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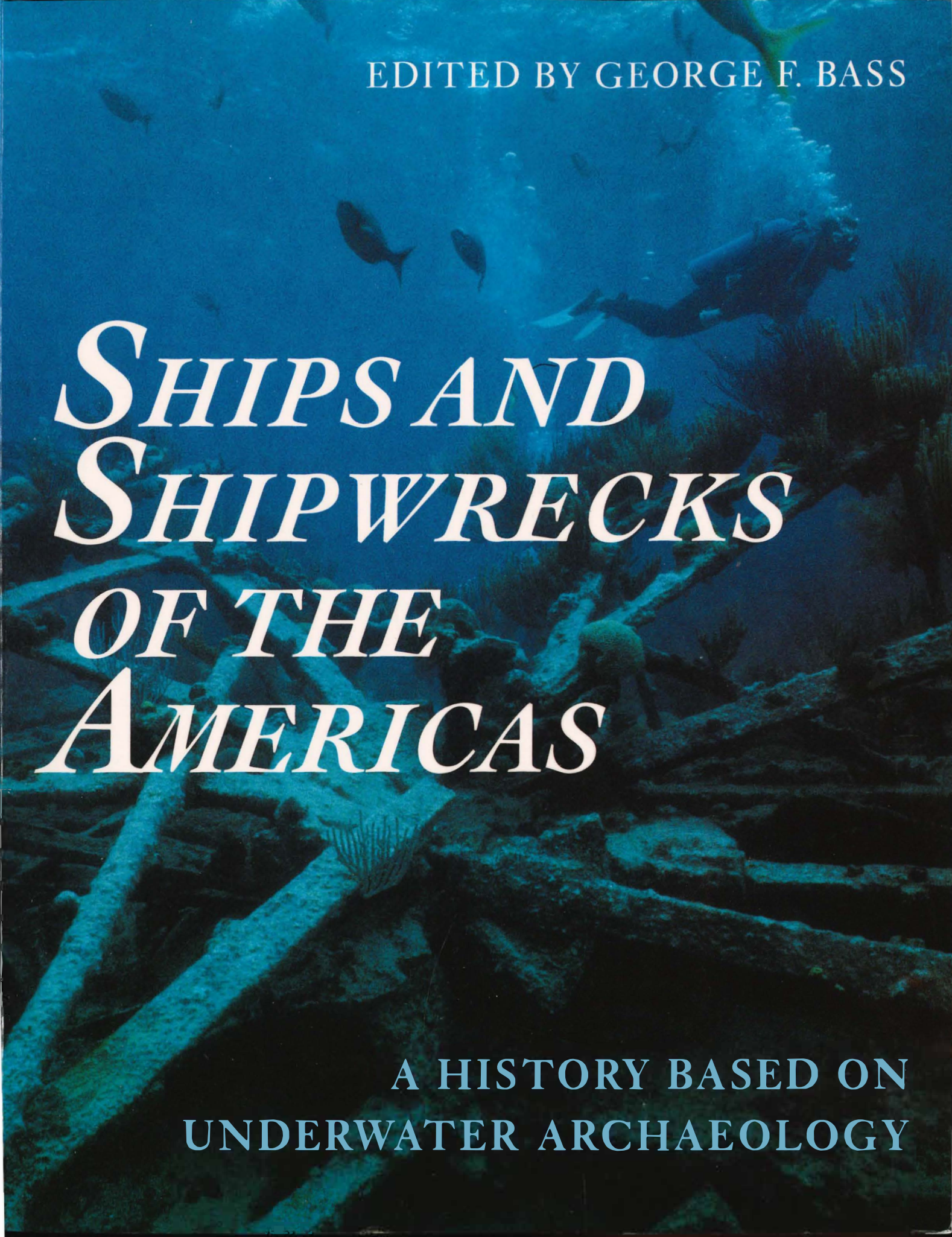
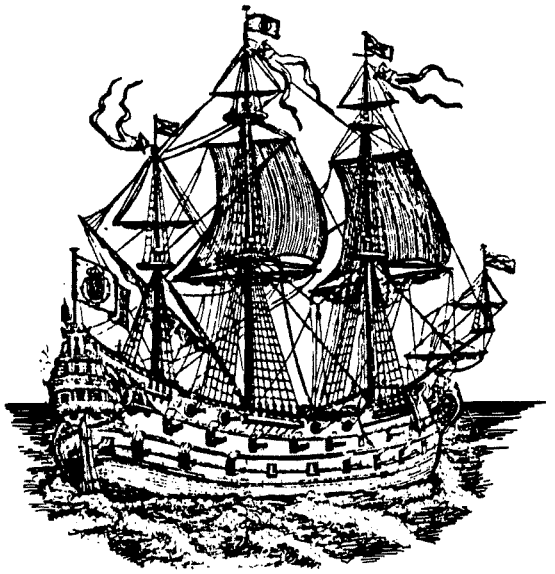


SHIPS AND SHIPWRECKS OF THE AMERICAS

A HISTORY BASED ON UNDERWATER ARCHAEOLOGY



Ships and Shipwrecks of the Americas

SHIPS AND SHIPWRECKS OF THE AMERICAS

A History Based on Underwater Archaeology

Edited by GEORGE F. BASS

With 376 illustrations, 80 in colour

Thames and Hudson

To John H. Baird,
pioneer patron of nautical archaeology,
and friend

Editor's Note

We have tried to be consistent in the spelling of placenames, using those which appear most frequently in English, or those used by accepted authorities, although these may not have been the first choices of individual authors in this book. Both English and metric measurements are given, which has led to minor problems. Archaeologists normally use the metric system in recording their sites, whether watercraft or not, but many of these watercraft were built to the English standard. We have, therefore, for instance, given the metric measurements first in Chapter One, which concerns pre-Columbian watercraft not built by people using feet and inches, whereas in Chapter Ten, discussing nineteenth-century steamboats, English measurements are listed first. Approximate figures present a problem: a vessel 'around 45 ft long' becomes an overly precise 'around 13.7 m' long when converted literally, and the measurement cited first should be taken to be the more correct one.

Title page A diver dismantles a floor timber from a sixteenth-century Basque galleon found in Red Bay, Labrador. See Chapter Four.

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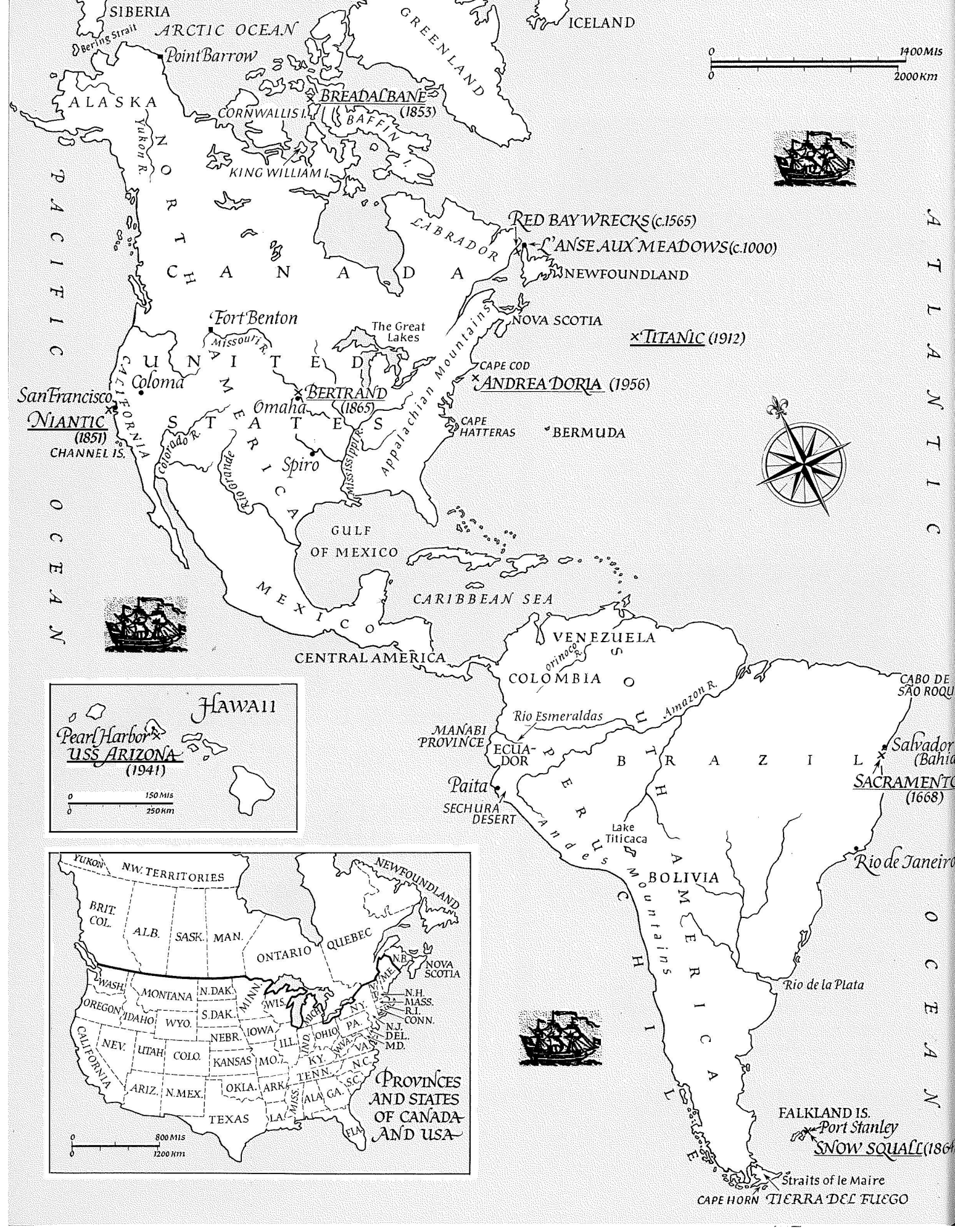
SIBERIA
ARCTIC OCEAN
Bering Strait
Point Barrow
GREENLAND
ICELAND
0 1400 Mls
0 2000 Km
ALASKA
Yukon R.
BREADALBANE (1853)
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0 150 Mls
0 250 Km
YUKON
N.W. TERRITORIES
NEWFOUNDLAND
BRIT. COL.
ALB.
SASK.
MAN.
ONTARIO
QUEBEC
N.B.
NOVA SCOTIA
P.E.I.
WASH.
MONTANA
N.DAK.
MINN.
WIS.
MICH.
N.Y.
VT.
N.H.
MASS.
R.I.
CONN.
OREGON
IDAHO
WYO.
S.DAK.
PA.
N.J.
DEL.
MD.
NEBR.
IOWA
ILL.
IND.
OHIO
W.VA.
VA.
CALIFORNIA
NEV.
UTAH
COLO.
KANSAS
MO.
KY.
N.C.
TENN.
S.C.
ARIZ.
N.MEX.
OKLA.
ARK.
MISS.
ALA.
GA.
TEXAS
LA.
FLA.
0 800 Mls
0 1200 Km
PROVINCES AND STATES OF CANADA AND USA

Introduction

George F. Bass

It is impossible to imagine a history of the Americas without ships and boats.

The European discovery, exploration, colonization, commercial development and defense of this New World have all depended on ships.

But European explorers, even as early as Leif Eiriksson, were not the first to use water transport in the Americas. Columbus' ships were met by Caribbean watercraft, and Europeans who followed the great admiral encountered specialized local craft – birchbark canoes, log dugouts, skin-covered kayaks and reed *balsas* as they pushed overland from the Atlantic to the Pacific.

The soldiers, priests, merchants and adventurers who both westernized and plundered much of South and Middle America arrived by sea. Columbus himself founded the first Christian town in the Americas, La Isabela in the Dominican Republic, in 1494. Cortés, Cabral, Balboa and Pizarro were among those who followed in his wake.

Farther north, discoveries by other intrepid mariners led to the colonization of what today are the United States and Canada. Ponce de León discovered Florida in 1513 by sea, and eleven years later Verrazzano made landfall in present-day North Carolina before sailing all the way up the coast to Maine. Basque seafarers entered still more northerly waters, not for what the land could yield, but for whales.

The first permanent European settlers in North America reached Jamestown in the *Susan Constant*, *Godspeed* and *Discovery*. A replica of the *Mayflower*, which not long ago duplicated the Pilgrims' transatlantic crossing, represents the interest we still have in the vessels that populated our early colonies. The replica of a Manila galleon, recently built in Mexico, demonstrates an equal interest in the ships that once brought goods from across the Pacific, goods that were transshipped overland to cargo holds waiting to ferry them on to Europe.

Throughout the Americas, ships made possible the wretched trade in African slaves.

When some of the North American colonies opted for independence from the Old World, a naval blockade of the York River was decisive to the outcome of the battle of Yorktown, which led to Cornwallis' final surrender of British forces.

