

Troubled Waters for Ancient Shipwrecks

As archaeologists find new ways to pull precious data from wrecks, they are squaring off against those salvaging ships for profit



IN 1993, ARCHAEOLOGISTS SURVEYING THE seafloor near Lisbon spied several pieces of old timber jutting out from a mash of mud and peppercorns 10 meters below the water's surface. The site was modest in appearance and partially looted, but it contained a key find: fragments of an ancient wooden ship known as a Portuguese Indiaman, built during the Renaissance to sail what was then the longest and most dangerous commercial route in the world—from Portugal to India, the land of pepper and spice. Designed for an age of discovery, the Indiaman “was the space shuttle of its time,” says nautical archaeologist Filipe Vieira de Castro of Texas A & M University in College Station.

Historical accounts described the ship as a miniature floating city that carried 450 people—but many researchers thought the accounts were exaggerated. Castro and colleagues began excavating in 1996 and in 17 years of detailed study have produced research on everything from the ship's design to its sailing abilities; their latest findings appear in the February issue of the *Journal of Archaeological Science*. The team has extracted “more data

[from the wreck] than you would think possible,” says nautical archaeologist Wendy Van Duivenvoorde of Flinders University in Adelaide, Australia. The overall conclusion: the Indiaman lived up to its press and was indeed a sophisticated—if congested—craft.

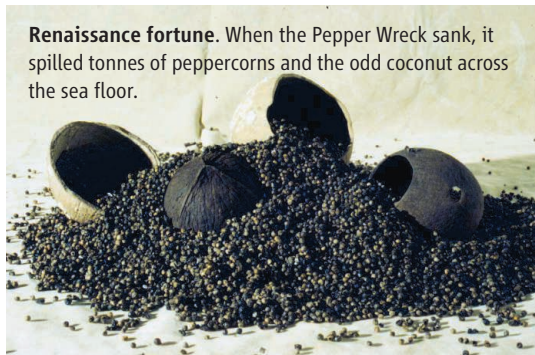
This detailed portrait of a Renaissance ship is just part of the scientific bounty now accruing from advanced new techniques for excavating and analyzing underwater wrecks. But as scientists dig into this wealth of data, they are also waging bitter, high-profile battles to protect these sites. Finding shipwrecks has never been easier, and a spectrum of archaeologists, explorers, salvage operators, and treasure hunters all are setting out to do so. Local

divers scavenge wrecks for coins and ingots, while companies equipped with remote-sensing technology recover artifacts for sale to collectors and museums. Specialized antiquity dealers do a brisk trade in shipwreck artifacts such as coins and Chinese porcelain.

For years, the law of the sea was essentially finders keepers, and salvors who located shipwrecks and brought up their cargo were entitled to a reward at the least. But in recent years, archaeologists have argued that this maritime right of salvage should not be applied to ancient, archaeologically valuable ships. “We stand to lose access to enormous segments of the human story, information about our ancestors and ourselves,” says archaeologist Douglas Comer of Cultural Site Research and Management, an independent consulting firm in Baltimore, Maryland. Underwater archaeologist James Delgado, director of maritime heritage at the National Oceanic and Atmospheric Administration in Washington, D.C., asks: “Where does it all stop, if we accept that evidence of our past can be converted into something that people can buy and take home?”

Firms that sell artifacts say there is nothing inherently wrong with the practice, particularly when it applies to only coins and

Renaissance fortune. When the Pepper Wreck sank, it spilled tonnes of peppercorns and the odd coconut across the sea floor.



Timber treasure. Careful analysis of every remaining hull timber allowed archaeologists to reconstruct the Pepper Wreck.

duplicate cargo items. Such sales can benefit museums struggling to maintain large collections, points out Greg Stemm, chief executive officer of Odyssey Marine Exploration Inc., a deep-ocean exploration company based in Tampa, Florida, in an e-mail interview.

Most archaeologists, however, sharply disagree with the idea of selling artifacts. The history of archaeology has repeatedly shown that “where exploration and fieldwork were steered by the market value of objects, the approach and documentation are so compromised that even the most basic observations become unreliable,” says maritime archaeologist Thijs Maarleveld of the University of Southern Denmark in Esbjerg.

