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Museums and the underwater heritage

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Cover photo : A very small part of the treasure found in the wreck of the *Conde de Tolosa,* which sank in Samaná Bay, Santo Domingo in 1724 (see article, pp. 41). [*Photo :* ©Jonathan Blair, Cosmos.]

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Museums and the underwater heritage

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Editorial

'Treasures beneath the Seas' was the title of a recent cover story in the French news magazine *L'Express* (6–12 August 1982). Mystery, romance, adventure and ... buried treasure—underwater archaeology has indeed seized the popular imagination of our times.

Sometimes gigantic, often complex and costly, underwater excavations and their follow-up are always news. Today, many such operations are being carried out by responsible archaeologists, motivated by scholarly interest and a desire to share a common heritage. But clandestine excavations and pillage—mere treasure-hunting—are still all too frequent and the policing of all underwater sites is clearly impossible.

Behind the glamour of many salvage projects lies a desperate gamble as well: will massive hull structures and their contents find a home once they have been raised and documented? How will they be preserved and displayed? When resources are just adequate to complete an excavation, how are the subsequent museographical costs going to be met? These are among the whys and wherefores raised in the pages that follow.

The distinguished diving archaeologist Honor Frost (see article on page 11) describes ships as man's 'noblest artefact'. Properly excavated, studied and preserved, shipwrecks have contributed enormously to our knowledge of shipbuilding, seafaring and maritime history. Indeed, most underwater archaeologists still use adjectives like 'nautical' or 'maritime' to characterize their discipline. Today, however, other colleagues also bring up objects and structures—or a combination of the two—submerged on lake or river beds as well as on coastlines.

The term 'underwater heritage' is used here in a purely 'cultural' sense. But threats to the earth's waters as a 'natural' environment are grave. Our awareness of these destructive effects is growing perceptibly, thanks to the efforts of such figures as Jacques Yves Cousteau (who, as inventor of the scuba, was a founding father of underwater archaeology). An example of museum response to the problem would have rounded off this issue nicely; but the catch in terms of cultural sites has proved so rich that an article on a novel presentation of the coral reef ecosystem at the Smithsonian Institution's Museum of Natural History in Washington, D.C., will have to wait till No. 2 of this year.

Bodrum Castle, which houses the Bodrum Museum of Underwater Archaeology. [*Photo :* Don Frey]

Museums are often the patrons—and sometimes the embarrassed beneficiaries—of the archaeologists' exploits. Hence it seemed appropriate to open this issue with an overall assessment of roughly three decades of underwater archaeology. Professor George Bass, founder-president of the Institute of Nautical Archaeology in Texas, whose research teams have worked all over the world, has kindly provided the introductory article. Next, Robert F. Marx, a free-lance marine archaeologist, denounces the man-made destruction of sites throughout the world, while the Museum of London's Peter Marsden, who is director of the Nautical Museums Trust in the United Kingdom, surveys the status—often poor—of shipwrecks in relation to national legal, museological and administrative provisions. Legislation is indeed one of the basic protective needs; a comprehensive international overview of legislation worldwide by Dr Lyndel V. Prott and P.J. O'Keefe has already been published in Unesco's technical handbook *Protection of the Underwater Heritage* (1981).

Excavation without conservation is tantamount to vandalism. But panaceas for the peculiar conservation problems created by waterlogged material are clearly impossible. Environmental conditions and professional development in Canada have brought conservators there face to face with the conservation problems of a wide range of waterlogged materials; the experience, both Canadian and international, of two colleagues is shared with you in the conservation section. This look at the state-of-the-art will, we hope, help those concerned better to understand the nature of deterioration, take stock of the types of remedies already tested and know where to look for more detailed information.

Case-studies of museum-linked underwater excavations across the world are grouped together on the basis of shared characteristics of sites or artefacts rather than according to the type of museum. As specified in R. F. Harrison's chapter in the Unesco technical handbook referred to above, museums dealing with the underwater heritage can be classified into the following three categories: (a) internationally significant collections of objects recovered underwater, including ships' structures; (b) major thematic maritime collections; and (c) general maritime collections. [1]

The first group of articles does indeed cover hulls recovered with the intention of reconstructing and displaying them; these cases thus correspond to the first museum category described above. This section includes the now legendary *Mary Rose,* raised from the mud of the Solent on 28 September 1982. Hulls recovered off the coasts of Kenya, Australia, the Republic of Korea, Poland, the Dominican Republic and France are also included. The last-mentioned is of particular significance for it will be the centrepiece of the new Museum of History at Marseilles and is being preserved by a freeze-drying operation unprecedented in scale. Conspicuous by their absence are the *Wasa,* repeatedly cited in various articles, and the Roskilde Viking Ship Museum. The former will figure in a forthcoming issue, once the competition for a new building for the *Wasa* has been adjudged, while an article on the latter appeared in *Museum,* Vol. XXVII, No. 1, 1975.

Another group of articles concerns the discovery, treatment and display of finds scattered off the coasts of Mauritius and Norway, where significant hull structures have not survived. The collection of the excellent Museum of Underwater Archaeology at Bodrum, Turkey, based on a combination of structures and scattered finds, also figures here.

Concluding our overview are articles on cultural property discovered in lakes and wet-sites in Switzerland, the USSR and French Polynesia. Another significant example, that of the sunken city of Port Royal (Jamaica) will be presented in a future issue.

These articles form a conspectus of the world's underwater heritage and the tasks that await museums: scientific collection and conservation, the protection of underwater sites, the elaboration of appropriate methods of storage and display and presentation of information. Not all the cases described here, however, conform to the ideal. Some may come close to it, but for the majority of the world's museums the protection of the underwater heritage is still a major challenge.

This issue is necessarily incomplete. We would be grateful to readers for their opinions and criticism, as well as any information they can provide about other significant projects concerning the underwater heritage. Your contribution will help us together to promote its protection.

1. Museums in these categories were listed in the publication. An up-to-date list can be made available on request by the Unesco-ICOM Documentation Centre, 1 rue Miollis, 75015 Paris.

THE WIDER CONTEXT

The promise of underwater archaeology in retrospect

The importance of ships and boats throughout history is unquestioned. Exploration, warfare, commerce, colonization, fishing, and even pleasure undertaken on or from watercraft have left an indelible mark on our globe. Although complete Viking ships and various ancient hull remains have been known for decades on land, along with hulls and parts of ships located and salvaged by helmet divers, it was the invention of self-contained underwater breathing apparatus in the 1940s that now allows archaeologists to trace the history of seafaring through seabed excavations conducted to the same exacting standards as those considered normal in land excavations.

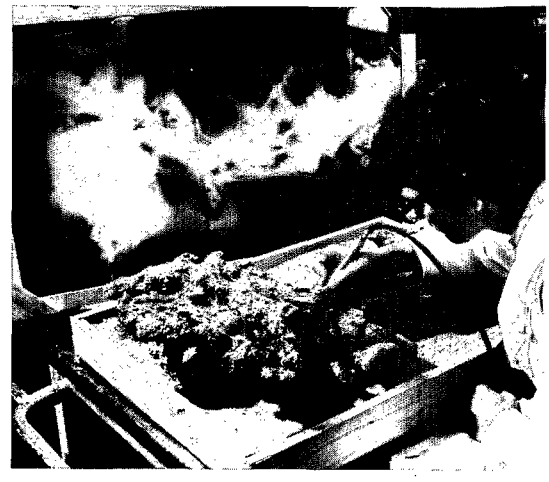
Twenty years ago, while I was directing the first complete and systematic excavation of an ancient shipwreck on the floor of the Mediterranean, off Yassi Ada, Turkey, I wrote an article entitled 'The Promise of Underwater Archaeology'.[1] In some ways, as I write the present article, again at Yassi Ada, that promise has been more than fulfilled.

Techniques of locating, mapping, excavating, and ultimately conserving and restoring ancient ships have been vastly improved since my earlier article. Serious excavations have been conducted from northern Europe to the Caribbean, and from Kenya to the Mediterranean, to Australia and Korea. Academic courses and programmes in nautical archaeology are appearing in universities. And an increasing number of nations are passing legislation to protect their underwater sites as rigorously as they protect their land sites. From a different perspective, however, the promise has not been fulfilled.

1. George F. Bass, 'The Promise of Underwater Archaeology', *The American Scholar*, Vol. 32, 1963, pp. 241–54.

Archaeology is not a search for souvenirs and profit

First of all, there is still too much looting of ancient shipwrecks. Archaeology, whether on land or under water, is a scholarly pursuit, a search for knowledge. It has nothing to do with personal or corporate profit, and it has very little to do with the simple raising of artefacts from the sea. An amphora or cannon salvaged from an early ship and displayed alone is almost meaningless. If the wreck that yielded an amphora has been carefully mapped and excavated, however, we are able to ascertain the total number of amphorae and how they were stowed, thus providing information on the tonnage of the ship that carried them. Study of the shapes of, or inscriptions on, amphorae, perhaps with other shipboard finds, may provide a date for their use, and perhaps their place of manufacture, adding clues to the route of the ship and the date of its sinking. If mud contents of amphorae are carefully screened, seed or bone remains may reveal the containers' original contents. Because ancient documents provide prices for many commodities from various periods of the past, we may then estimate the original costs of those parts of the cargo carried in various amphorae. Their very positions in a wreck may additionally tell us whether any one amphora indeed held cargo or, instead, held stores for the ship's crew and/or passengers. Further analyses of the amphora's clay and possible resinous lining might also be made, but my point should be clear. The study of a single ceramic container, if it has not been taken out of context to grace a collection, may contribute to our understanding of early trade and economics and, thereby, to a better understanding of early man. Archaeology is not a search for souvenirs. Yet one cannot travel the perimeter of



Painstaking treatment and study are required: cleaning iron artefacts from sea-bed concretions, using an X-radiograph as a guide. The artefacts are from a 1554 shipwreck off Padre Island, Texas. [*Photo:* Texas Antiquities Commission.]

George F. Bass

Born in Columbia, South Carolina, 1932. M.A. in Near Eastern Archaeology from the Johns Hopkins University; Ph.D. in Classical Archaeology from the University of Pennsylvania. Has excavated five shipwrecks off the Turkish coast since 1960, and has been involved in land excavations in Greece, Turkey and Italy. Holds an Alumni Professorship in Anthropology at Texas A & M University. President of the Institute of Nautical Archaeology. His fifth book on underwater archaeology is now in press.

Studying the total context of an underwater site: excavation of an eleventh-century wreck at Serçe Limani, Turkey. [*Photo:* Institute of Nautical Archaeology.]

the Mediterranean without seeing hundreds of single amphorae decorating museums, offices, homes, and restaurants.

An amphora presents an obvious case. Recently, I and my colleagues excavated an eleventh-century A.D. shipwreck at Serçe Limani, Turkey. The site contained thousands of artefacts, including approximately three tons of broken Islamic glass which we believe represent the remains of about 10,000 glass vessels, many of which we are now restoring. Because our study of the wooden hull of the ship shows that it is one of the earliest known examples of a seagoing ship built in the modern, as opposed to Graeco-Roman fashion, its nationality is of historical importance to us. Was it Islamic? The cargo of intact and broken glass clearly is Islamic, but a secondary cargo of wine was carried in amphorae marked as Byzantine Christian by inscriptions on them. Islamic gold coins were intermingled with Byzantine copper coins on board, and official Islamic glass weights were matched by official Byzantine lead seals, at least one of the latter still unused. At first I believed the crew of the ship to be unquestionably Islamic because of the large number of Islamic glazed plates and bowls which we assumed were for meals eaten on board. Two later revelations by my colleagues, that butchered pig bones were among food remnants and that the glazed wares seemed to be cargo rather than for shipboard meals, now place my hypotheses in doubt, as does the fact that many of the 900 fishing-net weights on the ship are now known to be marked with purely Christian symbols. It will be many years before we can reach our most reasonable conclusions about the nature of this eleventh-century trading venture, but during those years the number of wrecks that can yield such information about the past will have decreased drastically; most Mediterranean sites I have dived on outside Turkey, where diving is strictly controlled, have been badly disturbed or totally destroyed.

Poor archaeological practice

Wreck looters are not, however, the only cause of the unfulfilled promise. Let us forget them for a moment and concentrate on the archaeologists who excavate ancient ships.

Out of thousands of artefacts on board the eleventh-century ship, let us consider some of the most humble—ten spindle whorls which some archaeologists might simply catalogue and publish with minimal identification. We must wonder, however, if the whorls were for shipboard use or if they were for sale. If the whorls were for shipboard use, were there women on board? We have studied the role of women on medieval Byzantine and Islamic ships, as well as on more modern Greek and Arab ships. We have looked for other evidence of women on the Serçe Limani ship. Wooden combs of a type used mainly by women in medieval Islamic times were also found on the eleventh-century wreck, but they could also have been articles of trade. Did fishermen, themselves, spin threads for their nets on board, and could the whorls have been used for this? Iron netting needles were found, as well as traces of threads inside the lead net-weights, and a determination of whether these were S-spun or Z-spun might tell us whether the spinners and, therefore, the fishermen (or the women) were Near Eastern or European. An immense amount of research will go into an attempt to understand these seemingly insignificant objects, for we want to understand the ship's last voyage as completely as possible.

This all seems very obvious. One might suppose that every archaeologist does this type of analysis of his findings. Alas, it seems instead a rarity.

While serving recently as a consultant for a historical map of the Mediterranean, I was asked to list important shipwrecks in that sea. Out of hundreds of known ancient wrecks, I made a list of the hundred which seemed best known archaeologically. How much do we really know about them? Virtually nothing. A

Bibliographical orientations

Detailed bibliographies of underwater archaeology are published regularly in the *International Journal of Nautical Archaeology*, a quarterly published by Academic Press (London and New York) for the Council for Nautical Archaeology. Major excavation reports are listed in Keith Muckelroy, *Archaeology Under Water, An Atlas of the World's Submerged Sites* (New York and London, McGraw-Hill Book Company, 1980, 192 pp.); although somewhat out of date, George F. Bass (ed.), *A History of Seafaring Based on Underwater Archaeology* (New York/London, Walker & Company/Thames & Hudson, 1972, 320 pp.) is useful for its bibliography because the book has appeared in Durch, German, Swedish, French and Italian editions. The most recent complete excavation report is: George F. Bass and Frederick H. van Doorninck Jr, *Yassi Ada* I: *A Seventh-Century Byzantine Shipwreck* (College Station, Texas, Texas A & M University Press, 1982).

brief and descriptive preliminary report, perhaps a popular article, is all that exists on most of them, and I doubt that many will ever be thoroughly interpreted or published. Nautical archaeology remains a poor relation of land archaeology with its definitive, multi-volume reports. The wrecks should have been left alone. They have suffered almost as much as if they had been salvaged by looters, no matter how serious the intent of their excavators or how careful their techniques.

Too much of what passes for underwater archaeology around the world—and there are notable exceptions in Australia, Canada, Cyprus, France, Germany, Scandinavia, Turkey and the United Kingdom, plus a few other places—is poor archaeology or it is not archaeology at all.

Much so-called underwater archaeology is undertaken for the wrong reasons. In the Caribbean especially, but unfortunately elsewhere as well, most of what is described to the public as archaeology is no more than treasure-hunting for profit; perhaps a token archaeologist is hired by an expedition to lend respectability to its treasure salvage, but the archaeologist is never in charge of the 'archaeology', and no meaningful publication has yet resulted from these collaborations.

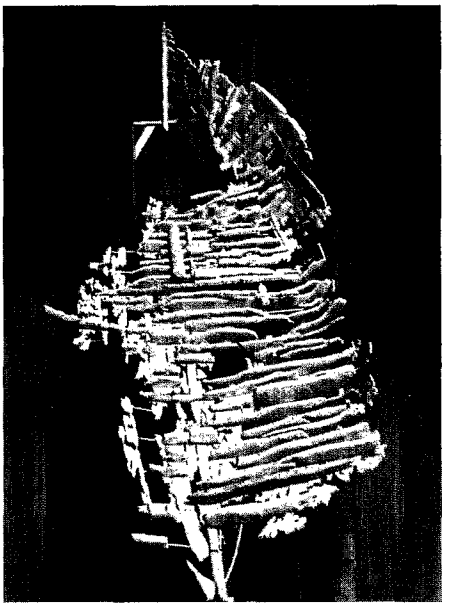
Another type of underwater archaeology that has contributed almost nothing to the understanding of our seafaring past is, in the United States especially, contract archaeology. Almost anyone with a degree in anthropology (and the degree need not be the doctorate usually required of classical archaeologists excavating and publishing Mediterranean sites) can learn to dive and operate remote-sensing equipment and then, without any knowledge of seafaring history, obtain lucrative contracts by conducting legally required cultural-resource surveys around sea-bed areas where oil drilling or pipelines may disturb the bottom.

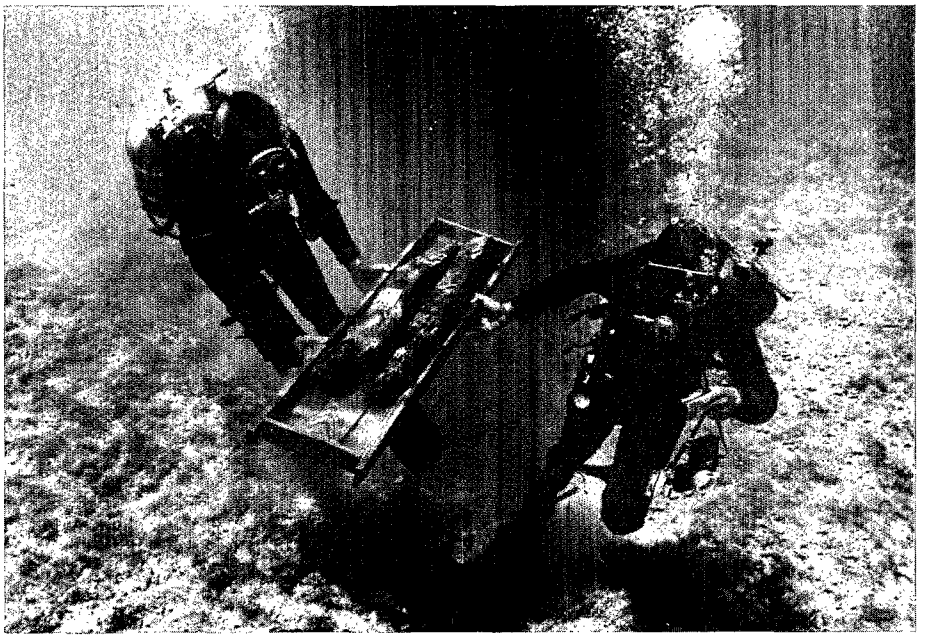
I have yet to see any worthwhile scholarship derive from archaeologists motivated by profit; those of my students who have worked with contract archaeologists are universally appalled by their lack of intellectual curiosity about the sites they seek or excavate. Is not intellectual curiosity the sole motivation of the scholar?

Unfortunately, even those archaeologists who work with private support rather than contracts too often do so at the whims of financial sponsors rather than from the desire to solve some historical or archaeological problem.

The result of all this is that after more than two decades of established underwater archaeology, only a handful of complete excavation reports on early ships have been published, including one from the entire Western Hemisphere, a couple from Turkey, one from France, and one from Australia. How can professional archaeologists, if they do no better than this, fault treasure-hunters, a number of whom at least have brought out popular books based on their archival research and subsequent salvage efforts. I know more about the *Concepción,* salvaged by a treasure-hunter, than I do about most wrecks excavated by archaeological teams around the world. The promise of underwater archaeology is no better than the promise of detailed publications.

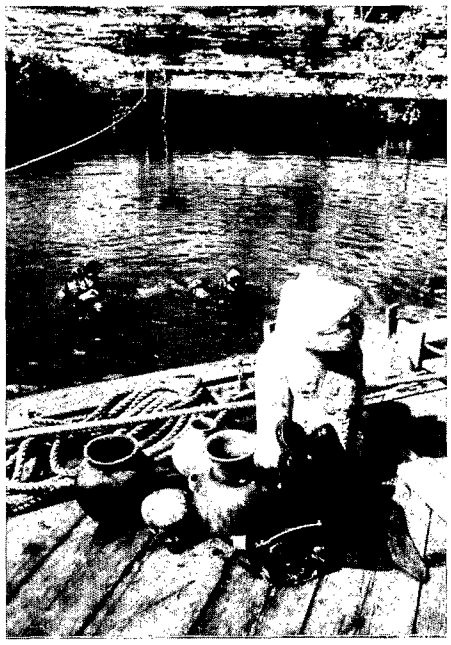
Reconstruction model of the hull fragments. [*Photo:* Institute of Nautical Archaeology.]





Raising hull fragments at Serçe Limani. [*Photo:* Institute of Nautical Archaeology.]

Mayan artefacts recovered from the sacred *cenote* at Chichen Itzá, Yucatán, Mexico: a precious ensemble that treasure-hunters would have broken up and dispersed. [*Photo:* Robert F. Marx.]



Sharing the underwater heritage

Underwater excavations serve another purpose, which should supplement but cannot take the place of publication. The public, through government funds, tax-deductible donations in some countries, and even direct donations, ultimately pay for archaeology, and the public deserve to enjoy its fruits. The archaeologist, when possible, should share his experiences and results with the public through films, popular books and articles, and, of course, through museum displays.

Maritime museums are not uncommon; some show objects raised from shipwrecks, as do art museums when the objects concerned are classical statues or painted pottery. The more meaningful museums for underwater archaeology are, however, those based on complete shipwreck excavations, where the public can glimpse man's maritime past directly by seeing everything remaining of a ship and its contents still kept together after centuries or millennia. Excellent examples are the Roskilde Museum in Denmark, with restored Viking ships; the Wasa Museum in Stockholm, with a complete seventeenth-century Swedish warship on display; the Kyrenia Museum in Cyprus, with a restored fourth-century B.C. Greek merchantman and its original contents; and Punic wrecks restored in Marsala, Sicily. In the United States there is a superb travelling exhibit of the remains of the 1554 fleet wrecked off Padre Island, Texas. The Museum of Underwater Archaeology in Bodrum, Turkey (see article below, p. 61), houses the contents of five completely excavated shipwrecks ranging between 1600 B.C. and A.D. 1025, along with the scale model of one; the restoration of the complete hull of another is now under way. Similar displays are being prepared. The ironclad *Cairo* of the American Civil War is finally being restored in the Vicksburg National Park after years of neglect following its raising. The Dutch East Indiaman *Batavia* is being prepared for display in the Western Australian Museum after its careful excavation under poor sea conditions and the *Mary Rose* will one day make a most spectacular exhibit in the United Kingdom. And museums are being planned or completed for the Bremen Cog, the colonial Brown's Ferry ship in South Carolina, the *Santo Antonio de Tanna* in Mombasa, and others. [2]

In fact, the conservation and restoration of ships, themselves, have far exceeded the promise I proposed in my early article. [3] It is now the responsibility of every excavator to have a fully equipped and staffed conservation facility to treat both artefacts and hull remains by appropriate methods. Many of the artefacts will be exactly like those found on land, although often in a better state of preservation, and they may often be studied by archaeologists not conversant with technical aspects of seafaring. There is no longer the slightest excuse, however, to treat lightly the largest artefact on most shipwreck sites—the hull itself. It is as obligatory for a nautical archaeology team to have a hull specialist as it is for a land team to have someone competent in architecture. Frederick van Doorninck and J. Richard Steffy have led the way in showing that even the most fragmentary and disjointed sea-bed remains of a hull may be sufficient to allow its reconstruction. Although hulls must be considered as archaeologically important as the cargoes they carry, I have seen more than one film of an underwater excavation with timbers treated with almost no care or regard. Wood must be inspected and recorded *in situ* and, when raised to the surface, examined for tool marks and cuttings, angles of nail holes, and traces of other wood, so that, through a series of plans and models, the ship and its method of construction may be understood and published. Only such detailed work has in recent years enabled maritime historians to follow the evolution of ship design and to attempt to determine its historical causes.

Underwater archaeology has made great advances during the past two decades. The public and nautical archaeologists alike must continue to strive for the fulfilment of its vast potential.

2. Various articles in this issue describe several of the museum initiatives mentioned here.

3. Bass, op. cit.

Robert F. Marx

Born in Pittsburgh, Pennsylvania, in 1936. Studied Anthropology and Archaeology at Los Angeles City College and the University of Maryland. Specialized in marine archaeology and naval and maritime history. Has been carrying out archaeological explorations throughout the world since 1953. Author of over 400 scientific reports, popular articles and books. Has been involved in the production of over thirty documentary films and has lectured for more than ten years throughout the world. Co-organizer and navigator of the voyage of *Nina II*, a replica of Columbus's caravel, from Spain to San Salvador in 1962; as a result was made a Knight Commander of the Order of Isabel the Catholic by the Spanish Government.

The disappearing underwater heritage

The vast, still unfathomed storehouse of sunken ships and cities throughout the world offers a unique opportunity to the archaeologist. Underwater sites are generally less disturbed than those on land. With the exception of a few sites such as Pompeii, Herculaneum and Thera, which were entombed in a fiery flood of lava, land sites typically present stratum after stratum of occupation. Sites often span thousands of years and frequently artefacts from one period become mixed in with those of another when a site is disturbed, making the archaeologist's unravelling of the puzzle more difficult.

The most challenging problem confronting all archaeology is the accelerating pace at which sites are being destroyed. As bulldozers scar millions of hectares each year and whole valleys are inundated for reservoirs and recreational lakes, irreplaceable opportunities to unravel and illuminate the past are lost. Man is indeed earth's most destructive force, but until recently most of his depredations were confined to the land. Today, however, he dredges and fills, floods, pollutes and plunders. Although scuba divers are responsible for looting and destroying many underwater sites of archaeological significance, a greater number are actually ruined by dredging and landfill operations. In fact, this problem is so grave that literally hundreds of shipwrecks are being lost every year and yet no outcry has been uttered either by archaeologists or the public.

An eloquent example of site destruction is that at Cadiz, on the south coast of Spain. Cadiz is an important seaport which has been in continuous use since the eighth century B.C. Beneath its waters lie hundreds of sunken ships of many types, nationalities and historical periods. Under the auspices of the Archaeological Museum of Cadiz a visual survey was conducted during 1960–62. Within a three-kilometre radius of the modern port, fifty-four classical-period shipwrecks and ninety-seven of later dates were located. During a recent survey of the same area it was discovered that more than two-thirds of these shipwrecks had been totally obliterated by dredging operations, which are still going on today. Most of the dredged material has been used as landfill and is now covered over by newly constructed buildings.

In neighbouring Portugal the situation is equally grave. During the recent construction of a deep-water port at Sines, a port first used by the Carthaginians and later by the Romans, dredging operations completely destroyed at least four Punic shipwrecks and many others of later periods. Further down the coast at Portimão, recent dredging operations destroyed one known Punic and two Roman shipwrecks and, no doubt, many other shipwrecks were also lost for ever in this port as more than a third of the port has been covered over with fill to form the base for a large ship wharf.

In the area of Lisbon, where at least 500 ships are known to have sunk since the late fifteenth century, the devastation is even worse. In a recent interview, the captain of a dredge boat reported that 'rarely a day passes in which some vestiges of an old shipwreck are not seen spewing out of the discharge end of the dredge pipes'.

On the other side of the Atlantic the problem is equally acute. Dredging and landfill operations at Cartagena, Colombia, one of the most important seaports during the Spanish colonial period, have resulted in the destruction of more than 50 per cent of Cartagena's known shipwreck sites. At Veracruz, Mexico, another major colonial port, the devastation is deplorable. Probably less than 10 per cent of the area's colonial shipwrecks remain. At Rio de Janeiro, Brazil, landfill was used in constructing an airport which completely covers the anchorage area used during the colonial period.

Shipwreck sites are not only being erased in protected harbours, but offshore as well. Dredging operations are conducted in the process of laying offshore petroleum pipelines, building breakwaters, gathering landfill and beach-replenishment materials, opening new entrances to ports and rivers and for other reasons. Several years ago during the dredging of a new channel at Padre Island, Texas, one of the Spanish shipwrecks from the 1553 fleet which lay offshore was sucked up in the hungry jaws of the dredge pipe and spat out on a nearby beach. Fishing nets have also inadvertently damaged shipwrecks for centuries and will continue to do so in both shallow and deep water.

On a lesser scale, many sites are also being plundered and destroyed by divers. The first culprits were commercial salvage divers. During the Second World War, when there was a keen demand for scrap metal, they combed lakes, rivers and the seas and recovered for melting down thousands of old cannon, anchors and other metallic objects from sunken ships as well as modern scrap. In most cases they were unaware that they were making it impossible ever again to locate a historical wreck site by removing the only clues that could be detected with electronic search equipment.

Since the introduction of scuba equipment in the early 1950s the devastation of sites by souvenir collectors and treasure hunters has escalated. Along the French Mediterranean coast sport divers are reputed to have plundered every old wreck lying above a depth of 50 metres. The weekend diver who simply picks up a cannon ball or a bronze spike from a wreck and carries it home to decorate his living-room perhaps has little idea of the

harm he is doing. The very accessibility of many shallow-water sites makes them vulnerable to the sport diver.

Increasing amateur involvement

However, if amateur divers could be enlisted to take part, under professional direction, in underwater excavation projects certainly many of them would gain far more reward than they do from random removal of artefacts. Most divers would rather make a contribution, albeit a small one, to archaeology than pick up an anchor out of context.

Until recently there has been a failure on the part of many archaeologists to communicate to the general public the significance of underwater sites; there has been very little effort to educate and work with the interested public. Those few professional archaeologists, who have worked closely with amateurs, have been pleased with the results, but closer co-operation on a larger scale is needed. The British, with their traditional appreciation of the amateur who engages in cultural or scientific activity for pleasure rather than gain, lead the way in utilizing trained amateurs. During the summer of 1982 a total of twenty-four shipwreck sites were worked by amateur divers and treasure-hunting firms in the United Kingdom following strict government guidelines and supervised by professional archaeologists.[1]

The future of underwater archaeology hinges, to a great extent, on such collaboration between professional archaeologists and non-academic divers. The motivated amateur should be encouraged to acquire the basic skills needed for archaeological work through training programmes such as those offered at Fort Bovisand in Plymouth, United Kingdom. The funds available for training professionals are severely limited, so the vacuum must be filled by the competent amateur for whom underwater archaeology is an avocation.

There are fewer than fifty underwater archaeologists in the world and most of them are self-taught. There are few incentives to lure young people into the field full-time. Until a few years ago, it was virtually impossible even to earn a degree in underwater archaeology. Most school-affiliated underwater archaeologists find themselves limited to a relatively few months of field-work each year because of other academic responsibilities. Few land archaeologists have shown interest in learning to dive, and yet some of these professionals categorically state that underwater excavations, when they should be undertaken at all, should only be carried out by teams of underwater archaeologists with university degrees.

This is an unacceptable position for any scholar to take, given the alarming rate at which underwater sites are being lost for ever, and the particular urgency to excavate underwater sites threatened by man and nature. As proof of the contribution that can be made by the non-professional archaeologist, one has only to recall that almost every important underwater site excavated to date was originally discovered by an amateur. Furthermore, they have designed and built most of the sophisticated equipment used under water today.

Public interest in archaeology has grown, so that the gap between the trained, paid archaeologist and the educated, disciplined amateur is narrowing. The majority of members of societies interested in land archaeology are amateurs, so-called because they hold no degree in archaeology. Yet they undertake more field-work and laboratory research and publish more reports of their findings than do the limited number of professionals. In an underwater excavation many non-academics contribute specialized skills such as advanced diving techniques, use of elaborate equipment, surveying, drafting or photography, which they may have acquired or polished in pursuit of their avocation.

In the United States, the Council of Underwater Archaeology was founded in 1958. Unfortunately, it is little more than a name, although it has the potential to foster non-professional contributions to underwater archaeology. Thus far, the council's chief activity has been to organize annual conferences at which professional underwater archaeologists are invited to present papers. Amateurs are not encouraged to attend. The council, which could be a vital force in encouraging public education, training and supervised participation in underwater archaeology, has yet to support a single major underwater excavation.

The British were the first to take the logical step of co-ordinating the activities of divers and vocational archaeologists, who had long been in conflict with each other. In 1963 the Council for Nautical Archaeology was formed in London by representatives from institutions such as the British Museum, the Science Museum, the National Maritime Museum, the Institute of Archaeology and the National Institute of Oceanography. Since the establishment of this organization great progress has been made. In 1969 members of the Council were instrumental in forming the School for Nautical Archaeology at Fort Bovisand where thousands of sport divers from a variety of countries have been instructed in the rudiments of underwater archaeology.

As soon as graduates of the school's courses began participating on underwater projects the incidence of plundered sites in the British Isles decreased dramatically, even though the ranks of divers are growing with each year. In almost every case in which an old wreck is located by a sport diver, he reports it to the committee, which in turn provides technical and financial assistance for the excavation. Thus far there is no comparable body in any other country.

British tradition dictates that everyone who is prepared be given an opportunity to participate and not just a select few. Since the Council for Nautical Archaeology was a closed group with few new members admitted, a group was recently formed named the Nautical Archaeological Society in which both professional and amateur devotees of underwater archaeology hold membership. The society was principally established as a forum for the exchange of ideas and information relevant to all aspects of underwater archaeology among all those who are interested. Until such organizations are created in other countries, wherever there are underwater sites of archaeological significance, there will continue to be debilitating problems of communication between the professionals and the amateurs. The regrettable and unnecessary loss of so much valuable historical and archaeological information will be the inevitable result.

1. See the article on the *Mary Rose*, on page 44; see also the example from Norway, page 57. —Ed.

Museums from the depths

Honor Frost, the distinguished classical archaeologist, is among the pioneers of underwater archaeology in the Mediterranean. She also edited Unesco's major manual Underwater Archaeology: A Nascent Discipline *(1972) and now has this to say:*

Ships that know no frontiers on the oceans also, metaphorically, traverse the frontiers of man's achievement by virtue of the multifarious skills he has lavished upon them; they are his noblest artefact. As a wreck on the sea-bed, each ancient ship is a miniature Pompeii that vanished tragically at a precise point in time, still encapsulating the secrets of a civilization. From both archaeological and museological standpoints such time-capsules present a challenge, because, even when wood has perished (as is the case on some wrecks), what survives of the vessel and its contents still represents a unity or, in archaeological jargon, a 'closed group'. Other submerged antiquities—harbours, lost anchors, jetsam, etc.—are all in some measure ancillary to wrecks.

As a discipline, archaeology is the same whether it is practised wet or dry, but the exhibiting of 'little Pompeiis' raises new museum problems—ethical, technical and legal. Some notable ship museums are described in the pages that follow, but until now each has materialized as the result of exceptional local circumstances. Wreck display as a general concept has yet to take shape. The fact that a wreck may contain a work of art is incidental; in any case, works of art have a life of their own and can look after themselves in any display context. How then should one imagine museums from the depths? Need one even try to do so? May not archaeology under water be a passing fashion? To arrive at answers, let us examine the present situation.

The recent popularization of a sport—scuba diving—almost accidentally focused attention on ships as antiquities by revealing that there were a great number of ancient wrecks on the sea-bed. The public became aware of the accessibility of this 'treasure'. Among specialists there was a renaissance of interest in ship architecture (which had lapsed with the passing of the wooden ship), but to specialists it was irrelevant where their evidence came from because sunken ships, as artefacts, were no more interesting than the ancient ships occasionally found on land in silted docks, or in Viking tumuli, or in a religious repository like the Cheops Ship or mouldering by the shore like Brunel's nineteenth-century innovation the *Great Britain.* The important difference between wet and dry sites is that statistically the former are far more numerous; there can never be as many ships on land as there are, even now, known ancient wrecks on the sea-bed.

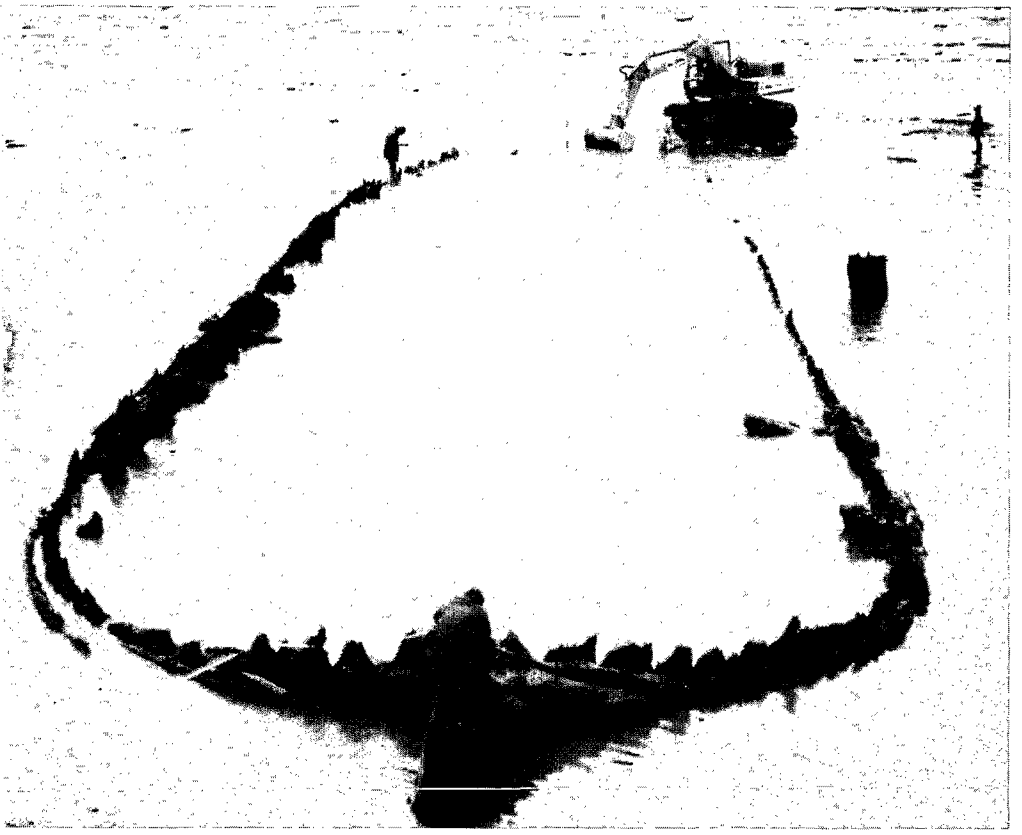
Another factor affecting museologists is that no ship excavation should be partial. Unlike buried towns, where trenching is deliberately limited so as to leave something for posterity, it would be as pointless to excavate only part of a ship as it would be to dig up only the wheels of a buried car while abandoning search for the engine that had made them turn. The size of entire vessels does, however, raise the question of expressly built museums. Discovery of a wreck does not, of course, necessitate its excavation but it imposes a choice and, if criteria for this choice are not established, future generations will be severe in their judgement. There is no way of preventing discovery and, as matters stand, wrecks will either be pillaged or excavated. But will they be published and displayed?