Much later, when these colonies had become united states on the verge of becoming disunited, naval forces again played a crucial role in the outcome. In his book, *The Civil War* (1971), the eminent historian Bruce Catton writes:

> While the rival armies swayed back and forth over the landscape . . . a profound intangible was slowly beginning to tilt the balance against the Confederacy. On the ocean, in the coastal sounds, and up and down the inland rivers the great force of sea power was making itself felt. By itself it could never decide the issue of the war; taken in conjunction with the work of the Federal armies, it would ultimately be decisive. In no single area of the war was the overwhelming advantage possessed by the Federal government so ruinous to Southern hopes.

Even today, the most powerful military deterrent in the Americas probably lies in the fleet of Trident submarines gliding silently beneath the waves. Even today, immigrants disembark onto American shores from ships and boats. Even today, bulk cargoes, from oil to the automobiles that devour it, reach our coasts by sea.

More than a dozen years ago, I edited *A History of Seafaring Based on Underwater Archaeology*, a book intended to combine and supplement existing information with the latest results of the new field of nautical archaeology. I had not anticipated the public interest that led, eventually, to the book's publication in six languages.

That original volume emphasized mostly earlier ships and boats, watercraft about which we would have had few details without archaeology. Only the last two of twelve chapters dealt with watercraft in the Americas. There were two reasons for this. The first was that nautical archaeology was pioneered in and matured in the Mediterranean and in Northern Europe. The second was that I believed archaeology had far more to offer to, say, the study of classical or Viking ships than to the study of

ships of the modern era. What new information could shipwreck archaeology offer us about much more recent vessels?

The answer came to me several years ago when I was asked to give a paper on 'Shipwreck Archaeology in the Eastern United States' at a published symposium organized by Louisiana State University. My own experience as an underwater archaeologist had been mostly with ancient Mediterranean shipwrecks. Thus, I was surprised to learn that we know more about the construction of Greek and Roman ships than we do of relatively modern Spanish and Portuguese ships of exploration. I found how vividly careful excavation can bring to life the crews and passengers of even more recent vessels. I was heartened to learn that a small but growing number of nautical archaeologists are conducting excavations in the New World to the same exacting standards as those established earlier in Europe.

Why nautical archaeology in the Americas has lagged behind that in Europe is not easily explained. Perhaps it is because New World archaeologists traditionally have been most interested in pre-Columbian sites and cultures. Thus, it went almost unnoticed by many of them that historic shipwrecks were being looted by treasure-hunters who would have been prohibited by law from bulldozing Indian mounds for pottery or dismantling historic dwellings for souvenirs they might sell for personal gain. At last, largely through the work of the authors of this book, nautical archaeology in the Americas has a bright future, a future to benefit historians, other archaeologists and, most importantly, the general public.

Archaeologists trained on Mediterranean shipwrecks, in fact, are playing a major role in starting scholarly underwater archaeology in the New World. I had a modest part in beginning the first scientific excavations of both American and British shipwrecks from our War of Independence. David Switzer, director of the *Defence* excavation in Maine, was trained on a Late Roman wreck in Turkey. John Broadwater, now excavating one of Cornwallis' ships in the York River, Virginia, earlier dived on wrecks in Turkey, as well as in North Carolina and Truk. The first hull Richard Steffy ever restored was that of a classical Greek ship in Cyprus. Donald Keith had excavated wrecks in the Mediterranean before beginning the first full-scale, thorough excavation ever conducted of a ship of the exploration period in the Caribbean. Their work is described in the following pages.

The chapters here, as in the original *History of Seafaring*, are all written by scholars who have studied firsthand ships and shipwrecks of the periods they cover. By good fortune, all are friends. I have personally explored with them some of the sites they describe, and in other cases they have worked on my underwater projects.

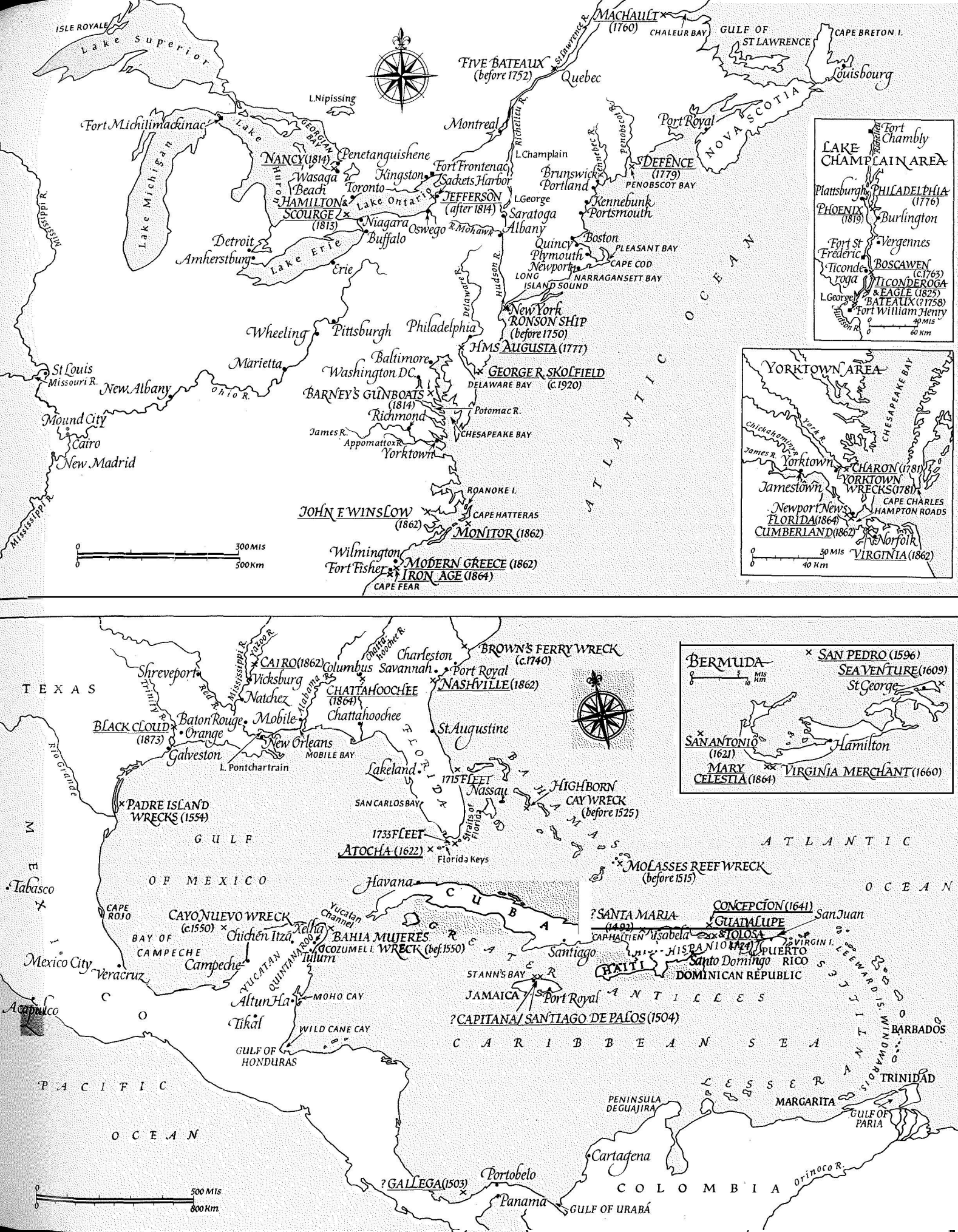
Margaret Leshikar describes indigenous watercraft from Peru to the northwest of North America, illustrated by evidence ranging from Maya reliefs to descriptions and drawings of early explorers in the New World; she has studied surviving Aztec dugouts, and has recorded in detail present methods of building dugouts in the Caribbean. **Roger Smith**, who is conducting a search for two of Columbus' ships abandoned off the north coast of Jamaica, presents evidence for locations of other Columbus shipwrecks, and what might be learned from them to supplement existing information from contemporaneous models and paintings.

Donald Keith moves the story forward by writing on the ships of exploration that followed immediately after Columbus, and the knowledge gleaned from the wrecks of such ships he has examined off the Bahamas, the Turks and Caicos Islands, and Mexico. Hulls of Iberian ships locked in the frozen north are better preserved than those of ships sunk in the shipworm-infested Caribbean, and these are described by **Robert Grenier**, director of the excavation of a remarkable Basque whaler in Labrador. **Roger Smith** then combines both field and archival research to present a vivid picture of the treasure-laden Spanish galleons that carried the riches of the Americas back to Europe.

Shipping in the English colonies was involved with the transport of more mundane goods and with people. **J. Richard Steffy** describes modern replicas of the famed *Mayflower*, *Susan Constant*, *Godspeed* and *Discovery* mentioned above, and provides construction details from shipwrecks of both coastal and transoceanic vessels of the period. **Kevin Crisman**, who pioneered the excavation and study of wrecks in the lakes of the northern United States, draws on an abundance of well-preserved ships to describe the role of watercraft in the westward movement of Europeans during the French and Indian War. **John Sands**, who is engaged in current excavations of British ships lost by General Cornwallis in the York River, Virginia, describes these ships in their historical context, and illustrates other ships from the War of Independence, including the American brig *Defence*, recently excavated in Maine, and the famous *Philadelphia*, raised from Lake Champlain.

Perhaps the most perfectly preserved early ships ever found in the Americas are those of the *Hamilton* and *Scourge*, sitting upright at a depth of 300 ft (90 m) on the bed of Lake Ontario in Canadian waters. Even their painted figureheads have survived in excellent condition since the War of 1812, as **Kenneth Cassavoy** and **Kevin Crisman** show.

Joe Simmons, in writing on the steamboats that carried bulk cargoes and passengers throughout North America, concentrates on the wreck of the *Bertrand*, a stern-wheeler sunk in the Missouri River in 1865; its excavation yielded 140 tons of mid-nineteenth century artifacts, more than a million items! **Gordon Watts** combines space-age technology and Civil War history in discussing his dives from a special submarine on the famed ironclad *Monitor*, 200 ft (60 m) below the stormy waters off Cape Hatteras. He relates his own experiences on blockade runners sunk off the same North Carolina


ISLE ROYALE
Lake Superior
L.Nipissing
Fort Michilimackinac
Lake Huron
GEORGIAN BAY
Lake Michigan
NANCY(1814)
Penetanguishene
Wasaga Beach
Toronto
HAMILTON & SCOURGE (1813)
Lake Ontario
Niagara
Oswego
Buffalo
Detroit
Amherstburg
Lake Erie
Erie
MACHAULT (1760)
CHALEUR BAY
GULF OF ST LAWRENCE
CAPE BRETON I.
Louisbourg
St Lawrence R.
FIVE BATEAUX (before 1752)
Quebec
Richelieu R.
L.Champlain
Montreal
Fort Frontenac
Sackets Harbor
JEFFERSON (after 1814)
L.George
Saratoga
R.Mohawk
Albany
Kennebec R.
Penobscot R.
DEFENCE (1779)
PENOBSCOT BAY
Port Royal
NOVA SCOTIA
Brunswick
Portland
Kennebunk
Portsmouth
Boston
PLEASANT BAY
Quincy
Plymouth
Newport
CAPE COD
NARRAGANSETT BAY
LONG ISLAND SOUND
Hudson R.
Delaware R.
New York
RONSON SHIP (before 1750)
HMS AUGUSTA (1777)
Philadelphia
Wheeling
Pittsburgh
Baltimore
Washington DC.
GEORGE R. SKOLFIELD (c.1920)
DELAWARE BAY
Marietta
St Louis
Missouri R.
New Albany
Ohio R.
BARNEY'S GUNBOATS (1814)
Potomac R.
Richmond
James R.
Appomattox R.
CHESAPEAKE BAY
Yorktown
Mound City
Cairo
New Madrid
Mississippi R.
ROANOKE I.
JOHN F WINSLOW (1862)
CAPE HATTERAS
MONITOR (1862)
Wilmington
Fort Fisher
MODERN GREECE (1862)
IRON AGE (1864)
CAPE FEAR
0 300 MIS
0 500 Km
ATLANTIC OCEAN
LAKE CHAMPLAIN AREA
Fort Chambly
Richelieu R.
Plattsburgh
PHILADELPHIA (1776)
PHOENIX (1819)
Burlington
Fort St Frédéric
Vergennes
Ticonderoga
BOSCAWEN (c.1763)
TICONDEROGA & EAGLE (1825)
L.George
BATEAUX (?1758)
Fort William Henry
Hudson R.
0 40 MIS
0 60 Km
YORKTOWN AREA
CHESAPEAKE BAY
York R.
Chickahominy R.
James R.
Yorktown
CHARON (1781)
YORKTOWN WRECKS (1781)
Jamestown
Newport News
CAPE CHARLES
HAMPTON ROADS
FLORIDA (1864)
CUMBERLAND (1862)
Norfolk
VIRGINIA (1862)
0 30 MIS
0 40 Km
TEXAS
Shreveport
Trinity R.
Red R.
Mississippi R.
Yazoo R.
CAIRO (1862)
Vicksburg
Natchez
Baton Rouge
Mobile
Alabama R.
Chattahoochee R.
Columbus
CHATTAHOOCHEE (1864)
Chattahoochee
Charleston
Savannah
BROWN'S FERRY WRECK (c.1740)
Port Royal
NASHVILLE (1862)
St Augustine
BLACK CLOUD (1873)
Orange
Galveston
New Orleans
MOBILE BAY
L. Pontchartrain
Rio Grande
Lakeland
1715 FLEET
Nassau
HIGHBORN CAY WRECK (before 1525)
SAN CARLOS BAY
Straits of Florida
1733 FLEET
ATOCHA (1622)
Florida Keys
PADRE ISLAND WRECKS (1554)
GULF OF MEXICO
MOLASSES REEF WRECK (before 1515)
ATLANTIC OCEAN
Tabasco
Havana
CUBA
CAPE ROJO
CAYO NUEVO WRECK (c.1550)
Yucatan Channel
?SANTA MARIA (1492)
CONCEPCION (1641)
GUADALUPE
TOLOSA (1724)
San Juan
PUERTO RICO
VIRGIN I.
LEEWARD IS.
WINDWARD IS.
CAPHAITIEN
Isabela
HISPANIOLA
Santiago
HAITI
Santo Domingo
DOMINICAN REPUBLIC
BAY OF CAMPECHE
Chichén Itzá
Xelha
BAHIA MUJERES
COZUMEL I. WRECK (bef.1550)
Tulum
Campeche
Mexico City
Veracruz
YUCATAN
QUINTANA ROO
Acapulco
ST ANN'S BAY
Port Royal
JAMAICA
ANTILLES
Altun Ha
MOHO CAY
Tikal
?CAPITANA/ SANTIAGO DE PALOS (1504)
WILD CANE CAY
GULF OF HONDURAS
CARIBBEAN SEA
BARBADOS
TRINIDAD
PACIFIC OCEAN
PENINSULA DE GUAJIRA
MARGARITA
GULF OF PARIA
Cartagena
Portobelo
?GALLEGA (1503)
Panama
GULF OF URABÁ
COLOMBIA
Orinoco R.
0 500 MIS
0 800 Km
BERMUDA
0 5 10 MIS 0 10 Km
SAN PEDRO (1596)
SEA VENTURE (1609)
St George
SAN ANTONIO (1621)
Hamilton
MARY CELESTIA (1864)
VIRGINIA MERCHANT (1660)

