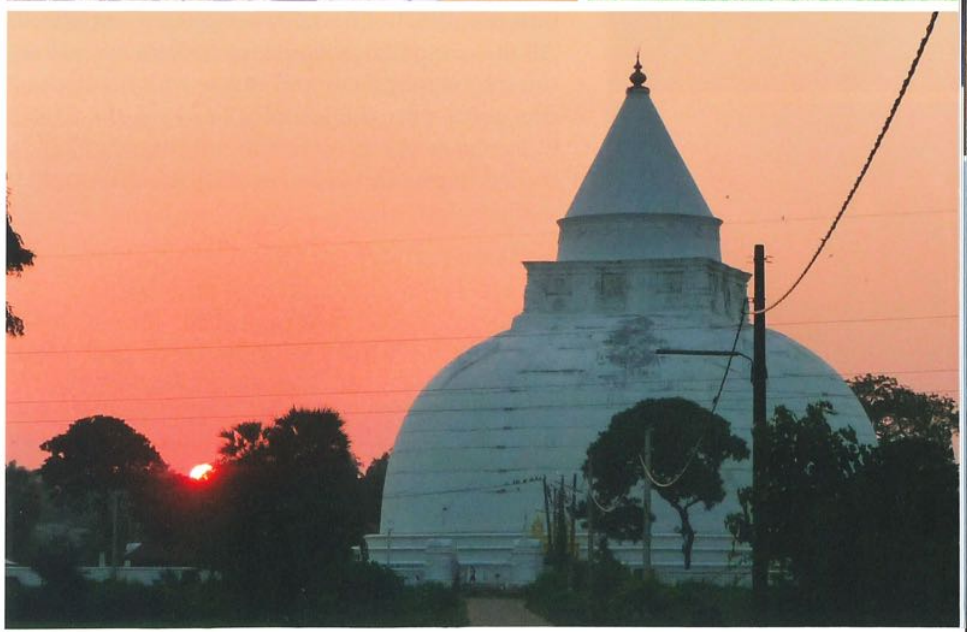
Having achieved our basic objectives, Sheila and I said goodbye to Ariane, Sanjyot and Osmund, and grudgingly departed from the sunny tropical island, hoping that the samples would confirm an ancient date for the wreck. The suspense built as we were forced to wait days longer for the Carbon 14 analyses of the wood samples, as they had been so impregnated with iron that they required a lengthy pre-treatment. At long last we received the results: the two samples yielded a date ranging from the second to the first century BC, so the ship is in fact ancient!

The Godavaya shipwreck presents an exciting opportunity for INA. It will allow us to collaborate with Sri Lankan archaeologists and archaeological agencies, forming bonds that could foster further cooperation and exciting future opportunities. It will expand INA's operations into South Asia and the Indian Ocean. And it will give us a look at a ship and its cargo from the era of the Roman Republic, a ship that may prove to be well-preserved due to the significant iron impregnation of the wood, and that seems to have been carrying a sizeable cargo of many different materials including raw glass, ceramic, and metal.

I would like to thank Deborah Carlson for offering me the opportunity to participate in this preliminary project, which has been made possible by funding from the National Endowment for the Humanities. Ariane, Sanjyot, Osmund and Sheila proved to be delightful companions on this mission, and Osmund was indispensable in Sri Lanka.

—**Ken Trethewey**, Ph.D.
As a student of the Nautical Archaeology Program at Texas A&M University in the late 1990s, Dr. Trethewey was a team member on the excavations at Bozburun and Tektaş Burnu, and served as Dive Safety Officer at Kızılburun.