It was during the 1940s and 1950s that the first sport-divers laid algae-encrusted antiquities at the feet of the nearest museum official, confidently awaiting his gratitude. They were often disappointed; their trophies tended to be relegated to dank courtyards where, still unidentified, they gradually disintegrated. Disenchanted, the sportsmen reacted variously: some kept their finds in their own homes, others sold them on the clandestine antiquities market. A minority of divers did, however, take up archaeology as a hobby, while an even smaller minority of archaeologists took up diving. Gradually these two groups formed associations, starting on a regional, but soon extending to a national and then an international, level.

Aware of the lack of museum facilities, diving archaeologists recommended that antiquities be recorded, then left *in situ.* Divers retorted that this would be the surest way of destroying sites because other less scrupulous divers would watch, then, as soon as the coast was clear, start looting.

Meanwhile the public had been aroused: 'Divers Discover World's Most Ancient Treasure Galleon' is a headline that recurs in the press every summer to titillate holidaymakers and strike horror into the souls of those concerned with the protection of the same public's cultural heritage.

The average museum still has neither the conservation facilities, nor the staff, nor the space to deal with an annual influx of waterlogged material, while antiquities departments are powerless either to inspect or legally and materially to protect underwater sites within their area. Nevertheless, antiquities continue to be raised, so something has to be done about them. The ethics of diving archaeology have been discussed often enough, but their implications in terms of museology have been neglected.



The outline of the Dutch East Indiaman *Amsterdam* looking aft, as exposed at low tide near Hastings, in the United Kingdom, in January 1970. The ship was wrecked in January 1749, and quickly sank about nine metres into the mud and sand of the sea-bed before the cargo and stores could be salvaged. Many valuable antiquities were found, but all were treated as commercial salvage as the law required, and few received any conservation. No museum in the United Kingdom or the Netherlands was prepared to take responsibility for this remarkable historic ship, two-thirds of which survives buried in quicksand and clay. The ship is now a protected historic monument, following a detailed survey of its structure.
[*Photo:* Peter Marsden.]

The challenge of nautical archaeology

Peter Marsden

A senior archaeologist at the Museum of London, Peter Marsden has also become a specialist in ancient and historic ships. Having excavated Roman, Saxon, medieval and later ships and shipwrecks he is particularly aware of the problems and opportunities that shipwrecks have to offer. A founder of the Council for Nautical Archaeology in 1964, he was later to become a member of a Dutch 'foundation' to raise the eighteenth-century Dutch East Indiaman *Amsterdam*, which he had investigated at its wreck site near Hastings in southern England. A former member of the British Government advisory committee which defined the Protection of Wrecks Act, 1973, by which historic shipwrecks are protected, he is now Director of the Nautical Museums Trust which was created in 1982 to take responsibility for several historic shipwrecks in Britain.

The last two decades have seen a gradual acceptance of nautical archaeology internationally, and the results of excavations are now integrated much more than hitherto into more general historical and archaeological researches. In spite of this, however, nautical archaeology still remains the poor relation of the world of archaeology generally, and it is clear that there need to be substantial improvements in the near future.

One of the problems has been the fear that sunken historic shipwrecks were the exclusive realm of organized treasure hunters, but fortunately this view has slowly receded. But, although occasionally museums and archaeologists have taken responsibility for some individual shipwrecks, the looting and organized salvage of historic and ancient wreck sites for non-archaeological purposes certainly continues in many countries. Underwater sites cannot be policed, and there is no means of knowing what has been removed from any site. Nevertheless, major archaeological projects in some countries have had important and far-reaching results. Following the raising of the seventeenth-century warship *Wasa* in Stockholm harbour in 1961, Sweden has developed a national centre for nautical archaeology. A similar result has occurred in Denmark following the recovery of the Viking ships that are now preserved at Roskilde. In the Federal Republic of Germany a national maritime museum has been built around the medieval 'cog' found at Bremen, and this museum, situated at Bremerhaven, is now a national archaeological centre. In Western Australia a maritime museum and an archaeological unit have been established by the Western Australian Museum to illustrate and investigate the wrecks of Dutch and British ships wrecked between the seventeenth and the nineteenth centuries. In addition, the preservation of intact and surviving historic craft, such as the *Great Britain* built in 1845 and now being restored at Bristol, is increasingly taking place, and is adding a further dimension to the role of nautical archaeology.

Although less spectacular, projects in other countries, particularly in Canada, Finland, France, Greece, Israel, Italy,

Kenya, the Netherlands and Turkey, are nevertheless important, for apart from the results of research these projects have helped to solidify attitudes, which are so often expressed in new legislation. Projects continue to be created: in the United Kingdom the warship *Mary Rose,* sunk in 1545, is being raised and preserved in a new museum near Portsmouth (see article, p. 44); and in the United States the ironclad warship *Monitor* is expected to be recovered and preserved in a museum so that the story of its work and loss in 1862 can be fully told.

The effect has been to create a growing body of experience and informed opinion, in which the Council of Europe and Unesco are playing a crucial part by collating information and recommending future needs. The results fall into three main categories: technical methods (i.e. conservation, display, etc.), archaeological and historical research, and legal protection and ownership. Books and articles dealing with nautical archaeology are now frequently publishing information on all of these aspects, and there is an increasing number of academic journals in various parts of the world in which information is published in a regular form. In particular the *International Journal of Nautical Archaeology,* published since 1972, has taken a lead in this subject.

The techniques of excavation, recovery, conservation, research and publication have been well described in various publications (e.g. *Protection of the Underwater Heritage,* published by Unesco in 1981), and it is clear that the major advances of the future are required primarily in the administrative field. The Council of Europe report on *The Underwater Cultural Heritage* (edited by John Roper, Strasbourg, 1978) set out the situation and its problems very clearly. The Parliamentary Assembly adopted the report and offered Recommendation 848 (1978) to the Committee of Ministers. This report, therefore, is an essential study document for in it the future path of nautical archaeology has been clearly mapped out, and although applied to the European situation it is equally relevant to other nations.

Some of the basic needs

As historic wrecks cannot be policed for their protection, immediate action is usually necessary to rescue the information and objects within them. This means that a team of professional archaeologists is needed in each country to investigate new discoveries. The Council of Europe's Parliamentary Assembly recognized this, and stated that regarding the underwater heritage 'positive action is urgently needed both on national and European levels in order to ensure its proper protection'. Simply changing the law does not give such protection from treasure and souvenir hunters, and indeed it is not always clear whose law applies when a historic wreck of one nation is found lying within the territorial limits of another. Thus more international collaboration and agreement is needed in the field of nautical archaeology than in any other area of archaeological research, and the assembly recommended that there should be a European convention on the underwater cultural heritage. Specialist groups of archaeologists should be established to co-ordinate actions, monitor archaeological techniques, legislation and administrative regulations.

The basic elements of any national archaeological framework clearly include laws to protect wreck sites and the antiquities found there; financial provisions to create and maintain the professional organizations and to administer the law; a professional organization which would include an archaeological team, a conservation laboratory and a museum to preserve and display the archaeological discoveries, and to provide a base for archaeological and conservation operations.[1] Recourse to amateur help is also indispensable, for the active participation of the amateur provides training on the basis of which future professional archaeologists will emerge. It establishes people who will police sites, and who will discover and report new ones; it also creates a deeper general understanding of the past —the ultimate aim of all archaeological work.

The law and actual practice

Underlying such arrangements is a need for a satisfactory law that will deal with wrecks of archaeological importance. In the Council of Europe report a number of criteria were listed. Legal protection should cover all objects that have been beneath the water for more than a hundred years. National jurisdiction should be extended up to the full 200-mile limit where possible. Existing salvage and wreck law should not apply to any protected historic wreck. The reporting of finds should be compulsory. A

Part of a small bronze gun from the *Amsterdam* recovered by treasure hunters in 1969. The gun, one of five found in the wreck, was made by C. Crans in 1748 and bears the V.O.C. insignia. Owing to thefts only three of the five guns were returned to the Netherlands when the legal problems had been clarified in about 1975. [*Photo:* Peter Marsden.]

1. See the article by R. F. Harrison on page 44 of this issue.—Ed.

single authority should deal with both land and underwater finds. There should be rewards for finders of wreck sites. Finally there should be provision for the enforcement of the law.

How do these requirements work out in practice? The situation in each country is different and, except in Western Australia, the facilities tend to fall far short of even minimum needs. The situation in the United Kingdom, best known to the author, may be fairly typical of other countries as well. Public interest certainly exists in the United Kingdom, but established museums and the government-sponsored archaeological service have a very limited involvement in nautical archaeology. The result is that there are an increasing number of archaeological projects that are either controlled or administered by private individuals with few facilities and limited finance.

When a historic wreck is found in the territorial waters of the United Kingdom the salvors can seek its protection under the Protection of Wrecks Act 1973. This means that if anyone interferes with it without a licence from the Department of Trade which administers the act, that individual is liable to be fined and his salvage equipment confiscated. The act does not require the salvors of protected wrecks to deposit their discoveries in a museum, and since the act was only intended as an interim measure, presumably the museum and conservation aspects may be reconsidered in later legislation. Lord Runciman is the Chairman of the Wreck Committee advising the Minister for Trade who issues licences, but the Department of Trade is restricted by not being able to offer any financial grants either to museums or to the diving groups so as to help them cover their costs. In fact, to have a historic wreck protected under this act can create additional expenses that the individual salvors, usually amateur divers, find hard to meet. Apart from financing their own diving and underwater work they have to pay the expense of producing reports for the Runciman Committee, and may have to finance conservation of the antiquities.

The result is that there is sometimes pressure on the diving groups to sell the antiquities that they have recovered, particularly as even protected historic wrecks are still under the commercial law of salvage, the Merchant Shipping Act of 1894. This act requires that all unclaimed 'wreck' is sold, though the form of the sale is not specified. It is therefore possible for a museum to enter into a purchase agreement with the Receiver of Wreck, who acts as an umpire between the salvor, the owner and the purchaser. This arrangement has been reached in the case of the personal possessions of the crew from the sixteenth-century English warship *Mary Rose*, raised in 1982.

Museum policies

Many museums will not purchase shipwreck antiquities, however, since such objects are rarely considered as part of the local history, and anyway the objects tend to require considerable storage and display space, as well as financial outlay, particularly for conservation, which the museum does not have. The *Mary Rose* is a case in point.

Other important historic wrecks have been found elsewhere along the south coast of England, in Sussex, and although two are protected by law as historic sites, again there has been no museum or other organization to take permanent responsibility for them. A trust, the Nautical Museums Trust, has been formed to take charge of some of the wrecks and to create a maritime museum. The trust is acquiring ownership, from the Ministry of Defence, of the protected English warship *Anne*, lost near Hastings in 1690, and has acquired custodianship of a large unidentified and unprotected historic wreck near Rye. In addition the trust has acquired many antiquities, including a major part of a small fifteenth-century sailing ship from the Thames, and a few objects from around the protected site of the Dutch East Indiaman *Amsterdam* which was lost on the Sussex coast near Hastings in 1749.

The difficulty, however, is that like most governments the British Government has no policy regarding nautical archaeology other than the protection of some sites. The rest is left almost exclusively to private enterprise, and although there is provision for grants for archaeological work generally to be made to museums and charitable trusts from the Department of the Environment, in practice these are almost impossible to obtain for nautical archaeology. Although the single diving archaeologist at the National Maritime Museum at Greenwich has achieved much in investigating certain sites, it could be said that by encouraging and training amateur divers in archaeological techniques he is merely adding to the problem since more historic wrecks are likely to be found.

An important aim must be the integration of archaeological research into major topics so that each discovery can be slotted into a broad programme of research. For example, although British warships dating from the fifteenth century have been found in several countries there has never been any attempt to draw together the information gained. Similarly, many shipwrecks of the Spanish-American trade have been found off central America, and although much popular writing has resulted, there has been little academic reporting, nor has there been any attempt to make a detailed study of the information from all of the wrecks. Broad research studies have been carried out to great effect by the archaeological team of the Western Australian Museum, not only in the history of the Dutch East India Company's trading ships wrecked off their coast, but also in the important nineteenth-century colonial trading vessels. This level of research has also been achieved by the Institute of Nautical Archaeology, an American charitable organization based in Texas. Their archaeological team, created and directed by Professor George Bass and Dr. Michael Katzev, has patiently transformed our knowledge of the early history of ship design, construction, trade and navigation in the Mediterranean.

Nautical archaeology is still in its infancy, not because of a lack of trained personnel, experience, research aims or academic standards, but simply because governments and local authorities will take little or no financial responsibility. Future improvements will only occur when governments give a reasonable level of financial commitment to the maritime heritage preserved around their shores.

CONSERVATION

The conservation of objects brought up from sea- or lake-beds and other submerged environments poses special problems. Formidable difficulties arise at the very moment of discovery, while all treatments to ensure long-term conservation must take into account various complex alterations to the deep structure of materials. As Colin Pearson points out in his chapter on conservation in Unesco's technical handbook Protection of the Underwater Heritage (1981): *'it is of course impossible to cover in a few pages details of the deterioration of all types of objects that exist on a shipwreck or in a wet-site, followed by complete guidelines on their conservation and restoration'. (See extracts in* Museum, *Vol. XXXIV, No. 1 (inside back cover).) Today, published procedures and case-histories abound and critical assessment of the state-of-the-art should be possible. However, as Parks Canada's Victoria Jenssen observes, 'only seasoned marine conservators or broad-minded chemists can critically evaluate the usefulness of the literature'. Nevertheless, Victoria Jenssen herself is able to look evaluatively in the following article at a cross-section of results achieved on various organic materials. She homes in on leather, whose problems typify perhaps those found in other waterlogged materials. Wood is, of course, the degraded organic material most commonly found; it is after all the medium of underwater archaeology's prime artefact, the ship. The conservation of waterlogged wood has been the focus of increased international exchange in recent years and co-operation in this area has been directly furthered by Unesco. David Grattan from the Canadian Conservation Institute, Co-ordinator of a Working Group on waterlogged wood in ICOM's International Committee for Conservation, takes a measured look at the state-of-the-art.*

Water-degraded organic materials: skeletons in our closets?

Victoria Jenssen

Born in 1949 at Great Barrington, Massachusetts, United States. B. A. in Classics-Art History from New York University; M. A. and Conservation Certificate from New York University's Conservation Center at the Institute of Fine Arts, concentrating on the history of technology and ancient Mediterranean civilizations. Site conservator on excavations in Turkey, Greece and Canada. Received additional experience at the Römisch-Germanisches Zentralmuseum (Mainz), the Rheinisches Landesmuseum (Trier), the Nationalmuseet (Copenhagen; Brede). Worked at the University Museum of the University of Pennsylvania before joining in 1976 the Underwater Section of the Conservation Division, Parks Canada, where she is Senior Archaeological Conservator.

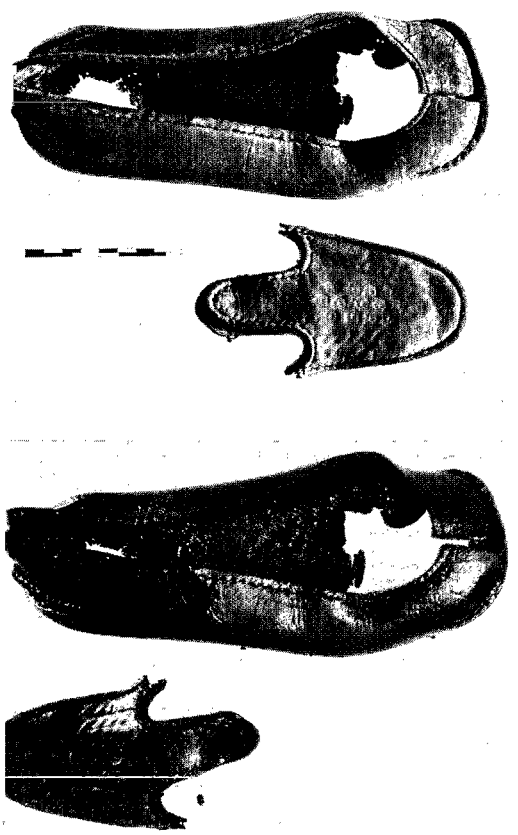
The remarkably preserved appearance of rope, leather and other organic materials as they are freshly retrieved from marine and terrestrial wet sites can be easily lost with improper handling. Conservation treatment must start immediately, sometimes at the very moment of discovery.

Ingenious encapsulating methods for excavation are being devised every season, sometimes by diving conservators.[1] Methods for packing, storage and shipment of fragile wet finds are also being developed and published in detail.[2] Although field treatments are carried out on these materials from time to time,[3] conservators prefer to examine, analyse and conserve finds in well-equipped laboratories with access to scientific services so as to avoid irreversible damage and loss of potential information.[4]

Information, whether site measurements or artefacts themselves, must be preserved or conserved, in the strictest sense, so that hypotheses may be tested against the data, whether a year or a century hence. Thus objects together with their contaminants, their deterioration products and their associated sediments are all scientific specimens which inform us about a shipwreck. The conservator is thus faced with a conflict between professional ethics, which charge him to conserve the integrity of his finds, and the public's demand for objects of study or display which can lead him to less than professional deeds, particularly in the areas of cleaning and consolidation.

Nowhere is this predicament more keenly felt than with respect to organic wet materials. In few other areas are such sensitive degraded materials of animal or vegetable origin found in such contaminated, physically weakened and chemically unstable condition. Since these finds often uncannily preserve the appearance of their original form, much more effort has been devoted to preserving this outward appearance than to conserving their inner substance. Conservators are encouraged to stop pondering complexities and to get on with the work at hand.

The conditions that can lead to preservation of organic matter under water are complex[5] and directly contribute to their conservation problems. In marine sites, rapid fine sedimentation ultimately will favour anoxic preserving conditions, once the aerobic and then the anaerobic bac-



A waterlogged leather shoe from Les Forges du Saint-Maurice, Quebec, (a) after superficial cleaning; (b) after chemical cleaning and dimensional stabilization with freeze-drying using a dilute polyethylene glycol 400/6-butanol pre-treatment. Note the excellent preservation of wear-marks, texture, stitching and shape. Need a leather dressing be applied?
[*Photo:* Parks Canada/G. Vandervlugt.]

teria have metabolized their respective oxygen supplies. The rotten-egg H_2S odour common to marine artefacts is a by-product of sulphate-reducing bacterial activity, which also contributes to iron-staining in artefacts. Sulphuric acid by-products solubilize enough iron from the wreck or the sediments to be absorbed by the artefact, and even complexed by the cellulose, collagen or keratin components. Artefacts can also be found partially concreted or totally encapsulated in hard, misshapen concretions. In addition, the polypeptide or polysaccharide chains that form the artefact's substance are partially broken down during burial by hydrolysis, and the soluble components can be leached out.

Cases have been made for the study of shipwrecks by marine scientists to assess the chemical, physical and biological dynamics of the burial system with respect to the ship's history, the conservation requirements of the finds, and, most important, to determine the potential damage to the previously dormant site by archaeological disruption. The few modest efforts to date have been highly rewarding, for example in determining the 'rate' of the ship's sedimentation.[6]

Leather: a sad example of the state-of-the-art of conservation of organic marine materials

The professional dilemmas facing marine conservators are best illustrated by the case of one material—water-degraded leather. Sizeable quantities of leather shoes, clothing, bilge-pump parts, and countless nameless fragments are often retrieved. Their appearance is good, often blackened, presumably by iron-tannate complexes, but their sensitivity to handling attests their deteriorated state. Also, the leather is often iron-stained, concreted, or exists as a composite: manufactured with another material such as wood, rope or stitching. Few objective criteria have been applied to such leather in order to characterize it, much less categorize it for treatment.[7] This is due chiefly to the large sample sizes required for some leather-industry standard tests and to a remarkable gap in our repertory of analytical techniques normally adapted for micro-scale requirements. We should like to be able to say that our leather artefact is suitable for *x* procedure based on, say, any of the following data: fat content, non-hydrolysable matter, protein content, moisture content, tannins present, mineral content, animal species, ash, shrinkage temperature, pH of extracts, colouring agent present, burial contaminants present, etc.

Specialists in waterlogged wood conservation have attempted to apply industrial wood standards, starting with the *Wasa*, and recently have begun to be well rewarded for their efforts.[8] Methods devised by the leather industry, however, are often neither useful nor appropriate, as our examinations are often subjective—observations about texture, suppleness and colour. They include some objective data: outline tracings to monitor any subsequent dimensional change, weight, photography and possibly moisture content. The various mineral accretions and contaminants resulting from burial, chiefly iron and sulphur compounds, are estimated to endanger the leather's longevity. In recognition of their deleterious effects on leather bookbindings, conservators feel obliged to remove or somehow inactivate them.[9]

Unfortunately, the sorts of reagents that are used to remove rusts and mineral concretions (e.g. oxalic acid, EDTA, HCl, etc.) may not only promote further hydrolysis of the proteinaceous collagen fibres, leather's main constituent, but can also remove whatever tanning or colouring agents remain, losing information about the artefact's manufacture and history.

Plainly, research is needed to assess the need for cleaning leathers of chemical contaminants and to determine just what is required to preserve information in water-degraded marine leathers. Is a form of drying necessarily the best strategy for preserving information? What do the alternatives offer: freezing or fluid-preservation as in dissections, for example?[10]

However, in the normal course, the conservation profession's secondary occupation is pressed into service: to prepare the leather artefact as a specimen for study, storage or display. Restated, it is important in preparing for archaeological publication to know just what the artefact is, cleaned of obscuring materials; articulated, etc.; to obtain good photographs and drawings; to make the item easily available to contemporary scholars. Also, it is usually important for display, as well as study, purposes that the artefact be dry and therefore dimensionally unchanged, robust with its fragments reassembled. In our frustating experience, however, no two water-degraded leathers, even from the same site, react in quite the same way to treatment with respect to shrinkage, flexibility, brittleness, clean-

ing, colour change or reshaping. Hence the need for basic research to characterize water-degraded archaeological leathers and their treatment requirements. But the high priority of study and display seem to have propelled conservators away from the necessary research in this area. The practice has been to subject water-degraded leather artefacts to the most astonishing battery of chemicals, fatty/waxy/oil/watery lubrication compounds, emollients, enzymes, tanning agents, humectants, consolidants and adhesives, all in the hope of finding an elixir and softener.[11] Some stem from folklore tradition and some are experimental proprietary compounds berrowed from industry. Many major marine collections have already been treated along these lines. Some methods have necessitated re-treatment only five years later. Moreover, non-conservators in North America, usually anthropologists, who treat finds usually depend on the older but easily accessible literature which still recommends high temperatures, high concentrations of lubricants and so on.

On the positive side, a recent Scandinavian symposium publication, *Conservation and Restoration of Leather, Skin and Parchment*, provides a good overview of the present state of wet-leather conservation technology as well as methods of examination and microscopy.[12] The Museum of London's recently published work on waterlogged leather treatment trials demonstrates a highly enlightened empirical approach to treatment which more labs might adopt and publish.[13] The newly established Leather Conservation Centre in the United Kingdom intends to offer conservation services and to initiate scientific studies.[14]

Very recently, some fundamental conservation research has been initiated in Canada in the areas of skin (Canadian Conservation Institute) and iron-stained vegetable-tanned leather (Conservation Division, Parks Canada). The chemistry and microscopy is complicated to carry out, expensive to contract out to other laboratories, and the results can be difficult to interpret.

Fortunately, the criteria for what constitutes as successful treatment are changing. Some conservators and curators question the need for archaeological leathers to be supple if this condition requires infusion of foreign substances. They propose that a stiff stable piece will supply as much physical information as a flexible one and, reshaped, will display nicely as well. There has also been a recent swing towards more 'conservative' treatment including vacuum freeze-drying for all waterlogged organics as well as leather. Low-temparature treatments are now favoured, recognizing that tannin-poor collagen shrinks at lower temperatures than tanned pieces. Some practitionners have been able to dry veg-tanned leathers from wet sites through ethanol, alcohol or glycerine solutions.[15]

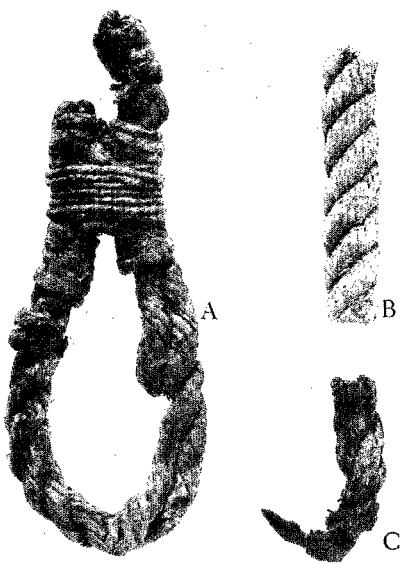
Nineteenth-century waterlogged leather dress shoes: Memorial University, St John's, Newfoundland. After dimensional stabilization, the dried boot fragments were mounted on carved polyethylene foam shoe-forms with corrosion-proof dress-maker's pins inserted through stitching holes.
[*Photo:* Canadian Conservation Institute/W. Bokman.]

Vacuum freeze-drying of wet leathers has proved successful in terms of improved dimensional stability, decreased amount of residual pre-treatment impregnants, time of treatment, ease of reassembly, appearance, survival of wear and manufacturing marks.[16]

The necessary pre-treatments include PEGs (polyethylene glycols, e.g. Carbowax 400 or 1450), PEG-cellulose derivatives, glycerine and homologues, or Bavon ASAK.[17] This approach parallels developments in waterlogged wood treatments. As a bonus, a springier, almost soft leather in the case of thinner items can result since the web of swollen collagen fibres appears to be left open, rather than collapsed in drying or coagulated with oils, etc. Some believe that leather artefacts should not be dried to desiccation in the chamber, but rather just enough to leave a moisture content that will be in equilibrium with ambient conditions.

Plainly, some basic research is needed in the area of freeze-drying pre-treatment

Use of water-cooled ultrasonic dental scalers facilitates mechanical cleaning of water-degraded materials. C. Newton prepares a concreted textile fragment from the *Machault*.
[*Photo:* Conservation Division, Parks Canada/G. Vandervlugt.]



Water-degraded cordage from the eighteenth-century wreck the *Auguste* (A), and from the eighteenth-century *Machault* (B) and (C). Water-degraded cordage can shrink if air-dried (C); however, it can be dimensionally stabilized using solvent drying (B), tetraethylorthosilicate treatment (A), or freeze-drying with pre-treatment.
[*Photo:* Parks Canada/G. Vandervlugt.]

to see if we can avoid adding any foreign materials. Alternatively, we could determine which impregnants are 'acceptable' with respect to anti-shrink efficiency, ageing characteristics, compatibility, reversibility if possible, and potential effects on future analyses questions, whose methods are not always possible to predict.

Finally, the treated leather must be stored (or displayed) to ensure its endurance for future generations.[18] Physical protection can be offered in the form of special boxes, tissue or as articulating mounts, which are suitable for handling and, if required, display. However, the physical and chemical condition of the treated leathers may not be stable over the years owing to an inherent vice: any leather tends to become stiff and brittle if is not manipulated, as can be seen in old shoes in our own closets. Residual mineral impurities in the leather or composite parts, for example iron nails orburial contaminants, may slowly deteriorate the leather, especially in humidities above 40 per cent. Environmental pollutants may affect the treated items as they do bookbindings, which is bound to raise the suggestion for the incorporation of buffers, as is the practice in archival conservation. Naturally, it is preferable to purify the artefact's local environment. Again, basic research is required.

Brief remarks along the same lines may be made with respect to a variety of other organic materials.

Textiles

Both cellulosic (cotton, linen, hemp, etc.) and proteinaceous (wool, silk) textiles are encountered, each fibre type having its own sensitivities to deterioration and treatment. Unconcreted items may arrive jumbled with adhering sediments. Here, preliminary unfolding and rinsing, which require sensitivity and dexterity, aid the examination. Sometimes, this procedure, possibly coupled with a mild detergent washing and/or incorporation of a humectant, constitutes the wet portion of the treatment. In robust samples, ultrasonic baths improve washing and rinsing.

Basic research is required to determine the effects of the chemical cleaning agents on the deteriorated fibres.[19] Cellulosics can be damaged by acidic solutions of the same low pH (0–3) required to remove rust, whereas wools may fare better. Complexing agents, while adjustable to more acceptable pH range for textiles (4–7), require much consideration to ensure that ions are being solubilized for complexing. A slightly alkaline detergent solution can remove many common dyes of the acid type. Oxalic acid is known to degrade cellulose, which suggests that we discontinue or modify its use.[20]

Textiles may require strengthening. Fewer formulae appear to be used now than in the past. Conservators seem to favour cellulose derivatives or their mixtures with PEGs or glycerine as consolidants, introduced by Geijer in 1960.[21] In several laboratories, textiles are freeze-dried after pre-treatment with these mixtures, giving great success.[22] The conservation properties of these mixtures, however, must be re-evaluated since Geijer's work, as she herself commented in 1975.[23] Humectants may be added to textiles to maintain a steady moisture content in desiccated fibres: glycerine, sorbitol, PEG 400 or lanolin.[24]

The treated degraded cellulosics may be liable to acid damage from residues of burial or treatment, inherent acid degradation products or pollutants. This has suggested that 'deacidification' or incorporation of alkaline buffering be investigated.[25] At least one marine laboratory 'deacidifies' archaeological textiles.[26]

Finally some progressive work is looking into fibre regeneration both in wools and in silk, the potential benefits of which could outweigh ethical concerns.[27]

Packaging or mounting of fragile fragments, especially in large quantities, has posed a problem since a study mount should allow complete access to the pieces. This rules out the customary approach of couching fragments on fabric with small windows or gluing to matboard.[28] Several approaches have proved successful, such as mylar encapsulations, crêpeline floating mounts in matboard frames, snug floating mounts in plastic boxes, and plexiglas-mylar floating mounts.[29]

As in the case of leather, more basic research is required in the area of textile conservation in order ethically to preserve these specimens.

Cordage, grasses

While tarred cordage has been air-dried with some success after thorough desalination, untarred hemp air-dries to a clotted dark mass. The fibres which had been held in the shape of the original rope by water are pulled together as the water dries out.

Test samples from this severely weakened grass-matting from the seventeenth-century wreck H.M.S. *Sapphire* shrivelled dramatically with air-drying. The artefact was dimensionally stabilized using tetraethylorthosilicate treatment and subsequently strengthened with an organosoluble cellulose derivative. The remnant sediment from the silt encapsulation, excavation method can be seen in the finished piece. [*Photo:* Parks Canada/G. Vandervlugt.]

Concreted or stained cordage follow textile cleaning methods, using makeshift three-dimensional auxiliary supports to catch loosening elements. Composites are usually separated. However, in the case of the whipped-iron loop (see photo), removal was debated and found undesirable since it would interfere with the artefact's integrity.

Although classical PEG 400 (average molecular weight) high-concentration impregnation has been used as well as thermoplastic resins in solvents and resin emulsions, conservators are leaning towards simpler methods: acetone or ethanol drying, cellulose ether or polyvinyl pyrrolidone and/or PEG mixtures alone or as pre-treatments for freeze-drying.[30] As a bonus, the normally weak, slippery rope can be articulated at the gelling stage during the freeze-down, obviating cumbersome supports and ties. Since the cellulose fibres will still twist in presence of moisture, in the manner of fresh fibres, some prefer to use non-polar solvents for either solvent drying or consolidation. Certain cellulose ethers are organo-soluble but, while their working properties are superb, their conservation properties are as yet unproved. Aesthetically acceptable results can be obtained by using versions of the tetraethylorthosilicate (TEOS) treatment for dimensionally stabilizing fibrous media.[31] TEOS-treated fibre artefacts normally require subsequent strengthening. It is a useful field treatment where air or solvent drying is not practical and no freeze-drier or even deep-freeze is available; however, its conservation properties are largely unknown.[32] Once again, basic research is required in the area of vegetable fibres in order to preserve these artefacts properly.[33]

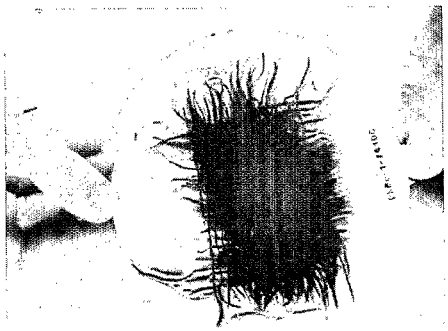
Bone, ivory

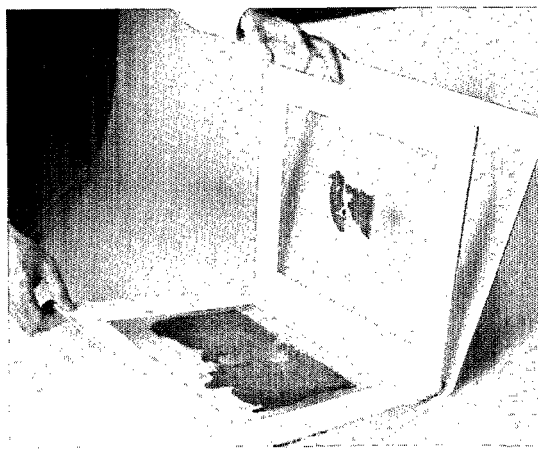
Although bone and ivory artefacts appear occasionally on wreck sites, we may encounter numerous remnants of meals, wreck victims or fishery-related operations. In the cases of sixteenth-century cod-bones and whale-bone from Red Bay Harbour, Labrador, desalination and controlled air-drying has been successful. Where softness and spalling was indicated on a juvenile polar-bear skull, a dilute aqueous solution of acrylic emulsion was used. On the other hand, the teeth, apparently robust, tend to split upon drying. But if the bear's natural habitat was 'aquatic', should the tooth ever be asked to dry out? Would not preservation in a liquid or an extremely high RH be better? Bones and teeth are materials whose archaeochemistry traditionally has been well studied. While conservation science still lags,[34] by doing less to these 'non-display' specimens, we are closer to maintaining our professional ethics.

Other materials

Rubber is encountered in marine excavations, for instance in the *Monitor* survey (North Carolina), opening up a Pandora's box of chemical instability; Japanese conservators must treat waterlogged lacquer;[35] tars, caulking compounds come up, sometimes caked to timbers; corks, by nature impermeable to liquids, often defy dimensional stabilization, though success with PEG and slow-drying are reported; paper, where it has survived, has been treated according to paper procedures except for initial iron-salt removal;[36] even coal can become water-degraded.[37]

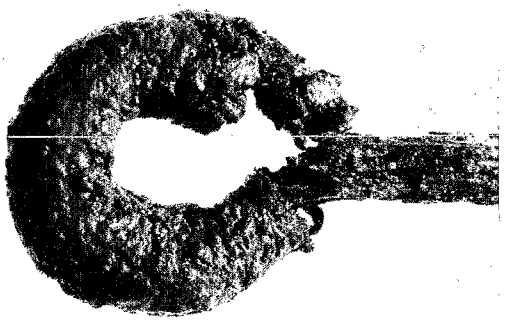
Sixteenth-century Basque woollen textile: Memorial University, St John's, Newfoundland. A floating-mount within a lidded plastic Petri dish is being removed from the dish by fabric tabs, allowing examination. The mount is constructed from chromatography paper and acid-free cardboard, and sits on a polyethylene foam base within the Petri dish. The textile's reverse side may be studied by first replacing the circular filter paper inside the plastic lid, then inverting the mount so that the paper receives the textile. [*Photo:* Canadian Conservation Institute/W. Bokman.]





Sixteenth-century Basque woollen textiles: Memorial University, St John's, Newfoundland. A compound crêpeline-ragboard-hinged floating-mount preserves the stratigraphy and juxtaposition of the various fragments yet allows inspection of both sides of the textiles. The fragments are couched with hair-silk thread to silk crêpeline previously stretched and stuck on to the ragboard frame. [*Photo:* Canadian Conservation Institute/W. Bokman.]

Composite marine finds often cannot or should not be separated for the components' respective treatments. Here, hemp cordage whipping is concreted on to a wrought-iron tool from the *Auguste*. A careful combination of electrolysis and chemical cleaning is proposed. Low-humidity, post-treatment storage is essential. [*Photo:* Parks Canada/C. Vandervlugt.]



Conclusion

By not initiating or supporting basic research into these multiple conservation requirements, we conservators, archaeologists and museologists court a more costly and shameful eventuality. In years to come, artefacts that are deteriorating from mysterious causes will need intermittent re-treatment until very little remains of the original pieces. A good case-history describes the repeated exhumations of the Danish Archbishop Absalon whose graveclothes first went on public exhibition in the 1820s, and at the most recent conservation examination were found to be in lamentably diminished condition.[38] What will be the lifetime of our treated water-degraded organic archaeological materials? Are they literally skeletons in our closets and showcases?[39]

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39. Thanks are due to George Vandervlugt and Wilf Bokman for providing photographs for this article at short notice; also to Charlotte Newton for her helpful comments.

The degradation of waterlogged wood

What causes the degradation of waterlogged wood?

To understand the effects of degradation, it is necessary to comprehend something of the structure of wood. Wood can be simply envisioned as being composed of bundles of tiny hollow tubes, closed at both ends and held together by a cement. These tubes, or cells, may vary considerably in size, shape and composition from species to species, but in the waterlogged condition they are usually full of water and allow the passage of this water (albeit sometimes a very slow passage). The walls of these tubes are constructed of fibrous units composed of cellulose. Cellulose is a natural polymer of high molecular weight (i.e. the cellulose molecules are very large), which is white, crystalline, strong and durable. It is, however, subject to enzymatic hydrolysis, giving rise to breakdown and allowing it to be digested easily by some biological organisms. Lignin is the other principal component in wood and is found in the intercellular layer as the major component along with hemicellulose. Together they form the amorphous cement holding the cells together. Lignin is also found in various parts of the cell wall. The cell wall is not an impermeable region, but contains numerous tiny cavities and passageways between the fibrils composing it. Thus water can enter into it, causing it to swell as the cellulose absorbs it.

How do various types of biological organisms affect wood?