As more and more ancient wrecks are revealed, shipwreck preservation stands “on a knife edge internationally,” says archaeologist Colin Renfrew of the University of Cambridge in the United Kingdom. He also holds a seat in the House of Lords, and from there he recently blasted plans to allow Odyssey and a charitable trust known as the Maritime Heritage Foundation to excavate a historic British warship, HMS *Victory*, which foundered in the English Channel in the mid-18th century. It is very clear, he told *Science*, that governments should not allow “salvage of this kind.”

The battle lines are hardening. “We speak two different languages,” says Castro. “We are after knowledge and they are after money.”

Aboard a Renaissance craft

Sunken ships are packed with archaeological information, says maritime archaeologist Paul Johnston of the National Museum of American History in Washington, D.C. Often the vessels went down with all the tools, supplies, and cargo needed to succeed on their voyage, and “the organic artifacts tend to be much better preserved than they are on land,” he says, due to anaerobic conditions in many marine sites. Unlike terrestrial sites that were often occupied

repeatedly over centuries, shipwrecks date to one moment in time, offering tight chronological control.

However, wresting knowledge from an underwater site is often a slow, laborious task. In the case of the Pepper Wreck found near Lisbon, Castro’s team used \$500,000 from the Portuguese government to dig the site and raise the hull timbers over four field seasons under the supervision of Portugal’s national agency for nautical archaeology. (The equipment the team bought became part of a new national center for underwater archaeology in Lisbon.) Team members spent 2 years conserving artifacts to avoid rapid deterioration on land.

To help identify the wreck, the researchers searched historical records. In 1606, they learned, a Portuguese Indiaman christened *Our Lady of the Martyrs* sank in the area of the wreck site with a large cargo of peppercorns. Many artifacts from the Pepper Wreck fit that ship’s description, including Chinese

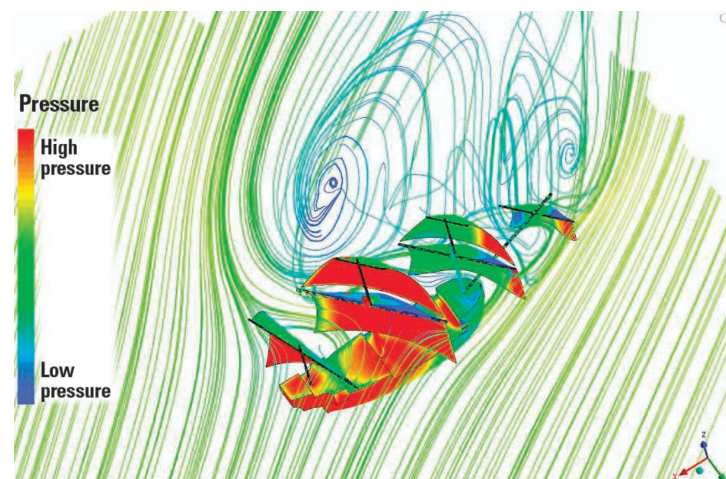
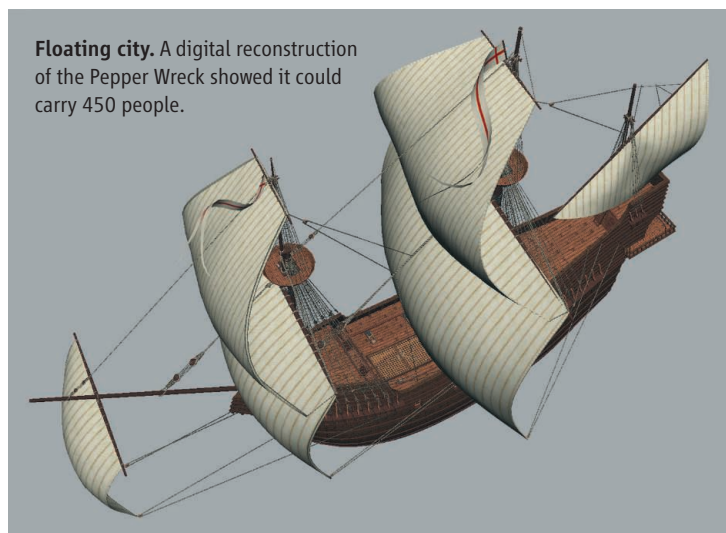
porcelain dated to 1600 and a navigational instrument called an astrolabe inscribed with the date 1605. Because the ship “was built in the royal shipyard in Lisbon, and wasn’t just an anonymous ship, the level of analysis that could be carried out was immensely greater,” says nautical archaeologist Brad Loewen of the University of Montreal in Canada, who was not part of the team.