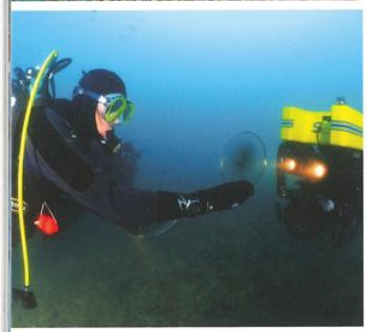
The Gnalić Shipwreck

The Mirror of Renaissance Europe

BELOW
Remains of the ship's hull visible in the trench in 1996
PHOTO **Z. Brusić**

Round window glass still visible on the seabed.
PHOTO **D. Frka**

Archaeological survey conducted in 2011.
PHOTO **M. Brzac**



The Gnalić shipwreck project will begin in 2012, though the site was discovered by sport divers in the early 1960s, lying at a depth of 26 to 29 meters near Gnalić, a small rocky islet situated at the entrance of the Pašman channel, on the North Dalmatian coast of Croatia.

The remains of this late-16th century merchantman have been tentatively identified as the Venetian round ship *Gagiana*, lost in the area in 1583. As a time capsule with a coherent and well preserved artifact collection, this site is tremendously important for the study of Mediterranean seafaring and trade in the late 16th century. Its importance, however, extends far beyond the economic and social history of the Adriatic Sea and the Eastern Mediterranean, as these merchantmen were among the most complex machines of their time. Although its situation and the nature of the artifacts strongly suggest a Venetian identity for this ship, at this point it is impossible to state where it was actually built. During the 16th century it was common for Venetian shippers to build their ships in respectable shipyards outside of Venice, some of them situated along the Dalmatian coast.

Part of the hull remains seem very well preserved, and promise to yield precious information about the vessel's conception and construction. Almost half a century after its discovery, the mapping and documentation methods available to archaeologists, as well as our understanding of the methods used to build these ships, have increased substantially, making this project especially interesting.

The Gnalić wreck was partially recorded and trenches opened during several campaigns over past decades, but never systematically excavated. All the campaigns focused exclusively on raising the ship's equipment and cargo, with no attention paid to the ship's hull. Therefore, the first objective of this project is to fully excavate, record, study, and preserve what was left on the seabed.

A number of artifacts have been raised since the site was first found, and some have been conserved, studied and published. They include a volume and variety of glassware (vessels, beads, window and mirror glass, etc.), brass candelabras, spectacles, sleigh bells, as well as a wooden box with three linen shirts, eight woolen caps and nearly 58-meters of richly decorated red damask.

The ship was also laden with a variety of semi-finished products and raw material, and was armed with guns. Two large iron anchors and eight bronze guns were raised from the seabed. The most significant are a pair of sakers (length 3.5 m; calibre 91 mm) produced in Venice by Giovanni II (Zuan) Alberghetti in 1582. Parts of wooden barrels loaded with cinnabar, cones of lead carbonate and many glass fragments are still visible on the surface of the site, while more material likely lies beneath.

The second objective of this project is to create a comprehensive inventory of the previously raised artifacts, assess their condition, conserve and analyze them for publication.

The third objective will be the virtual reconstruction of this ship using digital tools, and its study in the context of the seafaring world in which it was conceived, built, and sailed.

The end of the 16th century was a period of change in European thought. It was a time for the reassessment of various religious beliefs that had torn the continent apart during that century. The arrival of the Renaissance in northern Europe boosted the rise of maritime nations such as the Netherlands and England, together with the consolidation of the modern state and the maturation of mercantilism as the dominant ideology. And thus, the fourth objective of this project is the study of the unfinished voyage of the Gnalić merchantman in the political and socio-economic contexts of late-16th century Europe and the Ottoman eastern Mediterranean, and the interaction of these two worlds in the upper Adriatic region.

by **Irena Radić Rossi**, Ph.D., Assistant Professor, Maritime Archaeology, University of Zadar

and **Filipe Castro**, Ph.D., Professor, Nautical Archaeology Program, Texas A&M University

Treatment of Decompression Illness
IN REMOTE LOCATIONS

Matthew S. Partrick, M.D.

