A diver in a dark blue tank is shown underwater, holding a small, ornate metal vessel. The diver is illuminated by a bright light source, creating a strong glow around them. The background is a deep blue, slightly hazy underwater environment. The diver's gear, including a mask, regulator, and tank, is visible. The vessel they are holding appears to be a small, rounded metal pot or jar with a handle.

Edited by George F. Bass

*BENEATH
THE
SEVEN
SEAS*

*Adventures
with the
Institute of
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SEAS*



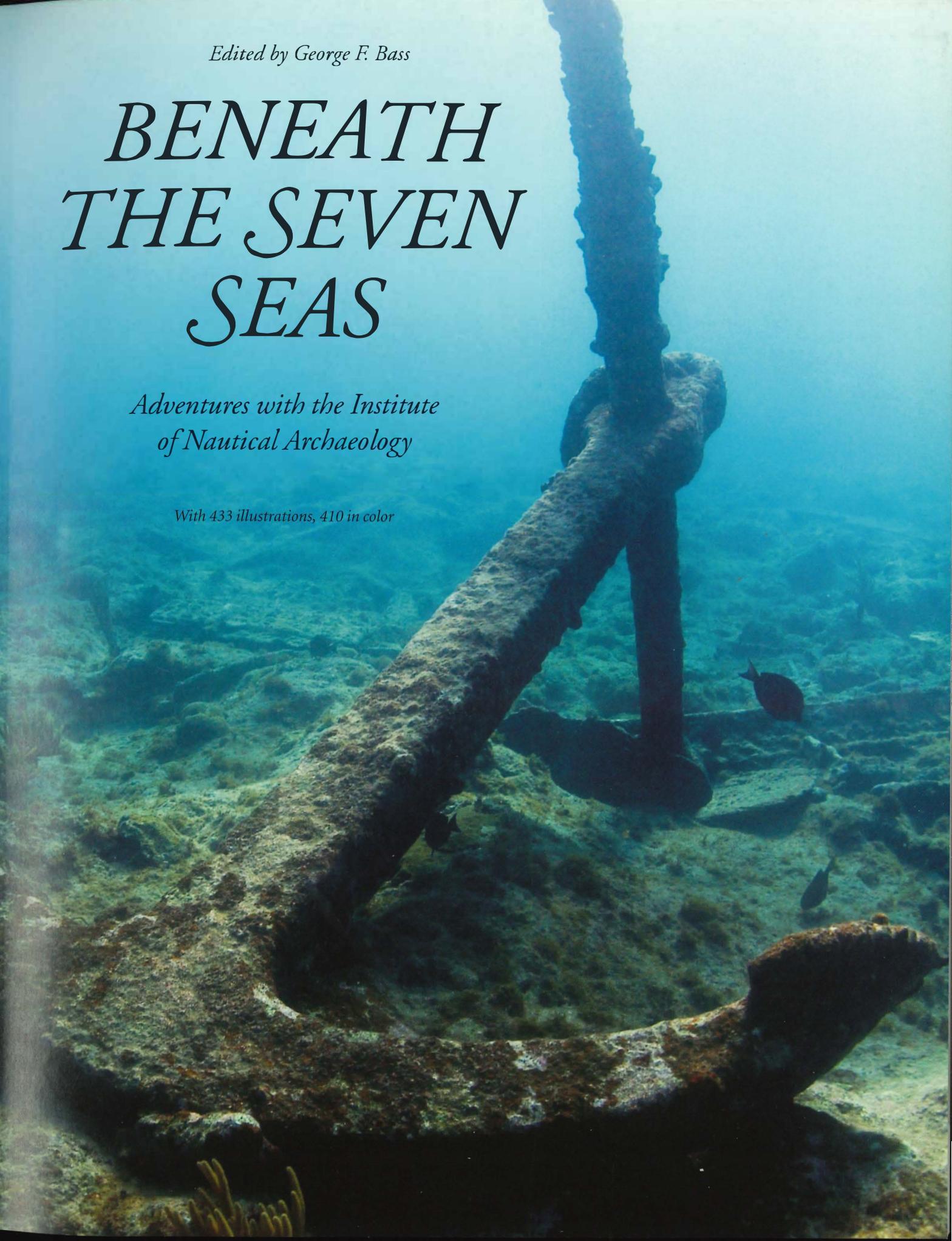
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BENEATH THE SEVEN SEAS

*Adventures with the Institute
of Nautical Archaeology*

With 433 illustrations, 410 in color



Half-title: *A Canaanite gold pectoral from the Uluburun shipwreck, Turkey.*

Title-page: *Anchor from the probable wreck of the Glamis, built in Dundee, Scotland, in 1876 and lost on Grand Cayman's East End in 1913.*

Contents pages: *Canaanite gold jewelry, including a fertility goddess, from the Uluburun shipwreck; replicas of iron javelin heads from the Kyrenia ship, Cyprus; Byzantine gold coins from the 7th-century Yassiada shipwreck, Turkey; bronze lion from the Shinan wreck, Korea; gold earring from the Pepper Wreck, Portugal; Chinese porcelain from the Sadana Island wreck in Egypt; door handle from Cleopatra's Barge, Hawaii; pewter tableware from Port Royal, Jamaica.*

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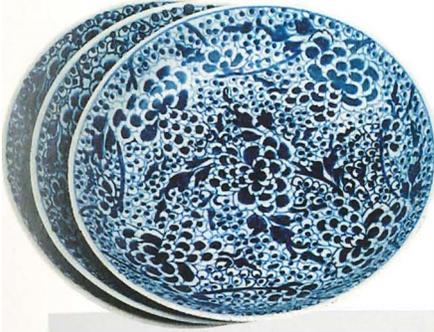
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Contributors

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ROBERT D. BALLARD is a Professor of Oceanography and Director of the Institute for Archaeological Oceanography at the University of Rhode Island's Graduate School of Oceanography. His major research interests are archaeological oceanography, ocean exploration, educational outreach, and the development of tele-presence technologies needed to implement them. His archaeological research focuses on the deep-water trade routes of the Mediterranean and Black Seas. His publications in archaeological oceanography have appeared in *Deep-Sea Research* (2000), the *American Journal of Archaeology* (2001 and 2002), and the *International Journal of Nautical Archaeology* (2004).

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FILIPE CASTRO, with degrees in Civil Engineering and Business Administration, first became involved in nautical archaeology as an amateur, and was part of the team that in 1997 created the Portuguese state agency for nautical archaeology. In 2001 he received a PhD in Anthropology from Texas A&M University, where he now teaches in the Nautical Archaeology Program. He has directed or participated in the excavation of shipwrecks from the period of European maritime expansion, and published *A Nau de Portugal* and *The Pepper Wreck*. Currently he is writing a book about 16th-century Iberian ships.

WILLIAM H. CHARLTON JR is a retired US Marine Corps officer who earned his Master of Arts degree in Nautical Archaeology at Texas A&M University in 1996. He has served as Divemaster for various INA shipwreck excavations in Turkey and Israel, and as the Diving Safety Officer for the Institute for over ten years. While working on the Kinneret Boat project, he hand-built the model that is now displayed alongside the ancient boat in the Yigal Allon Museum at Kibbutz Ginosar, Israel.

ARTHUR COHN is co-founder and Executive Director of the Lake Champlain Maritime Museum. After a short career in law, he became a professional diver. For three decades he has worked on the documentation, management and public policy issues of underwater cultural resources. Art, who served as a US State Department Delegate for the development of the UNESCO Treaty for the Protection of Underwater Cultural Heritage, has received honorary doctorates from the University of Vermont (1996) and Middlebury College (2004). He recently published *Lake Champlain's Sailing Canal Boats* (2003).

KEVIN CRISMAN is an Associate Professor in the Nautical Archaeology Graduate Program at Texas A&M University. He has specialized in ships, seafaring and the maritime world from 1400 to 1900, with a focus on the inland waters of North America. Since 1980 he has studied a wide variety of steam, sail, canal, and naval vessels. Dr Crisman's publications include books on the War of 1812 brig *Eagle* and horse-propelled ferryboats of the 19th century.

DONALD A. FREY, a former professor of physics, has been with INA from its beginning. Now its Vice President, he served as INA's second President. A director of past INA surveys, with a special interest in remote sensing, Dr Frey is also INA's photographer and videographer, with results seen in books, articles, and on television around the world. A resident of Turkey since 1974, he also has a special interest in foreign languages.

JEREMY GREEN has been Head of the Department of Maritime Archaeology at the Western Australian Maritime Museum since its establishment in 1971. In 1996 he was appointed head of the Australian National Centre for Excellence in Maritime Archaeology. He helped to found the Australasian Institute for Maritime Archaeology and has been editor of the Institute's *Bulletin* since 1977. He is a fellow of the Australian Academy of the Humanities, Research Associate with INA, advisory editor for the *International Journal of Nautical Archaeology*, and adjunct associate professor at Curtin University of Technology, Perth, and James Cook University, Townsville.

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NERGIS GÜNSENİN is Professor at Istanbul University's Vocational School of Technical Sciences, and chair of its Underwater Technology Program. Her research interests concern late Byzantine amphoras, their kiln areas, and the monastic wine commerce in the Sea of Marmara, where she has conducted land and underwater surveys and excavated an 11th-century amphora kiln. She has participated in

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JEROME LYNN HALL is Assistant Professor of Anthropology at the University of San Diego. He continues to excavate the Monte Cristi “Pipe Wreck” and is working on two books chronicling the story of the excavation and finds. Dr Hall earlier served as the Director of the Office for Underwater Archaeology in Puerto Rico, and then as INA President. His special interest is European – and specifically Dutch – expansion in the New World during the 17th century.

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FRED HOCKER is the Director of *Vasa* Research for the National Maritime Museums of Sweden. He was formerly a research director at the National Museum of Denmark and Yamini Associate Professor of Nautical Archaeology at Texas A&M University. He has excavated, recorded and reconstructed shipwrecks in North America, Turkey, the Netherlands, and Scandinavia, on land, under water and under ice. His research interests concentrate on maritime economics and shipbuilding in the Middle Ages and Renaissance. Dr Hocker’s publications include *The Philosophy of Shipbuilding* (2004) with Cheryl Ward.

PAUL F. JOHNSTON is Curator of Maritime History at the Smithsonian Institution’s National Museum of American History in Washington, DC. He has worked on shipwrecks in the Mediterranean and Baltic Seas, the Atlantic, Pacific and Indian Oceans, the Great Lakes and some great little lakes, rivers and harbors. Dr Johnston has around 100 publications, including seven books, and is now completing a book on the Royal Yacht of Hawaiian King Kamehameha II. He also rides and writes about motorcycles.

SUSAN WOMER KATZEV, a graduate of Swarthmore College, trained as a sculptor. Starting in 1961 she was diving artist for excavations of the 7th- and 5th-century AD

merchantmen off Yassiada, Turkey, where she mapped remains on the sea bed and made artifact drawings for publications. Her husband Michael L. Katzev directed the Kyrenia Ship’s excavation and preservation. Since his death in 2001, Susan has headed the Kyrenia Ship Project, coordinating the work of ten scholars to complete publication of that excavation.

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BRETT PHANEUF is a doctoral student in the Department of Oceanography at Texas A&M University, and a founding member of the program in Archaeological Oceanography, launched in the fall of 2005. He has directed numerous research projects for INA in Turkey, Morocco, Italy, France, and the United States, and also founded ProMare, Inc., a non-profit corporation dedicated to marine research in the deep ocean.

ROBIN PIERCY is an INA Field Staff Member in Bodrum, Turkey. He has participated in numerous excavations underwater in both the Mediterranean and North America. His research interests include waterlogged wood conservation, and wooden hull restoration and display. He is currently publishing the results of his excavation in Mombasa Harbor, Kenya, of the wrecked Portuguese frigate *Santo Antonio de Tanna*.

CEMAL PULAK is an Associate Professor in the Nautical Archaeology Program at Texas A&M University and INA’s Vice President for Turkey, where he has excavated shipwrecks, directed underwater surveys, and currently is involved

with the publication of the 14th-century BC Uluburun wreck. With post-graduate degrees in both mechanical engineering and archaeology, Dr Pulak’s research interests include various aspects of nautical archeology, ancient ship construction, and Bronze Age maritime trade. He has published numerous scientific and popular articles.

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FREDERICK VAN DOORNINCK is Emeritus Professor of Nautical Archaeology at Texas A&M University. In Turkey, he was assistant director of the Byzantine shipwreck excavations at Yassiada, co-director of the Byzantine shipwreck excavation at Serçe Limanı, and has been a major contributor to their publication. His research interests have included the manufacture, use and standardization of Byzantine amphoras and anchors, Byzantine ship construction, and the history of the waterline ram.

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Introduction: Reclaiming Lost History from Beneath the Seven Seas

GEORGE F. BASS

Before there were farmers or shepherds, there were seafarers. Before people could make pottery or work metals, before they even lived in houses, they could cross expanses of open water. As far back as 40,000 years ago they reached and populated the continent of Australia by watercraft. A new land cannot be peopled by just two or three individuals washed ashore by accident; a deliberate population movement is necessary.

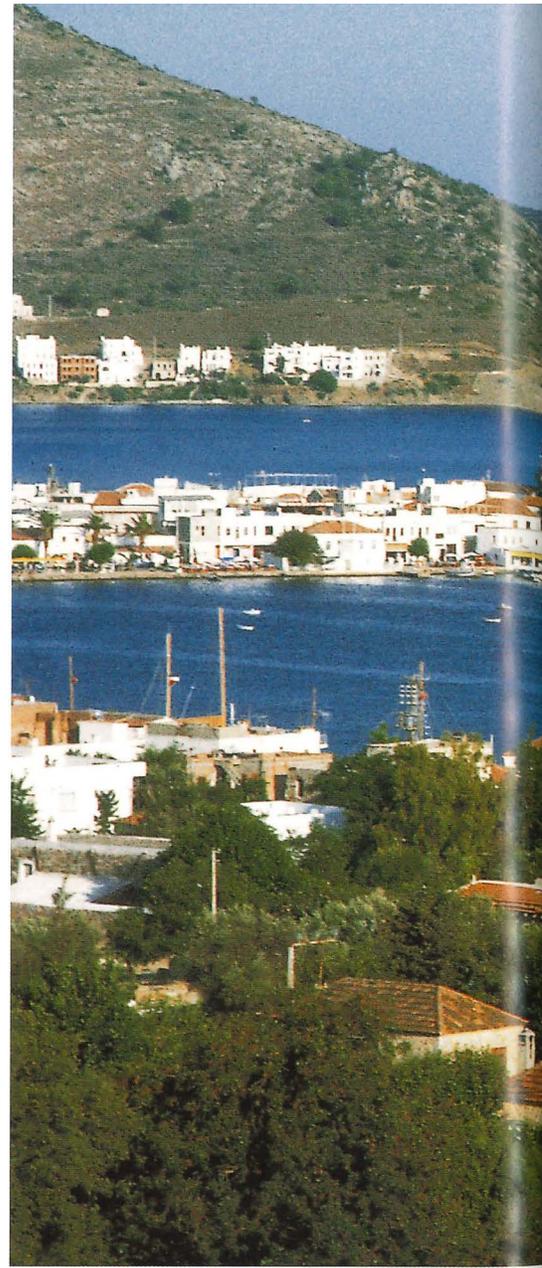
In the Mediterranean 11,000 years ago, cave dwellers made round trips from the Greek mainland to the island of Melos, where they collected obsidian, the volcanic glass that they fashioned into blades and scrapers. Mariners colonized the large Mediterranean islands of Crete and Cyprus some 8,000 years ago.

Without seafarers, then, there would have been no Minoan civilization. Without river craft the great Egyptian pyramids could not have been built of the massive stones quarried far up the Nile. Without great merchant vessels, neither Greece nor Rome, dependent on grain from the Black Sea and North Africa, could have prospered. And without rowed warships, the Greeks could not have turned the tide against invading Persians in the famed sea battle at Salamis in 480 BC.

Try to imagine a history of the world without the ships, boats, and mariners that followed: Viking longboats, Chinese junks, Vasco da Gama, Columbus, Magellan, the Spanish Armada, kayaks, Arab dhows, the *Mayflower*, birch-bark canoes, East Indiamen, Trafalgar, steamboats, ironclads, clipper ships, *Titanic*, *Lusitania*, U-boats, aircraft carriers... the list goes on. Entire continents have been discovered, re-discovered, colonized, supplied, invaded, and defended by sea. D-Day and the Battle of Midway, turning points in the European and Pacific theaters of World War II, were both dependent on seagoing vessels designed for warfare. Even now, to fuel our cars and factories, we are dependent on oil shipped around the world in giant tankers.

There can be no meaningful study of the past, therefore, without some knowledge of the history of the watercraft that helped shape our globe as we know it.

There is another, equally important reason to study watercraft from the earliest times. Everything ever made by humans has been transported at one time or another by water, from tiny obsidian blades to the marble elements of great temples and churches. Further, when any vessel sinks, it takes with it to the bottom, except for those objects that float away, everything used or carried on that vessel during a finite moment of time. In freshwater rivers or lakes, or even on the ocean bed if quickly covered by protective sediment, all of this material, both organic and inorganic, is preserved – comparable to the preservation found in frozen northern lands or dry desert sands.



Above The Bodrum Museum of Underwater Archaeology, which displays the results of INA research in the 15th-century Castle of the Knights of St John, is the most visited archaeological museum in Turkey. Bodrum sponge divers have guided INA archaeologists to more than a hundred ancient shipwrecks.

Right INA's Research Center in Bodrum comprises five buildings, including this central neo-Ottoman office building. The other buildings are a dormitory, a library, a conservation laboratory, and a computer center.



If a shipwreck can be dated – by historical records, tree-rings, radiocarbon, or coins or inscriptions in the wreck – its contents, except for the rare antiquity or heirloom that might have been on board, can be dated. The century-by-century and even decade-by-decade study of shipwrecks, therefore, will ultimately provide the most accurate and complete story of material remains ranging from weapons and tools to ceramics and glass to games and musical instruments.

This book describes shipwreck excavations by an institute devoted to the archaeological study of the history of ships, the Institute of Nautical Archaeology, or INA. Not all of the excavations were sponsored by INA, but all were conducted by members of INA's extended family, who will be introduced, in turn, in the history that follows. Some of the projects were started under the aegis of the University of Pennsylvania Museum, but in each case were completed by INA. We must, however, start at the beginning:





Above Conservator Jane Pannell Haldane treats the bronze statue of a tunic-clad African youth netted by Bodrum sponge-dragger Mehmet Imbat near Yalıkavak, Turkey. The discovery led to pioneering uses of sonar and submersibles in the search for the ancient wreck that carried it and at least two other netted bronzes.

Opposite In his quest for ancient wrecks in 1958 and 1959, Peter Throckmorton dived with helmeted Turkish sponge divers who had stumbled on and remembered dozens of cargoes lost since antiquity.

Right By the mid-1960s, the University of Pennsylvania archaeologists who later founded INA were mapping sites with stereo photographs taken from the submersible *Asherah*, decompressing in a submerged chamber (upper right), and using an underwater telephone booth and various types of metal detectors, lifting balloons, and airlifts.

Pioneers of Shipwreck Archaeology

The wealth of archaeological material to be found under water has long been known. For centuries after the Greek city of Helike sank into the Gulf of Corinth during an earthquake in the 4th century BC, visitors wrote of the large bronze statue and other relics they could still see beneath the waves. In the first half of the 16th century, a diver gazed in wonder through the crystal plate in his wooden helmet at a giant Roman pleasure barge lying on the bottom of Italy's Lake Nemi. That was only a hint of what was to follow. To date, for example, most extant Greek bronze statues in the world's museums have come from the sea, netted by fishermen or salvaged by helmeted sponge-divers in the 19th and 20th centuries, and found more recently by sport divers wearing scuba (self contained underwater breathing apparatus). Statues that remained on land were mostly scrapped and melted down for other uses.

It was the development of reliable, easily maintained scuba by Jacques-Yves Cousteau and Emile Gagnan in France in the 1940s that gave divers the necessary mobility to do more than salvage artifacts. In the 1950s, serious studies of Roman shipwrecks were made by Italian and French teams off their own shores, and by the French off Tunisia. Their projects introduced some of the basic items of equipment still used in shipwreck excavations: metal or nylon grids to divide wreck sites into coherent squares to allow controlled excavation and to aid mapping; vertical pipes, called airlifts, that suck up and discharge sediment like underwater vacuum cleaners;



large balloons that, once attached to a heavy object on the sea floor and inflated, can buoy the object to the surface; underwater cameras for recording sites; and underwater television to monitor the work from the surface.

These pioneering efforts culminated in 1960 in an explosion of underwater archaeological projects in Europe, Asia, and North America. Diving archaeologists were planning construction of a coffer dam around five Viking ships they had found in Roskilde Fjord, Denmark, so that the water could be pumped away from the vessels before excavation. Elsewhere in Scandinavia, divers were preparing to raise the almost perfectly preserved royal Swedish warship *Vasa*, which had heeled over and sunk in Stockholm Harbor almost immediately after being launched in 1628.

In North America, the Civil War ironclad *Cairo* was being raised from the Yazoo River in Mississippi, while farther north, in the state of New York, the first colonial bateaux seen in modern times were raised from Lake George. Still farther north, on the Canadian border, “white water” archaeologists began searching beneath dangerous rapids for artifacts spilled from overturned fur-traders’ canoes.

In all but the last case, the goal was to study a vessel in open air, as in a terrestrial excavation, either by pumping the water away from it, as from the Roskilde cofferdam, or by taking it completely out of the water.

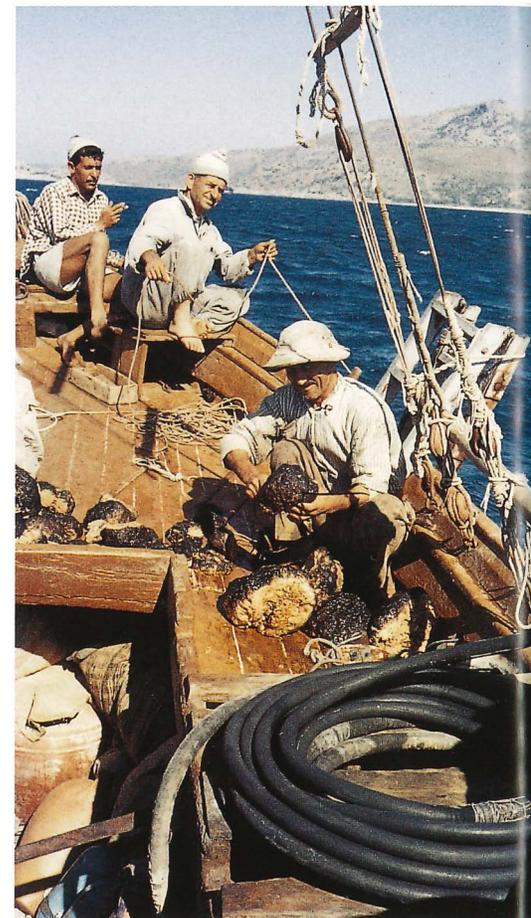
Archaeologists Take the Plunge

On the Asian side of Turkey, in 1960, the approach to a shipwreck was different. American photojournalist Peter Throckmorton had lived on Turkish sponge boats in 1958 and 1959, asking the divers to show him any ancient remains they had seen on the sea floor. Among the wrecks Peter recorded was the oldest then known, a Bronze Age wreck from about 1200 BC. It was Peter’s idea that wrecks could and should be excavated as carefully on the seabed as terrestrial sites are excavated on land. He wrote to Professor Rodney Young at the University of Pennsylvania Museum, asking if the Museum would sponsor an excavation of the wreck. He knew that Young was already excavating in Turkey, at Gordion, capital of King Midas of the golden touch. By chance I had worked as a student assistant at Gordion in 1957. By chance I was one of Professor Young’s doctoral students in 1959, freshly returned from being the officer in charge of a small US Army signal unit in post-war Korea. By chance my major interest was the Mediterranean Bronze Age. And by chance I had read everything on diving I could get my hands on since I was a child, although I never dreamed that I, myself, would dive.

In retrospect, it seems it was almost fated that Professor Young asked me if I would learn to dive to be the archaeologist for Peter’s proposed excavation of the Bronze Age shipwreck. After six weeks of a ten-week YMCA diving course, I headed with Peter Throckmorton for Turkey, to begin working 28 m (92 ft) deep off Cape Gelidonya. Elsewhere in this book, I describe what followed, but it resulted in the first complete excavation of an ancient shipwreck on the seabed, and the first directed by a diving archaeologist.

This set the stage for much that went after. Professional divers, wanting to keep a monopoly on underwater work, even after 1960 wrote that archaeologists could never learn to dive well enough to accomplish anything useful at depth. That notion was put firmly to rest between 1984 and 1994, when archaeologists and archaeology

Below One diver cleans freshly harvested sponges while another tends a companion searching for sponges far below the 10-m (33-ft) *Mandalinçi*, on which Peter Throckmorton lived during the summer of 1958, and which served as a diving platform during the 1960 excavation of the Cape Gelidonya shipwreck.





students made the majority of 22,500 dives to between 44 m (145 ft) and 61 m (200 ft) in order to excavate another Bronze Age shipwreck, at Uluburun, Turkey. It was the deepest large-scale diving project ever conducted with normal scuba, made possible by extreme safety measures that could not be duplicated by weekend avocational divers, who should not dive to such depths.

The year 1960 was the only time I would ever work with Peter Throckmorton, who went on to find Bronze Age wrecks in Greece, excavate Roman and Byzantine wrecks in Italy, and pioneer the study of the last surviving clipper ships, in the Falkland Islands. He also saved from a shipyard in Greece the disintegrating 19th-century sailing ship *Elissa*, now restored as a major tourist attraction in Galveston, Texas.

I did not intend to continue diving. I was ready to return to dry land archaeology, *real* archaeology. At the end of the 1960 excavation, however, Claude Duthuit, a French diver brought to Cape Gelidonya by Peter, said that we had started something good together, and that I, with the archaeological credentials to make it possible, ought to continue this promising field of research just a bit longer.