To reconstruct the ship’s design, Castro painstakingly recorded the size and shape of every piece of wood, as well as the location of shipwright marks, caulking, and spikes used to join pieces together. Then he studied shipwright marks and design formulae in ancient shipbuilding treatises. By combining the formulae with their measurements, Castro and colleagues extrapolated the design, revealing a sturdy, massive ship with a 28-meter-long keel and a 31-meter-tall main mast (see image).

Could such a ship really carry 450 people and some 250 metric tonnes of cargo safely

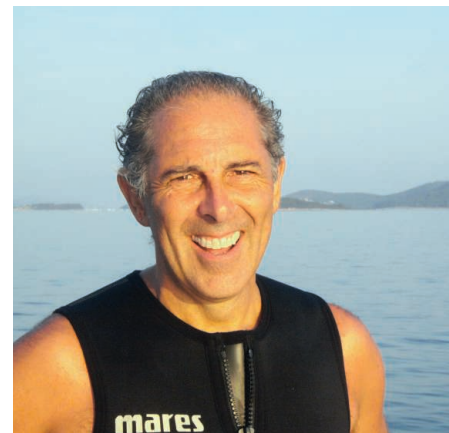
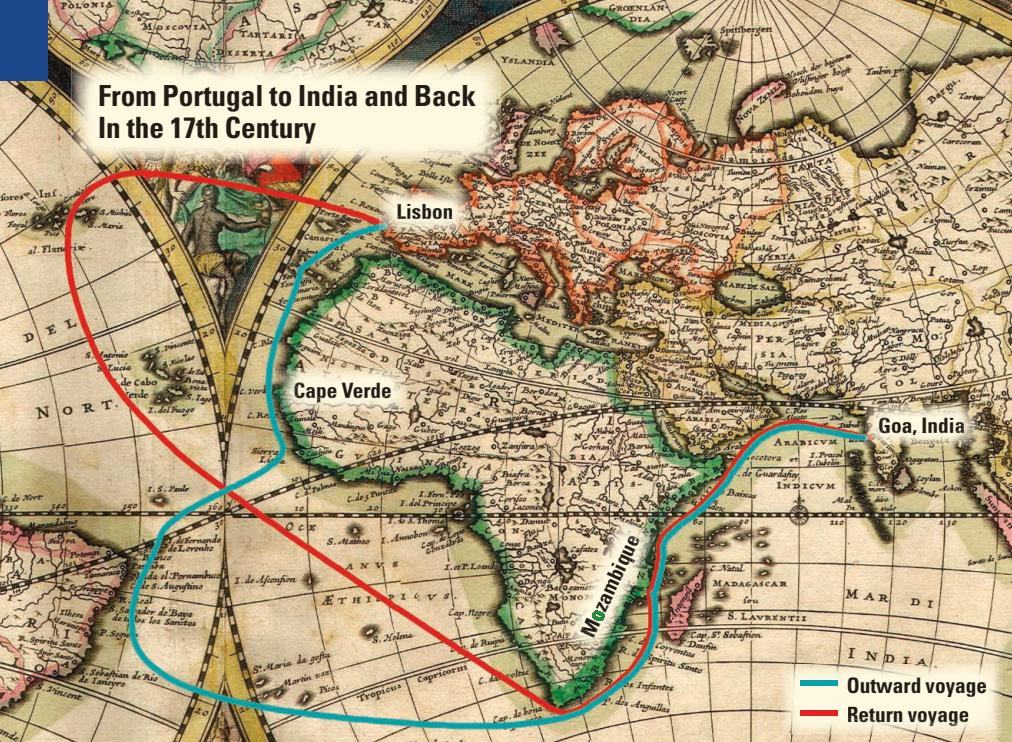
around Africa’s Cape of Good Hope and through Indian Ocean monsoons? Castro and a small team combed historical records to compile a list of items needed to outfit an Indiaman for this voyage and calculated their volume and weight, from 175 tonnes of ballast to 292 tonnes of water, wine, and food. Using 3D software, the team positioned the items inside the digitally reconstructed ship to determine how much space was left for passengers and crew. Their study, published in *Historical Archaeology* in 2010, revealed that the ship indeed could have departed from Lisbon with 450 people, although conditions aboard would have been very crowded early in the voyage (when the ship was fully loaded with food and water), with just 1.3 square meters of living space per person. Such cramped quarters were “common at the time,” Castro says.