coast, but ranges from Texas to Mississippi in describing other wrecks from the war between the states.

Paul Johnston describes the great sailing vessels that made America a commercial power in the nineteenth century, from eastern whalers and Clipper ships to the wrecks of Gold Rush ships in California. Finally, I found myself so dependent on the vast knowledge of marine salvage stored by **Captain W. F. Searle**, USN (ret), who was Director of Ocean Engineering, Supervisor of Salvage, and Supervisor of Diving for the United States Navy between 1964 and 1969, that I prevailed upon him to write with me a chapter about the future of underwater archaeology in the Americas.

Many of the authors share a common training. Smith, Crisman, Cassavoy and Simmons received their MA degrees in nautical archaeology at Texas A&M University, where Steffy and I were among their professors, and where Smith and Keith are now completing doctorates. Leshikar, Sands, Watts and Johnston have assisted field projects of the Institute of Nautical Archaeology, now based at Texas A&M, where Grenier visits for consultations with Steffy. Searle, who had lent Navy support to some of my own early efforts in underwater technology, was a founding director of the Institute, and the driving force behind the Institute's first New World project the excavation of the *Defence*. The family of nautical archaeologists remains small.

Nautical history, however, is not simply for scholars. We cannot and should not deny the simple romantic appeal of experiencing the past. As I wrote some of this introduction I was sailing through the Virgin Islands, struck by the awesome isolation of the landfalls that Columbus saw on his second voyage. One night there was a rough crossing. Most of us did not sleep. A few were seasick. Yet we were stabilized and air-conditioned, guests on the 170-ft motor yacht *Michaela Rose*. I wondered idly what it was like for the crews of early caravels and *naos* in these Caribbean waters. Later, from my porthole, I could see a future archaeological site the rusting hulk of *Sarah*, on her side, half above and half below the surface of the harbor of Aquilla in the British West Indies. Civilization now is near at hand. But what was it like to be wrecked centuries ago? Within sight of *Sarah* is a desert island – a few palm trees in the midst of white sand a cartoon island out of the pages of *New Yorker* or *Punch*. One morning, sitting on the sand while my companions swam and dived, I tried to imagine the loneliness of being marooned. Even there my imagination was not vivid enough.

It was not until I had edited almost the entire manuscript and written the above words that, at last, the significance of seafaring to almost all Americans of European, African or Asian descent really struck home. Going through old family papers for the first time, I discovered that my great-great-grandfather, the Reverend William Jessup Armstrong, drowned in November 1846 when the side-wheel steamer *Atlantic* was wrecked in Long Island Sound with the loss of forty-two souls. And that my great-great-great-great-grandmother, Nancy Alexander Wauchope, gave birth to a son on 15 December 1727 during a three-month crossing from Ireland to Pennsylvania. Having made a December crossing of the North Atlantic on the *Queen Mary*, I shudder to imagine *that* experience! That ships of almost every century covered in this book affected my forebears later came to light when I found that the first European in my family to reach the New World, Captain Nathaniel Basse, arrived by ship at Jamestown on 27 April 1619. And when I learned that some of my ancestors on that paternal side were Algonkian-speaking Indians, I realized that even native American canoes and dugouts must have played a role in my distant past. I had been a nautical archaeologist for more than a quarter of a century, but it was through these dry-land discoveries that the importance of watercraft to my life, and to the lives of virtually all Americans, finally made an emotional impact. Those who want to understand the Americas and Americans cannot distance themselves from the ships and boats described in the following pages. They have touched us all.

Editor's Note for the Paperback Edition

Since this book was first published, New World nautical archaeology has thrived, in part because of our authors. The first three received doctorates from Texas A&M University: **Margaret Leshikar-Denton** then became chief archaeologist of the Cayman Islands and published *The Wreck of the Ten Sails* (Cayman Islands National Archive and Cayman Free Press, 1994); **Roger Smith** excavated the sixteenth-century Emanuel Point wreck in Florida and published *Vanguard of Empire* (Oxford University Press, 1993); and **Donald Keith**, with **Joe J. Simmons**, founded Ships of Discovery and Exploration, a research group at the Corpus Christi Museum in Texas. **Robert Grenier**'s landmark publication of Red Bay is nearing completion. Emeritus professor **J. Richard Steffy** published *Wooden Ship Building and the Interpretation of Shipwrecks* (Texas A&M University Press, 1994). **Kevin Crisman**, now on the Texas A&M faculty, has completed study of the *Jefferson*, the *Boscawan*, a nineteenth-century horse-powered ferry, and numerous other wrecks in the northern lakes. **Gordon Watts** has excavated the sixteenth-century Western Ledge Reef wreck off Bermuda, and assisted a French team excavating the C.S.S. *Alabama* near Cherbourg. **Paul Johnston**, now Curator of Transportation at the Smithsonian Institution, has investigated the *Indiana*, mentioned by Simmons in his chapter, and found the long-sought American yacht *Cleopatra's Barge* off Hawaii.

Epilog

George F. Bass and W. F. Searle

What does the future hold for ship and boat archaeology in the Americas?

Allow two veteran divers – one with a background in nautical archaeology and the other in navy and commercial salvage and wreck clearance – to close this book by speculating on the answer.

There is no question that there are and will be many sites for future study. 'Statistics for the eighteenth and nineteenth centuries', states Willard Bascom in *Deep Water, Ancient Ships*, 'indicate that approximately 40 percent of all wooden sailing ships ended their careers by running onto reefs, rocks, or beaches made of rock, sand, or coral.' Another 10 to 20 percent, Bascom estimates, sank offshore in deeper water.

Lloyd's List demonstrates that losses at sea remain a daily occurrence. One can add to this the myriad small craft that sink in ponds, lakes and rivers across the continents on any given date.

Although most shipwrecks studied in the near future will be in relatively shallow water, deeper wrecks are in many instances better preserved. Largely as a by-product of military research and development, there already exist the means to locate and inspect even the deepest shipwrecks or, as in the case of the *Breadalbane*, those under Arctic ice.

Breadalbane

In 1846 a British expedition led by Sir John Franklin, looking for the elusive Northwest Passage between the Atlantic and Pacific Oceans, was trapped by Arctic ice while aboard the ships *Erebus* and *Terror*.

When no news had arrived from the explorers by 1847, a series of search teams were dispatched to find the lost men. One team sailed in 1853 aboard the ten-year-old British bark *Breadalbane*. But *Breadalbane* survived the cruel Arctic no better than the ships she sought. She was sunk by ice – fortunately without loss of life.

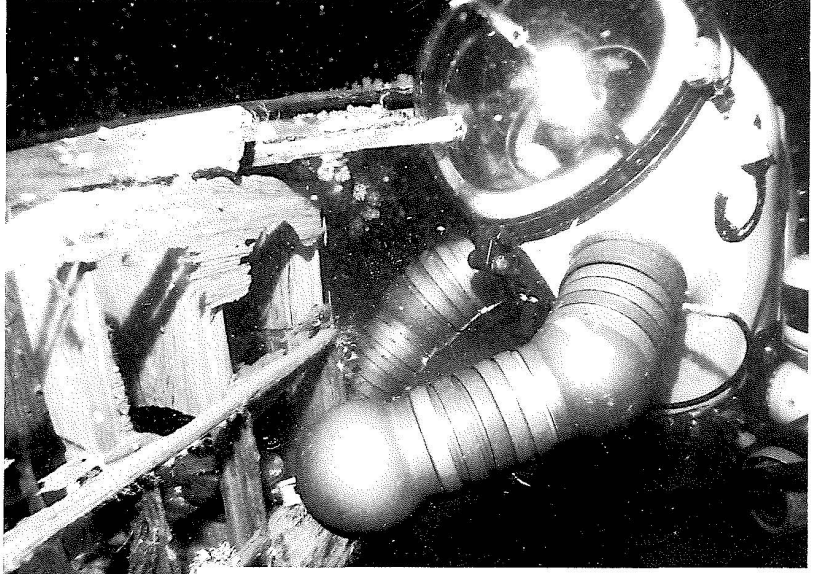
Breadalbane's crew did not know that they were already too late to rescue Franklin and his men. An 1859 rescue team would find on King William Island skeletons and a written account of the last days of the original, ill-fated expedition: their ships crushed by the ice, and their leader and two dozen fellow crewmen already dead, the remaining men had abandoned the ships on 22 April 1848. The account stopped only three days later. An Eskimo witness described how the starving men had fallen and died as they walked. In 1984 archaeologists discovered some of the sailors in frozen, shallow graves.

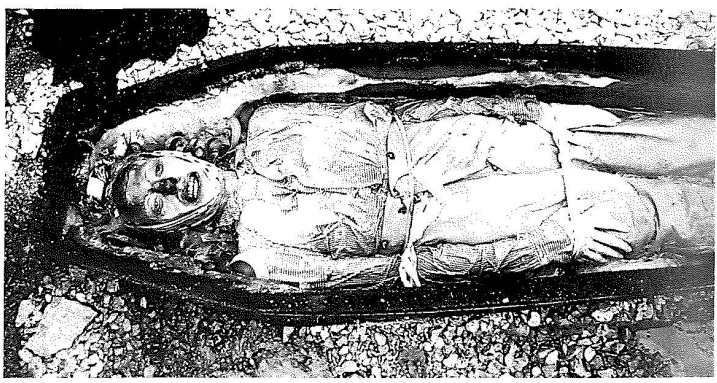
More than a century after the *Breadalbane* went down, a team of modern explorers set out to locate her remains. The problems associated with finding a shipwreck under 6 ft (1.8 m) of ice and 340 ft (100 m) of water were great, but the search, directed by Canadian physician and underwater explorer Joe MacInnis, was successful. In 1980 a Klein Associates sonar, just as on the *Hamilton* in Lake Ontario several years earlier (see Chapter Nine), printed out the ghostly silhouette of a ship still upright on the seabed, her masts standing tall.

Sonar detects wrecks by emitting sound waves and measuring with extreme accuracy the length of time it takes these sound waves to bounce back from the sea or lake bed to the sonar unit. Thus if some obstacle rests on or protrudes from the sea or lake bottom, the sound waves return from it sooner than from the bottom beyond, and this time differential is recorded on a paper chart. Sometimes the obstructions are simply rock outcrops, but as sonar becomes increasingly refined these can be distinguished on the paper from the recognizable shadows of sunken ships – such as the *Breadalbane*.

Three years after *Breadalbane* was found, MacInnis directed a large team, supported by airplanes and a snow tractor, which cut through the Arctic ice on which they were camped and lowered diver Doug Osborne to explore the remarkably preserved ship. Osborne rode in a recent invention, the WASP, a kind of one-person, surface-powered submersible with arms. The team cut another hole, through which yet another invention, a Remotely Piloted Vehicle (RPV), was lowered to enable *National Geographic* photographer Emory Kristof to record both Osborne's work and the wreck. The results show how well isolated Arctic sea water, free of marine borers, can preserve a wooden ship for more than a century.