So I returned to Turkey in 1961 with Claude and a group of mostly novice divers, including fellow University of Pennsylvania graduate Frederick van Doorninck, Boston University undergraduate David Owen, and Swarthmore College undergraduate Susan Womer who would draw our artifacts. For four summers at Yassiada we excavated a 7th-century Byzantine wreck about 39 m (129 ft) deep, also found by Peter Throckmorton, constantly improving techniques of mapping, airlifting, and conservation. During those years we were joined by another University of Pennsylvania archaeology student, Michael Katzev. More than a decade later, all of these people played pivotal roles in the creation of the Institute of Nautical Archaeology.

In the 1980s, several of the original excavators of the Cape Gelidonya shipwreck returned to the site annually and, with sophisticated metal detectors and motorized underwater scooters, located and uncovered many artifacts undetected during their 1960 excavation.



Above Donald Rosencrantz slides a camera, hanging vertically on gimbals, along a horizontal bar above the 7th-century Byzantine shipwreck at Yassıada, Turkey. He takes pictures at predetermined points marked on the bar, providing pairs of stereo photographs from which accurate three-dimensional plans can be made.

Fred van Doorninck, after his initial excavation campaign at Yassıada, asked if he could undertake a study of the broken bits of wood we were recording and raising. For the following three summers, and several years thereafter, he slowly made sense of what sometimes seemed little more than kindling, eventually writing his doctoral dissertation on a reconstruction of the ship and its anchors, the first reconstruction of a wrecked ship excavated on the seabed. Mediterranean hulls became as exciting as their contents.

In 1963, J. Richard (Dick) Steffy, an electrical engineer with a serious interest in ship modeling, read an article I wrote for *National Geographic* on the Byzantine wreck, and asked if he could build a series of research models of it. I put him in touch with van Doorninck, beginning a cooperation that continues to this day.

Meanwhile, I was spending perhaps more time on engineering than archaeology, developing a method of mapping seabed remains in three dimensions with stereo-photography, first suggested by Claude at Cape Gelidonya, and ordering construction of the first commercially built submersible for any field of research in the United States. Before launching the two-person *Asherah*, named for a Phoenician sea goddess, I obtained on loan from the US Navy a 20-m (66-ft) steel-hulled vessel, *Virazon*, to tend the little sub, and arranged for it to be shipped to the Mediterranean without charge as deck cargo. That year, 1964, I received my doctorate in Classical Archaeology and joined the faculty of the University of Pennsylvania, where I soon offered a graduate seminar on ancient seafaring. Annually I invited Dick Steffy to lecture on what he was learning from building research models of ancient hulls we were excavating.



Right INA's *Virazon*, built in 1954 as a US Army T-boat, was first taken to Turkey for archaeological work in 1964. Now fitted out with a deeper keel and all necessary equipment for major underwater projects, including a double-lock recompression chamber, this 20-m (66-ft) vessel annually serves both excavations and surveys.



Above A treacherous reef running out from Yassiada, literally “Flat Island” in Turkish, has sunk nearly a dozen ships from Roman times until 1993, when a modern freighter went down. Excavating remains of these ships, some lying just below the wooden diving barge, the author spent seven summers in a camp established on the barren rock. The 20-m (66-ft) trawler *Kardeşler*, also anchored off shore, served INA’s initial 1973 survey.

New Tools for Undersea Archaeology

During our next excavation, in 1967 and 1969, a wreck from the late 4th or early 5th century AD at Yassiada, Fred and I were obsessed with improving seabed efficiency. Our greatest enemy was time. To understand why, one must understand decompression sickness, or the bends.

When a diver descends, the weight, or pressure, of the water on his or her body would soon crush the diver’s lungs, ears, sinuses, or other air-filled cavity unless the diver is breathing air at a pressure equal to that of the surrounding water. Diving equipment provides such pressurized air, whether through a hose to an air compressor on the surface or through a regulator attached to a tank of compressed air on the diver’s back. There is, however, a limit beyond which divers cannot descend while breathing compressed air. Nitrogen, which comprises 80 percent of air, produces an increasingly narcotic effect as pressure increases when the diver goes deeper. A rule of thumb is that every additional 15 m (50 ft) of depth is like drinking another gin martini, a major reason sport divers should not try to imitate the deep work mentioned above. In addition, oxygen, the other 20 percent of air, becomes increasingly toxic under pressure. Nevertheless, although slightly tipsy from narcosis, we regularly work between 30 m (99 ft) and 40 m (132 ft) deep.

While working at depth, our bodies absorb the compressed air we breathe. At reasonable depths, this does not present a problem – as long as we remain at depth, under pressure. If one ascends too rapidly at the end of a dive, however, the gas in the diver’s body can come out of solution and form bubbles, just as the sudden release of pressure on champagne causes it to bubble. Nitrogen bubbles in one’s blood can block its flow, leading to paralysis or death.

To avoid this diver’s illness, called the bends, the diver must ascend in stages, pausing to breathe off the pressurized air. This is called decompressing. According to tables designed by diving physiologists, the deeper the dive, and the longer the dive, the longer must be the decompression. In the 1960s, we sometimes worked for 40 minutes at a depth of 40 m (132 ft), requiring extremely long, twice daily decompression stops. To avoid the cold and boredom (although we soon learned that paperback books can last for weeks under water without disintegrating), I designed a submersible decompression chamber into which the divers could swim and let themselves up 3 m (10 ft) at a time, while sitting in dry comfort. (Today, on the advice of specialists in hyperbaric medicine, we never work at depth for more than 20 minutes, decompressing with tables designed by Richard Vann of Duke University,



which call for us to switch from air to pure oxygen during decompression to flush the nitrogen out of our bodies more quickly.)

To provide a safety refuge in case of equipment failure and a place from which to speak to the surface by telephone, Michael Katzev and Susan Womer, by now Mr and Mrs Katzev, designed what we call an “underwater telephone booth,” an air-filled Plexiglas dome into which divers can swim and stand, dry above their shoulders, in case of equipment failure.

At this time we also experimented with methods of finding wrecks deeper than we could dive. The catalyst for building *Asherah* was a sponge-dragger’s netting, in 1963, of the bronze statue of a tunic-clad African youth at a depth of 85 m (280 ft), beyond the limits of compressed-air diving. Limited visibility through our submersible’s small ports, however, made her unsuitable for open water searches. Thus, although we knew the general area where the statue had been caught, we wanted to pinpoint the wreck before sending *Asherah* down. Volunteer engineer Donald Rosencrantz, who had helped design *Asherah* and who had perfected a method of accurately mapping the seabed from the sub by stereo-photography, organized a search with side-scan sonar, although no ancient shipwreck had been found by sonar. In just one morning a team from the Scripps Institution of Oceanography spotted a wreck in the area with its sonar, a target verified by *Asherah*.

During those early days we also used a towed, one-person submersible called a Towvane, shaped like an early Mercury space capsule. The pilot, by depressing or raising the leading edges of wings on the capsule’s sides, could make it descend or ascend. After one of our team found himself being bounced upside down over the seabed at a depth of around 90 m (300 ft), we decided this was not the safest method for finding wrecks!

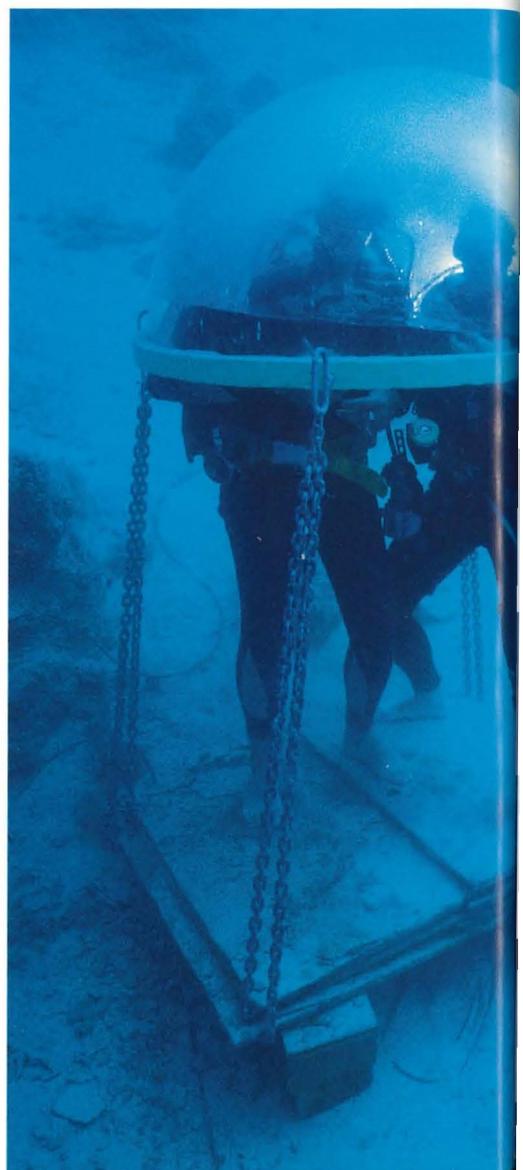
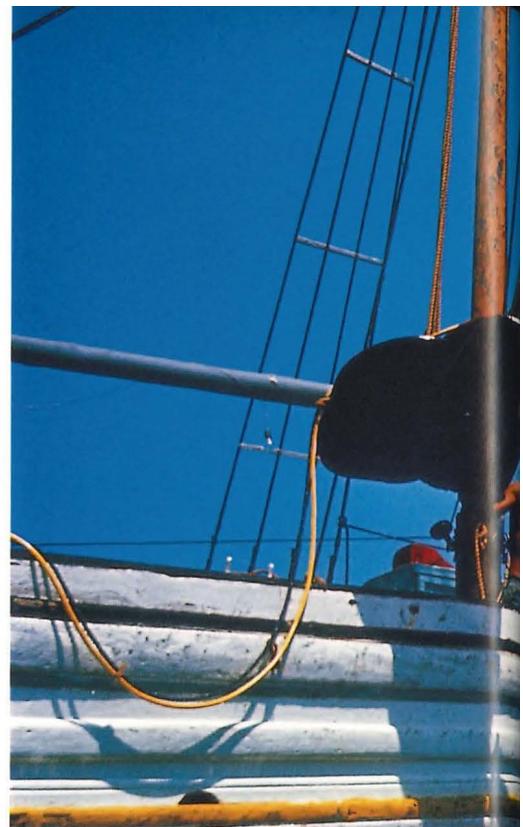
Another device tested in our research in Turkey in the 1960s was a magnetometer – an instrument capable of detecting iron – brought to us by Englishman Jeremy Green, who describes some of his own research in these pages.

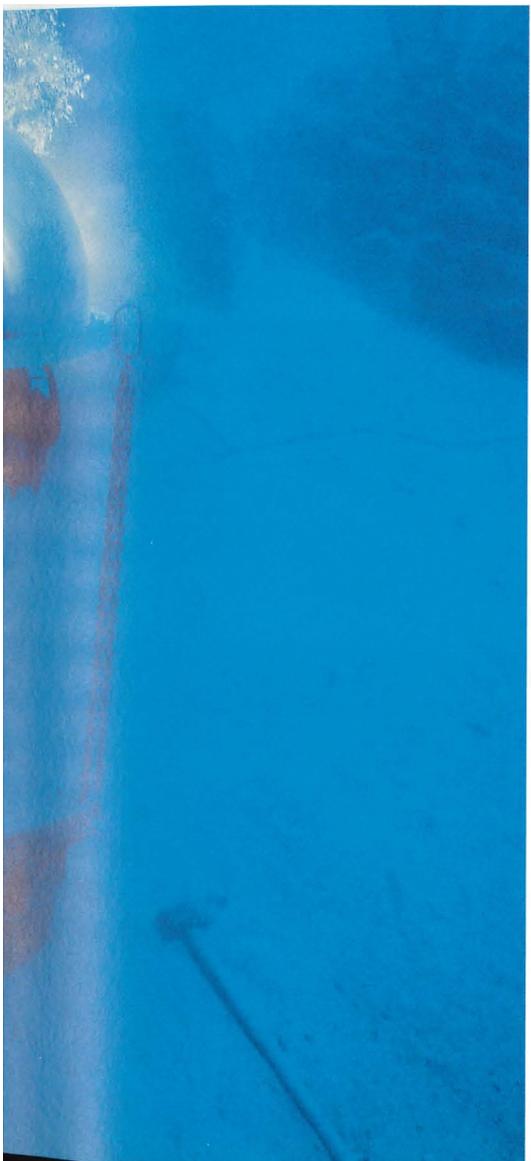


Above right The single occupant of the Towvane, seen being lowered over the side of a Turkish trawler, planed downward by angling the vanes or wings while being towed.

Right INA's underwater telephone booths, air-filled acrylic hemispheres, allow divers to remove their mouth pieces and, dry from their chests up, talk to one another or, via cable, to the surface, or to change their scuba in case of equipment failure.

Left Maurice McGehee of the Scripps Institute of Oceanography, examines the paper print-out of a sonar that in a single morning revealed the position of an ancient shipwreck, positively identified from the submersible *Asherah*, in the center of the area being searched for the wreck that yielded the African youth and two other statues.





Nautical Archaeology Comes of Age

When invited to undertake a survey for ancient shipwrecks by the government of Cyprus, I asked the Katzevs to go in my stead. Their subsequent excavation and restoration of the 4th-century BC wreck off Kyrenia set a new standard for shipwreck archaeology in the Mediterranean. They had learned all they could at Yassiada, and then improved on it, not only raising the timbers, but conserving them. And then, working with Dick Steffy, who took leave of his electrical business, they began to actually put the hull back together both for study and for public display in the castle at Kyrenia.

This was another first for underwater archaeology in the Mediterranean. While by no means ignoring the cargoes that first attracted archaeologists to the seabed, our specific branch of underwater, marine, or maritime archaeology was now focused more than ever on the ship itself – the *naus* in ancient Greek. Publication of the *International Journal of Nautical Archaeology* began at about this time in the United Kingdom.

Burned out in 1969 from teaching a normal load of courses while directing and raising funds for what the head of US Navy salvage and diving told me was the largest diving operation in the world at the time – 25 divers working twice a day at 40 m (132 ft) for months on end – I decided to retire from underwater archaeology. We had already sold *Asherah*. In 1971 I started the excavation of a mainly Neolithic land-based site in southern Italy, trying to determine how and when certain animals were introduced into the region. But I never stopped wondering how much more knowledge of this period we might gain from just one Neolithic shipwreck in the Adriatic Sea.

An Institute Devoted to Shipwreck Archaeology: First Glimmerings

Fred van Doorninck and I, while spending a summer working on the final publication of the Yassiada 7th-century Byzantine ship, began vaguely discussing ideas of an institute devoted just to shipwreck archaeology. We naively dreamed aloud of building a compound and growing our own food outside Bodrum, Turkey, which had served as our annual base of operation. Remember, this was the early 1970s – as revealed by the size and lengths of our sideburns in photographs taken in those days!

In 1972, while driving back from inspecting a hull recently uncovered in the sands of a New Jersey beach, Dick Steffy pulled to the side of the highway and waved for me to stop my car behind his. He then told me that he had decided to sell his electrical business and become a professional ancient ship reconstructor. He had a wife and two sons to support. I told him he was crazy. Within months, however, I gave written notice to the University of Pennsylvania that I was resigning my tenured associate professorship to form an independent institute devoted to shipwreck archaeology. Professor Young wrote to a colleague that he thought I had gone a little crazy, but, although he had groomed me to head the department on his retirement, he told me that he understood why I had to leave: “You have the 40 fidgets.”

Michael and Susan Katzev were living on Cyprus, on leave from Oberlin College where Michael was teaching, in order to reassemble the Kyrenia ship. They suggested that I base the new American Institute of Nautical Archaeology (AINA) there, where the cost of living was less, and where we would be centrally located in the eastern

Mediterranean, the area that interested us most. I would serve as president and Michael would resign his position at Oberlin to be AINA vice-president.

But who would pay for this new institute? I thought that all of the people and foundations that had supported my shipwreck excavations for the University of Pennsylvania would put even more money into an institute devoted to full-time underwater archaeology. An institute without even a business address, however, must not have been tempting. I was turned down by every foundation I approached.

Then I mailed a copy of my newly published *A History of Seafaring Based on Underwater Archaeology* to Tulsa, Oklahoma, businessman Jack W. Kelley, only an acquaintance, asking if he would like to sit on the Board of Directors of AINA. To my surprise, he called immediately, not only agreeing to serve, and making a three-year pledge of funding, but telling me that he had a friend who would probably join him, retired Cleveland, Ohio, businessman John H. Baird. They were soon joined by John Brown Cook, a generous supporter of the Katzevs' Kyrenia project.

An Institute for Nautical Archaeology

We held our first board meeting in Philadelphia in the spring of 1973. Melvin M. Payne, chairman of the board of the National Geographic Society, and another AINA founding director, arrived with a check to pay for our first field project, a search off the Turkish coast for another wreck to excavate.

Before the survey, however, I attended a week-long, federally sponsored conference at a retreat in Virginia to help write a national program projecting the role of humans in the sea. My roommate was a doctoral candidate in oceanography, about ten years my junior. We sat up late, talking of dreams. I dreamed of a successful Institute of Nautical Archaeology. He dreamed of exploring the seabed in the deep-diving submersible *Alvin*. A student later interviewed us independently and wrote a term paper entitled *And All Their Dreams Came True*. His name was Robert Ballard, who would go on to find the *Titanic*. In this book he describes the deep-water archaeological work he has done with the assistance of our institute's Cheryl Ward.

My wife, Ann, and I soon afterward sold everything we owned – house, car, furniture, pictures off the walls, even our two sons' toys – and moved to the island of Cyprus, where we were greeted by the Katzevs, Dick Steffy, and the rest of the Kyrenia team, including Robin Piercy.

There was, however, a serious problem. None of us knew of another wreck to excavate. Leaving Ann on Cyprus to find a house and locate schools for our boys, I returned to Turkey, where I had done all of my previous underwater excavations.

For the first six weeks I lived on the open deck of a 10-m (33-ft) fishing boat, *Günyel*, with seven companions. One was physics professor Donald Frey, who had been a volunteer diver my last summer at Yassıada. Another was sonar-operator John Broadwater, who had taken me on my first Atlantic dive, on a Civil War blockade-runner, not long before. John later abandoned his career as an electrical engineer, obtained a doctorate in maritime studies at the University of St Andrews, and fully excavated the wreck he describes in these pages.

There was no room in *Günyel's* cabin for anything other than the sonar and underwater television gear. Unwilling to dive without a recompression chamber on hand to treat any possible case of the bends, we swept swaths of seabed hundreds of

For three months in 1973, during INA's initial survey for ancient shipwrecks, the author and five companions lived on Turkish fishing boats, first on the 10-m (33-ft) *Günyel* (below), its cabin so filled with sonar equipment that the team had to eat and sleep on the crowded open deck for six weeks. With the arrival from the United States of a two-person, double-lock recompression chamber, now bolted to the deck along with compressors and air bank, the survey team moved for six weeks onto the larger trawler *Kardeşler* (right), sleeping in its fish hold.





meters wide with the sonar. When a possible wreck appeared as a dark smudge on the sonar read-out paper, we lowered our television camera from *Günyel*'s stern. Only one of the targets proved to be a possible wreck, a scatter of Byzantine pottery not worth excavating. I was more than discouraged. As the weeks passed, most of my companions had to return to their jobs.

Then our two-person, double-lock recompression chamber arrived from America, a gift of Cleveland businessman Alex Nason. With three Turkish and two American divers, I moved from *Günyel* to the larger 20-m (66-ft) trawler *Kardeşler*, onto whose deck we strapped the chamber and its supporting compressor and air bank. Now we could dive.

We followed the proven method of finding wrecks by interviewing local sponge divers. By talking to the divers of just 20 sponge boats, we calculated that we were learning about any antiquities they had seen during 10,000 hours on the seabed that year.

Retired sponge-diver Mehmet Aşkın soon led us to the wrecks at Bozburun and Serçe Limanı whose excavations are described in this book. Others followed. But Cumhuriyet, a young Turkish diver on my team, had no background in archaeology. He had been a cabin boy on my first underwater excavation, at Cape Gelidonya in 1960, had turned to sponge diving for a few years, and in 1973 was a charter boat captain. His idea of shipwrecks, when he joined us, was of modern vessels, whose

Below Interviewing sponge divers proved more efficient than using sonar: retired diver Mehmet Aşkın (center) directed the author and Yüksel Eğdemir (right), from the Turkish Ministry of Culture, to the nearby Bozburun wreck and two wrecks at Serçe Limanı.





Diver Joe Alexander examines a 7th-century cargo of Byzantine roof tiles in Turkey's Gökova Bay during our initial 1973 survey.

bronze or brass fittings and propellers could be salvaged and sold for scrap. But after diving with us on a cargo of ancient tiles, he voiced surprise, and said he knew of other places like that. Pressed for more information, he recalled two large jars he had seen only once, seven years before, about 30 m (99 ft) deep, at a place called Şeytan Deresi, in English “Devil Creek.” By the end of the survey, in November, we had found a dozen wrecks, at least a third of them worthy of archaeological excavation.

The year on Cyprus passed quickly. Dick Steffy sold his business completely to join the fledgling institute for a pauper’s salary. Fred van Doorninck joined us for part of the year to continue research on the Byzantine shipwreck.

In the summer of 1974, we planned to complete the excavation of the 4th-century Yassıada wreck, and we had a good contingent of paying field-school students, including David Switzer, a professor of history at Plymouth State College, and Faith Hentschel, a Yale University doctoral candidate. The excavation was only days old when the outbreak of war on Cyprus ended it – and our idyllic situation on that lovely island.

The Katzevs moved to Greece, Dick Steffy moved back to his hometown of Denver, Pennsylvania, and I simply followed him with my family, all of us war refugees. Some people urged me to give up and simply return to teaching, but instead I convinced our Board of Directors to hire Robin Piercy, Michael Katzev’s right-hand man on Cyprus, and Donald Frey, my right-hand man in Turkey.

AINA Director Elizabeth Whitehead proposed that we find a university home, where AINA would be affiliated but would retain its own corporate structure, like the Whitehead Medical Institute her husband had just founded at the Massachusetts Institute of Technology. But how does one shop for a university home? I had no idea, but the word got out, and soon we were approached by a number of universities.

Nautical Archaeology as an Academic Discipline

Texas A&M University made by far the most generous offer, proposing to establish a separate graduate program in nautical archaeology, with Dick Steffy, Fred van Doorninck, and me joining the faculty, each of us teaching either in the spring or fall, but free to pursue AINA research during the other term, paid by AINA; we would also offer summer field courses.

In our case, the cloud of war had more than one silver lining:

First, we learned not to put all of our eggs in one geographical basket, and soon were accepting invitations to work in North America and in Africa. I asked David Switzer to direct the first excavation of a Revolutionary War vessel in the United States, in Penobscot Bay, Maine; Dave describes his excavation in this book. Then I asked Don Frey and Robin Piercy to examine a Portuguese shipwreck at Mombasa, Kenya, where AINA had been invited by the director of the Fort Jesus Museum; Robin, too, describes his subsequent excavation in this book.

Second, the Turkish military initially allowed AINA to continue its work at Şeytan Deresi, but only if we used Turkish students as our volunteer staff. Don Frey chose ten students, and then brought multi-talented Donald Keith to Turkey to teach them to dive. Not long thereafter, Tufan Turanlı and Cemal Pulak joined AINA. Tufan later found the wreck described by Deborah Carlson in these pages, and Cemal Pulak writes about his excavation for the Institute of the Bronze Age shipwreck at Uluburun; some years later another of the students, Ayhan Sicimolğu, who had gone

into business, joined the Institute's Board of Directors.

Third, affiliating with Texas A&M University relieved to some extent the institute's financial burden because of some shared costs, although in the years since the affiliation, the Institute's income has risen from \$50,000 a year (for *everything*, including salaries) to \$1–2 million a year.

Fourth, during negotiations with Texas A&M University, we mutually decided to add a New World archaeologist to our team. Our choice was Dr Donny Hamilton, then at the University of Texas at Austin in charge of conserving artifacts from the Spanish fleet that sank off Padre Island in 1554. This led Texas A&M and the Institute not only to become world leaders in archaeological conservation, with both teaching and innovative research laboratories, but to conduct a ten-year excavation of Port Royal, Jamaica, which Donny describes here. As I write these words, Donny is president of INA.

Fifth, Michael, Fred, and I had done most of our work while we were still graduate students, and now, with a virtual department devoted to our field, we had a self-replacing stable of nautical archaeology thoroughbreds able to direct their own projects. Among the former students who have contributed to this book are Robert Neyland, underwater archaeologist for the US Navy, who went on to direct the recovery and conservation of the Civil War submarine *Hunley*; Fred Hocker, now at the *Vasa* Museum in Stockholm, Sweden; Bill Charlton, a retired Marine Corps Officer and INA Divemaster; Elizabeth Greene, teaching at Wellesley College; Jerome Hall, on the faculty of the University of San Diego; Margaret Leshikar-Denton, an archaeologist at the Cayman Islands National Museum; Cheryl Ward, on the faculty at Florida State University; Brett Phaneuf, now a graduate student in oceanography; and, finally, Deborah Carlson, Filipe Castro, Kevin Crisman, and Cemal Pulak, all members of the Texas A&M nautical archaeology faculty – Dick Steffy, Fred van Doorninck, and I having graciously made room for them by retiring!

Other graduate students in the Texas A&M Nautical Archaeology Program have come from Albania, Belgium, Bulgaria, Canada, China, Denmark, Greece, Jamaica,

Graduates of the graduate program in Nautical Archaeology at Texas A&M University, with field experience gained on INA projects, have gone on to successful careers. Dr Robert Neyland, assisted by other former Texas A&M students, directed the raising and conservation of the Confederate submarine *H.L. Hunley*, the first submarine ever to sink an enemy vessel. Shortly after sinking the *USS Housatonic* in 1864, during the American Civil War, the *Hunley* disappeared for over a century in Charleston Harbor, South Carolina.



Japan, Malaysia, Mexico, the Netherlands, New Zealand, Peru, Portugal, South Africa, Switzerland, Turkey, and the United Kingdom.

Not long after affiliating with Texas A&M University, the Institute shortened its name simply to the Institute of Nautical Archaeology (INA) to reflect more accurately the international nature of its staff, sponsors, and projects. INA has since conducted projects in Albania, the Bahamas, Bahrain, Bulgaria, the Caymans, Cyprus, the Dominican Republic, Egypt, Eritrea, Georgia, Israel, Italy, Jamaica, Kenya, Lebanon, Malta, Mexico, Morocco, the Netherlands, Panama, Portugal, Turkey, the Turks and Caicos Islands, and from the Great Lakes to the Gulf of Mexico in the United States; additionally, it has conducted joint projects with national agencies in Greece and Mexico.