What about safety? One well-known 18th century book, *The Tragic History of the Sea*, painted a bleak picture of the Indiaman’s record. So the team used modern mathematical tools to see how well the reconstructed ship rode out storms. In a *Journal of Archaeological Science* paper in 2012, they



Seaworthy. Computer models of a Portuguese Indiaman and the air pressure around it show that the ship met modern stability criteria; sails colored red took most of the wind.

From Portugal to India and Back In the 17th Century



Passage to India. Archaeologist Filipe Castro (*above*) recovered artifacts and wood from the Pepper Wreck (*below*), which would have made the long journey around Africa to India and then back to Portugal in routes shown on this antique map.

found that the reconstructed Indiaman met modern stability criteria set by the U.S. Coast Guard for large wooden sailing ships. Even when the wind gusts strongly, the reconstructed ship goes “back to the vertical condition so quickly that seasoned sailors could get seasick,” Castro says.

Van Duivenvoorde, who was not involved in the research, calls the work “valid and very important,” adding that “we now know that these ships were well designed and well built, given the constraints of the period.”

Laws of the sea

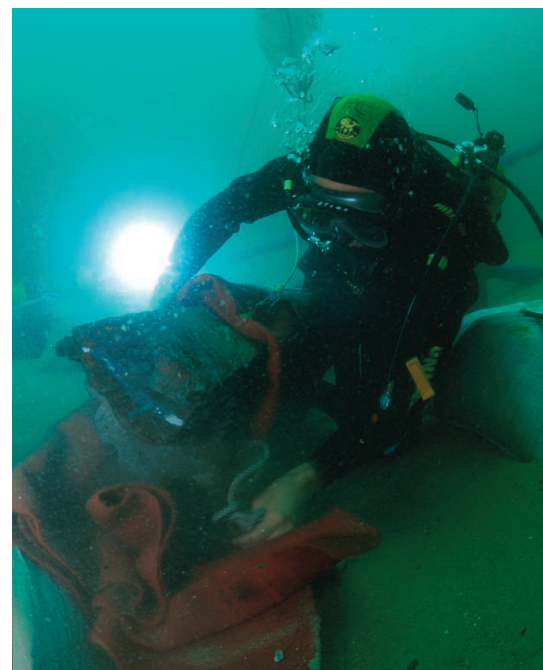
Castro and his colleagues’ three books and 17 primary publications serve as an outstanding example of the archaeological knowledge that a single shipwreck can generate. Other wrecks are also yielding rare and detailed findings about the past. Seeds from Israel’s *Hahotrim* wreck, for example, have revealed the ancient spread of an exotic plant along the Mediterranean coast, probably carried by ships, while marble aboard the *Kizilburun* ship has yielded new information on the workings of marble quarries in Roman-era Turkey (see sidebar, p. 805). Sailors’ personal effects found in the 17th century Swedish warship, *Vasa*, are shedding light on the privations of naval life, including the lack of medical equipment. Such studies fill in many blanks in the archaeological record, says archaeologist Deborah Carlson of Texas A&M University, offering “tremendous insight into what people were doing and eating, where they were going, what music they were listening to, and what games they were playing.”