The Institute of Nautical Archaeology has always been a leader in developing archaeological techniques for the excavation of deep wrecks, which required INA to also be a pioneer in the use of advanced diving procedures to ensure the safety of its scientists. This has included use of mixed gas, oxygen decompression, and the evaluation and treatment of divers with diving-related illnesses in remote locations. For two seasons in 2009 and 2011, I served as the dive medical officer for the excavation of a first-century BC shipwreck off the coast of Kızılburun, Turkey. This site poses many unique challenges pertaining to diving medicine, particularly due to the depth of the wreck at nearly 150 feet.

The care of the scientific diver in remote locations can be very challenging. While the day-to-day medical care of a working diver usually involves more mundane issues such as ear infections, one of my biggest concerns is a life-threatening episode of decompression illness, otherwise known as DCI. In Turkey, INA has the distinct advantage of a multi-place hyperbaric recompression chamber aboard INA's 65-foot long research vessel *Virazon*, which provides definitive therapy for potential cases of DCI. However, for most situations this is the exception rather than the rule. Without a formal multiplace recompression chamber, other bridges to definitive therapy, such as portable hyperbaric oxygen (PHBO) chambers or in-water recompression (IWR) may be employed.

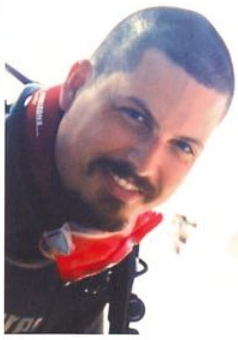
When treating DCI in remote locations, judicious screening of appropriate patients is of the utmost importance. Due to limited resources, it may not always be practical to treat every patient experiencing signs and symptoms of DCI with definitive therapy. A three-tiered triage system can be useful in deciding which patients will most benefit from recompression versus more conservative management. Tier 1 patients have mild disease, Tier 2 patients have more moderate symptoms, and Tier 3 patients have life-threatening DCI.

In patients with mild symptoms, mild joint pain or rash consistent with "skin bends," is common. Because of the benign nature of Tier 1 patients, it may be reasonable to manage these cases conservatively by administering 100% surface oxygen, intravenous hydration and oral nonsteroidal anti-inflammatory drugs (NSAIDs) such as Motrin. More definitive therapy may not be required as the natural progression in these cases is toward improvement, but patients must be carefully monitored for progressive signs or symptoms with serial neurologic exams.

Tier 3 patients are those with life-threatening DCI, either severe Type II spinal cord DCS, cardiovascular DCS or arterial gas embolism (AGE) with altered mental status or cardiac arrest. Advanced cardiac life support such as CPR may be life-saving and would take precedence over hyperbaric therapy. These patients are too sick to go back in the water for a trial of IWR and too sick to be put in a small portable hyperbaric chamber where team members would be unable to intervene without decompressing the chamber.

Tier 2 patients are the best candidates for either IWR or PHBO therapy. Typically, these patients have moderate to severe Type I DCS including significant joint pain and rash. In contrast to Tier 3 patients, Tier 2 patients are generally able to actively participate in their own care: they're awake, oriented, able to maintain their own airways and are spontaneously breathing. Most important, they must be willing and able to either get back into the water with the appropriate IWR staff and equipment or complete a modified treatment table in a portable chamber.

During the last season of excavation at Kızılburun, my organization, the Institute for Diving Medicine, ran a trial of IWR as a test of feasibility for INA's future use. This technique involves breathing 100% oxygen while a few meters below the surface; logistically this is very similar to decompression tables employed by INA for the past 15 years that were designed by Dr. Richard Vann at the Divers Alert Network (DAN). These tables provide a decompression stop at 20 feet while breathing 100% oxygen for about 5-35 minutes dependent upon the depth and duration of the dive. From a physiologic standpoint, this essentially provides a type of hyperbaric oxygen treatment. In the past, very



Matthew is currently the only board certified and fellowship trained diving and hyperbaric physician in New Jersey. He is board certified in Emergency Medicine and is the vice chairman at Southern Ocean Medical Center in Manahawkin. In 2009, he founded the Institute for Diving Medicine. Matthew was accepted into The Explorers Club as a fellow in 2010.