The INA Center in Bodrum

In Bodrum, Turkey, Don Frey, while serving as INA's second president, raised the funds to acquire a beautiful piece of land and start a building project, which I continued while serving again briefly as president. Today INA has a five-building campus with offices, dormitory, four-story library building, conservation laboratory, and computer center. Cemal Pulak, Fred van Doorninck, Tufan Turanlı and I bought adjacent plots of land on a small lane adjoining the INA campus, where we have built our own homes.

We also added a small fleet in Turkey. We bought *Virazon* outright, and acquired a new two-person submersible, *Carolyn*, whose occupants sit in a clear acrylic sphere able to look in all directions except directly behind. To carry and launch *Carolyn*, we built a 15-m (50-ft) steel catamaran, named *Millawanda* after the Bronze Age name for Miletus on the Turkish coast. In just one month in 2001, surveying from *Carolyn*, we located 14 ancient wrecks and 10 possible wrecks, while re-examining a dozen wrecks we already knew.

INA also established a modern conservation center in Alexandria, Egypt, now operated by the Egyptian government.

In just a month INA's two-person submersible *Carolyn*, during a 2001 survey off the Turkish coast, helped to locate 14 ancient wrecks and 10 possible wrecks, while revisiting a dozen known wrecks. Here the sub approaches a medieval cargo of at least 32 immense millstones.



Spreading the Discipline

Other archaeologists who gained their first field experience with us, studied with us, or pursued postgraduate studies at Texas A&M University, have gone on to direct their own major projects. They include some of the authors of this book.

John Broadwater, sonar operator on INA's first field project, a 1973 survey of the Turkish coast, and later a member of an INA excavation team working in the York River, Virginia, is now Manager of the *Monitor* National Marine Sanctuary for the National Oceanic and Atmospheric Administration, and was recently in charge of raising the turret of that famed Civil War ironclad. In these pages he describes his excavation of the British ship *Betsy*, scuttled in the York River in the closing days of the American Revolution.

Jeremy Green, whose introduction to underwater archaeology was with me at Yassıada in 1969, soon afterward became head of the Department of Marine Archaeology at the Western Australian Maritime Museum in Fremantle. In addition to his own excavation of the Dutch East Indiaman *Batavia*, now beautifully conserved and restored in his museum, and the Far Eastern research he describes here, he has played important roles, as an INA Research Associate, in INA excavations at Mombasa, Kenya, and at both Tektaş Burnu and Pabuç Burnu in Turkey.

Nergis Günsenin, who while still a high-school student assisted INA's excavation at Serçe Limanı, Turkey, went on to earn a doctorate at the Sorbonne and, later, a professorship at Istanbul University; as an INA Adjunct Professor, she provides field experience for Texas A&M graduate students on her excavations, and INA accepts her students for training in Bodrum, Turkey.

Ralph Pedersen, while still a graduate student at Texas A&M not only worked at Uluburun, Turkey, but directed an INA survey in Bahrain and excavated a Byzantine wreck off

Below The crew of the Civil War ironclad **USS *Monitor*** relax on deck after her 1862 battle with the Confederate ironclad **CSS *Virginia*** (ex-USS *Merrimack*).

Bottom The ***Monitor's*** turret, when recovered in 2002, still contained its two 11-inch Dahlgren guns, gun carriages, and more than 100 artifacts, in addition to the remains of two of the crew.



Eritrea. Since obtaining his doctorate, he has studied the thousand-year-old hull of a sailing barge at Kadakkarapally, near Chertala in Kerala, India.

Robert S. Neyland, although mentioned earlier for his work as Head of the Underwater Branch of the Department of the Navy on the Civil War submarine *Hunley* in Charleston, South Carolina (illustrated and described on page 23) had already, while still a student at Texas A&M University, conducted the excavation of a 17th-century wreck in the Netherlands that he describes here.

Paul Johnston worked as a graduate student volunteer on INA projects at Serçe Limani, Turkey, and in Penobscot Bay, Maine, and the York River, Virginia, before earning a doctorate at the University of Pennsylvania and becoming Curator of Maritime History at the Smithsonian Institution's National Museum of American History, for which he excavated the remains of the royal yacht off Hawaii.

After receiving an M.A. from Texas A&M University, Kenneth Cassavoy returned to his native Canada where he studied the remarkably preserved War of 1812 *Hamilton* and *Scourge* in Lake Ontario, and, as this is written, is excavating at Southampton on Lake Huron the earliest warship yet found in the Upper Lakes, probably the British Navy brig *General Hunter* built in 1806.

Zhang Wei, who studied with us at Texas A&M University in 1989, now heads underwater archaeology in China for the National Museum of Chinese History in Beijing, for which he has directed excavations of 14th- and 13th-century ships laden with large cargoes of beautifully preserved porcelain.

Donald H. Keith, after his start as a diving instructor at Şeytan Deresi, went on to excavate what was the oldest known shipwreck in the Western hemisphere, at Molasses Reef in the Turks and Caicos Islands, where he established on Grand Turk



Below left Archaeologists George Bass, Zhang Wei, and Ao Jie examine some of the ceramics excavated in the Yellow Sea and the South China Sea by Zhang Wei's team, now displayed in a museum in the Ocean Visitor Hotel in Yangjiang, a tourist center on the South China Sea.





Above Former INA Executive Director Kenneth Cassavoy stands on the stern of the excavated hull of a War of 1812 ship, believed to be the British brig *General Hunter*.

Below Divers under the direction of INA's Donald Keith raise a cannon from the early 16th-century Molasses Reef Wreck in the Turks and Caicos Islands, at the time the oldest known shipwreck in the New World.



Island a permanent display of that wreck in the Turks and Caicos National Museum. After earning a doctorate at Texas A&M University, he formed his own group, Ships of Discovery, based at the Corpus Christi Museum in Texas.

Jeffrey Royal, with experience on the Bozburun excavation, described in this book, and with a doctorate from Texas A&M University, took a position as Archaeological Director of the RPM Foundation, established by George Robb, a member of the INA Board of Directors. The Foundation has archaeological research vessels in both the Caribbean and Mediterranean, and its close collaboration with INA should lead to astonishing discoveries on both sides of the Atlantic.

Oğuz Alpözen, who as an Istanbul University undergraduate student joined us at Yassıada in 1962 to learn to dive, and worked with us for years thereafter, has been director of the Bodrum Museum of Underwater Archaeology for more than 20 years. The museum, with separate galleries devoted to all of the shipwrecks excavated by INA off the Turkish coast, has become under his leadership the most visited archaeological museum in Turkey.

The Future

The dream of an institute of nautical archaeology has become a reality far beyond my wildest expectations. Now I dream of INA research vessels in both the New and Old Worlds, the first American research vessels designed specifically for the humanities, vessels large enough to carry and launch submersibles like our current *Carolyn*, vessels that will lead to unimaginable discoveries. I dream of an endowment to guarantee their continued operation.

We will never run out of worthy sites. If only one vessel sank in every year of every decade of every century of every millennium since the first seafarers sailed out from their cave dwellings in Greece 11,000 years ago, we would have 11,000 wrecks in the Aegean alone. But hundreds of ships have sunk in Aegean storms in a single day. We cannot calculate the number of wrecks in that one sea. The number of wrecks beneath the Seven Seas is truly unimaginable.

Archaeologists, however, face the constant threat of the looting of historic wrecks by treasure hunters for personal gain rather than for the benefit of humankind. Every known wreck from the period of discovery of the New World, for example, has been destroyed or badly damaged by those seeking non-existent gold in them. With false promises of paying off the debts of nations by the treasures they will find and share, they often profit most from the finances they have received from their investors. No country has ever benefited as much from treasure hunting as from true archaeology, which results in museums that attract thousands, even millions, of visitors, each one of whom boosts the local economy by paying for hotels, taxis, restaurants, and souvenirs, in addition to their museum tickets.

One day, INA will have excavated a wreck of every century of the past, and then can turn its attention to tracing the evolution of specific types of ships, from warships to ferries to fishing boats. This will contribute to an increasing number of informative museum displays around the world. But the ultimate product, shelves filled with large volumes written on these vessels and their contents, will provide for the world not only the ultimate histories of watercraft, but the ultimate histories of virtually everything ever made by humans.



THE OLDEST WRECKS

Excavations of the three Bronze Age shipwrecks described here have resulted in a puzzle, a ridiculed hypothesis, and a royal cargo beyond imagination. Archaeologists divide the Bronze Age into three periods, Early (around 3000 to 2000 BC), Middle (around 2000 to 1600 BC), and Late (around 1600 to 1000 BC). The Bronze Age people who inhabited the island of Crete are called Minoan (after the legendary King Minos of Crete), and those on the Greek mainland, southern Italy, and the western coast of Asia Minor (modern Turkey) are called Helladic. The Late Helladics are also known today as Mycenaeans, after King Agamemnon's great citadel at Mycenae.

The Bronze Age civilizations of the eastern Mediterranean were clearly dependent on watercraft. Only by water could islanders go anywhere, and since the invention of the sail, around 3500 BC, it has been far easier and cheaper to move people and cargoes over water than over land.

Greek archaeologists have excavated an Early Helladic cargo of pottery off the island of Dokos; have discovered a Minoan cargo; and have excavated a cargo of Minoan, Mycenaean, and Cypriot pottery from around 1200 BC off Point Iria in the Peloponnesus.

Three Bronze Age wrecks studied by the Institute of Nautical Archaeology off the southwest Turkish coast, described in the following pages, include a site whose date and very nature remain puzzles. No wooden hull remains lay beneath the scatter of large jars on the seabed at Şeytan Deresi, suggesting that the pottery spilled from a capsized vessel – in which case the site should not really be called a shipwreck – or that the hull was made of such fragile material, such as sewn animal hides, that none of it survived. Only two of the jars closely resemble any known jars, suggesting that the pottery was made by a local culture that has not yet been discovered and identified on land. The two jars are near duplicates of a jar found on Crete, but it was called Neolithic (pre-Bronze Age) by its excavator. Other Şeytan Deresi pots resemble ceramics from around 1600 BC on Crete, in the interior of Asia Minor, and at Troy. Yet a thermoluminescence dating of fragments of the pots places them in the Late Roman or Byzantine period! Are two spills of pottery involved? Puzzling, indeed.

The other two wrecks investigated by the Institute of Nautical Archaeology have made substantial contributions to our knowledge of the Bronze Age. These are the wrecks at Cape Gelidonya and at Uluburun.

The Cape Gelidonya wreck has a solid place in the history of nautical archaeology, being the first ancient Mediterranean shipwreck excavated in its entirety on the seabed, and being the first excavated by a diving archaeologist. It, like the Dokos and

Archaeologists excavating at Uluburun. In the foreground, a diver measures some of the many copper ingots that were found. The diver in the background hovers near one of the ship's heavy stone anchors, while fanning sand away from a second. Airlifts rise up behind him.



Above A beautifully preserved sword is raised from the depths of the Mediterranean by archaeologist Faith Hentschel during excavation of the Uluburun wreck.

Right Places mentioned in this section, with the featured wrecks in bold.

Point Iria wrecks mentioned above, was discovered by Peter Throckmorton, whose vision led to the original excavation of the site by the University of Pennsylvania Museum. When I excavated the site with Peter, I was still a graduate student at that university, but after founding the Institute of Nautical Archaeology (INA) I returned to the site several times with INA colleagues, making additional discoveries and interpretations, which allows inclusion of the site in this book. The Cape Gelidonya excavation, which led me to recognize a significant but at that time unsuspected Semitic presence in the Bronze Age Aegean, was proof that underwater archaeology could rewrite history, although my initial publication of this presence was criticized and even ridiculed. I did not think I would live to see my once controversial ideas validated, as they were by the Uluburun wreck.

The wreck at Uluburun was voted one of the ten greatest archaeological discoveries of the 20th century – along with King Tut’s tomb and Machu Picchu – in a poll of archaeologists taken by *Discovering Archaeology* magazine. It, perhaps more than any other underwater site, has shown how shipwrecks can provide unique information about the past, contributing to such diverse fields as Egyptology, Homeric studies, and biblical studies, and to the histories of metallurgy, metrology, glass, ceramics, foodstuffs, weapons, tools, musical instruments, trade, international relations, technology, and much more.

The Cape Gelidonya and Uluburun wrecks revealed how ships were built at the time of the Trojan War, although not being Mycenaean they may not have been of the types of which Helen’s face launched a thousand.



Şeytan Deresi

Date c 1600 BC?

Depth 27–33 m (89–109 ft)

Found by Cumhuri İlik, 1965

Excavation 1975

Cargo storage jars, krater,
pitchers

Hull unknown

An Enigma at Devil Creek: Şeytan Deresi, Turkey

GEORGE F. BASS

If it hadn't been so cold, we never would have seen them. The two jars sparked little interest. But on a cold November evening in 1973, bundled in jackets on the deck of the Turkish trawler *Kardeşler*, we looked for any excuse to stop for the evening and perhaps warm ourselves over glasses of *raki*.

We'd been living on fishing boats for three months, eating on deck from communal pots and sleeping in fish holds. We were on our way to examine a reported Roman wreck in Turkey's Gökova Bay when we realized we were passing Şeytan Deresi. The Roman wreck was still two hours away.

"Maybe Cumhuri's jars are worth a photograph," suggested Yüksel Eğdemir, the diving commissioner assigned to us by the Turkish Ministry of Culture. "This is where he says he saw them."

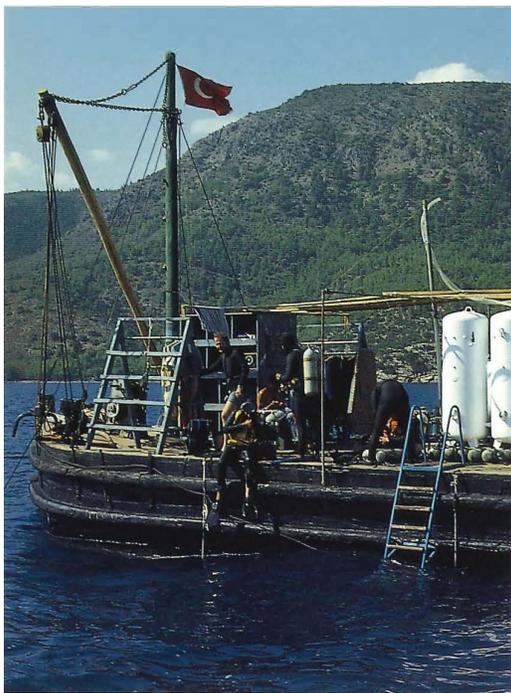
I doubted that Cumhuri İlik could spot again jars he had seen only once, seven years earlier, when he was diving for sponges at a depth of 33 m (109 ft). But it was getting colder. I asked Captain Mehmet Turguttekın to stop for the night.

Next morning, with *Kardeşler* anchored nearby, Cumhuri uncannily led Yüksel and me, with no guideposts, directly to the jars. One was a *krater*, a large bowl for mixing wine and water. I reached for its rim, but Yüksel pulled me away, pointing to the large moray eel living inside and looking more than annoyed by uninvited visitors.

After placing lead markers in the depressions they left in the seabed, we raised the *krater*, along with a large, intact storage jar, and part of what proved to be a smaller, two-handled jar. I was not sure of their dates, but the faint black spiral painted on a single sherd made me think of the Late Bronze Age (1600 to 1000 BC). At the same time, we picked up broken bits of Roman amphoras, the kind of rubbish found everywhere on the sea floor. Colleagues in Turkey and Cyprus all told me that the *krater* could not possibly be earlier than the 8th century BC, so when I first mentioned the site in print, I said it was from the Iron Age.

Above During the survey that led to the discoveries at Şeytan Deresi, the 10-m (33-ft) fishing boat *Günyel*, anchored in the cove, was used for sonar work, while the larger *Kardeşler*, heading out to sea, was equipped for diving, with compressors and recompression chamber on its deck. *Right* The survey team dined on *Kardeşler's* deck and slept in the trawler's fish hold. Enjoying a meal of beans are, clockwise from left, Cumhuri İlik, George Bass, John Gifford, and Yüksel Eğdemir.





Above A 15-m (50-ft) wooden barge served as a dive platform, holding on its deck the white air-bank for a recompression chamber, high- and low-pressure compressors, and storage spaces for diving equipment. The barge was used for excavations off the Turkish coast for nearly two decades.

Right One of six large storage jars lay in isolation about 30 m (99 ft) from the major concentration of pottery. An octopus has pulled rocks and broken pottery into its mouth to protect its home inside.

Return to Devil Creek

Turkish place names like Karatoprak and Kızılağaç sound so exotic, not like Big Lake, Coldspring, Grapevine, Longview, and Sweetwater in Texas. But translated into English, they are just as prosaic: Black Earth and Red Tree. *Şeytan* (pronounced Sheytan) is the same as our Satan, and *dere* means stream, so I call *Şeytan Deresi* simply “Devil Creek.” I’m not sure of the name’s origin, but we usually encountered winds when we arrived there, and Captain Mehmet recalled seeing a waterspout there when he was a boy.

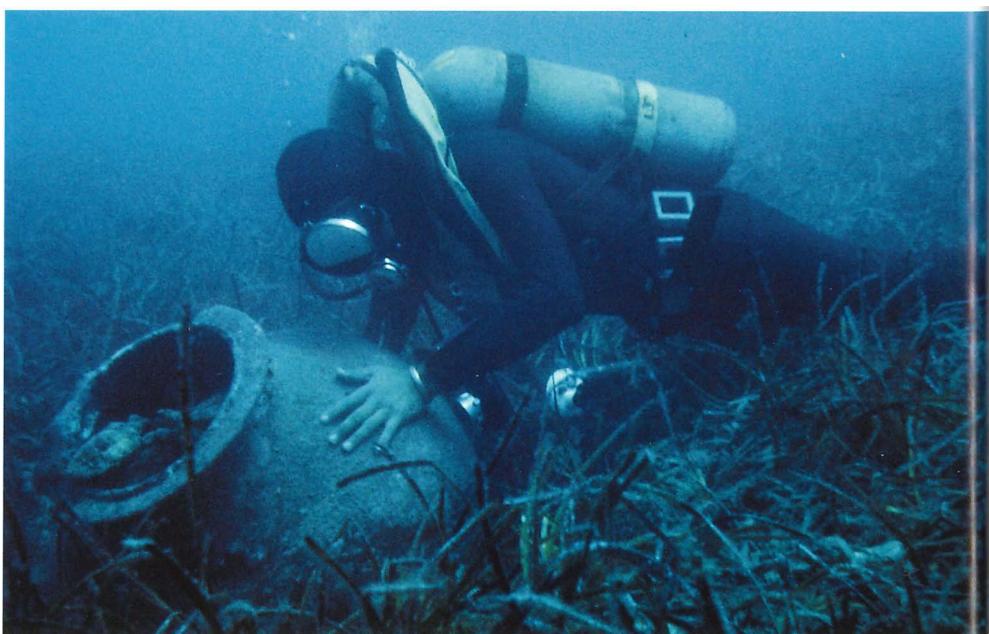
I returned to Devil Creek in 1975, for INA’s first full-scale excavation. With me were several veterans, and ten Turkish students chosen by Don Frey, who had been teaching physics at Robert College in Istanbul.

We built a camp of woven mats and tents in a nearby pine forest, heavily screened against constant swarms of yellow jackets that stung everyone at least once. Although the Turkish students had to learn to dive, I was struck by their multi-talented ability to do anything asked of them, from wiring the camp to repairing the generator to running the photographic darkroom. All were excellent cooks.

To support the compressors and recompression chamber, we moored over the site the old 15-m (50-ft) wooden barge we had used in the 1960s when we excavated at Yassıada for the University of Pennsylvania Museum. Then we put our underwater telephone booth and airlifts in place, laid down a metal grid to break the site into coherent squares for systematic excavation, and began to dig.

A Puzzling Site

We found nothing – absolutely nothing – other than more pottery, mostly jars and mostly close together. Some, however, were scattered. One of six large jars lay about 30 m (99 ft) from the other five, only 27 m (89 ft) deep, as if it had floated there separately. Inside was a fragment of pottery that joined a broken pot in the main concentration; we suppose it had been carried to the isolated jar by an octopus that once made its home there. In addition, there were smaller two-handled jars and a couple of pitchers.





Top At the Bodrum Museum, excavation director George Bass repairs one of the large jars, and Ann Bass mends a pitcher, before they color the white plaster used to fill gaps. The smaller jar with two horizontal handles, above, closely resembles a jar found on Crete.

The sand was deep enough to have covered and protected remains of a wooden hull, which suggests that a small, local craft capsized, spilled out its cargo, and floated away. I do not think of the site as a shipwreck.

After looking for published parallels for our pottery during a term at the University of Cambridge, I decided that my first assessment of the site was correct, that it dated to the Bronze Age. Comparing similar pieces found at Troy and Beycesultan in Turkey, as well as at sites in northern Greece and on Crete, I concluded that the pottery dated to around 1600 BC.

Some colleagues, however, continued to doubt this early date. So in 1996 I had the Research Laboratory for Archaeology and the History of Art in Oxford date two sherds by means of thermoluminescence. One sherd dated to between AD 110 and 640 and the other to between AD 510 and 770, giving a possible date of around AD 600 for the site, putting it well into the Byzantine period – 2,200 years later than I had thought possible!

I invited Roxani Margariti, a brilliant Greek student, to write her Texas A&M University M.A. thesis on the site. She, like me, concluded that the pottery was made in the first half of the 16th century BC, at the beginning of the Late Bronze Age. In the course of her research, she found the report of an excavation on Crete, published in a Greek archaeological journal, with the picture of a two-handled jar exactly like our smaller jars – the most perfect parallel for any of our pottery – but the caption below the picture says that the jar is Neolithic, before 3000 BC, or more than 1,000 years earlier! Alas, the jar is not mentioned in the text of the report.

We plan to have more samples dated by thermoluminescence, while trying to contact the excavator of the “Neolithic” jar to learn the exact context in which it was found.

Archaeological detective work can be long and tedious. One day, however, I am sure we will understand this still puzzling site.

Cargo from the Age of Bronze: Cape Gelidonya, Turkey

GEORGE F. BASS

Cape Gelidonya

Date late 13th century BC

Depth 26–28 m (86–92 ft)

Found by Kemal Aras

Excavation 1960

Cost \$18,000

Cargo copper, tin, scrap bronze

Hull size unknown

The place of the Cape Gelidonya shipwreck in the history of underwater archaeology, as the first ancient wreck excavated in its entirety on the seabed, is less important to me than how its excavation rewrote a significant part of the history of the Bronze Age.

In the introduction to this book, I describe how the excavation came about: how Peter Throckmorton reported a wreck of the Late Bronze Age (1600 to 1000 BC) to the University of Pennsylvania Museum, how I was asked to learn to dive and become archaeologist in charge of its excavation, and how I took the first six lessons of a ten-lesson YMCA diving course before heading for Turkey with Peter in the spring of 1960. I did not describe the physical and intellectual adventures that followed.

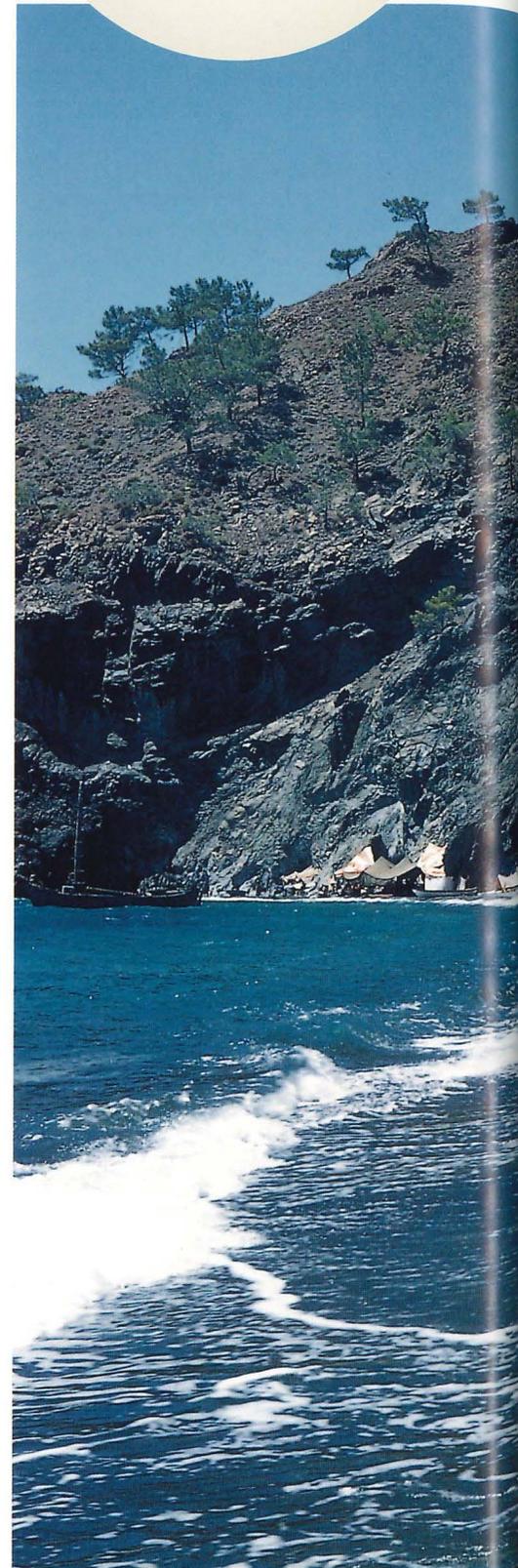
In mid-June I sailed on a sponge-diving boat from Bodrum, then the sponging center of Turkey, accompanied by a vessel that normally dragged for sponges with a net attached to a metal axle on wheels. Neither boat was more than 10 m (33 ft) long. I had no inkling that my life was changing forever.

The wreck lay 26–28 m (86–92 ft) deep between two of five small, barren islands that run out from the cape, today known as Taşlıkburun, but we needed a source of fresh water for drinking, bathing, and cooking, and for leeching corrosive salts out of the artifacts we hoped to find. About an hour's sail from the wreck I spotted two damp patches in the sand on a narrow beach surrounded by high cliffs. We dug into the sand until we had two streams of fresh, cold water, which we dammed to form two basins. Between them we pitched our camp.