Frozen Tombs in the Arctic





1, 2 Petty Officer John Torrington, whose deep-frozen corpse (*below right*) lies buried in the permafrost of northern Canada's Beechey Island, was a member of the ill-fated British expedition trying to discover a Northwest Passage in 1846. The *Breadalbane*, sent in search of the lost explorers in 1853, herself was sunk by the ice. A team led by Joe MacInnis tracked down the wreck in 1980 and three years later sent diver Doug Osborne (*right*) to inspect the hull 340 ft (100 m) down in a kind of one-person submersible, the WASP.

But the technology used on *Breadalbane* would not have existed, or been so refined, had it not been for earlier work on more recent and equally tragic catastrophes – not on the sea, but under it and in the sky.

The Beginning of Deep Search and Recovery

Comet. On 10 January 1954 a British Comet jet liner, with twenty-nine passengers and a crew of six, broke apart and dropped from the sky near the Italian island of Elba. The steps taken to discover the cause of the crash were similar to those used today by marine archaeologists (and were used more recently, in 1986, to explain what went wrong with the space shuttle *Challenger* after it fell into the Atlantic Ocean). It was necessary to locate the wreck, raise the pieces, and study them.

Within days of the Comet's loss, British naval vessels were on the scene, searching in 400 ft (120 m) of water. Witnesses to the crash, and reports both from the aircraft which spotted floating wreckage and from Italian sailors who picked up the only recovered bodies, narrowed the search field to an area of about 100 square miles. As with the *Breadalbane*, the first contact with the wreck was by sonar, or, as it is called in Great Britain, ASDIC. In those days, however, underwater television or manned observation capsules used for identifying sonar contacts were simply lowered, or 'dunked', from surface vessels. The only means of moving them through any kind of search pattern was to alter the position of the surface vessel by shortening or lengthening the mooring cables, or otherwise moving her about. The method was inefficient – impossible in high seas – but in this case, it was successful. The underwater television showed the sonar contact to be the Comet.

Once located, the scattered pieces of the Comet were recovered, some by a grab directed from the sea floor by an observer in a watertight capsule, but many trawled up in nets. The urgency of the operation was heightened when, on 8 April of the same year, a second Comet disappeared over the Mediterranean under similar circumstances. In seven months about 70 percent of the first Comet had been recovered. Painstaking reconstruction pointed to the cause of the disaster – metal fatigue – and allowed successful changes in the Comet's design. No attempt was made to recover the second Comet, which sank in water more than half-a-mile deep.

'Thresher'. How far search and recovery techniques advanced in less than a decade was demonstrated by the search for the USS *Thresher*, a 278-ft (85-m) nuclear-propelled attack submarine, lost with her crew of 129 men on 10 April 1963. The submarine was making a test dive about 200 miles off the coast of New England when her surface escort, the Submarine Rescue Ship USS *Skylark*, heard over her underwater, sonar-like communications system sounds of what may have been an attempt to surface, a few garbled words and then silence. Although there was no chance of finding the submarine's crew alive in water 1½ miles deep, a search was immediately initiated. A fleet that grew to three dozen ships, some employing sonar and underwater cameras, was ultimately successful.

This time, however, a new dimension was added. The search was not conducted exclusively from surface vessels. The Navy employed its famous research bathyscaphe *Trieste*, which three years earlier had dived to the deepest part of any sea, almost 7 miles down. In late June, at a depth of 8,400 ft (2,600 m), and with Lieutenant

(now Rear Admiral) Brad Mooney at the controls, *Trieste II*'s crew spotted bits and pieces of what seemed to belong to the *Thresher*. In subsequent dives which continued through August, *Trieste II* not only photographed structural parts of the lost submarine, but, with an externally mounted mechanical arm, retrieved among other things several pieces of *Thresher*'s copper nickel piping. These dives led to confident conclusions as to the systems which failed and caused the submarine to be lost, and consequently led to corrective design and shipbuilding techniques.

H bomb. On 17 January 1966 a mid-air collision between an American strategic bomber and its refuelling tanker caused four unarmed hydrogen bombs to be dropped near Palomares, Spain. Three of the bombs impacted on land and self-destructed in non-nuclear explosions. The only remaining bomb, with its parachute intact, fell well out to sea where it promptly sank in deep water. Even though great strides had recently been made in deep ocean search and recovery techniques, the problems presented by the missing H-bomb severely tested these new capabilities.

Many of the advances were the result of study by the post-*Thresher* Navy-sponsored Deep Submergence Systems Review Group. There were other catalysts, however, than the loss of the *Thresher*. Methods of retrieving tested weapons from the sea floor, as well as mine countermeasures technology after the Korean War, led to the development of underwater robotic equipment systems which could swim down, search out objects on the sea floor and, as necessary, work on them. By the mid-1960s the result of this was the Navy's CURV (Cable-controlled Underwater Research Vehicle), the first successful, work-oriented ROV (Remote Operated Vehicle). CURV was the key to the successful manipulation which led to the recovery of the H-bomb.

A pair of manned research submersibles, *Aluminaut* and *Alvin*, both launched after the *Thresher* tragedy and both capable of diving to greater than 6,000 ft (1,800 m), were instrumental in the search and identification phases, and were critically involved in the recovery phase. Once *Alvin* had located the bomb, *Aluminaut*, with her longer battery life, drew baby-sitting duty and kept the bomb in view while *Alvin* was readied on the surface for a recovery attempt. *Alvin*'s job was to attach lines to the bomb's parachute harness by means of grapnels. But this lifting attempt failed when the bomb, only a short distance off the bottom, broke free and tumbled farther down the submarine canyon in which it had been found. After several stressful days of renewed searching, the errant bomb was relocated at 2,850 ft (870 m). This was frighteningly near the maximum depth to which CURV was limited, but CURV was now given the assignment of rigging the lift lines to the bomb's parachute harness. CURV successfully attached two lift lines. Then, while maneuvering to attach a third line, its propulsion propellers became entangled in the parachute nylon, presenting a dilemma to the controllers on the surface. In short order the decision was made to carefully lift the entire entanglement – CURV, parachute and bomb. The three were successfully raised to some 60 ft (18 m) below the deck of the lifting platform (Submarine Rescue Ship USS *Petrel*), at which point divers entered the water and attached a heavy lifting strap directly to the bomb, which was hoisted onto the ship's afterdeck. This successful operation had demonstrated for the first time the employment of both manned submersibles and unmanned vehicles in deep ocean recovery.

'*Scorpion*'. When another nuclear attack submarine, *Scorpion*, was reported missing in 1968, somewhere between the Azores and her destination in Norfolk, Virginia, the U.S. Navy was presented with a far greater challenge. The search area was enormous. The distance between the Azores and Norfolk is nearly 2,500 miles, the depth of water sometimes 4 miles. Both submarines and a fleet of surface vessels were brought into the task which lasted from May through October and involved thousands of men. Eventually the Navy's Oceanographic Research Ship USNS *Mizar*, which had photographed *Thresher* five years earlier, discovered the *Scorpion* nearly 2 miles deep and about 400 miles from the Azores.

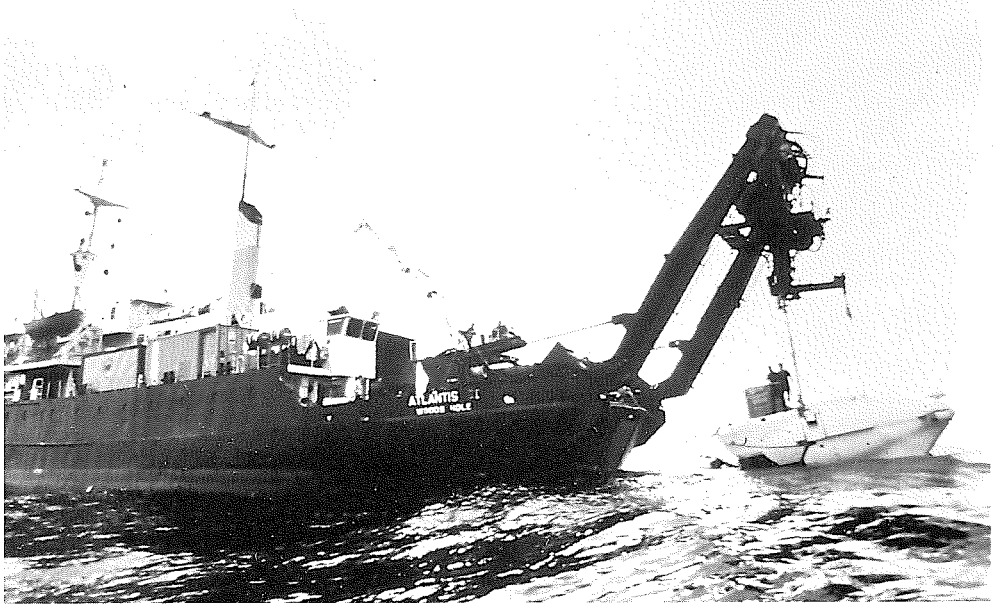
The following year *Trieste II* dived with submarine designer/naval architect Captain Harry Jackson on board to inspect the *Scorpion* and evaluate, or at least postulate, the manner in which she was damaged and the reason for her loss. This basic lesson must not be lost on those who explore shipwrecks from submersibles. Just as physicians are called to observe patients for medical diagnoses, those observing historic shipwrecks from submersibles should include people trained to evaluate hull damage, state of preservation and other pertinent factors.

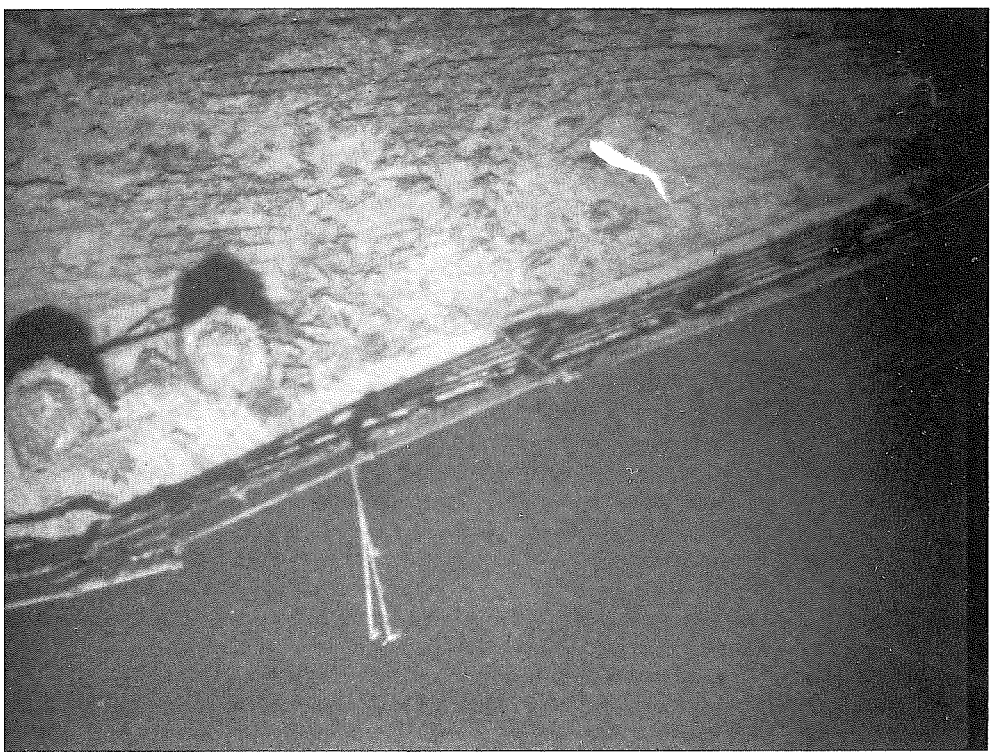
Titanic

The search and survey techniques developed by the Navy in the 1960s and afterward eventually made possible the discovery and inspection of the most famous shipwreck of modern times.

Everyone knows the story of the 'unsinkable' *Titanic*, the largest and most modern ship of her day: How she sank on her maiden voyage in April 1912 after striking an iceberg in calm seas. How radioed pleas for help were unheeded by other ships in the vicinity. How 1,522 lives were lost. As children we learned of cowardice and bravery, of insufficient lifeboats, of dying cries in the night.

Now everyone knows how a joint project from the United States and France, under Dr Robert Ballard of the Woods Hole Oceanographic Institution, and Jean-Louis Michel of the Institut Français de Recherches pour l'Exploitation des Mers, located the ship on 1 September 1985. A video cassette of the expedition became the largest selling television documentary in history, showing the interest the public has in historic shipwrecks.