ABOVE
The SOS Hyperlite is a portable pressure vessel (or hyperbaric chamber), that provides immediate treatment for different medical conditions, by supplying 100% oxygen to the patient at above atmospheric pressures, whilst being transported to a medical facility.

PHOTO **Courtesy of SOS Hyperlite Ltd.**

Treatment... (continued)
experienced divers have employed this technique in the event of a hugely omitted decompression if they have signs and symptoms consistent with DCI. In the field of diving medicine, IWR has been and will continue to be very controversial and a hotly debated topic; but it may be of use in INA's future excavations due to the high level of experience that our divers typically have.

An alternative option for bridging to definitive hyperbaric therapy is the use of a portable hyperbaric chamber, or PHBO. Most "portable" hyperbaric chambers found on the internet are soft-sided and only provide mild elevations in pressure, typically 1.3 times atmospheric pressure (1.3 ATA). This is woefully inadequate for treatment of DCI, as pressures typically need to exceed 2.5 ATA in order to have any hope of improving symptoms. There is a paucity of true PHBO chambers on the market today; the only one that meets U.S. engineering standards and regulations is the Hyperlite chamber from the U.K. Currently employed by various government agencies, this is particularly effective as a hyperbaric stretcher for transporting patients under pressure to a more formal multiplace recompression chamber. The major disadvantage of this device is its small diameter, which can which can create or exacerbate feelings of claustrophobia. Physicians must alter treatment tables to adapt to this, which typically requires smaller and more frequent "dives" for treatment of DCI.

Regardless of patient selection, treatment of DCS in remote locations with either IWR or PHBO chambers requires significant training, equipment and experience. All patients should receive 100% oxygen, intravenous fluids and possibly NSAID therapy. Those who have more significant disease should be considered for recompression therapy. The logistical and financial difficulties associated with both IWR and PHBO can be challenging but are not insurmountable. In the future, either of these advanced therapies may be utilized in the rare event of a diver experiencing DCI when traditional, proven treatment options are unavailable.

Further inquiries should be directed to:
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www.scubadivingmedicine.com

Shipwreck Weekend

The graduate students of the Nautical Archaeology Program (NAP) of the Department of Anthropology at Texas A&M University hosted the 2012 Shipwreck Weekend March 30-31, maintaining founder Barto Arnold's original vision of promoting the various ongoing research projects of NAP/INA and making nautical archaeology accessible to the general public.

The event kicked off Friday evening with a lecture by Benjamin Rennison, an archaeologist at the Clemson Conservation Research Laboratory. As part of the archaeological team excavating *H.L Hunley*, a Confederate submarine that sank in 1864, Mr. Rennison's presentation highlighted the fascinating history of the submarine, as well as its discovery in 1995, the recovery in 2000, and subsequent excavation, with particular focus on the advanced recording techniques pioneered in documenting this historic wreck and associated artifacts.

The following morning, NAP graduate students donned their pirate caps and rolled up their sleeves to show off their tattoos, and engaged the public in hands-on activities that exhibited not only what we know about ancient seafarers, but also how we learn it. Attendance this year was tremendous, and over a hundred people had the chance to draw under water, race boats, design their own pirate flags, raise a sail, and learn about ships, pirates, sailors and more. In a new partnership, undergraduate students from Texas A&M Galveston joined the activity fair, demonstrating traditional woodworking techniques used in shipbuilding.

The afternoon's lecture series ranged from exploring the religion and infrastructure of the Nile Delta, and the hunt for Black Bart's pirate ship in Port Royal, to the legacy of the iron-hulled tall ship *Elissa*. Closing out a phenomenal line-up was Mr. Loren Steffy, who presented his newly released biography of Texas A&M University Professor Emeritus J. Richard Steffy, *The Man Who Thought Like a Ship*, which honors his father's significant contributions to nautical archaeology.

Shipwreck Weekend 2012 was funded by INA, the Department of Anthropology, the Center for Maritime Archaeology and Conservation (CMAC), and the Nautical Archaeology Student Association.

