Solaris, dir. Andrei Tarkovsky, 1972. Frame enlargement. 00:16:46.

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Fieldnotes from Solaris: Ship's Logs, Shipwrecks, and Salt Water as Medium

BYRON ELLSWORTH HAMANN

> *It is a striking thing, and very notable in Spain, to be surrounded by two seas so great and so diverse as are the [Atlantic] Ocean and the Mediterranean. Virgil counted among the other excellences of Italy to be surrounded by two seas, the Tyrrhenian and the Adriatic, which are just small parts of the Mediterranean. Our Spain possesses in almost equal parts the greatness of all this sea, joined with the immensity of the Ocean, with the division of its Strait of Gibraltar, where both seas are joined and are parted: this place being one of the most amazing things to be found in all the universe, mixing there the natures of East with West, and truly dividing within Spain the whole world—where the ancient philosophers believed it ended.*
> —Ambrosio de Morales, *The Antiquities of the Cities of Spain*, 1577[1]

> *A proper consideration of Dutch maritime hegemony in the seventeenth century would embrace the Atlantic, the Baltic, and the Mediterranean—to say nothing of the Indian Ocean. We would be very foolish then to allow the mere names of these diverse seas to oblige us to separate them as distinct objects, rather than interconnected spaces.*
> —Sanjay Subrahmanyam, "Afterthoughts: Histories in Bottles," 2013[2]

In a famous essay from 1989, Jeff Wall argued that predigital photography was premised on *liquid intelligence*. This "sense of immersion in the incalculable" had a deep history, an ancestry present in darkroom photography as "a memory-trace of very ancient production processes—of washing, bleaching, dissolving and so on."[3] Yet even as he surveyed this technical genealogy, Wall also pondered the future of liquid intelligence—especially as it applied to the craft of photography at the then-dawning of a new digital age. And in his final paragraphs, Wall looked to the distant horizons imagined by *Solaris*, Andrei Tarkovsky's sci-fi epic from 1972. Most of the film takes place far from Earth, on a space station orbiting an oceanic

planet. But that planet—Solaris—is not simply an object of investigation for human scientists. Solaris itself is alive, a literally liquid intelligence studying the scientists studying it.

Five centuries ago, a more literal kind of liquid intelligence—the arts of long-distance navigation—fundamentally changed our own planet. Unprecedented global networks emerged from then-new technologies for immersion in the incalculable. *Solaris* multiply references this early modern era. Five paintings by Pieter Bruegel the Elder decorate the space station's cabinet-of-curiosities library, which also holds a copy of Miguel de Cervantes's *Don Quixote*. The film's final scene stages Rembrandt's *Return of the Prodigal Son*. But if *Solaris* connects early modernity to an imagined future, this article considers the challenges, now, in writing histories of early modern salt water.

The past two decades have seen a resurgence in studies of saltwater worlds, precisely because oceans and seas have brought together different parts of our planet for centuries.[4] Navigational circulations provide a rich framework for crafting connected histories of the globe. The historical context for this surge of aquatic engagement is also relevant. As brilliantly diagnosed in Allan Sekula's 1995 *Fish Story*, the turn of the century experienced an oceanic return of the repressed, the catalytic confluence of waterborne shipping containers (global capitalism's essential material medium), digital connectivity (the metaphorically watery world of surfing, phishing, internet), and navigational deskilling (automatizations enabled by global positioning systems—GPS—and harbor robotics).[5] Global warming and its effects on saltwater acidification were also rising to public consciousness. Rather extraordinarily, for example, a 1994 article on the ability of acoustic signals to travel long distances underwater (an experiment discussed below) opened its first paragraph with global warming's projected impact on the ocean.[6]

Yet there are two paradoxes in much recent aquatic history. First, although salt water is supposedly central, it often disappears. "The Atlantic history that many historians produce," writes Alison Games, "is rarely centered around the ocean, and the ocean is rarely relevant to the project."[7] A similar lacuna marked the Mediterranean. "Looking at journals such as the *Mediterranean Historical Review* and *Mediterranean Studies*," observes David Abulafia, "we encounter any number of excellent articles on the Mediterranean region, many of the most memorable of which do not actually mention the sea."[8] This absence is not unique to history: it is found in literary studies as well as art history. "It seems strange," critiques Elizabeth B. Davis,

> that even scholars who write about the literature of travel during the [early modern] period show so little interest in the experience of

***Solaris*, dir. Andrei Tarkovsky, 1972. Frame enlargement. 01:02:15.**

> navigation. . . . Ignoring the fact that a minimum of forty-five days onboard ship separated Spain from the West Indies, these studies almost give the impression that travelers got off a plane to contemplate the marvelous vistas of the New World.[9]

And in her elegant meditation on *Boy with Squirrel* (a portrait John Singleton Copley painted in Boston for shipment to London in 1765), Jennifer Roberts laments how previous interpretations ignored the peril-filled ocean crossing this image was created to endure. Instead,

> the vast breadth of the Atlantic passes in the blink of an eye. These spatiotemporal compressions have the implicit effect of representing the space between Boston and London as an inert gap, a predictable intermission . . . [I]f we imagine the Atlantic and other interstitial eighteenth-century spaces along the lines of our own experience, as non- or negative spaces, as abstract, merely categorical or cartographical boundaries, we will fail to see—even to seek to see—the strategies that Copley and other agents devised to navigate them. In Copley's case, we will fail to see the ways in which the Atlantic functioned as a medium.[10]

Across many disciplines, then, seas and oceans are transformed into voids. At the same time, paradoxically, these scholarly voids are riven by conceptual barriers. Too often (as Sanjay Subrahmanyam points out) our contemporary common-sense notions about saltwater boundaries limit our understanding of the past—so that Atlantic studies, for example, seldom spill over into Mediterranean studies.[11] Once Europeans "discover the Atlantic" (in Fernand Braudel's memorable phrase), the Mediterranean can be left behind.[12] This is an artificial separation, of course. Many ships built in the Mediterranean traveled out into the Atlantic, sometimes as far as the Americas (nautical biographies provided in a delightful paragraph of Braudel's own book on the Mediterranean world).[13]

The following pages emerged in response to these dual paradoxes of void and barrier, and explore Mediterranean-Atlantic history in the Hispanoamerican world from 1421 to the late seventeenth century.[14] The term *Mediterratlantic* is used to counter the second paradox of oceanic studies—but it has implications beyond them as well, as my conclusions propose.[15] To counter the first paradox, I bring together two kinds of material traces dynamically generated by the act of navigation itself: ship's logs and

shipwrecks. These eloquent fieldnotes from a watery world provide us with a kind of saline archive. They offer an important complement (and contrast) to the land-based records so useful for previous studies of early modern navigation, sources that documented saltwater journeys after the fact: navigation treatises, satiric letters, cautionary travelogues, courtroom proceedings.[16]

Ship's logs and shipwrecks are densely layered records, each with a distinct temporal structure. Each has a distinct orientation relative to the water's surface. These are sources that connect us to deep media genealogies of salt water, via imaginations of navigation and of subaquatic worlds. Above all, logbooks and sunken ships reveal the watery refractions of space and time.

Logbooks were built up slowly, day by day. Their often terse and telegraphic entries, recording over and over again the direction of the wind, estimates of distance traveled, and calculations of latitude by sun or stars, give us some sense of the sheer boredom and monotony involved in sailing for weeks on end. Yet a monotonous journey, an uneventful one, was in many ways an ideal journey. Entries describing storms or ships falling apart and needing repairs certainly make for engaging reading now. But when those events were written down, they were sources of sheer terror.[17] And justifiably so. Many ships never reached port, and ended their journeys beneath the waves. If logbooks are documents generated gradually over time, shipwrecks are produced by a cataclysmic disaster, in which the process of maintaining a vessel afloat day after day for days on end is ruptured, cut short. Of course, the material lives of sunken ships did not end on the day of their wreck, and the interpretation of waterlogged remains is in many ways more complicated than the interpretation of logbooks. But together, these two kinds of material traces give us a sense of the long, slow journeys endured by so many people, willing or no, across the early modern world.

In relation to the water's surface, ship's logs are horizontal, shipwrecks vertical. These two axes have, for thousands of years, shaped human thought experiments pondering the alternative lifeways that watery environments enable: under or on the surface of the waves. Marshall McLuhan's subaquatic aphorism ("one thing about which fish know exactly nothing is water, since they have no anti-environment which would enable them to perceive the element they live in") has a genealogy going back to Plato, and recent media archaeologies envision in depth the worlds of aquariums and marine life.[18] But underwater existence is fundamentally alien to human beings, and so for millennia extended human-saline interactions have required machines enabling travel along the interface of water and air

("interface," Melody Jue reminds us, originally being a liquid category).[19] Such overwater travels have inspired another long history of aquatic meditations: on the sacrilegious freedoms of the mariner-pirate, or the terrors of shipwreck—both themes continued by watery archaeologies today.[20]

Together, ship's logs and shipwrecks reveal salt water as a very strange medium for early modern space and time. Consider, by analogy, general aquatic physics. Sound and light behave quite differently when their medium is liquid instead of air. Sound's capacity is amplified. It can travel thousands of miles underwater. In a famous 1991 experiment, signals broadcast beneath the South Indian Ocean were picked up on both the east and west coasts of North America.[21] The vast distances underwater noises traverse raise fascinating issues of asynchronous temporalities: an older sound traveling from far away may actually reach the hearer before a closer and more recent sound does (see John Durham Peters's charming appendix on "Nonsimultaneity in Cetacean Communication"). Many marine species have developed echolocation capacities to take advantage of saltwater acoustics: using sonic signaling to find prey, to stun it senseless, and even (in a possibly fantastic take on dolphin sensoria) to look inside other bodies via wet-wired ultrasound.[22] Turning to light, the medial effects of water are uneven. Light is refracted underwater, travels more slowly, and its different wavelengths are variously absorbed by the deep. To human beings used to seeing through air, underwater objects appear closer and larger. Water as an optical medium may even correct some forms of nearsightedness (with or without goggles, depending). But only to a certain depth. At ten meters below the surface, the longest wavelengths of sunlight (visible reds and oranges) have been scattered; by a hundred meters, most of the shorter wavelengths (greens, blues, purples) are dissipated as well. This marks the lower limit for plants that depend on photosynthesis. Below a thousand meters, underwater environments are plunged into darkness—and animal bioluminescence becomes more common.[23]

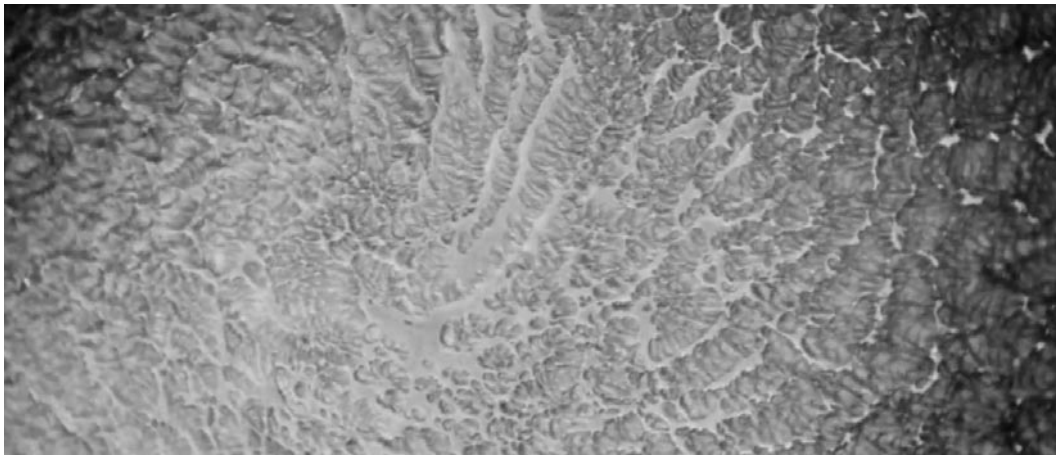
In the sources I study here, spatiality and temporality are similarly refracted. Although it is quite common to write about "oceanic space" today, early modern logbooks reveal a far more complicated situation.[24] Out of sight from land, everything was estimation. Distance covered day by day, direction traveled, location on the surface of the terraqueous globe, maps representing that sphere as a flat surface: all were approximations—and a single storm could render prior wayfinding efforts useless. Early modern aesthetics of precise spatial geometry had little relevance for blue-water navigation.[25] Thus after describing two alternate methods of position tracking in his 1673 *Art of Navigation*, Julián de Flores added that "all of this usually suffers from some uncertainty, because one does not know well,

and with exactitude, the route by which the ship travels."[26] Not for nothing did early modern pilots describe their sailing practice as *por fantasía* (by fantasy, imagination, guesswork).[27] None of this meant that ships were unable to (eventually) reach their destinations. But arrival was never a given, or easy. Logbooks, then, were a record of—and a tool against—the spatial refractions of open-water sailing. Shipwrecks, in turn, reveal parallel refractions of time. Where certain materials are concerned, time's passage can be all but stopped underwater (in striking contrast to what would happen to those materials on land). Yet bringing long-submerged objects up to the surface can also accelerate time's flow, compressing the processes of months or years into a few hours. And in a ship's pile of ballast, we find a history of navigations literally turned into stone.

Logbooks

> Burton: When I first descended below three hundred meters, I had trouble maintaining altitude. There was a strong wind. All of my attention went towards operating the ship. I did not look out of the cabin. As a result, I wound up in a fog. . . . It seemed to be colloidal and viscous. It covered all the windows. Because of the fog's resistance, I began to lose altitude. I couldn't see the sun, but the fog glowed red in its direction. After half an hour I came out into a large, open space. It was almost round, a few hundred meters across. At that point, I noticed a change in the Ocean. The waves disappeared. The surface became almost transparent, with cloudless patches.[28]

Copies of ship's logbooks are surprisingly scarce before the eighteenth century, and even when they survive they are usually clean (re)copies.[29] What this means, unfortunately, is that I'm unable to make any comments about logbooks themselves as material objects, history-of-the-book style, or about the ways pilots visually structured their day-by-day records on the page. We will have to focus, instead, on the contents of their daily entries. Like any other document, logbooks were subject to "cooking"—Christopher Columbus describes how he kept two logbooks on his first voyage: a secret one, with actual distance-traveled calculations, and the one he shared with his sailors, in which estimates were strategically underestimated.[30] But questions of empirical accuracy aren't what I'm interested in here. Instead, I want to convey the rhythms and conventions of logbook writing as shared



over three centuries across the Mediterratlantic world. These can give us a sense, at least, of the inescapable disorientations faced by travelers who, day in and day out, moved across salt water in a tiny wooden box.[31]

I focus on five journeys made between 1429 and 1661. The earliest, from 1429–1430, is a truly Mediterratlantic itinerary: it begins in the port of Pisa, coasts westward with many stops along Mediterranean shores (Marseille, Barcelona, Valencia, Cartagena, . . .), passes through the Strait of Gibraltar, continues up through North Atlantic waters to Sluys and then Southampton, and finally back to Pisa after seven months of travel. The second, from 1492–1493, is the logbook of Columbus's first six-month trip to the Americas, from Iberia to the Caribbean and back again. The third, from 1525–1526, is pilot Martín de Uriarte's account of the transatlantic first leg of a journey from Spain to the Philippines, starting from Europe and arriving at the southern tip of South America five and a half months later. From there, Uriarte's convoy rounded the Strait of Magellan and continued across the Pacific—a reminder that Mediterratlantic connections flow into other bodies of water as well.[32] The fourth journey, spanning two and a half months in the spring of 1627, is an anonymous account of how a fleet of six galleys sailed from Livorno to the Dardanelles and then back to Taranto (via many ports along the coasts of Spanish Naples), part of a military strike by the Knights of Saint Stephen against the Ottomans. And the fifth, dating to 1660–1661, is another anonymous logbook, this one for a seven-and-a-half-month transatlantic circuit from Cádiz (southwestern Iberia) to Portobelo and back.[33] Together, these logbooks reveal a surprising aspect of duration: sailors who traveled round-trip from Iberia to the Americas in the seventeenth century were away from their homes just as long as sailors who, in the fifteenth century, journeyed round-trip from Italy to England. And although these accounts span more than two hundred years, and deal with supposedly different liquid realms (the Mediterranean versus the Atlantic), they all share basic concerns: daily documentations of navigation procedure, unexpected irruptions of wonder, terror, and repair.