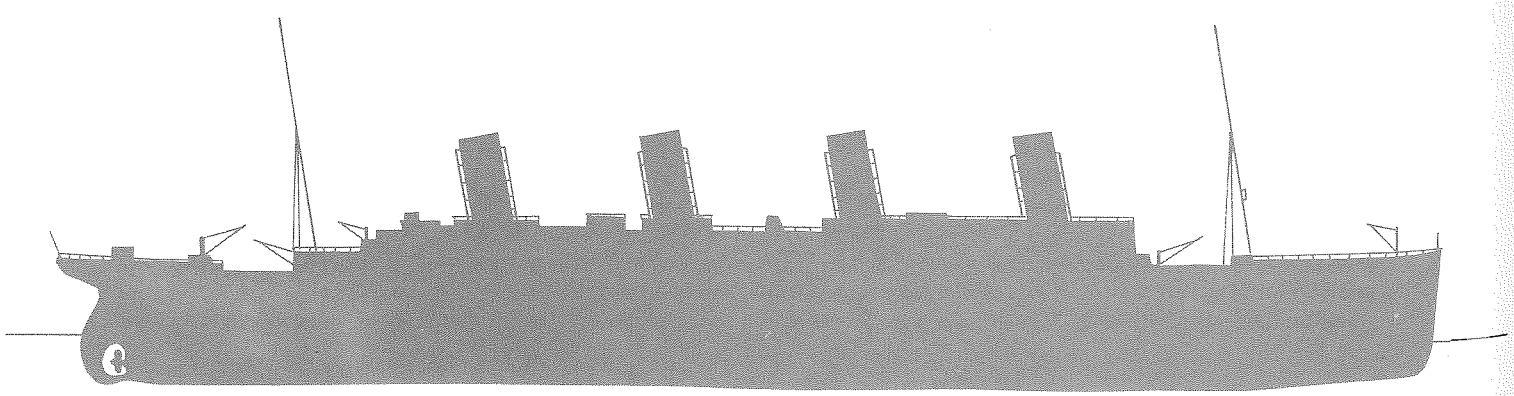
Final Resting Place of the 'Titanic'

The largest and most modern ship of her day, the *Titanic* struck an iceberg and sank on her maiden voyage in April 1912, 350 miles southwest of Newfoundland. Now, through a triumph of present-day underwater technology, the liner has been located, mapped and explored $2\frac{1}{2}$ miles deep on the ocean floor. But her discovery has created a controversy over salvage, brought to a head in July 1987 when a separate expedition raised more than 300 items from the shattered ship.

3 (*above left*) The U.S. research submersible *Alvin*, rebuilt with a strengthened hull to dive to 13,000 ft (4,000 m), being launched from the support ship *Atlantis II* in 1986, as part of the research expedition led by Robert Ballard of the Wood's Hole Oceanographic Institution.

4 (*center left*) This ghostly image – one of thousands of photographs taken of the wreck – records the edge of the *Titanic*'s bow on the starboard side, with two bollards and railing visible. A 3-ft (1-m) long fish swims over the deck.

5 (*below*) Profile of the *Titanic*. It now appears that when she sank on the night of Sunday 14 April, her hull broke in two, the stern section pivoting round in the opposite direction from the bow. The two halves today lie 1970 ft (600 m) apart on the floor of the Atlantic.



Although not in classical domestic American waters – she lies 350 miles southeast of Newfoundland – *Titanic* was nearing North America when she sank, and her discovery is included here as an example of the use of modern technology in finding an historic wreck so far at sea, $2\frac{1}{2}$ miles down on a mountainous seabed, with conflicting contemporary reports of her last position!

The wreck was spotted by video cameras that are part of *Angus*, an unmanned search system that also carried sonar and other electronic equipment down to just above the ocean floor. The following year, during a second expedition, Ballard and his colleagues inspected and photographed the wreck, inside and out, by means of *Alvin*, now rebuilt with a strengthened hull to dive to 13,000 ft (4,000 m), and *Jason Jr*, a robot tethered to *Alvin* that swam down stairwells to photograph the interior of the rusting giant.

Although no ship designers or naval architects were involved in these submarine inspections of the *Titanic*, the explorers decided that the great vessel had not been sunk, as believed, by a long gash inflicted by the iceberg. It seemed to them, instead, that the ship's riveted plates had simply separated under the blow. More surprising to them was the extensive damage caused by pressure on the hull as it sank. The stern, torn away and turned completely around, lay 600 ft (180 m) from the rest of the ship. All wood had disappeared, although ceramic, glass and other artifacts appeared like new in expedition photographs.

Deep Cargo Salvage

When Searle was a midshipman at Annapolis in the 1940s, the 'deep ocean' commenced at the 100 fathom line, or 600 ft (180 m), leading to the phrase to 'deep six' materials such as code books, crypto wheels and the like, which meant jettisoning them deeper than 100 fathoms, where they were beyond the limits of location and retrieval. It was only after the successful search for and recovery of the H-bomb off Palomares that the jettisoning limits were redefined. But will this redefinition affect marine archaeology in the near future? Now that the deepest and most isolated wrecks can be located and visited systems under development will soon allow the U.S. Navy to record 98 percent of the ocean bottom – what are the possibilities of actual excavation at depths inaccessible only a generation ago?

It is true that salvage operations have been conducted at appreciable depths for some time. Millions-of dollars-worth of gold and silver was salvaged in 1932–35 from the wreck of the *Egypt*, sunk 400 ft (122 m) deep in the Bay of Biscay in 1922, and additional millions in gold bars were recovered in 1941 from the *Niagara*, sunk at a similar depth off New Zealand in 1940. In both cases an observer, dangling in a metal chamber over the wreck, directed by telephone the movements of a grab sent down from the surface. And in both cases the salvors simply blasted their way through the ships with explosives. Neither technique could be employed in careful archaeological excavation.

It was the development of self contained underwater breathing apparatus (SCUBA) that revolutionized underwater archaeology around the world in the middle of the twentieth century, for it gave divers and archaeologists, for the first time, the mobility to do delicate work. Excavations conducted with SCUBA, however, are limited to depths seldom exceeding about 150 ft (46 m). There are two reasons for this. Firstly, nitrogen, which constitutes 80 percent of the air we breathe, becomes narcotic under pressure; at depths much greater than 150 ft, the diver can become confused and disoriented, incapable of careful excavation or even safe diving. Secondly, the deeper one dives and the longer one stays at depth, the greater the length of time it takes to return to the surface without risking the bends, the painful and sometimes fatal illness caused by the formation of bubbles in the bloodstream and body tissues; for the deeper one dives, the greater the pressure of the air one breathes to prevent being crushed by the increasing weight, or pressure, of the water surrounding the diver. The diver avoids the bends by rising slowly to the surface, usually in stages, pausing for certain lengths of time at various depths determined by how deep he or she has been and how long the dive. At each pause, or stage, the diver breathes off more of the pressurized nitrogen in his system. This is called decompression. A twenty-minute dive at 150 ft (46 m), for example, calls for more than eleven minutes of decompression. A one-hour dive at the same depth, however, calls for nearly two hours of decompression, which is totally impractical in any extended diving operation, especially since archaeological teams, for safety, usually decompress much more than is required, often using pure oxygen to hasten the removal of nitrogen from their bodies.

There are methods of overcoming both nitrogen narcosis and the impracticality of inordinately long decompression following each dive. If a diver breathes something other than air, most commonly heliox (a mixture of helium and oxygen rather than the normal nitrogen and oxygen of air), nitrogen narcosis is avoided. Avoiding intolerable decompression periods after extremely long, deep dives, however, is more complex and is dependent on a technique known as saturation diving.

As described above, the deeper one dives and the longer one stays at depth, the more pressurized gas (whether air or heliox) one absorbs into the system, thus necessitating decompression periods of ever-increasing lengths. At some point, however, the diver's body has absorbed all the pressurized gas it can hold. After this saturation point, the length of decompression is not increased, regardless of how much longer the diver stays at depth.

Saturation diving allows divers to live under pressure for days or weeks at a time. Normally they live in pressurized metal chambers aboard surface vessels, and are lowered to the seabed in pressurized capsules from which they can exit and work for several hours. At the end

of their work period, they re-enter the capsule, seal its hatch, and are raised back to the surface where the capsule is mated with the deck chamber in which they live. After days or weeks or even months the amount of decompression will be great several days but once the diver has become saturated his decompression penalty will not increase.

This was the method used in 1981 to salvage £45 million in Soviet gold bullion from the HMS *Edinburgh*, sunk during World War II in 800 ft (250 m) of water 170 miles north of Murmansk.

Saturation divers may, alternatively, live on the seabed in an underwater habitat, but when they do surface they must still be raised in a pressurized capsule and locked into a deck chamber for the proper period of decompression.

Both approaches to saturation diving have been used on another famous shipwreck.

Andrea Doria

At 11:10 pm on 25 July 1956, 50 miles south of Nantucket Island, the 697-ft (212-m) *Andrea Doria*, pride of Italy's passenger fleet, collided with the Swedish liner *Stockholm* and settled on her starboard side in 240 ft (73 m) of water. Thirty-four people were killed by the collision, but the ship did not stop claiming victims. Because she can be reached by air diving, but only at great risk, she remains especially dangerous.

Immediately following the disaster, divers descended at least to the ship's uppermost structure, 165 ft (50 m) deep, to obtain 'front page' or 'cover' photographs, and these dives were followed by more-or-less 'official investigation dives', during the training for which one diver died while using an unfamiliar mixed-gas breathing system.

In the intervening years since the *Doria* went down there have been numerous diving expeditions to her, both surface-based air dives and at least three expeditions using saturation techniques. Dive-shop gossip has it that freelance divers have hacksawed away a statue of Admiral Doria – leaving the feet welded to the pedestal. (The statue is variously reported to be in a bar room in Norfolk, in a museum in Florida, or elsewhere.) Sport divers, additionally, visited the wreck both for the thrill and for souvenirs. At least two died, and Bass knows a third who was paralyzed by the bends from her 'ultimate dive'.

Clearly, saturation dives were necessary for any reasonably long visits to the ship. Alan Krasberg of Boston was the first when he used a two-man, towable, winch-itself-down underwater habitat in a 1968 'salvage' attempt.

'The habitat', Krasberg wrote to Searle in July 1987, 'was intended to be attached via a winch and wire rope to a locked toggle through a porthole near the promenade deck thru-way. Diver gas was carried on board.'

Luck was against Krasberg. Day after day high seas prevented his team from placing the toggle, and a diver/photographer for a news magazine almost died from what must have been an air embolism, requiring immediate treatment in the expedition's combination habitat-decompression chamber. 'The next day the sea was flat calm at last', Krasberg continued, 'but we were now on our way back to shore with the man in the chamber.'

'All I have to show for it', he added by telephone, 'is half of one porthole and a sign from the ship that says "Men's Room".'

Nearly two decades later, saturation diving of the type used in offshore oil work allowed a team led by the late Peter Gimbel and his wife Elga Anderson to actually explore the *Doria*'s interior. Gimbel had dived on the wreck the day after she went down, when he was only twenty-eight years old, not knowing that his curiosity about the tragedy would become an obsession to which he devoted much of the second half of his life. In 1985, with hundreds of tons of diving equipment mounted on an offshore supply vessel moored to four 3-ton anchors, Gimbel's divers remained under pressure for a month, lowered each day to the wreck in a 4-ton steel bell from which, attached to umbilicals bringing air and warmth, they cut a hole in the hulk and swam inside. Although not an archaeological project, Gimbel's curiosity was the same kind of curiosity that drives the archaeologist. Did this virtually 'unsinkable' ocean liner truly go down because a crucial watertight door had been left open? Gimbel's well-organized and fully manned expedition confirmed that the door was open, but a 65-ft (19-m) gash he found in the *Doria*'s hull made the question more or less academic, thus confirming the post-accident inquiries in the federal court in New York, as well as in the London insurance community.

Were rumors of fortunes stored in two of the *Doria*'s safes true? The safe Gimbel raised contained paper money and certificates, but not the rumored fortune. Bass cannot believe, however, that Gimbel thought he could recoup from those safes the costs of the expedition he mounted. He is convinced it was a mixture of curiosity and challenge that pushed Gimbel on.