Fungi. Fungi are the organisms most destructive to wood and are responsible for rot. However, they need oxygen and thus waterlogging reduces the rate of attack (depending on the oxygen content of the water). Fungal damage may precede immersion, except where wood is subjected to wetting and drying cycles. Different species attack wood in a variety of ways. The Ascomycetes (fungi bearing their spores in a sac-like structure) and Fungi imperfecti (fungi in which the sexual stage is not present or not known) cause the least amount of damage, some digesting only the starch in the cell walls and others working primarily on water-saturated wood surfaces, causing fairly shallow soft rot.

The Basidiomycetes (fungi bearing their spores on the swollen end of a fertile hypha) on the other hand can degrade extensively either lignin or cellulose or both, causing the familiar white rot where lignin is consumed, or cuboidal rot (brown rot) where cellulose is digested. In waterlogged wood it has often been shown that it is the cellulose that is lost, whereas the lignin seems much more resistant to attack. European oak wood has been found in which only about one-fifth of the original cellulose remains. (It is worth noting that even wood in this lamentable condition can be retrieved by appropriate conservation.)

Bacteria. Bacterial activity tends to be limited before immersion, but can be greatly increased in anaerobic conditions depending on the type of bacteria present. It is sulphate-reducing bacteria that produce hydrogen sulphide and thus give waterlogged wood the familiar odour of bad eggs. Bacterial damage can cause loss of strength in wood, but is not as serious as fungal damage. However, bacteria may also cause the destruction of pit membranes in wood, allowing the penetration of other more destructive agents of decay. (Pits are essentially connecting valves between adjacent wood cells, and the pit membrane is the plug; pits are often closed in dead wood.)

Insect attack. Many types of insect consume wood. Insect attack obviously takes place before immersion and consists of tunnels, galleries and offlight and entry holes. Insects such as termites, carpenter ants, powder-post or death-watch beetles can have devastating effects.

Shipworm and wood-borer attack. This affects wood principally (but not necessarily) in the warmer marine environments. There are two basic kinds of borer: the molluscs such as the *Teredo* and *Bankia*, and the crustaceans such as *Limnoria* and *Sphaeroma.* Their action is very destructive and not always obvious from the outside. Tiny entry holes may be the only sign of extensive mollusc activity in which the whole interior of the piece of wood may have been destroyed.

Conclusion

These are the usual types of damage which the conservator has to contend with (there are many other forms of damage too!). It should be obvious that the type and extent of damage suffered is an important factor in determining the behaviour of archaeological wood and of course means that analysis is essential before treatment can begin. Many other factors must also be borne in mind such as contaminants that might have been associated with the wood in use or in burial, and analysis should seek to determine this, too. The important thing to remember is that wood from any archaeological site is very different from normal wood, it is much more sensitive and must be handled with care and understanding.

David Grattan

Recent progress in conserving waterlogged wood

David Grattan

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Waterlogged wood presents the conservator with a rather difficult task. It is usually unattractively black, soggy and spongy, with an unpleasant smell, is complex to understand and difficult to work with.[1] Although an object composed of wood may have been preserved under water[2] in form for millennia, in substance it may have suffered considerable material losses, which greatly reduces its structural strength. This loss of substance is not always obvious, a false impression soon corrected, for when such a piece is allowed to dry it may shrivel and become gnarled and unrecognizable. If, on the other hand, it is passed to the conservator, the cost and the technical difficulties may prove equally daunting.

The first stage in the conservation treatment is analysis, in order to identify the wood species and wood features present, the type and extent of degradation, and the inorganic and organic contaminants. But not all conservators have the resources to carry out analysis beyond probing with pins or carrying out some microscopic examination; and even if full analysis is carried out its interpretation is a matter of debate and what it predicates for treatment equally uncertain.

A bewildering variety of treatments have been proposed. The value of many is difficult to assess and, indeed, several have been shown to be of little value. Thus the conservator has lacked a scientifically established rationale for a choice of treatment.

Demand for treatments

Despite the imperfect state-of-the-art, non-conservators generally believe that the problems of conservation have been solved. This is one of the reasons why the

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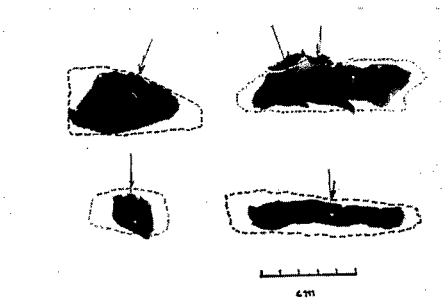
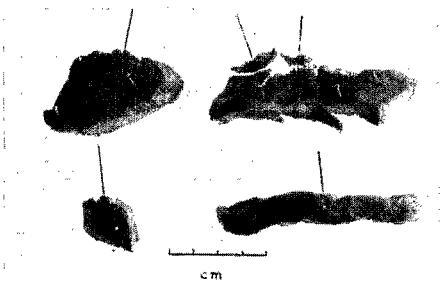
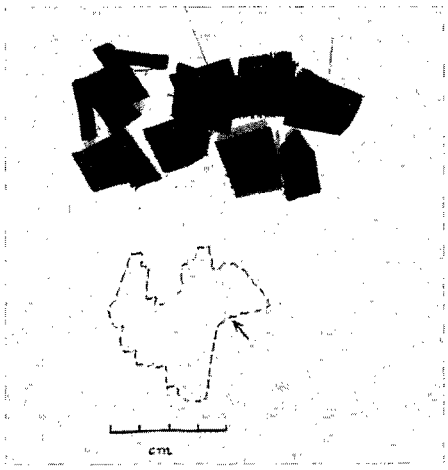
2. I use the term 'under water' to mean under the water in the sea, a lake or river, etc., or under the water-table on a land site.



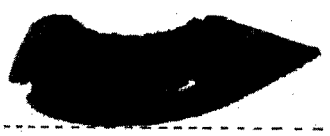
Photographs in silhouette of waterlogged wood, taken after air-drying. The dotted lines show the original outline of the wood when waterlogged. The pin in the side of each piece was originally aligned with the arrow and this helps to assess the wood for measurement of dimensional change. [*Photo:* D. W. Grattan.]

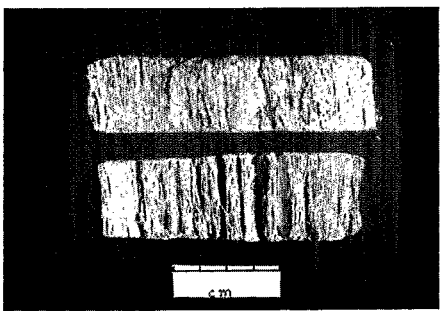


The same wood samples differently lit, to show the gnarled condition. [*Photo:* D. W. Grattan.]

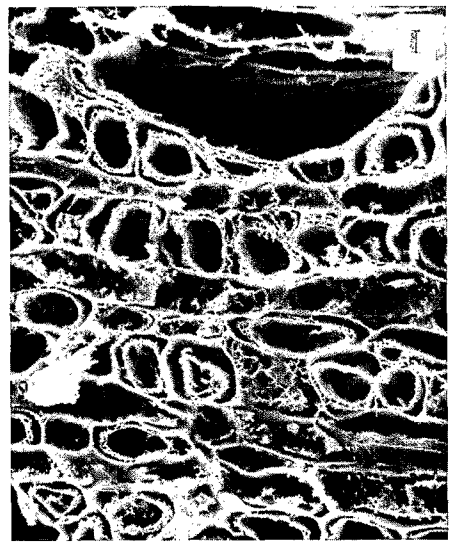


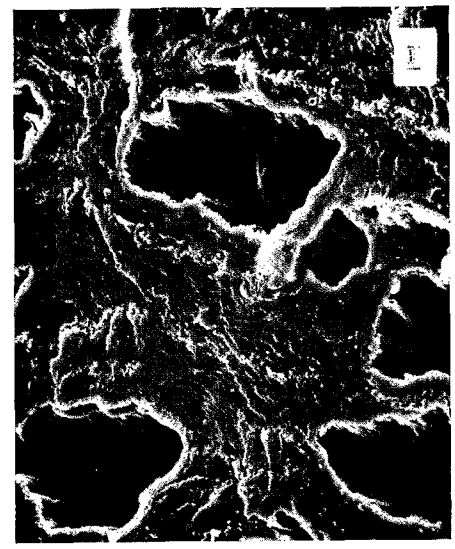
Warping and fragmentation are also common effects. [*Photos:* D. W. Grattan.]





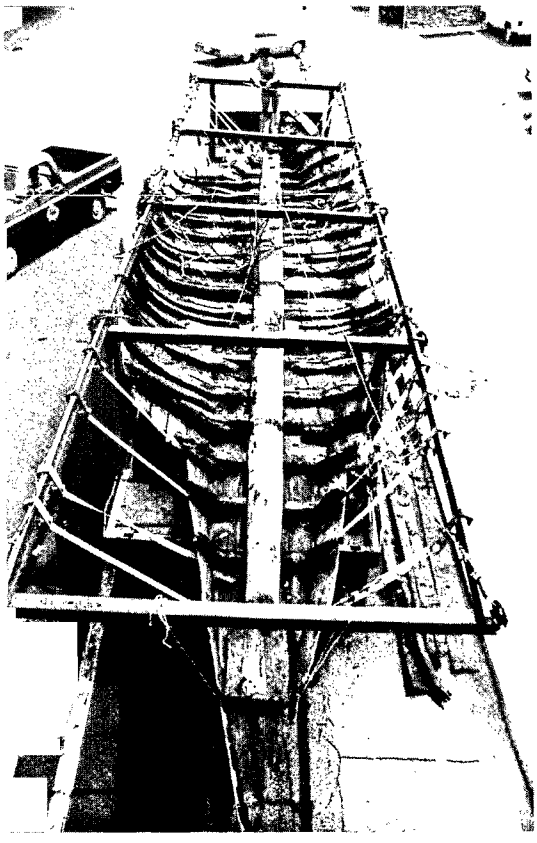
With less degraded wood where shrinkage, rather than cell collapse, is the dominant effect, the surface can still be badly damaged. The upper sample was treated with PEG 400 before freeze-drying, and as a result shrinkage and collapse have been prevented. In the lower, air-dried example shrinkage is evident in the reduced overall width (initially both samples were approximately the same width), but collapse in the surface zone has caused deep checking to be very marked. [*Photo:* D. W. Grattan.]





Left: waterlogged alder from the Hoko river site in the state of Washington as it exists in the fully water-saturated condition (600 per cent moisture).

Right: the result of air drying of the sample—all trace of the open cellular structure has disappeared.
[*Photos:* by permission of R. J. Barbour and L. Leney.]



The main section of the hull of the Brown's Ferry vessel, welded to a truck for transport to the conservation facility where it is being treated in a large tank containing a PEG 1450 solution.
[*Photo:* University of South Carolina.]

demand for conservation services is increasing at a greater rate than the supply. On the one hand there is an increasing amount of pressure for shipwrecks, etc., to be raised, stabilized and put on display, and on the other there is an increasing demand for treatment from archaeologists investigating wet-sites on land.

Such wet-sites—peatbogs, marshes or simply locations below the groundwater table—have enabled organic material to survive. According to Professor John Coles of the University of Cambridge, these sites are very important for prehistoric archaeology, which has been mainly concerned with inorganic material. However, stone tools, ceramics, etc., represent only 5 per cent of the artefacts used by early man, the other 95 per cent being organic in nature.

But the conservator, who is often neither listened to nor adequately funded, all too often is regarded as a person who is not quite a professional, more a mechanic who is simply called in to fix things up if and when they go wrong. This is a ridiculous situation, because conservation is far too complex to be dealt with in this way. It demands the mind and knowledge of a scientist, the skill of a craftsman and the eye of an artist. It must be taken into account before the first spade goes into the ground or the first diver goes down to a shipwreck. Unfortunately, the disregard for it is such that several major archaeological sites, in which some of the most important material recovered is waterlogged wood, do not even have a budget for conservation.

However, progress continues to be made. Nearly all the conservation work being done today is carried out extremely well. Conservators have shown great imagination and skill in coping with technical problems and overcoming inherent difficulties in treatments, or improvising equipment which is often prohibitively expensive.

Communication

The Waterlogged Wood Working Group of ICOM's International Committee for Conservation attempts to coordinate the research of its members at the Committee for Conservation's triennial meetings. It also distributes a newsletter among its members (and anybody else who is interested) that passes on current information and circulates the research interests of the members of the group.

The group has also supported specialist conferences, for example a four-day meeting in Ottawa in September 1981 at which a wide range of problems were discussed. The proceedings of the meeting have just been published with financial assistance from Unesco.[3] They provide the most recent account of waterlogged-wood conservation and give a good indication of the true state-of-the-art. For this reason I have devoted the remainder of this article to some of the highlights of the meeting.

The behaviour of wood on drying

This is a most interesting phenomenon, yet surprisingly it has been little studied. For this reason the findings of Jamie

3. D. W. Grattan and J. C. McCawley (eds.), *Proceedings of the ICOM, Committee for Conservation, Waterlogged Wood Working Group Meeting, Ottawa* 1981, Ottawa, 1982.

Professor John Coles and colleagues lifting an ancient waterlogged hurdle in the Somerset Levels, United Kingdom. This hurdle was part of an ancient trackway in the Levels and has been preserved in a peat bog. It was discovered through a commercial peat-cutting operation. The panel has been isolated and undercut, with marine ply-boards pushed through to make a platform; the first of these boards is in process of positioning. The platform will then be bolted to a steel-girder framework and made ready for hauling and lifting from the peat. The structure weighed about 700 kilograms and measured roughly 3 × 1.3 metres.
[*Photo:* by permission of J.M. Coles.]

Barbour, a wood technologist from Washington State University, United States, which concerned the drying of a sample of degraded alder from the Hoko river site, in the state of Washington, proved to be most revealing. The weakened cells of degraded wood are rather prone to collapse as water is lost, whereas in non-degraded wood this does not usually happen. All volume change occurring as water is lost occurs because of normal shrinkage processes, as the cells themselves shrink. Barbour distinguished carefully between the entirely separate processes of shrinkage and collapse, and showed, with the aid of scanning electron micrographs, what were the processes that cause collapse and at which stage of the drying they took place.

In many respects the key stage in drying is the fibre-saturation point of the wood, when all the water has been lost from the cell cavities, but the cell walls are still fully saturated with moisture. Above this point, dimensional changes tend to be caused by collapsing cells, whereas below they are caused by normal shrinkage as moisture evaporates from the cell walls. It is the processes of collapse that cause waterlogged wood to shrivel up on drying.

Analysis and classification

One of the most difficult problems with waterlogged wood has been to make classifications of the various types and conditions.

Per Hoffman of the Deutsches Schiffartsmuseum in Bremerhaven has conducted chemical analysis of waterlogged wood, which relates alterations in the chemical composition to ultrastructural changes. He confirmed earlier studies by demonstrating that cellulose from the cell wall is lost as degradation proceeds, and showed that there is a simple relationship between the maximum water content (a simple measurable indicator of the density of wood and hence of the condition) and the amount of cellulose present, as measured by chemical means. On the other hand, the lignin present remained remarkably consistent, suggesting that it is much less affected by degradation. Hoffman proposes the universal adoption of a simple scheme of chemical analysis, by which wood can be properly compared. In this way, proper information on the effects of treatment will accumulate and could lead to accurate selection of treatment programmes. The proposed scheme includes eight analyses from which the state of degradation can be determined and some idea of structural coherence can be obtained. Opinions vary as to the usefulness of this approach, but as Hoffman rightly points out, until we have obtained much more data, we are not in a position to be able to evaluate the tests. Various laboratories in Europe and North America are adopting Hoffman's scheme, but it remains to be seen how it works in practice.

Complementing this approach is a scheme suggested by Richard Jagels, of Maine State University, which depends on the interpretation of thin sections of wood by light microscopy. Though this method is less tedious and expensive than chemical analysis, it should not be considered as an alternative. For proper analysis, both schemes should be undertaken, for they both stand a good chance of being widely adopted and can thus give us the beginnings of standards.

Treatments

The number of entirely new treatments being introduced has been dwindling. Several have been found to perform poorly and as a result are being abandoned, while others have been modified and improved. There has been, in general, a return to methods that employ polyethylene glycol (PEG). A second development is the growing awareness that size of timber or structure is a key factor in treatment selection.

Richard Clarke of the National Maritime Museum in London made this point very clearly with respect to choices of treatments for large structures, such as shipwrecks. At present it seems that the most practical choice is to spray the structure with PEG solutions and gradually to increase the strength of the solutions as impregnation proceeds. In the slow-drying process following impregnation, the PEG acts by reducing the drying rate, hence lessening the drying stresses in the wood, by keeping the wood in a fully expanded condition (at least where penetration has taken place) and also by preventing collapse by filling the cell cavities.

For smaller ships or structures, it becomes possible to use total-immersion methods, and several vessels are being treated in this way by complete submersion in a tank. Use of a tank has the advantages that impregnation can be more precisely controlled and that the object is in no danger of damage by drying. Katherine Singley described the use of a very large tank, constructed in South Carolina for the treatment of the Browns Ferry wreck, and in Canada there is a project to raise from the bed of Lake Ontario two armed schooners, the *Hamilton* and

the *Scourge,* dating from 1812, possibly the best-preserved wrecks ever discovered anywhere, and to preserve them permanently in tanks which will attempt to reproduce the lake-bed environment.

Artefacts of intermediate size are usually treated by tank-immersion procedures, and success is being obtained by impregnation in dilute PEG solutions followed by freeze-drying. Normally the size of artefact that can be treated in this way is severely limited by the size of the drying chamber of the vacuum freeze-dryer employed. However, as the present author and two colleagues at the Canadian Conservation Institute, Cliff Cook and Cliff McCawley, demonstrated, it is possible to use other means to achieve freeze-drying which are not subject to rigid limitations of size, for example within a modified domestic deep-freezer or outside in the cold Canadian winter. However, these methods are limited in scope and do not work well for all categories of wood.[4]

Small artefacts can be preserved in many different ways and, as pointed out by Howard Murray of the Mary Rose Trust, treatment selection should be geared to the purpose for which an artefact is to be used—for study, for display, for educative purposes.

It is also important to compare the results of different treatments. Fritz Schweingruber, of the Swiss Federal Forestry Institute, described a very comprehensive study, undertaken by several laboratories in Switzerland in collaboration with each other. Kirsten Jespersen of the Danish National Museum described a thorough comparative study of the use of tetraethylorthosilicate (TEOS), showing quite clearly that it could not give results as good as those of other more conventional methods, such as the Danish technique of impregnation of PEG 3350 in tertiary butanol as a solvent, followed by freeze-drying. The author has also carried out a comparative study, and came to the same conclusion as many other workers in this field, that in general, methods employing PEG are among the most successful and when coupled with freeze-drying give exceptionally good results.

The success of freeze-drying methods which employ PEG has fostered several improvements. One very interesting technique was described by Jacqui Watson of the Ancient Monuments Laboratory in London, who has been using mixtures of PEG 400 and PEG 3350 instead of either of the pure resins. This approach apparently gets round the difficulty of treating badly degraded wood which is otherwise very delicate after treatment. Support for these modified procedures comes from the work of Gregory Young and Ian Wainwright of the Canadian Conservation Institute. They haves directly observed the penetration of PEG into the ultrastructure of wood, with a specially developed staining technique—a remarkable achievement. In the wood examined it was found that whereas PEG 400 had penetrated the cell walls, material of a higher molecular weight, PEG 3350, did not reside in the cell cavities.

Archaeological conservation and professional relations

Concern about conservation must apply equally to objects wherever they may be—as yet undiscovered on-site or in museum storage, etc. The safety of many of the world's wet-sites is gravely threatened. In many parts of the world, marshes, swamps and peat bogs are being drained. Such land, once regarded as useless and hence largely ignored, is becomming economically important and as a result drainage projects, some of which are on an enormous scale, are being carried out everywhere. This is tragic because a site may not survive for more than five years after the water table has dropped.

New ideas have emerged concerning the working relationship between archaeologists and conservators. Some archaeologists already see the benefits of involving conservators from the planning stage of an excavation to the time the objects reach their final home, and realize that to have a conservator on-site can be enormously useful for the lifting and storage of delicate and fragile artefacts, and even for special recording techniques involving moulding or soil-section transfers. All present at the meeting were agreed on the necessity of having a conservator on-site, although not all were able to see how he or she could be funded.

Conclusions

It was obvious that many of the issues confronting us were too great to be resolved at one meeting, but at least those attending went away with a better understanding of what they should be attempting to achieve. Success in this field is entirely dependent on collaboration and understanding between the many professional groups involved. The key workers are naturally the conservators who should supervise the care of the objects at all times; thus they must be able to communicate effectively and they must also be listened to. The spirit of co-operation, enthusiasm and willingness to understand different points of view, displayed at the Ottawa meeting, was impressive and bodes well for the future. We all hope that this spirit will continue to develop and that wet-site and underwater excavation will become much more collaborative in future.[5]

4. On freeze-drying of a large structure see the article by D. Drocourt and M. Morel-Deledalle, on page 49.—Ed.

5. This brief account by no means does justice to the many papers presented. Anyone wishing to learn more about waterlogged-wood conservation might be interested in obtaining a set of the proceedings of the Ottawa Conference. Quite apart from anything else, the set of references which it contains will be found to be most useful. It can be obtained by writing to: David Grattan, The Canadian Conservation Institute, 1030 Innes Road, Ottawa, Ontario K1A 0M8, Canada. Anyone seriously interested and involved in this aspect of conservation might also be interested in receiving the ICOM waterlogged wood working group *Newsletter* which comes out twice a year. This can also be obtained by writing to the author at the above address.

Acknowledgements are due to Gregory Young and John Dawson of the Canadian Conservation Institute who helped me with the section on the deterioration of wood.

HULLS UP!

The Mombasa Wreck Excavation

Robin C. M. Piercy

Has directed the Mombasa Wreck Excavation since 1976 and for the last eight years has been a staff member of the Institute of Nautical Archaeology, Texas, United States. Has participated in more than fifteen surveys and excavations of ancient and historic shipwrecks, most notably the Kyrenia ship excavation in Cyprus on which he was assistant director from 1970 to 1975. Currently resides in Bodrum, Turkey, with his wife and daughter.

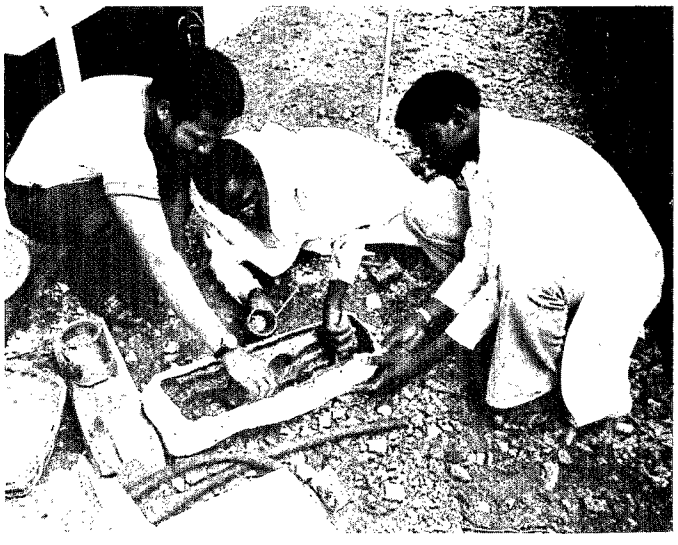
In the latter part of the sixteenth century and into the seventeenth, Mombasa was an important and safe anchorage for Portuguese vessels trading to India and the East. In 1593, the Captain of the Coast, Mateus Mendes de Vasconcelos, was instructed to build a fortress on the eastern point of Mombasa Island. Fort Jesus, as it was called, was designed by a leading Italian military architect and was intended to guard the seaward approaches to the harbour and give sanctuary to Portuguese traders. During the sixteenth century, the Portuguese largely controlled the trade in spices, which were in great demand in Europe and commanded high prices. By the late seventeenth century, however, Portuguese influence and trade monopoly in the Indian Ocean were nearly at an end. The Dutch and the English usurped their hold on the Spice Islands and the Omani expansion to the north posed a threat to their trade routes to India. This culminated in the siege of Fort Jesus by the Omani Arabs, which began in 1696.

During that year, several requests for help were sent to the Portuguese colony of Goa. In September 1697 the *Santo Antonio de Tanna,* one of two frigates sent by the Viceroy, finally entered the harbour after a number of reverses and a detour to Mozambique. Off Fort Jesus the frigate was heavily damaged, both by enemy action and by a series of unfortunate mishaps. The ship's cables parted, she lost her rudder, a barrel of grenades exploded, causing fire, and finally she stuck fast on the reef below Fort Jesus. Fortune was still against the ship and her crew as the tide went out, leaving the stern of the vessel high on the reef, forcing the bow beneath the water. On the incoming tide, the frigate failed to right herself and sank slowly beneath the reef.

An excellent opportunity for scientific excavation

For nearly three centuries, the *Santo Antonio de Tanna* lay buried under water. In the 1960s, its chance discovery by a local diver led to a small excavation, directed by Dr James Kirkman, then curator of Fort Jesus Museum. Some years later, the Institute of Nautical Archaeology was invited, by the National Museums of Kenya, to survey the wreck-site and assess its value for further excavation. The National Museums of Kenya was also concerned that excavation should go ahead as soon as possible to avoid the site being looted by souvenir and treasure hunters. The outline of the vessel was clearly defined by two rows of frames, protruding through a thick covering of sand, mud and coral, indicating that the

Mombasa Wreck Excavation team members clean concretion from a tool box with airscribes.
[*Photo:* Netia Piercy.]



Staff of the National Museums of Kenya casting object replicas for display.
[*Photo:* Robin Piercy.]

Small finds from Asia, Africa and Europe represent the wide trade links of the seventeenth-century Portuguese. [*Photo:* Chip Vincent.]

ship's remains would be well preserved. Little is known of Portuguese vessels from this period; many records housed in Lisbon were destroyed by the earthquake of 1755 and, at the end of the nineteenth century, more records were destroyed by fire in the Naval Academy and Maritime Museum in Lisbon. Certainly, the site in Mombasa presented a perfect opportunity scientifically to excavate and study a forty-two-gun Portuguese frigate from the seventeenth century.

The first season of excavation commenced in 1977 under the direction of the author. The main objective was to assess the orientation of the hull and to ascertain how much had been preserved. A 27-metre-long lighter was anchored over the site and served as a base for all aspects of the operation. This included the housing of day-to-day excavation records and the temporary wet storage of diving equipment. Over the following four years, a team, representing at least ten nations, would come together to study and record, in detail, the ship's construction. By the end of 1980, more than 6,500 objects had been raised and presented a unique opportunity to study Portuguese shipboard life. Amongst the artefacts were porcelain bowls and plates from China, unglazed flasks from India, pewter plates and jugs from Europe, faïence jars from Portugal and a varied collection of unglazed cooking pots from the African coast.

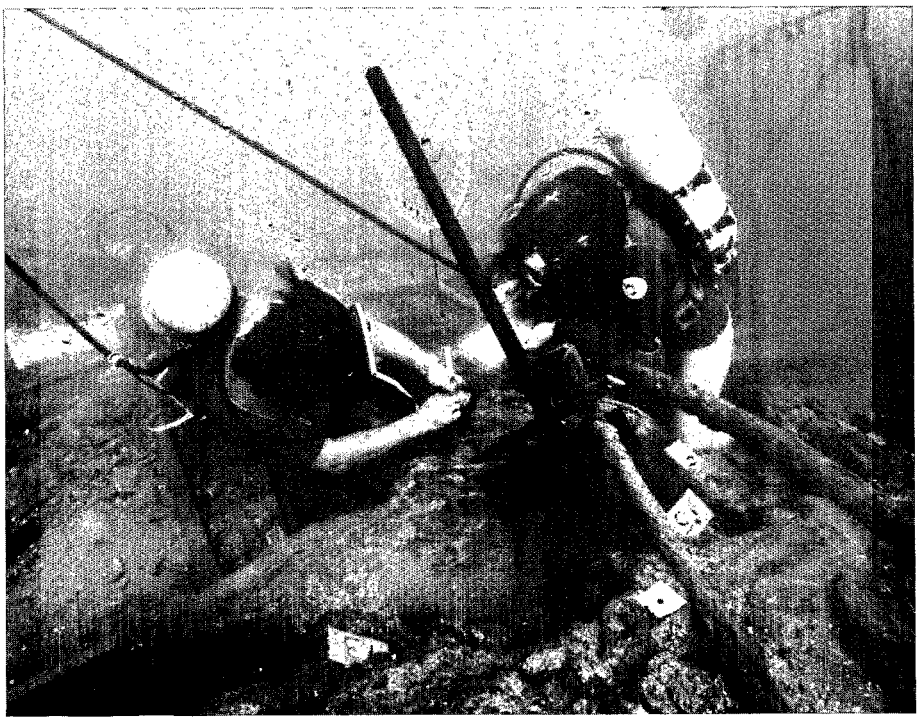
The hull, when uncovered, measured 34 × 8 metres and was well preserved up to the gun-deck knees on the port side. The starboard side had long ago collapsed downslope where it remained unburied to be destroyed by marine organisms. A massive teak keelson with a centrally located mast-step mortise lay firmly clamping the ship's frames to the keel. The stern extremity was identified by fragments of the stern knee and post with rudder gudgeon. Such a wealth of information from both the hull and the objects will take many years of research to interpret fully.

The museological problems

Artefact storage, conservation and museum display often require more time, effort and finance than any other aspect of the excavation. In the early seasons of excavation, it was decided to record and study the hull of the ship *in situ* rather than raise the remains. This decision was taken for a variety of reasons, not the least of which was financial. The expense alone of conserving such a large and solid teak hull was prohibitive. Added to this was the cost of providing a heavily air-conditioned building which would need to be at least 40 × 15 metres in dimension. Careful recording of the hull with measured sections and stereo photography was followed by back-filling, thus sealing and preserving the hull for the future. When an economical and satisfactory method is found for treating this type of wood, then the situation can be reappraised. Waterlogged artefacts from the sea often require more attention than their counterparts found on land. Museums are sometimes unaware of the amount of space needed to wet-store and treat these objects. Often, each delicate artefact needs its own individual con-

Mombasa schoolchildren listen to a lecture in front of the excavation's temporary display.
[*Photo:* Chip Vincent.]

tainer of water, prior to treatment. Certainly, the last season's influx of 3,500 objects at Mombasa put considerable strain on storage and conservation facilities. The Mombasa Wreck Excavation was particularly fortunate in receiving grants from the British Council and the National Museums of Kenya. This enabled a professional conservator to visit and train museum staff as well as allowing a Kenyan student to attend a conservation course in London. Museum display at Fort Jesus has played a very large and important role in the work of the Mombasa Wreck Excavation. Very early on, a small temporary exhibition was opened to the public; over the years it was constantly changed and expanded to promote local support for the project and to be of interest to Kenyan and foreign visitors. The National Museums of Kenya has plans to further enlarge the display, in a more permanent setting, as soon as space becomes available. The education department at Fort Jesus runs an active programme for schoolchildren, which includes films, slide shows and lectures as well as guided tours. One of the most rewarding aspects has been the attention paid to the Mombasa Wreck exhibit. Seated in front of it, the children show lively interest and participate in a historical quiz based on the display.



Archaeologists record the ship's profile, at one-metre intervals, down the length of the hull for production and analysis of the ship's lines.
[*Photo:* Robin Piercy.]

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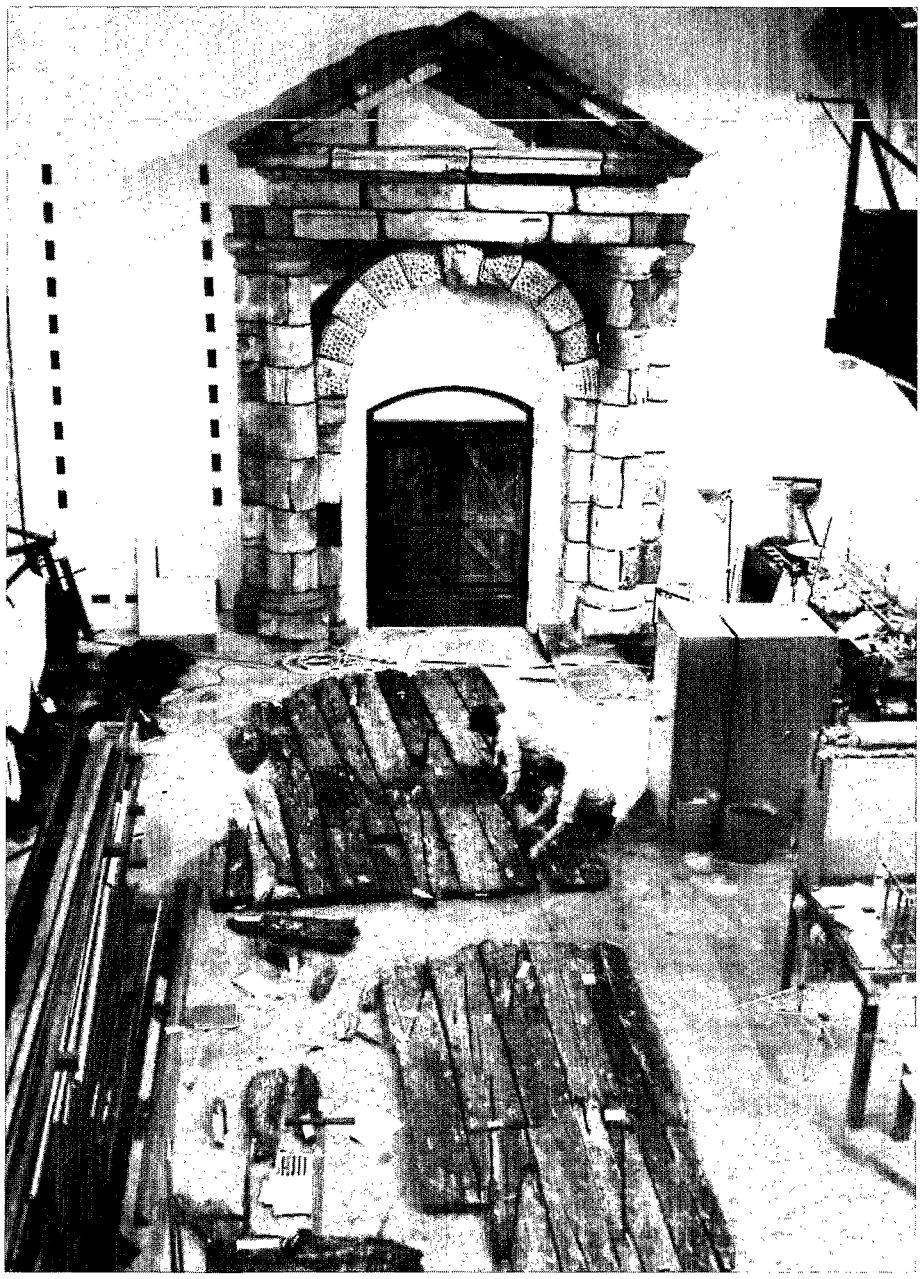
The excavation and reconstruction of the Batavia, *Western Australia*

Jeremy N. Green

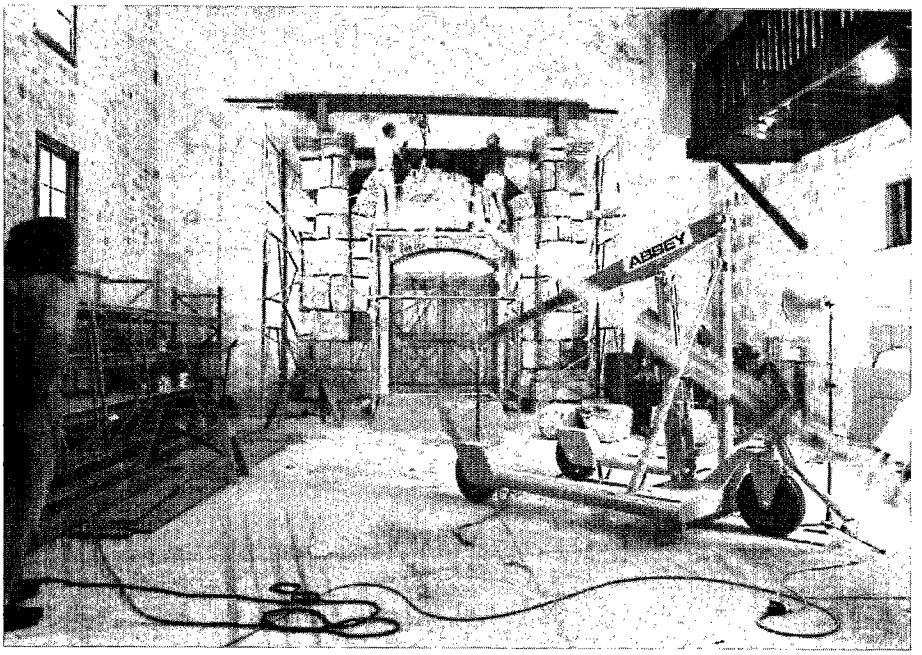
Born in the United Kingdom, 1942. B.Sc. in Physics, University of Hull, B.A.(Oxon.) in Physiology before becoming a research assistant at the Research Laboratory for Archaeology and History of Art at Oxford. Worked for two seasons on the Kyrenia excavation and led two survey expeditions to Cape Andreas, Cyprus. Worked on surveys of the *Amsterdam* and the *Trinidad Valencera.* Appointed Head of Department of Maritime Archaeology at the Western Australian Museum. Has surveyed and excavated several sites in Australia and Thailand and assisted on the Mombasa Wreck Excavation. Research associate for the Institute of Nautical Archaeology, Texas, and President of the Australian Institute for Nautical Archaeology.

The *Batavia* was a flagship of a fleet of ships belonging to the Dutch East India Company (Vereenigde Oostindische Compagnie, or VOC) that sailed from the Netherlands for the Indies in 1628. During the voyage, the ship was separated from the fleet in the Indian Ocean, and was subsequently wrecked on the Houtman Abrolhos off the then little-known Western Australian coast on 3 June 1629.

In 1963 the wreck-site of the *Batavia* was discovered and, at about the same time, legislation was enacted to protect all early wreck-sites on the coast of Western Australia. The Act dealt specifically with the four known VOC ships of which the *Batavia* was the oldest. The legislation protected these sites and gave the responsibility for their proper scientific excavation to the Western Australian Museum.