Before the arrival of GPS, Western saltwater navigation was a profoundly *bureaucratic* technology—a watery paperwork that, as Edwin Hutchins's *Cognition in the Wild* brilliantly reveals, survived basically intact to the end of the twentieth century.[34] But this was not a bureaucracy of precision. It was, instead, a bureaucracy of fantasy. On open water, at the whim of waves and wind and weather and currents, no one could ever tell, really, where they were—or how long it was going to take to reach their destination.

At first glance, logbook entries may appear rather boring: a seemingly endless drone of directions and distances and latitudes, day after day after day. A ship's log from a journey across the fifteenth-century Mediterranean

***Solaris*, dir. Andrei Tarkovsky, 1972. Frame enlargement. 01:39:15.**

may seem just as tedious as a ship's log from a journey across the seventeenth-century Atlantic. Entries from Columbus's diary in 1493 . . .

> Monday January 28: All this night he sailed to the ENE; must have made thirty-six Roman miles which are nine leagues. Between sunrise and sunset he proceeded to the ENE twenty Roman miles, which are five leagues. The air very mild and soft; saw boatswain birds, petrels, and much weed.
>
> Tuesday January 29: Sailed to the ENE and must have gone in the night, with S and SW [winds], thirty-nine Roman miles, which are nine and a half leagues; in the whole day must have gone eight leagues. The air very mild as in April in Castile; the sea very smooth; fishes that they call *dorados* came aboard.
>
> Wednesday January 30: In this entire night he must have made seven leagues to the ENE: by day ran to the S by E thirteen and a half leagues; saw boatswain birds and much weed and many porpoises.
>
> Thursday January 31: He sailed this night thirty Roman miles to the N by E, and afterwards to the NE thirty-five Roman miles, which are sixteen leagues. From sunrise to night proceeded thirteen and a half leagues to the ENE; saw boatswain birds and petrels.
>
> Friday February 1: He proceeded this night sixteen and a half leagues to the ENE; by day ran on the same course twenty-nine and a half leagues; the sea very smooth, thanks be to God.[35]

. . . read a lot like entries from Martín de Uriarte's voyage to the Strait of Magellan in 1525 . . .

> From Sunday at midday to Monday at midday August 28, we traveled to the south: this day at midday I calculated our latitude as twelve degrees.
>
> From Monday at midday until Tuesday August 29 at midday we traveled to the south; this day I calculated our latitude as eighteen degrees twenty minutes.
>
> From Tuesday midday to Wednesday at midday August 30, we traveled to the south by a quarter to the southeast: this day I calculated our latitude as nine degrees fifty-four minutes.
>
> From Wednesday midday to Thursday midday August 31, we traveled to the southeast; this day I did not steer a quarter to the south, because we didn't have much wind: this day I calculated our latitude at nine degrees forty-one minutes.
>
> From Thursday to Friday midday, the first of the next month of September, we traveled to the southeast; this day I did not calculate our latitude.[36]

. . . and both, in turn, are echoed by the monotonous rhythm of entries from the Portobelo trip in 1660 . . .

> Monday the 15th of the said [month of November] I steered to the southwest by a quarter to the west; this day I calculated our latitude as thirty-four and a half degrees; I sailed the ship twenty-five leagues; this day we had good southeast winds.
>
> Tuesday the 16th of the said [month] we traveled much less than we had done; this day I calculated our latitude as thirty-three long degrees; having steered to the southwest by a quarter to the west the ship sailed twenty-five leagues; this day the wind died down and shifted to the northwest until midnight, when we turned to the south by a quarter to the southeast with good winds.
>
> Wednesday the 17th of the said [month] I steered to the southwest with the wind blowing a little from the west northwest; I calculated our latitude as thirty-three long degrees; I sailed the ship seven leagues this afternoon and at night we were becalmed.
>
> Thursday November 18th we were becalmed and we steered to the southwest by a quarter to the west with a little easterly wind; I calculated our latitude as thirty-three short degrees; I sailed the ship five leagues this day; at four in the afternoon the wind picked up.
>
> Friday the 19th we sailed with a good southeast wind; I steered to the southwest by a quarter to the south; I calculated our latitude as thirty-two and a quarter degrees; I sailed the ship ten leagues to the southwest; this night we used the foresails, with a southwest wind and the current flowing to the west northwest.[37]

Travel in the Mediterranean was somewhat less monotonous, since it often involved arriving in a new port of call every evening. (Whether sailors and passengers were allowed to go ashore is another story.)[38] But inclement weather could cause a Mediterranean vessel to be stranded for days on end in a particular harbor, and contrary winds could turn crossing a small distance into a frustratingly drawn-out ordeal. A sense of the endurance required even for Mediterranean sailing is captured in Luca di Maso's logbook entries from mid-October 1429, when he tried for five days to round the southeast coast of Iberia:

> Wednesday the 12th there was wind from the east, and that evening at nightfall we found ourselves by Cartagena in Spain.
>
> Thursday the 13th we sailed with little wind; in the evening we found ourselves at Cape Lenzuloi in Granada, about ten miles from Cape Gata, and there we arrived with wind in the prow.
>
> Friday the 14th we sailed into the wind almost the entire day with

calm sea; in the evening we arrived at Llanos de Almería with wind from the southwest.

On the morning of Saturday the 15th we left that place and we sailed around twenty miles; then, with wind from the west and southwest, we had to return to the said place of Llanos from which we had departed, and there we arrived almost at nightfall.

On the morning of Sunday the 16th we left from there to head to Almería, and the wind picked up after about fifteen miles; and about halfway there was wind from the east, because of which we had to change our plans and with effort cleared the headland of Llanos and found rough seas in the prow. We sailed all day with little wind and off of our route, and the galley steered poorly because there was too much cargo.

Monday morning the 18th there was wind from the south and we encountered swells; we sailed all day and night and Tuesday until mid-afternoon.

Tuesday the 18th, the day of Saint Luke, late afternoon and just before sunset we arrived in Malaga, having a great need of water and other supplies, and there we arrived etc.[39]

Boredom was an inescapable feature of early modern navigation. Voyages by sea and ocean often lasted for months, during which sailors and passengers were all but trapped in conditions uncomfortable even by early modern standards. Ships were small ("a very cramped prison," in the words of Friar Tomás de la Torre).[40] Atlantic vessels had something like one and a half square meters of free space per person, and Mediterranean galleys were even more confining.[41] Nor were human beings the only voyagers—rats and cockroaches were onboard as well, to say nothing of lice.[42] The need to endure such claustrophobic conditions for long periods partially explains why laws against shipboard gambling were issued over and over from at

least the fifteenth century: games of chance were a basic way for sailors and passengers to pass the time.[43] Reading was another option. In his 1539 list of suggestions for galley travel, Friar Antonio de Guevara stressed the importance of bringing several books along for any Mediterranean journey ("because of the three things one can do at sea—that is to say gambling, talking, and reading—the most beneficial and least harmful is reading").[44]

At the same time, the repetitions of direction and distance and latitude we see in logbook entries are far more than registries of onboard boredom. They are records of a complex effort to assert control over the disorientations of open-water travel.

Bureaucratic navigation in the Mediterranean had long been based on gauging one's location according to two factors (and this basic method was carried into the Atlantic). Pilots would use a magnetic compass to determine the direction they were sailing, and would estimate speed to assess how far they had traveled each day.[45] Both of these measurements were profoundly imprecise—which is why this method is called "deduced" or "dead" reckoning in English.[46] The orientation of magnetic compasses shifted as one sailed from east to west, and always involved individual idiosyncrasies as well (partially related to where on the earth's surface the compass had been made).[47] Skilled pilots were probably quite good at gauging their speed, but this was typically an estimate and not a measured velocity (the "chip log" apparatus was not widespread until the mid-seventeenth century, and in any case rate of travel would vary over the course of a day).[48] Latitude calculations were not common until the 1570s (always depending on cloud-free skies and smooth sailing), and longitude calculations were basically impossible.[49] Yet these guesstimations had to be carried out every day, and the longer one sailed on open water the more uncertain one's location became.

Writing down directions and distances in a logbook was only a first step in the process of bureaucratic navigation. Next, this data was translated onto graphic space using a mostly vanished category of material culture dynamically generated (like logbooks and shipwrecks) through the process of navigation. This was the marked-up ship's chart. Although essential, charts were another source of imprecision, since translating the round earth to a flat surface always involves distortions (as early modern sailors were well aware).[50] Pilots, having gauged how far and in what direction they traveled each day, would use the dual points of navigational dividers to turn logbook entries into a location on their chart. This was the ship's "fantasy point" (*punto de fantasía*), "because it has no more foundation than the *fantasía* of the pilot."[51] Day after day, one after the

Opposite: Frontispiece and title page of Bernardo de Vargas Machuca, *Milicia y descripcion de las Indias* (Militia and description of the Indies), 1599. John Carter Brown Library, Providence, Rhode Island.

Left: Bronze navigational dividers from the wreck of the *Trinidad Valencera*, sank 1588. Recovered from the wreckage in Kinnagoe Bay, Ireland. © National Museums Northern Ireland, Collection Ulster Museum, BELUM.BTV.252.

other, divider-measured fantasy points generated an ever-extending line of uncertainty across cartographic space. Dividers were thus key instruments for immersion in the incalculable, and they often appear in early modern images of navigation. Made of durable brass, they are frequently recovered from early modern shipwrecks.[52]

These mapping practices allowed pilots to fantasize not only how far they had traveled, but also how far they had to go. This was an important concern even in the Mediterranean, where a preference for coastal sailing meant that one rarely spent more than a week on the open sea.[53] For example, during the final weeks of his Mediterratlantic voyage in 1430, Luca di Mazo didn't just record the distance sailed on particular days; he also estimated location *relative to unseen land masses revealed by his chart*, perhaps sedimenting for us his own eagerness to end a seven-month journey:

> Saturday March 25th, the day of Our Lady, we sailed all day by the grace of God with a prosperous wind; that afternoon at nightfall we found ourselves around a hundred miles by sea from the Citadel of Minorca [to the southwest].
>
> Sunday March 26th 1430 we sailed all day and most of the night, with a prosperous wind almost the entire day, except during mid-afternoon when we had a lot of fluctuations. That night we estimated that we were around two hundred and sixty miles by open sea from Minorca [to the southwest], and about eighty or ninety from the Island of Hyères [off the coast of France, to the north].[54]

Sixty years later, Columbus used the same navigational technique on his journey into the unknown Atlantic. That the admiral could have a chart for waters that had never before been crossed might seem strange, but Columbus knew where he wanted to go (Asia) and so had drafted a hypothetical map of the Atlantic that included the theorized locations for Cipango (Japan) and Cathay (China).[55] His logbook entry for September 25, 1492, reads as follows:

> The Admiral was speaking with Martín Alonso Pinzón, captain of the other caravel *Pinta*, about a chart which he had sent three days

Below: Francesco de Cesanis. Portolan chart, 1421. Vellum and pigment, 22.8 × 38 in. (58 × 96.6 cm). Museo Civico, Venice. Collezione Correr Cl. XLIVa n. 0013.

Opposite: Paolo dal Pozzo Toscanelli. Chart of the Atlantic, ca. 1474. As reconstructed by Hermann Wagner in 1894.

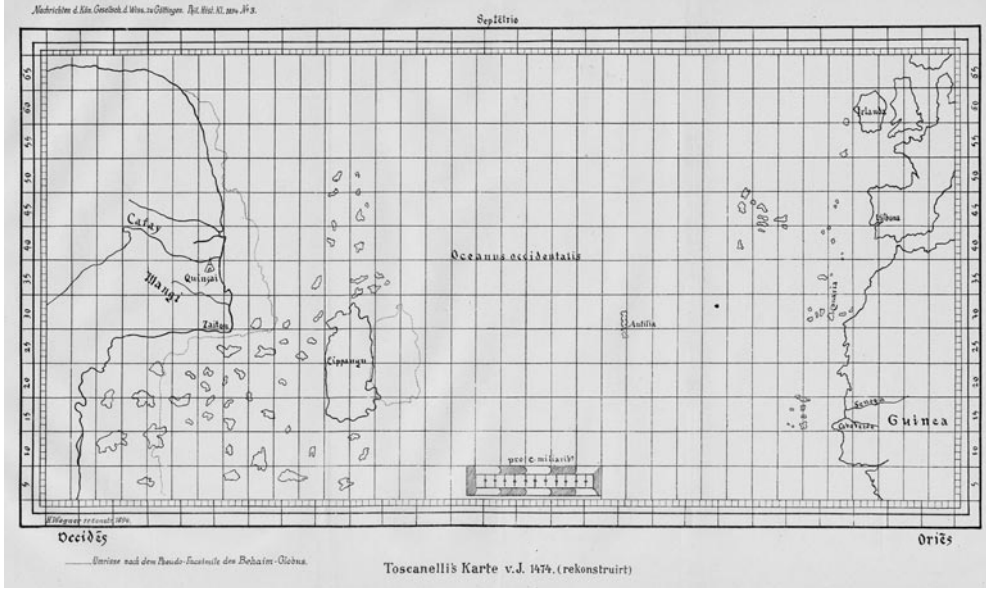
before to the caravel, on which it seems the Admiral had depicted certain islands on that sea, and Martín Alonso said that they were in that region. . . . [T]he Admiral asked him to send back the said chart. When it had been sent over on a line the Admiral began to plot their position on it with his pilot and mariners.[56]

Similarly, on the journey home Columbus used his Atlantic chart to triangulate estimated position relative to the Azores (from which he had come) and Madeira and Iberia (toward which he was sailing):

> Friday February 15. This night and day he was off his course owing to adverse winds and great swells and sea, and found himself one hundred and twenty-five leagues from Cape Saint Vincent [to the east] and eighty from the Island of Madeira [to the south], and one hundred and six from Santa María [in the Azores, to the west].[57]

Columbus seems to have monopolized his map of the Atlantic. More commonly, when a group of ships sailed together, each pilot kept his own charted record. This allowed for periodic comparisons of location estimates—with the (inevitably desperate) hope that these would be, more or less, in agreement.[58] A decade after Columbus returned to Europe, Queen Isabel of Castile established an Atlantic House of Trade (Casa de la Contratación) in Seville. Among other things, this was a place where official sailing charts were drafted and disseminated.[59] And so when García Jofre de Loaísa set out in 1525 to retrace Ferdinand Magellan's journey to Asia, his fleet carried two different maps of the world created by House of Trade cosmographers: one by Nuño García de Toreno and one by Diogo Ribeiro.[60] Just over a month into that journey, on Thursday, September 7 (heading south off the African coast), Martín de Uriarte described fleet pilots comparing their estimated positions, locations plotted on those two different maps: "We were fifty-two leagues from Sierra Leone according to the chart of Diogo Ribeiro, and fifty-six leagues northeast-southwest from it according to the chart of Nuño García."[61]

One hundred and thirty-five years later, chart-plotting and estimation



Toscanelli's Karte v.J. 1474. (rekonstruirt)

comparisons were still central to transatlantic navigation: "Thursday December 28th today the defense flagship gauged our position and estimated [that we were] eighty leagues from Dominica, and I estimated seventy-five leagues from Dominica; the defense flagship [for latitude gauged] according to the sun estimated [that we were at] fifteen long degrees; our own estimate was according to the new map."[62]