The Beach

I was still only a student. I'd never even dived in open water before I arrived in Turkey. No one had ever done on the seabed what we hoped to do. It had been difficult to attract funding. So our camp for eight people was mostly what Peter and I scrounged from a US Air Force base near Istanbul: part of a canvas mess tent, some discarded cot mattresses, torn parachutes we strung up for shade, and an electric generator that powered the darkroom we installed in a shallow cave at the base of the cliff. The wooden crates in which our diving equipment arrived from America served as furniture.

Without refrigeration, in a natural oven that reached 110°F (43°C) most mornings, we lived on little more than beans, rice, tomatoes, olives, and watermelon for three months, sending one of our two boats weekly to a distant village for supplies. We were a multi-national team, from the United States, Britain, France, and Turkey, joined later by Waldemar Illing, a powerful German diver who, when he had time, supplemented our diet by spearing fish.



Below The expedition's home for three months was a narrow strip of beach about an hour's sail from the wreck site. Seen here on a calm day, it was abandoned when the first south wind of autumn sent waves crashing over it.

Below right Excavation director George Bass (left) and Peter Throckmorton puzzle over bits of wood and corroded bronze implements in the camp's simple "conservation laboratory."



I had married Ann Singletary shortly before sailing to Turkey. She joined me after completing her master's degree in music, carrying two suitcases, one of clothes and one of music – expecting to find a piano?

French diver Claude Duthuit had the only pup tent.

"Take it, George," he gallantly offered. "It's your honeymoon."

Claude remains my closest friend!

The Excavation

Daily we sailed to the site, where we had permanently moored metal oil drums to which we tied our boats. We dived 40 minutes in the morning and 28 minutes in the afternoon, working hard on the seabed, with only a few minutes of decompression after each dive. Without a physician, or recompression chamber, or even medicinal oxygen, we must have had a guardian angel, for we suffered no cases of the bends.

When our little high-pressure compressor broke down and had to be sent to the nearest machine shop, an overnight sail away, we could no longer fill scuba tanks. Peter and I attached a hose to the sponge-boat's originally hand-cranked compressor, having made gaskets from old leather shoes, and continued to dive, although we were in what our pilot book said was the strongest current in the Mediterranean. We held on for dear life descending and ascending a rope running to the bottom, our bodies flapping like laundry on a windy day, and took turns bracing ourselves between rocks to hold our partner's hose so that he or she could let go and work with freed hands.

Chief diver Frédéric Dumas, on loan from Jacques-Yves Cousteau, was regarded as the world's greatest diver. He told Peter and me we were crazy, and refused to dive with our jury-rigged gear. Normally, however, we dived with scuba.





Above With an ordinary pencil Claude Duthuit draws on a sheet of frosted plastic the positions of artifacts lying in a rocky gully.

Below The cargo was brought to the surface still embedded in large chunks of concretion that were put back together at the camp like pieces of a giant jigsaw puzzle. Ann Bass removes concretion, revealing copper ingots.

Laboriously we mapped the site by measuring with meter tapes from spikes we drove into the rock around the mostly metal cargo. This cargo was embedded in rock-hard seabed concretion that had built up in thickness over the years. Dumas suggested that we bring the cargo to the surface still encased in this concretion, so that we could extract it more carefully back at camp. From that time we hammered and chiseled to free massive lumps of concretion that we raised with air-filled lifting balloons, and then fitted back together on the beach.

The depth of sand was not sufficient to have covered and protected from shipworms and other marine borers the ship's wooden hull, although we found a few scraps of wood and, under some of the metal cargo, layers of twigs with the bark still preserved. This explained the brushwood Odysseus spread out in a ship he built, which had puzzled classicists. The twigs formed dunnage, a cushion for the cargo.

We removed sand with airlifts, nearly vertical metal pipes to whose lower ends we pumped air from the surface through hoses; as the air entered the pipes, it formed bubbles which rushed upward, creating a suction that pulled in both water and whatever sand we swept into the pipes' lower ends.

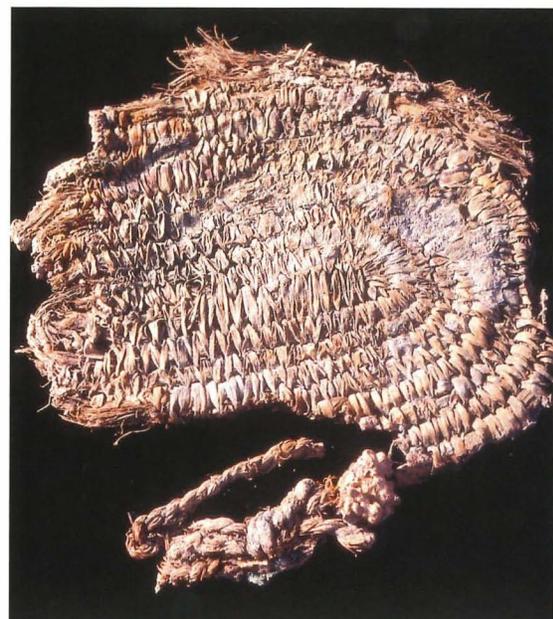
We had all but completed the excavation before the first south wind of autumn sent waves crashing completely across our narrow beach in mid-September, driving us from the Cape.

Fatal Final Voyage

We had excavated a ton of metal. Thirty-four flat, four-handled ingots of almost pure Cypriot copper, weighing on average 25 kg (55 lb), were still stacked as they had been in the ship 3,200 years before. A material like white toothpaste was later shown, by chemical analysis, to be the remains of tin, probably tin ingots. Mixed with the ingots



Below A bronze swage, 10 cm (3.9 in) long, was used like a small anvil for shaping metal. Sockets for tools were hammered out at one end. *Above center* Stone hammers 6 and 8 cm (2.4 and 3.1 in) in diameter, displayed with modern wooden hafts, resemble more recent hammers used for working metals. *Below center* Pan-balance weights of stone were based on Near Eastern weight standards. *Above right* The remarkably preserved bottom of a woven basket that held scrap bronze in the cargo. *Center right* Scarabs were Syro-Palestinian imitations of Egyptian scarabs. *Below right* A stone seal about the diameter of a pencil is like those once worn at the wrists of Near Eastern merchants. It is shown with modern string and modern clay onto which it has been rolled.

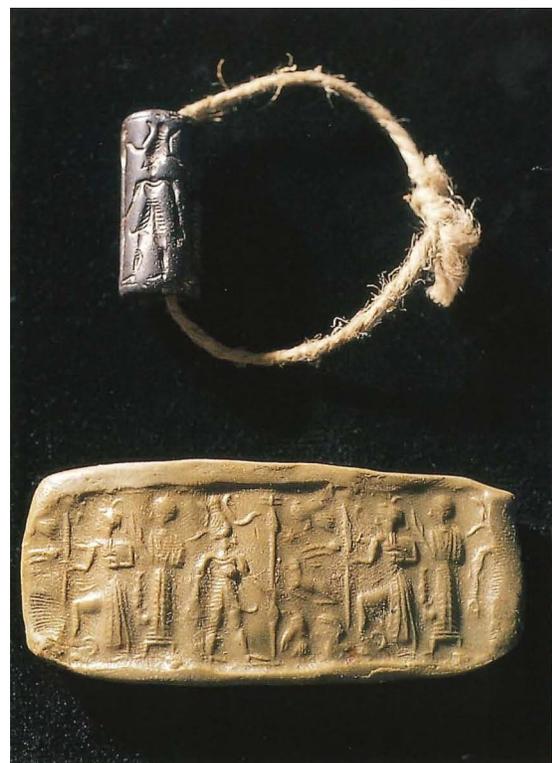


were broken bronze tools made on the island of Cyprus and carried in baskets, one of which we found remarkably preserved. The copper and tin, ingredients for making new bronze, and the scrap bronze, were all intended to be melted down and cast in molds to form new bronze objects.

The discovery of a grooved and pierced bronze swage (a kind of small anvil), two stone hammerheads of types sometimes used in metalworking, a whetstone, numerous stone polishers, and a large, close-grained stone with flat top that could have served as an anvil suggested that a traveling smith, or tinker, may have been on the ship's last voyage.

At one end of the site, which we believe to have been the living quarters of the ship, probably at the stern, we found the personal possessions of those on board – along with olive pits that had been spat into the bilge. About 60 small stone objects, some shaped like domed marshmallows and others like pointed American footballs flattened on one side so they would not roll, were merchants' weights for pan balances. The ship's saucer-like lamp, its rim pinched to form a spout to hold in place a wick that once floated on oil inside, was intact, but most of the pottery was broken. Each of two stone mortars was carved with a spout and three stubby legs.

From here, too, came unbroken metal objects such as a bronze razor and a small chisel once used for cutting mortises, four scarabs and a scarab-shaped plaque, and a cylindrical stone seal of the kind rolled out on clay documents as a kind of signature



by Near Eastern merchants. An astragalus, or knucklebone, of a sheep or goat, reminded us of the game of knucklebones still played, like dice, in Europe. In antiquity, knucklebones were also used in divination, to receive a sign from the gods, and I wonder if it was by tossing a knucklebone that “fair-haired Menelaus” received such a sign when he debated which route to sail in the *Odyssey* (Book 3.173).

Anyone reading this can date a photograph to the early 20th century or to the late 20th century from the style of clothes, hairdos, or automobiles in it. Archaeologists similarly date artifacts, for styles have always changed. Thus, we knew early on that the ship sank around 1200 BC, probably just before, a date later verified by the radiocarbon dating of some of the twigs.

Rewriting History

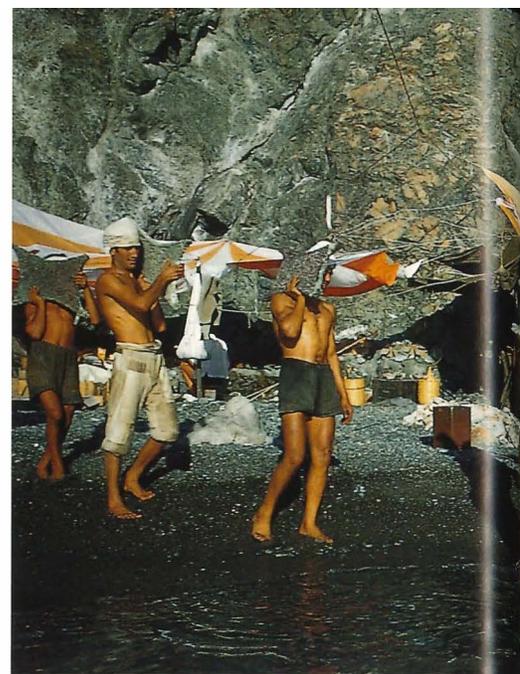
At the time of the excavation, virtually all Classical archaeologists and ancient historians held that Late Bronze Age Greeks, today called Mycenaeans after Agamemnon’s great citadel at Mycenae, monopolized maritime commerce in the eastern Mediterranean in the 14th and 13th centuries BC. They further believed that Semitic traders and seafarers, best represented by Phoenicians, did not begin their famed seafaring activities until the Iron Age, after 1000 BC, and more especially after 800 BC. Indeed, the main reason most scholars have dated Homer’s composition or compilation of the *Odyssey* to the Iron Age, long after the Bronze Age events described in his epic poems, is his frequent mention of Phoenician seafarers, merchants, and metal smiths.

Small wonder that throughout the excavation, my colleagues and I assumed we were excavating a Mycenaean ship.

It was not until I began to study the stone weights that I had my first stirrings of doubt. Before hand-held calculators, I sometimes sat up through the night doing long division, trying to learn the standards of the weights. Just as today, where some nations use pounds and others use kilograms, there were various weight standards in antiquity. When I realized that the Cape Gelidonya weights were often multiples of 9.32 g, an Egyptian *qedet* used throughout the Near East and Cyprus, or 10.3 g, a Syrian *nesef*, I wondered why a Mycenaean merchant carried Near Eastern weights; anthropological studies show that merchants traditionally carry their own, familiar weights, even when they travel abroad.

From library research I learned that our terracotta lamp was probably Canaanite, and that the stone mortars had been manufactured on the Syro-Palestinian coast where the Canaanites lived. An Egyptologist determined that our scarabs were not Egyptian, but were Syro-Palestinian imitations of Egyptian scarabs, the hieroglyphs on them only meaningless decorations. Lastly, two scholars recognized the cylinder seal as having been carved in north Syria, although it seemed to be centuries older than the wreck, probably an heirloom passed from father to son. The bronze razor was another personal possession of Near Eastern origin.

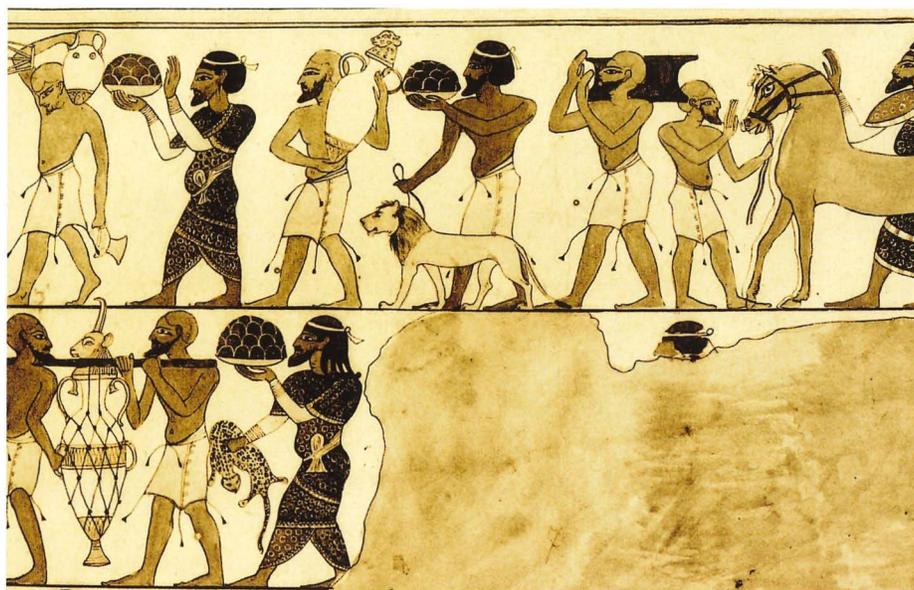
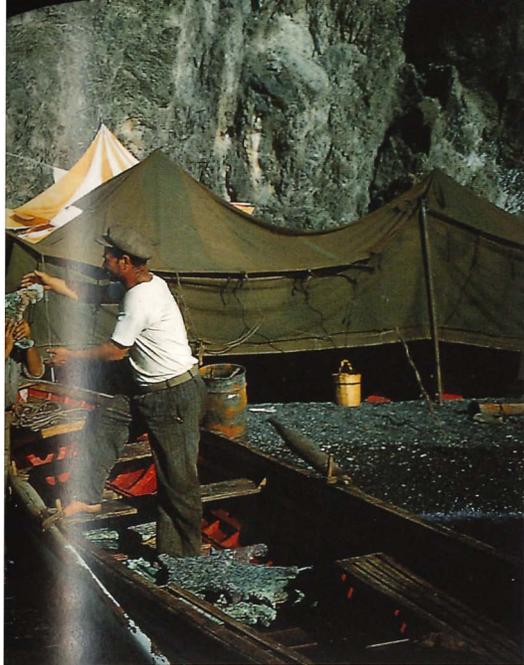
With surprise I concluded, from these personal possessions, that our ship was Canaanite or proto-Phoenician or Syrian – in other words, of Near Eastern origin. A single ship, of course, is not a fleet, nor can it rewrite history. Our shipwreck was only the catalyst that led me to question prevailing views of scholars around the world.



Above Like tribute bearers in ancient Egyptian tomb paintings, Turkish sponge-divers carry copper ingots from the wreck to the waiting hands of Captain Kemal Aras, discoverer of the site, for transport to storage and eventual display in Bodrum.

Below The ship’s sole source of light after dark was a terracotta Canaanite bowl with pinched rim to hold a wick floating on olive oil inside.





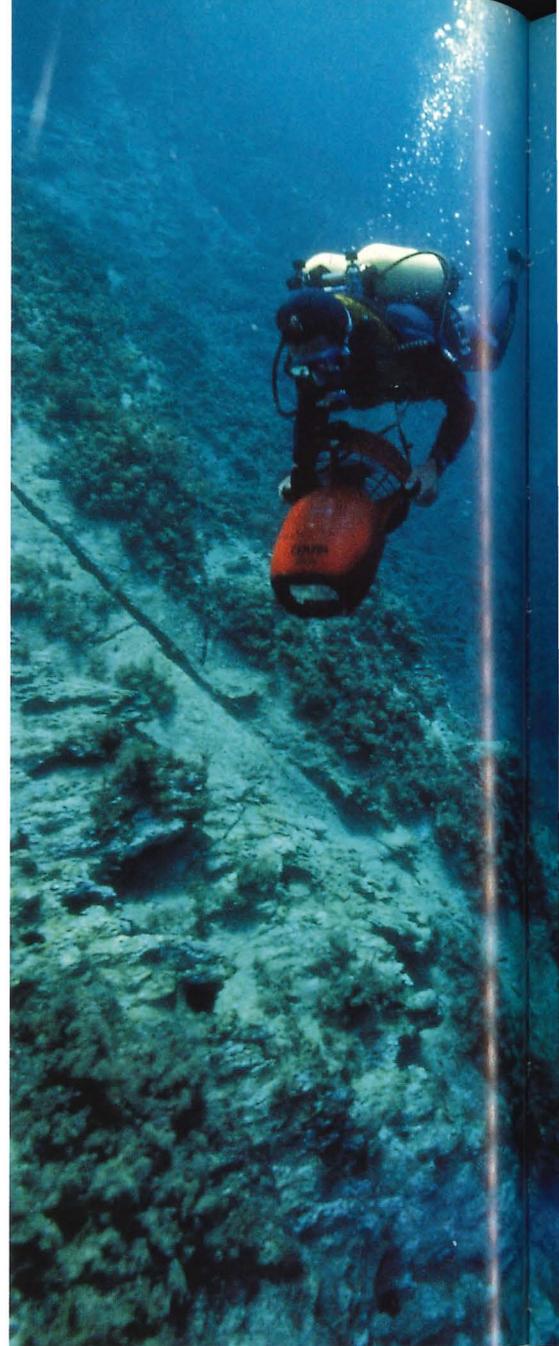
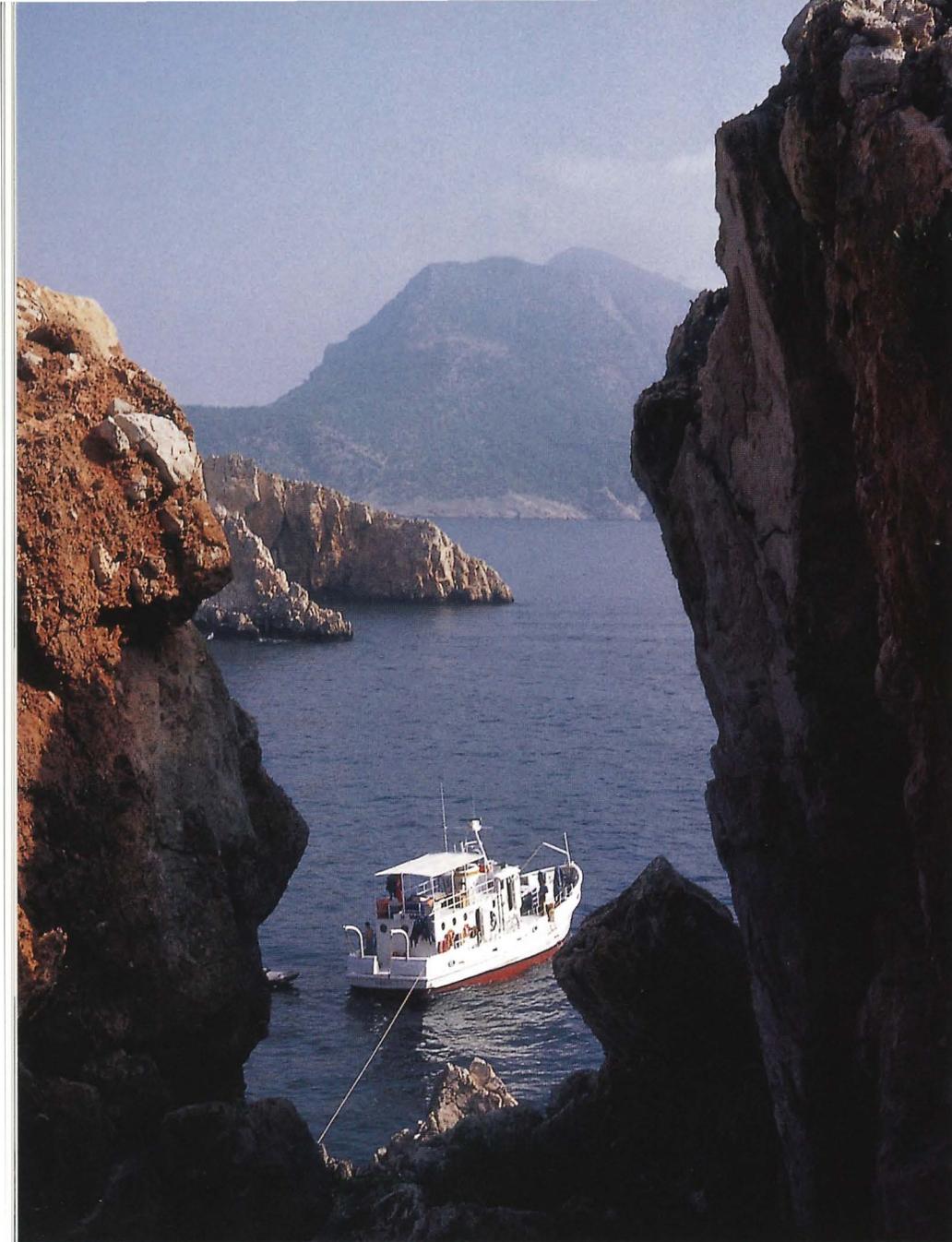
I re-examined virtually all published Egyptian tomb paintings and found that in the 14th and 13th centuries BC, four-handed copper ingots brought as tribute to the pharaoh are identified as Syrian, in one case even shown being borne from a Syrian ship. Another painting depicts a Syrian merchant fleet newly arrived in Egypt. Nowhere do we see Greeks. I turned to hundreds of 14th-century BC cuneiform documents excavated at el-Amarna in Egypt. They describe gift cargoes from various Near Eastern lands, without mention of Greece. I later learned that in Bronze Age Greek, written in what scholars call Linear B script, there is not even a word for merchant.

What had been the evidence before 1960 for the presumed Mycenaean monopoly on maritime commerce? The frequent finds of Mycenaean pottery throughout the Near East, including Egypt and Cyprus. Because there were not similar finds of Near Eastern goods in Greece, it was assumed that Mycenaean ships carried all this pottery.

To me there was a flaw in this reasoning. That Mycenaean pottery reached the Near East was unquestioned, but nothing proved it was carried there in Mycenaean ships. Further, I doubted that Mycenaean sailors were sailing around the eastern Mediterranean giving out free samples of their pottery. Something of equal value had to be coming back to Greece in return. Yet that something had to be invisible to the archaeologist. My published doctoral dissertation suggested that the invisible cargoes must have been raw materials – copper, tin, ivory, gold, cloth, and spices – things that left no trace in the archaeological record because soon after reaching port they were quickly consumed or manufactured into objects of the land or culture that imported them.

My publication received universally unfavorable reviews by Classical archaeologists. Luckily, I lived long enough to begin the excavation of another Late Bronze Age ship, one that sank about a century earlier, off the very next cape to the west, at Uluburun. Cemal Pulak, who directed most of its excavation and is responsible for its interpretation and publication, describes it elsewhere in this book. Its 20 tons of raw materials – copper, tin, ivory, ebony, glass, resins, shell, and spices and other foodstuffs – carried on a ship of almost undoubted Near Eastern origin,

Above Although from a century earlier than the ingots lost at Cape Gelidonya, a painting in the tomb of the nobleman Huy at Thebes, in Egypt, depicts a Syrian bearing a similar copper ingot as tribute to the pharaoh.



On a return visit to the wreck nearly three decades after its excavation, the Institute of Nautical Archaeology's research vessel *Virazon* is anchored directly over the site, which lies between two of five small islands that extend out from the cape, seen in the distance.

convinced most scholars of an appreciable Semitic presence in the Bronze Age Aegean. Because of underwater archaeology, Homer's Phoenicians are no longer anachronistic.

Return to the Cape

By the 1980s, the Institute of Nautical Archaeology (INA) had its own research vessel, *Virazon*, fully outfitted with diving and underwater excavation equipment, including a double-lock recompression chamber. In 1987, while we were excavating the Uluburun site, Claude Duthuit, by now an INA director, suggested:

“Why don't we run over to Gelidonya with *Virazon*, just for nostalgia.”

Cemal Pulak, to whom I had by now entrusted the excavation at Uluburun, came with us – and immediately found a sword, the first weapon from the site, which we had



somehow overlooked nearly two decades earlier. With a better metal detector than we had in 1960, INA's Tufan Turanlı found additional metal finds, some trailing toward a pinnacle of rock that reached nearly to the surface and almost certainly tore open the bottom of the Bronze Age ship. Motorized underwater scooters now allowed INA divers to search far from the original cargo during almost annual visits to the Cape.

Discoveries were also being made in College Station. In 1990, Peter Throckmorton died quietly in his sleep, leaving his library, notes, and photographs to INA. Cemal Pulak soon recognized in photographs of scanty wood remains evidence that the Cape Gelidonya hull was constructed like his earlier Uluburun hull, in the same technique as that used to build the much later Kyrenia ship, also described in this book.

In 1994, Don Frey and Murat Tilev, using scooters, located the Cape Gelidonya ship's large stone anchor. It is of a type found throughout the Near East and Cyprus, both under water and on land, but in the Aegean only at a Bronze Age site on Crete that seems to have served as a harbor for Near Eastern traders. If we had found the anchor in 1960, perhaps my assigning a Near Eastern origin to the Cape Gelidonya wreck would not have been so controversial.