WESTERN AUSTRALIAN MUSEUM, Perth. Laying out the side planking of the ship's hull in the Batavia Gallery. The completed gateway from the *Batavia* is in the background.
[*Photo:* P. Baker.]



Placing the stone blocks of the gateway on a prefabricated support. [*Photo:* B. Richards.]

A major excavation project

As part of the museum's overall wreck-excavation programme, the *Batavia* excavation was the second and largest underwater excavation carried out to date. In 1973 the major excavation of this site started. A base camp was established on Beacon Island, an island close to the wreck-site. This camp had accommodation, storage facilities and a large jetty suitable for loading and unloading and also tying up the museum's workboat *Henrietta.* This vessel was constructed especially for the Department of Maritime Archaeology for excavation work.

The excavation of the site required a heavy mooring and ground tackle to ensure the safety of the vessel when working on the site. The wreck-site is exposed to the prevailing south-westerly Indian Ocean swells, which means that under certain conditions it was not possible to work on the site. On average, we could work on the site one day in three; usually in periods of about five to six days with a long break due to bad weather. The weather pattern had a quite interesting effect on the excavation, since there were often long periods when no diving was possible. During these periods, it was possible to process the excavated material, sort, clean and carry out limited conservation on-site.

On arrival at the base camp each artefact was stored temporarily in sea-water in a bag. During the bad weather periods, this material was sorted out. Artefacts were registered using a material type code under the major headings of stone, ferrous, non-ferrous, organic, ceramic and miscellaneous. Each object was entered in the registration book with a description, location and date of collection and stored in an appropriate storage medium with a tag marked with its registration number. Some conservation, e.g. mechanical cleaning, was carried out on-site but the main emphasis was to store material in a stable environment.

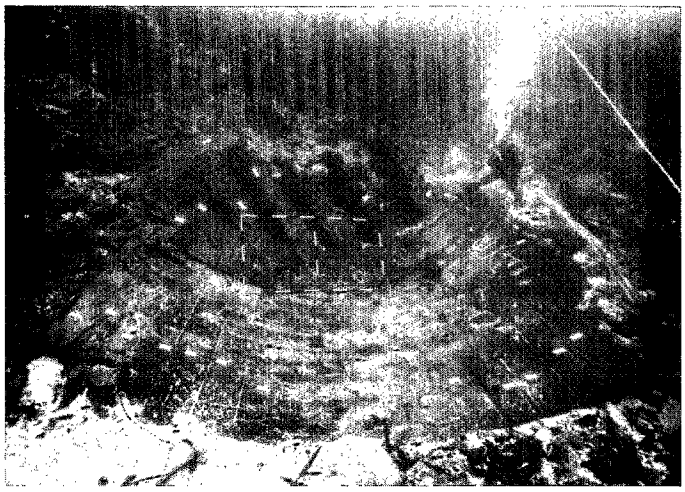
The excavation proceeded in a systematic manner. A trench was opened across the site about one-third of the way forward. Excavation then proceeded aft, the object being to ensure that if strong stormy seas came up, the site would remain reasonably protected and that debris and spoil would not clog the areas to be excavated. The first objective was to remove a large quantity of shaped sandstone building blocks. The blocks appeared to be some form of portico façade, and, in all, 134 blocks were raised from the site with an estimated total weight of more than 37 tons. The blocks were individually freed from the light concretion or coraline algae on the sea-bed, strapped with ropes, and raised by a winch on the work-boat. When the conditions were too rough to moor the work-boat over the wreck-site, blocks were raised by using lifting bags hauled out to the work-boat, which was anchored seaward from the site, and there raised on board.

When it was too rough to dive on the site, the blocks were catalogued, cleaned, photographed and drawn. It soon became clear that the original theory that the blocks were part of a façade was correct. Furthermore, it seemed that they formed some sort of portico. The blocks fell into several distinct groups. There were two half-column bases, two half capitals, with semi-circular and quarter-round blocks. Some of these blocks had mason's marks such as B3, B5, B7; it was clear that we had two columns belonging to a façade. The columns were made up of nine layers, including the base and capital. Blocks belonging to an architrave and pediment were noted, although the exact relationship with the frieze was unclear. By careful drawing and measurement, a group of eleven wedge-shaped blocks were found to form part of a semi-circular arch, with a honeycomb-like decoration on the face. An eroded keystone, with possibly a lion's head on it, fitted into this arch to complete the semi-circle. Another group of eight blocks of unknown purpose were noted. Because of the difficulty in moving the blocks by hand, initial attempts to carry out reconstruction at the base camp on Beacon Island were rather disappointing.

Conservation and reconstruction of a stone gateway

At the end of the excavation, the blocks were taken to the Maritime Archaeology Department at the Western Australian Museum at Fremantle, where they were further cleaned and consolidated. Using a fork-lift truck, it was possible to rebuild small sections of the façade and check for exact matching: something that we had not been able to do on Beacon Island. It became evident, after cleaning the blocks, that the mason's marks ran from B2 to B7, and referred, in fact, to the respective layer number on the columns. Working on the pediment and architrave required a temporary reconstruction to determine the distance between the columns. From this information we found that the arch fitted under the architrave and sprang from the fifth layer of the columns. Thus at last it was possible to account for the majority of the blocks. A theoretical reconstruction showed the portico to be over seven metres high. It now became evident that blocks of unknown purpose were in fact part of the top of the wall on to which the gateway was to be mounted.

Small ceramic jar found intact on the wreck-site.
[*Photo:* Western Australian Museum.]



Stern section of the *Batavia* wreck-site showing the transom and side of the hull.
[*Photo:* Western Australian Museum.]

There were also some blocks that still did not appear to have any place in the portico at all; these included those making up the two honeycomb annuli.

At this time, a new maritime museum was being established in the old Commissariat Building at Fremantle. This historic building was originally associated with the transportation of convicts in 1851. It was decided to reconstruct the portico in the Museum's Batavia Gallery, where height and width were ideal for the purpose. The façade would frame the existing doorway.

A major problem in the reconstruction was how to hold the façade together. Most of the blocks were eroded, so that it was impossible for it to stand freely. Some form of support was therefore necessary. Furthermore, it was considered inadvisable to allow the blocks to bear any heavy weight. Since the blocks had been under the sea for 350 years, they could deteriorate in the future and therefore they had to be easily accessible for repair or consolidation. A framework was designed to support the façade: two pairs of steel columns, mounted on deep concrete foundations, were constructed and steel plates, cut out to the outline of the base of each layer of the façade, were welded on to the steel columns. Thus each layer of blocks was stood independently on its own plate, so they do not weigh down on those below, being separated by a small gap. A steel arch was also prefabricated and welded into place, with flanges to support the blocks of the original arch. A pair of girders ran between the two steel columns to support the architrave. A triangular framework was welded on to the top of the steel columns; this supported the pediment. When all the blocks had been drilled, epoxy-resin was embedded in steel studs which were attached to the supporting framework to ensure that even in the event of an earthquake, the blocks could not be dislodged. In December 1979, the last block was put in place and the façade completed—three and a half centuries late.

Hull problems

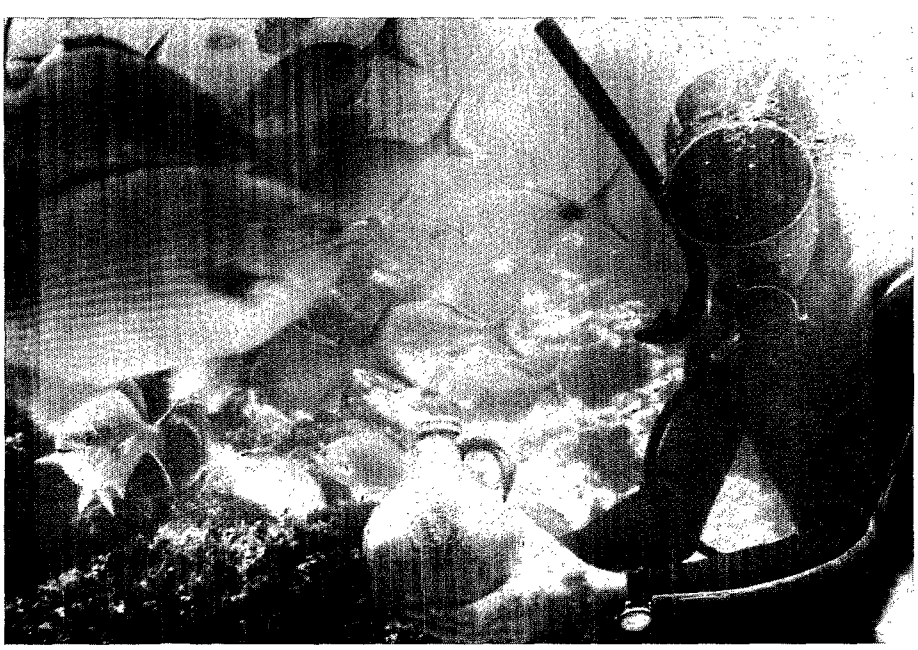
During the excavation, part of the port stern section of the hull of the *Batavia* was uncovered. This was tagged and photographed *in situ* before dismantling and removing from the site. Through three excavation seasons the whole of the remaining hull structure was removed from the site. In some cases the timbers were too long to remove in one piece, particularly the strakes. These were cut using a pneumatic chain-saw so that they could be removed in manageable pieces. As the timber arrived on the work-boat at the base camp on Beacon Island, it was immediately transferred to sea-water holding tanks. These tanks were simply holes dug into the coral of the island and lined with sand and thick polythene sheet. When the bad weather period came, as it inevitably did, the timber was taken out of the holding tanks, washed down, tagged, registered and identified. It was then accurately photographed on all sides and traced using clear polythene sheeting and felt-tipped pens. Finally, after all the recording was finished, the timbers were wrapped up in polythene tubing with water and fungicide and stored until the end of the season.

From this point onwards, we were not to see the timbers again until the end of their conservation period, up to ten years. This proved to be exceedingly frustrating and is a situation to be avoided in the future. The problem was that on return to the Maritime Museum in Fremantle they were stored by the Conservation Laboratory in tanks of fresh water until the polyethylene-glycol treatment tanks were ready to treat a batch of timber. Thus, in order to examine a particular timber at any one time, it would be necessary to completely unpack a whole tank. A better method of storage would be to store the timber in a rack which could be lifted out of the tank with a crane or fork-lift. A particular timber could then be removed from its rack without disturbing the others.

The archaeologist excavating such a site has to contend with a number of serious problems. The most significant is the inability to predict the site's working conditions from one day to the next. Because of the danger of rough seas, any material left loose on the site could be driven off, over the reef, and be lost for ever. Thus it is not possible to uncover the site completely and examine and record the full structure at leisure, or excavate layer by layer or in any leisurely manner. It was necessary to uncover very small areas and completely excavate these down to the sterile layer before moving on. A layer of semi-consolidated dead coral forms a sort of crust over the site. Once this crust is broken the site could erode quite quickly and most destructively. This made it necessary to take a different approach to the excavation, particularly with the ship's structure. As each layer was uncovered it was cleared of all overburden, sand and silt. It was then tagged according to the structure concerned: frames, inner planking, outer planking, skin, etc. Then a series of overlapping vertical photographs of the structure were taken, using a square-grid frame to give two-dimensional control. Each layer was then dismantled and the process repeated for the next layer. The system then resulted in a series of photomosaics of the whole site layer by layer, which served as an essential part in the reconstruction programme.

Thus at the end of the excavation we had a series of photo-mosaics of the *Batavia*'s hull structure under water, a photographic record of each individual timber, and a tracing of each timber to a 1:1 scale. The tracings were reduced photographically to a working scale of 1:10 and all the plans were produced on this scale. The next phase of the project was to construct a scale model of the hull structure. This was produced by the Institute of Nautical Archaeology at Texas A&M University under the direction of R. Steffy. Later, P. Hundley joined the museum staff to assist with this work. Each timber was scaled to 1:10 and fitted together to create the first research model. This gave the general shape of the hull and an impression of how it all fitted together. However, there were a number of problems with this. First, because of the small scale, some angles were not clearly defined and as a result some looseness was observed, i.e. the exact location of the side of the ship relative to the transom. It was therefore necessary to obtain a graphic solution to the problem in order to test the validity of the model. Using a plan of the transom and the known bevel angles, a calculation was made on a minicomputer to solve the co-ordinate transform, allowing for known tilts both vertically and horizontally. This served as the start of a series of projections of the hull structure. It determined the location of the strakes and formed the basis for establishing a supporting framework.

The *Batavia* project has been an extremely long and involved project—one and a half years of field work to excavate the hull and nearly ten years to treat the timbers. The reconstruction of the hull is just about to start and the project will only be complete with the final excavation report now being written. But once completed, it will give us a wealth of information about the VOC and its ships. Already information has been published which has revolutionized many aspects of the archaeology and art history of the early seventeenth century. There is little doubt that when the *Batavia* is reconstructed and housed in its own museum, it will provide a full justification for all the time, effort and money that have gone into the project. This success has been the direct result of a number of factors: the legislation protecting the wreck-site; the assistance of the Australian Federal Government and the Government of the State of Western Australia; the support of the Trustees, Director and Staff of the Western Australian Museum; and, finally, the dedication of the Members of the Maritime Archaeology Department who have participated enthusiastically over the years.



Diver with a ceramic Beardman Jug on the wreck-site.
[*Photo:* Western Australian Museum.]

A historical conundrum

What was the intended destination of the façade found on the *Batavia*?

The historical evidence indicates that the ship was being sent to the town of Batavia for the Waterport or Seagate of the town's castle. This evidence comes from two independent sources, one being the records of the decisions of the Heren XVII (Directors) of the VOC, the other from Pieter van den Broecke. The Heren XVII made brief reference to the commissioning of stonemasons, to construct the gateway for the Castle of Batavia.

In 1634, Pieter van den Broecke, who left Batavia on 18 December 1629 and arrived in Holland on 6 June 1630, published a journal of his voyages and travels. In this publication were a number of engravings by Adriaen Matham of various places he had visited. His handwritten journal still exists in the archives, and with it were found two original sketches. These two sketches are omitted from his published journal. It may be assumed therefore that originally van den Broecke or an artist that he commissioned drew the sketches. During the printing of his journal, all the sketches were given to Adriaen Matham for engraving, except for the two that remain with his journal. The others no longer survive, but it is certain that Matham would have worked from the original material. The importance of all this is that one of the engravings shows a bird's-eye view of the fortifications of Batavia. In the foreground is the castle, showing the Waterport unfinished with scaffolding and a ladder in place. The original sketch is possibly by van den Broecke himself. It is highly indicative that the façade on the *Batavia* which was due to arrive at the capital in July 1629 was destined for the Waterport. The first illustration of the completed Waterport appears on the gold pendant of Governor General Jacques Specx, dated 25 November 1632. On it, the town of Batavia can be clearly seen, with the Castle and Waterport in the foreground. A later illustration from the Vingboom Atlas shows the Waterport quite clearly. This is the best illustration of the Waterport that has been found so far. It shows that our reconstruction is similar to the one that replaced it. Obviously, following the loss of the first façade on the *Batavia,* another was ordered; this is the one illustrated in the Specx medallion and the Vingboom Atlas.

This gateway served for over a hundred years as the main entrance to Batavia. Out through these portals passed the spices of the East, destined for the markets of Amsterdam and Europe, and in their place came silver, to fund the company's operations. Oddly, this silver was mainly Spanish in origin, and came from the mines and mints of South and Central America. Through these portals, too, passed servants, slaves, emperors, princes, the rich and the poor. If the company's employees survived the unhealthy climate, they returned home richer.

In 1756, the company decided to improve the external appearance of the castle. The Waterport was demolished and replaced by a more imposing, though by our standards a rather tasteless, entrance. By an odd coincidence, the stones from the old gateway were taken to Ambon and incorporated in the main gate of Fort Nieuw Victoria, which still stands.

There are, as with all good stories, still a number of unsolved mysteries. The records state that the Waterport was finished in 1630 but this is far too soon for a new façade to have been sent out from the Netherlands. Perhaps there were alterations to the plans. There are still a number of blocks which have no obvious place in the reconstruction. What were they intended for? However, one puzzle that this reconstruction has solved was the use of six curious large bronze wishbone-shaped objects. For a number of years these objects from the *Batavia* mystified everyone who examined them. Suggestions as to their purpose ranged from obscure ship's mast fittings to swivels for ice-boards on the ship's boat. None of the suggestions was convincing. One day the penny dropped. They were in fact the pintle or hinges for the two massive doors that would have hung between the pillars of our gateway.

The Shinan shipwreck [1]

Kim Ki-Woong

Born in 1923. Graduated in archaeology from Waseda University, Japan. Ph. D. thesis on the ancient tombs of the Kaya Kingdom. At present, expert and senior consultant, Cultural Properties Preservation Bureau, Republic of Korea. His publications include *Ancient Tombs of the Silla Dynasty; Ancient Tombs of the Paik-Chae Dynasty* and *Rock Art and Tombs on the Korean Peninsula.*

In 1976 two fishermen brought up Chinese ceramic vessels—authentic Yuan celadons—at Shinan-kun on the south-western coast of the Republic of Korea. Upon receiving a report on the find, the Cultural Properties Preservation Bureau and the Navy quickly organized a team to excavate the ancient ship that lay submerged there. The size of the vessel was estimated to be 28.4 metres long and 6.6 metres wide.

Archaeologists in the Republic of Korea had no previous underwater experience. Extreme tides create highly dangerous currents at the site and visibility is practically nil. Hence the excavation was an arduous undertaking. Aluminium grid frames were installed directly over the sunken ship: these were in two-metre squares to guide exploration square by square.

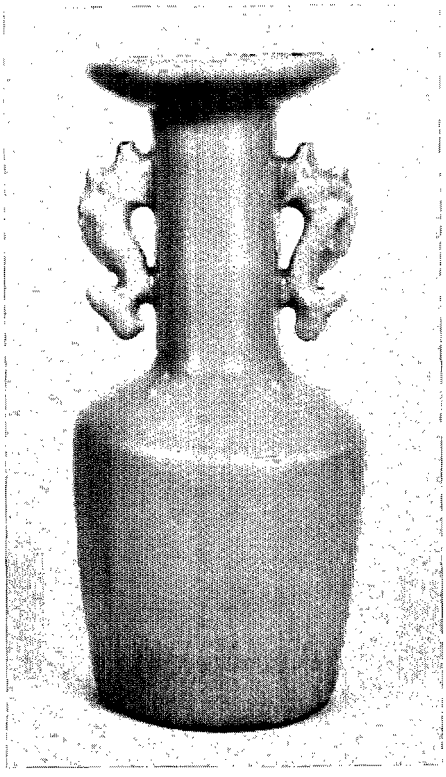
The first excavation was carried out in 1976; since then eight seasons have been held. Much of the ship was buried in the mud. From its bowels and from the mud layer thousands of artefacts have been recovered: 8,838 pieces of celadon, 4,585 white porcelain objects, 341 pieces of black ware (*ten-mokku*), and other earthenware and stoneware items, as well as metal, stone and wood objects. Archaeologists of the Cultural Properties Preservation Bureau have been in charge of the recovery work and have recorded all the relevant archaeological information during the successive seasons. Objects have been sent to the conservation laboratory of the National Museum in Seoul after being initially treated at Shinan.

Tons of timber (more than 200 mahogany logs up to two metres long) have been removed from the wreck. The presence of this cargo as well as the other materials of both Chinese and South-East Asian origin indicate that the ship had sailed at least as far as central China and even to South-East Asia. It was returning with its valuable merchandise to trade in Japan and Korea when it was probably shipwrecked in a storm.

Among the artefacts so far discovered, porcelains predominate. The Kryo celadons found are thought to be of the twelfth and thirteenth centuries, while the Chinese celadons could be dated a century later. Most of the latter are the products of the Lung-chien kilns in Chekiang province. The white porcelains seem to have been fired mainly at the Ching-t'e kilns in Fukien and Chekiang provinces. The black-glazed ware found is either the common black type or the *ten-mokku* (iron black). In the former group, brownish black cups are predominant; in the latter some are made from black-clay base, while others are made from beige-clay base with *ten-mokku* glaze added. In addition, there are some earthenwares and stonewares, and cooking utensils.

Among the metal objects are bronze, silver, lead and iron vessels, although these are few in number compared with the thousands of pots. There are also bottles, mirrors, incense burners, sinks, lamp-stands, saucers, dishes, trays, dipper and cauldron sets, *ho* pots, pots, drums, drum hammers, shovels, locks, kettles, candle stands, knife handles, pin-sets, bowls, bells, and miscellaneous other kitchen utensils. Utensils, in particular, require prompt conservation work and, as soon as they are taken out of the water, they are treated directly at the site and then taken to the conservation laboratory of the Cultural Properties Preservation Bureau in Seoul to be properly conserved.

The stone objects consist of inkstones of various types, whetstones, millstones and bowls. Wooden artefacts are scanty, probably because of deterioration in the water. Some of the wood fragments have been identified as having been used as containers for the pottery; others are remains of lacquer works and food vessels. The wood containers comprise square, oblong or cylindrical boxes, several of which were found remarkably intact. Lac-



Blue celadon jar (*Ch'ing-pai* type) with carved dragon handles recovered from the Shinan shipwreck.
[*Photo:* Kim Tae-byŏk.]

1. This text was translated from Korean by Kim Byung-mo and revised by W. A. Simpson.

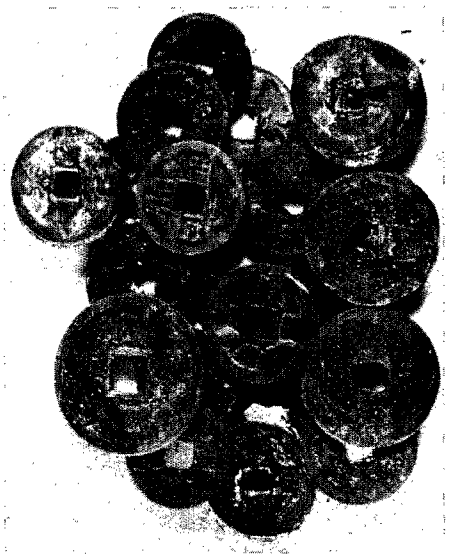
quer pieces include bowls, cups and cases for inkstones.

Among the food remains, the excavation team identified seeds, including peppercorns, peach stones and beans, cinnamon, fragrant wood, incense, etc.

Tons of Chinese coins were excavated which give us important information as to the date of the shipwreck. Among the coins, the earliest were minted during the Sui (A.D. 581–618) or T'ang dynasties (A.D. 618–906), while the latest are the Chi-dai T'ung-bao, which are dated 1310 (the third year of the chronological era Chi-dai of Yuan China). This confirms that the ship was sailing during the early Sung period and is therefore one of the oldest extant examples of its kind. The reconstruction of the ship would, no doubt, contribute significantly to the study of the world's ancient vessels, while study of the various objects recovered should shed much light on the history of Chinese porcelains and the history of medieval international sea trade (see box). Hence, specialists are now trying to bring it up piece by piece and re-assemble them into a complete structure.

Some of the finds are already on display at the Kwangju National Museum, Kwangu City, Cholla Namdo province. Excavation is expected to be carried on for several years more. In 1982 a special conservation laboratory was set up at the site itself.

[*Translated from Korean*]



These Chinese coins (*Chi-dai T'ung-bao*) are of the latest date among those found at the site. They were minted in the early fourteenth century and have enabled archaeologists conclusively to date the vessel.
[*Photo:* Kim Tae-byŏk.]

The Shinan shipwreck excavation: a few pieces among the thousands of Chinese pottery and porcelain items being recorded by archaeologists on the site.
[*Photo:* Cultural Properties Preservation Bureau, Seoul.]

In 1978 archaeologist Donald H. Keith was sent by the National Geographic Society, on the recommendation of the Institute of Nautical Archaeology, to the Republic of Korea to assist excavators at the site. In an article entitled 'A Fourteenth-century Shipwreck at Sinan-gun', written for the New York-based magazine Archaeology *(Vol. 33, No. 2, 1980) Keith discussed many fascinating aspects of the excavation and its lessons for archaeologists (see also his article 'A Fourteenth-century Cargo Makes Port at Last',* National Geographic Magazine, *Vol. 156, August 1979. The following extract is reproduced with the kind permission of* Archaeology *magazine (the author's spelling of the name of the site is based on a different system of transcription of Korean).*

Very little is known about hull construction and other aspects of nautical technology in the Orient before the arrival of the Portuguese in China during the sixteenth century and the subsequent sustained contact with Europeans. A few basic facts were known about the state of Chinese seafaring technology in the Medieval period. Chinese ship hulls were built without keel, stem or stern-post. They had flat or slightly rounded bottoms which curved upward markedly at both ends. Their ends were squared off, rather than pointed, which while a useful characteristic for river craft, detracted from their seaworthiness and sailing efficiency, rendering them unsuitable for ocean navigation. Chinese ships differed from Western ships internally in the use of watertight bulkheads, rather than frames or 'ribs'. Finally, Western nautical specialists have frequently asserted that the traditions and techniques of ship-building in China evolved independently from and contributed surprisingly little to those of the rest of the world.

The evidence forming the foundation for all of these tenets was derived from three areas of investigation: historical literary references, artistic depictions and modern observations of contemporary Chinese watercraft. Yet in all cases, the evidence is ambiguous to some degree. The first opportunity to check the

accuracy of these assumptions concerning Medieval Chinese sea-going ships came in 1974, when Chinese archaeologists discovered and excavated a large Sung merchant vessel in a field by the shore of Ch'uanchou Bay in Fukien province.... With an overall length of 34.6 metres, breadth of 9.8 metres, hull depth below the waterline of 3 metres, and a displacement of approximately 374 tons, she was comparable in capacity to the largest known European merchant ships from the period, for example, the *Paradisus Magna* and the *Oliva,* both of which dated to approximately A.D. 1250 and hailed from Venice, Italy. Possessing a pointed bow, squared-off stern, three masts, a modern-looking balanced stern rudder and an internal 'skeleton' utilizing both bulkheads *and* frames, the Ch'uanchou ship also had a deep V-shaped bottom and true keel firmly attached to her up-sweeping stem post. There was nothing tentative or prototypical about the ship's unexpected features. They were obviously the result of a long evolution of technology. Did the invention of these traits and their subsequent integration and evolution occur independently in the Orient or did they diffuse from the West?...

The documented construction features of the Sinan ship's hull coincide closely with those of the Ch'uanchou vessel, providing additional evidence for the existence of a hitherto unsuspected tradition of Chinese sea-going ship construction. More significantly, there is every reason to believe that the hull remains of the Sinan ship may be more extensive than those of the Ch'uanchou vessel and potentially more revealing.

The Sinan ship has already proved to be perhaps the richest ancient shipwreck ever found, both in terms of the modern value and quality of the cargo as well as the completeness and uniqueness of the archaeological information. But it is also one of the most difficult and hazardous underwater excavations ever attempted. Ironically, the very conditions that preserved the ship and her cargo for more than 600 years now thwart precise scientific excavation. Discovery of the ship has put archaeologists in a difficult position. Her rich cargo demands swift salvage; her unique hull pleads for careful scientific study and reporting. Realizing the potential significance of the Sinan discoveries, Korean officials are presently enlarging a newly constructed museum in Kwangju to accommodate both the cargo and eventually the conserved and reconstructed hull itself. There the ship and her contents will be placed on permanent display —her last port of call after six-and-a-half centuries beneath the Yellow Sea.

From Polish waters

Przemysław Smolarek

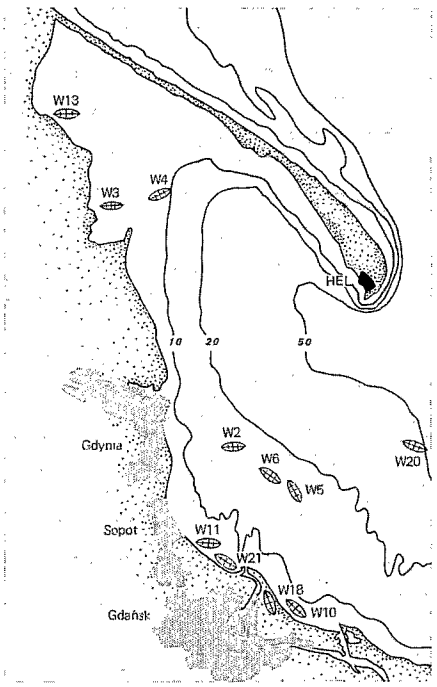
Born in Łódź in 1925. Studied at the Jagiellonian University in Cracow. M.A. (Phil.) 1948, Ph.D. 1950, Dr. Habil. 1969, Docent 1975. Keeper of the Maritime Department of the Muzeum Pomorza Zachodniego in Szczecin. Organizer of the Polish Maritime Museum in Gdańsk and director since its establishment in 1960. Initiator of Polish underwater investigations in the Baltic. Author of books and articles on the history of shipbuilding and museology. From 1965 a member of the ICOM Committee for Transport Museums, and from 1968 member of the Board of the International Association of Transport Museums; chairman of the IATM since 1977.

Polish underwater archaeology in the Baltic commenced relatively late. There were several reasons for this, including the long-term partition of Poland, which lasted until 1918, and the fact that after the First World War, Poland regained only a small, bare stretch of coastline.

At the beginning of the 1920s, work was taken up to organize the maritime economy in the region and build a port at Gdynia, then only a village. Remains of old boats and ships were found during the excavation of the port basins and approach roads. The greatest interest, at that time, was aroused by a wreck found by the dredger *Warszawa* in 1928. Classical divers were employed to investigate the condition of the wreck, dated tentatively to the seventeenth century. The result of this and other work was, however, primarily the gathering of objects—it would be incorrect to speak of methodical underwater research. In the late 1930s, attempts were made to take up underwater investigations inland, beginning with the well-known archaeological investigations at Biskupin. The Second World War not only brought this evolution to a standstill, but, much worse, resulted in drastic losses.

Over the centuries, historical-maritime collections had been built up in the port towns of the southern Baltic such as Gdańsk, Kołobrzeg and Szczecin. Unfortunately, during the war, the old districts of these towns, not to mention many other towns and settlements on the coast, were badly damaged. This resulted in the loss not only of museum collections but also of an almost inestimable number of interesting artefacts relating to shipping, shipbuilding, fishery and seascape paintings from the homes of merchants and sailors, old town halls, seats of shipping enterprises, etc. Only a very few fragments of such groups, or single objects —usually more or less damaged—survived the war by being scattered throughout the whole country. It should be added that the very modest maritime museums, or maritime departments of historical or technical museums, which existed in Poland prior to 1939, were destroyed during the war.

Chart showing the location of several wrecks now being investigated by the Maritime Museum, Gdańsk. [*Drawing:* L. Nowicz.]



New beginnings

Thus it was necessary after the war to set up maritime museums from the very foundations. The first such institutions, organized after 1945, underwent various vicissitudes; at the close of the 1950s there was no maritime museum of any size in Poland. The turning point was the establishment in 1960 of the Maritime Museum in Gdańsk.

Created from rock bottom, the museum began to build up a collection: surviving relics of former collections scattered throughout the country as well as exhibits illustrating contemporary problems; from their very nature, these began to accumulate fairly rapidly. As regards the historical-maritime objects, it was understandable that they would have to be completely new collections. One of the main paths leading to them would obviously be underwater archaeology.

Such was the genesis of the underwater investigations taken up by the Polish Maritime Museum in Gdańsk. The starting point was thus, on the one hand, the desire to create new historical-nautical collections and, on the other, an attempt to compensate—naturally only to a modest extent—for those lost in the Second World War.

With the intention of taking up underwater investigations in the Baltic, which were to become a permanent form of the museum's activities, we began to work out the conceptional, organizational and technical bases for such a programme. This work was preceded by historical-archival studies, for the purpose of drawing up a register of maritime catastrophes in Polish territorial waters and an analysis of the hydrological conditions in these waters.

The programme was conceived in several stages. In the first phase, we wished to establish suitable organizational and technical foundations. Thus an Underwater Research Centre was to be set up in the museum and have at its disposal a research vessel, conservation laboratory, etc. Taking into account the Polish coastline it is only in certain cases that investigations can be conducted from the shore. Apart from this, we found it necessary to have our own vessel in order to ensure regular work on a wider scale.

The second stage was foreseen as the drawing up of 'inventory charts' for the territorial waters. It was only in the third phase that, on the basis of these charts, it was intended to begin systematic exploration of selected, interesting objects. I consider such selection to be essential. Underwater research, and particularly the conservation of large, wooden objects raised from the sea-bottom, is both labour-consuming, expensive and—as a matter of fact—unending.

Surveys made for the purpose of drawing up the inventory charts—those of Gdańsk Bay first—were begun in 1968. The bay was divided into sectors which were successively and systematically penetrated.

Wrecks located during surveys, or of which the museum was notified by fishermen or hydro-engineering enterprises, were entered on to the chart and given codes (e.g. W–1, W–2, etc.) Each find is, of course, given its own file containing relevant documentation and, among other things, opinions as to the value of the find and suggestions as to further proceedings.

Underwater material identified

The wrecks located so far are of varying value and originate, of course, from different periods. Their state of preservation also differs. In general, of wrecks lying at depths of about 20 metres, only parts of the bottom or part of one side usually remain. Objects lying at greater depths are as a rule much better preserved. This phenomenon has also been observed in other regions of the Baltic.

According to the initial plan, we were to have started systematic excavation of located wrecks only in a later phase. In several cases, however, specific circumstances forced us to change our approach.

For instance, in connection with the building of the so-called North Port at Gdańsk, vessels belonging to the port administration came across several wrecks whilst trawling the sea-bottom of the outer port. Further wrecks were found during dredging of the port basins. Since the building of the port could not be held up it was necessary to take up salvage work immediately. In one or two cases, salvage became systematic excavation—anchorage. To have left the wrecks there would have led to their destruction. Meanwhile, initial reconnaissance proved them to be of outstanding value.

One of them, coded W–5, lay in Gdańsk Bay at a depth of about 16 metres, about 5 kilometres to the north-east of Gdańsk, situated 54° 27′ 94″ N. and 18° 42′ 65″ E. It turned out to be the wreck of a fifteenth-century merchant ship, probably a hulk, of a type popular in the later Middle Ages on the routes

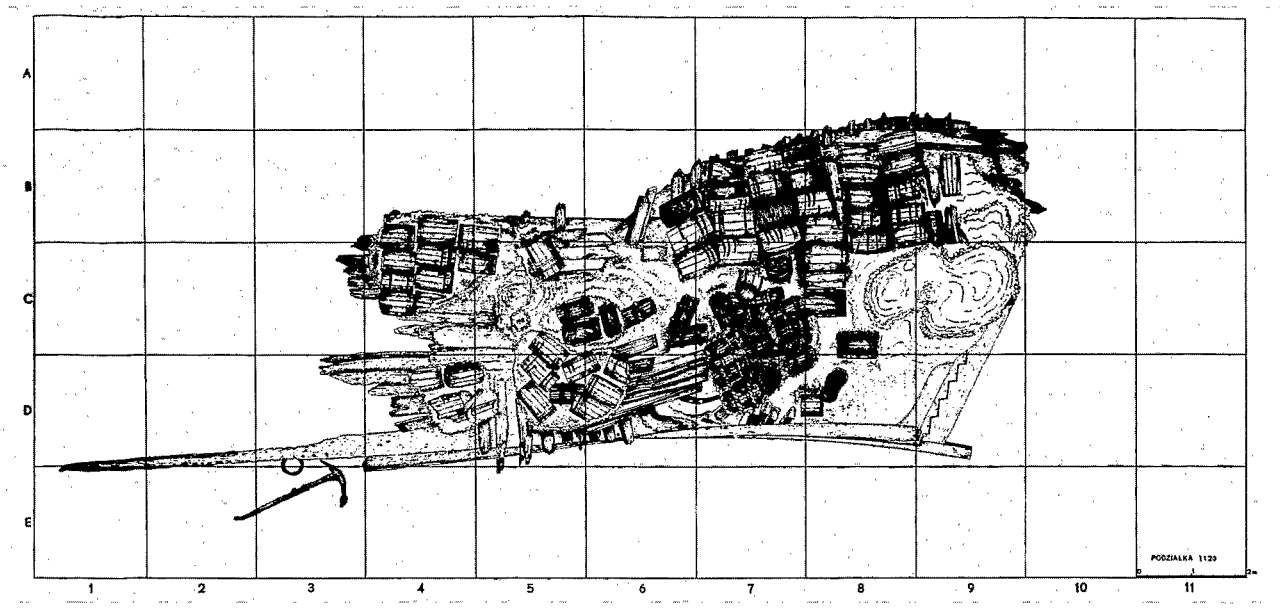


Diagram of the E–5 wreck, showing the back of the starboard side and the outline of the buried cargo.
[*Drawing:* L. Nowicz.]

between the Baltic and North Seas. The ship sank shortly after leaving the port of Gdańsk, where she had taken on cargo. A substantial, very well-preserved part of the cargo constitutes a group of artefacts of particular value to the museum. These include goods which for centuries were typical of the Polish export trade as well as goods which passed in transit through Poland in the Middle Ages. They consist primarily of forest and mining products, and include large quantities of various kinds of timber, such as staves used in the production of barrels, so-called splintered oak, etc. Over 100 barrels in varying states of preservation were found. These were used to carry pitch, wood-tar, tar, potash, resin, wax and iron ore. Each barrel had its own mark and some of these belonged to merchants from Toruń on the Vistula. The ship also carried copper in characteristic slabs, bundles of iron bars tied together with brass bands, etc. Most of the cargo lay as it was originally stowed, stiffened with wedges. This find provides valuable information on shipbuilding in the later Middle Ages, on trade, on shipping and stowage techniques, etc. After the relevant documentation had been drawn up on the sea-bottom, the wreck was raised in 1975. This was, incidentally, the first raising of such a wreck in Poland.

The second wreck systematically investigated was the W–6, which lay at a depth of about eighteen metres, several cables away from the W–5. As the result of investigations conducted, it has been assumed that this was the Swedish orlog *Solen*, which was sunk in the famous sea battle between the Polish and Swedish fleets off Oliwa on 27 November 1627. For this reason, the field investigations were followed by the Polish public with great interest.

After having conducted the underwater surveys, drawing up the necessary documentation and raising all the objects (several thousand items altogether), the wreck was towed with the necessary technical preparations from its original underwater site, where it was in danger of suffering damage from ships anchoring, to a safe region in the bay. The possible raising of the hull remains was considered inexpedient, at the time, as the ship originated from the same period as the *Wasa*, was also a product of the Dutch shipbuilding school, and was employed in the same Swedish fleet. What is more, only the bottom part remained. Should the necessity arise, in the future, to raise, or carry out further investigations of the wreck, it will be possible to do so without great difficulty.