Bureaucratic navigation was an unending, always imprecise effort to impose locational certainty on a fluctuating surface of salt water. Yet any one of the long, difficult days on unpredictable waves could be interrupted by something unexpected. Signs of wonder—marvels that broke up the droning rhythm of wind directions, distance estimates, and latitude calculations—were eagerly entered into logbooks. Wonders ruptured the undifferentiated expanse of open water: even if evanescent, they provided beacons in the mind and foundations for storytelling. In his outbound voyage, Columbus witnessed "a great fire come out of the mountain on the island of Tenerife" in late August, and on Saturday, September 15, "they saw fall from the sky a marvelous branch of fire into the sea."[63] Over a century later, one of the longest entries for the 1637 galley expedition records a watery miracle-tale heard off the northwest coast of Anatolia. On the morning of June 5, the Knights of Saint Stephen intercepted two Greek ships sailing from Istanbul. Some of the those aboard were monks, and they told how an image of the Virgin Mary had just been discovered in the church-turned-mosque of Saint Sophia. The Ottomans threw the image into the Bosporus, but it miraculously returned to the converted building. When a janissary then identified the image as the "Mother of Christ, God of the Christians," both he and the icon were hacked to pieces and dumped in the sea. But the next morning, both were returned whole to Saint Sophia. At this point the building was sealed off, and all were forbidden from providing food or water to the soldier—who remained, kneeling, in front of the image, illuminated by a golden lamp (originally commissioned by the sultan) that did not run out of oil.[64] A few decades later, on his return journey from Portobelo to Cádiz in 1661, our anonymous pilot describes "a column of smoke to the northeast, whose base did not touch the horizon" (on Sunday, August 7) as well as floating "pumice stones and bad waters" (on Thursday, August 11, and Friday, August 12).[65]

But not all of the unexpected signs encountered on the rolling salt waters of Mediterratlantic journeys were wondrous. Some were signs of terror.[66] Often they were signs of shipwrecks. Columbus came across a broken "big piece of the mast of a ship of a hundred and twenty tons" on September 11,

1492, as did our anonymous pilot on November 9, 1660: "this day at seven in the morning we came upon some masts from a large ship."[67] Two centuries earlier, near the end of his outbound journey to Southampton, Luca di Maso met a Genoese carrack coming up from Seville. Swapping news, di Maso learned that three days before, on the Feast of Saint Catherine (November 25), a massive storm struck Galicia. The tempest "had broken and destroyed sails and rigging etc."[68] Three months later, rounding the southwest coast of Portugal on his way back home, di Maso saw two of the storm-shattered ships in the port of Silves. Their broken hulls had been scavenged "for timber and other things."[69]

We could continue from these tales of sundered vessels to a number of other logbook themes that illuminate the day-to-day texture of months on the waves—such as hair-raising storm narratives, or the annoyed entries of travelers stuck in a port for days on end because the weather was bad.[70] Instead, I want to end our logbook navigations with accounts of ships breaking down and needing repairs. Like signs of wonder and signs of terror, these failures of liquid technology provided another irruption of life on the waves.

On Saturday, September 24, 1429, Luca di Maso and his two galleys arrived in Barcelona with high seas and strong winds. Sending a small boat to shore was difficult enough, but by the time the crew had returned the rough sea made it impossible to winch the boat back up into the galley. The iron mooring-rope rings were actually ripped out of the galley's hull. In the end, the skiff had to be cut loose and abandoned. The next morning they continued south to Cape Salou, where a shipwright set to work on repairing the galley.[71] More repairs were needed just over a month later. By November 3 the two ships were in the Atlantic, north of Bayonne, when the second galley's stern rudder broke. The ships attempted to double back to take refuge in Bayonne's port, but rough seas made that impossible. They went to the port of Pontevedra instead. There the second galley's (extensive) rudder damage was repaired, and both ships had their leaking hulls resealed.[72]

The rudder was also a problem on the transatlantic voyage of 1492–1493. In the first days of Columbus's journey, the rudder of the *Pinta* twice jumped its gudgeons and so twice had to be patched up on the open ocean. (The admiral suspected sabotage by the owner of the vessel, who was opposed to the voyage.) When the three ships reached the Canary Islands, full repairs were carried out—after which we hear no more reports of mechanical failure on the *Pinta*. On his return voyage, Columbus records that he ordered repairs on the *Niña* when anchored off the Azores—but exactly what needed fixing, he does not say.[73]

Three decades later, on August 18, 1525, Martín de Uriarte writes that

Diogo Ribeiro. *Carta del navegare universalissima et diligentissima* (A most universal and thorough sailing chart), 1525. Also known as the Castiglioni World Map. Vellum and pigment, 32.1 × 84.3 in. (81.5 x 214 cm). Biblioteca Estense Universitaria, Modena, Italy. C.G.A.12.

shortly after leaving the Canary Islands the mainmast of the fleet's guardship broke. Rather than turning around, the captain of the *Santi Espiritus*, Juan Sebastián, sent two carpenters over in a skiff to do the repairs at sea. Six months later, Uriarte's own vessel broke its anchor. Fortunately, at this point the convoy had reached the southern coast of South America, and so a return to the nearby port of Santa Cruz was easy enough. On arrival, however, the sailors discovered things were far more serious: more than five meters of the keel had broken off, along with all of the bilge pump's wastepipe.[74]

Yet repairs were not always successful, and even new ships could not survive being storm-driven against coral reefs. This brings us to our second material archive, one produced by ships whose Mediterratlantic journeys were cut short by disaster. Under the waves, we enter a territory both rich and strange.

Shipwrecks

> Snaut: Everything began after we started experimenting with radiation. We hit the Ocean's surface with strong X-ray beams.
>
> Kelvin: But if . . .
>
> Snaut: Incidentally, consider yourself lucky. After all, she's a part of your past. What if it had been something you had never seen before, but something you had thought or imagined?
>
> Kelvin: I don't understand.
>
> Snaut: Evidently the Ocean responded to our heavy radiation with something else. It probed our minds and extracted something like islands of memory.
>
> Kelvin: Will she come back?
>
> Snaut: She will . . . and she won't.[75]

As with our logbooks, the shipwrecks considered here span the fifteenth to the seventeenth centuries. Their geographic distribution—the scattered plot points for journeys begun but never finished—is uneven.[76] A great deal of effort has been put into the search for Spanish treasure ships lost in the Caribbean, most of which were heading back to Spain when they sank. These include the three "Padre Island wrecks"—the *Santa María de Yciar*, the S*an Esteban*, and the *Espiritu Santo*—lost off the coast of Texas (1554); the two Emanuel Point wrecks (1559), the *Atocha* (1622), the *Santa Margarita* (1622), and the Cape Canaveral wreck (late seventeenth century) off the coast of Florida; the Highborn Cay wreck (early sixteenth century) in the Bahamas; the Molasses Reef wreck (early sixteenth century) in the Caicos Islands; the *Asunción* (1641) off Hispaniola; and the Western Ledge Reef

***Solaris*, dir. Andrei Tarkovsky, 1972. Frame enlargement. 01:49:44.**

wreck (ca. 1577), the *San Pedro* (1596), the *San Antonio* (1621), and the Stonewall wreck (ca. 1650) in Bermuda.[77]

A second, and perhaps unexpected, center for Iberian underwater archaeology is the northern coast of the British Isles. This is the final resting place for many ships from the defeated Spanish Armada of 1588: the Tobermory wreck, the *Girona*, the *Santa María de la Rosa*, *El Gran Grifón*, the *Trinidad Valencera*, the *Lavia*, the *Juliana*, and the *Santa María de Vison*. At least five of these vessels—the *Girona*, the *Trinidad Valencera*, the *Lavia*, the *Juliana*, and the *Santa María de Vison*—were originally built for Mediterranean journeys, perfectly illustrating the connections of Mediterratlantic navigation.[78] Another doomed Iberian armada to the British Isles was storm-destroyed off the northern coast of Spain in 1596; its remains include the Punta Restelos wreck as well as the *Santa María la Anunciada* and *Santiago de Galicia* (Mediterranean war galleys built in Spanish Naples).

The legacy of Basque shipbuilding creates a fourth category for Ibero-Atlantic archaeology, and includes the *San Juan* (a whaling vessel lost off the coast of Canada in 1565) and the Studland Bay wreck (a merchant vessel laden with Sevillian pottery when it sank off the southern coast of England in the early 1500s).

In contrast to this rich underwater archive from the Atlantic, the study of early modern shipwrecks in the Mediterranean has been less successful—especially when contrasted with the active maritime archaeology of the ancient world.[79] Efforts in the 1970s and 1980s to locate remains from the 1571 Battle of Lepanto, for example, have been inconclusive.[80] Fortunately, two Mediterranean wrecks with ties to the Iberian world are sufficiently published for my purposes here. Both were merchant vessels. The first left Valencia sometime around 1440, laden with ceramics (including custom coat-of-arms floor tiles for a palace being built by the Becadelli family in Sicily). The ship made a port of call at Palma de Mallorca, where it picked up a cargo of cloth, and then continued to Sardinia, where it was riven in two. The origins and destination of a second ship, wrecked off the coast of Zakynthos, Greece, are less certain. But it sank around 1585, according to the large quantity of Spanish coins onboard, and carried a most unusual cargo: thousands of hazelnuts, so many that in some places today they form a solid pavement on the ocean floor. Perhaps it had sailed east from Barcelona, one of Iberia's most important ports and just north of the peninsula's richest hazelnut groves.[81] Overall, then, the numeric den-

sity of documented Mediterratlantic shipwrecks decreases as we move west to east from the Caribbean to the Mediterranean.

Understanding these underwater archives requires a new set of strategies. Where the interpretation of Mediterratlantic logbooks allows us to consider themes shared across centuries by early modern sailors themselves, to understand Mediterratlantic shipwrecks we have to consider not only material evidence but also the ideas of twentieth- and twenty-first-century archaeologists, whose books and reports bring sunken evidence to the surface. Again and again, these reveal the underwater refraction of time.

First, consider death. A common motif in the literature of treasure hunting is the moment when a diver, having carried something up from the ocean floor, enters into a melancholy reverie, dreaming about the drowned victim who last held the item in their hands. Robert Sténuit writes this of his work on the *Girona* (1588):

> For all of us the remains of the wreck were strangely evocative. The gold summoned up figures of long dead hidalgos as clearly as if we had stolen the ducats from their half open purses. . . . The copper, pewter, and lead medallions, mass-produced, bearing images of the Virgin Mary, Christ or the Holy Family, medallions bought on some pilgrimage, told us of the death of the galley slave who must have clutched them in the palm of his hand, as he murmured a silent prayer and his irons and chains dragged him down to the bottom.[82]

Colin Martin, writing about another Armada wreck (the *Santa María de la Rosa*), provides this fantasia on a pewter pendant of the Virgin Mary:

> Though crude in design, and obviously mass-produced, the medallion was a particularly touching and evocative find, for it must once have belonged to one of the Santa Maria's ordinary seamen or soldiers. . . . Did it comfort him through the terrible days of the voyage round the British Isles, and during those horrific final moments of despair in Blasket Sound?[83]

Diver Mel Fisher, as part of a fundraising speech for his *Atocha* project, brought out a golden bosun's whistle and said, "The last time anybody blew this was over three hundred and fifty years ago—he was a sailor who is still down there. After all that time, silver turns green, brown, or black, but gold shines forever."[84] *Atocha* historian Eugene Lyon reports a similar moment when Bleth McHaley, project diver and publicist, gazed down at a coral-and-gold rosary and asked, "I just wonder who was clutching this rosary when the ship went down."[85]

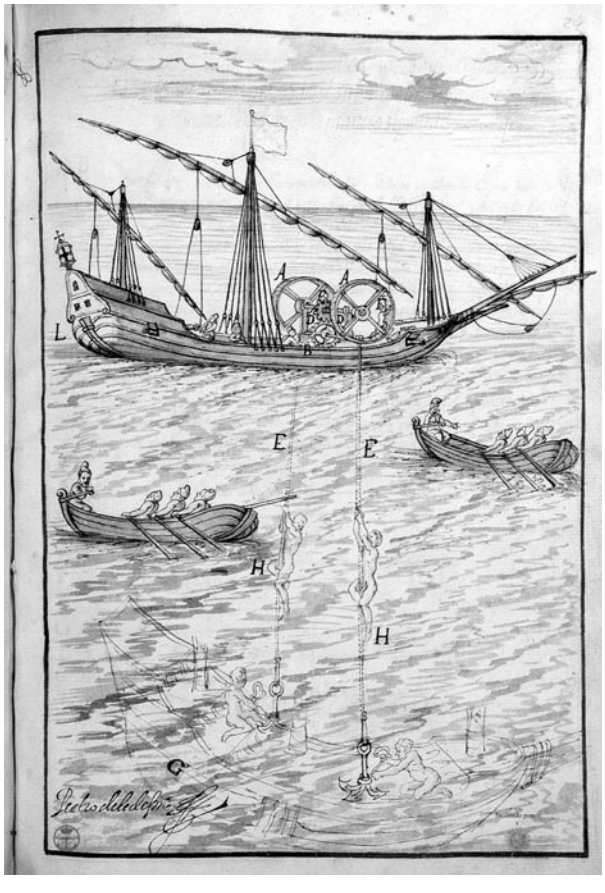
This necromantic romanticism is disquieting, and it can also be mislead-

ing. Depending on how a ship was damaged, weather conditions, and the presence of other ships, many or all of the people aboard might have been saved before the doomed vessel finally disappeared beneath the waves. When the scattered ships of the Spanish Armada were driven by storms onto the northern coasts of Scotland and Ireland, some broke up instantly and plunged their crews into death (the *Santa María de la Rosa*), but others went down slowly, allowing crews to escape (*El Gran Grifón*, the *Barca de Amberg*, the *Trinidad Valencera*).[86] Shipwrecks, then, are not always tombs.

But a ship that went down alone, in a storm, could indeed be a death trap. And yet from our vantage point today, it is often quite hard to recognize when sunken ships were sites of horrific carnage: vessels that were tombs four centuries ago are often *empty* tombs today. Human bones are rarely found in shipwrecks. As Colin Martin explains, "usually the bodies float away, or are reduced to nothing by the scavenging attention of crabs, lobsters, and other marine organisms."[87] That is, even when a shipwreck resulted in the deaths of hundreds of people, the corpses of the drowned vanished centuries ago. Unlike the excavation of terrestrial graves, aquatic graves seldom contain bodies. Shipwrecks can be disturbingly *clean* sites of death, from which the material traces of corpses have disappeared—thus clearing the field for macabre imaginings about prior owners of drowned artifacts.