The superb preservation that attracts archaeologists to shipwreck sites, however,

also draws local divers hunting for treasure. As a result, wrecks around the world are being outright looted or salvaged quickly, with little if any attention paid to documenting the sites. “It’s a very, very serious problem,” says Wu Chunming, a maritime archaeologist at Xiamen University in China.

It’s not a new problem for archaeologists—terrestrial sites have long been plagued by looters and still are. But on land, researchers have several legal weapons: A U.N. Educational, Scientific and Cultural Organization (UNESCO) convention bars international trade in looted artifacts, and some archaeologically-rich countries have declared all undiscovered artifacts state property. The situation in the sea is different. Under the ancient maritime law of salvage and the common law of finds, salvors who find sunken ships and their cargo are often entitled to a reward, either a flat fee or a percentage of the value of the discovery. Sometimes they can even claim legal ownership of a wreck and its contents. As a result, salvors are often entitled to sell part if not all of what they discover on a wreck, a nearly universal right that long extended to ships carrying key archaeological data.

Recently, advances in remote-sensing technology have allowed salvors to locate ancient ships where they never looked before—in deep water—putting more of the world’s archaeological record in danger. So in the mid-1990s, nautical archaeologists began pressing for a new international law to protect



ancient sunken ships. The 2001 UNESCO Convention on the Protection of the Underwater Cultural Heritage is the result. It recommends the preservation of shipwrecks in situ as the first option, and prohibits buying, selling, and dispersing their artifacts, because this practice encourages excavation for the marketplace rather than for knowledge and boosts trade in objects of scientific value.

The convention entered into force in 2009, after 20 countries ratified it, and the number of states signing on is steadily climbing. It’s now 42. Public opinion appears to back shipwreck preservation: 60% of American adults agreed that artifacts from the

RMS *Titanic* should not be auctioned off, according to a poll released last week by the Marist College and Sea Research Foundation. But nations as diverse as Mozambique, the United States, and Cape Verde have yet to sign on to the convention, leaving wrecks in many waters open to salvage.

Tracking salvage in the world's oceans is difficult, so nautical archaeologists monitor eBay and online auction catalogs, and watch high-profile lawsuits to find out what's happening. One such case heard by the U.S. District Court in Florida in 1997 reveals how some treasure-hunting operations have worked.

In this case, the U.S. government alleged that a Florida company, Salvors Inc., illegally destroyed seagrass and removed artifacts from a shipwreck site in the Florida Keys National Marine Sanctuary, a protected area. In its findings of fact, the court determined that Salvors used three ships equipped with propeller-wash deflectors, large bent pipes that channel the powerful thrust of a ship's engines towards the ocean floor, blasting sediments away in order to swiftly find coins and ingots. Archaeologists don't use this technique because it also blows away important but lightweight organic materials such as leather and wood. In 3 months, Salvors blasted more than 600 holes of 6 to 9 meters in diameter in the seafloor, seriously damaging at least 1.63 acres of sensitive seagrass habitat, according to the findings of fact. The court ordered the company to pay restoration costs and compensation totaling \$589,311 and to return the recovered artifacts to the government.

This kind of operation would be legal in many waters today, a situation that worries most nautical archaeologists. Equipped with sophisticated gear for locating wrecks, these operators "drain a non-renewable resource," Johnston says.

Rights to wrecks

Many companies that today excavate and sell artifacts from shipwrecks vigorously disavow such destructive practices. The Lisbon-based company, Arqueonautas Worldwide Arqueologia Subaquática, S.A., for example, has a scientific board, employs two archaeologists, and self-publishes archaeological reports on its website, which proudly proclaims: "Saving World Maritime Heritage since 1995." Arqueonautas has negotiated exclusive licences with the governments of Cape Verde and Mozambique to conduct maritime archaeological operations, according to documents posted on its website.

Arqueonautas has located 150 historic shipwrecks worldwide and excavated 20 in Africa over the past 18 years, notes com-

pany spokesperson Miguel Gomes da Costa. He argues that sunken ships are seriously threatened globally by both local looters and fishing trawlers' nets, and that this demands rapid recovery operations.