Wet-site and inland waters

Without mentioning other wrecks investigated in the waters of the bay, let us just say a few words about objects discovered in the earth. These wrecks sank centuries ago in the region of the former roads of the port of Gdańsk. Over the years, as the result of 'land accretion', part of the roadstead, silted up, became shoal. Thus the wrecks lying in the region were covered under layers of mud and sand, under the sea-bottom. Part of the roadstead was transformed into dry land and the wrecks were absorbed.

During excavations of the North Port basin, dredgers and excavators struck upon quite a number of such objects (e.g.

Several copper plates such as this were found on the E–5.
[*Photo:* L. Nowicz.]

The 'horseman' head from the E–5. [*Photo:* E. Meksiakowa.]

W–7, W–8, W–9, W–10, W–11, W–12, etc.). The wrecks discovered on land were also investigated by the museum.

The museum also conducts investigations in inland waters, e.g. in Lake Głębokie in Pomerania and at Tolkmicko on the Vistula Lagoon when a 'cemetery' of thirteenth- to sixteenth-century wrecks was found. It also participates in investigations carried out by the Muzeum Archeologiczne (Archaelogical Museum) of Gdańsk, at Gniew on the Vistula, where traces of a medieval port were found. Generally speaking, however, inland underwater investigations are carried out by other institutions. Recently, following the establishment in the 1970s of a special centre at the University of Toruń new prospects appear to be opening up for underwater archaeology.

Underwater materials naturally create problems of conservation and storage. The necessity of salvaging the W–5 and W–6 wrecks meant that the museum was faced with these problems earlier than it had expected. Our experience has confirmed that not only must a selection be carried out among the objects to be investigated under water, but also among those to be raised and preserved. This concerns, in particular, the remains of ship hulls and other large structures. There is, of course, no universal prescription, as each object requires individual evaluation of its museum and scientific value. The rule accepted by our museum, in the majority of cases, is that detailed documentation of the hull is drawn up under water, the cargo, fittings, etc., being raised and subjected to conservation. Specific qualities may constitute the decisive factor influencing the eventual raising from the water of hull remains or parts. Even in such cases, after being examined on the surface, these elements may be placed back on site, or in a 'natural storage', in conditions as similar as possible to those of the environment from which they were taken.

In this connection it is worth giving a brief description of the documentation of our research. As regards methods, these are adapted to suit the character of the particular objects, the result being, naturally, the investigations log, field acquisition book, drawings, photographs, records on video-tape, photogrammetry, etc. The documentation as a whole is conceived so as to enable those interested, in the future, to trace the progress of investigations on a particular site step by step, and the work technique, and simultaneously supply an original image of the wreck and its elements *in situ*, layer after layer.

The results of excavations carried out so far encourage their continuation. The initial reconnaissance of several more wrecks, entered in our inventory chart and awaiting exploration, has also led us to suppose that they offer the museum and Polish maritime museology as a whole a chance to obtain significant additions to our nautological collections. Our work has also encouraged other Polish institutions to follow in our footsteps.

In the next few years, the museum intends to continue drawing up inventory charts and to take up work on the wrecks lying at greater depths and in the waters outside Gdańsk Bay. The most important undertaking will certainly be the excavation of an eighteenth-century wreck, W–20, lying at a depth of about 55 metres off the tip of the Hel Peninsula. The hull is in very good condition; the masts are broken, but they are set in their steps and partners. It is planned to tow the hull under water to a lesser depth and there to explore it systematically.

There are numerous problems still awaiting solution. One of these is that of the legal protection of objects lying in Polish coastal waters. The law covering museums and protection of cultural values makes no mention of relics lying in the sea.

[*Translated from Polish*]

Riches on the Caribbean sea-bed

Pedro J. Borrell

An architect by profession, he is a founder of the photographic group Jueves 68 and of the Grupo de Investigaciones Submarinas (GIS). He is at present executive secretary of the Dominican Republic's Commission for Underwater Archaeological Rescue Work. Author of the book *Arqueologia submarina en la Republica Dominicana* (Underwater Archaeology in the Dominican Republic) and numerous articles on general marine topics.

Thousands of ships were wrecked in the Caribbean during the three and a half centuries of European colonization of the Americas. Over the centuries they have fascinated countless 'treasure hunters' who pinned their hopes on finding the huge treasures of gold, silver, pearls and emeralds that were sunk in the legendary Spanish galleons that never reached port in the mother country. The remains of those galleons and their cargoes are still scattered along many Caribbean reefs.

Recently, however, there has been a new and different upsurge of interest in underwater archaeology in our waters. In fact the recovery of sunken cargoes started right from the early sixteenth century. Nations such as Spain and England even set up salvage squads in certain strategic ports such as Portobello, Havana, Veracruz and Port Royal. In some instances, when the shipwreck occurred in relatively shallow and calm waters, these salvage squads successfully managed to retrieve most of the cargo and equipment. However, for most wrecks such salvage operations, or attempts at plunder, were a failure. Many cargoes were lost and remained submerged for hundreds of years. They included not only treasures from the colonies but also a large number of personal belongings and different types of goods which fed the vast maritime trade between the Old and New Worlds.

Although there have recently been a few chance discoveries, experience has shown that locating these wrecks is a complicated matter, requiring not only nautical skills and knowledge of salvage techniques but also extensive research in archives and chronicles and on the wreck-sites.

Actually, very little systematic underwater archaeological work has been carried out in the Caribbean, since it has concentrated only on Port Royal, Jamaica, and a few isolated wrecks.

The Dominican Republic has played little part in these activities, despite the fact that historical records show that since 1492 several hundred shipwrecks occurred off the coast of Hispaniola. In the years following the discovery of the island, and during the first three decades of the sixteenth century, before the large-scale continental conquests, Santo Domingo was a destination or port of call for all ships coming to the New World. Hispaniola served as a focal point for the conquest of the whole of South America.

An average of 60 to 100 vessels stopped at the island every year and many of them were wrecked on its coasts and reefs. Among them were: Columbus's caravels *Marigalante* and *Gallega* in 1494 sunk off the island of Isabela, the first Spanish settlement in America; Columbus's caravels *San Juan* and *Cordera* and four ships belonging to Juan de Aguado sunk in a hurricane off the island of Isabela in 1495; twenty ships of the fleet returning to Spain, including the flagship *El Dorado* wrecked on the east coast of the island; and finally, in 1584, the slave galley *Santiago* ran aground near Isabela. Many of these wrecks are among the oldest that the continent has known. The discovery in 1976 of the wreck of the galleon *Nuestra Señora de Guadalupe*, sunk off the north-eastern coast of the Dominican Republic, led to a series of activities directly related to the country's colonial maritime past. In that year the

Federico Schad, a member of the Grupo de Investigaciones Submarinas (GIS) and adviser to the commission, taking samples of the mercury still to be found in the chests and barrels in which it was packed from the wreck of the *Tolosa.*
[*Photo:* Comisión de Rescate Arqueologico Submarino.]

Museo de la Casas Reales in Santo Domingo launched a pilot project to salvage that part of the Dominican cultural heritage that is still submerged in its territorial waters and which is of great historical and museographical value. So far excavations have been carried out on the following five wrecks: *Nuestra Señora de la Concepción,* a Spanish galleon sunk in the Banco de la Plata in 1641; *Nuestra Señora de Guadalupe* and *Conde de Tolosa,* Spanish galleons sunk in the Bay of Samaná in 1724; the *Scipion,* a French warship sunk in the Bay of Samaná in 1782; and the *Diomède,* a French warship sunk by a British squadron during the Battle of Palenque in 1806.

These five vessels differed greatly from one another in their construction, the uses to which they were put, and the type of merchandise, equipment, passengers and crew on board at the time of the disasters.

The Spanish galleons can be divided into two categories: those on their way to the New World and those returning to Spain. The former, which were settlers' boats, carried objects used in everyday life: utensils of ceramic and glass, religious objects, musical instruments, tools for use in agriculture, mining, masonry and carpentry, kitchen utensils, furniture, medicines, ironware and, above all, an abundance of personal effects. Galleons returning to Spain were laden, on the other hand, with treasure—gold, silver, precious stones, pearls, Indian artefacts, and perishable goods such as tobacco, cochineal, indigo, cotton, rum, chocolate and wood.

It is quite common to find among the wreckage of a galleon iron anchors, various types of guns and light weapons, part of the ship's iron fittings, nails, carpentry tools and navigation instruments, ropes, wooden pulleys and, in some cases, the remains of the wooden structure of the hull.

The waters of the Caribbean were also frequented by other types of vessel: merchant ships, warships, pirate ships, slave ships, galleys, tenders, brigantines, schooners and other smaller craft. Many of them were wrecked off Hispaniola and their remains have not yet been brought up to the surface to provide a faithful record of centuries past.

Very few wooden structures from the hull and superstructures of these ships have survived intact. An exceptional case is the wreck of the galleon *Nuestra Señora de Guadalupe* the lower part of whose hull was preserved intact as it was buried in the muddy ocean bed. It is 36 metres in length, 10 metres broad with a draught of 2.5 metres. Inside it were found the lower sections of the ballast holds designed to transport mercury and hundreds of wooden chests containing iron nails and various metal objects. In the fore and aft holds there were various types of merchandise, including hundreds of crystal glasses still in their original packings. The state of conservation of this wreck makes it unique in the Americas. It is of great historical and archaeological interest since the ship was specially built to carry mercury, 400 tons of which, intended for use in the mines of New Spain, were on board when the ship, together with the *Conde de Tolosa,* went down in a storm on the northern side of Hispaniola.

Caribe Salvage S.A., a company working under contract to the Government of the Dominican Republic, has been working on the wrecks for several years. These efforts have resulted in the recovery of the most varied and comprehensive collection known to date of objects from eighteenth-century shipwrecks.

The *Tolosa* turned out in fact to be a more interesting wreck than the *Guadalupe,* for the latter sank near the coast and some of its cargo was salvaged immediately after the disaster. The fishermen who discovered it in 1976 also recovered many objects, most of which are now in the possession of private collectors. The *Tolosa*, however, ran aground on some reefs, sank completely and was covered by sand which has preserved the entire wreckage to the present day. This galleon had a displacement of 1,500 tons and was carrying 600 passengers and crew. Its holds contained vast quantities of supplies and personal belongings. Thus, 258 years after its sinking it was possible to recover an amazing quantity of personal effects and everyday objects.

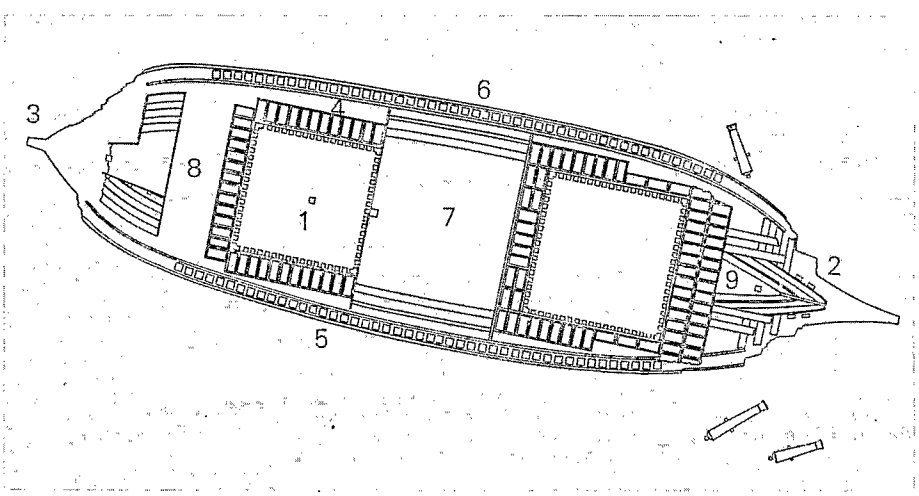


Diagram of the remains of the hull of the galleon *Nuestra Señora de Guadalupe*, after the survey made by Caribe Salvage S.A. This lower part of the hull is still intact, awaiting future studies on its structure and the construction methods used. (1) Mercury hold—the mercury containers were aligned on a plank, around which were chests containing thousands of iron nails and fillings; (2) poop; (3) prow; (4) inner lining of the hull; (5) outer lining of the hull; (6) main timbers; (7) main hold; (8) amphorae; (9) glassware; (10) cannons. [*Drawing:* Comisión de Rescate Arqueologico Submarino.]

Chests and barrels in which mercury was packed were discovered still with traces of the metal inside and buried under tons of sand and coral. Although there are documents which explain how the Spaniards packed mercury for sea transport, this is the first time that a wreck has been found with this metal still in its original containers.

In November 1978, the researcher Burt Webber, working under contract for the Government of the Dominican Republic, discovered the remains of the legendary galleon *Nuestra Señora de la Pura y Limpia Concepción.* Flagship of the fleet that was on its way back to Spain in 1641, it was caught off guard, along with thirty other ships, by a hurricane in the Florida Strait. The galleon suffered severe damage and on its way to Puerto Rico for repairs ran aground on some reefs to the north of Hispaniola. As the years passed those reefs began to be known as the Banco de la Plata, because of the large quantity of silver that the ship was carrying in its holds.

After almost three and a half centuries, the wreckage of the *Concepción* was found to be scattered among the large masses of coral that form this bank, at an average depth of 15 metres. The wooden structure had disappeared and only a few fragments of iron fittings and of the cargo remained as evidence that a ship had been wrecked in that area.

Webber's divers made planimetric and topographical surveys of the area and put together all the objects they had located, thereby obtaining a relatively clear idea of how the tragedy occurred. This substantiated the seventeenth-century records and documents in which the different aspects of the event were described.

One of the most interesting finds in this wreckage was the false bottom of a wooden trunk containing 1,440 silver coins and eight reales, perfectly placed and aligned, and welded together to form a solid slab 60 × 120 centimetres. It is obvious that they were being smuggled in this way so as to avoid payment of the taxes due to the King.

Three bronze nautical astrolabes were recovered from the *Concepción.* These instruments along with the dividers, octant, cross-staffs, sundial, compasses and sounding-lines recovered from other wrecks, were extremely helpful in studying the navigation techniques used in Spain. The Dominican Republic now possesses a fine collection of seventeenth- and eighteenth-century navigation instruments.

A large number of ceramic objects were recovered from the various wrecks: large earthenware jars, plates and dishes, cream-jugs, glasses, and various personal effects and everyday objects.
[*Photo:* Comisión de Rescate Arqueologico Submarino.]

The excavations now under way are being directed by the Comisión de Rescate Arqueologico Submarino (Commission for Underwater Archaeological Rescue Work). The commission's aims are: to recover cultural property submerged in the territorial waters of the Dominican Republic; to compile an inventory of wrecks of historical interest; to identify underwater archaeological sites; to preserve and restore the wrecks salvaged; and finally, to display a selection of objects in museums for educational purposes and as a focus of interest for tourists. [1]

The commission's immediate plans include setting up a Colonial Maritime Museum in Santo Domingo and training Dominican personnel to undertake archaeological and conservation work.

Although the commission at present has a few conservation laboratories, economic and technical problems have made it difficult to give objects recovered from wrecks the appropriate treatment and many of them, especially those made of wood and iron, are still being kept in large water-filled vats, awaiting treatment, preservation and exhibition.

The geographical location of the Dominican Republic and the large number of historic wreck-sites in its waters would, when circumstances permit, make it the ideal centre for historical and archaeological activities concerned with the fascinating colonial maritime history of the whole Caribbean area.

[*Translated from Spanish*]

1. The creation of a regional centre for the restoration of underwater materials is also envisaged in view of the finds that future archaeological exploration is bound to bring in.

The Mary Rose Tudor Ship Museum[1]

Richard F. Harrison

Joined the museum profession in 1953 and, after a number of museum posts in York, Stevenage and Bradford, joined the Museum and Art Gallery Service for Yorkshire and Humberside in 1963 as display and publicity officer and subsequently as its first director. In 1970 he was appointed first Director of Area Museum Service for south-eastern England. Appointed director of Portsmouth City Museums and on the formation of the Mary Rose Trust in 1979 became its Executive Director. Fellow of the Museums Association; Churchill Fellow, 1967. He has written a number of articles and papers on museum philosophy.

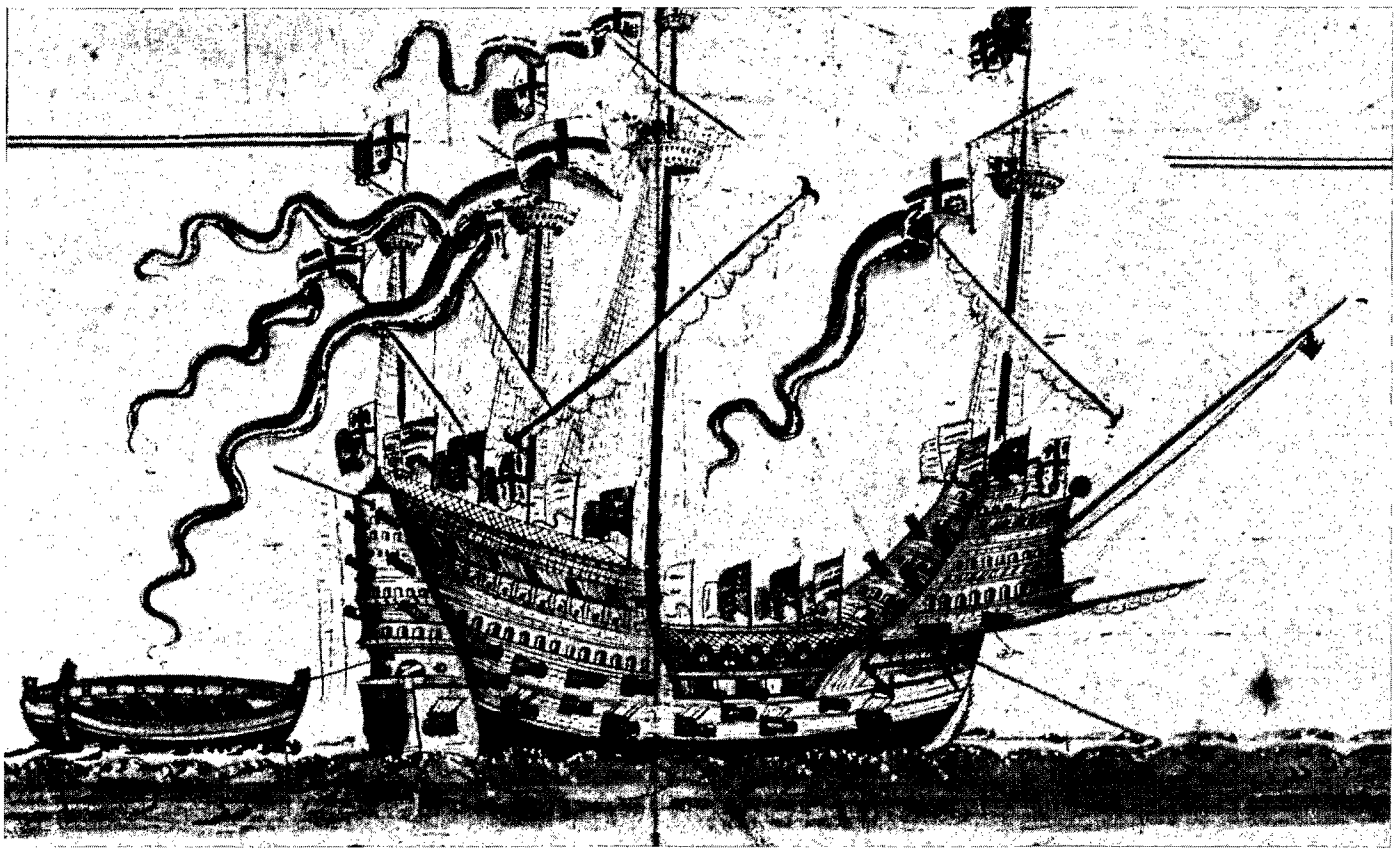
In the autumn of 1982 the world's most ambitious underwater archaeological operation reached its climax with the raising of Henry VIII's favourite warship, the *Mary Rose,* from the sea-bed mud of the Solent, between Portsmouth and the Isle of Wight, where she had lain since 1545.

When maritime archaeologists discovered the ship in 1967, they uncovered a time capsule of Tudor life. The 700-ton Portsmouth-built carrack was the pride of Henry VIII's fleet. She was also of a new type, and it was probably a combination of poor handling and overloading that led to her foundering during a skirmish with a French invasion fleet. The 130-foot (40-metre) ship sank in full view of the King. Her normal complement of soldiers and sailors was 415, but there are thought to have been as many as 700 on board. Fewer than 40 survived. King Henry is said to have heard the cries of his drowning men.

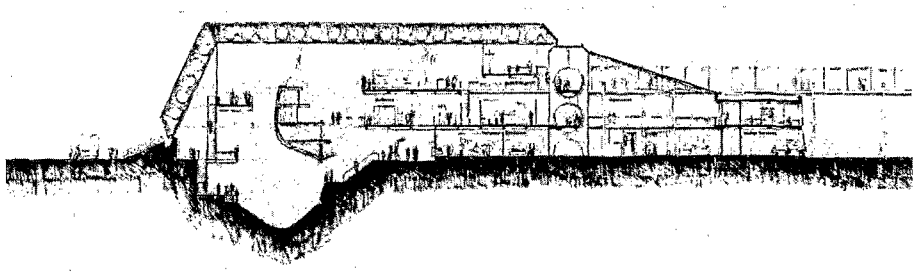
In the late 1960s, amateur divers began the search for the *Mary Rose.* Between 1967 and 1978 the site was painstakingly surveyed. This early work confirmed that much of the ship and her contents had survived by what has been called 'a miracle of preservation'. On the basis of this evidence, a £4 million full-scale operation was launched with the aims of archaeological excavation, recovery and display. On site, a shift system of divers has recorded thousands of man-hours on the sea-bed every year.

Although the Mary Rose Trust has only a small team of full-time employees, more than 500 people assist in achieving each year's programme. Among them are volunteer divers from all over the world,

1. This article is an amended version of one that first appeared in *Museums Journal,* Vol. 81, No. 1, June 1981, pp. 11–17. We are grateful to the publisher and to the author for permission to reprint this material here, particularly the drawings, plan and photographs.—Ed.



The only known representation of the *Mary Rose*—a watercolour included in an inventory of Henry VIII's ships, published in 1546.
[*Photo:* © Magdalene College, Cambridge.]



Cross-section plan of the museum.
[*Plan:* Ahrends, Burton and Koralek.]

voluntary finds-handling workers and office helpers.

Since 1977, as chairman of the Mary Rose Committee, organizer of the two working parties which created the Mary Rose Trust and as the Trust's executive director, my primary concern has been to make every aspect of the project as professional as possible.[2]

The objectives of the trust provided a challenge rare in the museum world. They are:

To find, record, excavate, raise, bring ashore, preserve, publish report on and display for all time in Portsmouth the *Mary Rose.*

To establish, equip and maintain a museum or museums in Portsmouth to house the *Mary Rose* and related or associated material.

To promote and develop interest, research and knowledge relating to the *Mary Rose,* her place in maritime, naval, military and social history and her excavation, and display, and all matters relating to underwater cultural material, wherever located, for the education and benefit of the nation.

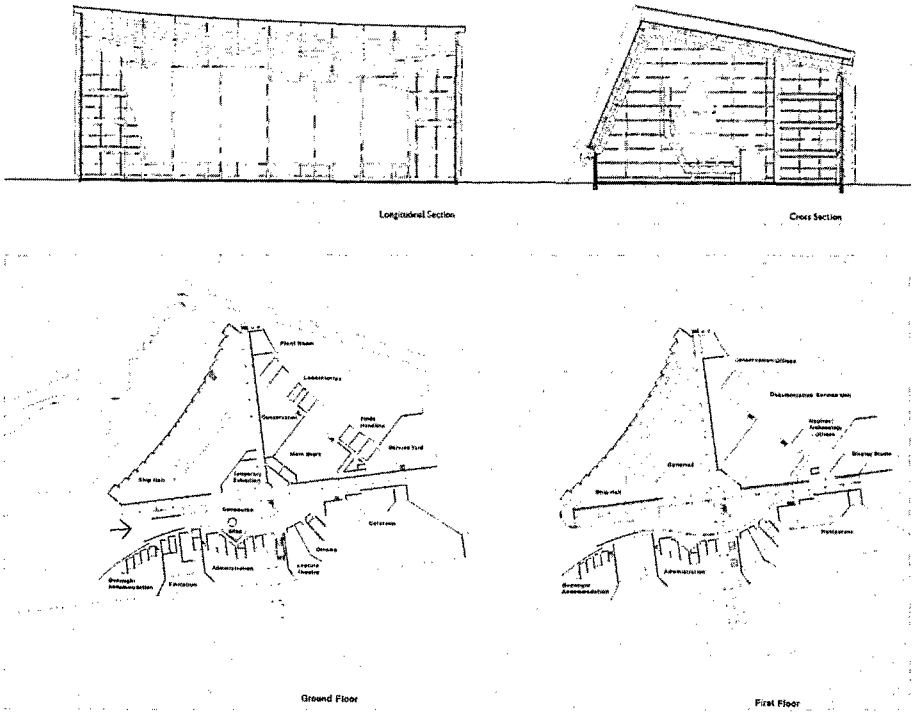
To meet these objectives a three-year programme (extended to four in 1980) was established, which envisaged three years of excavation leading to the recovery of the hull in 1982.

Why a new museum?

The excavations of 1971–78 showed that a substantial part of the *Mary Rose* had survived intact. In the excavations, more than 10,000 objects were recovered. Important finds—many of them unique—have included hundreds of bows, arrows, archery equipment, guns and other weapons; Tudor navigation and medical equipment; musical instruments and leisure items; personal items, including clothing and footwear, tableware, books, coins and even the pocket sun-dials used by the officers of the *Mary Rose.*

By the end of 1981 the hull had been totally excavated. As part of this programme the whole of the internal structure of the ship, its decks and internal partitioning were dismantled and brought ashore. After three years of planning, the details for lifting the hull were also worked out. In June 1981 a 40 × 16 metre steel lifting frame with four legs was positioned over the hull. The hull was attached to this frame by a lifting suspension system. The hull and lifting frame were then transferred under water into a steel cradle previously lowered on to the sea-bed. This cradle was lined with a pliable mattress for the protection and support of the hull. The three elements were then raised to the surface, placed on a barge and towed into a dry dock.

The vessel's importance in the history of shipbuilding and of the Royal Navy also justified one of the trust's main objectives, to recover and display the hull. This decision alone demanded a structure



Proposed layout of ground and first floors illustrating size and relationship of various functions.
[*Drawing:* Ahrends, Burton and Koralek.]

2. The trust is a company limited by guarantee, registered as a charity. Its members have overall responsibility but they have delegated day-to-day management to seven of their number supported by four advisers nominated by members of the trust from their staff. Together they form the executive committee.

of at least 48 metres long, 20 metres wide and 18 metres high. Since the hull encapsulated artefacts representing a cross-section of Tudor life and it was certain that the ship and her contents would be a major new tourist attraction, we came to the conclusion that only a new building which incorporated all the academic, museological and interpretative features demanded by the modern museum would suffice. I certainly felt that there was grave risk that a Mary Rose Museum would be a nine days' wonder, if it were not conceived as a museum offering a wide range of facilities for visitors. This is also reflected in the concept implied by the name and embodied in the trust's objectives that the museum will continue to expand its collections in the context of Tudor maritime history.

Choice of site

The trust's objectives make it clear that the Mary Rose Tudor Ship Museum had to be in Portsmouth, one of the most densely developed cities in Britain. A suitable site for the museum would not therefore be easy to find. Portsmouth City Council, a supporter of the project from the outset, was ready to make available a site for the museum at minimal cost. Consequently, in the autumn of 1978 the City Planning Officer, Ken Webb, was asked to consider all possible sites and prepare a shortlist for the City Council and trust to consider. As part of this exercise he visited the *Wasa* in Stockholm and the Bremen Cog at Bremerhaven.

His brief contained many constraints. The site would have to accommodate a building of substantial proportions and be capable of eventually receiving up to an estimated million visitors a year. It would have to be owned by the Portsmouth City Council and be located on the seafront, as closely associated with the site of the sinking as possible. It would also have to be available by 1982 and without major planning constraints, and physically associated with other heritage resources in Portsmouth.

Among the twenty-four sites considered, a five-hectare site adjoining Melville Road at Eastney, farthest from historic old Portsmouth and the site of the sinking, was the only one to meet the other criteria. As an empty, featureless, exposed site at the eastern end of Portsmouth, it clearly would also be a challenge to any architect. The site would also provide a much needed major tourist facility at the eastern end of the seafront. Most of the city's holiday hotels and guest-houses are located at this eastern end and would undoubtedly benefit. The site would be a focal point for a number of less well-supported heritage features in Portsmouth —the Royal Marines Museum, Eastney pumping station and Fort Cumberland, now being restored. With the planned building of an extension of the road system southwards on the eastern seaboard of Portsea Island it would encourage visitors to Portsmouth to use this access, thus relieving traffic pressure on the city centre.

Choice of architect and design team

The Mary Rose Trust approved the choice of site in August 1979. Initial consideration had already been given to the question of selecting an architect, and in June the executive committee appointed a site-development panel to make recommendations for the choice. The management team suggested that the advice of the Royal Institute of British Architects (RIBA) be sought first. Its president, Bryan Jefferson, readily agreed to give all the help he could and following a number of consultations the trust was recommended to use selection as the method of appointment and to appoint the best available British architect to design the museum.

A programme was established for the selection process and faithfully adhered to. Seventeen architectural practices of high standing and relevant experience, recommended by RIBA, were selected. After detailed consideration of this list seven of them were visited by the management team accompanied whenever possible by members of the panel. The trust had great difficulty in making the final selection. Each team had been asked to submit proposals as to how it would approach the trust's requirements, including their proposals for integrating the other skills required, i.e. quantity surveyor, structural and service engineer. This created one of the primary philosophical choices that had to be made, for two of the practices interviewed had in-house resources, while the other two presented teams of consultants.

The firm of Ahrends, Burton and Koralek was finally appointed in January 1980 just prior to the decision to extend the programme into 1982. I felt it very important that a museum designer be included in the team from the outset. In consultation with Ahrends, Burton and Koralek and with the approval of the executive committee, Robin Wade of Robin Wade Design Associates was invited to join it.

Preparing a long-term plan

Between January and August 1980, there were numerous consultations and discussions between the design team and the trust's management team, the site-development panel and the National Maritime Museum (in respect of their research programme on the conservation of the hull), which were reported from time to time to the executive committee. I also accompanied the design team on visits to the Wasa Museum in Stockholm, the German National Maritime Museum at Bremerhaven and the Viking Ship Museum at Roskilde in Denmark. At the August meeting of the trust a site-development plan submitted by Ahrends, Burton and Koralek was approved.

The trust itself contributed an overall brief, prepared by the author in consultation with his colleagues and based to a large extent on experience previously gained on briefs prepared for a proposed new central museum in St Albans and the Guernsey Museum and Art Gallery.

The constituent parts of the brief were as follows:

1. *Museum Theme and Facilities.* This document embraced such matters as the overall objectives of the museum, the major and secondary interpretative themes, and a detailed list of facilities required, including visitor and interpretative services together with those to meet museological and academic needs.
2. *Schedule of Functions:* collections divided into storage, documentation, conservation; study; interpretation divided object related, visitor related, education and recreation; visitor services; nautical archaeology; security; administration; plant, etc. Under each function the specific activities are detailed: office; research and development laboratory; conservation laboratory (organic materials and inorganic materials); treatment of large objects; workshop; temporary storage; provision for handling (reception area); post conservation treatment. Each function was also placed under two broad categories: (a) with public access and (b) with no public access. These were further identified as: supervised public

access; public access by appointment only; general public access. For example:

Function: study:

+ individual study areas
Ø seminar room
Ø user library and records
I study areas in public galleries
O staff study areas
+ study displays.

Key: O = no general public access; Ø = public access by appointment; + = supervised public access; I = general public access.

3. *Schedule of Accommodation.* This information was listed under primary functions, secondary functions, purpose/activity, size, direct access to, likely number of people working in. Information from (2) and (3) above was brought together by the architects into a 'direct access requirements' chart. Space requirements of just under 10,000 m^2 were also indicated.
4. *Schedule of Accommodation by Function.* This related to a limited number of specific design requirements such as high-level environmental control (normal museum standards), low-level environmental control, high-level security, low-level security, open access, controlled access, twenty-four-hour access, physically linked with service access, physically linked with public access, goods access to service area only, goods access to rest of museum, double-door access and controlled lighting.
5. *Schedule of categories of users of the museum service.* This was intended to give an indication of the broad spectrum of users and included all sections of the community wishing to use the museum for educational, recreational or academic purposes.
6. *Schedule of staffing.* This was necessarily a preliminary list but it embodied important management principles, and groupings of staff related to the functions and activities already indicated. It was intended to divide the staff into two broad groups: (a) academic (curatorial) and (b) museum services, housed in different parts of the building. The staffing proposals also underline two concepts which are implied throughout: that the museum will become an international centre for the conservation of material recovered from a marine environment and that a field capacity to undertake underwater excavations will be retained.

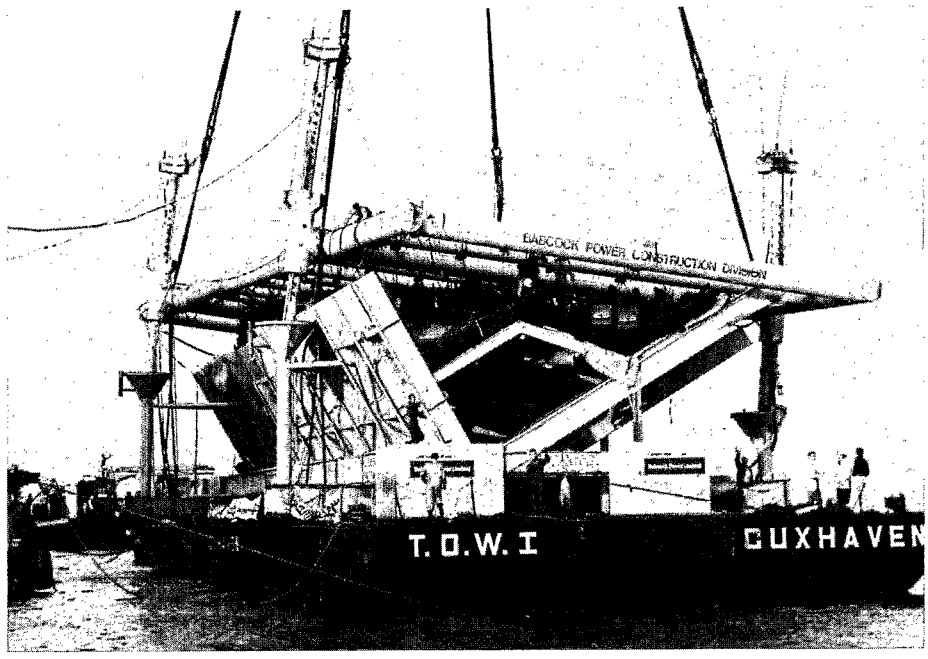
The development plan, which is illustrated on page 45, is the architect's interpretation of this brief, supported by important inputs from all the other consultants. In this connection, I would particularly like to record the input of the designer. It is still rare for a museum designer to be involved from the outset in designing a new museum. The dialogue between architect, designer and client has had a most significant impact on the plan. This is particularly true of the evolution of the way in which the visitor is to view the hull and the relationship between the hull and the interpretative display galleries. In support of the development plan as presented to the trust, the architect Peter Ahrends wrote the following description.

Typical of the range and rarity of objects from the *Mary Rose,* this is a selection of items from the medicine chest of the ship's barber-surgeon.
[*Photo:* © 1982 Mary Rose Trust.]

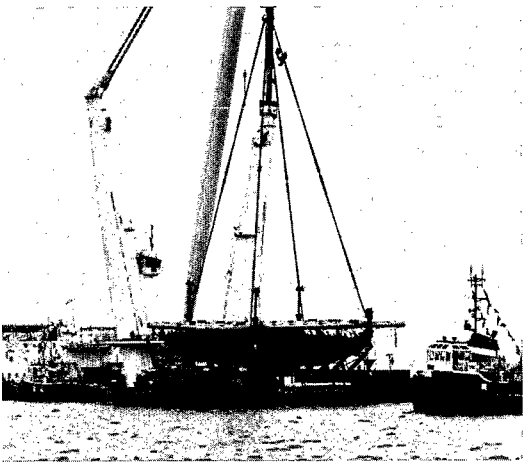
The Development Plan is not intended to be a building design but rather a proposal which embodies in a zoned three-dimensional form the ideas laid down and developed in the brief. The programme of conservation for the hull is likely to extend over a period of at least ten years. The problem therefore is not now to design in detail what the completed building will look like but rather to lay down a planned framework which can be developed in time to respond to the conditions surrounding the future growth of the museum. The Plan embodies a number of ideas which is expressed in the geometry of the forms.

Part of the character and significance of the site at Eastney lies in the proximity of the important eighteenth-century Fort Cumberland immediately to the east which gives the site the character of a coastal outpost to Portsmouth. This relationship is expressed in the alignment of the east/west axis of the plan lying parallel to the shoreline; in effect a linear extension of the Esplanade. A second major axis which crosses the first in a north/south alignment represents the journey out to sea and return to the security of the land. The hull will be located along a third axis diagonal to the axes of the cruciform....

The arrangement of the museum is derived



The hull of the *Mary Rose* was eventually raised from the bed of the Solent on 11 October 1982, after fifteen years of continuous work.



from the unique characteristic of the recovered hull. Whilst much of the starboard is intact, the port side is missing due to underwater erosion. This provides a unique opportunity to display the two aspects of the ship, i.e. its exterior form and interior structure, in distinctly different ways. The display galleries will be arranged at several levels along the missing port side of the ship thereby giving opportunities not only to view the contents and portrayals of life on board but also to gain views of the interior structure of the several remaining decks of the ship.