The absence of the dead from the material assemblage of most shipwrecks leads to a second complicated theme: the time capsule. "With the realization that each wreck represents a priceless resource, a legacy for posterity, efforts have been made by a number of coastal states to preserve these 'time-capsule' records in the most meaningful manner."[88] "All over the world, day after day, the sea is giving up her secrets. Shipwrecks are being discovered and artifacts are being recovered from these unique time capsules of history."[89] "Shipwrecks constitute authentic scenes of the life from other eras, suspended in the moment in which men or natural forces triggered their sinking and loss."[90]

That the material remains of sunken ships and their drowned cargoes link us to centuries-old cataclysms is certainly true. Yet the assumption that these wrecks are sealed capsules of past events

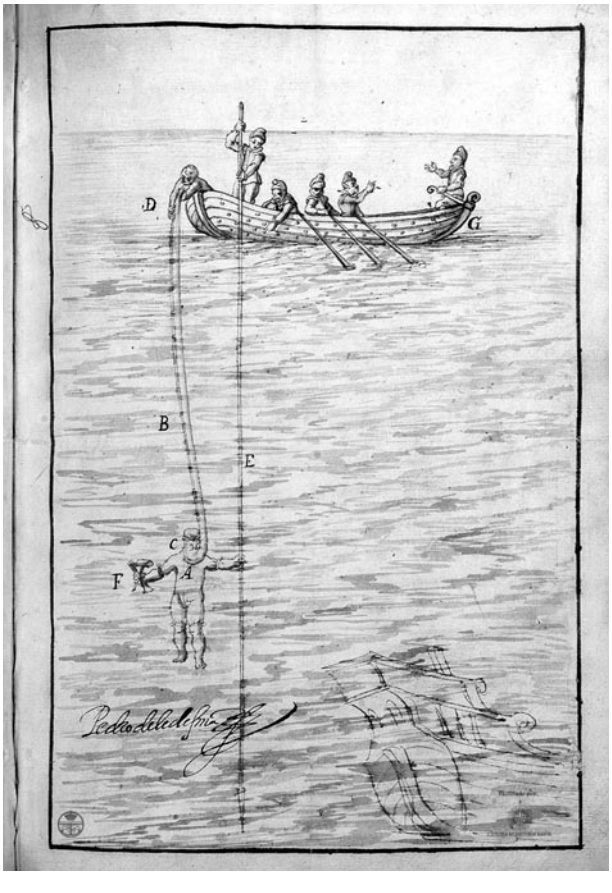


Pedro de Ledesma. *Pesca de perlas y busca de galeones* (Fishing for pearls and searching for galleons), 1623. Folio 24r. Archivo del Museo Naval, Madrid, MS 1035/000.

is not quite right. As mentioned above, the disaster of a ship's sinking could last several hours, leaving the crew and passengers time to escape and to offload cargo. Even after a ship went down, salvage operations could be organized to recover the precious metals on board—chests of gold and silver, of course, but bronze and iron cannons as well. These recovery missions were organized at least as early as the fifteenth century, and could involve well-trained divers (both free and enslaved), as well as diving bells and submarine suits.[91] Salvage missions became so common that in 1623 Pedro de Ledesma wrote and illustrated a treatise on the subject: *Fishing for Pearls and Searching for Galleons*. This was one year after the wreck of the *Atocha*, and Ledesma even refers to the techniques used in the waters of the Caribbean to search for that ship (and its companion, the *Margarita*).[92]

For all of these reasons, the image of shipwrecks as time capsules is problematic—and archaeologists working on sunken vessels can often tell whether those wrecks were visited centuries before.[93] Nonetheless, underwater environments do have the ability to arrest time. Properly buried in silt and sand, organic substances can survive for centuries—materials that in landlocked graves would have quickly rotted away. In this sense, shipwrecks can indeed be time capsules, which when carefully opened present us with forms of material culture that have long since vanished from the terrestrial world. Their raw substance is often quite humble, but the sheer improbability of their survival makes them priceless.[94]

A short list of amazing finds would include: whale blubber residue from barrels in the *San Juan* (1565);[95] "pieces of canvas-wrapped grape shot," a whole brazil nut, and "beech, ash, and pine branches" used to pack barrels together from the *Santa María de la Rosa* (1588);[96] "a barrel-load of Baltic tar, still pliable and sticky" (and stinky), from the *Trinidad Valencera* (1588);[97] the cargo of thousands of hazelnuts from the Zakynthos wreck (ca. 1585);[98] a "Guyana war club" and fragment from the *San Pedro* (1596);[99] "a wooden chest packed with balls of pressed indigo dyestuff" that, when found in the *San Antonio* (1621), "turned the surrounding water a deep blue";[100] ivory panels carved in Ceylon from the *Santa Margarita* (1622);[101] still-readable pages from a printed book (Johann Justus Winkelmann's 1664 *Der*



Pedro de Ledesma, *Pesca de perlas y busca de galeones* (Fishing for pearls and searching for galleons), 1623. Folio 14r. Archivo del Museo Naval, Madrid, MS 1035/000.

Americanischen Neuen Welt Beschreibung) from a wreck off Cape Canaveral;[102] and seeds of the humble beggar tick plant that, when brought to the surface from the *Atocha* (1622), sprouted to life again.[103] The material legacies preserved in shipwrecks are not entirely anthropocentric, however: they can also involve evidence of nonhuman stowaways, in the form of cockroach parts and mouse molars. Careful study of rodent remains from the Emanuel Point 1 and 2 wrecks in Florida revealed that the drowned beasts suffered from vitamin D deficiency. They may have never seen sunlight, and lived their entire lives below deck. Thus even darkness can be recovered by underwater archaeology.[104]

The metaphor of the time capsule is appropriate in another way as well: once objects are roused from their watery slumber and taken to the surface, they are literally awakened from suspended animation. If not treated properly, they may die. And this brings us to a third refractive theme: the sea-change.

Underwater treasure hunting places a premium on gold and silver artifacts, which unfortunately means that many of the most valuable treasures preserved in shipwrecks are abused once they are discovered. The beggar tick seedlings from the *Atocha* soon died; the vessel's shipment of indigo was used up in face painting and T-shirt tie-dyeing.[105] But these actively destructive practices point to a more general problem: bringing objects to the surface puts them at risk. During their centuries of slumber, both organic and manufactured materials undergo a strange transformation. The cells of wooden implements become bloated and literally waterlogged. Glass surfaces react like dry skin, spalling away in brittle flakes.[106] Even weirder changes affect metals. Simple suspension in salt water causes corrosion in iron and silver, but when that suspension is combined with a mixture of different metals in close proximity, an electric alchemy is triggered. Underwater batteries are created, and the flowing current causes surrounding metals to bloom into monstrous shapes encrusting underwater debris. This produces massive concrete-like accretions:

> By reacting with sea water the iron has produced complex sulphides and oxides which had acted as a strong adhesive cement, to which sand, pebbles, and shells bonded themselves to form a solid concrete several inches thick. Within this concretion the original object remained preserved, at least in so far as its shape was concerned; but in chemical composition it had undergone a radical transformation. The reduction process had taken away most of the metal to leave only ferrous impurities, mostly graphite, which retained within the concretion mould the exact shape of the original object. What the

Guiana warclub (left) with detail and fragment (right) from the wreck of the *San Pedro*, sank 1596. National Museum of Bermuda, accession numbers 79:155.211 and 79:155.212.

> iron objects did not retain was their original weight; the loss of pure metal had reduced this in some instances by as much as two-thirds, so that what appeared superficially to be a solid lump of iron weighed little more than a similarly sized pumice stone.[107]

On the one hand, dense chemical accretions help preserve the objects trapped within—including fragile organics that happen to be in the way. Just as important, these accretions fossilize *groups* of objects in relative position to one another—details of context central for archaeological interpretation. The final report on the Padre Island wrecks (1554), for example, describes how accretions were first X-rayed before being chipped apart. Tracings based on those X-rays are included in the publication.[108] They are fascinating visual documents. Conglomerate no. 156, for example—which bloomed up around two wrought iron anchors—entrapped within its field obsidian blades, olive pits, a brass sheath for straight pins, and even cockroach eggs and exoskeletons. When entrapped organic materials like wood or cloth rot away, they are preserved as empty hollows within the conglomerate's matrix. And conglomerates can preserve unexpected details of early modern technology as well. Inside the oxidized outer shell of a cannonball brought up from the *Santa María de la Rosa* (1588), archaeologists discovered a layer of rancid animal fat applied centuries before to prevent rust.[109]

But sea-changes also mean that wood and metal objects brought to the surface can literally turn to dust if not correctly treated. Two graphic accounts, both of Armada wrecks, are worth quoting at length for their horror-movie stylings:

> Such objects, on being exposed to the atmosphere, became highly unstable. Oxidisation set in so fiercely that in some instances [cannon] balls became hot and began disintegrating before our eyes. Even apparently well preserved samples did not remain unaffected for long.

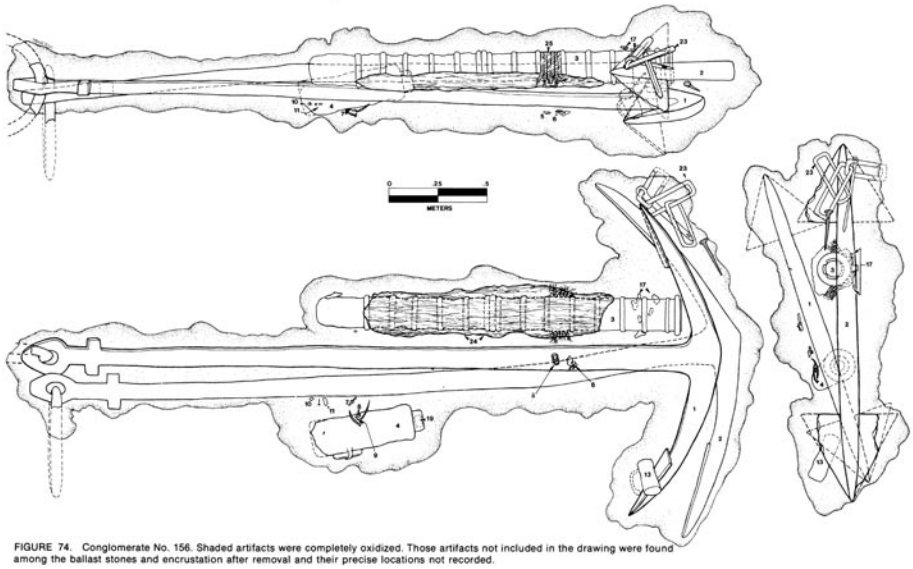


FIGURE 74. Conglomerate No. 156. Shaded artifacts were completely oxidized. Those artifacts not included in the drawing were found among the ballast stones and encrustation after removal and their precise locations not recorded.

1 Wrought iron anchor.
2 Wrought iron anchor.
3 Wrought iron bombard cannon.
4 Hooped barrel breech chamber, 2 ring.
5 Brass buckle.
6 Glass rim sherd and fragments.
7 Decorative brass fragments.
8 Obsidian blades.
9 Brass sheath for straight pins.
10 Square quartz bead.
11 Obsidian blade.
12 Two olive pits.
13 Wrought iron verso breech chamber.
14 Two cockroach exoskeletons.
15 Wood fragments.
16 Iron ring.
17 Resin.
18 Five potsherds (two vessels).
19 Wooden plug from verso breech chamber.
20 Cockroach exoskeleton.
21 Cloth fragment.
22 Potsherd.
23 Oxidized iron chain and bolt, discarded.
24 Wooden carriage from bombard.
25 Cockroach egg cases found under rope lashings.
26 Ballast stones.

> Keeping them in water held the decay in check, but it was not until Wignall and Casey between them constructed a vacuum chamber in which the iron could be impregnated with stabilising chemicals that the problem was finally solved.[110]
>
> Anything made of metal, other than gold or lead, that has spent a long period of time in the sea, requires very delicate preservation, as does anything made from an organic material (such as bone, leather, or wood). Otherwise, as soon as they come into contact with the air, they are swiftly and totally destroyed. An iron cannon ball, for example, just out of its gangue of oxide and sand, looks as good as new, black and perfectly round. Once exposed to the air, it turns brown in a matter of minutes, red in an hour, and after a few days the changes in temperature and humidity in the atmosphere cause it to crack and scale, and sweat great drops of brown liquid. After two weeks it begins to erupt in blisters and the whole of its outer layer flakes off. After another month or two all that will be left of the ball will be a shapeless little mound of rust. The same process occurs over a longer period with iron cannons and anchors. . . . Protected from erosion and borers by mud and sand, a wooden pulley block or figurehead may have remained in perfect condition. But without treatment the fibres of the wood will contract as it dries out. It will warp and crack, lose its shape and finally disappear to nothing. As the water seeps out, the destroyed cells of the wood collapse completely if left unsupported (briefly the treatment consists in replacing the water in the wood with polyethylene glycol to keep the fibres in shape). This is why bringing things up from a wreck, as souvenir hunting divers sometimes do, is effectively to destroy them.[111]

The problems involved in preserving waterlogged wooden hulls led the excavators of the Mediterranean Zakynthos wreck to experiment with underwater methods of preservation to defend in situ against the vagaries of shifting sands and ravenous parasites.[112]

The term *sea-change* comes from the most famous early modern meditation on storms, shipwrecks, and Mediterratlantic navigation: Shakespeare's *The Tempest* (1611). Early in act 1, the spirit Ariel appears to Ferdinand, washed-ashore shipwreck survivor. He and his kingly father, Alonso, were returning to Milan from North Africa (where Ferdinand's sister had married the King of Tunis) when a magically conjured storm drove their ship to Bermoothes (Bermuda). Ferdinand assumes his father died in the shipwreck, and this belief is encouraged by Ariel's song, which proclaims that the drowned king's body had already become one with the sea:

Three views of conglomerate no. 156 from the wreck of the *San Esteban*, sank 1554. Drawing by Edwina Traverso. Courtesy the Texas Antiquities Committee.

Full fadom five thy Father lies,
Of his bones are Corall made
Those are pearles that were his eies,
Nothing of him that doth fade,
But doth suffer a Sea-change
Into something rich, & strange.
Sea Nimphs hourly ring his knell
Harke now I heare them, ding-dong bell.[113]

In fact, however, no one died in the magical storm, and Ferdinand's father was safely ashore on another part of the island. I bring up Ariel's song not simply because it is the source of the idea of a sea-change, but because the sea-change it describes is a lie. Ariel's lyrics are an unreliable guide for understanding what lies on the ocean floor. And this brings us to a final refractive theme in shipwreck interpretation: the gaps that often exist between the alphabetic archival record on land, and the aquatic archival record beneath the waves.

In transatlantic shipping, at least, goods were subject to various taxes. To levy those taxes and to monitor what was being carried to and fro, all Spanish ships were to create a register of their cargoes before departure. Actually two registers: one to carry onboard and a copy to be sent on another ship in case disaster struck.[114] Hundreds of these documents are preserved today in Seville's Archive of the Indies, and they have often been used in tandem with shipwreck archaeology. Registries of gun weights and silver bars, for example, allowed a positive identification of the *Atocha*, as well as several Armada wrecks.[115]

But ship registers do not always correspond to what is found on the seabed, and one reason is smuggling. This is hardly news: the practice is mentioned at least as early as the sixteenth century. Contraband goods could be hidden in plain sight, something revealed when early modern inspectors compared a ship's register with its actual contents. Alternatively, illegal imports might be squirreled away in unexpected places. Fascinating exposés write of gold bars concealed in baskets of cacao or among a ship's ballast stones, as well as coins smuggled in water jars or the hollowed-out heels of shoes.[116] Similar practices are documented underwater: a false-bottomed chest with a cache of silver coins was discovered in the wreck of the *Asunción* (1641).[117]

The contrast between what we learn from documents and what excavation reveals is a central issue in historical archaeology overall, and perhaps the most exciting things we can learn from shipwrecks have to do with past practices that no one bothered to write about. For example, we have surprisingly few documents about the construction of early modern ships.[118]

***Solaris*, dir. Andrei Tarkovsky, 1972. Frame enlargement. 02:13:41.**

These wooden machines were the product of centuries of handed-down knowledge and practical craftsmanship, little of which was ever recorded on paper.[119] The excavation of shipwrecks allows us to recover centuries-old skills. Publications on early modern underwater archaeology often contain lovingly drafted, board-by-board line drawings of the shattered fragments of ship's hulls.[120] In some cases, these carefully studied fragments act like the drowned seeds from the *Atocha* that sprouted when brought to the surface: that is, fragments of shipwrecks are used to reconstruct entire vessels—on paper and sometimes even in wood.[121] One of the greatest treasures that underwater archaeology can recover is thus not gold or silver but sedimented knowledge: the long-forgotten carpentry skills of long-dead shipwrights. These fossilized skills are not just those used to build vessels anew. Often wrecked ships had been *repaired* many times before their final demise, and so early modern patching techniques can also be recovered from the watery depths. One of the Padre Island vessels, for example, had a hull mended with strips of cloth, which were then sealed over with nailed-down strips of lead. Analysis of those textiles showed them to be woven from American agave fibers, revealing the incorporation of New World materials into long-established nautical techniques.[122]

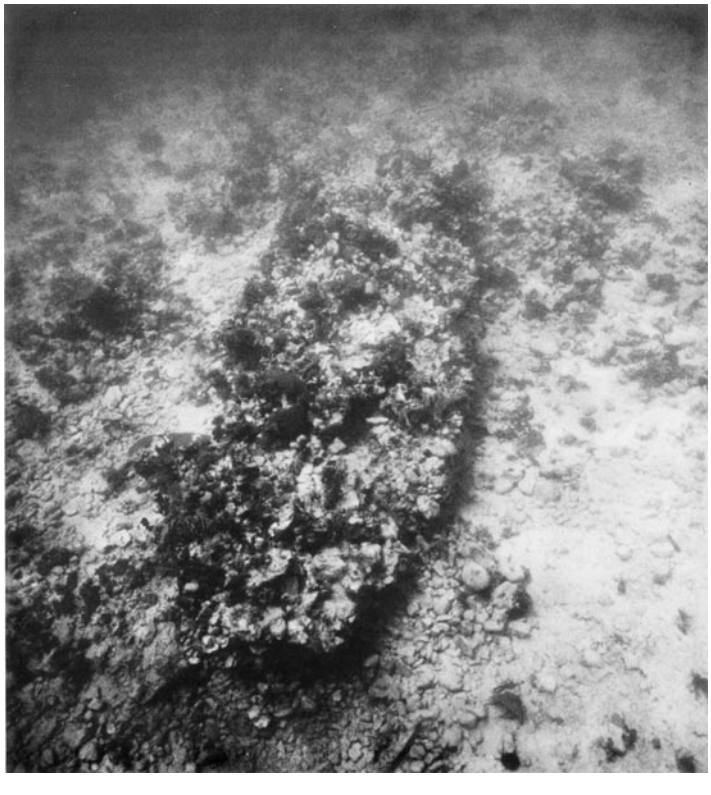
But by far the most poetic information that can be recovered from sunken ships—information totally absent from the alphabetic record—is connected to a ship's ballast.