Staci Willis, *Ph.D. student, Nautical Archaeology Program, Texas A&M University*

INA indepth

Murat Tilev is INA's Chief Engineer in Turkey and responsible for the organization's research vessel* Virazon*, as well as safety and excavation equipment including the diving gear and the recompression chambers.

When did you become involved with the Institute of Nautical Archaeology?
I have been working with Dr. Bass since 1973 as an equipment specialist, and participated in the York River Project with him in 1976, but took on the role of Chief Engineer in 1982. I have taken part in all of INA's Bodrum-based projects since that time including the Late Bronze Age shipwreck at Uluburun.

What is your related background/education?
I have always been interested in the engineering aspect of science. I enjoy learning the inner workings of machines, figuring out what makes them function the way they do, and I am fascinated by the people who design such pieces of machinery. In 1977 I graduated from the Commercial Fishing and Marine Sciences program at Cape Fear Tech in Wilmington N.C. I had been living in Bodrum since 1967, and was taught how to dive by a local sponge fisherman. I am very good with my hands and built my own diving equipment with the help of a friend. My love of tinkering with machines made me a perfect match for this job with INA's Research Center in Bodrum

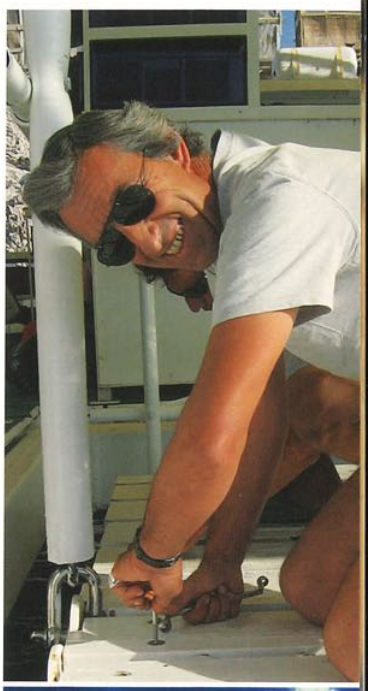
What part of your role with INA do you look forward to the most each day?
Working for INA is the best thing that has happened to me ever! I look forward to my job every day of the week, and spend time on the weekends as well for I really love what I am doing. I look forward to assessing and maintaining the dive gear as well as taking care of the ships. I drive out to Yalıkavak Marina where the ships are moored—a 22-mile round trip—to check on the lines of the ships, as well as their bilges and fire up the generator. When I want to start up *Virazon*'s main engine I take along Captain Zafer Gül, as it takes two of us to fire it up.

What does being an INA team member mean to you?
I feel that I am part of a team that has contributed so much to the science of archaeology and I am very proud to be working with a world-renowned nautical archaeologist like Dr. George Bass.

I have made close to 10,000 dives with the institute. Recently, I took part in the Bajo de la Campana excavation in Spain, in which we moved close to 20 tons of rock with the help of lifting balloons. During the Uluburun excavation, I worked the deepest part of the wreck at 185 feet and spent four seasons making two dives a day to that depth. I worked with Don Frey on the underwater lighting required for the film and photography work being done on the projects. As a result there are many photographs of me in the INA archives.

In 2000, I had the opportunity to become a pilot for INA's newly acquired submersible *Carolyn*.

I have had many adventures with INA including an incident at the Tektaş Burnu site in which I was injured when an electrical cable powering the light I was holding broke away… something that Don Frey caught on film, sparks included! And I hope to have many more adventures in the future.

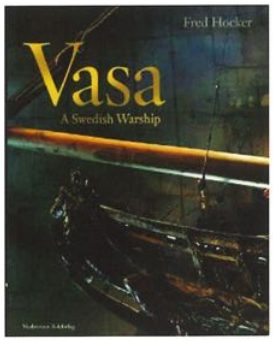


ABOVE
Murat Tilev keeping *Millawanda* shipshape!
PHOTO **D. Carlson**

Murat in a classic INA photograph taken by Don Frey during the excavation at Uluburun. See Don's article on page 10.