Visitors will make their way into the Ship Hall by ramp which rises from the Concourse. There will be a gathering space at the point of entry to the Ship Hall with views out to Southsea Castle. The first impression of the hull will be gained from an oblique view towards the bow with the display galleries beyond. Inside the Hall, the ramp rises up a curved alignment giving visitors an ever changing sequence of views of the large hull. Below the ramp an imprint should be formed in the floor beside the starboard side of the hull as a physical trace of the ship's history lying buried in the mud at an angle of 60°. The ramp leads up to introductory galleries behind the stern. Visitors will have the opportunity of returning to the Concourse by walking along the pier-like structure over a portion of the beach to gain panoramic views of the sea to complete the cycle of impressions. [3]

Phase One of the plan

By the time the development plan was approved in August 1980 the trust had to give urgent consideration to the need to provide a cover over the hull of the *Mary Rose* immediately it came ashore in 1982.

It was also clear by the middle of 1980 that the economic situation in the United Kingdom was going to have a major impact on the trust's ability to raise sufficient funds to pay for the recovery of the hull (estimated at £1 million) as well as for the first phase of the museum.

With hindsight, the sequence of decisions then taken by the trust may seem somewhat illogical, but were influenced by a desire to follow the lead given by the development plan, the need to protect the hull as soon as it came ashore, a desire to allow the public to see the hull as soon as possible after recovery and the inevitable financial constraints.

Accordingly, in November 1980 the trust approved proposals for a 'low cost' Phase One design for a permanent ship hall into which visitor facilities could be inserted as a Phase Two. Detailed designs were completed by mid-1981 and put out to tender in August. At this point the total financial requirement for 1982 became apparent and the trust decided to defer proceeding with Phase One until a decision had been made on the recovery proposals in January 1982, following completion of the underwater survey of the hull. On the basis of this survey, which emphasized the need to provide flexible accommodation, and the continuing financial constraints, in January 1982 the trust approved alternative proposals to provide protection for the hull using a low-cost 'off-the-shelf' modular building.

In March 1982, the trust received a report on proposals for developing tourism facilities in Portsmouth arising

3. P. Ahrends, 'Mary Rose Tudor Ship Museum Development Plan', 1980 (unpublished notes).

from the government decision in mid-1981 to reduce substantially the activities of the dockyard whilst maintaining its naval base. This report indicated that the Eastney site for the Mary Rose Tudor Ship Museum might become isolated from other tourist facilities. The trust's reaction to this report was to agree that because of these changes no irreversible decisions on siting the museum should be made until the situation had been clarified. It was therefore agreed to negotiate an earlier offer made by the Royal Navy to locate the hull in a dry dock for a period of two years.

As a result, the hull went into a dry dock adjoining H.M.S. *Victory* in the autumn of 1982. It will stay there for two years, allowing time for a long-term museum development policy to be finalized. During this period the reconstruction of structure removed from the hull will take place under a temporary roof. By the spring of 1983, it is also hoped to allow public access and to have a temporary exhibition of artefacts, etc., housed in an adjoining building. This dockyard change has of course affected the decision to build at Eastney. Provided suitable space can be found, the location of the Mary Rose Tudor Ship Museum alongside the growing collection of historic warships in Portsmouth harbour is now a distinct possibility. Nevertheless, the important work carried out on the development plan remains valid and will influence the final shape of the Mary Rose Tudor Ship Museum, wherever it is finally located.

The Roman ship of Marseilles: a world première

Daniel Drocourt

Born in Paris in 1942. Architect, historian and archaeologist. 1970–71: cultural activities for the *Centre du Futur* at Arc-et-Senans. Architectural adviser to the City of Marseilles since 1975. Appointed director of the *Atelier du Patrimoine* at its creation in 1980. Member of ICOM and ICOMOS.

Myriame Morel-Deledalle

Born in Thionville in 1948. Ph. D. in Roman history and archaeology. Has participated in numerous excavations in Tunisia and France, and in emergency excavations in urban areas (Marseilles: Stock Exchange, Metro, Butte des Carmes). Has published articles on various aspects of archaeological excavation and the history of Marseilles. Collaborated in the translation into French of Sir Mortimer Wheeler's work *Archaeology from Earth*, to be published by Éditions Payot in 1982. At present curator of the Museum of History of Marseilles charged with a section of the exhibits on classical antiquity. Member of ICOM.

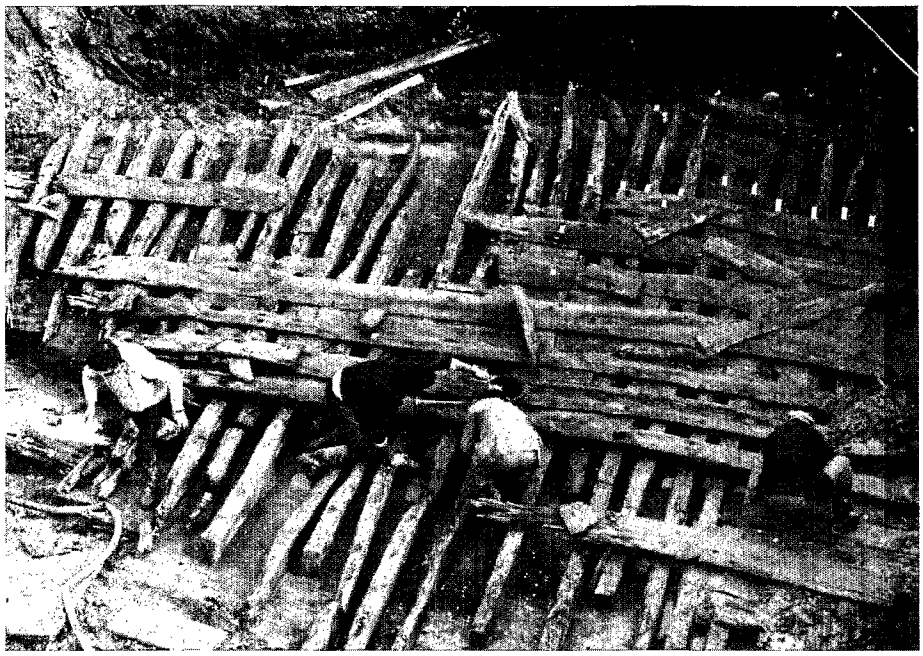
It was in November 1974, as earthworks were in progress behind the Stock Exchange in the heart of Marseilles, that the wreckage of a Roman ship was discovered. Construction workers, unaware that they were digging inside the precincts of the ancient port, noticed the ribbing of a ship caught between the teeth of the shovel-dredger.

Realizing that rapid action was called for, the City of Marseilles gave the green light to archaeological excavation to release the ship, sunk deep in marine silt. It was an impressive find: 20 tons of waterlogged wood, 19 metres long and 8 metres wide, preserved in the fine impermeable silt which had filled the port towards the end of the third century.

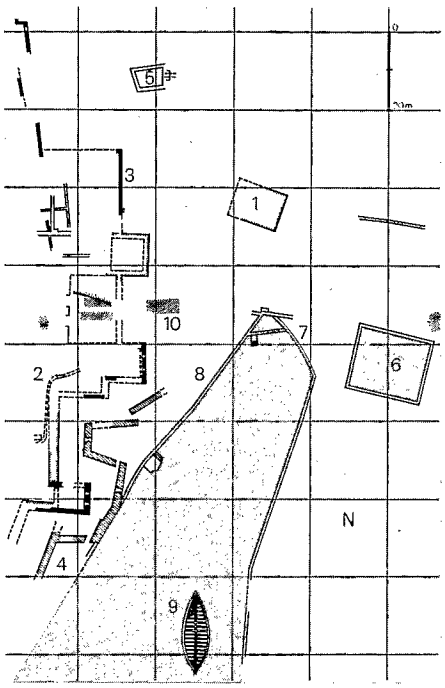
In less than thirty days, the remains of the ship had been excavated and raised, and the artefacts in the immediate area collected and catalogued. The boat had to be cut in two before it could be disengaged and transported by a 300-ton crane to a shed not far from the excavation site.

While awaiting the outcome of a study on conservation methods, the ship was immersed in a tank of water under a lean-to. For more than five years it lay in this body of water, which contained nothing more than an admixture of antiseptic products. Obviously, the aim of this first step was to prevent decomposition of the waterlogged wood (about 250 per cent humidity) by sudden exposure to the open air. But, brief though it was, the time required to complete the excavation, together with the arrival of a strong Mistral wind, had already caused irreparable damage to the wood which, it should be remembered, had been preserved since the third century. Moreover, the ship, abandoned in the Roman port at the end of its career, had already undergone a number of repairs and was a prey to diseases such as cuboidal rot (brown rot) in an aerobic condition and soft rot in an anaerobic condition.

Several sections had been eaten away by parasites. Thus, it was not simply a



The ship being excavated.
[*Photo:* Musée d'Histoire de la Ville de Marseille.]



Sketch plan of the vestiges on the stock exchange site showing location of the 'stock exchange ship': (1) triglyph in bas relief; (2) sewer: Hellenistic period; (3) the Wall of Crinas: Hellenistic period; (4) the south tower: Hellenistic period; (5) reservoir: Hellenistic period; (6) fresh-water reservoir: Hellenistic period; (7) tip end of the Roman port; (8) quay of the port; (9) the 'stock exchange ship'; (10) road into the city.
[*Drawing:* Musée d'Histoire de la Ville de Marseille.]

matter of saving an ancient relic, but one which was infected into the bargain.

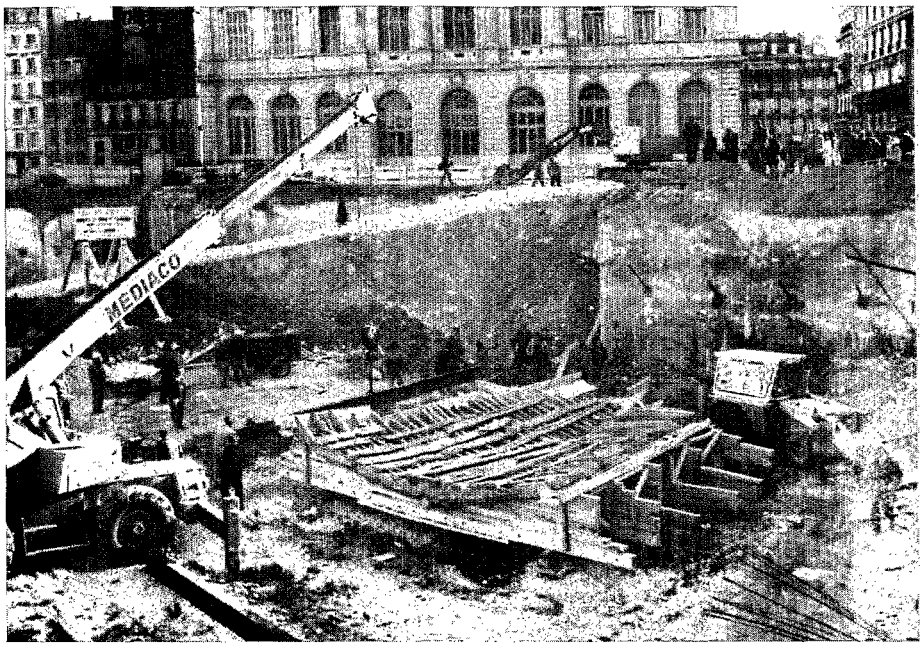
Concerned to formulate a dynamic programme for the Marseilles Museum of History, being erected in the commercial centre bordering the excavation site, the municipal authorities had made up their minds to display this ship in the future museum. The criteria governing restoration and conservation were therefore linked to considerations of a museographical nature: to present to the public an exhibit which remained as faithful as possible to reality, in so far as concerned the appearance, feel and colour of the wood, while at the same time retaining its genuine characteristics and allowing observation and research focused, for the time being, on two areas: naval architecture and the biological environment.

A further concern was to find a method for treating waterlogged wood which would be suited to the particular problem at hand. The size of the ship was a major factor in determining the type of treatment. Various methods had been tried in other countries, but no wreck of this size and period had as yet been treated or preserved. Moreover, little was known, so far, of the outcome of earlier experiments. With these facts in mind, the City of Marseilles decided to organize a study trip to the main European centres for the treatment of waterlogged wood.

In search of a method of treatment

At the time different methods for the conservation of large waterlogged wooden objects were being used elsewhere in Europe. The most widely used was, essentially, immersion in polyethylene glycol (PEG). This consists of gradually replacing the water in the wood by impregnation with PEG diluted in alcohol. The method had become famous through its use on the *Wasa* and on other ship structures elsewhere. However, this procedure is not ideal: the wood reaches PEG saturation point while retaining a certain amount of water. Thus, it is still possible for deterioration to take place. The Bremen Cog for example, which is the same size as the Roman ship at Marseilles, was kept in a special shelter where it was doused with water three times daily. Today it is immersed in a tank lined with portholes containing a bath of PEG. As the *Wasa* experiment was not complete in 1975, it was difficult to draw any conclusions regarding the efficacy of PEG. In any case, maximum PEG saturation had evidently been attained, and still it had been necessary to replace some portions of the ship. But, in the case of small boats, such as the monoxyle pirogues of prehistoric lake dwellers, impregnation takes place more rapidly, and this type of treatment had been applied with complete success.

Another technique, the gamma-ray method, was developed by the Centre d'Energie Nucléaire at Grenoble in France. It consists of impregnation with synthetic resins which replace the water, followed by bombardment with gamma rays. This method appeared conclusive and inexpensive. Unfortunately, the size of the Marseilles ship prohibited its use. Indeed, it would have been necessary to construct an immense kiln, with all



The ship being transported by crane. [*Photo:* Musée d'Histoire de la Ville de Marseille.]

of the unforeseeable risks this would entail.

Therefore, a third technique, freeze-drying, was adopted. This technique, long familiar to the medical profession, has numerous applications in the fields of pharmaceutics and food preparation. Invented in 1960 by two Frenchmen, d'Arsonval and Bordas, it consists of extracting the water from an object by sublimation, i.e. by conversion of water from the solid to the gaseous state under the double action of cold and vacuum. This method has the advantage of exposing the material to minimum mechanical pressure, and of ensuring conservation for an unlimited period, on condition that the operation is carried out in the absence of humidity and oxygen. Research into the conservation of living organisms coincided with a decision by the City of Marseilles to undertake an examination of the micro-organisms and other forms of life latent in the wood which might be detected after treatment. An examination of the paint on the ship had already been made, and it had been caulked often enough to envisage carrying this type of research still further.

Freeze-drying had the additional advantage of conserving the natural aspect and colour of the wood, two criteria which are all the more important when we remember that it was not simply a question of safeguarding and conserving the wreck, but of presenting it before the public as well.

An experiment attempted for the first time

An experiment in freeze-drying was conducted in 1975 on ten test samples taken from the ribbing of the Marseilles boat. They were entrusted to Geneviève Meurgues of the Natural History Museum in Paris, who had treated wood successfully on previous occasions: these were fragments of the dykes of La Rochelle (seventeenth century) and Gallo-Roman statuettes found at the source of the Seine.

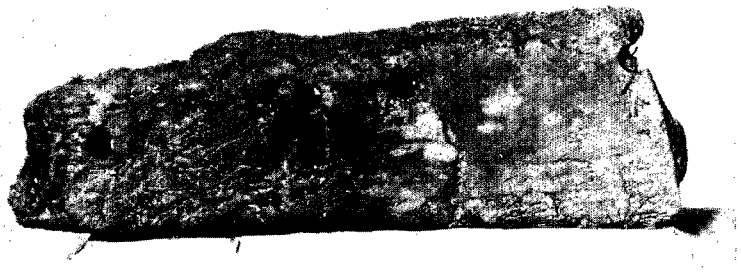
Ten pieces of wood were freeze-dried in a vacuum, then purposely brought out into the open air at normal temperatures and handled freely. They are still being transported from place to place, and often form part of scientific communications. In this way, the experts are able to see for themselves that neither their colour nor their texture has altered. Their water content has stabilized at 9 per cent (as against 30 per cent for normal wood), whereas that of the wreck was 200 to 350 per cent.

In view of these results, the freeze-drying solution was adopted. Two physicists from the French firm Usifroid were called in: Jacques Amoignon, the director, and Philippe Larrat, an engineer specializing in extreme low temperatures and high-purity gases. The team put forward suggestions for a treatment adapted to the size of the ship and the constraints imposed by the location where it was to be treated: the Marseilles Museum of History which is situated on the ground floor of the commercial centre of the Stock Exchange. Safety requirements and the size of the ship ruled out the construction of a vacuum chamber several hundred cubic metres in size, due to the risk of implosion. It was therefore decided to treat the ship under normal atmospheric pressure and to build a suitable prototype.

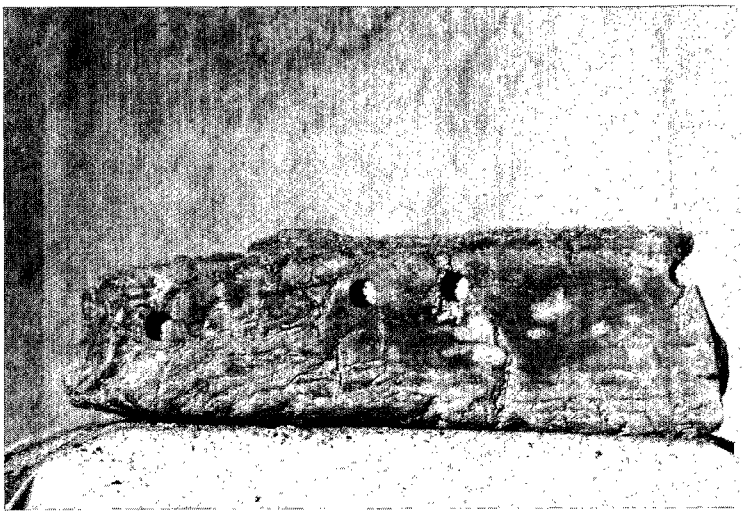
The ship, which was then being conserved in a tank of water beneath a lean-to on the precincts of the Stock Exchange, had to be transported to the Museum of History where it was to be treated in its permanent display case. In practical terms, this meant transporting a relic 2,500 years old over 250 metres of chaotic terrain on the Stock Exchange work-site very quickly, so that it should dry out as little as possible. The original plan was to move the ship—duly protected, and doused with water at regular intervals—on air-cushions. However, the cushions refused to function, much to the delight of M. Turon, the master carpenter who was finally asked to do the job; he reverted to the age-old method of using a winch and billets.

Once inside the Museum of History, the ship was placed in its metal cradle in a chamber consisting of a concrete floor and alternating glass and solid walls, which were covered with foam-rubber: this was ultimately to become its permanent showcase. Next, the machinery designed and built at the Usifroid workshops near Paris was mounted. The treatment chamber, perfectly airtight, was linked to the machine by two insulated ventilation shafts, one carrying the flow of cold, dry gas in, the other extracting the humid gas at the same flow-rate. A set of compressors and filters fed the machinery and purified the gas.

Test sample before freeze-drying: weight 1.91 kg. [*Photo:* Muséum National d'Histoire Naturelle.]



Test sample after freeze-drying: weight 0.68 kg.; weight loss in water: 1.23 kg. [*Photo:* Muséum National d'Histoire Naturelle.]



The operation commenced in January 1980. It was the first time this type of experiment had been attempted anywhere in the world. Although it had already made a heavy financial outlay to launch the operation to save the ship, the City of Marseilles was sufficiently venturesome to adopt this entirely new solution, whose total cost amounted to a million francs.

The operation was made up of three phases: the first consisted of freezing the water contained in the wreck using nitrogen; the second was to subject the wood to a continuous flow of ultra-dry air over its surface at a rate of 20 km/h. This flow of air sweeps away the tips of the ice crystals which have been transformed into droplets. This is the sublimation phase. In the third, the stabilization phase, the ship is kept at a low temperature and a low level of humidity.

A console installed next to the machinery made it possible to follow the evolution of treatment (monitoring it once or twice daily according to the phase), and to check the operation of the entire installation. Probes had been set up to keep track of the temperature of the wood at various points, of that of the gas as it flowed out of the machines, the pressure inside the chamber, and the degree of humidity. Concurrently with this, two test samples—Rib No. 144 and another fragment of the ship—were weighed each week, and their water-loss recorded. The measurements were made regularly by M. Rouanet and Bernard Rémond of the Water Authority of Marseilles. Other wood specimens had been sent to the city authorities to be tested in this experiment in freeze-drying under normal atmospheric conditions: fragments of the Bremen Cog which had been treated elsewhere with PEG, a cannon wheel from the *Mary Rose.* Besides these, numerous small pieces of the ribbing of a wreck from the Golfe du Lion, together with wreckage from Port Vendres, Fos, Anse Gerbal, etc., were tested. All of these specimens have now been removed from the treatment chamber. The machines have been dismantled, and the area which they occupied given over to the Museum of History's collections. They are ready to be used again for a further treatment of this type. As for the ship itself, its treatment is completed. The chamber has been relieved of its foam-rubber covering, and the ship will be on view in its case when the Museum of History opens its doors in 1983.

Scientific spin-offs

Before, during and after treatment, the operation generated a multiplicity of activities of all sorts. Observations of an archaeological nature to begin with, in view of the interest of this important find, but also of a more technical sort, particularly with regard to the method of treatment itself.

After the completion of treatment, three sets of twenty-five test samples were extracted from the heart of the wood, taking account of the position and the variety of tree, and their desiccation graphs compared. For it is an indisputable fact that the reaction to treatment also depends on the type of tree, and the part of the wood used.

The final scientific aspects still being

Recommended reading

AMOIGNON, J.; DROCOURT, D.; LARRAT, P.; MEURGUES, G. Le sauvetage et la conservation du bateau de la Bourse à Marseille. *Archeologia* (Dijon), No. 15, January 1981, pp. 61–5.

CONTRUCCI, J. Dix médecins du bois pour sauver le bateau antique. *Le Soir,* 24 February 1979, p. 3.

——. Quand Marseille dialogue avec Massilia. *Le Monde,* 16 December 1975.

CUOMO, J. P.; DROCOURT, D.; GASSEND, J. M.; MOREL-DELEDALLE, M.; TERRER, D. *Le navire antique du Lacydon.* Marseilles, Musée d'histoire de Marseille, 1982, 149 pp.

VAROQUEAUX, C. L'épave du Musée des Docks. *Études classiques,* 1968–70. Aix-en-Provence, 1970.

studied will be the subject of communications and a colloquium whose main focus is to be the treatment of waterlogged wood by freeze-drying. Thanks to other scientific studies, it should now be possible to move forward to the second phase of analysis of the wreck.

As for archaeological studies, these are now completed and have been published. We now know that the remains discovered were those of a Roman merchant ship, of which the longest surviving section is 19 metres, but whose original length is estimated to have been 23 metres. This boat had probably served for many years; it had been repaired many times and, after springing a leak, had sunk to the muddy bed of the port whose draught by the third century had already been reduced to 1.2 metres. Little by little the boat sank beneath the silt on the sea-bed the pressure of which split its sides open. A layer of gravel was laid down to fill this camber in the receding port of Marseilles. This layer of gravel, accumulated at roughly the time that the boat was abandoned, sealed it into the mud; the ceramic fragments found in, under and around the ship in the course of excavation are obviously not its cargo. None the less, the examination of these fragments was useful in narrowing down the chronology: the fine ceramic is, for the most part, light A and light B sigillate from southern Gaul; the ship probably, sank some time between 160 and 220 B.C. The fine marine silt, which began from that very moment to cover it, preserved it perfectly until the day in November 1974 when a shovel-dredger brought up some of the ribbing in the teeth of its bucket.

The exhaustive study of naval architecture which this discovery made possible has furnished interesting information concerning structural shapes and has enabled experts to analyse building techniques and to estimate the tonnage of the vessel: 197 casks, for a volume of 285 cubic metres, represents a cargo of 140 tons of cereals such as wheat, barley or oats.

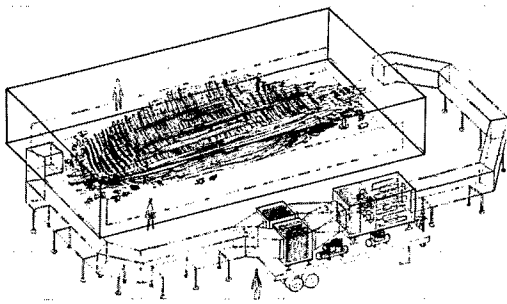
The variety of timber was studied in 260 test samples. Five different types were used in construction: pine, larch, cypress, poplar and ash. The keel was of cypress wood, well known for its imputrecibility; all the ribbing was of pine, and the stringers of larch. The use of deciduous species seems to correspond to repairs.

Certain varieties of wood were used for the longitudinal elements of the boat (keel, planking, inner planking or sheathing) and others, for the transversal elements (ribbing). These findings confirm what we are told in ancient texts (Vitruvius, Pliny or Theophrastus) concerning the qualities of the different varieties of wood, their use and their provenance.

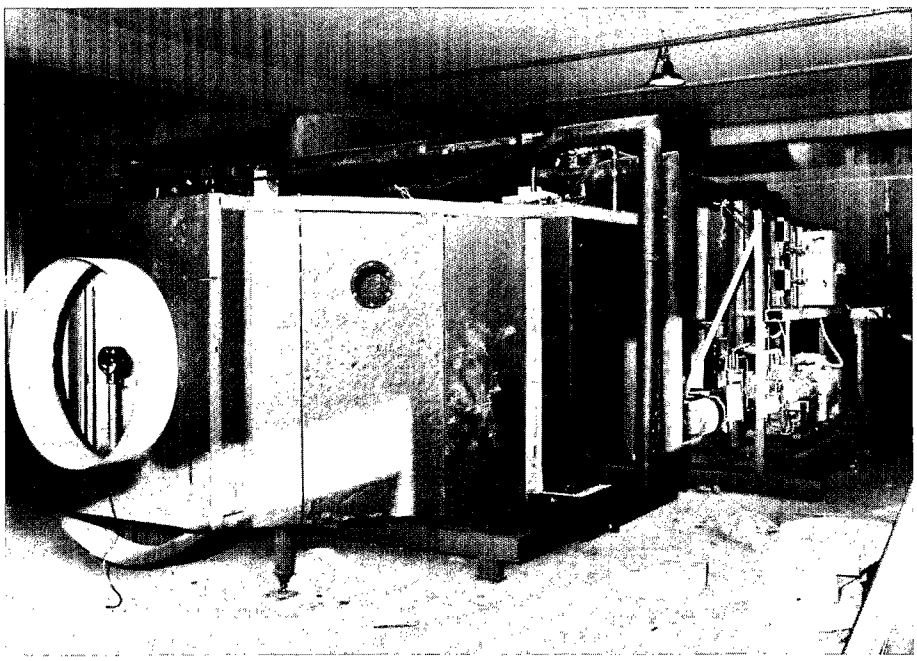
In view of the abundance of resinous species present, pine for the most part, it is reasonable to assume that the wood used in the construction of the Lacydonian ship came from somewhere in Provence. As for cypress and larch, which at that time grew mainly in Italy, they appear to have been transported to the shipyards. No shipyard sites have been pinpointed in Marseilles with any accuracy, though excavations by F. Benoit in 1945 gave the impression that shipyards once existed not far from the present city hall.

So, we see how, thanks to the energy and audacity of a few devotees of science, and of the nation's cultural heritage, and because the oldest city in France was able to recognize its historic riches and to take the risks of a world première in the field of museographic conservation, the *épave de la bourse* was refloated.

[*Translated from French*]



Plan of the machinery.
[*Drawing:* Usifroid.]



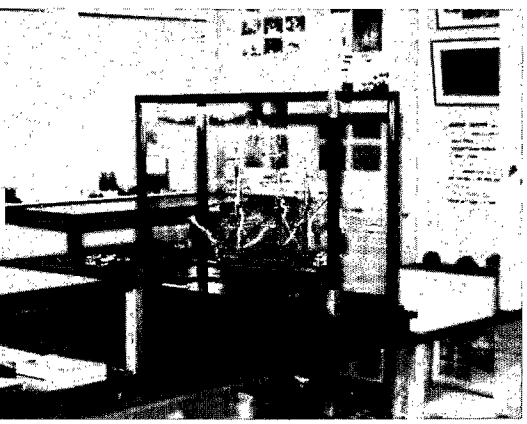
Machinery and treatment chamber in place in the History Museum.
[*Photo:* Musée d'Histoire de la Ville de Marseille.]

COLLECTIONS OUT OF SCATTERED FINDS

The Saint-Géran: *from literary myth to museum object*

Deva Duttun Tirvengadum

Born in Mauritius in 1936. Botanist, scientific assistant at the Muséum National d'Histoire Naturelle in Paris, until 1978. Director of the Mauritius Institute, President of the Board of Ancient Monuments and Nature Reserves and Editor of the *Mauritius Institute Bulletin,* 1978–81. ICOM consultant in 1981, he is at present Research Associate at the University of Aarhus, Denmark. Author of *Mauritius Institute, 1880–1980* (1980), 'The Mauritius Institute, a Hundred-year-old Institution at the Service of the Community', *Mauritius Institute Bulletin,* Vol. 9, No. 1, 1980, and 'Underwater Archaeology, A New Contribution to the Knowledge of the Mauritian Heritage', op. cit., Vol. 9, No. 2, 1980.



Natural History Museum, Port Louis. Overall view of the temporary exhibition, *The* Saint-Géran, *Its History through Underwater Archaeology and Literature.* [*Photo:* D. D. Tirvengadum.]

The Saint-Géran, *a 600-ton ship of the Compagnie Française des Indes, wrecked off the coast of Mauritius in 1744, became famous through* Paul et Virginie, *a novel that won universal acclaim. Fiction and authentic historical facts were closely intermingled. It was not until 1979, however, through the development of undersea archaeology techniques that a French expedition scientifically explored the site of the wreck, casting new light on what really occurred. In this article, the author sets out the problems confronting the Mauritius Institute, the repository of the collection built up during that expedition. Despite its meagre technical and financial resources, the Mauritius Institute was able to carry out its mission of protection, conservation and display.*

The Saint-Géran: *the story in brief*

On 24 March 1744 the *Saint-Géran* set sail from Lorient in France. Its destination was Isle de France, at that time a French possession, later to become Mauritius when it was seized by the British in 1810. The ship, on its fourth voyage along the Route des Indes, was transporting, in addition to articles that constituted the normal trade of the Compagnie des Indes, equipment for the island's first sugar refinery, 25,000 piastres and approximately 200 people.

On the afternoon of 17 August 1744, the *Saint-Géran* sighted the shores of Isle de France. Some time during the night, however, through a navigational error, the ship smashed against the coral reef situated to the north-east of the island. There were only nine survivors. Because of the heavy losses sustained, this shipwreck, of which there were no eye-witnesses, created a stir among the inhabitants of the island.

Bernardin de Saint-Pierre, who had lived on the Isle de France from 1768 to 1770, published *Paul et Virginie* in Paris in 1788. The novel, set on this subtropical island still in its pristine state, ends with the death of Virginie in the wreck of the *Saint-Géran.* As a result of the novel's immediate success, what would normally have been just another shipwreck entered the annals of history.

Undersea archaeology upon discovery of the Saint-Géran

The *Saint-Géran* remained untouched until 1966. In that year its wreckage was discovered and plundered by amateur divers using dynamite, which made it easier for them to recover the larger objects. Thus, the site was irreparably damaged, making it impossible ever to establish the extent of deterioration. The objects illicitly removed on that occasion dispersed among private collections in Mauritius and abroad. Only the large ship's bell and a few piastres were handed over to the Mauritius Institute, which administers Mauritius's three museums.[1]

In 1979, after signing a protocol of agreement with the Mauritian Government to exploit the site, Jean-Yves Blot, a French archaeologist, carried out a mission on the site of the wreck of the *Saint-Géran* between January and May 1979, in co-ordination with the Mauritius Na-

1. Natural History Museum (Port Louis), Historical and Naval Museum (Mahébourg), Robert-Edward Hart Memorial Museum (Souillac).

Jean-Yves Blot with parts of the wooden framework of the *Saint-Géran*. [*Photo:* J.-Y. Blot.]

tional Commission for Unesco. This mission was preceded by archives research and a detailed study of some of the objects recovered in 1966.

Although the site of the wreck had already been plundered, the results of this mission were highly productive, as a result of the introduction of new techniques—mapping in real time using theodolites, infra-red telemetering and map-squaring with a programmed computer, remote-control aerial photography and a multidisciplinary approach to the study of the growth of coral on dated specimens.

While the explorations did not lead to spectacular discoveries, they did make it possible for previously unknown items (various metal elements, ballast stones) to be brought to the surface and for a new site to be discovered inside the lagoon containing parts of the ship's structure: wood used for the framework, resinous wood used for small pieces of the masts and hardwood used for the pulley wheels. It was the first time that parts of a ship belonging to the Compagnie Française des Indes had been recovered.

The Mauritius Institute's mission of protection and display

In accordance with the terms of the agreement signed with the Mauritian Government, the archaeologists handed over to the Mauritius Institute the objects recovered during this mission. Some duplicates were deposited in the museum of the town of Lorient, France, devoted to the history of the Compagnie Française des Indes, while others were kept by Jean-Yves Blot.

Temporary measures had to be taken very quickly, with the makeshifts available. The wooden objects were immersed in a large pond belonging to the Port Louis Natural History Museum and the pond was filled with a chemical solution for the purpose of gradually eliminating the salt-water. Metal objects, such as cannon-balls, were immersed in containers filled with fuel oil to avoid rusting, and placed in the Institute's laboratory.

Since there was no local scientific body in a position to undertake the conservation of such a heritage, Jean-Yves Blot approached various specialized laboratories in France. In December 1979, following a visit to the site by the Director of the Mauritius Institute, the Institut de Recherche Appliquée sur les Polymères (IRAP), at Le Mans, France, agreed to accept and treat these objects, particularly in order to try out new conservation techniques.

In February 1980, 660 kg of freight were dispatched to London by courtesy of Air Mauritius, the national airline, and thence to Le Mans. The objects, comprising mainly large wooden fragments, were packed with the utmost care so as to keep them in a sufficiently humid atmosphere throughout the voyage.

After a stage during which the resistance of the wood was studied and analysed, treatment at IRAP made slow progress because of lack of funds. It is hoped that following the negotiations now under way assistance will be given by international organizations so that this operation can be successfully completed. The procedure adopted for safeguarding the wood is original in that it draws largely on international co-operation. Thus, it could be a model for other countries that do not possess adequate local facilities for carrying out such operations on their own.

It is estimated that the complete operation will take two years from the time the last phase of the treatment actually starts. In addition, anatomical studies carried out on the samples by the Centre Technique du Bois, Paris, have led to the identification of fragments of deciduous oak and three species of pine (Scotch fir, Corsican pine, pitch pine).

Display and cultural mission

The home of the *Saint-Géran* collection should rightly be the exhibition rooms of the Historical and Naval Museum at Mahébourg. But the cramped premises of this museum located in a one-time colonial residence dating back to the late eighteenth century made it impossible to display the collection immediately. To give it as much publicity as possible, it was decided to start by assembling a temporary exhibition that could illustrate the historical and educational content of the collection. The organizers' main concern was to add a new dimension to museology in Mauritius. By evoking as tangibly as possible the literary and cultural repercussions of the history of the *Saint-Géran*, the museum has, so to speak, bridged the gap between the past and the present. The first of its kind in the island, this exhibition has made the Mauritian public aware of the concept of a collective memory and that of a national heritage which it is important to protect.

The exhibition was held in a long-unused display room in the Natural His-

tory Museum at Port Louis. In this site in the heart of the capital, the Mauritius Institute had the use of premises which, pending its final installation, were particularly suited to this type of temporary exhibition and which were to become a multi-purpose room. The exhibition, entitled *The* Saint-Géran, *Its History through Underwater Archaeology and Literature*, was officially opened on 17 August 1979. It marked the 235th anniversary of the shipwreck and was prepared with extremely modest resources. However, it was so successful that it had to be extended for three months.

For this occasion, the Mauritius Institute published, for the first time, the text of Léon Doyen, a Mauritian historian, on the wreck of the *Saint-Géran*. Moreover, in November 1980, to celebrate the centenary of the founding of the Mauritius Institute, an *Institute Bulletin*—the first of a new series on the Mauritian cultural heritage—was devoted entirely to the recent findings off the island and to its contribution to our knowledge of the Mauritian heritage.

In preparing for this centenary, the Mahébourg Museum was rearranged and, insufficient and outmoded exhibition material and equipment notwithstanding, this archaeological collection was installed among the other Mauritian national collections. On this occasion the elements and documentation used for the temporary exhibition were again widely employed.

The project for setting up a site museum for the *Saint-Géran*, that would make it possible to explore the scene of the wreck, where some large cannons, in particular, are to be seen, has not yet been carried out because of insufficient resources. In addition to its tourist and cultural interest, it would have had the merit of permanently protecting a site that is far too exposed.

Protection of the underwater heritage of Mauritius

Mauritius now has in its Ministry of Education and Cultural Affairs a Subcommittee on Shipwrecks, which is placed under the responsibility of the Mauritius National Commission for Unesco, the Mauritius Institute being represented on it. Its task is to supervise all authorized archaeological exploration within Mauritian territorial waters.

Consequently, two new exploration concessions were granted in July 1979 to Jacques Dumas to explore the *Banda*, a Dutch East India Company ship that disappeared on 6 March 1615 off the south-west coast of the island, and the *Speaker*, a pirate ship grounded on 7 January 1702 on the south-east coast. The objects salvaged during these two operations were shown to the Mauritian public in a temporary exhibition, which was organized for the Mauritius Institute's centenary celebration and which displayed significant objects, both old and modern, that form part of the institute's permanent collections.