The massive sails of early modern vessels made them extremely top-heavy, prone to capsize. To counterbalance this, the hulls of ships were filled with ballast—usually stones—and this weight lowered a vessel's center of gravity.[123] Since wooden hulls could not be sealed completely, their stone-filled holds would slowly fill with water. In other words, early modern ships carried at their core a kind of portable archipelago. Internal flooding was kept in check by regular pumping. Since accumulated hold water was mixed with trash and refuse that trickled down from the upper decks, these internal seas were usually rancid, and so operating the pumps was a hated chore.[124] The smell was difficult to escape, as both Mediterranean and Atlantic travelers complained. Friar Antonio de Guevara, writing of Mediterranean galley travel in 1539, advises that before setting sail "perfumes should be obtained, scented oil, sweetgum, liquidambar, or aloes, if not a good pomander, because many times it happens that such a great stink emerges from the pump of the galley that without carrying some-

thing else to smell it makes one dizzy and causes vomiting."[125] Eugenio de Salazar, in a scathingly sarcastic letter about transatlantic travel from 1573, says of pumped holdwater that "neither the tongue nor throat want to taste it, nor the nostrils smell, nor even the eyes see, because it comes out foaming like hell, and reeking like the devil."[126]

When a ship sank, and its upper structure rotted away, these internal archipelagos became cairns, stone memorials marking the vessel's final resting place. Ballast piles can perfectly replicate the phantasmal outlines of a vanished hold. For this reason, ballast often aids the search for wreck sites.[127] The massive piles of stone also help protect a ship's wooden underside from the ravenous appetites of underwater parasites. One of the main reasons we can use shipwrecks to study early modern carpentry is because that carpentry was shielded from harm by tons of rock.

But for all their functionality—counterbalancing sails, marking wreck sites, preserving wood—ballast stones are also eloquent witnesses to a ship's accumulated travels. When a ship was built—wherever it was built—its hold would be filled with "permanent ballast": massive stones that, in theory, would form the core of a vessel's counterweight for years to come. Over the course of many journeys, stones would be added to or removed from the initial core to adjust for the weight of cargo. In theory, this meant that as a ship traveled hither and yon, the stones in its hold would gradually build up a lithic archive of the many ports to which that ship had called.[128] In practice, things were a bit messier. Because hold space was so disgusting, all of a ship's ballast stones would sometimes be removed and dumped on a beach for the tides to clean—a process called rummaging.[129] In major ports, this could mean that beaches became lithic museums, scattered with rocks from far and wide—and so, after rummaging, a hold might



Ballast pile of the early sixteenth-century shipwreck in Highborn Cay, Bahamas, as seen in the 1980s. Photo by Dennis Denton.

be filled with stones from lands never visited by the ship in question. However, by paying attention to the dominant patterns of rock origins in ballast piles, archaeologists are able to reconstruct the major ports of call through which a ship passed before its final, interrupted journey. Donald H. Keith's 1977 dissertation was a trailblazing study of the ballast pile of the early sixteenth-century Molasses Reef wreck. Final analysis revealed the presence of diagnostic stones from south-central Lisbon, Lisbon or eastern Spain, and the Azores, Madeira, or Canary Islands.[130] In contrast, 55 percent of the ballast in the Studland Bay wreck came from Basque country—meaning that this ship had, at the very least, sailed from Spain's northern coast and down to Seville before making its final doomed voyage to England.[131] The ballast from another Basque ship—the *San Juan*, a whaler that sank off Canada in 1565—consisted mostly of Basque country limestone, but 15 percent was stone from North America.[132] The construction techniques of the Emanuel Point I wreck (1559) also suggest a Basque origin, but most of its sampled ballast can be traced to the Caribbean. In contrast, several samples from the Emanuel Point II wreck (also 1559) come from the Azores, Canary, or Cape Verde Islands.[133] And the ballast of the Bay-of-Biscay-wrecked *Santiago de Galicia* (1596) included volcanic stones from its site of construction in the Neapolitan shipyard of Castellammare di Stabbia, just down the coast from Vesuvius.[134] Ballast, then, is a perfect example of how the passage of Mediterratlantic time can be physically sedimented in material objects: the assemblages of rock carried in the holds of ships.[135]

Conclusions: Mediterratlantic Hydrographies and the Two Treaties of Tordesillas

Salt water was, and continues to be, a refractive medium for early modern navigation: bending spatiality at the surface of the waves and temporality beneath them. In logbook entries (composed day after day on an unstable surface where water met air) we find a bureaucracy of fantasy directed against the inevitable disorientations of open-water sailing, an indispensable but inadequate technical paperwork whose droning rhythms are punctuated by irruptions of wonder, terror, and repair. In the remains of shipwrecks (plunged by mechanical failure to a seabed topography of water over earth) we encounter strange wormholes linking ancient catastrophes to our present, waterlogged residues in which death is elusive and time capsules are only partially sealed, and where sea-changes and material histories of construction and repair and travel provide us with fragments of the past without parallel in terrestrial archives.

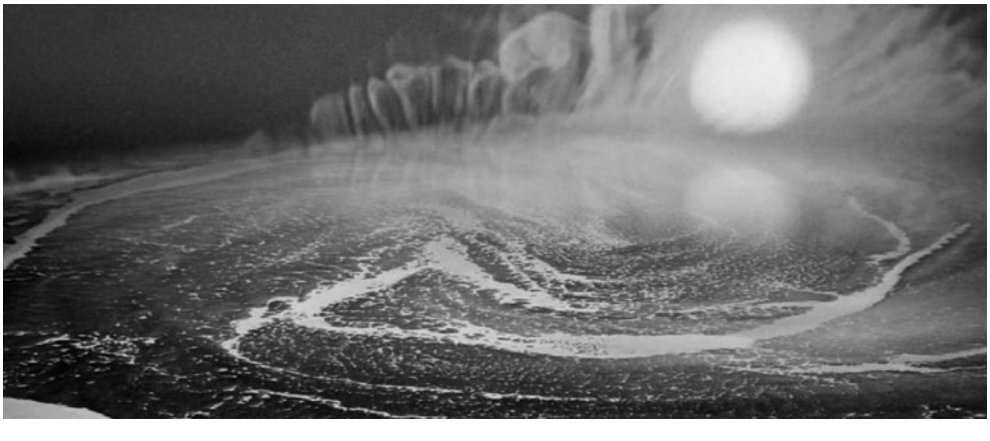
By way of conclusion, let us return to a map we looked at earlier—Diogo

Ribeiro's *Carta del navegare universalissima et diligentissima* (A most universal and thorough sailing chart; 1525)—and consider what it reveals about the generative refractions of Mediterratlantic salt water, both for navigation and for empire.

The liquid cartography of its central *MARE OCCEANVM* presents several striking homologies. The Caribbean to the west appears the same size as the Mediterranean to the east, and both are only slightly larger than the waters that connect the Bay of Biscay to the North and Baltic Seas (the map's *Mare germanicum* and *goticum mare*).[136] These marginal zones of the Mediterratlantic are comparable not only in scale, but also in terms of the advantages they offered for sailors. These were waters where the literal landmarks of coastlines and islands were never more than a week away—in some direction, somewhere. Wayfinding guidebooks (*derroteros*) on these tributary regions provided detailed instructions for sailing along established watery "roads" (*caminos*) linking one landfall to another: from Nombre de Dios to Cartagena to Havana, or from Crete to Cyprus to Tripoli to Oran, or from Bayonne to Brittany.[137] The Atlantic world just west of the Strait of Gibraltar was a point of overlap for both Mediterranean- and Caribbean-focused *derroteros*, with their sailing directions from Finisterre to Sanlúcar to the Cape Verde Islands, or from Oran through the Strait of Gibraltar and down to Cape Bojador.[138] But details dry up in the thousands of kilometers of open water between the Canary Islands and La Deseada, or between the Cape Verde Islands and Dominica: there was very little one could say.[139] Thus although the same basic techniques of bureaucratic navigation were used across all of these connected waterforms, this was not a homogenous expanse so far as the durations of navigational ambiguity were concerned. How long you might travel without being quite sure where you were was comparable in both the "Atlantic" Caribbean and the Mediterranean, but was something else entirely halfway between those two basins.

Just to the right of where the map's Caribbean islands begin flutters a vertical banderole: it marks the *LINEA DELA PARTICION*, a division decreed by the Treaty of Tordesillas on June 7, 1494. That document created an abstract border between Spanish and Portuguese empires: a "straight line, from pole to pole, from the Arctic pole to the Antarctic pole, which is from the north to the south . . . 370 leagues west of the Cape Verde Islands."[140]

This agreement and its meridian are infamous: their hubris fits the feel-bad-feel-good kind of history the contemporary West likes to narrate about



brash Euro-American impositions across the globe over the past five centuries. By itself, this treaty seems to tell an Atlantic story that gestures to an unknown world "beyond the line." But there is a second Treaty of Tordesillas as well, signed on the same day as the first in the same small town, and this usually ignored document has many implications for how we understand its far more famous twin. The political geometry of the two Treaties of Tordesillas is one in which separating Atlantic and Mediterranean histories makes little sense.[141] Together, the two treaties reveal the properly Mediterratlantic ambitions of Iberian powers at the end of the fifteenth century—ambitions that in the years and decades that followed involved conquests not only across the Atlantic but across the Mediterranean as well.

Where the first treaty drew an abstract line across the ocean, and spoke generally of jurisdiction over lands "discovered and to be discovered" on either side of that line, the second treaty was far more concrete in both implementation and implications. It involved two issues. First was a disagreement over Atlantic fishing rights along the coast of Africa from Cape Bojador south to the River of Gold (the latter located along the Tropic of Cancer, the uppermost horizontal line across Diogo Ribeiro's map). Second were the eastern and western limits of the Wattasid kingdom of Fez, rights of conquest to which Spain had ceded to Portugal in the 1479 Treaty of Alcáçovas. In 1494, fishing rights were given to Portugal. The eastern border of Fez was decreed to begin at the "limits of Cazaza," a Mediterranean town about 350 kilometers east of the Strait of Gibraltar. The western border of Fez, in contrast, could not be determined by the Iberians, so they agreed on the limits of the Atlantic town of Massa (about 500 kilometers north of Cape Bojador).[142]

One reason the (first) Treaty of Tordesillas could be so abstract was a lack of familiarity with geographies and societies on the other side of the Atlantic. (Perhaps accidentally, the Tordesillas line "granted" to Portugal a large section of Brazil.) But that kind of blissful ignorance of facts-on-the-ground was not possible in Mediterratlantic Africa, as many details of the second treaty reveal. Its points of division are all concrete: town limits, a cape, a river.[143] Although fishing rights were taken by Portugal, Spain was still allowed to launch military strikes (read: retaliations against piracy and slave-raiding) on coastal Muslim communities in the disputed zone.[144] The second treaty also notes that the western border question might be answered "in the city of Fez"; that is, by Muslim experts on political geometry.[145] Spaniards and Portuguese were well aware that their imperial ambitions in Africa did not involve a blank slate. They would soon learn this was true in the Americas as well.

And at the same time Spain's representatives were attempting to impose

***Solaris*, dir. Andrei Tarkovsky, 1972. Frame enlargement. 02:21:24.**

new political geometries across the Atlantic, they were doing the same thing across the Mediterranean. After Tordesillas, a series of conquests moved east from Cazaza: Melilla in 1497 (Spanish territory to this day), Oran in 1509, Algiers and Bougie and Tripoli in 1510, Tunis in 1535.[146] But the violence of these eastward invasions respected no line of amity separating Europe from Africa. The Kingdom of Naples was conquered in 1504, and remained a viceroyalty ruled from Spain until the eighteenth century.

Notes

Thanks to my fellow *Grey Room* editors for their transformative comments; to Jane Downing of the National Museum of Bermuda for help with photographs of the museum's war club and club fragment; to Bernadette Walsh of the Tower Museum (Derry, Northern Ireland) and Stephen Weir of National Museums Northern Ireland for help with a photograph of the navigational dividers from the *Trinidad Valencera*; to Matthew Hunter for assigning Jeff Wall's "Photography and Liquid Intelligence" at a 2009 meeting of the Clever Object project in London; to Elizabeth Davis for her seminar on Seville and the Atlantic world; to Roger C. Smith for his expertise in underwater archaeology and shipwrecked books; and to Dana Leibsohn for first making me aware of Pedro de Ledesma's underwater images.

1. "Insigne cosa es, y muy notable en España, estar rodeada de dos mares tan grandes y tan diversos, como son el Oceano y Mediterraneo. Virgilio co[n]to entre las otras excelencias de Italia, estar cercada de dos mares Tyrrheno y Adriatico, que son vnas pequeñas partes del Mediterraneo. Nuestra España tiene casi por yguales partes la grandeza de todo este mar, juntamente con la immensidad del Oceano, con la diuision de su estrecho de Gibraltar, donde ambos mares se juntan y se apartan: siendo vna de las mas señaladas cosas, que en el sitio de todo el vniuerso se halla: mezclando por alli naturaleza el Oriente con el Occidente, y diuidiendo tan de veras en España el mundo, que creyeron los sabios antiguos, ser alli el fin del." Ambrosio de Morales, *Las antigvedades de las civdades de España* (Alcalá de Henares: Juan Iñiguez de Lequeríca, 1577), 48v–49r.

2. Sanjay Subrahmanyam, "Afterthoughts: Histories in Bottles," in *The Sea: Thalassography and Historiography*, ed. Peter N. Miller (Ann Arbor: University of Michigan Press, 2013), 282.

3. Jeff Wall, "Photography and Liquid Intelligence," in *Jeff Wall*, ed. Thierry de Duve, Arielle Pelenc, and Boris Groys (London: Phaidon, 1996), 90.

