Shipwrecks in the Wake of Columbus

This section dwells on the remains of sixteenth- through eighteenth-century European shipping found in American, African, Asian, and Australian waters. The New World comes first, and we open with the search for a Spanish treasure fleet of 1554. Our author is J. Barto Arnold III, marine archaeologist to the Texas Antiquities Committee. The site of one of these wrecks, probably the San Esteban, was the earliest in American waters to receive responsible archaeological treatment, and this account lays down the standards that can be achieved.

Unfortunately, many sites in the Americas have received no such respect, as Robert Marx explains in the following 10 pages. The reasons lie in complex legal and commercial considerations: only a few states (notably Texas and Florida) have begun to take steps to protect their archaeological heritage under water. Mr. Marx describes a number of interesting sites he has investigated, and explains how he has tried to maintain acceptable standards despite operational difficulties.

The final 12 pages of this section shift attention from the Americas to the Atlantic and Indian oceans. Jeremy Green considers the study of European trade with the East Indies between the sixteenth and eighteenth century, and provides brief descriptions of more than two dozen wreck sites related to this trade. Once again we see a great variation in standards of excavation, largely reflecting the laws regulating, or failing to regulate, such activities. Undoubtedly, some of the most satisfactory arrangements are those in Western Australia where Mr. Green is curator of maritime archaeology for the state museum. Before taking up that position in 1971. Mr. Green spent several years in the Laboratory for Art and Archaeology at Oxford University, where he developed electronic equipment for underwater reconnaissance.

The fleet of 1554

There are very few sixteenth-century wrecks in American waters. While Columbus himself left four wrecks for posterity, of which two have been located (pp. 110–11), other early sites are very rare. The remains of three ships lost in 1554 off Padre Island on the coast of Texas are thus most important. Moreover, the story of their investigation, from early treasure hunting to recent responsible excavation, mirrors the development of archaeology in American waters.

With his conquest of Mexico, or New Spain, in 1519, Hernando Cortes greatly increased the profitability of New World commerce. Vast quantities of precious metals began to be shipped back to Spain. And as the value of the cargoes mounted, so the numbers of privateers and pirates multiplied along the route. Thus Spanish treasure ships began to sail to and from the Americas in convoy for mutual protection. These flotas (that is, fleets) of merchantmen were also given an escort of warships paid for by a special tax imposed on the cargoes. These escort ships were similar to the merchantmen in appearance, but were supposedly less heavily laden and better armed and manned. But from the Archives of the Indies, contemporary commercial archives kept in Seville, Spain, we learn that the warships were frequently so overloaded with cargo that they proved clumsy to handle and were often unable to use their weapons effectively.

The three 1554 Spanish shipwrecks located near Padre Island were part of one of the first regularly organized convoys of the flota system. On November 4, 1552, some 54 ships had left Spain under Captain-General Bartolome Carreno, of which 16 were bound for Veracruz, in Mexico. In their holds were manufactured goods such as hardware (nails, latches, mallets, and knives), textiles (shirts, fabric, ribbons, and thread), carding tools, soaps, vinegar, and wine. There were also slaves.

The main fleet having been scattered by storms and pirates, the 14 survivors of the New Spain contingent reached Veracruz in February and March of 1553. Of these, only two managed to unload and reload in time to sail for Havana in Cuba with three other ships that had arrived a year earlier. This was partly because Veracruz had been wrecked by a hurricane the previous Sep-
tember. Four other ships waited for over a year before setting out. These were the San Andres ("St. Andrew"), Master and Captain-General Antonio Corzo; San Esteban (St. Stephen), Master Francisco del Huerto; Espiritu Santo ("Holy Spirit"), Master Damian Martin; and Santa Maria de Yciar ("St. Mary of Yciar"), Master Alonso Ojos, and Captain and Pilot Miguel de Jauregui, the ship's owner. The homeward cargo consisted of silver coin and bullion, together with a little gold bullion, valued at over 2,000,000 pesos, or more than $9,800,000 (1975 values). Other merchandise included wool, hides, cochineal, medicinal herbs, and sugar.

On April 29, 1554, all but the San Andres were driven aground on Padre Island in a storm. The three wrecked vessels carried about 300 people all told. As many as 200 may have been drowned in the wrecks, leaving the rest stranded on the beach hundreds of miles north of the nearest Spanish outpost. A small group of the survivors probably took a small boat to get help; but the rest, thinking they were only a day or two's march from civilization, decided to walk south down the beach. They fell foul of Indians, and all but twenty or thirty were slain in what became a death march, without food or water.