Above On visits to Cape Gelidonya in the 1980s and 1990s, divers with motorized underwater scooters were able to explore far beyond the original excavation site, allowing them to discover the ship's stone anchor.

Right Although the cargo found at Cape Gelidonya weighed only a tenth of that at Uluburun, the Cape Gelidonya ship's anchor, being weighed on *Virazon* by Cemal Pulak, was heavier than any found on the earlier wreck.



ANCIENT GREEK WRECKS

Ancient Greece depended on the ships that brought essential grain to her ports from the Black Sea, transported and supplied her colonists throughout much of the Mediterranean, and defeated her enemies in naval engagements. Without ships, Athens could not have become the definitive icon of Greek splendor. The Institute of Nautical Archaeology remains at the forefront of writing a detailed history of ancient Greek ships.

Excavations of 6th-century BC vessels found in Italian and French waters revealed construction methods unlike those associated with Classical shipbuilding of the 5th century BC and later. Their planks, instead of being fastened together by mortise-and-tenon joints, were laced together through pre-cut holes along the edges of the planks. Some scholars hypothesized that this was a peculiar Western Mediterranean tradition, perhaps representing and/or reflecting an Etruscan tradition, and that mortise-and-tenon joints continued in the Eastern Mediterranean from the Bronze Age (as we have seen in the Uluburun and Cape Gelidonya hulls) through the 4th century BC (as we shall see in the Kyrenia hull).

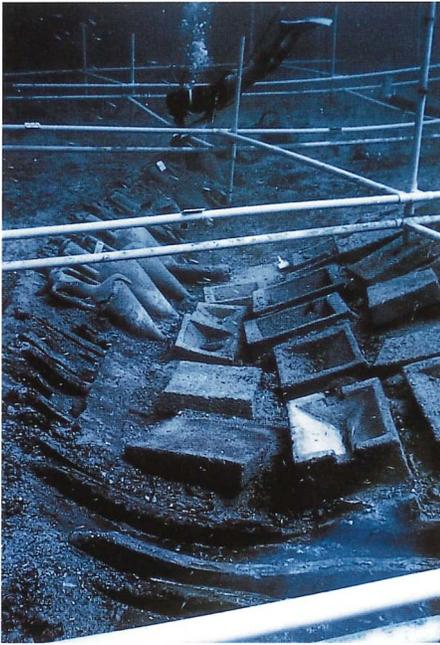
As described here by Elizabeth Greene, INA excavated for the first time in the Aegean a 6th-century BC shipwreck, at Pabuç Burnu on the Turkish coast. Almost certainly Greek, the hull was laced. We can now say with some confidence, therefore, that Greek ships of the Archaic Period (7th and 6th centuries BC) that preceded the glorious Classical Period (5th and 4th centuries BC) were all or mostly laced. And we may now assume that the 6th-century ships excavated in the Western Mediterranean were also Greek.

While Texas A&M University graduate student Sam Mark was working in the field with INA, he published two controversial articles proposing that the ships described by Homer were laced. Is it possible, then, that laced Greek hulls were the norm in the Bronze Age, the time of the Trojan War, and that Greeks borrowed mortise-and-tenon construction from Near Eastern Phoenicians in later Classical times? We need to find a Mycenaean hull, but when we do, I suspect that it will be laced, from a time when Near Eastern ships were already mortise-and-tenon joined.

INA has conducted the first complete seabed excavation of a Greek wreck from the 5th century BC, the century of the Parthenon, of philosopher Socrates, of political leader Pericles, and of dramatists Sophocles and Euripides. Deborah Carlson describes the Tektaş Burnu wreck and its excavation here.

The Kyrenia ship, built in the 4th century BC, has become the hallmark of nautical archaeology in the Mediterranean. It not only was the first shipwreck of its period fully excavated, but it was the first ancient hull ever raised from the Mediterranean

Archaeology student Deniz Soyarslan raises a large shallow bowl from the Pabuç Burnu shipwreck site. Items such as this, intended for shipboard use, are frequently found in the galley area of a wreck, usually located toward the stern of the vessel.



Above Three rows of millstones from Nisyros lie centered over the Kyrenia ship's keel, serving for trade and ballast. Rhodian amphoras are stacked above them.

Below Places mentioned in this section, with the featured wrecks in bold.

and reassembled on land. Further, two full-scale replicas have been built to show the public, from Greece and Cyprus to the United States and Japan, the exact appearance of the ships on which the ancient Greeks were so dependent. Even more, one of these replicas sailed from Greece to Cyprus and back, demonstrating its seaworthiness when going through a gale. Susan Womer Katzev, a driving force in the ship's excavation and conservation along with her late husband Michael, has taken time from completing the definitive scholarly publication of the site to share some of the highlights of the project here.

Although it sank about a quarter century later, it seems that the Kyrenia ship was built before the death of Alexander the Great in 323 BC. Thus we consider it a Classical Greek ship. After Alexander's death, three of his generals divided his empire among themselves, starting the two-century age known today as the Hellenistic Period.

INA has partly excavated two Hellenistic wrecks, one in Italy, at La Secca di Capistello, described here by Donald Frey, and the other at Serçe Limanı, Turkey, described by Cemal Pulak. Because of extreme conditions – the depth of the former and the fact that the latter was found to be partly covered by a rockslide of huge boulders – neither of these excavations has yet been completed.

As these lines are being written, INA archaeologists off the coast of Turkey are examining other 6th- and 5th-century BC wrecks to see if any are worthy of full-scale excavation. Annual surveys have revealed the locations of over 150 ancient wrecks on just a small part of that coast, but we believe that a wreck should not be touched unless it offers much new information about the past.





AND

ROMAN AND BYZANTINE WRECKS

Once found wooden hulls somewhat boring, and left the interpretation of often small and unattractive bits of wood to my expert colleagues Fred van Doorninck, J. Richard (Dick) Steffy, and Cemal Pulak, while I studied and published the “more glamorous” cargoes and personal possessions found inside the hulls. Slowly I came to accept that the ship itself – the Greek *naus* – is often the most important and exciting artifact on any shipwreck site. In the following pages, you will see how INA archaeologists have for the first time traced the evolution from ancient to modern ships – although I hope you will also be dazzled by the “more glamorous” artifacts from shipwrecks such as the 11th-century Serçe Limanı “Glass Wreck.”

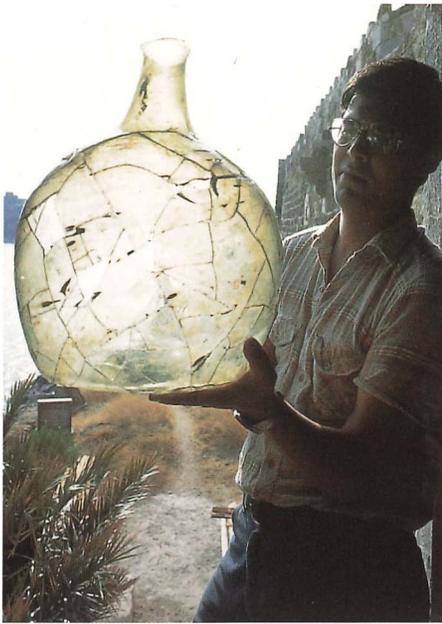
Because of excellent excavations and publications by French, Italian, and Spanish archaeologists of Roman shipwrecks off their own coasts, the Institute of Nautical Archaeology has not undertaken the excavation of a Roman wreck. INA’s only involvement with the Roman-period fishing boat excavated by Shelley Wachsmann, when he was still Underwater Inspector for the Israel Antiquities Authority, was the model of the boat he had built by INA’s Bill Charlton, a veteran of the Uluburun, Bozburun, and Tektaş Burnu excavations. Because of biblical associations, the Sea of Galilee Boat is one of the best-known ancient craft discovered anywhere.

The hulls of most ancient shipwrecks are only partially preserved. Marine borers devoured all their exposed wood long ago. That is why I find so exciting the incredibly preserved Early Byzantine ships found by Robert Ballard in the anaerobic depths of the Black Sea, where such borers do not live. When these ships can be fully uncovered, they will provide unprecedented knowledge of Byzantine ships to specialists like his colleague Cheryl Ward.

Between the 4th century AD, when Constantine moved his capital from Rome to Byzantium (later named Constantinople and now Istanbul), and the fall of that city to the Turks in 1453, the Byzantine period is sometimes seen as a transitional period between the ancient and modern eras. It was, indeed, a transitional period for ship construction, for it saw hull design evolve slowly from ancient shell-first construction to modern frame-first construction.

A late 4th- or early 5th-century wreck at Yassiada, Turkey, excavated first by the University of Pennsylvania Museum and then INA, showed the beginnings of the evolution toward modern hull construction. The mortise-and-tenon joints that held its planks together were smaller and farther apart than in the hulls of ships from at least the Late Bronze Age through Classical Greek and Roman times. In other words, the strength of the Yassiada hull was more dependent on its internal framework, or skeleton, than before. This trend continued with a 7th-century wreck also excavated

Over 30 m (99 ft) below the surface of the Aegean Sea, excavation director Fred Hocker puzzles over a group of pitchers found in the stern of the Bozburun wreck, perhaps the remains of the captain’s last meal before he abandoned his ship.



Above **Cemal Pulak holds a demijohn from the Serçe Limanı Glass Wreck. Perhaps the largest glass vessel surviving from antiquity, it was mended from pieces identified among perhaps a million glass shards.**

Right **Places mentioned in this section, with the featured wrecks in bold.**

at Yassıada by the University of Pennsylvania Museum and INA. The hull of this wreck, described by Fred van Doorninck, was truly transitional, built in the ancient manner below the waterline and in the modern manner above.

Exactly when the full transition from ancient to modern design was complete remains unknown. The 11th-century ship that sank in Serçe Limanı, Turkey, is the first fully excavated “modern ship,” built in the same manner as the ships that took Columbus across the Atlantic and Magellan around the world. Shelley Wachsmann, however, has found a partial 5th- or 6th-century hull in Tantura Lagoon, Israel, that shows no evidence of mortise-and-tenon joinery.

The 9th-century shipwreck excavated by INA President Fred Hocker at Bozburun, Turkey, was thought to be an even earlier example of a modern ship than the 11th-century Serçe Limanı ship, until Fred van Doorninck, who studied and published the latter hull, as well as the two Yassıada hulls, intently examined the Bozburun planks while they were still soaking in fresh water, and discovered that they had been held edge to edge by wooden pegs similar to the tenons of earlier hulls.

Now Nergis Günsenin, with modest support from INA, is excavating a 13th-century Late Byzantine shipwreck at Çamaltı Burnu in Turkey’s Sea of Marmara. Her hull specialist is Jay Rosloff, who studied nautical archaeology with us at Texas A&M University and later excavated the hull of a ship of around 400 BC in Israel.

By now the reader must wonder what these Turkish words *burnu* and *burun* mean (as in Taşlıkburun, Uluburun, Pabuç Burnu, Tektaş Burnu, Bozburun, Çamaltı Burnu). It’s the same word, meaning “cape” or “promontory,” which simply takes a different form if preceded by an adjective.



Solving a Million-Piece Jigsaw Puzzle: Serçe Limanı, Turkey

GEORGE F. BASS

Drop a light bulb. Try to put it back together again.

Drop three light bulbs. Stir the pieces. Then try to put them back together again.

Drop six light bulbs, four glass vases, and a dozen wine bottles, stir the pieces, and try to put them all back together, as if they were new.

That is like the problem I faced, starting in 1977 – except I was dealing with between 10,000 and 20,000 smashed glass vessels. But now, after more than two decades of year-round mending, my colleagues and I have assembled by far the largest collection of medieval Islamic glass in the world.

But I am getting ahead of myself.

The Discovery

During INA's initial 1973 survey along the Turkish coast, retired Bozburun sponge-diver Mehmet Aşkın told me that he had seen fellow divers bring handfuls of broken glass from the bottom of a nearby bay called Serçe Limanı ("Sparrow Harbor"), just opposite the Greek island of Rhodes. I was living with two other American and three Turkish divers on *Kardeşler*, a 20-m (66-ft) trawler, our recompression chamber, compressors, and air banks strapped to its sometimes wildly rolling deck. We sailed immediately for Serçe Limanı, where Yüksel Eğdemir, our commissioner from the Turkish Ministry of Culture, soon reported:

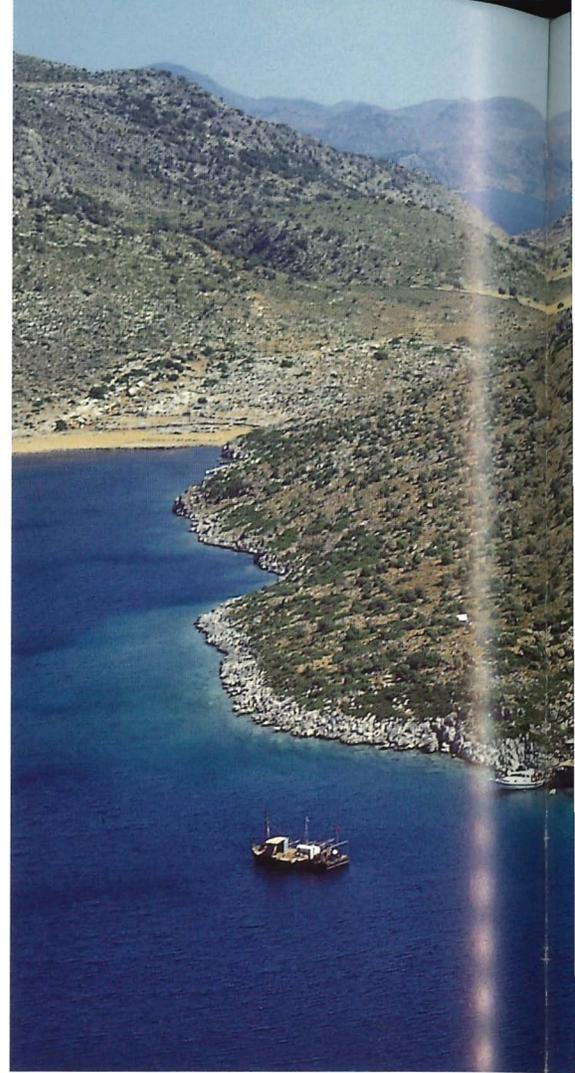
"There's glass everywhere! You can't fan the sand without cutting your fingers."

On a single, brief dive on the site, I decided that it would be a significant wreck for INA to excavate. But it was not the glass that interested me. It was the wreck's date.

During excavations described elsewhere in this book, at Kyrenia, Cyprus, and Yassıada, Turkey, my colleagues and I had been tracing for the first time the slow evolution of hull construction, from completely shell-first hulls in Bronze Age and Classical Greek times to Late Roman and Early Byzantine hulls in which frames, or ribs, that helped shape the hull were erected before the hull shell was completed. We wondered when the first "modern" hulls appeared in which frames were erected before construction of the hull shell was even begun. This wreck might provide the answer. An amphora I uncovered by sweeping sand away with my hand was from later in the Byzantine period than those at Yassıada. Amphora expert Virginia Grace soon dated it, from a photograph, to the 11th century AD.

The Excavation

Other projects delayed the onset of full-scale excavation at Serçe Limanı until 1977, when we built a camp of stone, concrete blocks, woven mats, and mosquito netting in



Above The expedition barge is moored over the wreck, just offshore from the camp. A seemingly safe natural harbor, Serçe Limanı holds at least three other ancient wrecks.

Right Fred the octopus lived in an amphora in Fred van Doorninck's excavation square, and constantly tried to pull shiny bits of glass from the excavator's hands.

Serçe Limanı Glass Wreck

Date c 1025

Depth 33 m (110 ft)

Found by Mehmet Aşkın

Excavation 1977–1979

Cargo glass cullet, glazed bowls, wine

Glass vessels c 10,000–20,000

Hull 15.6 m (51.2 ft) long

Crew Bulgarian



which as many as 35 people would spend the next three summers.

Excavation was in most respects routine. We put down our underwater telephone booth for safety and covered the site with a metal grid to break it into squares 2 m (6.6 ft) on a side so that each diver, or pair of divers, could be responsible for the excavation of a specific area of the wreck. We mapped the wreck with underwater drawings, photographs, and measurements taken from fixed metal stakes driven into the rock around the site.

Every wreck, however, has its own peculiarities. Soon we were uncovering not only the expected ceramic and metal artifacts, but dozens, then hundreds, then thousands of shards of glass. I don't believe in wearing gloves during underwater excavation. So much depends on touch. But soon our bandaged hands looked like they were excavating razors.

At a depth of 33 m (110 ft) the color red is absorbed from daylight and does not appear. Probably every excavator lost valuable bottom time by squeezing a cut finger or palm in order to watch in fascination the bright emerald blood that spiraled up into the seawater.

Another distraction was Fred, the octopus that lived in an amphora in Fred van Doorninck's square and never tired of trying to pull his watch off, or pull the glittering glass from his hands. On one of my dives I felt a shudder in the metal grid





on which I rested my body, looked for the cause, and saw an octopus, presumably Fred's grandfather or grandmother, coming toward me with tentacles that reached from one side of a square to the other. I decided to end my dive early.

We had to abandon any thoughts of labeling every glass shard, but instead gathered shards from squares 50 cm (20 in) on a side, and placed them into labeled plastic bags.

One day Texas A&M graduate student Donald Keith asked in surprise, when he saw us washing the mud from an amphora: "What in the world are you doing?"

"Cleaning the mud out."

"What about the seeds?" Don asked.

Above A metal grid placed over the wreck divided the site into squares that were assigned to pairs of divers for excavation. At this early stage, wood, amphoras, ballast stones, millstones, dark chunks of raw glass, and iron anchors had already come to light.

Right Much of the broken glass was embedded in rock-hard seabed concretion and had to be extracted with dental tools by Jay Rosloff and other expedition members.



“There aren’t any seeds in here, not after a thousand years.”

“Don’t be so sure,” Don responded. “Let me show you.”

We were pioneers. We made mistakes. For years we had casually hosed the sediment out of amphoras. Soon Don was sieving the mud, and followed that with flotation, the method of retrieving seeds and pollen from swirling water that has been used at archaeological sites on land for years. The results, as we shall see, were astonishing.

At the end of three summers, the real archaeology began. Finding, mapping, and raising things represent only the first step. Now we began a process that would last decades.

The Million-Piece Jigsaw Puzzle

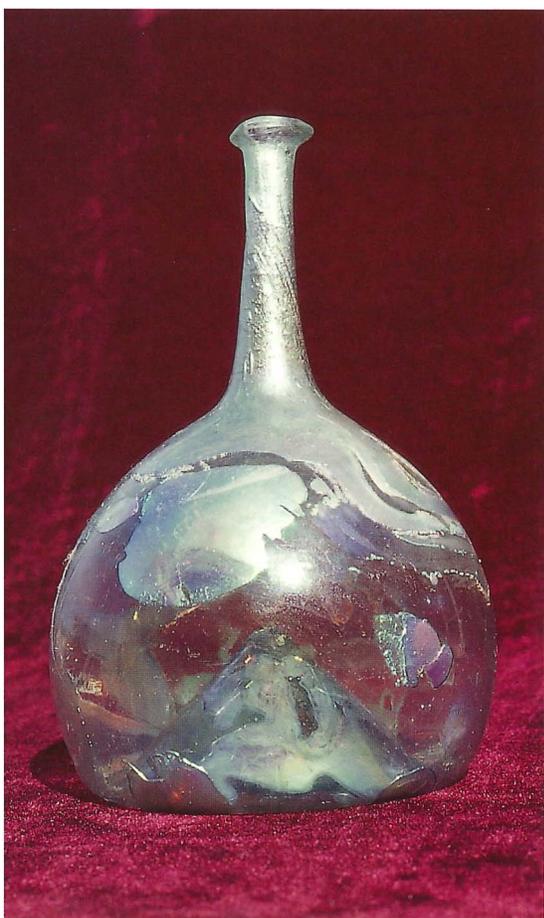
Oğuz Alpözen, who had first dived with us at Yassiada in 1963 as an undergraduate archaeology student, was now Director of the Bodrum Museum. He assigned to us as workspace the entire English Tower of the Castle of the Knights of St John of Malta, in which the Museum is housed, and additional space in which to build a conservation laboratory. Fred van Doorninck and his family spent the academic year 1978–1979 organizing the tons of material we had retrieved from the wreck, and the following year Ann and I took our 12- and 9-year-old sons out of school so that we could continue the task.

My first job was to tackle the 3 tons of glass we had raised from the wreck, now separated by Fred into 2 tons of raw glass chunks and 1 ton of broken glass vessels. Much of the broken glass was encased in large lumps of rock-hard concretion, from which we removed the shards with dental picks.

We hoped to start mending the broken vessels. All of us still assumed that we were dealing with vessels that had been broken by the impact of the shipwreck. That meant that the fragments of individual vessels should have been found near one another on the site. So we built wooden tables around the entire bottom floor of the English Tower and, using the labels on the bags, laid out all of the shards from a single 1-m (3.3-ft) square, keeping the glass from each bag still separated from the glass from other bags by wooden strips that acted as dividers. After weeks, we had not found a

Opposite Texas A&M University graduate student Joy Kitson-Mim Mack spent a year in the Bodrum Museum of Underwater Archaeology studying only one of over a hundred different vessel shapes mended from the broken glass.

Below One of over 200 intact and broken scent sprinklers of thin glass with high kicks in their bases.



single join and gave up, defeated. We began to sketch and catalogue thousands of bases, rims, and handles, an incredibly boring job.

One day it suddenly struck me. How does one work a jigsaw puzzle? Usually by separating out pieces that might join together, putting into separate piles, say, the pieces with green grass or blue sky or red bricks. Might this work with the glass?

None of us was a glass expert, so we invented our own 18 categories of glass: plain glass, green glass, purple glass, dimpled glass, purple dimpled glass, green-threaded rims, purple dimpled glass with green-threaded rims, and so on. Then we were almost ready to begin.

But there was a problem. To put all of the purple glass together into one pile meant taking all of the purple shards out of their labeled bags, losing forever any record of where they had been found on the wreck. Artifact provenience is vital on archaeological excavations. So, we copied each of the four or six-character provenience codes with black ink onto each of between half a million and a million shards, covering each number with clear fingernail polish to prevent its being inadvertently rubbed away. We shanghai'd passing tourists to help; one young man, on his way around the world, became so fascinated he stayed on the job for months. I even put my young sons to work, thankful that Charles Dickens was not around to write about it!

Once the shards were individually labeled, we could take all of one category and begin the task. I might sit before a pile of several thousand plain purple shards, dividing them into two piles: lighter purple and darker purple. I would then put one of the piles into storage and start again, dividing the remaining shards into darker and lighter shades, again putting one of the resultant piles into storage. After doing this long enough, I might have left before me on the work table only 18 or 19 shards, but all of exactly the same shade of purple. Then we would find the joins and stick the shards together temporarily with tape (often keeping their shapes in individually cut Styrofoam forms), until our conservators could mend them permanently with special glue.

It was only then, at the end of the first year, that we realized something startling about this part of the ship's cargo. We were dealing with a cargo of broken glass intended to be recycled! All of those millions of digits we had inked onto the shards were meaningless, except they provided the proof that the glass had been shoveled randomly into the ship's hold from some even larger pile of broken glass. In no case were all the pieces of any specific vessel on board, meaning either that all of the pieces of any one vessel had never made it onto the ship, or that some of the glass had already been sold during the ship's final voyage. For a long time we had trouble convincing even authorities on ancient glass that shipping broken glass was economically feasible, but some years later roughly contemporary documents were published that described the shipment of broken glass from the Near East to the glass factories of Venice.

Part of the hold had contained a cargo that left no trace, possibly plant ash used in making glass, a commodity known to have been shipped with broken glass from the Near East.

Some 80 intact glass vessels were not from the ship's hold, but from what we eventually proved were living quarters, at the ship's stern and bow; they were





Above Glass menders triumphantly raise examples of vessels they put together during two decades of year-round glass mending.

probably carried in bundles by merchants who were prepared to sell them intact.

Glass mending continued year-round for more than two decades. We saw the local glass menders who joined us right out of school not only become expert, but marry and raise children. At the end, they had assembled by far the largest known collection of medieval Islamic glass.

Almost certainly the broken glass was factory waste from one specific source. Some deformed vessels were clearly factory rejects. Other pieces, such as 11,000 moiles (tops of vessels that are cut off and discarded), could only have been factory waste. Robert Brill, Chief Scientist at the Corning Museum of Glass, showed by chemical analysis of samples that almost all of the glass was chemically homogeneous, as if it came from one factory, or perhaps several closely associated glassworks. Lastly, Spanish archaeologist Berta Lledó, lining up one on top of another of Sema Pulak's incredibly accurate drawings on transparent Mylar, showed that even vessels of completely different shapes had started out in the same few molds, and then been crafted into varied forms by the glassblowers.

Dating the Wreck

It was glass, too, that provided the closest date for the wreck. On board were 16 glass disks that had served as weights for pan balances. Some bore the name of a caliph in Egypt and the year of his reign. Michael Bates of the American Numismatic Society, using casts and photographs, informed us that the latest dated to either AD 1024/25 or possibly 1021/22, dates not contradicted by those on three Islamic gold coins,

Below When small change was needed, bits of gold were simply cut from Islamic coins and carefully weighed.



although they were from about a decade earlier. There were also Byzantine copper coins, but without dates.