But the firm does sell artifacts. In developing nations such as Mozambique, Gomes says, you can't expect "these countries to finance with the taxpayers' money marine archaeol-

ogy." He says that Arqueonautas provides an important service in Mozambique, excavating endangered ships and recovering important cultural objects which are then displayed in the country's museums—work it funds in part by selling "repetitive cargo artifacts," primarily coins and old Chinese porcelain. According to its website, the company has also sold a rare, 17th century mariner's astrolabe from

From Quarry to Temple

Sometime between 100 B.C.E and 25 B.C.E., a wooden ship carrying almost 60 tonnes of stone foundered in Aegean waters just off the coast of Turkey. It went down bearing its entire cargo, including eight massive drum-shaped blocks of white marble. Those blocks fit together to form part of a tapering column that likely stood more than 11 meters tall, plus a square uppermost piece: a Doric column.

Two thousand years after the ship went down, archaeologists excavating what is now called the Kizilburun shipwreck have figured out exactly where the marble blocks came from and where they were heading, illuminating the marble trade in the Roman province of Asia Minor. The work shows how underwater archaeology can add a new dimension and precise information to a period researchers thought they knew well (see main story, p. 802). "In the 1st century B.C.E., the Mediterranean was the highway by which everyone in the region was linked," says nautical archaeologist Deborah Carlson at Texas A&M University in College Station, who led the analysis. "This means shipwrecks connect sites on land in ways that archaeologists didn't see before."

Carlson and classical archaeologist William Aylward of the University of Wisconsin, Madison, first set out to learn where the marble came from. As reported in a 2010 study in the *American Journal of Archaeology*, the team sent out samples of the marble for stable isotope analysis and other tests. The marble's values of the isotopes $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ and its spectroscopic details led them to Marmara Island, known as Proconnesos in Roman times, in the Sea of Marmara, the inland sea connecting the Aegean and Black seas. This island was the site of an important marble quarry when Asia Minor became a Roman province around 130 B.C.E.

But where was the marble heading? The blocks' size and style suggest that the column was intended for a major public building, most likely a temple. Carlson and Aylward drew up a list of all the Doric-style monumental buildings under construction in the 1st century B.C.E. on coastlines south of the wreck site, the probable direction of travel away from the quarry. Then they searched for sites with a finished lower-column diameter of about 1.73 meters. They concluded that the marble was headed for the Temple of Apollo at Claros, where people in Roman times flocked to seek advice from oracles, just 50 kilometers from the wreck. That finding is "utterly convincing," says architectural historian Lothar Haselberger of the University of Pennsylvania.

The data show that the quarry workers on Proconnesos were in close contact with the temple builders some 500 kilometers or more away, shaping the marble to the builders' exact specifications. The findings also show that the builders received columns in pieces in small shipments, hinting at a lengthy construction process. This information, says Carlson, "is the missing link that tells us a lot about this process."

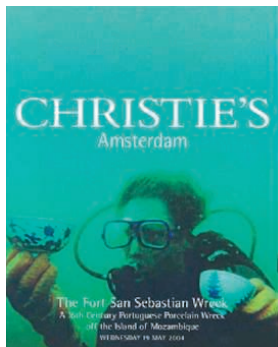
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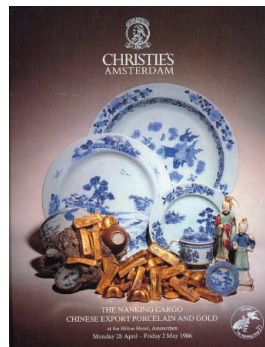
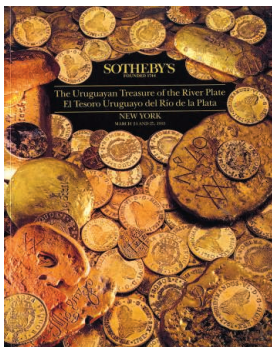
Missing link. A shipwreck's marble cargo reveals the construction of a Roman-era temple.

a wreck off the coast of Cape Verde, which was purchased by an American museum for some \$200,000 at a Sotheby's auction in 2000. "Of course this [selling of artifacts] is not accepted by a lot of the fundamentalists, principally, that like very much the UNESCO convention," Gomes says.