The authorities in Mexico immediately organized a salvage expedition, which remained at the wreck site from July until September 12, 1554. In water no deeper than 6 meters (20ft), with divers simply holding their breath and working with ropes and grappling hooks, the expedition retrieved rather less than half the treasure.

In recent times the general positions of these shipwrecks have been known locally because of the numerous coins washed ashore. In the fall of 1967, however, a treasure-hunting firm located and exploited one of the wreck sites. The public outcry that occurred when these treasures were removed from the state of Texas resulted in the passage of a very strong Antiquities Code and the creation of an agency, the Texas Antiquities Committee (TAC), to protect cultural resources on state lands and under state waters. One of the most pressing duties of this new agency was scientifically to reinvestigate the shipwrecks of the 1554 fleet. This was accomplished through underwater archaeological fieldwork in the summers of 1972 through 1976, followed by conservation of the treasure hunters' and state's collections of artifacts, archival research and translation of documents, and intensive study and analysis of the data gained during this project.
Searching for the San Esteban

Any search for wrecks of the three Spanish ships that sank off Texas in 1554 faced some discouraging problems. First was the sheer lack of remains. In the 1940s dredging work had smashed one wreck, probably that of the Santa Maria de Yciar. In 1967, treasure hunters had looted another, probably the remains of the Espiritu Santo. That left only the third wreck unaccounted for — the San Esteban. Spanish documents described this vessel as a nao (ship) about 30 metres (100ft) long.

The problem was finding the site off a sandy coast where sediments soon bury ships that sank off Texas. First came the remote possibility of underwater wrecks that the proton magnetometer has proved most effective in identifying old submerged shipwrecks. This device measures variations in the earth's magnetic field. Known as anomalies, these differ from anomalies scattered over a much wider area. Thus tracks outside the crucial two or three might prove fruitful as well.

With the sensor trailing behind the craft, turning the whole unit was a tricky and time-consuming business. We thus found the most efficient procedure was to make a relatively few long runs parallel to the shore. We kept the gaps between these tracks as wide as we could without risking missing a site. Previous experience suggested that tracks 50 meters (164ft) apart would pass over any ship-shaped anomaly at least twice in the worst possible situation, that is, where the long axis of the site ran parallel to the survey tracks. In the best conceivable situation, where the anomaly's axis lay at right angles to the boat's course, three survey tracks would cross the anomaly.

Besides processing data as the survey proceeded, the computer acted as a co-ordinator, controlling the frequency of instrument readings and correlating them with the locational information. It also supervised the track plotter, and arranged for accumulated data from its memory to be recorded on magnetic tape cassettes. Back at base we could run these cassettes in a machine that used them to produce contoured maps of the site's magnetic field. But we also wanted some immediate indication of major anomalies as we proceeded, so we wrote a special computer program whereby the onboard track plotter would show up significant changes in successive magnetometer readings.

Our survey vessel also had a fathometer, but because its output was incompatible with that from the other equipment, our computer could not integrate the different sets of data. Instead, we produced a separate depth profile along each survey line. By matching this profile against the locational data, we could make detailed contoured maps of the seabed.

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Once magnetometer readings had revealed a site, we performed a more detailed electronic survey of the area. We ran closely spaced tracks across the site in order to build up a highly detailed magnetic contour map. In such areas of poor visibility this information proved invaluable in assessing the extent of a site, and in enabling us to plan systematic excavation. Afterward we found we could match every cluster of objects found with an anomaly that had shown up in the magnetometer survey. The one or two anomalies that we could not relate to wreck material show the need for continuing research into magnetic field behavior.

For the type of water and seabed we worked in and on, the electronic survey I have described was the only possible method of searching. Nevertheless, it probably represents the most efficient initial detection technique in many other situations; at least so our statistics suggest. During the 1974 surveys we achieved an average rate of 13.88 kilometers (8.62mi) of track an hour, representing a coverage of 0.62 square kilometers (0.24sqmi) of seabed searched an hour. A visual survey using divers in reasonable conditions would take about a thousand times longer (compare p. 64 for the Salcombe Bronze Age site search). Against this, of course, is the high price of the equipment involved. Purchased outright, this would have cost about $50,000 at 1974 prices; fortunately, such machines can be hired, and the use of the whole package for a month cost us only $8,500. Bearing in mind the high costs of placing divers on the seabed, this procedure undoubtedly represented extremely good value for money.
The San Esteban discoveries

Between 1972 and 1976 we completely excavated the presumed wreck of the San Esteban following its discovery in the magnetometer survey that we have just described. Using the contoured magnetic site plans produced by that survey, the divers dealt with each anomaly in turn. Most proved to represent substantial metal objects such as iron cannons, anchors, spikes, and bolts; each surrounded by a considerable concretion of corrosion products. In fact, some 85% of all objects recovered came from such concretions. Storms giving rise to heavy seabed movement had removed almost all trace of light unencrusted objects. Apart from abraded ceramic sherds, the remaining 15% of artifacts were relatively heavy items made of iron, bronze, lead, silver, or gold. It is no wonder, therefore, that our divers complained that all they seemed to do was plot, bring up, and attach numbered tags to encrustations, seldom seeing objects they could recognize. Despite this disappointment for the divers there can be no doubt that the place to "excavate" such conglomerates is not actually on the site but (as the next two pages show) inside the laboratory.