An Early Example of a Modern Ship

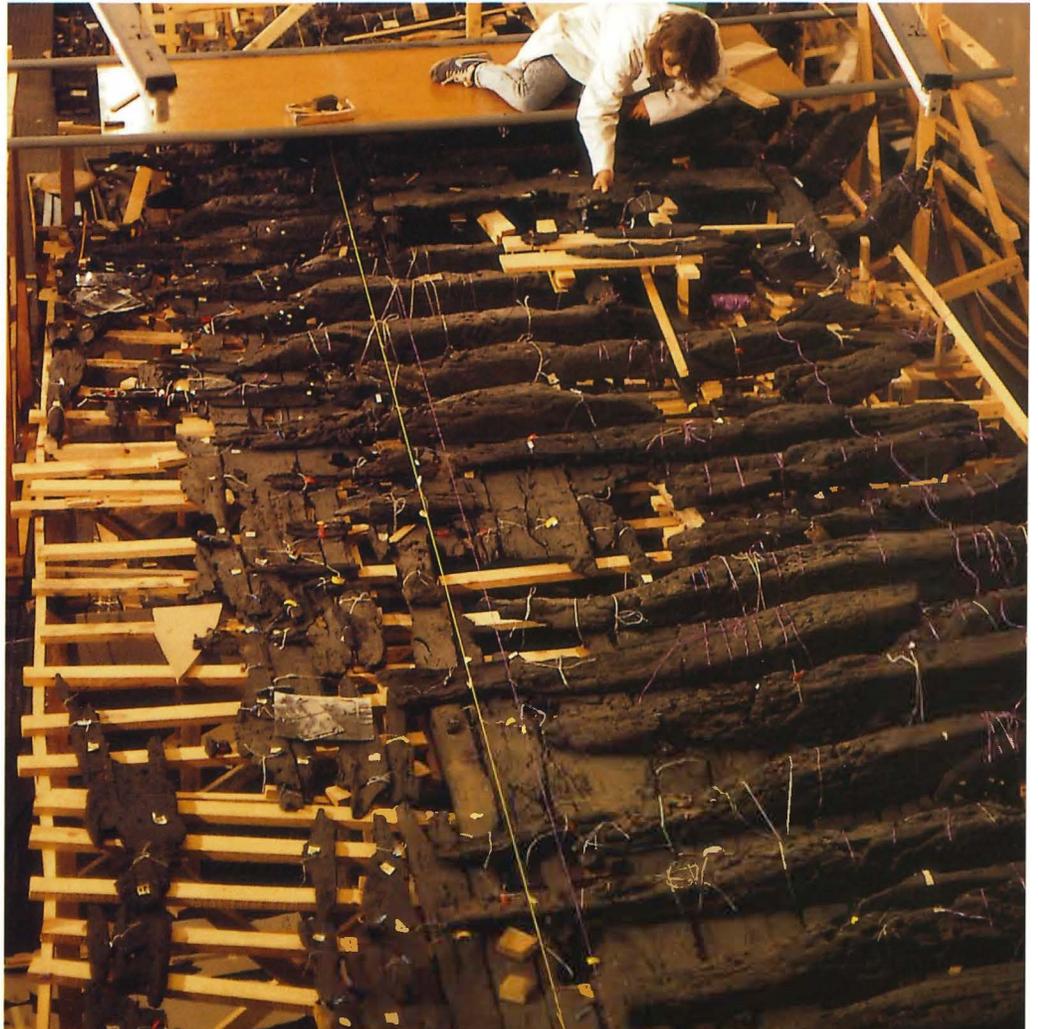
Texas A&M graduate student Sheila Matthews traced each wood fragment at full scale onto clear acetate sheets, marking with various colored pens every tool mark, nail hole, or bolt hole. Back at Texas A&M University, Dick Steffy made a one-tenth-scale model of every one of the fragments – twice. He used one set to build a diorama of the site, so that we could see everything together in three dimensions for the first time. Lining up nail holes, tool marks, and other clues, he used the other set to build a research model of the hull, a kind of “dress rehearsal,” as he called it, for what Sheila would eventually do in Bodrum.

While Steffy worked in Texas, Robin Piercy, who had worked with Michael and Susan Katzev on the preservation of the earlier Kyrenia hull on Cyprus, undertook the three-year process of soaking every piece of wood from the ship in heat-controlled polyethylene glycol, to prevent its shrinking and warping out of recognition if allowed to dry freely in open air.

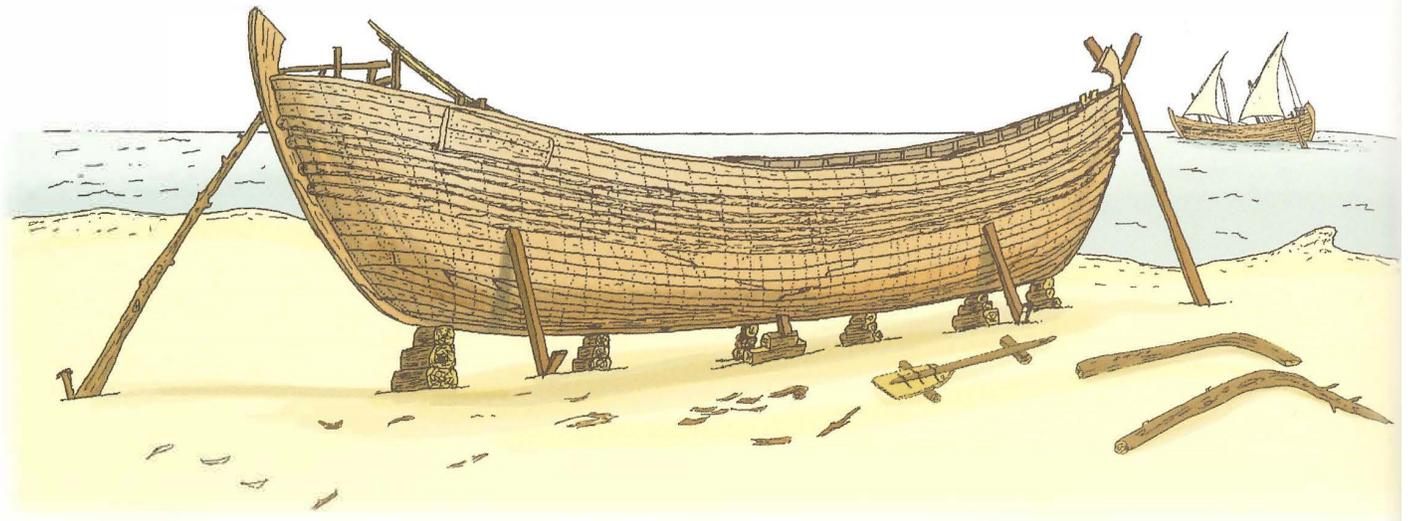
When the wood was conserved and dried, Sheila Matthews began another three-year task, piecing together with stainless steel wire more than a thousand fragments of wood in the Bodrum Museum’s newly built and humidity-controlled Glass Wreck Building. Only about 15 percent of the hull was preserved, so some of the hull’s shape was indicated by curved metal rods, but the resultant display was well worth the effort, allowing visitors from around the world to see the earliest known example of a



Above Dick Steffy carefully modeled every fragment of raised wood at 1:10 scale in order to produce a diorama that allowed him to study the hull’s breakup. With a second set of modeled fragments he assembled a hull that served as a dress rehearsal for the reassembly of the actual hull.



Right Sheila Matthews spent three years reassembling the hull, whose timbers had already been chemically treated for three years to preserve them. The temporary strings were replaced by stainless-steel wires invisible to museum visitors.



Above Dick Steffy's research revealed a ship about 15.6 m (51.2 ft) long, whose boxy hull would have allowed it to sail up shallow rivers. It probably sported two triangular lateen sails, and was steered by large oars, like that in the foreground.

modern ship; the more practical, flexible kind of ship that allowed Columbus to sail to a New World, and Magellan to encircle the entire globe.

It was a modest vessel, only 15.6 m (51.2 ft) long, its breadth one third of that, probably sporting two triangular, lateen sails; spare rigging, including pulley blocks, were stored on board. The ship's flat bottom would have allowed her to enter shallow rivers.

Life at Sea

The ship's contents provided more information about how people lived in the 11th century than any site previously excavated, but to interpret it properly took years of detective work. At the end of the first excavation campaign I was asked to write an article about the wreck for *National Geographic* magazine. It was a mistake I never repeated. Almost everything I said was wrong. Because of all the Islamic glass and Islamic pottery we had found, I assumed we had begun excavating a medieval Islamic ship, with Muslim crew and passengers. By the second summer, however, we were finding pork bones from meals, ruling out the possibility that the ship's crew were either Muslims or Jews. Then, while opening some of the 900-plus lead sinkers that had been folded over and crimped onto the edges of fishing nets, we found molded crosses and even the name "Jesus" inside. Finally, we found four lead merchant's seals, exactly like the seals crimped every evening onto wire passed through the lock of every Museum door, to show next morning that it has not been opened. One of the ship's seals had not been used, but the other three bore scenes of Christianity: that which depicted the ecstatic meeting of saints Peter and Paul carried on the opposite side, in Greek: "Guardian of the writing I have been placed, bond of Peter," presumably a seal on one or more written documents.

Because our plans showed with great accuracy the position of every artifact on the site, we could determine the social stratification of those on board. The most prominent people – officers and merchants – lived at the ship's stern, eating pork, goat (and possibly mutton), and fish, along with almonds, various fruits, and

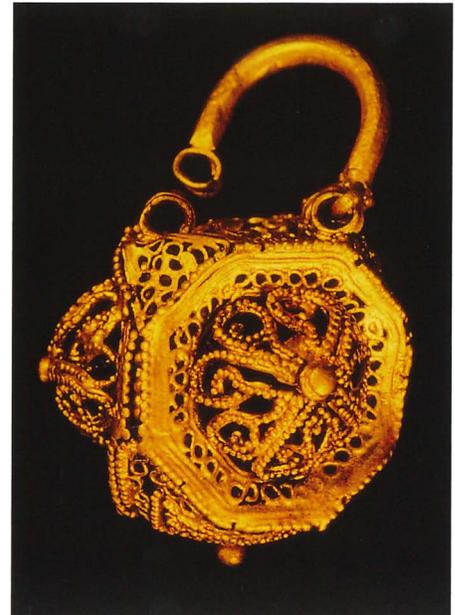
Below When pressed onto the strings that bound and safeguarded bundles of documents, lead seals were left with Greek inscriptions and religious scenes by the pincers used; the upper left seal is unused.





Left Hand-carved wooden rook or castle and queen (to the right) represent the oldest known firmly dated chess set. A single backgammon checker (left) shows that the much older game of backgammon was also played on board.

Right This filigree gold earring is of Fatimid workmanship according to Marilyn Jenkins-Madina of the Metropolitan Museum of Art.



olives. To while away the hours they played chess. Here, too, were the gold and copper coins, the jewelry, the weighing devices and sets of balance-pan weights, iron padlocks and keys, and most of the weapons and tools.

A slightly less grand living quarters for the merchants was found at the very bow.

The common sailors, however, lived amidships, unarmed, not sharing the pork and possibly not the fruit, and playing the “less intellectual” game of backgammon.

After years of experimentation, we had perfected the method of replicating iron artifacts by casting them with epoxy inside the natural seabed molds of concretion that had formed over them as the iron inside rusted away. Graduate student Joseph Schwarzer spent two years in Bodrum casting with epoxy. At the end, he had the largest collection of Byzantine tools in existence: a carpenter’s set including everything needed to build an entire ship from scratch, including axes, saws, adzes, hammers, bow drills, chisels, files, and even the earliest known caulking irons (earlier hulls, built shell first, were not caulked). For foraging on shore for firewood and water, there were two axes, a billhook, a mattock, and a pick; if there was a shovel, it did not survive due to the thinness of its metal.

At the end, Joe also had the largest collection of Byzantine weapons from any site, not surprising since piracy was rife at this time. He had 11 sets, each with a thrusting



Above A number of iron padlocks and a key were replicated by pouring liquid epoxy into the cavities left in seabed concretion when the original iron corroded away. Once hard, the epoxy casts can hardly be distinguished from iron.



Left All the tools necessary for building a ship were carried on board, including claw hammers (far left) and caulking irons, seen here as epoxy replicas of the original but no longer existent iron tools.



spear and four or five javelins, some still wrapped together in a burlap-like fabric, suggesting 11 armed men in the crew. An iron sword with wooden sheath and a bronze hilt ornately decorated with a plumed bird probably belonged to the captain.

We found one complete grooming kit, with wooden delousing comb, scissors, and razor, and part of another, reminding us of how the sailors under both Columbus and Magellan complained of vermin, and the fact that insect-spread typhus killed more 19th-century transatlantic passengers than shipwrecks. Near these kits were small piles of orpiment, a trisulfide of arsenic that puzzled us until I stumbled on the fact that orpiment mixed with quick lime (which would have dissolved in seawater) has been used for more than a century as a depilatory. Further research revealed that men have, from time to time, used depilatories down the ages.

Over 900 lead net sinkers in three distinct piles revealed that three nets were being mended on deck at the time the ship sank, each estimated to have been about 40 m (132 ft) long, a size matched by an Ottoman net found stored in the Bodrum Museum. Near each was a netting needle, and near one was a bag of spare, unused sinkers. Fish bones reveal that the crew was catching tunny, sea bass, tub gurnard, and drum.

Eight bone spindle whorls at first suggested the presence of women on board. After all, only female spinners are depicted in Greek art, and the excavator of the Viking site at L'Anse aux Meadows, Newfoundland, said that the discovery of a single spindle whorl indicated the presence of women there, proving that it was a Viking colony. However, when I noted that the Serçe Limanı whorls were found where the nets were being mended, I was reminded of pictures of men spinning, from ancient Egyptian tomb paintings to modern photographs of Iranian shepherds. A nearly contemporary Muslim saying expressed the opinion that it was all right for men to spin wool and goat hair, but not flax, which was a woman's job. Even before fibers in some of the net sinkers were identified as being goat hair, I had guessed that the sailors on board were spinning threads to mend their nets! Was L'Anse aux Meadows only a Viking fishing outpost?

Nationality

To emphasize the point that diving and raising artifacts has no more to do with archaeology than randomly collecting arrowheads on land, I must tell the story of how Fred van Doorninck not only determined the nationality of the crew, but revealed a stage in the beginnings of the free enterprise system.

Fred, having taught ancient Greek for years, began a study of the graffiti on the

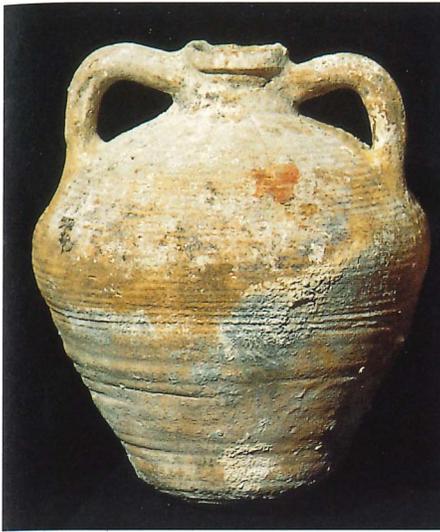
Above left The ship was armed with over 60 iron weapons, including javelins (seen here as epoxy replicas), spears, and at least one sword.

Above Grooming was important to vermin-infested sailors of the past, as shown by the scissors and fragments of a delousing comb.



Above Eight bone spindle whorls found where fishing nets were being mended on deck suggest that the crew were spinning goat-hair threads for their nets.

Opposite INA artist Netia Piercy draws Islamic glazed bowls that formed part of the ship's cargo.



Above Amphoras for wine and olive oil were scratched with their owners' initials, leading to the realization that merchants on board were Hellenized Bulgarians.

ship's amphoras. First he noted that all the amphoras marked with "M" (probably "Michael") were found together, as were those marked with "Leon." Eventually Fred identified about a dozen owners. He further noted that many of the amphoras had been damaged but kept in use, sometimes with lips filed smooth after being chipped when a stopper had been pried out, and other times when a handle stump was smoothed down where a handle had been broken away. Unlike the amphoras of the Imperial Roman fleets, which were discarded at voyage's end, these amphoras belonged to individual merchants who prized and protected them, sometimes for many years.

So far, so good. But Fred noticed that one of the amphoras was marked MIR. He couldn't guess what Greek name that represented. His realization that it stood for a Slavic name such as Miroslav, however, led to his teaching himself to read Bulgarian, Rumanian, and Russian, so that he could easily read Slavic and Rumanian excavation reports. He determined that the crew of the ship that sank at Serçe Limanı were Hellenized Bulgarians who lived on the shore of the Sea of Marmara not far from Constantinople. His theory was borne out when Nergis Günsenin excavated some pottery kilns on the shore of the Sea of Marmara that had manufactured amphoras identical in all respects to those on our shipwreck. Nergis, who describes her own shipwreck excavation in this book, had been a non-diving volunteer during the excavation of the Glass Wreck when she was still only a high-school student.

Our ship, it seems, had sailed from near Constantinople to a port on the Syro-Palestinian coast, such as Caesarea, where gold jewelry, glazed bowls, glass jars, and copper buckets like those on the ship have been found. After taking on its Islamic cargo, the ship on its return voyage sought shelter at an anchorage used for millennia inside Serçe Limanı. But then what happened?

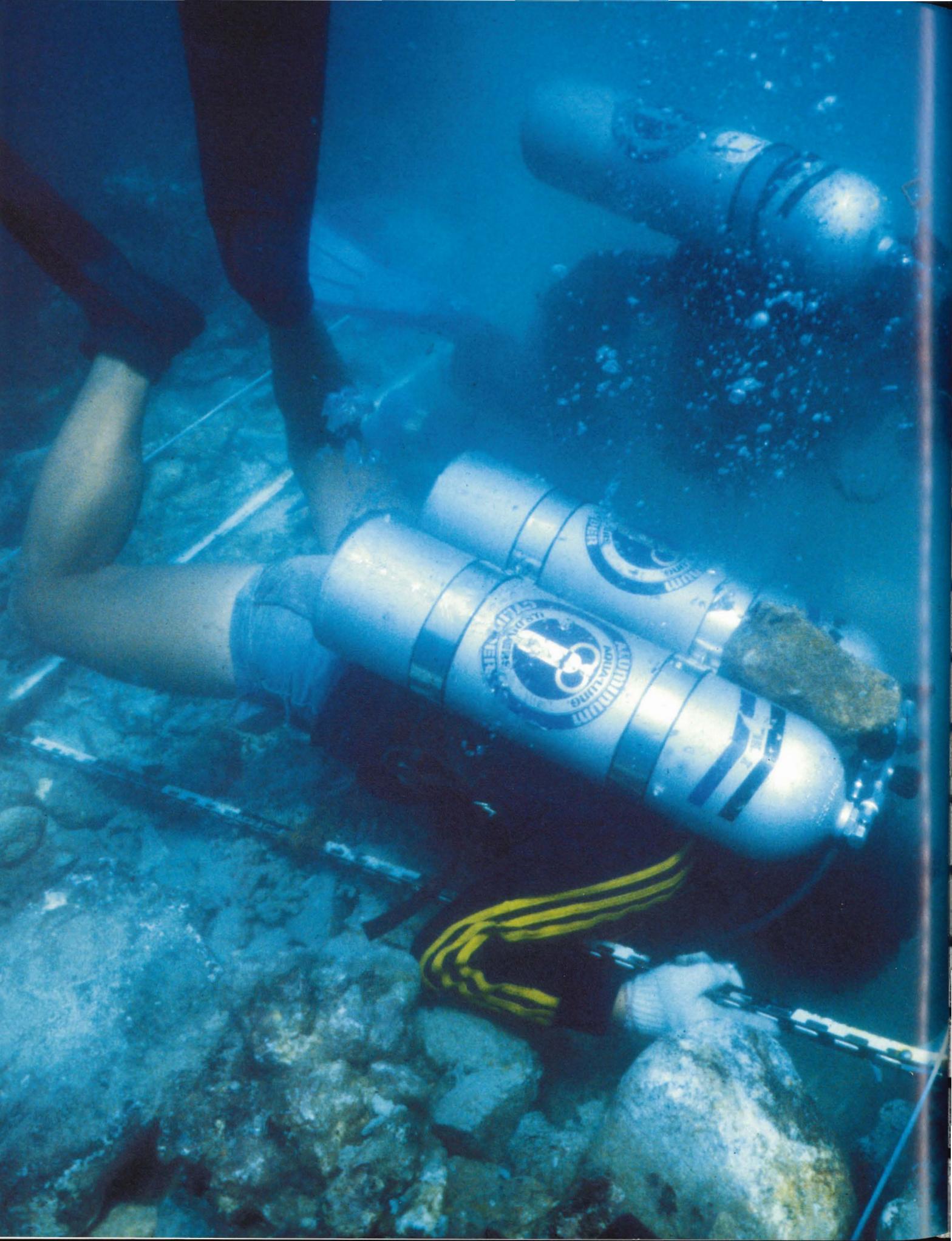
The Anchors

Again, Fred van Doorninck's careful detective work provided the answer. After making epoxy replicas of the ship's nine Y shaped anchors, Fred determined that, as on the 7th-century Yassiada shipwreck, there were two bower anchors on one bulwark near the bow, ready for use, and another on the opposite bulwark. Spare anchors – in this case five – lay stacked on deck near by. But what of the missing bower anchor? It was found where it had been cast, some distance forward of the bow, its shank snapped, presumably from the force of a sudden gust of wind, freeing the ship to be dashed against the rocky shore.

Fred further calculated that the weights of the anchors were multiples of Byzantine pounds, pointing toward the conclusion that laws governing the weights of anchors on ships of various sizes were in force earlier than realized. The unusual Y shape allowed anchors to be of greater weight without being weakened by overly long shanks.

Decades after the diving ended at Serçe Limanı, a 550-page analysis of the ship and its passengers was published, a collaboration of over a dozen scholars on three continents. It is only the first of three volumes of equal size. The second volume will present the Islamic glass and ceramic cargoes. Diving to an underwater site is no more important than driving a jeep to a terrestrial site. It is not the fieldwork, but the years of research, analysis, and interpretation that make it true archaeology.





MEDIEVAL AND RENAISSANCE WRECKS

I'm a Bronze Age scholar. I'm so ignorant of the medieval and Renaissance periods of Europe that when I was asked to speak on medieval and Renaissance shipwrecks at a national conference of historians, I asked my wife: "When was the medieval period? And when did the Renaissance start?"

"I think the medieval period was when everybody got the plague," she jokingly replied, "and the Renaissance is when they all got well."

These days I'm slightly better informed. The medieval period is also known as the Middle Ages and, more provocatively, the Dark Ages. So as not to confuse you, I will pass over quickly the fact that the Byzantine period we just left in the last section was also part of those Dark Middle Ages!

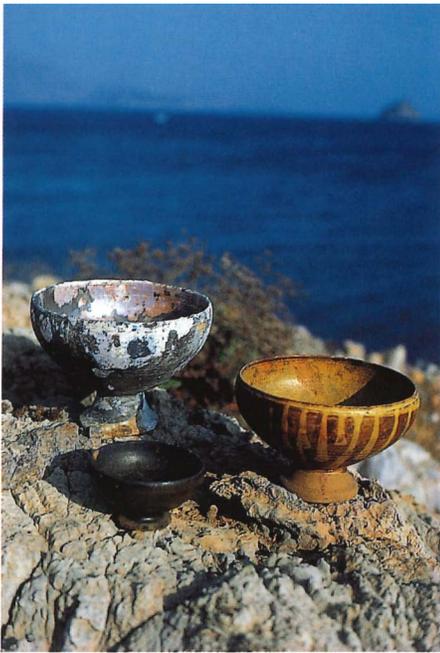
Although at the end it will return to Yassiada, Turkey, this section will finally take us out of the Mediterranean, with its long and well-recorded history of seafaring, and its long history of marine archaeology, to Southeast Asia and to the Far East – far from medieval Europe. It also takes us to a land excavation, for nautical archaeologists are interested in ships wherever they are found, including those intentionally buried in earlier times, whether by ancient Egyptians or by Vikings, Anglo-Saxons, or other northern Europeans.

The excavation of the 14th-century Shinan wreck was a purely Korean operation, but the Institute of Nautical Archaeology's Donald H. Keith was twice sent to the project by the National Geographic Society, both to offer advice and to recount the story of the excavation to English-speaking readers. More recently, INA Research Associate Jeremy Green visited the National Maritime Museum at Mokpo, which houses the vessel's hull, and talked to those who continue research on the wreck and its valuable cargo.

Although I have twice been to Korea, I have not yet seen the finds from Shinan in the museum at Mokpo. In 2004 in China, however, I was able to see the results of the excavation of a contemporaneous Chinese wreck, equally rich in beautiful, varied, and intact ceramics, excavated opposite the Korean Peninsula under the direction of Zhang Wei of the National Museum of Chinese History in Beijing. Because I knew Zhang Wei when he studied nautical archaeology at Texas A&M University in the spring of 1989, it gave me great pleasure also to visit, in the South China Sea, the diving barges from which he is now excavating an earlier, 12th-century wreck, raising thousands of pieces of intact, glazed ceramics, many of which I saw in the Yangjiang Museum. The publication of these wrecks should be truly extraordinary.

Fred Hocker next takes us to the Zuidersee of the Netherlands, where hundreds, or perhaps thousands of wrecks lie beneath the soil that has been reclaimed from

Two students excavate inside a 2-m (6.6-ft) grid frame on a shallow 16th-century wreck site at Ko Kradat, Thailand. The diver in the foreground, finding himself slightly buoyant, has supplemented his diving weights by placing a rock on his scuba tanks!



Above **Glazed bowls carried aboard an Ottoman ship that sank in the 16th or early 17th century off Yassiada, Turkey.**

Below **Places mentioned in this section, with the featured wrecks in bold.**

the sea. There are so many vessels there that Dutch archaeologists welcome help in recording them, which led to an arrangement whereby graduate students in the Nautical Archaeology Program at Texas A&M University had the opportunity for original research and publication. Fred describes his excavation of a cog, the primary merchant ship of Northern Europe from the 13th through to the 15th century.

Then Jeremy Green transports us to Thailand. The Western Australian Museum, where Jeremy heads the Department of Maritime Archaeology, is perhaps the only institute outside INA that conducts field operations globally, as seen in this book. We are pleased that Jeremy has also worked off and on with us, from the Mediterranean to the Indian Ocean, for nearly four decades. He describes here just one of a number of wrecks he studied during a nautical archaeology training program he conducted for Thai archaeologists.

Lastly, we are introduced to an Ottoman ship of the late 16th or early 17th century. I was personally involved in this one, for when I started tracing timbers going off at an angle from the late 4th- or early 5th-century Byzantine hull I was uncovering at Yassiada, Turkey, in the late 1960s, I thought it was part of the same ship. The Byzantine ship, I assumed, had broken into two pieces, and I was tracing the timbers of one of those pieces. Eventually we realized that this was a later, almost empty ship that had sunk directly onto the Byzantine ship. Cemal Pulak excavated this later ship, dated by a coin to the time of Philip II of Spain, or slightly later, and identified as Ottoman by its contents.