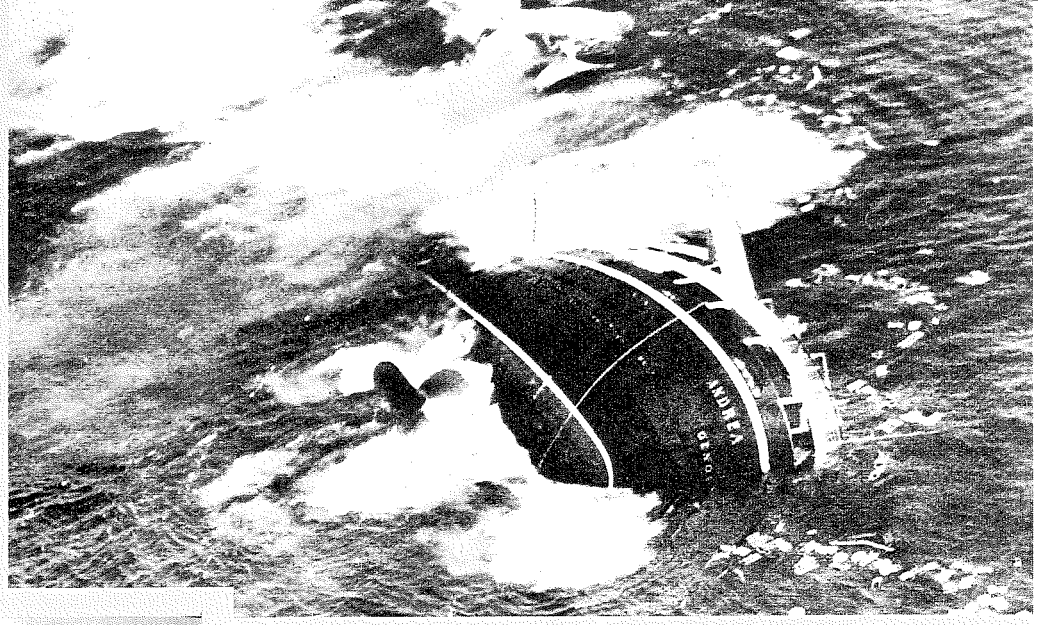
Shipwrecks and Society

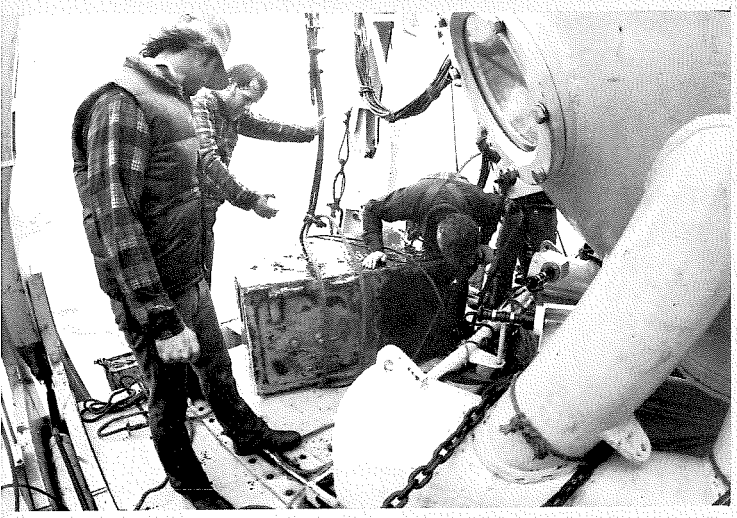
Shipwrecks in American waters can now, regardless of depth or temperature, be located and partly or completely recovered. This has led to intense interest in what happens to them, as shown by a sheaf of contemporary clippings sent by Searle to Bass:

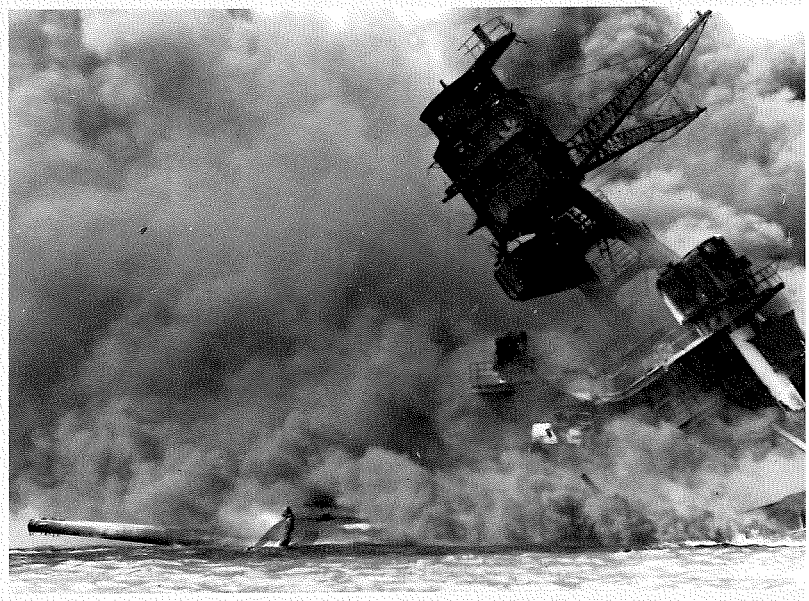
'Divers Hope to Hoist Ship's Safe Tomorrow' (*Post-Intelligencer*, Seattle, Washington, 31 July 1987) and 'Ship Salvage Plan Draws Protest' (*The Daily News*, Longview, Washington, 27 July 1987), concerning objections by the Underwater Archaeological Society of British Columbia to a salvage team's plans to recover $10 million in valuables from the *Governor* which sank in U.S. waters in 1921 with loss of life. 'Treasure Hunters Ordered Not to Damage Coral Reef' (*The Houston Post*, 25 July 1987): 'A federal judge refused Friday to allow a group of treasure hunters to tunnel into an already damaged Gulf of Mexico

Last Moments of a Luxury Liner

6, 7 On 25 July 1956, eleven hours after colliding with another liner, the *Andrea Doria* sank (*right*) 50 miles south of Nantucket Island. Thirty-four people died, and the wreck continues to claim victims as divers chance their luck on the ship, whose uppermost structure lies at 165 ft (50 m). In 1985 a saturation-diving team explored the *Doria*'s interior and brought up the ship's safe (*below*) containing paper money but not the rumored fortune.

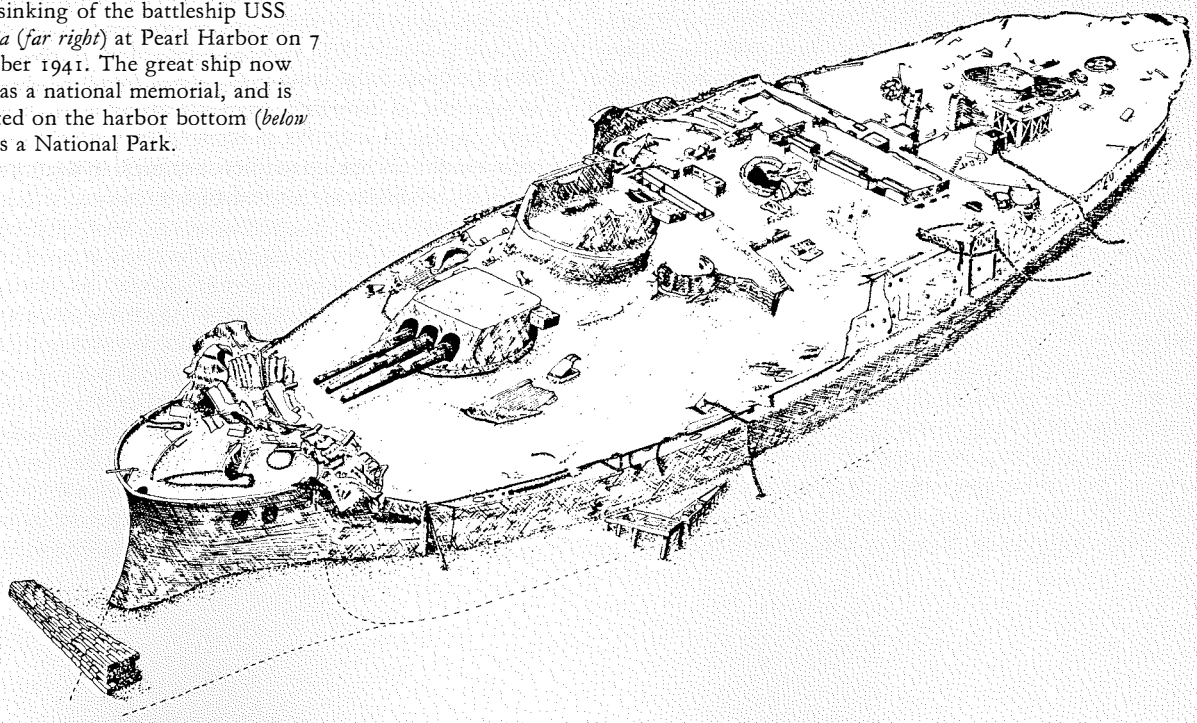






Death of a Battleship

8, 9 Over 1,000 sailors lost their lives in the sinking of the battleship USS *Arizona* (*far right*) at Pearl Harbor on 7 December 1941. The great ship now serves as a national memorial, and is protected on the harbor bottom (*below right*) as a National Park.



coral reef in search of a sunken Spanish galleon that purportedly carried $100 million in gold and other valuables.' 'Salvors Vie for Sunken Treasure off [*sic*] Central America' (*The Virginian-Pilot*, 9 July 1987), 'Treasure Hunters Claim $450 Million Shipwreck' (*Washington Post*, 18 July 1987), and 'Ship Defies Court Order, Hunts Sunken Treasure' (*The Virginian-Pilot and the Ledger-Star*, 18 July 1987), all concerning the 1857 wreck of the sidewheel steamer *Central America*, lost during a hurricane on a voyage from Havana to New York. 'Controversial Titanic Expedition Delayed by Bad Weather, Intention to Salvage Artifacts from Wreck Called "Grave-Robbing"' (*Washington Post*, 25 July 1987) and, later, 'Inquiry On Titanic Jewels: Descendant of Victim May Claim Satchel' (*Washington Post*, 3 September 1987), the last raising insurance and other questions that eventually must be decided by courts of law.

The *Titanic*, especially, has roused strong emotions over the question of 'to-touch' or 'not-to-touch'. A bill was even introduced into the United States Senate that would have prevented import into the United States of any of the artifacts being raised from the vessel. But this is not an archaeological matter. The *Titanic* is no more an archaeological site than is the *Andrea Doria*, yet there have been no outcries about disturbing the latter. It is said that the *Titanic* should not be disturbed because lives were lost during her sinking, but such reasoning would put both salvors and nautical archaeologists out of business around the world. Presumably, then, the rationale for leaving the *Titanic* undisturbed is the same as that which led to the raising of private funds to save and restore New York's famed Carnegie Hall when it was destined to be torn down: some structures are simply so venerable that a sufficient segment of society wants them left intact for posterity.

Such respect for certain noteworthy vessels is warranted, regardless of their archaeological value. An example is the USS *Arizona*, sunk during the Japanese attack on Pearl Harbor in Honolulu on 7 December 1941. Three battleships – *West Virginia*, *Oklahoma* and *Arizona* – were sunk by dive bombers, fighters and torpedo planes that day, but the single greatest disaster was the loss of the USS *Arizona* with 1,102 sailors on board. Now protected as a National Park, the USS *Arizona* National Memorial includes a concrete and steel structure which spans the ship's remains as they lie on the bottom of Pearl Harbor. The park attracts over a million visitors annually.

Certainly not all World War II wrecks should become national monuments. The debate over historic preservation on land – Are we saving too much? Are we saving the right things? must include historic preservation under water. It would seem wrong to allocate large sums for the preservation of one ship simply because she lies on the ocean floor, when an identical sister ship, rotting at her moorings, might legitimately and ethically be cut up and sold for scrap. Yet some preservationists seem still not to recognize this double standard.

With tens or even hundreds of thousands of wrecks in the Americas, the public may believe that this debate over what to save may be postponed, but such is not the case. Although only a fraction of existing wrecks warrant archaeological excavation, it is exactly that fraction wrecks of historical importance, or those rich in artifacts – that attract treasure-hunters who are not motivated by the desire to recover and restore the past of the Americas. As pointed out in Chapter Three, all the known wrecks of the Age of Exploration were damaged by modern looters before archaeologists reached them.

An example of a wreck that *does* warrant scientific examination is the British frigate *Hussar*. At 3 pm on 23 November 1780 she struck Pot Rock in the gauntlet of reefs called Hell Gate in New York's East River, and finally sank at 7 pm several miles upstream in the Bay of Brothers at a depth of 42 ft (12.8 m). Some $3 million in gold specie had supposedly been boxed and stored earlier beneath the ballast of the *Hussar* by a few trusted British tars; a new crew had then been recruited and only two officers notified of the existence of the gold. At Wallabout Bay in New York Harbor the *Hussar* was said to have taken on seventy American prisoners and an additional $1.8 million in gold from the backup ship *Mercury*, before sailing up the East River.

After over 200 years and a score of treasure-hunting expeditions the mysteries of the *Hussar* remain unsolved: Did she have gold aboard at all, or was it transferred to the *Mercury*? If she took four hours to sink, did she tie up and unload the gold? Why, in those four hours, did not the 107 men reported lost save themselves, and why in that time were the American prisoners not released? The answers to these questions will be found only when a proper archaeological expedition is mounted at the Bay of Brothers.

Society must decide, then, which wrecks should be protected from commercial exploitation, just as society protects certain structures on land while others of equal vintage are razed. In some cases this is easy. We would not allow an entrepreneur to dismantle either Mount Vernon or the Alamo for private gain. Why, then, should a diver be allowed to dismantle one of Columbus' or La Salle's ships to sell or own for personal benefit? Some historic wrecks should be preserved through excavation and conservation; others should be preserved under water for the pleasure of future generations of visiting divers.