This is no reason for belittling the achievements of the divers working on this site. The mere plotting of each lump in very poor visibility was difficult enough, but items lay buried up to 2 meters (about 6ft) deep in sediments. Accurately pinpointing their positions was an important first step toward a full understanding of what lay where, and this has helped to make it possible for archaeologists and conservators to discuss the wreck in remarkable detail. The resulting report and other scientific papers represent one of the most comprehensive studies in maritime archaeology. Then, too, the actual objects recovered by the divers now form an impressive public exhibition that can tour the state of Texas for the education and enjoyment of every citizen. The finds remain public property and the antiquities market will never scatter them around the world.

The range of objects from the San Esteban wreck site proved so extensive that we can only pick out some examples. One of the highlights of the whole collection is the weaponry. Finds include two varieties of breech-loading, wrought-iron artillery, namely, swivel guns and bombards. For these weapons there was ammunition in the form of iron, lead, and stone shot. In many instances the gunners had protected their weapons from damp by plugging the ends of the breech chamber with wood and sealing the touchhole with a twist of hemp. Other surviving weapons include crossbows, one with a well-preserved wooden stock and cocking mechanism.

The official cargo was mainly silver. Silver coins struck by several moneyers at the then newly established Mexico City mint appear in denominations of one, two, three, and four reales. There are also a few Spanish silver coins from other mints. Silver bullion takes the form of disks varying in weight from a few ounces to 30 pounds (13.61kg) and more. The upper surface of these disks bears tax, mines', or owners' marks. The only gold recovered consists of two small bars.

Among the personal possessions of the passengers and crew we find a gold crucifix and a broken wooden cross trimmed with gold. Several pewter items, including plates and porringer, bear the English touchmark: the crowned Tudor rose. The pottery is similarly cosmopolitan, including brightly painted majolica wares, and Cologne stoneware. Items for personal use and adornment include a quantity of straight brass pins, as well as brass shoe buckles, a silver thimble, and a fragment of chain mail. More surprising still are the obsidian blades and
Above: A plan of the San Esteban wreck site, with (below) conjectural reconstructions of the ship's plan and profile, based on the surviving section of keel and sternpost as well as on contemporary illustrations. The breech-loading cannon (right) was part of the ship's armament.

a polished iron pyrite mirror, items of American Indian manufacture presumably being taken home by someone as souvenirs. Iron tools and ship's equipment are plentiful, among them bolts; spikes; nails; a sledgehammer; pincers; a pickax; a gouge and a reamer; caulking tools; chains; rudder gudgeons (sockets) and pintles (pivot pins); and lead sounding weights. Smaller lead weights recovered may have been plumb bobs for gunners' quadrants, instruments used in taking aim. Navigational equipment features fragments of two sets of brass dividers, and three brass mariner's astrolabes, devices widely used in the sixteenth century for accurately finding latitude. Only about three dozen of these early instruments are known throughout the world.

Given the exposed nature of this site, it is not surprising that little remained of the hull of the San Esteban. What did survive, however, was the sternpost and a section of the keel, which together can tell us more than any other fragments of equivalent size about this vessel’s lines and build.

These finds from the San Esteban do not complete the list of preserved relics from the Spanish ships that sank off Texas in 1554. From the wreck destroyed when a dredger cut the Mansfield Channel through Padre Island we have an anchor, a few silver coins, and a pewter porringer—all found on the beach nearby. From the presumed wreck of the Espiritu Santo we also have a collection of artifacts looted by treasure hunters in 1967 but sequestered in 1969 by a U.S. district court acting in the public interest. These finds can tell us far less than they would have done if people had carefully plotted them before recovery, and set about preserving them soon afterward. Nonetheless, they, too, contribute something to our record of the lost ships.