Shinan Wreck

Date c 1323

Depth 20 m (66 ft)

Found by Choi Hyung-gun

Celadons 12,359

Coins 7,000,000

Hull 28.4 m (93 ft) long,
6.6 m (21.5 ft) wide

The glazed statuette of the Buddhist deity Kuan-yin, 24 cm (9 in) tall, was found on the Shinan wreck with part of its head cleanly broken away.



A 14th-Century Chinese Wreck: Shinan, Korea

GEORGE F. BASS

The Institute of Nautical Archaeology's first foray into the Far East, like so many INA adventures, began with a phone call. The year was 1979.

"The Korean Navy is excavating a 14th-century Chinese junk. It's the first real underwater excavation in the Far East. Would you go over as an adviser – and write an article for our magazine?" It was the National Geographic Society.

My hands were already more than full in Turkey.

"I can't make it, but I have the perfect person for you."

I was thinking of Donald H. Keith, who had been with me at Şeytan Deresi and Serçe Limani, and even on a Revolutionary War wreck in the York River, Virginia. Not only an innovative and brilliant student, Don was one of the finest diver/excavators I knew, uncannily skilled at making beautiful and accurate drawings on the seabed. Don would go on to excavate for INA what was then the oldest known shipwreck in the New World, at Molasses Reef in the Turks and Caicos Islands, where he later established a museum for the display of the finds.

Within days Don was descending a line down 20 m (66 ft) in zero visibility in the Yellow Sea, off the port city of Shinan in southwest Korea. A strong current tugged at him. On the bottom, his dive partner, Lieutenant In Seong-jin, guided Don's hands over what proved to be porcelain and wood protruding from the sediment. Don described what he learned during two trips to Korea in *National Geographic* and, later, *Archaeology* magazines.

The Discovery

The site was found in 1975 by fisherman Choi Hyung-gun, who netted pieces of pottery that were identified by experts as celadons – prized for their resemblance to jade – of the Yuan Dynasty (1260–1386). Choi and his younger brother were rewarded by the South Korean Cultural Properties Preservation Bureau for reporting the discovery, but before a proper excavation could be undertaken, other, less scrupulous fishermen were mining the site for celadons to sell to an antique dealer. Arrests were made, the celadons were recovered, and the Cultural Properties Preservation Bureau, assisted by a Korean Navy squadron commanded by Captain Choi In-sang, began full-scale excavation 2 km (1.2 miles) off shore, sometimes diving in the freezing cold of winter.

In 1982, INA Research Associate Jeremy Green, as part of a research project with Professor Zae Gun Kim of Seoul University, visited the Conservation Laboratory of the National Maritime Museum at Mokpo, and studied a one-fifth scale research model of the ship.

The Finds

By 1989, years after the visits by Don and Jeremy, the results of the excavation were astonishing. Seven million coins, weighing 26.8 tons, provided the earliest date the ship could have sunk; although the coins had been minted over six centuries, the latest was from 1310. An even more precise date for the sinking was provided by a wooden cargo tag with the year 1323 written on it. In addition, with thousands of pieces of porcelain, Korea had attained the largest collection of Yuan Dynasty celadons in the world, many found still cushioned by peppercorns in well-preserved wooden crates.

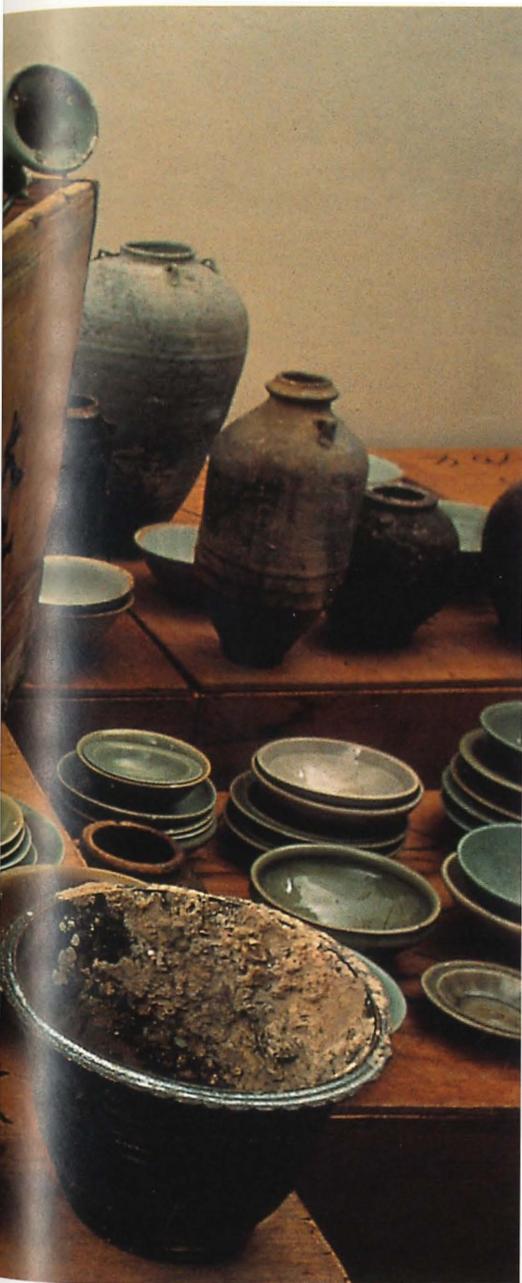
It seems that sailors of all nationalities have passed their time at sea playing games. On the 11th-century Serçe Limanı Glass Wreck, those on board had played both chess and backgammon, and on wrecks of all periods of antiquity in the Mediterranean,

Below Among the thousands of objects recovered from the Shinan wreck were Chinese ceramics still packed in remarkably preserved wooden crates – that on the right still marked with the words “great luck.” One crate was marked on its top with the grid pattern for the Chinese game of Go, presumably played by the mariners on board.



Right This late 18th-century painting of a Chinese ship by William Alexander is one of the earliest by a westerner. Korean and Chinese archaeological excavations are now adding greatly to our knowledge of still earlier Chinese ships.

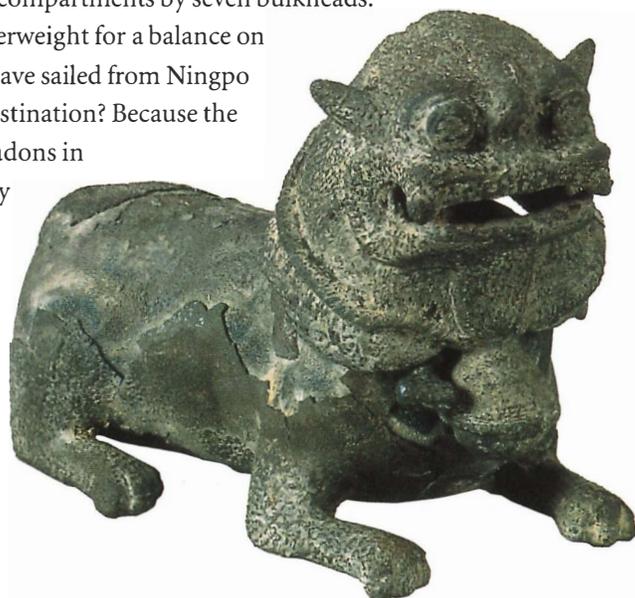
Below right This small bronze lion, only 10 cm (4 in) high, was a censer or incense burner whose head could be removed and replaced.



sailors seem to have played knucklebones. On top of one of the crates raised at Shinan someone had carved the board for the Chinese game of Go.

Although the lack of visibility prevented the excavators from making a site plan to the accuracy we are accustomed to in the Mediterranean, they placed a metal grid over the site, dividing it into squares 2 m (6.6 ft) on a side, and recalled just where every object in each square had been found during debriefing sessions immediately following each dive. The hull of this, the first seagoing Chinese vessel ever excavated by divers, was in many respects as expected: flat, with transom ends at bow and stern, its interior divided into eight compartments by seven bulkheads.

An inscription on a counterweight for a balance on board suggests the ship may have sailed from Ningpo in China. But what was her destination? Because the Koreans themselves made celadons in the 14th century, it is less likely that the ship was heading for Korea to unload its wares than that it was on its way to Japan, where Chinese celadons were prized imports. Probably driven onto rocks by a storm *en route*, the ship never reached her intended port.





SEVENTEENTH-CENTURY WRECKS

NA archaeologists need to keep their passports up to date. For the 17th-century sites they describe here, they excavated in both northern and southern Europe, on two Caribbean islands, and in East Africa, and then conserved an entire ship raised off the coast of Texas!

Robert Neyland, who would go on to salvage and conserve the famous Confederate submarine *Hunley* off Charleston, South Carolina, here describes an excavation he conducted in a hay field for the Netherlands Institute of Ship- and Underwater Archaeology (NISA) when he was still a doctoral candidate in the Nautical Archaeology Program at Texas A&M University. He takes us again to the Zuidersee, where Fred Hocker excavated the medieval Almere cog. Where else are nautical archaeologists photographed with windmills in the background?

In Portugal, as I stood high on Lisbon's São Julião da Barra fortress one day in 1998, I had goose bumps. Francisco Alvez, head of his country's outstanding program of nautical archaeology, was vividly recounting to a group of us the tragic events that had transpired below almost four centuries earlier. The *Nossa Senhora dos Mártires*, returning from India, tried again and again to enter the mouth of the Tagus River during a storm. Failing, the doomed ship was destroyed, with great loss of life, in full view of the families of those on board who were returning home after so many months away.

Filipe Castro, one of Francisco's assistants, whom I met the same day, soon enrolled at Texas A&M University, where he earned a doctorate, and then joined the faculty of the Nautical Archaeology Program. How pleased I was, then, when my new colleague, Filipe, completed the excavation and study of that terrible tragedy, which he describes here.

The role of Peter Throckmorton in the history of nautical archaeology should be clear by now to readers of this book. Not only had he initially involved me in diving on and excavating shipwrecks, but he did the same for Jerome Hall, who later served as president of the Institute of Nautical Archaeology. Jerome was earning a Master's degree in marine biology at Nova University in Florida when he met Peter, then on the university's faculty. It was Peter who directed Jerome to the Dominican Republic and the Monte Cristi wreck, the Pipe Wreck that Jerome describes in the following pages.

One rare wreck I can visit without a passport is that of famous French explorer La Salle's ship *La Belle*. In only 20 minutes I can drive to Texas A&M University's Conservation Research Laboratory, where I am repeatedly awed by the conservation of the ship's hull and contents, under the direction of INA's current president, Donny

A diver raises a decorative wooden cherub from the wreck of *Santo Antonio de Tanna* in Mombasa Harbor, Kenya. Carved wooden wings were found nearby.



Above Donny Hamilton gingerly removes concretion from an Amerindian vulture-headed metate (corn grinder) found at Port Royal. Below Places mentioned in this section, with the featured wrecks in bold.

Hamilton. Or I can step a few feet away from my office into the office of Barto Arnold, who joined INA shortly after discovering *La Belle* and overseeing construction of a cofferdam around it to enable its excavation in dry air.

Donny seems fated to deal with thousands of artifacts wherever he works. In 1692, the infamous pirate stronghold of Port Royal, Jamaica, at that time the richest English colony in the New World, became the submarine equivalent of Pompeii when it sank beneath the waves in a massive earthquake. In 1980 I was invited to Jamaica, where Prime Minister Edward Seaga asked if INA would undertake the archaeological excavation of the sunken city. Although this was not primarily a shipwreck excavation – a ship was later found driven into the city by the earthquake’s accompanying tsunami – I accepted on the spot, and then asked Donny Hamilton to direct the project, which he did in exemplary fashion for the following decade as a Texas A&M University field school.

INA’s involvement in East Africa similarly began with an invitation, this one from Hamo Sassoon, Curator of the Fort Jesus Museum in Mombasa, Kenya. Hamo asked me if INA would examine a wreck located by local divers in Mombasa Harbor, thinking it might be one of the Portuguese ships that had come to the aid of Portuguese Fort Jesus when it was besieged by Omani Arabs at the end of the 17th century. I asked Don Frey and Robin Piercy to undertake the examination, which they did in 1975. Two years later Robin began full-scale excavation of the wreck of the Portuguese *Santo Antonio de Tanna*, which takes him regularly back to Mombasa to study the artifacts for his ultimate publication of the site.





EIGHTEENTH-CENTURY WRECKS

Having been an avid science-fiction fan in my youth, I was thrilled when I received a telephone call from famed author Arthur C. Clarke while I was still a graduate student at the University of Pennsylvania. He was visiting Philadelphia, and invited me to tea. At his hotel, he asked if I would be interested in studying a shipwreck recently found by a friend in Sri Lanka, where he lived. It lay at a place called the Great Basses Reef. As so often has been the case, my continuing work in Turkey prevented my taking on any additional research, and thus it was my mentor in underwater archaeology, Peter Throckmorton, who went to the reef in 1963 to excavate the wreck.

Exactly three decades later, INA Research Associate Jeremy Green was conducting a nautical archaeology training program for Sri Lankan archaeologists when the Sri Lankan Department of Archaeology asked him to undertake an inspection of the early 18th-century site, which he describes here.

Cheryl Ward then transports us from the Indian Ocean to the Red Sea, where she and Douglas Haldane, both former students in the Texas A&M University Nautical Archaeology Program and veterans of INA fieldwork, excavated what was probably a local merchantman that sank soon after 1765.

Any reader jealous of the nautical archaeologists whose photographs show them swimming in the crystal waters of the Red, Mediterranean, and Caribbean Seas, or camped on the bright sands of the Egyptian desert, as was Cheryl Ward, will be in for a surprise when they see the conditions under which Fred Hocker and his team excavated a small sloop lost in the last decades of the 18th century near Savannah, Georgia, in the southern United States. Since Fred has set the scene, we will remain outside clear water for the next two wrecks.

I'm proud that the Institute of Nautical Archaeology undertook the first scientific excavations of both colonial American and British ships of the American War of Independence. The first wreck was reported to me by Captain W. F. Searle, former head of US Navy diving and salvage and a Founding Director of INA. When his students tested a sonar unit during a joint Maine Maritime Academy and Massachusetts Institute of Technology summer training project in Penobscot Bay, Maine, they discovered the wreck, soon identified as that of the *Defence*, a colonial vessel scuttled in 1779. David Switzer, who excavated the site, describes how we were both introduced to it on a January dive, when ice formed on our regulators and we were wearing only neoprene wet suits. As I hit the water it was as if my cheeks had been struck by two sledge hammers! Strangely, the water seemed not much warmer when summer arrived and I helped Dave set up the operation.

Although these large storage jars and 4-m (13-ft) long iron anchors at Sadana Island, Egypt, identify this site as a shipwreck, only its excavation revealed traces of the tons of coffee, coconuts, and incense the ship carried.



Above From the cold, murky water of Maine's Penobscot Bay divers raise a rack, still holding cannonballs, that had rested on the deck of the American privateer *Defence*.

Below Places mentioned in this section, with the featured wrecks in bold.

The *Defence* had provided my first experience of diving with only a few inches of visibility. The visibility was even less in Virginia's York River. There, John Broadwater, who had been with me on INA's 1973 survey of the Turkish coast, instigated serious work on the ships scuttled by General Charles Cornwallis just before his 1781 surrender, which gave independence to the colonies. Soon I was invited by Ivor Noel Hume of Colonial Williamsburg to undertake the excavation of the "Cornwallis Cave Wreck," so named due to its proximity to a landmark near the river. Having solved many of the problems of excavating in clear but deep water in the Mediterranean, I was intrigued by how one might overcome the obstacles of virtually zero visibility and a strong current, and tried building a cofferdam around the site to block the current and allow the water inside to be clarified by industrial filters. John worked with me on those problems during the partial excavation off Cornwallis Cave, and here describes how he vastly improved on that experience during his full-scale excavation of the better-preserved *Betsy*.

We end this section once more in clear water, this time in the Caribbean. Margaret Leshikar-Denton tells us how she located and studied the remains of "the most famous maritime disaster in Cayman Islands history": the Wreck of the Ten Sail in 1794. By combining archaeology, conservation, oral history, and archival research, she has woven a tale that has been commemorated by stamps, a book, a coin, a museum display, and the Wreck of the Ten Sail Park, which overlooks the reefs that sank the ships, and which was dedicated by Queen Elizabeth II during the bicentennial anniversary of the event.





WRECKS OF MODERN TIMES

Our coverage of modern times, from the beginning of the 19th century, begins with the rather bizarre story of the first deepwater yacht built in the United States, a yacht sold in 1820 to King Kamehameha II of Hawaii. Paul Johnston describes the history of the yacht and his excavation of its remains.

We then move to boats that were not propelled by wind or steam, but by horses. This might seem like the lead-in to a joke about how many horse-power any given boat had, but horse-powered ferries were surprisingly common in North America in the early decades of the 19th century, at the very time that steam propulsion was gaining popularity. Kevin Crisman had the good fortune to excavate what today would be considered a most exotic craft. As this is written, Kevin is excavating the earliest known steam-powered western riverboat yet found in the United States, the *Heroine*, which sank in 1838 in the Red River, which now separates Oklahoma from Texas.

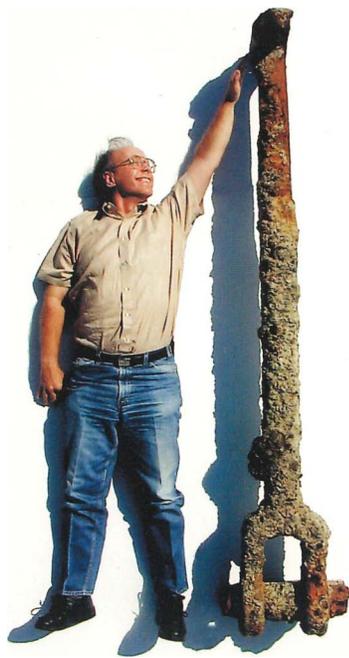
It is little appreciated that when the mass production of large steamboats began, they had a more profound effect on the western movement of people across North America than did the railroad – my great-grandfather, as a young man, wrote letters home about his trip from Virginia to Texas by river steamers in the 1850s.

Within a quarter century of the *Heroine's* sinking, steamships were serving other purposes in North America. The battle between the famed Civil War ironclads *Merrimack* and *Monitor* may have marked, according to Winston Churchill, “the greatest change in sea-fighting since cannon fired by gunpowder had been mounted on ships,” but fast, wooden steamships that evaded the blockade of the Confederate States proclaimed by President Lincoln were equally important at the time. Barto Arnold describes his work on one of the most successful of these blockade-runners, the *Denbigh*.

Art Cohn, who calls canal boats “the 19th-century equivalent of the modern tractor-trailer,” describes the discovery of a type of canal boat that was not thought to have existed in North America. Such discoveries keep nautical archaeology constantly exciting.

At last we enter the 20th century. I crossed the Atlantic Ocean 28 times by ship before ever I flew across, something I now do several times a year. Three times I passed through hurricanes, and once traveled from France to New York in a full December gale on the *Queen Mary*, before she was stabilized, in waves the size of mountains. These were unforgettable experiences. There were daily sailings from New York. “Do you want to go to northern Europe or to the Mediterranean on Tuesday?” the agent would ask. It is hard to realize, then, that to future historians of

One of *Titanic's* huge bronze propellers, more than 7 m (23 ft) in diameter, rests in a bed of rusticles that have fallen from the ship's deteriorating hull.



Above **J. Barto Arnold** with the 250-kg (550-lb) connecting rod of the blockade-runner **Denbigh's** port engine before it was cleaned of encrustation.

Below **Places mentioned in this section, with the featured wrecks in bold.**

seafaring, the entire history of transoceanic passenger steamships will be but a tiny blip, only slightly more pronounced than the history of transoceanic travel by propeller-driven airplanes, which lasted only decades. Transatlantic passenger steamships operated regularly for but a century and a half after their introduction in 1830. That is not much time to an ancient historian.

Yet that short era produced the most famous ship, and the most famous shipwreck, in history – the *Titanic*. Even before the blockbuster film “Titanic,” the story of the “unsinkable” ship, the iceberg, and how 1,500 people died in freezing water in April of 1912 was known around the world. Certainly, no other wreck could have tempted me to descend two and a half miles below the surface of the North Atlantic. What nautical archaeologist could resist? Would you have done it?

World War II saw the most powerful military fleets ever assembled. Yet the military vessels that are the subjects of the last two contributions to this book were not victims of giant naval battles between warships. All of the losses date to 1944. The Japanese ships that now make Truk Lagoon one of the most favored diving spots in the world were sunk by American warplanes while at anchor. Jeremy Green describes how he located one that had earlier escaped detection, and the immediate aftermath of his discovery.

The American vessels studied by Brett Phaneuf off the coast of Normandy were not battleships, cruisers, or destroyers, but the more modest landing craft that ferried thousands of troops across the English Channel to Normandy on 6 June 1944 – modest in size, perhaps, but not in their monumental contribution to eventual allied victory in Europe.



Mapping the “Unsinkable” Titanic

GEORGE F. BASS

Many events in my career as a nautical archaeologist have resulted from a single piece of mail. It was a letter from Peter Throckmorton to the University of Pennsylvania Museum in 1959 that led to my even learning to dive. Forty-four years later, on 22 May 2003, another letter arrived, this one by e-mail from Captain Craig McLean, Director of the Office of Ocean Exploration for the National Oceanic and Atmospheric Administration (NOAA):

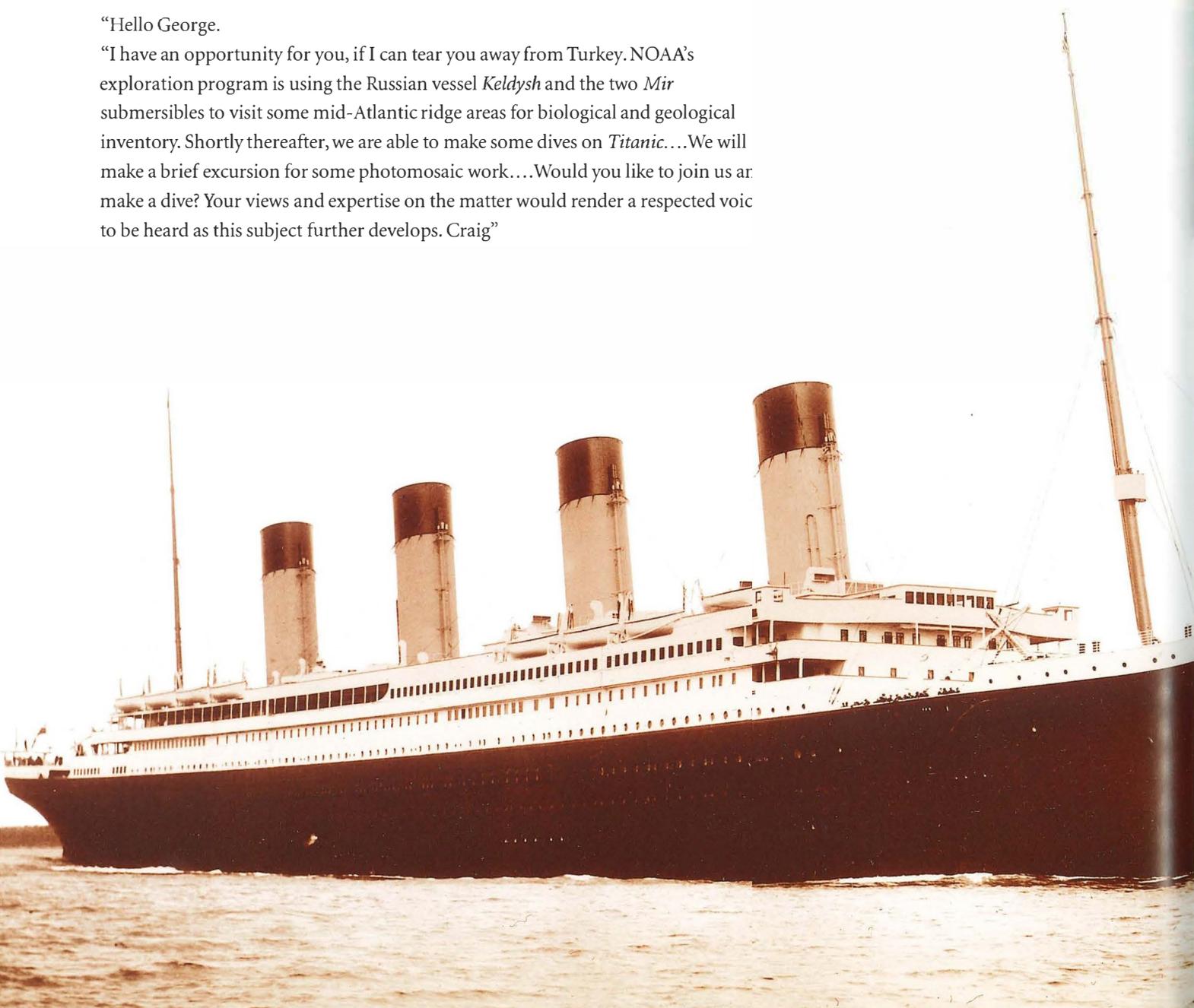
“Hello George.

“I have an opportunity for you, if I can tear you away from Turkey. NOAA’s exploration program is using the Russian vessel *Keldysh* and the two *Mir* submersibles to visit some mid-Atlantic ridge areas for biological and geological inventory. Shortly thereafter, we are able to make some dives on *Titanic*.... We will make a brief excursion for some photomosaic work.... Would you like to join us and make a dive? Your views and expertise on the matter would render a respected voice to be heard as this subject further develops. Craig”

Titanic

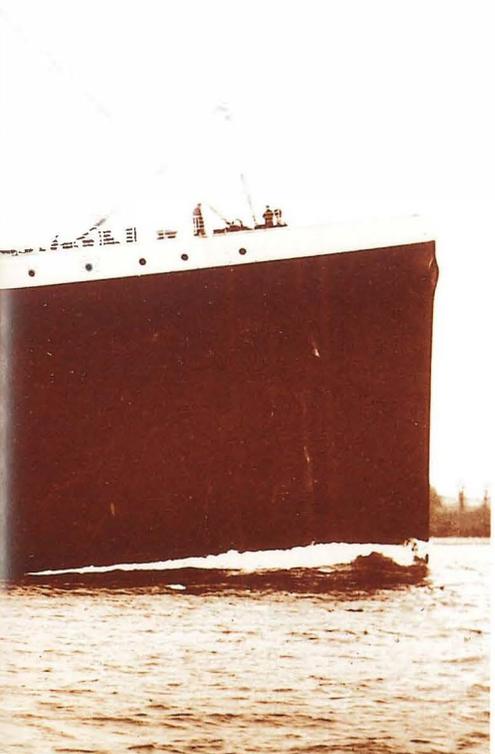
Sunk 14 April 1912
Depth 3,798 m (12,460 ft)
Length 269 m (882.5 ft)
Displacement 66,000 tons
Speed 24–25 knots
Passengers and crew 2,207
Survivors 705

Below For a brief few days, until sent to a watery grave two-and-a-half miles deep by an iceberg, RMS *Titanic* was the largest and most luxurious liner on the Atlantic Ocean.