The Sotheby's lots also included what Gomes described as Arqueonautas's "share" of recovered artifacts from the American warship USS *Yorktown*, which sank near a Cape Verde coast in 1850; the artifacts included items such as a powder flask and an inscribed teaspoon. But the U.S. Navy claims jurisdiction to its wrecks all over the world, and does not allow salvage, in order to prevent trade in artifacts and to protect sailors' graves. A member of the scientific board of Arqueonautas noted in a letter to the U.S. Department



Going, going, gone. To learn what salvors have found on wreck sites, archaeologists monitor the catalogs of shipwreck artifacts sold at auctions around the world.



operations argue that salvage is not the best policy for dealing with fishing trawler damage. Simply banning trawling in certain waters—as the Turkish government does near its shores, for example—can protect wrecks, says oceanographer Michael Brennan of the University of Rhode Island,

of Justice that the company's staff members couldn't identify the ship until after excavation. Sotheby's cooperated with the U.S. Navy to return some *Yorktown* artifacts, and the Navy is still seeking any items retrieved from the ship (<http://www.history.navy.mil/branches/org12-9b.htm>).

Some archaeologists think that the Arqueonautas license in Mozambique, which covers 700 kilometers of coastline, has hindered the development of underwater archaeology by local researchers. Local studies were just gaining momentum before the Arqueonautas deal was signed, says Ricardo Teixeira Duarte of Eduardo Mondlane University in Inhassoro, Mozambique. "Why does a group of scientists need exclusivity?" he asks.

In a paper published in the peer-reviewed *Journal of Maritime Archaeology* in 2012, Duarte uses data from the Arqueonautas website to suggest that the firm's choice of excavation sites looks like cherry-picking of wrecks that are likely to contain valuable goods such as gold and silver. The selection suggests that "the real objective of the interventions is profit," Duarte wrote. The paper adds that the company's online scientific reports for its operations in one region, Mozambique Island, are "incomplete," chiefly presenting "brief documentation in view of determining the financial value [of] the finds." Exclusive licenses to salvage firms, Duarte says, are "a wrong approach."

Other researchers critical of such recovery

Narragansett Bay. Brennan and colleagues found that this policy works, in a study published in *Continental Shelf Research* last year. They analyzed remote-sensing images and calculated the numbers of broken and unbroken amphorae on 14 shipwrecks off Turkey's coast, finding breakage rates from 0.6% to 62.5%. Some damage was clearly due to trawler nets. But the closer ships lay to shore, the fewer the shattered amphorae. Brennan argues that governments are better off creating no-trawl zones around shipwreck concentrations than opening these areas to companies that sell artifacts. "Trawling may threaten an important site to the point that excavation is warranted," he says, but "it does not in any way justify or make commercial salvage acceptable."

Victory, or defeat?

In the developed world, governments are also grappling with the issues of what to do with wrecks and how best to pay for the cost of underwater excavation. In the United Kingdom, an intense battle is brewing over a plan that many archaeologists say would commercially exploit *Victory*, once "the most powerful ship afloat," says Robert Yorke, chair of the Joint Nautical Archaeology Policy Committee, an umbrella organization representing 26 organizations as well as individual members in the United Kingdom. *Victory* sank in a violent storm in the English Channel in October 1744, claiming the lives of more than 1100 British sailors. Six weeks later, a Dutch newspaper reported that "people will have it that on board the *Victory* was a sum of £400,000 that it had brought from Lisbon for our merchants."

In 2008, Odyssey located the ship's wreckage beyond the United Kingdom's territorial waters, at a depth of about 75 meters. Since then, the company has described itself as "salvor-in-possession," and published online archaeological papers arguing that fishing and looters are damaging the wreck. These are "signs that the idea of preserving the site in situ is clearly not practical," noted CEO Stemm in a 2012 company press release.



Law of the sea.