4. Although accounts of this revival (by historians) usually start in 1997, even more important from a media-archaeological perspective is 1995, which saw the publication of two brilliant (and still must-read) books: Allan Sekula, *Fish Story* (Düsseldorf: Richter Verlag, 1995); and Edwin Hutchins, *Cognition in the Wild* (Cambridge: MIT Press, 1995). Two years later, the Ford Foundation–funded, area studies–rescuing "Oceans Connect" project began at Duke University (www.duke.edu/web/oceans), and that same spring in Paris another conference compared the Mediterranean and Indian Ocean worlds. Papers from the Paris conference were published the following year. See Claude Guillot, Denys Lombard, and Roderich Ptak, with the assistance of Richard Teschke, eds., *From the Mediterranean to the China Sea* (Wiesbaden: Harrassowitz Verlag, 1998). Papers from "Oceans Connect" appeared in the *Geographical Review* in April 1999: Kären Wigen and Jessica Harland-Jacobs, "Guest Editors' Introduction," *Geographical Review* 89, no. 2 (1999): ii; Jerry H. Bentley, "Sea and Ocean Basins as Frameworks of Historical Analysis," *Geographical Review* 89, no. 2 (1999): 215–224; and Martin W. Lewis, "Dividing the Ocean Sea," *Geographical Review* 89, no. 2 (1999): 188–214. See also Rainer F. Buschmann, "Oceans of World History," *History Compass* 2, no. 1 (2004): 1–10. The year 2000 was marked by two more conferences and a key publication. In the spring, a conference on maritime history and world history was held in Salem, Massachusetts—published as Daniel Finamore, ed., *Maritime History as World History* (Salem, MA: Peabody Essex Museum; Gainesville: University Press of Florida, 2004)—followed later that summer by a conference on oceanic history in Greifswald, Germany, published as Bernhard Klein and Gesa Mackenthun, eds., *Sea Changes: Historicizing*

***Solaris*, dir. Andrei Tarkovsky, 1972. Frame enlargement. 02:26:30.**

the Ocean (New York: Routledge, 2004). The same millennial year also saw the release of Peregrine Horden and Nicholas Purcell's mammoth *The Corrupting Sea: A Study of Mediterranean History* (Oxford, UK: Blackwell, 2000), the effects of which continue to be felt in various disciplines. The following year, for example, Columbia University's Center for the Ancient Mediterranean organized a conference at which (judging from the associated volume published in 2005) Horden and Purcell's opus was a constant point of reference. See William V. Harris, ed., *Rethinking the Mediterranean* (Oxford, UK: Oxford University Press, 2005). In 2002, David Armitage published an inspiring and much-cited meditation on the multiplicity of ways in which Atlantic history can be imagined: "Three Concepts of Atlantic History," in *The British Atlantic World, 1500–1800*, ed. David Armitage and Michael J. Braddick (Basingstoke, UK: Palgrave Macmillan, 2002), 11–29. That same year in May, the Volkswagen Foundation funded the creation of a multiyear project on "The East Asian 'Mediterranean,' c. 1500–1800," which ended in 2009. See Peter N. Miller, ed., *The Sea: Thalassography and Historiography* (Ann Arbor: University of Michigan Press, 2013), 7. In 2005 (in addition to Harris's *Rethinking the Mediterranean*), Bernard Bailyn published his concise *Atlantic History: Concept and Contours* (Cambridge: Harvard University Press, 2005). In 2006, Jorge Cañizares-Esguerra and Erik R. Seeman coedited *The Atlantic in Global History, 1500–1700* (Upper Saddle River, NJ: Pearson Prentice Hall, 2007). This was also a banner year for journal special issues. In the spring, *Worldviews* published an issue on the anthropology of "fluidscapes" that includes Yoshitaka Ota, "Fluid Bodies in the Sea: An Ethnography of Underwater Spear Gun Fishing in Palau, Micronesia," *Worldviews* 10, no. 2 (2006): 205–219; and Martina Tyrrell, "From Placelessness to Place: An Ethnographer's Experience of Growing to Know Places at Sea," *Worldviews* 10, no. 2 (2006): 220–238. In June, the *American Historical Review* included a special section on "Oceans of History": Kären Wigen, "Introduction, *AHR Forum*: Oceans of History," *American Historical Review* 111, no. 3 (2006): 717–721; and Alison Games, "Atlantic History," *American Historical Review* 111, no. 3 (2006): 741–757. In July followed a special issue on "Historical Geographies of the Sea" in the *Journal of Historical Geography*, including David Lambert, Luciana Martins, and Miles Ogborn, "Currents, Visions, and Voyages: Historical Geographies of the Sea," *Journal of Historical Geography* 32, no. 3 (2006): 479–493. And in October, the *William and Mary Quarterly* published a "Beyond the Atlantic" special issue that included Peter A. Coclanis, "Atlantic World or Atlantic/World?," *William and Mary Quarterly*, 3rd ser., 63, no. 4 (2006): 725–742; and Alison Games, "Beyond the Atlantic," *William and Mary Quarterly*, 3rd ser., 63, no. 4 (2006): 675–692. The next year, 2007, saw the creation of an Indian Ocean World Centre at the History Department of McGill University (and afterward at Witwatersrand and Avignon), as well as the first in a series of major exhibitions on the maritime world: Jay A. Levenson, ed., *Encompassing the Globe: Portugal and the World in the 16th and 17th Centuries* (Washington, DC: Arthur M. Sackler Gallery, Smithsonian Institution, 2007). In 2009, the four-hundredth anniversary of the transatlantic voyage that created the settlement of New Amsterdam was commemorated in New York with an exhibition at the New-York Historical Society and a conference at the Bard Graduate Center; the conference papers were published in 2013 (Miller, xi; Subrahmanyam). In 2010, the Peabody Essex Museum organized an aquatic exhibition on pre-Hispanic Mesoamerica: Daniel Finamore and Stephen D. Houston, eds., *Fiery Pool: The Maya and the Mythic Sea* (Salem, MA: Peabody Essex Museum; New Haven, CT: Yale University Press, 2010). The same year in May, the *Publications of the Modern Language Association* included a special "Theories

and Methodologies" section of ten articles on oceanic studies, and Margaret Cohen published *The Novel and the Sea* (Princeton, NJ: Princeton University Press, 2010). This was also a moment of acceleration for media-archaeological studies of the watery, themes Bernhard Siegert had been exploring since at least 2004 in his "Ort ohne Ort: Das Schiff" (Place without place: The ship) project (https://www.ifk.ac.at/fellows-detail-en/bernhard-siegert.html). See also Bernhard Siegert, *Passagiere und Papiere: Schreibakte auf der Schwelle zwischen Spanien und Amerika* (Munich: Wilhelm Fink, 2006); Bernhard Siegert, "Waterlines: Striated and Smooth Spaces as Techniques of Ship Design" (2011), in *Cultural Techniques: Grids, Filters, Doors, and Other Articulations of the Real*, trans. Geoffrey Winthrop-Young (New York: Fordham University Press, 2015), 147–163; Eric C.H. de Bruyn "Uneven Seas: Notes on a Political Ecology of Maritime Space, Part 1," *Einunddreissig: Das Magazine des Instituts für Theorie*, no. 16/17 (2011): 84–100; Vilém Flusser and Louis Bec, *Vampyroteuthis Infernalis: A Treatise, with a Report by the Institut Scientifique de Recherche Paranaturaliste* (1987), trans. Valentine A. Pakis (Minneapolis: University of Minnesota Press, 2012). On 25 October 2013 (six months to the day, my files reveal to me, after I began researching this article in earnest), Matthew C. Hunter convened a two-day conference at McGill University on "Liquid Intelligence and the Aesthetics of Fluidity," results from which were later published in this journal: Matthew C. Hunter, "Curve, Line, Circle, Slash, Cross; A Diagram of Liquid Intelligence," *Grey Room*, no. 69 (2017): 6–23; and Matthew C. Hunter, "The Cunning of Sir Sloshua: Reynolds, the Sea, and Risk," *Grey Room*, no. 69 (2017): 80–107. And the flow has continued uninterrupted. Earlier iterations of my own project were presented in 2014 (at the "Iberian Encounters in Africa and the New World: Nodes and Networks II" session of the Renaissance Society of America Meetings, and for the "Renaissances Project: Nodes, Networks, Names: Recovering, Understanding, Representing Them" at Stanford University; thanks to Cammy Brothers and Roland Greene) and 2015 (as the Carroll Lecture in Archaeology at George Washington University; thanks to Jeff Blomster). Published works from 2014 onward include Dave Arnold, *Liquid Intelligence: The Art and Science of the Perfect Cocktail* (New York: W.W. Norton, 2014); Eric C.H. de Bruyn, "Beyond the Line, or a Political Geometry of Contemporary Art," *Grey Room*, no. 57 (2014): 24–49; Bernhard Siegert, "The *Chorein* of the Pirate: On the Origin of the Dutch Seascape," *Grey Room*, no. 57 (2014): 6–23; Bernhard Siegert, "Kapitel 55: Of the Monstrous Pictures of Whales," *Neue Rundschau* 125, no. 1 (2014): 223–233; Bernhard Siegert, "Medusas of the Western Pacific: The Cultural Techniques of Seafaring," in *Cultural Techniques: Grids, Filters, Doors, and Other Articulations of the Real*, trans. Geoffrey Winthrop-Young (New York: Fordham University Press, 2015), 68–81; Nicole Starosielski, *The Undersea Network* (Durham, NC: Duke University Press, 2015); Peter Godfrey-Smith, *Other Minds: The Octopus, the Sea, and the Deep Origins of Consciousness* (New York: Farrar, Straus and Giroux, 2016); Christina Wessely, "Watery Milieus: Marine Biology, Aquariums, and the Limits of Ecological Knowledge circa 1900," *Grey Room*, no. 75 (2019): 36–59; and Melody Jue, *Wild Blue Media: Thinking through Seawater* (Durham, NC: Duke University Press, 2020). Literally immersive artistic projects also appeared in this decade, including Lucien Castaing-Taylor and Véréna Paravel's *Leviathan* (2012), Simon Starling's *Infestation Piece: Mussled Moore* (2014; http://ago.ca/media/1994), and Ursula Biemann's *Subatlantic* (2015) and *Acoustic Ocean* (2018). Finally, the emergence of elemental media studies has also been fundamental for my project. See John Durham Peters, *The Marvelous Clouds: Toward a Philosophy of Elemental Media* (Chicago: University of Chicago Press,

2015); Eva Horn, "Air as Medium," *Grey Room*, no. 73 (2018): 6–25; Matthew C. Hunter, *Painting with Fire: Sir Joshua Reynolds, Photography, and the Temporally Evolving Chemical Object* (Chicago: University of Chicago Press, 2020); and Emily Doucet, Matthew C. Hunter, and Nicholas Robbins, "Editors' Introduction: The Aerial Image," *Grey Room*, no. 83 (2021): 6–23.

5. See also Allan Sekula, "Between the Net and the Deep Blue Sea (Rethinking the Traffic in Photographs)," *October*, no. 102 (2002): 3–34.

6. Walter H. Munk et al., "The Heard Island Feasibility Test," *Journal of the Acoustical Society of America* 96, no. 4 (1994): 2,330–2,342.

7. Games, "Atlantic History," 745. See also W. Jeffrey Bolster, "Putting the Ocean in Atlantic History: Maritime Communities and Marine Ecology in the Northwest Atlantic, 1500–1800," *American Historical Review* 113, no. 1 (2008): 21 ("one area of inquiry remains largely absent from Atlantic history: the ocean itself"). Among the color-coded Atlantics of migration and diaspora (for which salt water provides a backgrounded framework of connections and circulations), Jace Weaver engages most extensively with the ocean: *The Red Atlantic: American Indigenes and the Making of the Modern World, 1000–1927* (Chapel Hill: University of North Carolina Press, 2014). See also Paul Gilroy, *The Black Atlantic: Modernity and Double Consciousness* (Cambridge: Harvard University Press, 1993); and Kevin Whelan, "The Green Atlantic: Radical Reciprocities between Ireland and America in the Long Eighteenth Century," in *A New Imperial History: Culture, Identity and Modernity in Britain and the Empire, 1660–1840*, ed. Kathleen Wilson (Cambridge, UK: Cambridge University Press, 2004), 216–213.

8. David Abulafia, "Mediterranean History as Global History," *History and Theory* 50, no. 2 (2011): 220. See also David Abulafia, "Mediterraneans," in *Rethinking the Mediterranean*, ed. William V. Harris (Oxford, UK: Oxford University Press, 2005), 64.

9. Elizabeth B. Davis, "Travesías peligrosas: Escritos marítimos en España durante la Época Imperial, 1492–1650," in *Edad de oro cantabrigense: Actas del VII Congreso de la Asociación Internacional del Siglo de Oro*, ed. Anthony J. Close and Sandra María Fernández Vales (Vigo: AISO, 2006), 31. Even in literary analyses of seafaring novels, watery saturation can be quite uneven. Two classic examples include Cesare Casarino, *Modernity at Sea: Melville, Marx, Conrad in Crisis* (Minneapolis: University of Minnesota Press, 2002); and Cohen.

10. Jennifer L. Roberts, "Copley's Cargo: *Boy with Squirrel* and the Dilemma of Transit," *American Art* 21, no. 2 (2007): 22.

11. See also Lewis; Bentley, 221; Wigen, 720; Games, "Atlantic History," 742–43; and Coclanis. Although Felipe Fernández-Armesto structures his classic *Before Columbus: Exploration and Colonisation from the Mediterranean to the Atlantic, 1229–1492* (Philadelphia: University of Pennsylvania Press, 1987) with a "Part One: From the Mediterranean . . ." and a "Part Two: To the Atlantic," he never leaves the Mediterranean behind.

12. Fernand Braudel, *Capitalism and Material Life 1400–1800* (1967), trans. Miriam Kochan (New York: Harper and Row, 1973), 31. See also assertions of separation and difference in Bailyn, 4–5; and critiques in Elizabeth B. Davis, "From the *Mare Nostrum* to the *Mar Óceano* and Back: Oceanic Studies, Mediterranean Studies, and the Place of Poetry," *Calíope* 19, no. 1 (2014): 196–216.

13. Fernand Braudel, *The Mediterranean and the Mediterranean World in the Age of Philip* II, 2nd ed. (1966), trans Siân Reynolds (New York: Harper and Row, 1976), 106; and

Pablo Emilio Pérez-Mallaína, *Spain's Men of the Sea*, trans. Carla Rahn Phillips (Baltimore: Johns Hopkins University Press, 1998), 137. Braudel presents the biographies of ships, but human biographies also connected these two bodies of water. For the story of Ourehouaré, a Cayuga chief who served as a Mediterranean galley slave for two years in the late 1680s (along with other Native American prisoners of war), see Weaver, 62–64.

14. Various eighteenth-century developments in nautical practices (and the archives that document them) partially explain my article's chronological focus on an earlier period. Changes include transformations in ship design early in the century, new technologies for longitude calculation and copper hull sheathing in its second half, and an exponential increase in surviving logbooks. See Trevor Kenchington, "The Structures of English Wooden Ships: William Sutherland's Ship, circa 1710," *The Northern Mariner/Le Marin du nord* 3, no. 1 (1993): 30; Eric Rieth, "A Similar Atlantic and Mediterranean Ship Design Method: The Case of the French Royal Dockyards at the End of the XVIIth Century," in *Shipbuilding Practice and Ship Design Methods from the Renaissance to the 18th Century: A Workshop Report*, ed. Horst Nowacki and Matteo Valleriani (Berlin: Max Planck Institute for the History of Science, 2003), 80; Ricardo Borrero Londoño, "Archaeology of 17th-Century Iberian Shipwrecks: Reassessment and Comparison of Excavated, Recorded, and Published Hull Remains," *International Journal of Nautical Archaeology* 49, no. 1 (2020): 157, 175–176; Dava Sobel and William J.H. Andrewes, *The Illustrated Longitude* (New York: Walker, 1996); and Ricardo García Herrera et al., "Understanding Weather and Climate of the Last 300 Years from Ship's Logbooks," *WIREs: Climate Change* 9, no. 6 (2018): 2 (see also n. 29 below).