Society must also decide the cost it will bear in order to learn about and preserve the past. In the near future, new knowledge will continue to come from relatively shallow or even underground wrecks. Will archaeology be able to take advantage of the new technologies to search and work deeper? Only the tiniest fraction of the millions spent on the H-bomb search would ever be available for seeking an archaeological site under similar conditions. The United States was willing to pay the necessary millions of dollars for the *Titanic* search primarily because it provided a test of equipment with potential military

value. The cost of saturation diving on HMS *Edinburgh* was more than offset by the value of gold recovered.

Archaeologists will not come by such vast sums in their search for knowledge. Should deep wrecks then be left to entrepreneurs who might pay for their recovery through sales of artifacts? Or should they be saved for the future, when new techniques could lower costs of working at great depth?

Education must play a role in the study of whichever wrecks do warrant archaeological study. Although often commendable, some of the pioneering research described in this book was conducted by divers with only a smattering of historical knowledge, or by archaeologists with scant familiarity with ship design.

Nautical archaeology remains an infant branch of archaeology, however, and most projects described in the preceding chapters were conducted only within the past two decades. Meanwhile, the number of archaeologists capable of excavating and interpreting both land and underwater sites is growing, as evidenced by the authors of those chapters.

Over the years Bass' teams have learned, both in the Mediterranean and in the Caribbean, that for every month of diving, two years must be spent on the conservation of excavated artifacts, including entire hulls; on the cataloging, drawing and photographing of these finds; on library, archival and museum research; and on interpreting and publishing the discoveries. The nautical archaeologist need not be expert in every phase of this research, but must have sufficient training to choose and evaluate able assistants and colleagues in each area. And he or she must remember that the cost of conservation and restoration in true archaeological work usually exceeds the cost of diving, even on wrecks more than 150 ft (46 m) deep.

Humans being fallible, mistakes will be made in the attempt to draw distinctions between wrecks of social or historic significance and those of more commercial value. 'Significance' is in the eye of the beholder. Yet the public has agreed that looters should not be allowed to bulldoze any native American mounds for pottery to sell. The public should come to see historic monuments under water simply as historic monuments.

At the same time the public, and especially the news media, must recognize the difference between those who excavate historic ships for knowledge and those who recover them solely for monetary gain. The press too quickly bestows the title 'underwater archaeologist' on any diver who raises artifacts from the deep. There is a long and honorable tradition of salvage at sea, but it must not be confused with archaeology. Nor should legitimate salvors be confused with plunderers and pirates, as U.S. statute makes clear:

> Whoever plunders, steals, or destroys any money, goods, merchandise, or other effects from or belonging to any vessel in distress, or wrecked, lost, stranded, or cast away, upon the sea, or upon any reef, shoal, bank or rocks of the sea, or in any other place within the admiralty and maritime jurisdiction of the United States, shall be fined not more than $5,000 or imprisoned not more than ten years, or both. (18 U.S. Code 1658).

In the debate over historic shipwrecks, care must be given to truth. Bass has published a list of more than a dozen myths spread by treasure-hunters in order to justify their often destructive work: that they are 'saving' the wrecks from future storms; that they do not need to record or preserve the hulls they destroy while searching for treasure because detailed plans of galleons and other early ships exist in Spanish archives; that hulls in the New World are not as well preserved as those in the Mediterranean and thus deserve no special care; that the only way to pay for underwater survey and excavation is through the sale of artifacts; that duplicate artifacts have no archaeological value; that the only incentive for looking for and excavating early shipwrecks is monetary gain. Perhaps this book will put some of the myths to rest.

The quest for history is as exciting as any search for treasure. It is a quest that benefits us all. It is a quest that has begun in earnest in the waters of the Americas. It is a quest that will continue as long as we care about our past.

Postscript

Since the first publication of this book, discoveries have been made from almost every period covered. Early- to mid-sixteenth-century wrecks include two in the Bahamas, one off Cuba, and one, probably lost by Spanish explorer Tristan de Luna, off Florida. Later sixteenth-century wrecks include the Western Ledge Reef Wreck off Bermuda, and the Spanish galleon *Nuestra Señora del Rosario* off Cuba. English-built ships of the seventeenth century include one at Monte Cristi, Dominican Republic, and another, perhaps *H.M.S. Swan*, in the middle of the sunken city of Port Royal, Jamaica. An exciting discovery of that era is French explorer René La Salle's ship *La Belle* in Matagorda Bay, Texas. The *Land Tortoise*, a British floating gun battery from the French and Indian War, was found in Lake George. Excavation of the Revolutionary War cofferdam wreck (*Betsy*) in the York River is completed, and a replica of the gunboat *Philadelphia* has sailed on Lake Champlain. From the War of 1812, research on the *Jefferson* in Lake Ontario is complete, and work has begun on the British brig *Linnet* and the American gunboat *Allen* in Lake Champlain. Hulls of early steamers *Water Witch* and *Champlain* have been studied in the latter lake, and the *Arabia*, recovered from the Missouri River, is another *Bertrand*. Located Civil War vessels include the steamer *Maple Leaf*, near Jacksonville, Florida, and the Confederate submarine *Hunley*, near Charleston.

Glossary

aft toward the stern of a vessel
amidships middle portion of a ship lengthwise or crossways
athwartships from one side of a ship to the other; at right angles to the keel
ballast heavy material in a ship's hold to lower her center of gravity and provide greater stability when she carries little or no cargo
bateau (batteau) flat-bottomed double-ended boat
batten strip of wood used in shipbuilding to reproduce the curves of a vessel's hull
beakhead ship's head forward of the forecastle, forming a small deck over the stem
beam maximum width of a vessel; a horizontal transverse timber forming part of a ship's structure
bergantin a brig (Spanish)
bilge bottom of a ship's hull
bonaventure mizzen second mizzenmast on four-masters
boom spar to which is attached the foot of a fore-and-aft sail
bow forward part of a ship's side, from the point where the planks curve inwards to where they meet at the stem
bower anchor anchor permanently attached to a cable and stowed in the bow ready for use
bowsprit spar projecting forward of a sailing ship's stem
brace rope attached to the boom or yard of a sail, used to control its position; a metal strap used to strengthen the framework of a ship
brig two-masted square-rigger
brigantine two-masted sailing ship, rigged square on the foremast and fore-and-aft with square topsails on the mainmast
bulkhead vertical partition dividing a ship into sections
bulwarks sides of a vessel above the upper deck
buttresses short timbers placed on either side of the keelson and mast step to provide lateral support for the step
caprail timber atop the side planking of a vessel
caravel two- or three-masted sailing ship with broad beam, high poop-deck and lateen rig; used by Spanish and Portuguese in 15th and 16th centuries
carrack round-sterned merchant ship with distinctive triangular bow used in the Mediterranean in the 15th and 16th centuries
carvel-built having the planks all flush from keel to gunwale
carvel planking smooth seamed planking
castle tower or defensive post on the deck of a ship
caulk to stop up the seams between planks
ceiling internal planking of a ship's hull
chine angle at which the side and bottom of a hull join
cleat short projections of wood or metal, used for a variety of purposes
clench bending over and pounding down a bolt or nail
clinker-built said of a vessel whose planks run fore and aft, with the lower edge of one plank overlapping the upper edge of the plank below
clipper fast sailing ship with concave bow, fine lines and raked masts
close to the wind sailing as nearly as possible towards the compass point from which the wind is blowing
composite ship wooden ship with iron or steel framing
deadeye round or pear-shaped wooden block pierced by several holes, used mainly to secure the standing rigging
deadwood blocks of timber attached to top of keel to fill out narrow spaces in hull
dhow lateen-rigged Arab vessel with one or two masts, usually raked
Down-Easter large wooden square-rigger built on the coast of Maine in the late 19th century
draft (draught) the depth of water displaced by a vessel
dunnage brushwood or other material used to protect cargo
fairlead any fixture which leads a rope in the required direction
filler short plank set between frames on the outboard edge of the ceiling to close the gap between frames
flukes triangular extensions to the arms of an anchor
fore in the forward part of a vessel; towards the stem
fore-and-aft rig sails fitted in a fore-and-aft direction and secured on their forward side to a stay or mast
forecastle the raised, forward part of the upper deck, extending from the beakhead to the foremast or just aft of it; the seamen's quarters in a merchant ship
forelock bolt a bolt with a head at one end and, at the other, a slot through which a metal pin or key is thrust to lock the bolt in place
foremast forward mast in a vessel with two or more masts
frames athwartship timbers forming the internal skeleton of a ship
freeboard distance from the waterline up to the rail or gunwale
frigate medium-size square-rigged warship of the 17th through 19th centuries
futtock one of several members joined to form a frame
gaff spar used along the head of a fore-and-aft sail
galleon large sailing ship with three or more masts, lateen-rigged on the after masts and square-rigged on the foremast and mainmast; used as a warship or merchant ship in the 15th through 18th centuries
galley oared warship or merchant ship also propelled by sails
garboard first range of planks above a ship's keel
gondola large, flat-bottomed river or lake barge much like a bateau
gudgeon metal strap with eye, bolted to the sternpost to hold rudder pintle
gunboat a small, shallow-draft armed vessel
gunwale the upper edge of a ship's side
half-deck a deck above the main deck which does not continue the whole length of the vessel
halyard rope or tackle used for hoisting or lowering sails and a vessel's other top gear
hawse-hole hole in bow through which anchor cable passes
hawser a mooring rope or cable
heel knee timber connecting the keel to the sternpost
helm the apparatus by which the ship is steered, consisting of the rudder and a tiller or steering wheel
hogging the result of stress on a ship's hull making her droop at stem and stern while her middle arches
hogging truss a cable running fore and aft, to prevent hogging
ironclad a 19th-century warship sheathed with iron or steel plates
kayak a canoe made of skins stretched over and covering a wooden framework, except for an opening on top for the paddler
keel the lowest longitudinal timber, forming the backbone of a ship
keelson longitudinal timber of a ship, fixed above the frames and to the keel
knarr broad-beamed Viking cargo vessel
knee a piece of timber having an angular bend, used to join two perpendicular members
lapstrake *see* clinker-built
lateen sail a triangular sail extended by a long tapering yard the lower end of which is brought down to the deck
leeward away from the wind; on the side sheltered from the wind
lighter boat used in port for transporting cargo between ship and quay
limber boards ceiling planks which can be removed for cleaning the bilges
mainmast principal mast; chief mast in two-masted vessel; center mast in a three-masted vessel; second mast from stem in others
man-o'-war warship
mast cap two-hole fitting which holds an upper mast in one hole the top of a lower mast which fits in the hole
mast partner fitment at deck level to provide additional support for a mast
mast step socket for the heel of a mast; an attachment for fastening the lower end of a ship's mast to the hull
mastercouple the midship frame, usually at the widest part of a vessel
mizzenmast the mast directly aft of the mainmast
mold mark raised line of metal left on shot at the juncture of the two halves of the shot mold
nao merchant ship square fore-, main- and sprit-sails and a lateen on its mizzenmast
orlop deck lowest deck in a warship, laid over the beams of the hold
packet 18th-century vessels named after the packets of mail they carried, but from 1818 merchant ships with regular schedules over fixed routes
parral collar by which a yard is fastened to the mast
parral beads wooden beads strung together to facilitate the smooth movement of a parral
pinnace open, general-service vessel propelled by oars or sails
pintle vertical bolt at the back of the rudder which fits into a gudgeon on the sternpost to form a hinge
privateer a privately owned warship under license to the government
prow pointed forward end of a ship
rabbet deep groove or channel cut into a piece of timber to receive the edge of a plank
ribs curved frame-timbers of a ship, to which the sideplanking is nailed
rigging system of ropes used to support the masts and operate the sails
rove small plate or ring on which the point of a nail or rivet is beaten down
row galley early 19th-century term for small oar- and sail-powered warships
rubbing strakes heavy protective side timbers on a ship
scantlings dimensions of any piece of timber used in shipbuilding
scarf lapped joint connecting two timbers or planks
schooner sailing vessel with two or more masts, with all lower sails rigged fore-and-aft
shank shaft forming the principal part of an anchor, connecting the arms to the stock
sheave the wheel of a block
sheet rope controlling the after (lower) corner(s) of a sail
ship-of-the-line warship mounting 50 or more guns
shrouds heavy ropes that brace the mast athwartships
sloop originally a single-masted vessel rigged fore and aft with a mainsail and sometimes topsails and a war vessel, larger

than a gunboat, with guns mounted on a single deck
snag submerged tree stump or branch dangerous to navigation
snag boat steamboat designed to remove snags
spar rounded length of timber such as a yard, gaff or boom
spike heavy nail
sponson structure projecting over the side of a vessel
spritsail small auxiliary sail at the forward end of a ship
sprue mark mark left on cast object where the metal column formed in the entry canal to the mold has been removed
square-rigged said of a vessel rigged with square sails
square-sail four-cornered sail set on a yard athwartships
stays strong ropes to support the mast fore and aft
steamship ship propelled by a steam engine
stem timber forming the front extremity of a vessel
stern rear end of a vessel
sternpost timber at the extreme rear end of a vessel and extending from the keel to deck level or above
stock heavy cross-bar of an anchor
strake one row of planking on the side or bottom of a ship
stringer heavy inside strake secured to the frames
tack forward lower part of a sail
thole wooden or metal pin or peg inserted singly or in pairs in a vessel's gunwale to hold and guide an oar
thwart cross seat in an open boat
tiller lever for controlling a ship's rudder or steering gear
tompion object, usually wooden, placed in the mouth of a breech chamber to keep the powder dry, or in a gun's muzzle to protect it from corrosion
transom athwartship timber attached to the sternpost
treenail cylindrical wooden fastening
trunnel colloquial term for treenail; also trennel
tryworks place for rendering, or melting out, fat or blubber
tumblehome the sloping-in of a vessel's topsides above the point of greatest width
umiak large open boat made of skins stretched on a wooden framework
wales horizontal planks heavier than the rest, extending along the whole of a ship's sides
yard horizontal athwartships spar fitted to the forward side of the mast, to support square sails