Salvors have used destructive equipment such as propeller wash deflectors (above) to quickly find and recover valuables like these old coins from Spain and the New World.





Bitter battle. Despite its cannons, viewed today on the seafloor (right), *Victory* sank in 1744, as depicted in this painting, and researchers now debate the fate of what was once considered the most powerful ship afloat.

Under a provision of international maritime law, the U.K. government claims jurisdiction over its naval wrecks, and it has adopted the UNESCO convention's annex, which rules out buying and selling artifacts, as "archaeological best practice."

Nevertheless, in January 2012, the government gifted *Victory* to The Maritime Heritage Foundation, a charitable trust established in October 2010 by Robert Balchin—a prominent Conservative peer who holds the title Lord Lingfield—and two other trustees. One week after the deed of gift was announced, Odyssey posted an online press release stating that it had signed an agreement with the foundation to excavate the wreck. The government later explained the gift by noting that it did not want to spend its money on managing the wreck.

Many archaeologists are up in arms over this proposed excavation, given some of Odyssey's practices: The company currently sells shipwreck artifacts on its website, and its business model includes "commercial monetization of recovered cargo" from wrecks, according to the 2012 annual report that Odyssey filed with the U.S. Securities Exchange Commission. In 2004, the company obtained in court legal ownership of a treasure-bearing 19th century steamer and its contents, the *SS Republic*, that the firm discovered in international waters off the east coast of the United States. Odyssey retrieved more than 51,000 gold and silver coins from the wreck, plus 14,000 artifacts, some of which it currently sells on its website.

In an online press release concerning the

Victory deal, Odyssey noted that The Maritime Heritage Foundation has agreed to reimburse the firm for its project costs, as well as paying a percentage ranging from 50% to 80% of the "fair value" of the coins and other artifacts recovered. The announcement also noted that the preferred plan was to pay the company in cash, but that the foundation "may choose to compensate Odyssey with artifacts in lieu of cash." These announced terms infuriate Yorke. "This is a salvage contract," he says. "It is not an archaeological contract."

Stemm says critics have based their attacks on "false and misleading information." Odyssey, he says, employs four archaeologists, has conducted substantial excavations on "about half a dozen" wrecks, self-publishes its own scientific reports, and creates museum exhibits that have been seen by more than 2 million people. "I believe that the quality of our fieldwork equals and in terms of deep-sea capabilities surpasses that of most academic archaeologists because of the quality of equipment and technology we can afford," he says. But this comes at a cost. With today's technology and remotely operated vehicles, the work costs \$20,000 to well over \$30,000 per day, according to Stemm.

Critics wonder where the money for the *Victory*'s excavation will come from. "The UNESCO Convention on the Protection of Underwater Cultural Heritage makes clear that the excavation of historic wrecks should not be financed by selling off the finds recovered," stated Renfrew in the House of Lords (he holds the title Lord Renfrew of

Kaimsthorn). "But that may be just what is now being planned for HMS *Victory*."

Stemm denies this, however. The foundation will own the ship's artifacts, and Stemm notes that the charity doesn't have to sell them in order to compensate Odyssey—the payment could come from many sources. But the foundation's plans for coming up with this compensation are unclear. Asked about this last November in the House of Lords, Balchin said that "such things will be revealed" when the foundation reported on its finances at the end of its financial year. However, the charity's year-end statement filed a few weeks later revealed a fund balance of just £13,275 (about \$21,000)—sufficient at best to cover just one day of Odyssey's fieldwork.

Renfrew and other opponents are now waiting to see whether the Ministry of Defence will consent to Odyssey's proposed excavation. Renfrew believes that the decision will influence governments around the world. "There are major ethical issues involved here," he said during the House of Lords debate, "and it is difficult to avoid the impression that the government are giving a poor and ill-informed lead internationally in their dealings with Britain's underwater heritage."

Nautical archaeologists and excavators around the world are watching the bitter struggle over *Victory* closely. It's a symbolic battle in a widening front, as more and more wrecks are located in their deep-water resting places.

—HEATHER PRINGLE

Heather Pringle is a science writer based in Victoria, Canada.