15. See also Peregrine Horden and Nicholas Purcell, "*AHR Forum*: The Mediterranean and 'the New Thalassology,'" *American Historical Review* 111, no. 3 (2006): 723 ("it is more enticing in many ways to propose less familiar, and sometimes smaller, maritime spaces"); and Davis, "From the *Mare Nostrum* to the *Mar Óceano* and Back."

16. Treatises include Pedro de Medina, *Arte de nauegar* (Valladolid: Francisco Fernández de Córdoba, 1545); Martín Cortés, *Breve compendio de la sphera y arte de navegar* (Seville: Casa de Antón Álvarez, 1551); Pedro de Medina, *Regimiento de nauegacion* (Seville: Simón Carpintero, 1553); Juan Escalante de Mendoza, *Itinerario de navegacion de los mares y tierras occidentales* (1575; Madrid: Museo Naval, 1985); Andrés de Poza, *Hydrografia: La mas cvriosa qve hasta aqvi ha salido a luz*, 2 vols. (Bilbao: Mathías Mares, 1585); Rodrigo Zamorano, *Compendio del arte de navegar* (Seville: Juan de León, 1588); Andrés García de Cespedes, *Regimiento de navegacion* (Madrid: Juan de Cuesta, 1606); and Lázaro de Flores, *Arte de navegacion astronomica, theorica y practica* (Madrid: Julián de Paredes, 1673). Letters and travelogues include Fray Antonio de Guevara, "De muchos trabajos que se pasan en las galeras, 1539," in *Pasajeros de Indias*, ed. José Luis Martínez (Mexico City: Fondo de Cultura Económica, 1999), 231–251; Eugenio de Salazar, "La mar descrita por los mareados, 1573," in *Pasajeros de Indias*, 294–317; Carla Rahn Phillips, *Life at Sea in the Sixteenth Century: The Landlubber's Lament of Eugenio de Salazar* (Minneapolis: University of Minnesota Press, 1987); and Antonio Vázquez de Espinosa, *Tratado verdadero del viaje y navegación*, ed. Sara L. Lehman (Newark, NJ: Juan de La Cuesta Hispanic Monographs Series, 2008). Courtroom proceedings are the basis for Pérez-Mallaína, *Spain's Men of the Sea*. See also Davis, "Travesías"; Pablo Emilio Pérez-Mallaína, "Los libros de náutica españoles del siglo XVI y su influencia en el descubrimiento y conquista de los océanos," in *Ciencia, vida y espacio en Iberoamérica*, vol. 3, ed. José Luis Peset (Madrid: CSIC, 1989),

457–484; and Martínez.

17. At least four ships sank en route during Vázquez de Espinosa's transatlantic journey from Veracruz to Cádiz in 1623. See Vázquez de Espinosa, 94–95, 97, 103, 144. On oceanic terror and its material residues, see Xabier Armendáriz, "Exvotos y ofrendas marineras en el País Vasco," *Itsas memoria: Revista de estudios marítimos del País Vasco* 6 (2009): 381–402; Davis, "Travesías peligrosas," 34; and Alain Corbin, *The Lure of the Sea* (Berkeley and Los Angeles: University of California Press, 1994), 1–53. See also Peters, 103 ("Boredom is the ever-present companion of the sailor, whose time, like that of a pilot or anesthesiologist, consists of long spells of boredom interrupted by moments of terror").

18. Marshall McLuhan and Quentin Fiore, *War and Peace in the Global Village* (New York: McGraw Hill, 1968), 175; Peters, 53–114, 389–392; Wessely; and Jue.

19. Jue, 29, 35–36, 40. See also Wessely, 43 (on the implications of a medial threshold "which quite concretely separates two media, namely water and air"); and Pérez-Mallaína, *Spain's Men of the Sea*, 63 (on ships as "the most complex machine of the epoch").

20. Michel Foucault, "Of Other Spaces" (1967), *Diacritics* 16, no. 1 (1986): 27; Sekula, *Fish Story*; de Bruyn, "Uneven Seas"; de Bruyn, "Beyond the Line"; Siegert, "*Chorein* of the Pirate"; Siegert, "Argonauts of the Western Pacific"; Hunter, "Cunning of Sir Sloshua"; Hans Blumenberg, *Shipwreck with Spectator: Paradigm of a Metaphor for Existence*, trans. Steven Rendall (1979; Cambridge: MIT Press, 1997); and Corbin, *Lure of the Sea*.

21. Munk et al.

22. Peters, 66–69, 84, 389–392.

23. Sy Montgomery, *The Soul of an Octopus: A Surprising Exploration into the Wonder of Consciousness* (New York: Atria, 2015), 127, 143; Ota, 210; Jue, ix–x; Harold V. Thurman and Alan P. Trujillo, *Introductory Oceanography: Tenth Edition* (Upper Saddle River, NJ: Pearson Prentice Hall, 2004), 398–401; and "Underwater Vision," *Wikipedia*, last edited on 6 May 2021, https://en.wikipedia.org/wiki/Underwater_vision.

24. See, for example, Roberts, 22; Luís Adão da Fonseca, "Prologue: The Discovery of Atlantic Space," in *Portugal, the Pathfinder: Journeys from the Medieval toward the Modern World, 1300–ca. 1600*, ed. George D. Winius (Madison, WI: Hispanic Seminary of Medieval Studies, 1995), 5–18; Siegert, "*Chorein* of the Pirate," 7–8; and Brian Patrick Jones, "Making the Ocean: Global Space, Sailor Practice, and Bureaucratic Archives in the Sixteenth-Century Spanish Maritime Empire" (Ph.D. diss., University of Texas at Austin, 2014), 174–269 (the "Oceans as Space" chapter).

25. The classic discussion is Branko Mitrović, "Leon Battista Alberti and the Homogeneity of Space," *Journal of the Society of Architectural Historians* 63, no. 4 (2004): 424–439. Siegert's observations on Dutch seascapes "based not on laws of mathematical geometry" are also important here. Siegert, "*Chorein* of the Pirate," 20. Open-water sailing need not be inherently disorienting, as revealed by the amazing techniques of sidereal-aquatic navigation developed by Pacific Islanders. See Hutchins, 65–95.

26. Flores, 242 ("Aunque este modo de echar punto en la carta es mas perfecto que el de Fantasia, con todo esto suele padecer alguna incertidumbre, por causa de no se saber bien, y con perfecion el rumbo por donde navega el Navio").

27. See Jones, 201–203. For early modern definitions of *fantasía*, see Sebastián de Covarrubias Orozco, *Tesoro de la lengua castellana o española* (Madrid: Luis Sánchez, 1611), 397v. The flexible relation of navigational understanding to position was a problem not only for early modernity: as Hutchins reveals, its complications survived to the thresh-

old of the twenty-first century. See n. 34.

28. *Solaris*, directed by Andrei Tarkovsky (1972; San Francisco: Kanopy Streaming, 2014), film (dialogue beginning at 00:12:54).

29. Columbus's logbook survives only as a copy (in the third person) by Bartolomé de las Casas. See Margarita Zamora, *Reading Columbus* (Berkeley and Los Angeles: University of California Press, 1993). The collection of *derroteros* in the Archivo General de Indias in Seville are all recopied summaries of journeys, not day-by-day accounts (AGI Contratación 4890, Derroteros 1564–1720). Previous scholarship on logbooks has used them to reconstruct weather patterns as well as sailing routes. Ricardo García-Herrera et al., "New Records of Atlantic Hurricanes from Spanish Documentary Sources," *Journal of Geophysical Research* 110, no. D3 (2005): 1–7; Alexis Lugo-Fernández et al., "Analysis of the Gulf of Mexico's Veracruz-Havana Route of *La Flota de la Nueva España*," *Journal of Maritime Archaeology* 2, no. 1 (2007): 24–47; and García Herrera et al, "Understanding Weather."

30. Samuel Eliot Morison, trans. and ed., *Journals and Other Documents on the Life of Christopher Columbus* (New York: Heritage Press, 1963), 57.

31. Some of these themes continue into the late eighteenth century, as attested by Captain Cook's logbooks from the 1770s. See Cohen, 15–58.

32. For an extended discussion of sixteenth-century Atlantic-Pacific connections, see Jones.

33. On the general rhythms of the trip to Portobelo, see Pérez-Mallaína, *Spain's Men of the Sea*, 10–14.

34. *Cognition in the Wild* is filled with luscious descriptions of pencils and paper maps and metal dividers marshaled to overcome a fundamental locational uncertainty in navigation that continued into the mid-1980s—ancient techniques all but overthrown a decade later with the arrival of consumer GPS. See Hutchins, 32–38, 46–48, 61–65, 124–126, 143–155, 159–163 (his brief but prescient comments on the then-future effects of GPS appear on pages 33 and 179).

35. Morison, *Journals*, 159–160.

36. Martín Fernández de Navarrete, *Colección de los viages y descubrimientos que hicieron por mar los españoles desde fines del siglo XV*, vol. 5, *Expediciones al Maluco. Viages de Loaisa y de Saavedra* (Madrid: Imprenta Nacional, 1837), 244.

37. Archivo del Museo Naval, Madrid (AMN), ms. 75 no. 50, 163v–164r.

38. Guevara, 239.

39. Michael E. Mallett, *The Florentine Galleys in the Fifteenth Century* (Oxford, UK: Clarendon Press, 1967), 220–221.

40. Fray Tomás de la Torre, *Diario del viaje de Salamanca a Ciudad Real, 1544–1545* (Burgos: Editorial Ope Caleruega, 1985), 63.

41. Pérez-Mallaína, *Spain's Men of the Sea*, 131. On galleys, see Luigi Monga, *The Journal of Aurelio Scetti, a Florentine Galley Slave at Lepanto (1565–1577)* (Tempe: Arizona Center for Medieval and Renaissance Studies, 2004), 9–13.

42. Guevara, 238–239 (lice and rats); Torre, 64 (lice); Salazar, 298 (lice, cockroaches, and rats); and Vázquez de Espinosa, 82, 110–114, 118, 128 (ratpocalypse). The underwater archaeology of rats and cockroaches is discussed in the second part of this article.

43. Mallett, 30; and Pérez-Mallaína, *Spain's Men of the Sea*, 153–157. See also Guevara, 241.

44. Guevara, 249. See also Pérez-Mallaína, *Spain's Men of the Sea*, 158–163.

45. W.G.L. Randles, "From the Mediterranean Portulan Chart to the Marine World Chart

of the Great Discoveries: The Crisis in Cartography in the Sixteenth Century," *Imago Mundi* 40, no. 1 (1988): 115.

46. Hutchins, 56, 192.

47. Hutchins, 107, 163; and Alison Sandman, "An Apologia for the Pilots' Charts: Politics, Projections and Pilots' Reports in Early Modern Spain," *Imago Mundi* 56, no. 1 (2004): 8, 17.

48. Hutchins, 90, 94, 103–106, 112; and Sandman, "An Apologia for the Pilots' Charts," 16.

49. Sandman, "An Apologia for the Pilots' Charts," 12; and Hutchins, 33–34.

50. Medina, *Arte de Navegar*, 30v ("vemos que las cartas de marear no son hechas en redondo sino en plano, pues del redondo al plano ay mucha diferencia"); Tony Campbell, "Portolan Charts from the Late Thirteenth Century to 1500," in *History of Cartography*, vol. 1, *Cartography in Prehistoric, Ancient, and Medieval Europe and the Mediterranean*, ed. David Woodward (Chicago: University of Chicago Press, 1987), 439–441; Piero Falchetta, "The Use of Portolan Charts in European Navigation during the Middle Ages," in *Europa im Weltbild des Mittelalters*, ed. Ingrid Baumgärtner and Hartmut Kugler (Berlin: Akademie Verlag, 2008), 469; and Sandman, "An Apologia for the Pilots' Charts," 8–13. Surviving examples of Mediterranean portolan charts, at least, seem never to have been used. See Kevin E. Sheehan, "Aesthetic Cartography," *Imago Mundi* 65, no. 1 (2013): 133–135.

51. Flores, 249. See also Medina, *Regimiento de nauegacion*, 9r, 12v, 42r, 62v; Poza, 1:12r, 14r, 33v, 39r; Zamorano, 41r–45r; and García de Cespedes, 97r–100r.

52. George F. Bass, ed., *A History of Seafaring Based on Underwater Archaeology* (New York: Walker, 1972), 257, 269; Robert Sténuit, *Treasures of the Armada*, trans. Francine Baker (New York: E.P. Dutton, 1973), 274; Colin Martin, *Full Fathom Five* (New York: Viking, 1975), plate 14; J. Barto Arnold III and Robert Weddle, *The Nautical Archaeology of Padre Island: The Spanish Shipwrecks of 1554* (New York: Academic Press, 1978), 254–255; Christie's, *Gold and Silver of the* Atocha *and* Santa Margarita*: Tuesday, June 14, and Wednesday, June 15, 1988* (New York: Christie's, 1988), 18, 167; and Borrero Londoño, 158. See also Siegert, "Waterlines," 155.

53. Campbell, 441; and Randles, 115. The multiple compass roses on this and other navigation charts make orientation lines always near at hand for plotting courses. See Hutchins, 143.

54. Mallett, 273. Hyères was a standard landmark on portolan maps, highlighted with a red dot (Campbell, 379).

55. Columbus received a copy of Florentine cosmographer Paolo dal Pozzo Toscanelli's Europe-to-Asia Atlantic map in the early 1480s, and probably used it to draft the chart he took with him on his first transatlantic journey. See Hermann Wagner, "Die Rekonstruction der Toscanelli-Karte vom J. 1474 und die Pseudo-Facsimilia des Behaim-Globus vom J. 1492," *Nachrichten von der Koniglichen Gesellschaft der Wissenschaften zu Gottingen*, *Philologisch-Historische Klasse* 1, no. 3 (1894): 208–312.

56. Morison, *Journals*, 57 (see also 61, 161–162, 166).

57. Morison, *Journals*, 172.

58. That different pilots in the same fleet could have widely divergent estimates of their position was often commented on by early modern authors. See Flores, 249; Salazar, 309; Alison Sandman, "Spanish Nautical Cartography in the Renaissance," in *The History of Cartography*, vol. 3, *Cartography in the European Renaissance*, ed. David Woodward (Chicago: University of Chicago Press, 2007), 1,102; and Jones, 170.

59. Barbara E. Mundy, *The Mapping of New Spain: Indigenous Cartography and the Maps of the* Relaciones Geográficas (Chicago: University of Chicago Press, 1996), 12–13; Sandman, "An Apologia for the Pilots' Charts"; Sandman, "Spanish Nautical Cartography in the Renaissance"; and Antonio Sánchez Martínez, "An Official Image of the World for the Hispanic Monarchy: The *Padrón Real* of the *Casa de la Contratación* in Seville, 1508–1606," *Nuncius* 29, no. 2 (2014): 389–438.

60. Louis-André Vigneras, "The Cartographer Diogo Ribeiro," *Imago Mundi* 16, no. 1 (1962): 76–83; Antonio Barrera-Osorio, *Experiencing Nature: The Spanish American Empire and the Early Scientific Revolution* (Austin: University of Texas Press, 2006), 43–44; and Antonio Sánchez Martínez, "Los artífices del *Plus Ultra*," *Hispania* 70, no. 236 (2010): 615–616.

61. Fernández de Navarrete, 245 (see also 243).

62. AMN, ms. 75 no. 50, 167v.

63. Morison, *Journals*, 50, 53.

64. Ilona Klein and Christopher Kleinhenz, "The Order of Santo Stefano in the Levant," *Viator* 21 (1990): 343.

65. AMN, ms. 75 no. 50, 177r–v.

66. On both of these modalities as "the remarkable," see Cohen, 23–24.

67. Morison, *Journals*, 52; and AMN, ms. 75 no. 50, 163r.

68. Mallett, 238. Swapping storm news was a common feature of saltwater conversation. Morison, *Journals*, 174.

69. Mallett, 268.

70. On storms, see Mallett, 240; and Morison, *Journals*, 163–166, 170, 173. On weather delays, see Mallett, 233, 246; Morison, *Journals*, 169–170; and Klein and Kleinhenz, 338, 344.