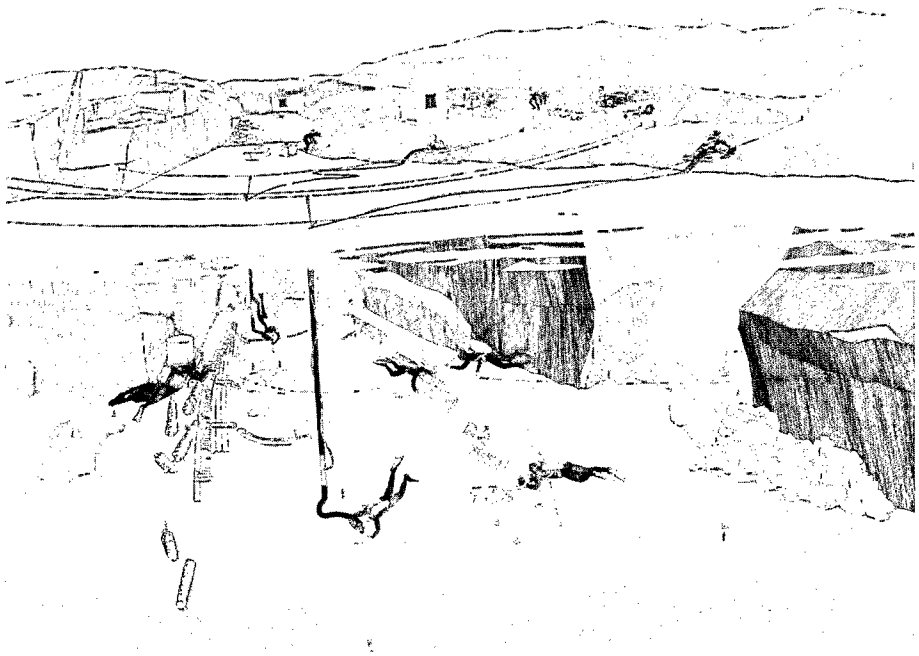
However, it must be admitted that the means available to the Mauritian authorities to provide effective protection for the island's undersea archaeological heritage remain very inadequate: an absence of patrol-boats to prevent unauthorized clandestine exploration and of adequate legislation for putting a stop to the illicit export of objects discovered during these operations, and, lastly, a dearth of Mauritian archaeologists who could take over the management of this heritage. As for the collections that have been legally handed over to the Mauritius Institute, their medium- and long-term protection, where necessary, is still a rather delicate matter owing to the absence of specialized laboratories and the shortage of qualified personnel.

The testimony of the cultural heritage

The effort made by the Mauritius Institute to set off the *Saint-Géran* collection is in keeping with the aims defined by ICOM in its Code of Ethics of Acquisition. It is a matter of seeing that the collections built up as a result of archaeological excavations remain in the countries of origin as testimony to the cultural heritage of the national community. This effort also fits in with the broadening of the role of museums, which should be more in touch with the community and its aspirations to information and education.

The case of the *Saint-Géran* is a particularly felicitous example of this aim, in that the evocation of this celebrated page in its history has provided the multiracial and multidenominational population of Mauritius with one of the constituent elements of the concept of 'Mauritianism'. For young, recently independent nations that have long been deprived of the evidence of their past, efforts of this kind can help them to rediscover their cultural identity. To this end the museums of these young countries have an increasingly important role to play.

[*Translated from French*]



Drawing of excavation site at Stolen. Communication box is shown on left. There are two air-lifts in operation. Sieve and low-pressure compressor are on shore. Three-point measuring system is in the centre. Stand for stereophotogrammetry in foreground.
[*Drawing:* © Norsk Sjøfartsmuseum.]

The Norwegian Maritime Museum organizes underwater archaeology

Svein Molaug

Born in 1914 at Stavanger, Norway. Conservator at the Vestfold Fylkesmuseum from 1944 to 1945. M.A. at Oslo University in 1945. Conservator of Norsk Sjøfartsmuseum since 1956.

Norway's coast is long and exposed, with a treacherous current moving westwards along the southern coastline. If unaware of the risk, a ship's watch might find his vessel driven against the shore before he realized what was happening. Skagerrak is the area between Jutland and Norway. As the only route to and from the Baltic, it has always been a busy shipping lane. The temptation to sail too close to the Norwegian coast in order to gain height in contrary winds or to find temporary shelter while waiting for favourable weather has often resulted in total disaster. Harbour entrances are studded with skerries. In wartime the English Channel was often blockaded, and ships leaving the North Sea had to sail round the north of Scotland. Norway's west coast consists chiefly of mountains and archipelagos, some stretches being particularly exposed to bad weather. Many a dramatic shipwreck has been caused by the strong, unremitting winds which can drive a ship relentlessly against the coast.

Aware of the abundance of material lying beneath the coastal waters the Norwegian Maritime Museum (Norsk Sjøfartsmuseum) embarked somewhat hesitantly on field-work in underwater archaeology in 1956 and has since then run a continuous programme of studies and expeditions. As its scope for investment was limited by a lack of funds, the museum had to adopt an approach that was suited both to the particular nautical environment and to the amount of resources available.

Amateur divers for scientific excavation

As it was impossible to hire professional divers at the prevailing rates, the museum had to rely on amateur divers, who were given some training in marine archaeology.

Most Norwegian amateur divers are members of clubs belonging to the Norwegian Diving Association; and divers from many of them have a special interest in marine archaeology.

By organizing annual courses, the museum has increased awareness of the historical value of shipwrecks, not only within the specialized groups but also in the clubs to which these divers belong. An arrangement is now being made whereby the clubs will be able to join in the work on shipwrecks and interesting harbour areas in the region where they normally operate. They can ask to be given assignments such as photography, temporary recording of finds, investigation of harbours, etc.

Their keenest members may take part,

Lead seal from the *Lossen* (1625–31). [*Photo:* Norsk Sjøfartsmuseum.]

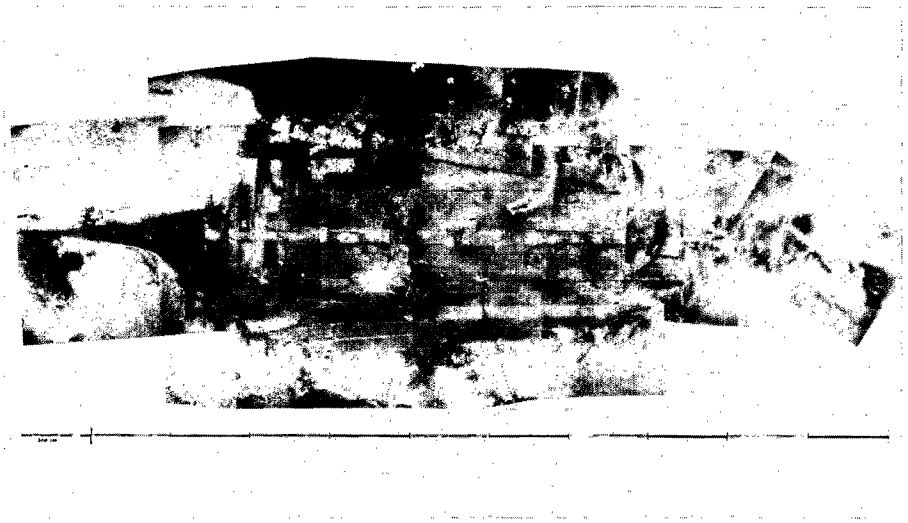


Photo-mosaic of a shipwreck at Skarveset excavated by the museum, 1975–77. [*Photo:* Bjarne Ims Henriksen.]

if they wish, in the museum's excavations. They receive no remuneration but their food is free, their travel expenses are covered and they receive some compensation for wear and tear of their personal gear. If they are on holiday, they are allowed to bring their wives, friends or children. This means spending more on food but it also means having more help with the cooking and, no less important, creates a happier atmosphere.

The amateur divers are often highly qualified in their own occupations and are selected in such a way as to ensure that the team includes a doctor, architects, engineers, mechanics, tradesmen, cooks, etc., a combination that has proved highly successful. As the excavation site is often at quite a distance from the nearest town, it must be possible to carry out repairs and to tackle problems on the spot without losing precious time.

Every diver is at all times covered by an accident and life insurance policy.

Before excavation is started the surrounding area is explored for a suitable camping-site. Each participant brings his own tent. The museum provides the mess-tent which is big enough to accommodate the whole team at one sitting. It is also equipped with desks for the architects, so that they can keep their drawings up-to-date as the shipwreck is progressively uncovered, and a blackboard for daily lectures and briefing sessions. The mess-tent contains cooking equipment, a refrigerator, washing-up facilities and shelves for storing food. One tent is used as a darkroom for developing and copying films, an important aid for the draughtsmen.

The area to be excavated is charted by means of a system of co-ordinates, with markers plotting a two-metre-square grid. On one of the walls of the expedition boat hangs a large board showing the up-to-date co-ordinate system and drawings of the uncovered sections. Each pair of divers is briefed in front of the board before going down. They take along a writing-frame and a pencil and paper. The squares on the map they have to work on are noted down, together with each diver's name, the date and the time spent under water. The divers record and draw what they see or what they have been asked to measure. A three-point system is used for measuring and drawing. Three fixed points are established above the wreck in a position that provides the best angles for measuring. A measuring-tape is attached to points A, B and C. When the tapes are extended to a specific point on the wreck, three distances can be read off at once. The measurements are fed into a computer which enters all the points to which they refer into a three-dimensional system of co-ordinates. The advantage of this system is that the curves of hulls, etc., can be measured with great precision, and the computer can provide data on all measured points from the angle desired.

Another useful tool is the glass rod which measures depths in relation to fixed point by means of water pressure. A video-camera can be used to film the work in progress, providing a valuable record of the excavation. When the wreck is excavated, a photo-mosaic is made by combining a series of detailed pictures on the same scale, using a special tracing table.

The participants gather together every

day after dinner to discuss the day's work and examine the latest finds. A lecture is given on some topic of relevance to the day's discoveries, since it is very important that the participants know what is happening and are aware of the significance of what they are doing. People living near by often attend the lectures, and this fosters good relations between the local population and the divers.

Cataloguing and conservation

No find is brought up until the go-ahead has been given. Every find is numbered, measured and described in detail. It is then photographed with its number. For this purpose, a stand with a large curved transparent plexiglas plate is used. Next the find is cleaned and placed in fresh water. All materials are packed in pressure- and shock-resistant plastic boxes of various sizes for transport to the museum.

The conservation facilities of the Norwegian Maritime Museum are limited and it is therefore unable to take on large-scale projects. Waterlogged wood is first treated with polyethylene glycol (PEG) then freeze-dried. The advantage of this method is its relative speed. Leather and rope treated with PEG recover a good deal of their natural softness. The museum sends iron, other metals and ceramics for conservation elsewhere, although it has, on occasion, used electrolysis to conserve certain metal objects. More complicated conservation methods have as yet been avoided.[1]

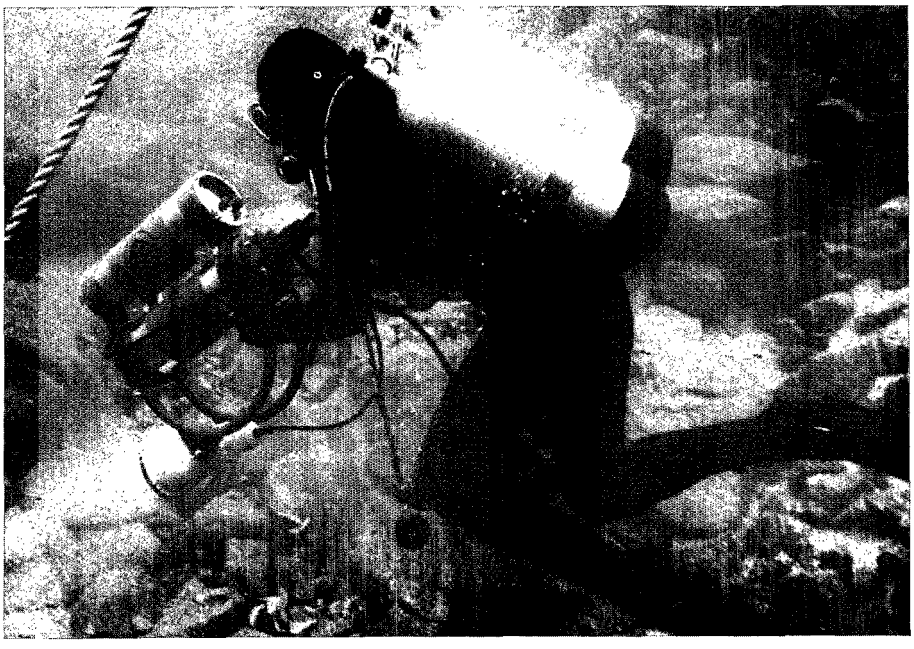
1. See articles by V. Jenssen and D. Grattan in this issue.–Ed.

Protective legislation

At a relatively early stage the Norwegian Maritime Museum drew attention to the need for legislation to protect ancient wrecks and other objects found on the sea-bed. Thus in 1963, a clause was inserted in the law on the cultural heritage, but it did not make explicit provision for cargo and thus led to a good deal of confusion. A new, more comprehensive law was passed in 1974. It specifies that ships, boats, parts of vessels, cargo and objects carried on board are the property of the state, provided that they are more than 100 years old and there is no reasonable prospect of finding an owner. Any person discovering such property is required to report it to a competent museum or to the nearest police authorities. The annotations to the law stipulate that the state may give the finder an appropriate reward either in cash or in kind. In the latter case, a reward in the form of cargo or artefacts in relatively abundant supply is suggested. The coast is divided into five districts, each with one museum acting as responsible authority. A team of marine archaeologists, including representatives of the Norwegian Diving Association, co-ordinate underwater explorations. The divers observe the law and this helps to maintain good relations between them and the museum.

Significant results

Sandy beaches are rare along the Norwegian coast; as as rule the sea-bottom is rocky. If a ship is wrecked in an exposed area, the rocks churn it into fragments. If



Video filming at a depth of 35 metres. [*Photo:* Norsk Sjøfartsmuseum.]

The low-pressure compressor is hauled into place. [*Photo:* Norsk Sjøfartsmuseum.]

it drifts into still waters, it may remain more or less intact but the ship-worm known as *Teredo navalis* rapidly devours any wood that is exposed. Only the portion that is buried in mud is protected.

For these reasons, no intact vessel has yet been found in our waters, unlike in the Baltic where there are no ship-worms. In most cases, along Norway's coast, only the bottoms of ships have been found in fairly intact condition. The most interesting finds are therefore loose wreckage, e.g. pieces of rigging, navigation equipment, personal belongings and cargo. As all these objects can be dated to the period shortly before the wreck, they are of exceptional value as a source of information concerning navigation, everyday life and trade. Written records such as statements made under maritime law, legislation, customs declarations, etc., are useful as broad indicators but rarely supply detailed information.

A glance at some of the many excavations carried out in the past will give an idea of what they can contribute to cultural history.

One document that came to light in the archives was a legal statement concerning a wreck that occurred on 24 December 1717. A frigate had been caught in a storm and driven towards the lower end of the Oslo Fjord. The details were studied. At 6 p.m. the ship was heading towards an island and a lighthouse, and six hours later it sank. We knew the force and direction of the wind and the spread of the sails and were thus able to calculate the ship's course. A diving expedition was sent to the area where we assumed the wreck had taken place and after a few dives, cannons were found on the sea-bottom. Further expeditions discovered major wooden structures in the mud. That was the opportunity we were waiting for. We wanted to organize an excavation project to train participants from the country's main diving centres.

Excavation work on the *Lossen*, as the ship was called, began in 1967. Stolen, the bay where it had gone down, was in a remote area. The depth of the wreck, 10–12 metres, was ideal for this type of excavation. The *Lossen* had drifted into the bay with a heavy list and had sunk with its starboard side facing downwards. The portion that did not sink into the mud was eaten by ship-worms. All that could be seen of the wreck before excavation began were the iron cannons 'floating' on top of the mud. As the work progressed, the framework of the ship could be discerned.

The three-point measuring procedure proved successful and enabled correct drawings to be made of the wreck itself. On the other hand, an attempt to use stereophotogrammetry failed because of the difficulties of allowing for temperature fluctuations and changes in salinity.

The most important finds from the wreck were individual objects, of which 4,500 were catalogued. Some of these were of interest to specialists only. A large number of bricks were found, for instance, in some cases showing traces of heat exposure. They must have come from a hearth, most likely an open fireplace with a chimney. Other fittings from the interior were also brought to light. The leaded windows of the aft saloon were reconstructed and two single beds with carved sides were discovered.

Pulleys and other rigging equipment were found in all shapes and sizes. The ropes, ranging from sailcord to thick anchor cables, were surprisingly well preserved. There was a thick rope with spherical attachments at regular intervals. The cable system was endless. The anchor cable was attached to it and hauled up one ship's length at a time.

A representative selection of navigation equipment was found, for example a hand lead and a deep-sea lead, a log chip and, strangely enough, a Jacob's staff. By that time one would have expected the Davis quadrant to have replaced the Jacob's staff. A Gunter's scale made of fruit-tree wood was so well preserved that the scale and numbers could still be read. It was used to divide, multiply and do calculations using sines and cosines. Two pocket compasses were found, one of which could also be used as a sun-dial. A small telescope, only 12 centimetres long, must have belonged to the captain. It was small enough to be carried in his pocket.

The galley was a further source of interesting information. A large copper cooking-pot was slightly damaged by electrolysis due to contact with iron. An inscription beneath the edge indicated that it had been taken over from another warship. Three-legged clay pots were common at the time and specimens were also found on other contemporary ships. A copper coffee-pot was a particularly interesting item and an example of the kind of information that marine archaeology can provide. It had been established that coffee was introduced into Norway in 1740 or thereabouts. But here was proof that it had already made its appearance aboard ship in 1717. This is not really so surprising since seafarers were generally the first to come into contact with foreign cultures.

The crew was served food on wooden trays. They ate with wooden spoons and knives. Provisions were stored in barrels which occasionally bore the ship's name, the date and the cooper's trade mark on their lids. Bone remnants indicated that the barrels had held salted mutton, beef and pork. There was a notable absence of pork chine, which seems to indicate that the meat was chopped up prior to being loaded on the ship.

Barrels were also used instead of chests for storing personal belongings. There were few chests, which shows that the regulation prohibiting ordinary crew members from taking chests on board was observed. It is interesting to note that the chests found on the wreck were not of the standardized shape prevalent in the nineteenth century.

The crew smoked pipes and took snuff. Some of the pipes were kept in wooden cases with ornamental carvings. They played dice, though it was against the rules. Materials for making wooden spoons show that this was a way to earn a few extra pence. A rather touching item was an artistically carved stick for winding wool which could also be used as a baby's rattle.

No textiles were found but about 600 buttons of bone, pewter, brass and silver and a selection of shoe-buckles, also of brass and silver, gave some indication of how people dressed at the time. Shoes, lasts, awls and pieces of leather show that shoes were made on board. Metal buttons were found in a small wooden box with a sliding lid. They were wound about with twine to protect them in heavy seas. The officers were better provided for than the crew. They had porcelain plates and crystal goblets and glasses. Two writing-boxes were also found, one with a lid and containing slate-pencils, pins, sticks of sealing wax, monogrammed seals, a few defective buttons and, strangely enough, one and a half nutmegs. The lieutenant who owned the box must have liked a few grains of nutmeg in his wine.

All these details have been mentioned so as to highlight the significance of individual artefacts and the glimpse they afford of life at the time of the wreck.

Another excavation in an entirely different category involved a ship carrying export goods from England that sank between 1625 and 1631. The cargo consisted mainly of clothes, but they had rotted away. Only 450 lead seals remained.

These were of two kinds: one with merchant trade-marks and the other with official stamps. The remainder of the cargo consisted of pewter goods, such as plates, large dishes, jugs, candlesticks and chamber pots. There was also a quantity of bronze spurs. Most remarkable of all were 600 lenses for eye-glasses to correct farsightedness due to old age.

Such cargoes tell us a great deal about the kind of trade practised at the time. Other ships that have been excavated carried cargoes of Dutch ceramics and clay pipes.

Harbour exploration has also given us vivid impressions of the kind of ship that visited the harbour and of the evolution of living conditions. A team excavating an area in Møvik harbour, for example, examined all objects in order to determine whether there were any rules governing the behaviour of objects buried in mud. The volume and specific weight of each object were measured and the depth at which it was found. Oddly enough, heavy iron objects were often found lying on the mud, while lighter objects had sunk quite deep. However, no clear trend, with a potential similar to that of stratigraphy in land archaeology, could be established.

The successful development of marine archaeology in Norway has been partly due to grants from the G. Unger Vetlesen Foundation. The Norwegian state, however, has also gradually increased its financial assistance.

This has been an account of how a museum with limited funds has tackled the problems of marine archaeology. We hope it has been of interest to readers.

[*Translated from Norwegian*]

The Bodrum Museum of Underwater Archaeology

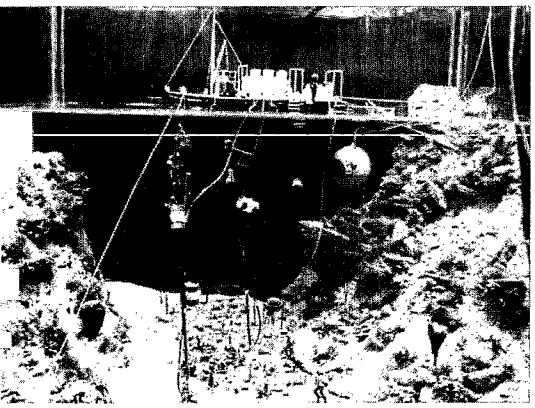
Oğuz Alpözen

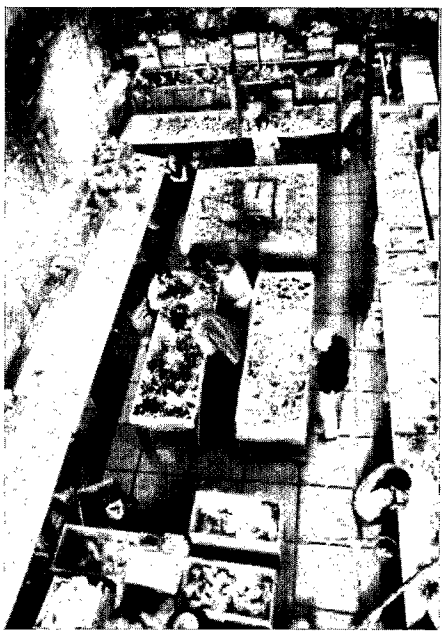
Born in Izmir in 1940; received his degree in Classical Archaeology from Istanbul University. Joined the underwater excavations at Yassi Ada in 1962, while still an undergraduate, and continued to work on shipwreck excavations while an assistant at the Bodrum Museum and later at the Antalya Museum. In 1978 became director of the Bodrum Museum, which was officially named the Bodrum Museum of Underwater Archaeology the following year. His publications include articles on amphorae and anchors, *Pamphylia, An Archaeological Guide,* and *Türkiyede Sualti Arkeolojisi* (Underwater Archaeology in Turkey).

Bodrum is a town founded on ancient Halikarnassos, the capital of Caria in Asia Minor. Its great tomb built by the Carian satrap (governor) Mausolus was not only one of the seven wonders of the ancient world, but has given its name, 'mausoleum', to denote a monumental tomb in many languages. The tomb later served as a quarry from which the Knights of St John took building stones to construct a castle over the remains of the ancient acropolis of Halikarnassos. The construction of the castle was begun in 1402 and continued intermittently until 1513. The castle was finally surrendered to Suleiman the Magnificent on, 1 January 1523, without battle. Under Ottoman rule, it became one of the more renowned prisons. During the First World War, in 1915, the castle was bombarded and eventually abandoned.

Today the Bodrum castle houses a unique museum of underwater archaeology which displays the remains of five scientifically excavated ancient shipwrecks, underwater finds made by fishermen and sponge-divers, and land finds from the vicinity. It was begun, unofficially, in the late 1950s, and in 1960 became a storeroom for underwater finds, especially those from the Bronze Age shipwreck at Cape Gelidonya, near Finike. After this modest beginning, the castle was thoroughly restored, as a result of which it is now one of the sturdiest castles in the Mediterranean. Its English, French, Italian and Spanish towers, along with other areas, are now used as showrooms. Although the castle was constructed to make entry difficult, alterations have been made to allow visitors easy access. They come into the inner castle by way of tree-lined paths and wide steps; the inner castle itself is decorated with specially selected Mediterranean perennial trees and flowers. The holy trees of the ancient world—olive, bay and plane—provide shade for the guests. Upon entry to the inner castle, the visitors are greeted by a flock of pigeons

Diorama of the fourth-century Roman wreck.
[*Photo:* Bodrum Museum.]





Mending glassware in the workshop of the Bodrum Museum.
[*Photo:* Don Frey.]

which flap their wings on a whistle from a guard just outside the first gallery, the Bronze Age Hall.

Lessons about antiquity

The Bronze Age Hall is housed in a structure which served as a chapel of the Knights of St John and later as a mosque for the Ottomans. In the apse of the chapel are large jars and pitchers from about 1600 B.C., excavated at Şeytan Deresi, with large underwater photographs showing how the oldest scientifically excavated shipwreck was uncovered. Along one side of the chapel are the finds from the shipwreck which sank at Cape Gelidonya about 1200 B.C. These finds are displayed in a manner which allows visitors not only to view old artefacts, but to understand the nature of the voyage. Copper ingots, for example, are arranged on sand as they lay on the sea-bed. On the wall above them is a large reproduction of an Egyptian tomb-painting showing how these ingots were used as ingredients for making bronze. Each glass case holds a picture showing how the artefacts in the case were used: smith's tools found on board, for example, are arranged with the illustration of a Bronze Age smith's workshop; personal possessions from the shipwreck, which suggest the ship's Near Eastern origin—cylinder seal, weights, scarabs, and stone mortars—are similarly grouped together with explanatory illustrations as well as labels in Turkish and English. The illustrations thus allow visitors to learn who the owners of the Bronze Age artefacts were, and how the artefacts were used in manufacture, trade, and daily shipboard life. As in all the galleries of the museum, enlarged photographs show how the excavation was conducted. Lastly, the opposite side of the chapel displays land finds from a Mycenaean cemetery excavated only a few kilometres from Bodrum.

Outside steps lead from the chapel to the knights' dining hall which is now the Byzantine gallery. Here one can view ceramic, glass and metal finds from a fourth-century A.D. shipwreck excavated at Yassi Ada during the late 1960s. Because this excavation introduced many of the modern techniques of underwater archaeology, an aquarium placed in a niche in the wall of the gallery holds a 1:20 scale diorama of the excavation in progress, with detailed models of the diving barge and its equipment, the grid system constructed over the wreck-site, lifting balloons and airlifts, an underwater telephone booth, and a submersible decompression chamber, as well as the three main types of amphorae carried on the fourth-century ship. A small compressor provides air for model divers and excavating tools.

The Byzantine gallery also displays the main objects from a seventh-century Byzantine shipwreck also excavated at Yassi Ada, grouped according to use: boatswain's and carpenter's tools, for example, are explained in cases separate from those which hold, say, the cook's materials. A detailed and accurate reconstruction model, the result of more than a dozen years of research, reveals the ship itself in the centre of the hall.

Amphorae, coins and the money economy

The Spanish tower, better known as the snake tower because of the relief carving of a snake on its wall, is reached by a short flight of steps. The lower floor of this tower is used as a display-storeroom to house part of the museum's vast collection of amphorae, said to be one of the largest and most varied in the Mediterranean. The walls of the lower floor have been decorated with paintings of ancient scenes illustrating the purposes and contents of amphorae, and why they are found in mounds under water. Outside the entrance to the storeroom, an open-air exhibition of an ancient wine shop with its array of amphorae can be seen. Explanations and drawings tell visitors about the capacities of amphorae, and how long a labourer would have to work in order to purchase an amphora of wine in comparison with modern wine prices.

The lower section of the Italian tower is used for the display of coins and jewellery, both from land and under water. In this gallery, minting techniques, denominations and values are displayed individually. Generally, museum coin displays are interesting to numismatists, but can be rather boring to the general public. For the first time in museum history, however, we attempt to show the purchasing power of money throughout the centuries with a combination of coins and models. For example, in the sixth century B.C., one tetradrachma could buy an ox, but the same ox would cost eight tetradrachmas in the fifth century B.C., thirteen tetradrachmas in the fourth century B.C., and twenty tetradrachmas in the second century B.C. The economy of various periods, compensation doled out for the poor, what could be purchased for

various sums, the cost of a slave for a single day, the cost of bread, meat and oil are all shown with the help of the models. The prices are compared with modern prices so that visitors have a better insight into the economy and daily life of the past.

Recreating the contexts of various ages

The medieval gallery, in the lower floor of the French tower, is reserved for the display of materials excavated on an eleventh-century A.D. shipwreck at Serçe Liman. The gallery consists of two rooms. The outer room displays Byzantine cargo amphorae, Islamic glazed plates, fishing gear, millstones, weapons, chessmen and many other finds whose recovery from the wreck is illustrated with colour photographs. An interested visitor can follow the complete process of underwater mapping, wreck excavation and recovery of artefacts, then conservation, drawing and cataloguing of the artefacts which are displayed in the cases. Again, the purposes of the artefacts are explained with drawings showing how they were used in antiquity. The inner room of the gallery houses some of the tons of Islamic glass recovered from the wreck. The black-walled, vaulted room has no lighting except for that in the cases, emphasizing the forms and colours of the glass objects.

The upper floors of the French and Italian towers are also used as showrooms. The uppermost chamber is the Hellenistic Period Hall which contains underwater chance finds brought up in sponge-divers' nets, including two bronze statues netted at a deep site (80 metres) which was later located by sonar, and photographed from a two-man research submarine near Yalikavak. How the statues were netted with the heavy, axled sponge-nets is illustrated, with an actual net (*kangava*) displayed outside the hall (a complete gallery devoted to the history of Bodrum sponge-diving is now being planned).

The central room of the Italian tower is used as the classical period gallery. Above the door lintel an Ionic capital built into the wall bears the word 'Italia', a clear indication of the reason why the various towers are named after different countries. This small gallery's most important piece is a part of the Skopas relief which once adorned the mausoleum, but which was later used by the knights as a building stone in the castle.

A sub-Mycenaean and archaic period hall is situated on the middle floor of the French tower, with artefacts from the eleventh to sixth centuries B.C., including a number of archaic marble statues. A protogeometric krater (ceramic mixing bowl) bears a rare painting of a ship of its time.

The top floor of the English tower has been restored and furnished in the fashion of the 1500s. Visitors entering the tower on many special occasions are greeted by knights and ladies in sixteenth-century garments. Servants in medieval clothes present mugs of wine under candlelight, with medieval music and incense; this enables the visitor to appreciate the display with all five senses of the body.

Just below the top floor of the English tower, and in several other areas of the castle, are the laboratories, workshops, library, offices and storerooms of the museum. In these, glass, ceramics, and the entire wooden hull of an ancient ship are being conserved, photographed, drawn and catalogued by a large staff of Turkish and foreign specialists.

The courtyards of the castle are used for open-air displays. Anchors are arranged according to their uses. Composite stone anchors are displayed on sand, whereas stone anchors for rocky bottoms are shown on rocks. Next to the stone anchors, lead anchor stocks are fitted to reconstructed wooden shanks and arms. Other areas of the courtyard hold amphorae stacked in the same manner as they would have been in the cargo holds of ancient ships.

The main courtyard includes a recreational area where visitors can sit in the shade of trees and buy refreshments. Behind this area, one can see an erected nomad tent containing the utensils, bags and weapons a nomad family might use. The guard of the tent is dressed in nomad style, and occasionally plays a nomad tune on his nineteenth-century nomad flute made from an eagle bone.

By the main entrance to the castle, what once was a casemated battery has been converted into an art gallery where contemporary artists and craftsmen display their works in rotating exhibitions. Works of art acquired from the artists will later be displayed in the German tower. The museum, with its exhibitions, conferences and lecturers, and public education days has become a vital, self-renewing institution, which, with the help of sponge-divers, seamen and scientists, has transformed the castle into a cultural centre.

BODRUM MUSEUM OF UNDERWATER ARCHAEOLOGY. The Byzantine gallery. [*Photo:* Don Frey.]

Drawing pottery from the sixteenth-century wreck at Şeytan Deresi. [*Photo:* Don Frey.]

LAKES AND WET-SITES

Archaeological discoveries in lakes and rivers

Ulrich Ruoff

Born in Zurich in 1940. Studied archaeology and prehistory at the University of Zurich. Became interested in underwater archaeology in the 1960s; developed excavation methods and created a team of divers and a dendrochronology laboratory. The methods of freshwater archaeology developed at Zurich have been adopted by many other archaeological groups in Europe. Zurich city archaeologist since 1962. Deputy director of the Baugeschichtliche Archiv (Architectural History Archives) since 1973. President of the Verband Schweizerischer Kantonsarchäologen, which is a union of archaeologists employed by the various Swiss Cantons.

At the mention of underwater archaeology everyone immediately thinks of the oceans. The archaeological wealth of inland sites is much less well known, however. Yet inland waterways throughout the world, even when not easily navigable, have served as busy natural routes since the earliest times. Thousands of years of intensive use must surely have left some traces. As a result of accidents, a great deal of material—some of it valuable—has fallen into the water. In addition, rivers have been not only routes for traffic but often obstacles as well. Vast numbers of people and huge quantities of goods have been conveyed across ferry crossings, fords and bridges. Losses were bound to occur when ferry equipment was damaged, bridges collapsed, cart axles broke and so on.

Objects have also been dumped in the water intentionally, and not always refuse, by any means. Ritual sacrifices of material objects were a feature of many early cultures. The water was also used as a hiding-place. A quiet way to get rid of an incriminating object has often been to consign it to the deep.

Lake shores and river crossings have always been popular sites for settlement, offering ease of transport and advantages for many trades. Lastly, we should mention the practice of founding settlements on natural or artificial islands for protection, or of building fortifications in the water.

Modern excavation methods make it possible to make more accurate observations underwater. This diver is recording various lake-bed strata, some of which date back to the Stone Age.
[*Photo:* Archaeological Bureau of the City of Zurich.]

In most cases, objects that fell into the water could not be salvaged and, as we know, much of this material has been conserved in its liquid environment. In Central Europe, for example, our knowledge of prehistoric textiles has been gleaned almost exclusively from sites in perpetually damp moorland or from lakes. Wood has been preserved in wet soil for thousands of years, and so, of course, have other materials of vegetable origin such as scraps of food. These are valuable to the prehistorian, for they often tell us more than any single artefact about life in primeval times.

Ancient settlements at the water's edge

In Switzerland and the adjoining countries, finds from so-called pile dwellings have achieved particular fame. These are the remains of settlements dating mainly from the Neolithic and the Bronze Ages: i.e. from the end of the fifth century B.C., up to and including the first quarter of the first century B.C. Sites can usually be identified by thousands of piles rising from the bed of a lake. The question whether these are the remains of houses that originally stood on the shore and were later submerged, or of villages actually built in the water, has led to heated and often passionate discussions among scientists and laymen. The romantic nineteenth-century image of the lake dwelling, based on reports of contemporary lake dwellings in the South Seas, was taken by many for gospel. Modern research, however, has made it clear that finds from individual settlements do not warrant a general inference, and that structures were built both at ground level and on raised floors. The latter may again be subdivided into structures standing on a normally dry shore and those built in the water.

Besides a large number of piles, a significant array of small objects can be found at the typical site. They are usually in an excellent state of preservation. Here and there ceramic vessels are found lying perfectly preserved, enveloped in soft lake sediment. Cultural remains in the form of organic materials of the kind already mentioned also occur. In the past fifteen years excavations in Lake Zurich and neighbouring waters have brought to light Stone Age and Bronze Age axe helves, ladles, flint knives with the handles completely intact, looms, archery bows, boxes made of bark, wooden caskets, scraps of netting and textiles, balls of yarn and a great deal more. Semi-finished articles afford a particularly

valuable insight into prehistoric technology. They can be highly effective in ridding the public of the prevailing impression of prehistoric handicrafts as crude, clumsy and artless. In a museum display they arouse interest in primeval times as virtually no other object can. How astonishing to find that an axe helve fashioned 6,000 years ago yields to no modern tool handle either in the careful choice of wood or in fine, purposeful finish! Bronze Age basketwork is scarcely distinguishable from that produced today; indeed, it is more beautiful than many of its modern counterparts.

Perils

This underwater cultural heritage is in great peril today. The main causes of its destruction are new construction works on the shoreline, dredging to accommodate shipping, and increased wave erosion in the shore area as the protective reeds are removed. Colleagues at Lake Constance give alarming reports of the rapid disintegration of prehistoric settlement strata on what is now a bare shoreline.

Merely to salvage individual items of interest is not enough. The significance of the cultural objects brought to the surface can be assessed only in conjunction with the findings of detailed archaeological investigation. Furthermore, finds which for technical or financial reasons can be salvaged only fragmentarily or not at all—the last remains of houses and other buildings and miscellaneous traces of other installations—should at least be properly recorded.

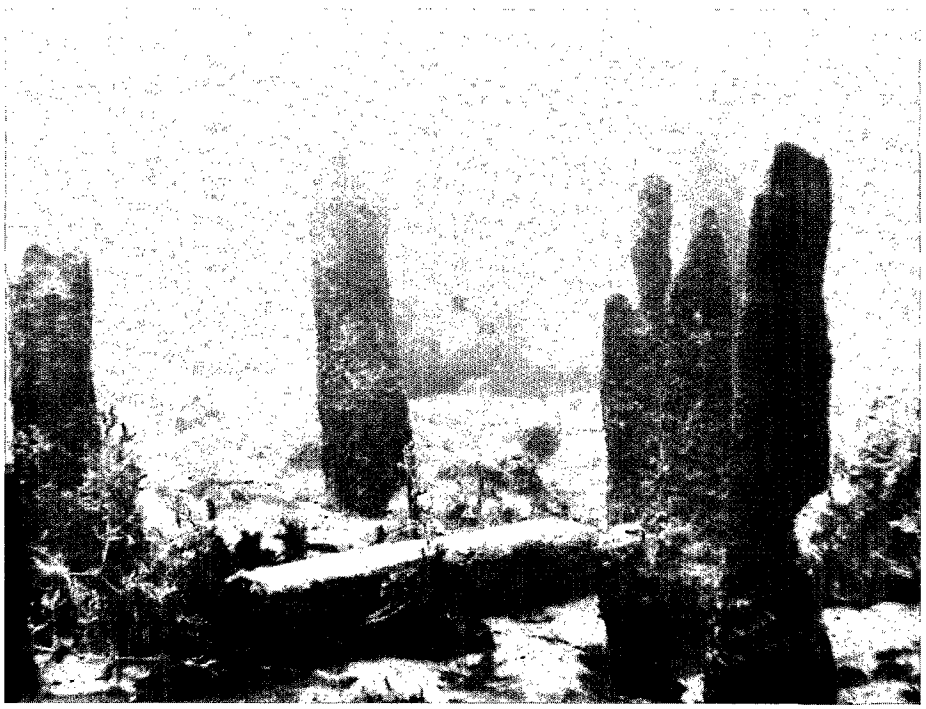
Museum people tend to focus their main attention on original finds, with the frequent result that treasure-hunters who offer them beautiful pieces meet with an insufficiently critical reception. In their eagerness to take what is offered, they do not go carefully into the exact circumstances of the find and thus fail to detect the devastating pillage that takes place at the sites. The underwater cultural heritage is particularly endangered. Only a few specialists see the damage that is inflicted on it. And since—especially in today's news-saturated world—mere hearsay never attracts the same notice as what is seen at first hand, it is often hard to convince even archaeologists of the urgent need for drastic action.