Above At the very tip of the bow, one of *Titanic's* spare anchors rests under the anchor crane, still secured to the deck. Rusticles on the railing were produced by iron-eating microbes.



Anyone, nautical archaeologist or not, would jump at the opportunity of visiting the most famous shipwreck anywhere – and since I had designed the first method of making shipwreck photomosaics from a submersible back in 1964, I might be helpful. But I was hesitant. It was not just that the deepest I had ever been was 90 m (300 ft), and *Titanic* lies two-and-a-half miles – that's 12,460 ft or almost 4 km – beneath the North Atlantic. I'm a little superstitious. In 2003, after more than four decades of fieldwork, being responsible for tens of thousands of deep decompression dives, and dives in various types of experimental submersibles, I had just decided to end it, without announcement, to simply stop while I was ahead – the news item about an aging stuntman who was killed when making one last jump with his car, after announcing his plan to retire, has long stayed with me.

Why would I go to a place where rescue was out of the question if any piece of equipment failed? What if a spark started an electrical fire? Or my *Mir* became trapped by wreckage? The pressure on the submersible at that depth would be 3 tons per square inch! Small wonder that more people have been in outer space than have ever visited *Titanic*. In fact, more people have been to the top of Mount Everest in a single month than have ever seen first hand those spectacular remains.

I turned to the ultimate authorities: my family. In less than 24 hours my writer son, Gordon, e-mailed me in Turkey: "Come on, you HAVE to do it!" Alan, my younger son, said by telephone that I'd be crazy not to go. I assumed that my wife, Ann, would talk me out of it. I was wrong.

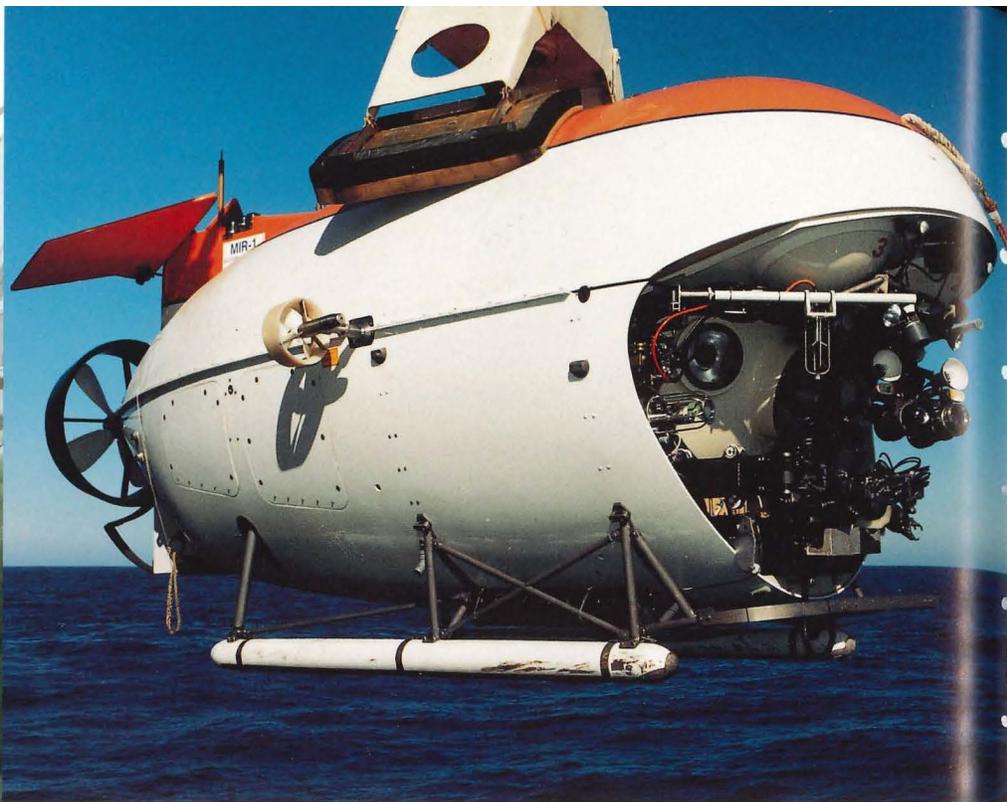
R/V Akademik Mstislav Keldysh

With no more excuses, I sailed out of St. John's, Newfoundland, on 20 June, aboard the Russian *R/V Akademik Mstislav Keldysh*, the world's largest research ship. Icebergs in the distance reminded me of why I was there.

I represented INA among a seven-person team headed by NOAA marine archaeologist Jeremy Weirich. Others were National Park Service archaeologist Larry Murphy, whose continuing study of the battleship *Arizona* at Pearl Harbor has made him especially knowledgeable about the long-term stability of iron hulls, and Drs. Roy Cullimore and Lori Johnston, microbiologists who specialize in the study of the microbes that eat iron and form, at *Titanic's* depth, huge brown things like stalactites that were dubbed "rusticles" by Robert Ballard when he located the wreck. Both Roy and Lori were returning to *Titanic*, Lori for her fifth visit. Rounding out the team were NOAA's Laura Rear, who had taken care of the logistics of the mission, and Craig McLean himself, whose impressive background includes not only degrees in zoology and law, but two years as a professional helmet diver.

The *Keldysh* carries *Mir 1* and *Mir 2*, two of only four submersibles in the world capable of diving as deep as *Titanic*, the subs used by James Cameron in his epic film "Titanic." Each cost \$20 million. They usually dive together, about an hour apart. No one said it explicitly, but I think part of the reason for this is safety, for one sub, with its manipulators, could help untangle the other should it become snared by cables or twisted metal.

Dr Anatoly Sagalevitch is the driving force behind *Keldysh* and the *Mirs*. Since the collapse of the Soviet Union, under which all three vessels were built, he has had to depend on private sources to fund their operation – indeed, to fund all of the



Above The crew of R/V *Akademik Mstislav Keldysh* unloosen the restraining cables of *Mir 2* in preparation for the submersible's dive. The great protective hangar for the two *Mirs* has already been raised up and out of the way on its hinges.

Above right *Mir 2* is lowered into the sea from the deck of R/V *Akademik Mstislav Keldysh*. Once in the water, it will be towed farther to sea by a launch before beginning its descent.

Opposite above During the dive, the two submersibles took turns at the widely separated parts of *Titanic*. Here, in this reconstruction painting, those in *Mir 2* map the bow section while those in *Mir 1*, in the distance, study rusticles at the stern.

oceanographic research conducted from *Keldysh*. He thus often uses them for projects like the one I was on, or for filming, or even for taking paying passengers to *Titanic* for \$36,000 a dive. I became highly impressed by Anatoly's entrepreneurship and his humanity.

On our first morning over the wreck, the crew of *Keldysh*, using GPS coordinates, dropped four transponders around *Titanic*. Every other day for the next ten days the *Mirs* dived and navigated with seeming ease within this "sonic box." I was scheduled to be on the last dive.

There were many books and videos about *Titanic* on board, so I spent the time before my dive becoming completely familiar with the story of the ship and what has happened to her since she was discovered. Early one morning I stood alone on deck, staring at the calm sea, thinking about the fact that one night in 1912, exactly at this place, over 1,500 people in life jackets were calling for help, drowning, or freezing to death.

Down in Mir 2

On the day of my dive, 29 June, I felt like an astronaut as I walked the corridor to the *Mir* laboratory in my blue, fireproof jump suit. Then, up the ladder, off with shoes, and down inside a steel sphere about 2 m (7 ft) in diameter.

Craig McLean had preceded me into *Mir 2*. I was followed by Victor Nischcheta, our Russian pilot. A technician closed the hatch, which would soon be held tight by mounting pressure, and we were attached to the ship's crane and lowered over the side, all 18 tons of us, barely swinging from side to side. We were blessed by smooth seas for the entire voyage, as today, when it was calm but foggy. The instant we hit the water, a Russian "cowboy" leapt from a Zodiac onto the top of the *Mir* to unhook us from the crane and hook us to a launch, which towed us clear of the *Keldysh*. We were



in a near dead calm, but I have seen films of these cowboys performing the same maneuver in large waves that washed completely over them as they held on for dear life like aquatic broncobusters.

Mir 1, with Anatoly Sagalevitch at the controls, had descended about an hour earlier. Now we began our two-and-a-half-hour descent. I glanced often at our depth gauge. Two miles down, Victor pulled out box lunches for the three of us. When we eventually reached 3,790 m (12,434 ft), the incredibly bright exterior lights went on, flooding the seabed. Almost immediately I spotted a large soup tureen, and then dozens or hundreds of wine bottles in the positions they had held in wooden cases

Below INA's George Bass, Russian pilot Victor Nischcheta, and Captain Craig McLean, Director of the National Oceanic and Atmospheric Administration's Office of Ocean Exploration, assemble in front of *Mir 2* just before it takes them down to *Titanic*.



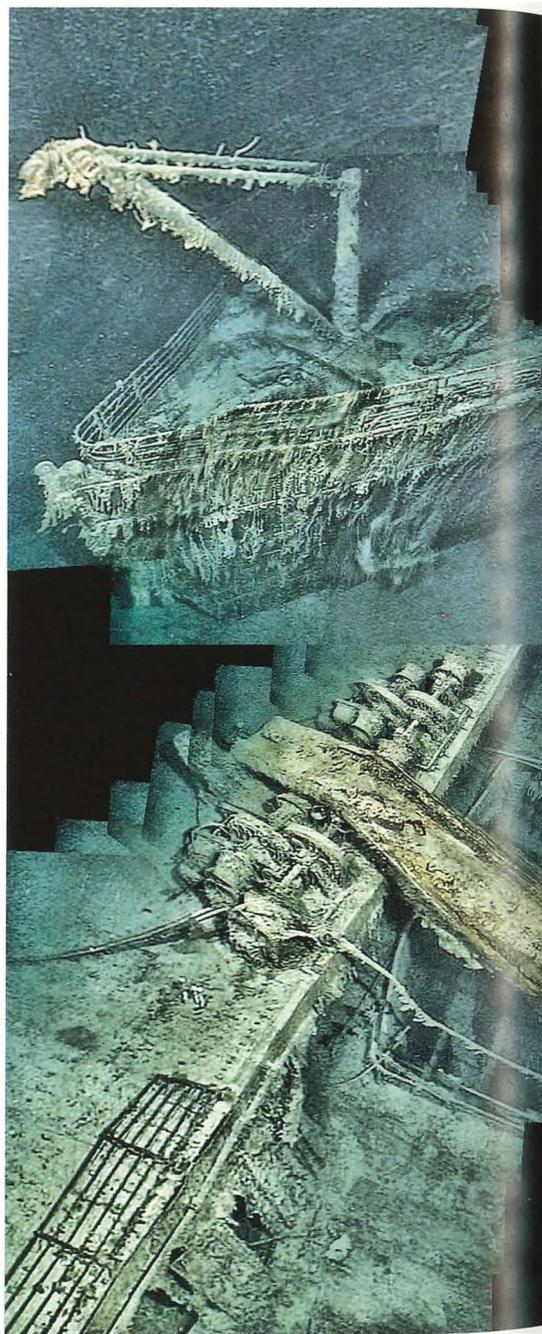
nine decades ago, followed by a bathtub. I was moved emotionally when I saw a woman's lonely, high-topped shoe.

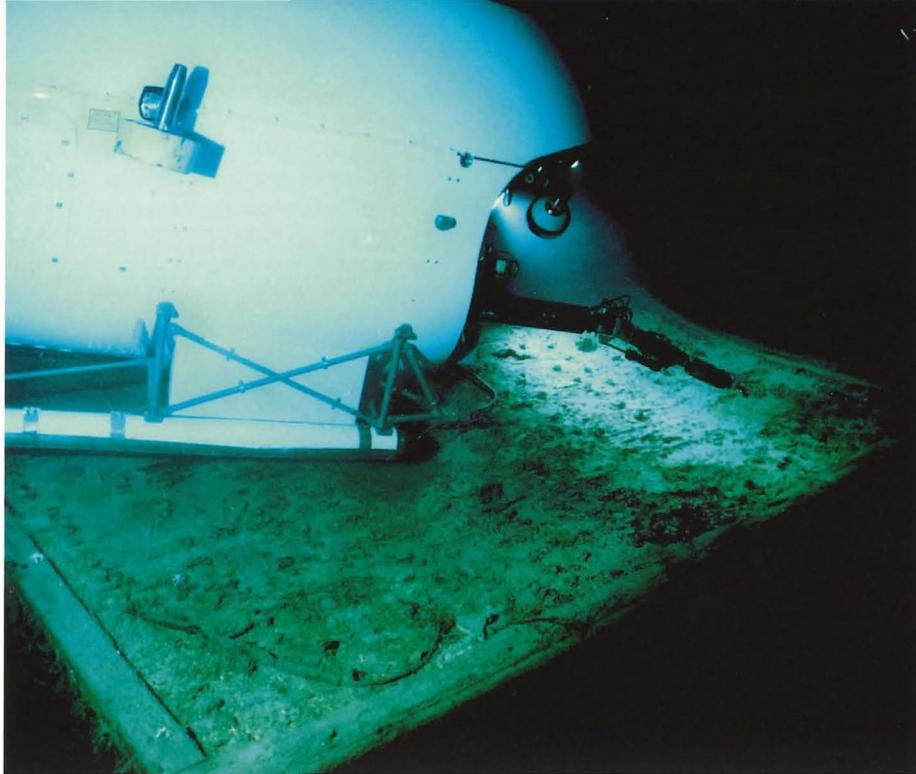
Our exact position within the four seabed transponders was being carefully monitored in the navigation room on *Keldysh*, which remained in contact with Victor over transceivers, so we knew that we would soon reach *Titanic's* badly mangled stern. Once there, we began a four-hour program of videotaping the wreckage for a photomosaic that should serve as a database against which future damage from age, visitors, and remotely operated salvage equipment can be measured. Kneeling before a central port about 20 cm (8 in) in diameter, Victor operated the *Mir* with intense concentration, often glancing quickly at a compass to be sure we were on line. Craig, using coordinates from the sonic transponder "box" in which we operated, guided

Below left *Titanic's* great bow remains an awe-inspiring sight, approached either from below or, as here, from above. Without the dangling rusticles, the railing would appear as new.

Below A photomosaic shows *Titanic's* anchor crane extending up and over the bow. A spare anchor, still secured to the deck, rests at the crane's base, and the port anchor is seen in the lower right corner of the image.

Bottom Looking from port to starboard, this photomosaic of *Titanic's* bow depicts the aft portion of the forecastle where the forward mast had fallen back, collapsing over deck winches and the #1 hold.





Left Traffic two-and-a-half miles deep! *Mir 1* seen from *Mir 2* as it passes just above the wreck of *Titanic*. The two *Mirs* normally operate in tandem.

Victor to the starting point for each of the 16 parallel passes, and then, reading from a digital monitor, recorded on paper at timed intervals our exact position. Similarly, so that Victor would not be distracted by keeping track of too many gauges, Craig routinely read aloud our depth from another monitor, letting us know that we were staying exactly 3,783 m (12,411 ft) deep. Sometimes I relieved Craig by reading our depth aloud. At other times I lay on my stomach on my bench to follow our progress, occasionally photographing through my smaller, starboard port.

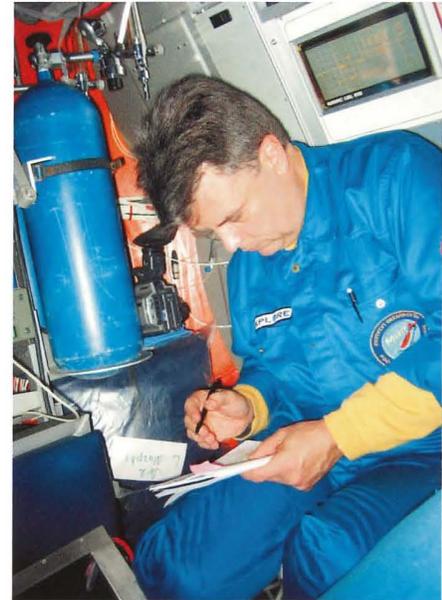
After nearly four hours, we saw a startling sight: traffic! Two-and-a-half miles down in the sea! *Mir 1*, with Lori Johnston and Jeremy Weirich inside, was coming to take our place at the stern. Although I often could not identify what I was seeing on the wreck, Roy and Lori must have had a field day studying the rusticles. They estimate, I believe, that the ship is disintegrating more quickly than previously supposed.

It was time for us to move about 600 m (2,000 ft) to *Titanic*'s better-preserved bow. The great ship broke into two immense pieces, which landed nearly half a mile apart. The vast debris field between the two halves of *Titanic* has been legally picked over by RMST Inc., which holds salvage rights to the ship, and which has raised and conserved several thousand artifacts that have been seen by millions of people. Still, many plates and other objects remain in this area. The salvors are forbidden by law to sell anything, I am told, or to take anything from inside the ship, itself.

14 April 1912

Then we arrived at the bow, which is magnificent, stunning – and unimaginably huge. More than 15 m (50 ft) of it are buried in the seabed into which the ship plowed with tremendous force when it landed, but its towering height remains awesome.

We rose slowly until we reached the railing. Here the ship is so well preserved I wondered if I would see Jack and Rose standing at the rail, with Jack proclaiming himself “King of the World.” We soon began to move slowly over the seemingly solid



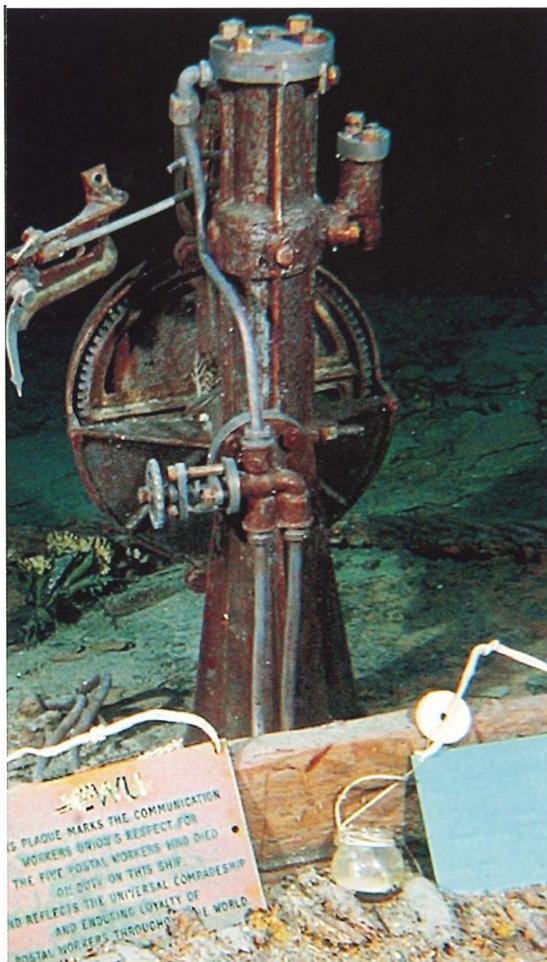
Above NOAA Captain Craig McLean, inside *Mir 2*, studies the submersible's position inside a “box” delineated by sonic transponders while directing the pilot to the starting point for another photographic pass over *Titanic*.



Far left A massive anchor chain still lies by one of *Titanic's* great capstans. The top of the capstan, being of bronze, has deteriorated less than the iron.

Left The mast from which lookout Frederick Fleet spotted the iceberg has now collapsed backward, its crow's nest fallen away.

Below *Titanic's* bronze telemotor, on which the ship's wooden wheel was once mounted, still stands on the bridge where First Officer Murdock made his fatal mistake. Modern memorial plaques have been placed at its base by previous submersible visitors.



deck in controlled and carefully navigated passes, at a fixed depth, making a mosaic of the shipwreck from above with the submersible's external video camera. Deck winches looked as if they could be oiled and put back to work. I spotted a davit from which one of the far-too-few lifeboats was lowered.

We reached the mast, which has toppled backward. As we moved along its length, we saw clearly the opening through which lookout Frederick Fleet stepped out into the crow's nest from which, not long before midnight on 14 April 1912, he rang the warning bell three times and called down to the bridge those immortal words, "Iceberg, right ahead!" The crow's nest was still in place when Robert Ballard found the *Titanic* in 1985, but we saw no sign of it. There are rumors of illegal and clandestine salvors visiting the wreck during winter months, with remotely operated vehicles to remove more objects, but we do not know if the crow's nest has simply fallen.

On the bridge, First Officer William Murdock made a fatal mistake when he received Fleet's warning. He ordered the ship turned hard to port, which meant *Titanic* scraped the iceberg, tearing a long gash in her starboard side that allowed too many watertight compartments to flood. A head-on collision would not have been so devastating.

The ship's brass telemotor, on which the great wooden wheel was mounted, stands as a silent reminder of the moment the helmsman spun it as far as he could. Memorial plaques have been placed at its base by past submersible visits.

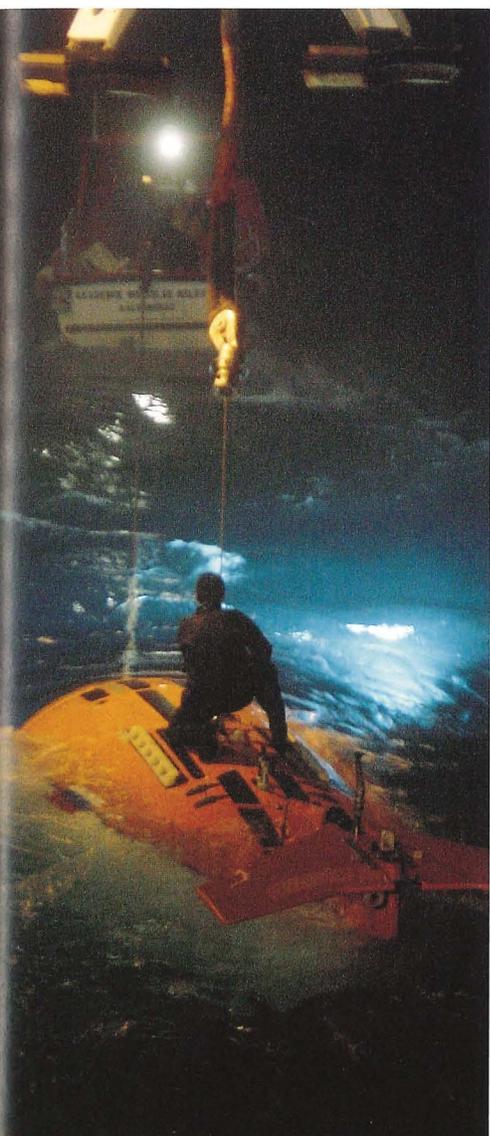
But we did not linger. There was more work ahead. We began to make a video mosaic of the starboard side of this part of the wreck, often drifting with the current at a fixed depth. The lights of the submersible were so bright I could see from the top of the ship to the seabed far below, and could imagine passengers promenading just inside on some of the open-air decks. Most of the portholes still have their glass in place. Several were open. Did a passenger look out of that open window, nearly a century ago, to see what all the commotion was about?

As excited as we were by our dive, we knew that on a cold night just over 90 years before, more than 1,500 passengers and crew perished in this ship or in the sea around it. There were only 705 survivors. Stories of bravery and cowardice have become legend. It is true that all the members of the ship's band played until the end, and all perished. One of the objects raised by the salvors is a clarinet. It is true that Captain Smith went down with his ship, and it is true that Mrs Isador Straus, on being urged to climb into a lifeboat, returned to her husband's side, saying: "We have been living together for many years. Where you go, I go." When offered space in a lifeboat so he could accompany his wife, Straus refused, saying there were still women

Right The rusticle-framed window of an officer's cabin remains open, as if someone had just leaned out to see what was causing the commotion on board. Such features are identified from photographs of the *Titanic* before she sank.



Below A Russian “cowboy” rides *Mir 2* to attach a lifting cable so the sub can be raised back onto the deck of the R/V *Akademik Mstislav Keldysh* at the end of a long day.



to be saved. They were last seen sitting side by side in deck chairs. Benjamin Guggenheim and his valet went below and returned in their evening clothes, prepared, as Guggenheim said, to “go down like gentlemen.”

Ascent

We had been in *Mir 2* for seven-and-a-half hours, with two-and-a-half hours of ascent still ahead. It was time to leave *Titanic*. Victor had been deep in concentration for every second during our mapping program. Now he could relax. As we started up, he offered Craig and me hot tea and biscuits. Later, in various positions, the three of us used the large plastic bottles that were under Craig's seat for their special purpose.

We came up after dark in a dense fog. After ten hours in the *Mir*, we flopped around for about half an hour more before we felt that we were being towed back to *Keldysh* by the launch. Soon the cowboy, balanced like a circus bareback rider, attached the crane's heavy lifting cable, which would bring us back on board *Keldysh*. Then he leapt back onto his *Zodiac*. We were quickly on deck and outside our *Mir*, with hugs all around (especially from Anatoly, who had preceded us up in *Mir 1*), followed by dinner that had been saved for Craig and me in the dining room. With most of the NOAA team around us, we toasted with Russian vodka our successful dives.

Then two full days back to St. Pierre (how many people know that there are two tiny, tiny French islands only a few miles south of Newfoundland?), an overnight stay, and on to St. John's by small charter jet.

On our way back from Turkey in August 2003, Ann and I visited Cobh, Ireland, *Titanic*'s last port of call – then called Queenstown – on the great ship's only voyage. In just one summer I had been to the beginning and end of one of the most famous ocean trips in history.

Further Reading

Past and future adventures of the Institute of Nautical Archaeology have been and will be described in the *INA Quarterly* (formerly the *INA Newsletter*), published by the Institute of Nautical Archaeology, P.O. Drawer HG, College Station, Texas 77841-5137, USA.

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