INAreads

REVIEWS & ANNOUNCEMENTS OF NAUTICAL ARCHAEOLOGY TITLES



ABOVE
Front cover of
Vasa: A Swedish Warship
Written by Fred Hocker
Published by Medstroms
Bokforlag (2011)
Hardcover: 212 pages
ISBN-10: 9173291013
Available through
Oxbow Books
(www.oxbowbooks.com)

Since the recovery of the Swedish warship *Vasa* from the bottom of Stockholm harbour in 1961, resources have been poured into the ship's conservation, reassembly (98% of the ship is original) and display in a museum built around her. In 2003 Dr. Fred Hocker—an NAP graduate, former NAP faculty member and former INA President—became Head of Research and Publication at the Vasa Museum and the focus finally switched to studying the ship and decoding what the ship could tell us of life in the 17th century.

Dr. Fred Hocker's ***Vasa: A Swedish Warship,*** is the first comprehensive and accurate account of the history and archaeology of the ship to be published. The target audiences of this book are the 1.25 million annual visitors of the museum and those interested in the history of seafaring. The book incorporates the latest results of the author's far-reaching research program. Chronologically it covers the period from *Vasa*'s building to the present day. Topics include the strategic context in which the king ordered her building, procurement of materials, the people involved in its construction, the vessel as a warship, its operation, the ship as a floating community, its loss, recovery, conservation and current research. A full chapter is dedicated to the subject of the ship as a symbol; a very important, rarely discussed topic. The book addresses and systematically dismantles widely circulating popular myths that have surrounded the ship since its discovery 50 years ago. The most popular is that of a meddling Swedish king, Gustav Adolf II, who ordered the shipwright to add a second deck (actually two more decks, as *Vasa* is in reality a three-decker), thus causing her to capsize 1200 meters into her maiden voyage.

In this reviewer's opinion, however, the greatest achievement of the book lies in placing *Vasa* in the strategic context of the early 17th century in the Baltic, presenting her as part of Sweden's rise to Great Power status. Hocker has an engaging, lively style of writing that makes the book read like an adventure story, making it hard to put down.

It is a lavishly illustrated work; the photography is of spectacular quality, the illustrations are well chosen and aid the understanding of the material. The captions are informative and contribute to the knowledge that the book offers. The production quality of the volume is that of an expensive coffee-table book, but the price is moderate, especially in view of the book's high quality. I can envision *Vasa: A Swedish Warship* being used also in teaching, at least until the completion of the multi-volume archaeological publication of *Vasa*, on which Hocker is currently working.

— Review by **Kroum Batchvarov**, Ph.D.
Assistant Professor of Maritime Archaeology, University of Connecticut

BELOW
Author Loren Steffy (center) poses with Professors van Doorninck (left) and Bass, while in College Station in March for Shipwreck Weekend

Dick Steffy (1924-2007) was ***The Man Who Thought Like a Ship***. This remarkable, self-taught scholar played a key role in the development of modern nautical archaeology, the NAP program at Texas A&M, and the Institute of Nautical Archaeology. Dick was the world's foremost authority on ancient shipbuilding, and his determination to follow his dream is revealed in a new book written by his son, *Houston Chronicle* columnist, Loren Steffy.

"...a professional biography and adventure story of the highest caliber, but also the first history of a field that continues to harvest important new discoveries from the depths of the world's oceans."
—Texas A&M University Press

To order this latest title in the *Ed Rachal Foundation Nautical Archaeology Series* please visit the TAMU Press website...
www.tamupress.com

For more information on this shipwreck visit the Kyrenia Project's page on our website: www.INAdiscover.com

INAretrospective

DICK STEFFY AT WORK ON THE RECONSTRUCTION OF THE KYRENIA SHIP (1972)
PHOTO COURTESY OF SUSAN KATZEV

INA Research Associates

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