Fortunately the general public, and hence also visitors to museums, demand more information on finds nowadays than they did previously. They are no longer content with a mere display of objects in a showcase. When they see a cooking-pot, they want to know what was cooked in it; when they see a cup, what was drunk from it. And one question leads to another. Where was food obtained, and how? Where did people find the necessary raw materials? How did they learn specialized handicrafts? Finds of weapons lead to questions about the relations between different tribes, imports from distant regions to questions about trade relations and traffic routes and so on.

A vast potential for knowledge and museology

Hence underwater sites such as the Stone Age and Bronze Age lacustrine settlements (pile dwellings) in Switzerland should also be of keen interest to museum curators. Enveloped in the damp sediment, parts of plants, even pollen, have kept very well. Analysis of these items by strata yields a wealth of information about the history of the landscape. For instance, we now know that the changeover from predominantly mixed-oak forest to beech forest in the Lake Zurich area occurred during the transition from the Neolithic to the Bronze Age. This must have had far-reaching economic repercussions. Moreover, the plant remains in the settlements show what people gathered at various periods and sometimes the use to which it was put.

Unearthed in a Zurich street: house-beams from the Bronze Age (about 1600 B.C.) excavated after the water-table was lowered. The pile remnants date from the Stone Age. [*Photo:* Archaeological Bureau of the City of Zurich.]



On the bed of Lake Zurich these Bronze Age piles date from about 1000 B.C. [*Photo:* Archaeological Bureau of the City of Zurich.]

Various domestic vessels dated about 4000 B.C. recovered from excavation at the 'Kleiner Hafner' site, on the banks of Lake Zurich.
[*Photo:* Swiss National Museum.]

An idea of the number of inhabitants of a prehistoric village can be formed only where it is possible to trace the ground plan of the houses or at least the area of the settlement. An important factor in all such research is the assignment of a date and duration to each situation. The sequence of strata is rarely as clear-cut on land as it is under water. In Lake Zurich traces of the different settlements lie one above the other, clearly separated by sterile layers of calcareous mud. Hence a careful excavator can tell immediately the relative age of the objects to be salvaged. Even more important is the abundant supply of wood. Dendrochronology—a method of dating based on differences in the width of the annular rings in trees due to annual fluctuations in climate—is now capable, under optimum conditions, of accurate year-by-year dating as far back as the third millennium B.C. We have no doubt that it will very soon reach the fourth millennium. We already know how to date the widest variety of villages from that millennium in relation to one another and the establishment of an absolute time-scale is simply a matter of time.

Museums can turn all these finds and findings to good account. No prehistoric site on dry land has increased the stocks of the Swiss National Museum on a scale comparable with our underwater excavations or explorations in what are now dry sections of the shoreline. An exhibition of the findings of major salvage projects on Lake Neuchâtel organized by the competent cantonal archaeologists showed that even displays dealing with the technical progress of archaeological digs and the problems of scientific analysis arouse keen interest among visitors. People like to get some idea how the researchers have come by their results, and the information they receive enhances in its turn their awareness of the care that needs to be taken to protect the underwater cultural heritage.

Unfortunately it is hardly feasible to move large portions of the remains of a settlement to a museum. In cases where particularly impressive remains are excavated, for instance a huge Bronze Age wooden floor near the Zurich opera house or interesting foundations of houses dating from the same period in the peat bog of Fiavè (Trento, Italy), the question arises whether these relics of the past can be preserved on the spot for all to see. Unfortunately, however, the preservation of organic remains *in situ* is still an unsolved problem. The solution applied, therefore, is to build replicas. Attempts are made to reconstruct prehistoric houses in open-air museums. The great popularity of the purported reconstruction of a pile dwelling at Unteruhldingen on Lake Constance shows how easily the layman can be captivated by visual representations of prehistoric conditions. It is all the more regrettable, therefore, that in this and other cases he is deceived by a semblance of scientific authenticity or dazzled by an exaggerated fantasy world. To my mind it is a museum's duty to present genuine knowledge in scientifically justified proportions as an adjunct to its overall display, and thus put paid to 'charlatans'. Underwater archaeological exploration can provide first-rate background material for this purpose.

In contrast to the situation twenty years ago, tried-and-tested methods of underwater exploration are now available. In the case of the technology of freshwater excavation, we ourselves were able to make a substantial contribution with the introduction of the so-called jet pipe and some other innovations. Since our first real underwater excavation at the Kleiner Hafner site in Zurich in 1967 (see Bibliography), a small archaeological diving team has been constantly at work there. Many improvements have been made in working methods, and we are now in a position to say that stratigraphic excavations can be carried out in a few metres of water with as high a degree of precision as on land. It is even possible to photograph vertical sections in colour under water. In order to improve the quality of the photographs, we recently attached a huge funnel-shaped device made of plexiglas and chromium steel in front of the camera. When filled with clear water, it enables us to obtain razor-sharp pictures of the stratification even in relatively turbid water. The idea of the clear-water attachment is not new, but it was previously used with much smaller equipment than our device with its square-metre pane.

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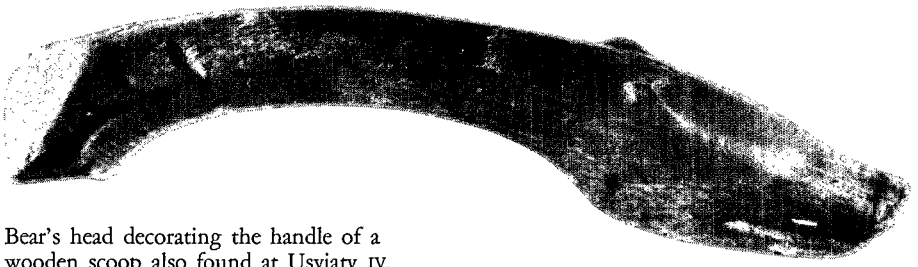
Eighteen months ago we modified our working procedure so as to remove only a narrow strip at a time and record the data on the section thus brought to light before moving on to the next strip. The advantage of this gradual advance from top to bottom of a vertical face is that the position of the fine individual layers can be accurately registered even where they are distorted by sedimentation or are discontinuous, or where, as often happens, they suddenly peter out. In this way even before the material is removed, we know how to proceed with classification. This approach has proved so successful that we have adopted it in appropriate cases in dry-land excavations. The reader should be warned at once, however, how risky it is to adopt a systematic approach to excavation. The art of the excavator consists precisely in choosing the right procedure.

After fifteen years of underwater archaeology the tasks confronting us are still enormous. New dangers and new forms of destruction are still being discovered. Only a few days ago we came upon the ground plan of a late Bronze Age house that had been uncovered by erosion. Three logs that had been used in constructing the house were still in their original position but the fourth had already disappeared. On the same spot two years ago volunteer divers found a whole collection of small Bronze Age vessels lying in a prominent but already uncovered calcined layer.

[*Translated from German*]



Bear's head decorating the handle of a wooden scoop also found at Usviaty IV. [*Photo:* Hermitage Museum.]

The Hermitage Museum under water

Alexander Mikhailovich Mikliaev

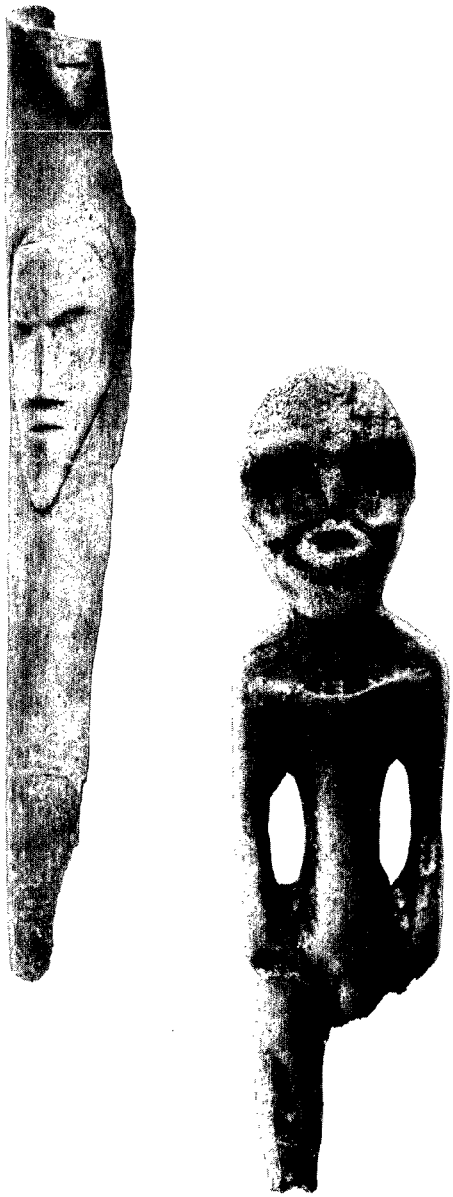
Born in 1934. Graduated from the Leningrad State University in history and archaeology, 1958. Holder of Candidate of Science degree (in history), senior professional staff member of the Hermitage State Museum, specialized in the New Stone Age and Bronze Age archaeology of the USSR's north-west. Curator of neolithic artefacts found in that region since 1960. Author of over sixty scientific publications.

In the 1970s the Hermitage Museum launched a major underwater archaeological project in the north-western USSR.

This area is defined by the Luga river basin, close to Leningrad, in the north, the Valdai Hills in the east, the sources of the West Dvina tributaries in the south and the Latvian and Estonian borders in the west. Until recently the oldest archaeological objects known here were Slav burial mounds and early Iron Age settlements. Outside this area, however, many neolithic settlements of the pit-comb ceramic culture and of the Narva culture had been found and excavated. It seemed as if in those ancient times a mysterious people kept the neighbouring tribes out of the area. Since no trace of the latter was found experts decided that unfavourable physical or geographical characteristics must have been responsible. Palaeographic data, however, did not confirm this hypothesis; rather they showed that the environmental conditions there had been no worse—and in some places even better—than in Karelia, and in the Baltic and Valdai regions.

In the early 1960s archaeologists from the Hermitage discovered Bronze Age settlements in the south of the Pskov region; some time later they came across a neolithic settlement near the village of Usviaty. In the lake and swamp deposits of the peatbog to the north of Lake Usviaty they found to their amazement pile-dwelling remains of the so-called 'lake type' culture (after G. G. Childe) typical of the European Alpine zone. In the course of excavations covering about 500 square metres (1964–67) archaeologists found nearly 2,000 oak, elm, birch and pine piles, with plank remains stuck between them. In sapropel layers with a high water content structural elements of houses were found in quite good condition, as well as many household utensils, tools and

A fragment with human faces in bas-relief, the art of an ancient pile-dwelling people who lived on the lakes of the West Dvina Basin in the third millennium B.C. [*Photo:* Hermitage Museum.]



From the Usviaty IV site, an idol, statue of a naked man carved on moose horn. [*Photo:* Hermitage Museum.]

weapons made of wood, horn and bone. Among them were unique pieces of neolithic art, for example an idol made of moose horn and a wooden scoop handle in the form of a bear's head. Flintstone tools and fragments of vessels decorated in the style of European funnelbeaker and subsequent cultures were quite a surprise to archaeologists. Who would have thought that the influence of this culture had reached so far east! The findings showed that the inhabitants here had maintained ties with central and western Europe. But what is still absolutely inexplicable is the fact that they had no contacts whatsoever with the population of pit-comb ceramic settlements located just 200–300 kilometres away.

In 1969 another pile-dwelling settlement was found in a peatbog near the village of Naumovo on Lake Zhizhitskoye. Its lower cultural layer contained neolithic material similar to that at Usviaty. Other layers contained ceramics and tools typical of other prehistoric cultures, particularly the North Byelorussian, a variety of which must have originated here.

Subsequent discoveries of nearby pile-settlements suggested that a civilization of pile-dwelling builders must have existed in the south Pskov region and the north Smolensk region. Integrated methods of dating including carbon-14 measurements showed that the construction of these settlements started in the second quarter of the third millennium B.C. and continued through the first half of the second millennium B.C. Each settlement was rebuilt many times, in the course of regular maintenance, after fires or due to the fluctuations of the lake level caused both by humidity dynamics and by Baltic sea-level fluctuations that influence the remote inland lakes through the West Dvina, in the basin of which they are located.

Lake-sites require underwater archaeology

Each of the lakes had its own destiny. Thus, Lakes Usviaty and Zhizhitskoye continue to shelter flocks of wild ducks and geese, which use them as their breeding sites. Lake Zhizhitskoye in particular is known for its fish resources. Peatbogs occupy only parts of these lakes and it was in the lower sediment layers that the pile-dwelling remains were found as in the other lakes which had long ago turned entirely into vast peatbogs. Naturally, we could expect that pile-dwelling remains might be found in the beds of lakes with no peat. Underwater archaeology would be the only way to explore them.

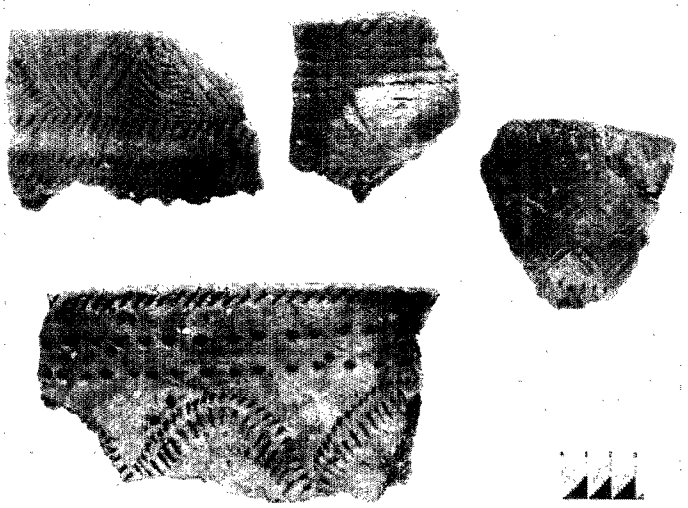
A settlement of this kind was indeed discovered in 1976 in Lake Sennitsa close to the village of Dubokrai near the town of Nevel. Although the cultural layer was very close to the surface (about 1.5 metres), work was very difficult because of the muddy water. Nevertheless, we discovered that this cultural layer, containing vessel fragments and flintstone tools from the Usviaty and North Byelorussian cultures, occupied an area of about 1.5 hectares. Apparently the pile-dwelling dated back to the third or second millennium B.C. It was abandoned in the middle of the second millennium B.C. and its remains were destroyed by ice and waves. It is possible, however, that below the silt we might still find some settlement remains. Unfortunately, poor visibility makes underwater excavations impossible.

Another settlement, Serteia II, was discovered while draining the peatbog. A drainage canal had already destroyed a small part of the settlement. Although begun in 1973 this excavation had to be postponed because of severe drainage problems, but was resumed in 1980. On the bottom and sides of the canal a great number of piles were found interspersed with planks as well as many Usviaty culture vessel fragments and flintstone tools. The water was clear and the rapid current washed away the clouds of mud that appeared from the sapropel. Deposits were first removed from the bottom piles and the sides of the canal. We found, measured and mapped about twenty-five piles varying in diameter from 7 to 20 centimetres; two boards 6 centimetres thick were also found. Above the boards there was a layer of oak or possibly elm bark, covered with a thin layer of medium-grain sand, found nowhere else. In the sand there were a lot of small charcoal pieces, some vessel fragments belonging to the Usviaty culture, flintstone tools and chips, and wild-animal bones as well. It all looked like part of an ancient village platform based on piles. If our guess is right, the findings in the Serteia Canal are extremely important because no lake settlement with its platform preserved has yet been found in Europe. By clearing the piles from the sapropel and mapping them we could only identify the location of the pile foundations and actually had no idea of what the settlements looked like.

Excavation data—charcoal, piles with charred surfaces, etc.—showed destruction by fire. On the canal bottom close to the platform structures we found human skull fragments, a shoulder-blade and several ribs. Above the platform we found pelvis fragments, a sacrum and a thigh bone, all belonging to a tall middle-aged man. The fire had been so fierce that the bones were also partly burnt.

This material has proved so interesting that in spite of technical problems the Serteia II underwater excavations will continue. The swamp and lake sediments will be removed to the level of the pile tops. The coffer-dam separating the canal from the excavation pit will be removed and the pit will be filled with water. Archaeologists moving from the canal side to the pit will then use ejectors to wash away the sapropel under which the settlement remains are buried.

This project aims at ensuring first of all that scuba-divers do not spoil the cultural layer and its content (as traditional archaeologists do —whether they want to or not—by walk-



Fragments of clay vessels found in the process of clearing the Serteia II platform (second half of the third millennium B.C.). [*Photo:* Hermitage Museum.]

This fragment of a wooden plate, dating back to the third millennium B.C., was found in the lower layer of the Naumovo pile settlement on Lake Zhizhitskoye. [*Photo:* Hermitage Museum.]

ing on it and thus damaging buried objects). Second, in the course of traditional excavations, archaeologists have to move downwards, clearing one layer after another and thus destroying the interconnections of the remains. We plan to move not only vertically, but also laterally, i.e. from the canal to the pit. That will give us a chance to leave the remains intact, to map their exact positions and to understand their interconnections right on the spot. It should be noted here also that underwater exploration has proved less dangerous to excavators than land archaeology, for there is no mass of peat, clay, sand, sapropel, etc., to fall on the archaeologists at any time. Strengthening walls and draining away water also usually takes much more time and money on land than in underwater exploration of an excavation site.

The pile-dwelling remains dating back to the third and second millennia B.C. are unique archaeological sites. Both organic materials have been preserved as well as dwelling remains. When working in the peatbogs of Usviaty and Naumovo we were forced to destroy the remains in order to study them. While moving downwards we increasingly deprived the piles of their humid protection; they became dark, cracked and damaged. Plastic covers of course were not sufficient to protect the piles. However, in water-filled pits piles are in no danger of drying. Traditional methods of excavation usually destroy not only the piles but the structural fragments on the horizontal plane. While draining the water of, say, a depth of 20 metres, we sometimes are not aware that we have dried up boards and planks located at a depth of about 2 metres, which will be cleared and thoroughly examined only a few days or weeks later. Underwater excavations pose no such danger.

These techniques will help preserve these unique sites with a view to making them accessible to visitors. But the creation of such site museums will be a very difficult task, for all pile-dwelling remains are located in flooded areas. If the sites are not separated from lake or river basin, spring floods will destroy them. Were the water level to fall sharply, the remains would also suffer. As to the museological problems of presenting 5,000-year-old waterlogged objects, these are considerable.

Nevertheless, we are determined to take all measures possible to preserve and exhibit these unique sites. Although few have been identified so far, in time the situation may soon change. For over a century fishermen and others have reported underwater obstacles that have snagged their nets and even heaps of debris visible here and there. Other sources have reported broken clay pots, 'giant' bones, mit and acron shells found while digging drainage canals.

Until recently archaeologists ignored this kind of information as well as more numerous (and more fantastic) reports about 'devil's bridges' constructed across lakes, 'devil's watermills' and 'king's boats' sunk with their passengers. Such data from folklore sources are not shown on the map, though they deserve serious consideration. After all, the remains of ninth- and tenth-century villages in Latgale flooded by Lake Araishu were well known to the local people in the nineteenth century, who took them for the ruined castles of wicked barons drowned in the lake for their evil deeds.

It is hard to say at present where new pile-dwelling settlements will be found. What we do know with a high degree of certainty is that in Byelorussia and the adjacent Pskov and Smolensk regions there existed in the third and second millennia B.C. a specific civilization of pile-dwelling builders who maintained continuous and stable cultural ties with the populations of central Europe.

Extensive study of this civilization appears to be one of the most important tasks that can be accomplished with the help of underwater archaeology.

[*Translated from Russian*]

Huahine: heritage of the great navigators

Yosihiko H. Sinoto

Born in Tokyo, Japan. Earned a B.A. degree at the University of Hawaii and joined the Museum as a Fellow in Anthropology in 1958. In 1962 received a doctorate from the University of Hokkaido, Japan, specializing in Japanese prehistory and Polynesian archaeology. Since 1960, has taken part in and led archaeological expeditions to the Society, Marquesas, Tuamotu, Pitcairn, Austral, Cook, Tonga, and Kosrae island groups. He has also played a major role in the research and restoration of religious structures and a meeting house in the Society Islands. Chairman of the Department of Anthropology, Bernice P. Bishop Museum, Honolulu, since 1970.

One of the most important archaeological sites in Polynesia today was discovered accidentally in 1972 during the construction of the Hotel Bali Hai on the island of Huahine, one of the Leeward Islands in the Societies, French Polynesia. The hotel site is located near Fare, the capital of Huahine, in the land divisions of Vaito'otia and Fa'ahia, facing the Ava Mo'a pass through the reef on the northern part of the island.

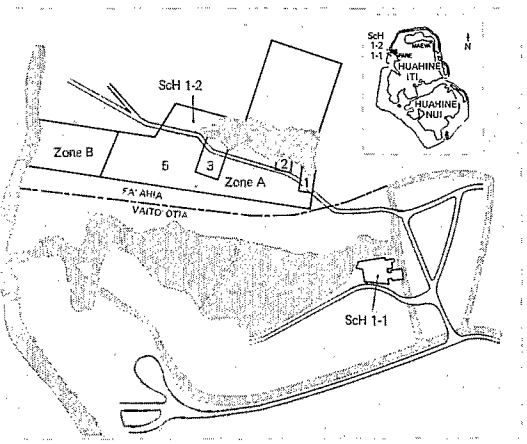
In 1973, while dredging to obtain sand for landfill, a hotel construction crew unearthed several large whale bones. I was conducting restoration work in the nearby village of Maeva, and when I was told of the discovery I immediately visited the hotel site. Richard Soupene, the hotel architect, had saved one object that he thought was man-made, and I cannot describe the surprise and excitement I felt when I saw it. It was a whalebone hand club, an object previously known only from the New Zealand Maori culture, where it was used as a thrusting hand weapon *(patu)*. Here was material evidence supporting the classical hypothesis, based on traditional legends, that the Maori ancestors had originated from Opoa on Ra'iatea, one of the Leeward Islands of the Society group. My immediate concern was to determine the archaeological context of the hand club and to ascertain whether any part of the cultural deposit at the site was still intact.

Successive excavations...

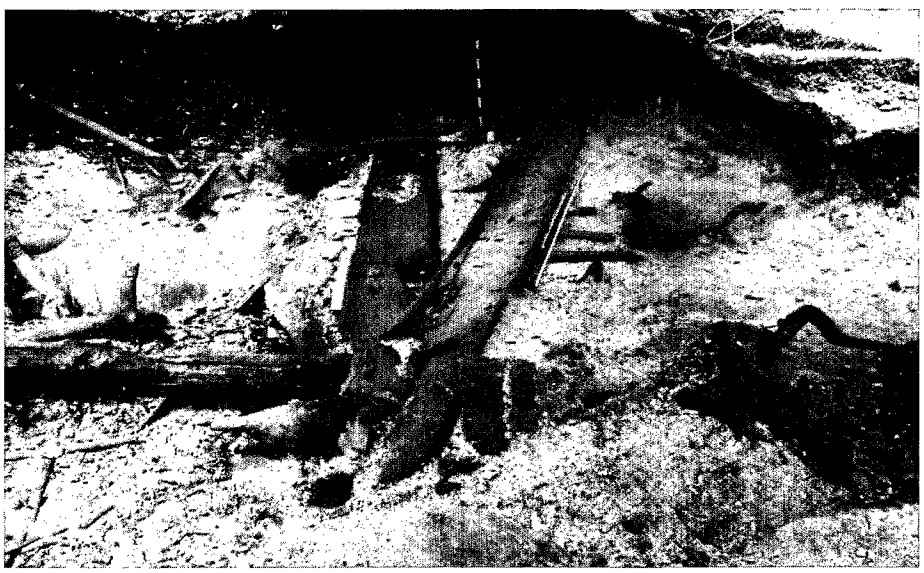
With financial support from the National Geographic Society, supplemented by private funds, I was able to return to the site in 1973 with a team of archaeologists from the Bishop Museum, Honolulu. Test excavation pits were placed in the bank of the dredged pond, near the original context of the hand club. The third test pit yielded another complete hand club, of similar form but—surprisingly—made of wood. We then realized that the cultural deposit was waterlogged; the water-level fluctuates with the ocean tides, as well as with groundwater seepage from the nearby hillside. Environmental survey and analysis was begun in 1975 by Dr Yoshio Kitagawa of the Historical Museum of Hokkaido, Japan, and continued in 1981 by Dr Douglas Yen of the Bishop Museum. The site area is low, and probably was originally a lagoon that had been filled in by sea action. The reasons for the submergence of the cultural deposits are still being sought, however.

Extensive excavations were undertaken in 1974 and 1975. Vegetal materials such as coconuts, pandanus, pieces of gourd, and various other plants—for example, *'ava*, used to make a Polynesian beverage—were also uncovered. Fallen wooden posts were found, with the bases still standing in place.

In 1977, the pond was dredged again and more cultural deposits were discovered. Once more, with the financial support of the National Geographic Society, we conducted an emergency excavation. This time we encountered large wooden canoe planks, a steering paddle, and bailers, indicating that canoes were manufactured in the village. The implications of this find were, of course, very significant. At this time I appealed to the Territorial Government to assume the responsibility of preserving this important site area, at least until the archaeological survey and test excavations were completed. The appeal was delivered with some urgency, as there were plans for expansion of the hotel on to the site area. My request for financial help was also granted by the government, matching the funds that the Bishop Museum had already expended. The wooden planks and other canoe-related objects were reburied that year, allowing nature to protect them until an appropriate way of conserving them could be



Map of the Huahine site area. Whalebone and wooden *patu* and post bases of storage houses were found in the excavation area marked ScH 1–1. Portions of canoes and other large wooden objects were found in ScH 1–2, Zone A–3. Remains of a cooking house, a canoe mast, and a house beam were found in Zone B.
[*Map:* Y. H. Sinoto.]



Two L-shaped canoe sideboards, exposed in 1981. Note the oblong wooden bowl, partially exposed under the lower board in foreground.
[*Photo*: Y. H. Sinoto, Bernice P. Bishop Museum.]

Whalebone *patu* held by the author and local crew member, Giselle Lai. [*Photo:* Y. H. Sinoto, Bernice P. Bishop Museum.]

arranged. We did not come back to this area until 1981.

...and a series of important discoveries

What we had learned up to the 1977 excavations was remarkable. The site area stretches from Vaito'otia, where the first whalebone hand club was found, to Fa'ahia in the north, where the canoe planks were found. Although the site extends across two present land divisions, it originally was a single community or village. Radiocarbon dates indicate that the site complex was occupied between A.D. 850 and 1100, making it the oldest site known in the Society Islands.

Another important discovery, resulting from studies of pit stratification and artefact-distribution patterns, was that around A.D. 1000 the site area was hit by tidal waves—causing the activities of the community to come to a sudden halt. With their force probably accentuated as they came through the pass in the reef, these waves first inundated Fa'ahia and then swung to Vaito'otia. Covered by tons of beach sand, many activity areas were left intact. Debris floated and was scattered all over the site area; thus, every test pit yielded artefacts that were not always associated with their original context. Because of this devastating occurrence, the majority of the people did not return to the area, as far as we know. However, it appears that the head of the village came back and built a comparatively large round-ended house in Fa'ahia. The Vaito'otia area became reserved for religious purposes, as evidenced by an upright stone, a small paved foundation, and a small well (probably all part of a men's house) found on top of the beach-sand deposit. After about A.D. 1100, people abandoned the area never to return, except to the nearby beach area.

Despite such unfortunate acts of nature, the site area was ideal for habitation. Through the pass, deep-sea fishing was accessible. Surrounding the site complex, the low marshy area was suitable for taro planting, as it is even today. Several hundred metres inland, sweet potatoes, yams and bananas could have been cultivated, as today.

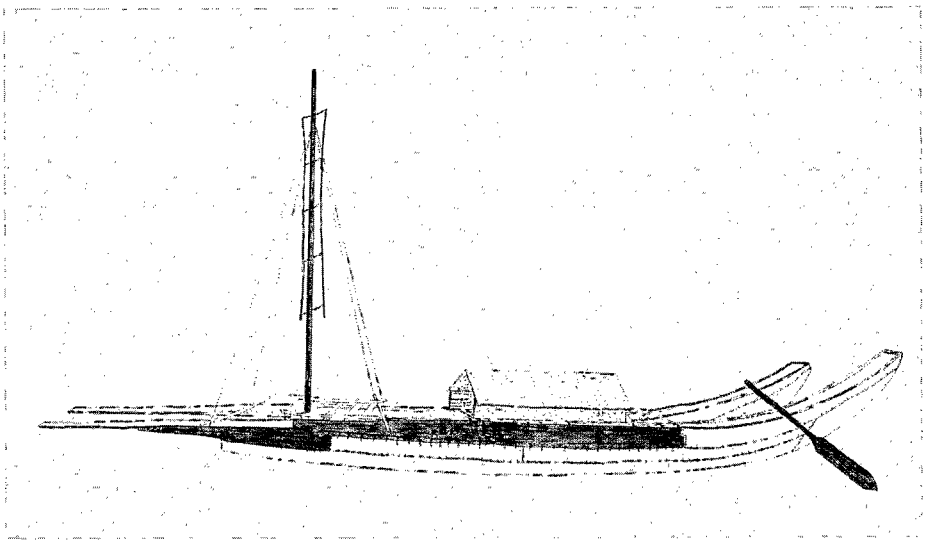
We found four apparent storage houses on low stilts in Vaito'otia, with adze-hewn coconut-tree trunks split in half and used as floorboards. Just 1.5 metres wide and 4 metres long, the houses, though well-built, were too small for people to live in. With the discovery of one intact gable post, we were able to formulate a reconstruction of a storage house. This suggests that enough food was produced to support a stratified community of ruling families, priests, craftsmen and farmers. Although exactly what was stored is still in question, it appears most likely to have been yams.

Evidence from subsequent site excavations indicates that specialized crafts took place in different areas of the village. Pearl-shell fishhooks were manufactured near the storage houses in Vaito'otia, and canoe and adze manufacturing took place in Fa'ahia.

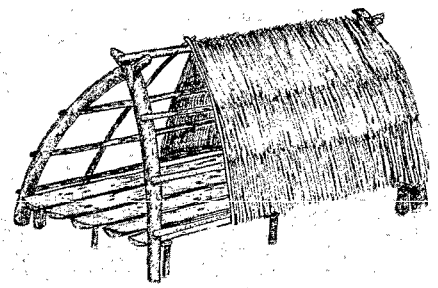
In the northern corner of Fa'ahia we found a number of house posts and fallen beams. The ends of some posts were still standing in their bases. We are planning to expand excavation in this area, hoping to reveal more habitation foundations than are ordinarily found in Society Island sites.

In front of the standing posts, on the lagoon side, were a stone anvil for *tapa* beating and a wooden *tapa* beater. So far we have collected four *tapa* beaters, all with longitudinal grooves. Because the cultural deposits were preserved in a waterlogged context, many other wooden objects were found. Among these are objects of unknown function, as well as objects known only from late eighteenth- and early nineteenth-century ethnographic collections—for example, a wooden bow, bowls, bailers, *tapa* beaters, and sweet-potato spatulas.

Dr D. E. Yen and the author (right) examine a complete hafted adze, probably 1,000 years old, excavated in 1981. [*Photo:* Y. H. Sinoto, Bernice P. Bishop Museum.]



Possible placement of recovered planks, mast and steering paddle, based on J. Webber's sketch of a Tahitian double canoe (Cook's third voyage, 1776–80).
[*Drawing:* Y. H. Sinoto.]



Reconstruction of storage house based on excavated evidence.
[*Drawing:* Y. H. Sinoto.]

We excavated the beach front in 1979, and the area immediately south of the canoe in 1980, in order to clear the area for the planned hotel expansion. (The condition of the world economy has been to our advantage, however, and no construction has started as yet.) During excavations of the beach area, we encountered a partially intact cooking house. A row of eighty-three small post bases were found, extending from the present beach into the lagoon. Stones from an earth oven and charcoal were uncovered near by. The radiocarbon date for one of the posts is A.D. 900, which indicates that the cooking house was contemporaneous with the rest of the Fa'ahia site. The cooking house must have been built either to the side or downwind from the major living and sleeping houses. This implies that a cluster of houses once stood in the present lagoon area. Information obtained from elderly people attests a change in the shoreline, as do the many coconut trees now fallen into the lagoon. Such coastline changes can be seen in many areas of Polynesia.

Slightly inland of the beach, excavations uncovered a 10.5-metre-long mast and a 10-metre-long house beam. These had probably been washed from farther inland and deposited there by tidal wave action.

In 1981, after four years of preparation, we reopened and expanded the pit where we had stored the wooden objects found in 1977. The two L-shaped canoe planks, each 7 metres long, were finally completely exposed. These planks and other wooden objects were carefully lifted, crated in their original wet condition, and immediately transported by ship to Tahiti. The shipments were received at the Musée de Tahiti et des Îles, where the objects were placed into specially built water tanks. There, in the back courtyard of the museum, they are now safely stored and being treated for conservation.

The wooden objects uncovered in 1981 came from a 2.5-metre-deep deposit with such densely packed debris that the pit had to be dug by water spray pumped by a three-horsepower gasoline engine. Digging with hand trowels while standing in the pit proved too dangerous for the fragile objects, many of them hidden in the wooden debris underfoot. It gradually became clear that this area represented a stream bed, running through the Fa'ahia area; great quantities of artefacts and debris had been swept into the stream by tidal waves, filling the bed. The canoe planks, house posts, digging sticks, and tree branches were all lined up in one direction, showing the orientation of the stream flow. One of the most remarkable discoveries from the pit was a complete hafted adze, i.e. a stone adze lashed with sennit cordage (braided coconut fibre) to a wooden handle. The style of the handle is simple and functional, different from the later, evolved Tahitian adze handles. Adzes were an important tool for manufacuring canoes, houses, and other wooden objects, and numerous handles were retrieved from the pit. We also found several pieces of fishing nets and pandanus-leaf mats. A metre-long, boat-shaped wooden bowl, found under one of the planks, is similar in form to the vessels presently used by the Tahitians.

The canoe planks have lap-joint ends, indicating that the planks were joined longitudinally on top of the canoe hull. Holes were drilled along one side for lashing. The composite length of these two pieces alone is 14 metres. If we approximate the lengths of the stern and bow to which these planks were fitted, then the complete canoe could easily have been 25 metres long. The recovery of the planks and other canoe pieces gave us enough evidence to postulate a reconstruction of an ocean-going canoe, built at Fa'ahia about 1,000 years ago. We based our reconstruction on an eighteenth-century sketch of a Tahitian double canoe by John Webber, artist for Captain Cook's third voyage. We also found a 3.6-metre-long steering paddle and an unfinished bailer, nearly 50 centimetres long. Although we found two pieces of small canoe hulls, these proved not to belong with the recovered planks. We plan to continue excavating in the adjacent area in 1983, hoping to find at least some part of the large hull.

The early radiocarbon dates for the site are well supported by the forms and types of stone adzes, pendants, fish-hooks, a harpoon head, tattooing combs, and other excavated artefacts. The material culture assemblage from the site is remarkably similar and, in some cases, identical to the one associated with early Marquesan culture. [1] I have hypothesized that Polynesians from Samoa or Tonga moved eastward to the Marquesan Island group, from which they subsequently settled the rest of Polynesia. The postulated initial settlement dates are A.D. 300 for the Marquesas, 850 for the Society Islands, and 1000 for New Zealand. The evidence we found from the Huahine site supports my hypothesis of this sequential settlement of East Polynesia, as well as the hypothesis that New Zealand was settled from the Society Islands. In addition to the *patu*-like hand clubs (over a dozen have so far been found from the Huahine site), shaped whale-tooth pendants, beads shaped like abacus beads, and stone adzes uncovered from Huahine are typologically related to early Maori material culture. Not part of the Vaito'otia and Fa'ahia inventory are typical Tahitian adzes of the reversed-triangular tanged type and stone taro pounders; these did not appear in the Society Island cultural assemblage until a few hundred years later.

Conservation problems

The storage and conservation of the waterlogged wooden objects presents some prob-

lems. The only available storage space at the Musée de Tahiti is in the back courtyard, where we arranged to have large tanks of water placed under a temporary roof. Because of this situation and the relatively high air temperatures, the water warms to about 25°C, allowing the growth of fungus. In order to keep the water temperature low (ideally at 10°C) we must install a water-cooling system, and this is presently being worked out with engineers in Tahiti. During the last ten months the water has been changed manually every few days, an inefficient and time-consuming process. Placing ice blocks in the tanks did not significantly improve the situation. Polyethylene glycol (PEG) will be used for basic conservation, but it cannot be implemented until the identification of the woods has been completed. The woods are being identified by James Barbour of the Forestry Division of the University of Washington, Seattle, who is also experimenting with various methods of PEG application. It may take as long as two years before scientists will be able to handle the wooden objects and conduct the detailed analyses that will eventually provide much additional knowledge about the development of the remarkable seafaring technology of the ancient Polynesians.

1. Yosihiko H. Sinoto, 'The Marquesas', in J. D. Jennings (ed.), *The Prehistory of Polynesia*, pp. 110–34, Cambridge, Harvard University Press, 1979.

Waterlogged? A new centre in France can help

The Centre d'Étude et de Traitement des Bois Gorgés d'Eau (Centre for the Study and Treatment of Waterlogged Wood) at Grenoble, France, is run by a team of physicists, chemists, conservators and restorers. It is currently treating a variety of collections, e.g. medieval objects from Charavines-Colletière, a Gallo-Roman pump from Périgueux, etc. It proposes a complete range of services in drying, conservation, presentation, conditioning and moulding—particularly important for fragile items. But apart from these service functions serious research is carried out as well.
In co-operation with the directorate of the Musées de France research is going forward into the reversibility of PEG and wood deterioration. The Commission à l'Énergie Atomique (Atomic Energy Commission) is helping to investigate freeze-drying, cryo-protectors and new reversible resins. Experimentation is systematic, using files to record all modifications during treatment and subsequent ageing. The CETBGE also provides advice to museums and archaeologists and can develop on their behalf temporary or definitive solutions to conservation problems.

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