Brief Guide to Museums and Research Institutes

GENERAL

Calvert Marine Museum
P.O. Box 97, Solomons, MD 20688
Chesapeake Bay Maritime Museum
St Michaels, MD 21663
Columbia River Maritime Museum
Astoria, OR 97103
The Great Lakes Historical Society
480 Main St, Vermilion, OH 44089
Maine Maritime Museum
963 Washington St, Bath, ME 04530
The Mariners' Museum
Newport News, VA 23606
M.I.T. Museum and Historical Collection
Hart Nautical Collection, 265 Massachusetts Avenue, Cambridge, MA 02139
Peabody Museum of Salem
East India Marine Hall, Salem, MA 01970
Philadelphia Maritime Museum
321 Chestnut St, Philadelphia, PA 19106
The Smithsonian Institution
National Museum of American History, Washington, D.C. 20560
Vancouver Maritime Museum
1905 Ogden St, Vancouver, British Columbia, V6J 3J9 Canada

CHAPTER ONE

The Cleveland Museum of Natural History
Wade Oval, University Circle, Cleveland, OH 44106
For Ringler dugout canoe
Museo Nacional de Antropología e Historia
Paseo de la Reforma y Ghandi, Mexico 5, D.F., Mexico
For Aztec dugout canoe

CHAPTER TWO

Comision de Rescate Arqueologico Submarino
Museo de las Casas Reales, Calle las Damas Esq. Mercedes, Santo Domingo, Dominican Republic
Responsible for underwater archaeology

CHAPTER THREE

Armed Forces History Collection
National Museum of American History, The Smithsonian Institution, Washington, D.C. 20560
Houses artifacts from the Highborn Cay wreck
The CEDAM Museum
Xelha, Quintana Roo, Mexico
Displays artifacts from the Bahía Mujeres wreck
Departmento del Arqueologia Subacuatica
Museo Nacional de Antropología e Historia, Paseo de la Reforma Ghandi, Mexico 5, D.F., Mexico
Responsible for archaeology in Mexico
Institute of Nautical Archaeology
P.O. Drawer HG, College Station, TX 77841
Conducts research on ships of exploration
The Mariners' Museum
Newport News, VA 23606
Houses artifacts from the Highborn Cay wreck

CHAPTER FOUR

Basque Whaler Project
Department of Indian and Northern Affairs, 1600 Liverpool Court, Ottawa, Ontario KIA OH4, Canada
Conducts Red Bay research

CHAPTER FIVE

Archaeological Research
Division of Historical Resources, Florida Department of State, R. A. Gray Building, Tallahassee, FL 32399-0250
Supervises shipwreck archaeology
Bermuda Maritime Museum
P.O. Box 273, Somerset, Bermuda
For 'San Pedro' and 'San Antonio'
Corpus Christi Museum
1900 North Chaparral, Corpus Christi, TX 78041
For remains of Padre Island wrecks
McLarty State Museum
Sebastian Inlet State Park, Sebastian, FL
For 1715 Spanish plate fleet
Museo de las Casas Reales
Calle las Damas Esq. Mercedes, Santo Domingo, Dominican Republic
For remains of 'Concepcion, 'Tolosa', and 'Guadalupe'
Museo Regional
Campeche, Mexico
For Cayo Nuevo shipwreck
Museo Servicio do Documentacao do Geral da Marinha
Rio de Janeiro, Brazil
For 'Sacramento'
Museum of Florida History
R. A. Gray Building, Tallahassee, FL
For 1715 Spanish plate fleet
St Lucie County Historical Museum
Ft Pierce, FL
For 1715 Spanish plate fleet
Treasure Salvors, Inc. Museum
Key West, FL
For 'Nuestra Señora de Atocha'

CHAPTER SIX

Bermuda Maritime Museum
P.O. Somerset, Bermuda
For 'Sea Venture'
Jamestown Festival Park
P.O. Drawer JF, Williamsburg, VA 23187
For replicas of 'Susan Constant', 'Godspeed' and 'Discovery'
The Mariners' Museum
Newport News, VA 23606
For remains of Ronson ship
Philadelphia Maritime Museum
321 Chestnut Street, Philadelphia, PA 19106
Pilgrim Hall Museum
Court St, Plymouth, MA 02360
hull remains of 'Sparrow Hawk'
Plimoth Plantation
P.O. Box 1620, Plymouth, MA 02360
For replicas of 'Mayflower' and shallop
Port Royal Museum
Port Royal, Jamaica
Port Royal Project
Nautical Archaeology Program, Texas A&M University, College Station, TX 77843
Excavates Port Royal and conducts summer field school
South Carolina Institute of Archaeology
University of South Carolina, Columbia, SC 29208
For information about Brown's Ferry wreck and underwater archaeology in the state

CHAPTER SEVEN

Adirondack Museum
Blue Mountain Lake, NY
Displays Lake George bateau
Basin Harbor Maritime Museum
Basin Harbor, VT 05491
Exhibit of Lake Champlain's history; also full scale replica of Lake George bateau
Champlain Maritime Society
P.O. Box 745, Burlington, VT 05402
Machault Museum
Restigouche, Quebec
Artifacts and hull remains of 'Machault'

CHAPTER EIGHT

Armed Forces History Collection
National Museum of American History, Smithsonian Institution, Washington, D.C. 20560
For 'Philadelphia'
Daughters of the American Revolution Museum
1776 D Street, N.W., Washington, D.C. 20006-5392
For 'Augusta'
Maine State Museum
State House Station 83, Augusta, ME 04333
For artifacts from 'Defence'
The Mariners' Museum
Newport News, VA 23606
For artifacts from York River wrecks
Research Center for Archaeology
Division of Historic Landmarks, Commonwealth of Virginia, P.O. Box 424, Yorktown, VA 23690

Yorktown Visitor Center
Colonial National Historical Park, P.O. Box 210, Yorktown, VA 23690
For Yorktown wrecks

CHAPTER NINE

Hamilton-Scourge Foundation
71 Main Street, Hamilton, Ontario L8N 3T4, Canada
Historic Naval and Military Establishments
Huronia Historical Parks, P.O. Box 160, Midland, Ontario L4R 4K8, Canada
Remains of the 'Tecumseth' and naval slip
Historic Naval and Military Establishments
P.O. Box 1800, -C.P.1800, Penetanguishene, Ontario LoK 1PO, Canada
Marine Museum of Upper Canada
Toronto Historical Board, Exhibition Place, Toronto, Ontario M6K 3C3, Canada
Model of the 'Nancy' and other 1812 material
Nancy Island Historic Site
c/o Wasaga Beach Provincial Park, Wasaga Beach, Ontario, Canada
Remains of 'Nancy'
Sackets Harbor Historic Site
Sackets Harbor, NY
Exhibits describe U.S. Naval base
U.S. Flagship Niagara Museum
Erie, PA
Restored 20 gun brig 'Niagara'
U.S. Frigate Constellation
Constellation Dock, Baltimore, MD 21202
U.S.S. Constitution Museum
Box 1812, Boston, MA 02129
Also displays 18th- and 19th-century shipbuilding

CHAPTER TEN

City Hall
Kaslo, British Columbia, Canada
For 'Moyie' (1898, steam-sternwheel)
Duluth, Missabe & Iron Range Railway Co.
Duluth, MN 55801
For 'Edna G.' (1896, steam-screw)
Historic Ships Unit
Golden Gate National Recreation Area, 2905 Hyde St, San Francisco, CA 94109
For 'Eureka' (side-wheel ferry)
The Howard National Steamboat Museum
1101 E. Market St, Jeffersonville, IN 47130
Models, pictures, shipyard tools
Inland Rivers Library
8th and Vine Streets, Cincinnati, OH 45202
Maine Maritime Museum
963 Washington St, Bath, ME 04530
For 'Seguin' (1884, steam-screw)
The Missouri Historical Society
Jefferson Memorial Building, St Louis, MO 63112
Sons and Daughters of Pioneer Rivermen
89 Park St, Canal Winchester, OH 43110
Steamship Historical Society of America
414 Pelton Avenue, Staten Island, NY 10310
Steamboat Photo Company
121 River Avenue, Sewickley, PA 15143
Vermont State Underwater Historic Preserve
Established over wreck of the 'Phoenix'
Visitor Center, Fish and Wildlife Service
Desoto National Wildlife Refuge, U.S. Department of the Interior, RR 1, Box 114, Missouri Valley, IA 51555
For artifacts from 'Bertrand'

CHAPTER ELEVEN

Calvert Marine Museum
P.O. Box 97, Solomons, MD 20688
Caswell Neuse Historic Site
Kingston, NC
Remains of CSS Neuse and associated collection
Confederate Museum
St Georges, Bermuda
Small collection of artifacts associated with blockade running
Confederate Naval Museum
201 4th St, P.O. Box 1022, Columbus, GA 31902
Displays CSS 'Chattahoochee' and CSS 'Jackson'|'Muscogee'
The Mariners' Museum
Newport News, VA 23606
Curates artifacts from USS 'Monitor' National Marine Sanctuary
Museum of the Confederacy
Richmond, VA
Curates artifacts associated with Civil War naval activities
National Maritime Museum
Greenwich, England
Plans of blockade runner 'Ella' and other ships register documents
New Hanover County Museum
Wilmington, NC
Displays of Wilmington and Fort Fisher during Civil War (dioramas with ship models)
North Carolina Division of Archives and History
109 E. Jones St, Raleigh, NC
Curates artifacts from blockade runners with additional collections at: Fort Fisher State Historic Site, Kure Beach, NC
North Carolina Maritime Museum
315 Front St, Beaufort, NC 28516
Program in Maritime History
Department of History, East Carolina University, Greenville, NC 27843
The Science Museum
South Kensington, London, England
Ericsson patent model of USS 'Monitor's' engine
Vicksburg National Military Park
Box 349, Vicksburg, MS 39180
Displays USS 'Cairo'

CHAPTER TWELVE

Bernice P. Bishop Museum
P.O. Box 19000-A, Honolulu, Hawaii 96819
For 'Falls of Clyde' (1878)
Chesapeake Bay Maritime Museum
P.O. Box 636, St Michaels, MD 21663
For 'Edna E. Lockwood' (1889)
Great Britain Foundation
Great Western Dock, Gas Ferry Road, Bristol, England
For 'Great Britain' (1843)
The Kendall Whaling Museum
P.O. Box 297, Sharon, MA 02067
Maine Maritime Museum
963 Washington St, Bath, ME 04530
Displays remains of 'George R. Skolfield'
Maritime Museum Association of San Diego
1306 North Harbor Drive, San Diego, CA 92101
For 'Star of India' (1863)
Mystic Seaport Museum
Mystic, CT 06355
For 'Charles W. Morgan' and whaling history, and other historic vessels
National Maritime Museum of San Francisco
Golden Gate National Recreation Area, San Francisco, CA 94123
For holdings of 'Niantic'
Old Dartmouth Historical Society Whaling Museum
18 Johnny Cake Hill, New Bedford, MA 02740
The Peabody Museum of Salem
East India Square, Salem, MA 01970
Philadelphia Maritime Museum
321 Chestnut St, Philadelphia, PA 19106
Ships of the Sea Museum
503 East River St, Savannah, GA 31401
South Street Seaport Museum
207 Front St, New York, NY 10038
Spring Point Museum
SMVTI, Fort Rd, South Portland, ME 04106
Displays bow of extreme clipper 'Snow Squall'

EPILOG

U.S. Naval Academy Museum
Annapolis, MD 21402
U.S. Navy Memorial Museum
Bldg 76, Washington Navy Yard, Washington, D.C.
U.S.S. Arizona Memorial Park
Honolulu, Hawaii 96818
Woods Hole Oceanographic Institution
Woods Hole, MA 02543
For information on 'Titanic'

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Further Reading

Abbreviations

IJNA	*International Journal of Nautical Archaeology*
JFA	*Journal of Field Archaeology*
MPMAE	*Memoirs of the Peabody Museum of Archaeology and Ethnology*
NG	*National Geographic*

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