But much the most important evidence remains the San Esteban assemblage, representing as it does a unique record of many aspects of culture in the middle of the sixteenth century. Together with a wealth of information from old archives, these finds help us to paint a detailed picture of many aspects of Spain’s relations with the New World in the first decades after its discovery.
We should have gleaned a bare fraction of what we now know about the San Esteban relics without the work of conservation experts. The tasks of cleaning and preserving items from this wreck fell to the Texas Archaeological Research Laboratory, part of the University of Texas at Austin. The laboratory had become involved in conserving objects from the sea in 1969. A court order in that year handed the laboratory temporary custody of material of disputed ownership recovered by a treasure-hunting firm from the supposed site of the Espiritu Santo. Empowered to study and preserve these items, the laboratory staff were, however, hindered by the fact that the treasure hunters had crudely hacked away the encrustations from many of the objects.

The handling of material from the San Esteban, excavated in a scientific manner a few years later, proved much more rewarding. But it was also very challenging. The collection from the San Esteban was unusual in that the great bulk of the material recovered consisted of conglomerates formed around one or more heavily corroded iron objects. During the many decades of submersion in seawater, some of these encrustations had built up to form huge, shapeless lumps incorporating sand and ballast stones, shells and other plant or animal debris, and even other objects belonging to the wreck. For example, the conglomerates surrounding some of the large iron objects, like anchors and cannons, included hundreds of smaller objects and ballast stones. In some instances, especially among the smaller iron objects, corrosion had gone so far that it had totally destroyed the metal artifact, leaving only its ghost in the form of a hollow inside the concretion (see also Yassi Ada, pp. 36-37).

Before they broke such concretions open, the conservators therefore photographed them from a number of angles, using natural light and X-rays. The resulting prints showed whether it was going to be necessary to take a cast of the object at the heart of the lump; the prints also served as guides for the technician entrusted with the tricky task of "excavation." Because concretions can be very hard, the technician used a pneumatic chisel for dissecting them. As he opened up each piece layer by layer, he took extensive notes and made a photographic record in order to preserve all information that might prove useful later on. Thus at this point the conservator was actually behaving more like an archaeologist: seeking to interpret the significance of the relationships before him, rather than just extracting objects in readiness for treatment.

Once the conservator and his team had freed each item from concretion they had to treat it according to its constituent material. For most metals, including silver, and iron, treatment meant immersion in an electrolytic bath. Passing a current through the object and the electrolyte in which it hung removed the negatively charged chloride ions from the structure of the metal so that, ideally, it emerged in a pure and stable form. But with iron this process called for careful control, for any chlorides left would combine with hydrogen from water vapor in the atmosphere. The resulting hydrochloric acid would then attack the iron in a self-renewing cycle until the iron had turned into a pile of rust. Small items such as silver coins needed only a few days' electrolytic treatment, but a large iron object like a cannon or an anchor required a year or more. Generally, once chemical tests of the electrolyte showed that all chlorides had been eliminated, laboratory staff removed the object, dried it off, and finally immersed it in a micro-crystalline wax in order to protect it completely from atmospheric corrosion.

Obviously, where an object survived only as a hollow at the center of a lump of concretion, all that the laboratory staff had to do was to clean out the hollow and inject it with some type of latex solution. Once this hardened, they broke away the surrounding concretion, revealing a perfect replica of the vanished original. But this sounds easier than it actually was: cutting through the conglomerate without damaging the hollow called for skill and accurate interpretation of the preliminary X-ray photographs.

Although most of the San Esteban artifacts requiring treatment were metallic, there...
were other substances, presenting other problems. For example, the surviving sections of the wooden keel and sternpost were waterlogged, and drying out would have distorted them. Their potential value for studies on the original hull and as relics to be put on public display meant that the laboratory had to tackle them. The chosen method was total immersion in polyethylene glycol (PEG). This treatment has proved slow and costly, involving years of soaking in vats of permanently heated solution kept circulated by pumps. Similar but less lengthy treatment has also helped save smaller wooden items.

Although firmly based on scientific principles derived from chemistry and the accumulated experience of museum and laboratory staffs over recent years, all this conservation work called for considerable imagination and flexibility. As with archaeological deposits on a site, no two objects or conglomerates were the same, and the conservator had to tackle each one individually in order to extract as much information as possible and to preserve that object for the future. At every stage in the San Esteban project, he also had to work closely with his archaeological colleagues, discovering the kinds of questions that we were pursuing, and informing us of better ways to recover, pack, and transport our finds before they reached the laboratory at Austin. This team aspect of archaeology under water was certainly most important.

Various stages in the dissection of a single conglomerate (top, left) from the San Esteban site. First, the material is X-rayed in the laboratory. The surface concretions are then removed. Next, the individual artifacts are extracted and conserved, and can be laid out as originally found. Finally, a drawing must be made of the various items. As you can see, the conglomerate was mainly made up of large iron bolts, spikes, and straps, although it contained also 12 coins and an aboriginal polished pyrites mirror.