71. Mallett, 214–215.

72. Mallett, 226. Thanks to Christian Kleinbub, Robin Thomas, and, above all, Borja Franco Llopis for helping me decipher these accounts of damage and repairs.

73. Morison, *Journals*, 50–51, 170.

74. Fernández de Navarrete, 243, 261. On the translation of *adasta*, see James J. Pontillo, "Veintiséis neologismos del siglo XVI," *Boletín de filología* 28 (1977): 156. Vázquez de Espinosa describes the recycling of a shipwrecked mast to repair another ship (Vázquez de Espinosa, 100).

75. *Solaris* (dialogue beginning at 1:24:50).

76. Online resources for the world's shipwreck heritage include the Nautical Archaeology Digital Library (https://shiplib.org/index.php/shipwrecks/), the Institute of Nautical Archaeology (https://nauticalarch.org/), and Archéologie Sous-Marine: Musée d'Archéologie Nationale (https://archeologie.culture.fr/archeo-sous-marine/en).

77. Underwater explorations for the remains of Hernán Cortés's scuttled ships off the coast of Veracruz remain inconclusive: Chris Howell et al., "Tras los barcos de Hernán Cortés: Arqueología subacuática en la Villa Rica de la Vera Cruz," *Arqueología mexicana* 28, no. 164 (2020): 41–45.

78. Colin Martin, "*La Trinidad Valencera*," *International Journal of Nautical Archaeology and Underwater Exploration* 8, no. 1 (1979): 13–14; and Steven Birch and D.M. McElvogue, "*La Lavia*, *La Juliana* and the *Santa María de Vison*," *International Journal of Nautical Archaeology* 28, no. 3 (1999): 265–276.

79. Most projects described in Martín Almagro-Gorbea's overview of underwater archaeology in Spain involve wrecks from the ancient world. Martín Almagro-Gorbea, "La arqueología submarina hoy en España," in *La España oceánica de los siglos modernos y el tesoro submarino español*, ed. José Alcalá-Zamora Queipo de Llano (Madrid: Real Academia de la Historia, 2008), 11–46. Another key (and just-updated) reference is the *Bibliografía de arqueología náutica y subacuática española*, 4th ed. (Madrid: Ministerio de Cultura y Deporte, 2020). See also (for underwater archaeology in the Bosporus) Elif Batuman, "The Big Dig: Istanbul's City Planners Have a Problem: Too Much History," *New Yorker*, 24 August 2015.

80. George Papatheodorou et al., "The Battle of Lepanto Search and Survey Mission," *Proceedings of the 9th Hellenic Symposium on Oceanography and Fisheries, May 13–16, 2009, Patras, Greece*, vol. 1 (Athens: Association of Employees of the Hellenic Center for Marine Research, 2009), 134–139.

81. Manuel de Terán, "La producción y comercio de la avellana en España y especialmente en la provincia de Tarragona," *Estudios geográficos* 10, no. 34 (1949): 33–49.

82. Sténuit, 203.

83. Martin, *Full Fathom Five*, 116.

84. Eugene Lyon, *The Search for the Atocha* (New York: Harper and Row, 1979), 164.

85. Lyon, 125.

86. Martin, *Treasures*, 61, 143, 147, 194–195. See also Donald H. Keith, "Shipwrecks of the Explorers," in *Ships and Shipwrecks of the Americas: A History Based on Underwater Archaeology*, ed. George F. Bass (London: Thames and Hudson, 1988), 60; and Ken MacMillan, "The Bermuda Company, the Privy Council, and the Wreck of the San Antonio, 1621–23," *Itinerario* 34, no. 2 (2010): 45–64.

87. Martin, *Full Fathom Five*, 117.

88. Arnold and Weddle, *Nautical Archaeology of Padre Island*, 177.

89. Mel Fisher quoted in R. Duncan Mathewson III, *Treasure of the Atocha* (New York: E.P. Dutton, 1986), 12 (see also 47).

90. Manuel Antonio Martín Bueno, ed., *La nave de Cavoli y la arqueología subacuática en Cerdeña* (Zaragoza: Universidad de Zaragoza, Departamento de Ciencias de la Antigüedad, 1993), 24.

91. Martin, *Full Fathom Five*, 100; Almagro-Gorbea, 12; F. Serrano Mangas, *Naufragios y rescates en el tráfico indiano durante el siglo XVII* (Lima: Seglusa Editores, 1991); and José Luis Casabán, "The Wreck of the 'Apostle' San Bartolomé (1597)," *Mariner's Mirror* 102, no. 2 (2016): 206–210.

92. Molly A. Warsh, *American Baroque: Pearls and the Nature of Empire, 1492–1700* (Williamsburg: Omohundro Institute of Early American History and Culture, 2018), 136–138.

93. Lyon, 69–85; Peter Earle, *The Treasure of the* Concepción (New York: Viking, 1980); Donald H. Keith and Joe J. Simmons III, "Analysis of Hull Remains, Ballast, and Artifact Distribution of a 16th-Century Shipwreck," *Journal of Field Archaeology* 12, no. 4 (1985): 423; Keith, "Shipwrecks," 60; Robert Grenier, "Basque Whalers in the New World," in *Ships and Shipwrecks of the Americas*, 69–84; and Gordon P. Watts et al., "Final Report on IMHA–3," in *Underwater Archaeological Proceedings from the Society for Historical Archaeology Conference* (Germantown, MD: Society for Historical Archaeology, 1994), 60. See also the classic "Pompeii premise" debate from terrestrial archaeology: Lewis R. Binford, "Behavioral Archaeology and the 'Pompeii Premise,'" *Journal of Anthropological Research*

37, no. 3 (1981): 195–208; and Michael B. Schiffer, "Is There a 'Pompeii Premise' in Archaeology?," *Journal of Anthropological Research* 41, no. 1 (1985): 18–41.

94. For underwater archaeology in the (extraordinary) oxygen-free environments deep in the Black Sea, see Kevin Rawlinson, "World's Oldest Intact Shipwreck Discovered in Black Sea: Archaeologists Say the 23-Metre Vessel Has Lain Undisturbed for More than 2,400 years," *The Guardian*, 22 October 2018.

95. E.D. Morgan, C. Edwards, and S.A. Pepper, "Analysis of Fatty Debris from the Wreck of a Basque Whaling Ship at Red Bay, Labrador," *Archaeometry* 34, no. 1 (1992): 129–133.

96. Martin, *Full Fathom Five*, 116, 123.

97. Martin, *Full Fathom Five*, 223.

98. Katerina Delaporta and Mensun Bound, "A Wreck beside the Signallo Reef outside the Main Port of Zakynthos (Zante), Greece," in *Tropis V* (Athens: Hellenic Institute for the Preservation of Nautical Tradition, 1999), 145.

99. Roger C. Smith, "Treasure Ships of the Spanish Main," in *Ships and Shipwrecks of the Americas*, 90; C.A. Hoyt, "Bermuda in the Age of Exploration," *Bermuda Journal of Archaeology and Maritime History* 2 (1990): 25–60; and Elena Strong, "War Club's Gruesome Past: Museum's 'Ceremonial' Artifact Saw Real Action in Indian Combat," *Maritimes* 24, no. 1 (2011): 6. See also Joanna Ostapkowicz et al., "The Origins of Tradescant's 'India Occidentali' Wooden Clubs: 14C Dating, Material Identification and Strontium Isotope Studies," *Antiquaries Journal* 98 (2018): 187–218.

100. Smith, "Treasure Ships," 91. See also Lyon, 108–109.

101. Ramon de Santiago, "Across Three Oceans: Shipwrecks as Early Modern Globalism" (senior seminar paper, University of California, Berkeley, 2016), https://escholarship.org/uc/item/87s7308h.

102. Charles B. Harnett, "Preliminary Report," *Florida Anthropologist* 18, no. 1 (1965): 39–45. Thanks to Roger C. Smith for bringing these to my attention.

103. Corey Malcom, "The Flotation of Waterlogged Organics," *Astrolabe* 8, no. 1 (1993): 2–7.

104. Christopher J. Durden, "Appendix H: Fossil Cockroaches from a 1554 Spanish Shipwreck," in *The Nautical Archaeology of Padre Island*, 407–416; and Colleen Reese Lawrence and Jacob D. Shidner, "Recovery Techniques and Preliminary Analysis of Plant and Animal Remains from the Emanuel Point II Shipwreck," *Florida Anthropologist* 62, no. 3–4 (2009): 105. Rats, as city-dwellers have known for thousands of years, are not (normally) fully nocturnal.

105. Lyon, 109.

106. C. Wayne Smith, "Preservation of Waterlogged Archaeological Glass Using Polymers," in *Underwater and Maritime Archaeology in Latin America and the Caribbean*, ed. Margaret E. Leshikar-Denton and Pilar Luna Erreguerena (New York: Routledge, 2016), 271–282.

107. Martin, *Full Fathom Five*, 102. See also J. Barto Arnold III and Robert Weddle, "Appendix I: Conservation Measures Utilized for the Sixteenth-Century Shipwreck Materials," in *The Nautical Archaeology of Padre Island*, 418–419; Lyon, 121; Mathewson, 129; and Manuel Antonio Martín Bueno and Julio Amare, "Tratamiento y conservación," in *La nave de Cavoli*, 67–76. For a seventeenth-century discussion of such shipwreck conglomerates, see James Delbourgo, "Divers Things: Collecting the World under Water," *History of Science* 49, no. 2 (2011): 177–178.

108. Arnold and Weddle, *Nautical Archaeology of Padre Island*, 295–322. See also

Martin, "*La Trinidad*," 25, 27.

109. Martin, *Full Fathom Five*, 103.

110. Martin, *Full Fathom Five*, 102.

111. Sténuit, 242–243.

112. Anastasia Pournou, "In Situ Protection and Conservation of the Zakynthos Wreck" (Ph.D. diss., University of Portsmouth, 1999). Another possibility for dealing with the remains of large hulls is to bring them to the Arctic or Antarctic for a kind of freeze-drying process (*liofilización*). See Martín Bueno, 72.

113. William Shakespeare, *Mr. William Shakespeare's Comedies, Histories, & Tragedies; Published according to the True and Original Copies*, ed. John Heminges and Henry Condell (London: Isaac Jaggard and Edward Blount, 1623), 5. On the play's complex Mediterranean-Atlantic "two hemispheres" geography, see Richard Wilson, "Voyage to Tunis: New History and the Old World of *The Tempest*," *ELH* 64, no. 2 (1997): 333–357.

114. Escalante de Mendoza, 61; Arnold and Weddle, *Nautical Archaeology of Padre Island*, 67–68; and Eugene Lyon and Barbara A. Purdy, "Contraband in Spanish Colonial Ships," *Itinerario* 6, no. 2 (1982): 92–93.

115. Martin, "*La Trinidad*," 19; Colin Martin, "De-particularizing the Particular," *World Archaeology* 32, no. 3 (2001): 384–390; Lyon, 101, 126–131, 175, 196–198, 210; and Birch and McElvogue.

116. Arnold and Weddle, *Nautical Archaeology of Padre Island*, 154; Lyon and Purdy, 98–102; and Pérez-Mallaína, *Spain's Men of the Sea*, 90, 111–112.

117. John Grissim, *The Lost Treasure of the Concepción* (New York: Morrow, 1980), 200. See also Warsh, 174–179.

118. Martin, *Full Fathom Five*, 59; and Carla Rahn Phillips, "Spanish Ship Measurements Reconsidered," *Mariner's Mirror* 73, no. 3 (1987): 294. Roger C. Smith provides a classic overview of shipbuilding techniques (reconstructed from period texts and archaeological evidence) in *Vanguard of Empire: Ships of Exploration in the Age of Columbus* (Oxford, UK: Oxford University Press, 1993). See also Borrero Londoño.

119. The first example of designing ships on paper before building them (and, specifically, the drawing of scaled multiview plans) is usually credited to a circa 1586 manuscript by English shipwright Mathew Baker. See David McGee, "From Craftsmanship to Draftsmanship: Naval Architecture and the Three Traditions of Early Modern Design," *Technology and Culture* 40, no. 2 (1999): 209–214; Siegert, "Waterlines," 148–157; Massimo Corradi and Claudia Tacchella, "At the Origins of Shipbuilding Treatises: Joseph Furttenbach and the *Architectura Navalis*" (paper presented at the Historic Ships Conference of the Royal Institution of Naval Architects, 5–6 December 2018); and Borrero Londoño, 158. But even Baker's designs leave much unspecified beyond the always-inevitable gaps between plan and realization and the ways material things are altered through use (by repairs, for example).

120. Edwin S. Dethlefson, Ellen Davidson, and D. Lynn Buchman, "The Stonewall Wreck," *International Journal of Nautical Archaeology* 6, no. 4 (1977): 316–321; Willis Stevens, "Underwater Stratigraphy at Red Bay," in *Underwater Archaeology*, ed. Donald H. Keith (Fathom Eight: 1984), 21; R. James Ringer and Michel J. Audy, "Cargo Lading and Ballasting on the Sixteenth-Century Basque Whaling Vessel," in *Underwater Archaeology*, 21, 25; Keith and Simmons, 419–420; Peter J.A. Waddell, "The Disassembly of a 16th-Century Galleon," *International Journal of Nautical Archaeology and Underwater Exploration*

15, no. 2 (1986): 137–148; Grenier, 71, 81; Thomas J. Oertling, "The Highborn Cay Wreck," *International Journal of Nautical Archaeology and Underwater Exploration* 18, no. 3 (1989): 230–239; Gordon P. Watts, "The Western Ledge Reef Wreck: A Preliminary Report on Investigation of the Remains of a 16th-Century Shipwreck in Bermuda," *International Journal of Nautical Archaeology* 22, no. 2 (1993): 111–114; Gordon P. Watts et al., 50–57; Martín Bueno, 64; Roger C. Smith et al., eds., *The Emanuel Point Ship: Archaeological Investigations, 1994–1995* (Tallahassee: Florida Heritage, 1995), 25–27, 36–45; Roger C. Smith et al., *The Emanuel Point Ship: Archaeological Investigations, 1997–1998* (Tallahassee: Institute of Archaeology, University of West Florida, 1998): 28–62; and Mikkel H. Thomsen, "The Studland Bay Wreck, Dorset, UK," *International Journal of Nautical Archaeology* 29, no. 1 (2000): 69–81.

121. Edwin Doran Jr. and Michael F. Doran, "Appendix E: A Reconstruction of the Padre Island Ship," in *The Nautical Archaeology of Padre Island*, 375–384; William A. Baker, "Appendix F: Comments on the Padre Island Ship," in *The Nautical Archaeology of Padre Island*, 385–390; Grenier, 80–81; Oertling, 232; J. Barto Arnold III, "Shipwreck!—The 1554 *Flota* Exhibit," *International Journal of Nautical Archaeology* 21, no. 4 (1992): 343–355; and Toni L. Carrell and Donald H. Keith, "Replicating a Ship of Discovery," *International Journal of Nautical Archaeology* 21, no. 4 (1992): 281–294.

122. James M. Vreeland, "Appendix G: Fibers and Fabrics of the 1554 Shipwreck (41 KN 10)," in *The Nautical Archaeology of Padre Island*, 391–406. See also Smith et al., *The Emanuel Point Ship: Archaeological Investigations, 1997–1998*, 34, 64, 108; Gregory D. Cook, "Luna's Ships," *Florida Anthropologist* 62, no. 3–4 (2009): 93–100; and Jeffrey G. Royal and John M. McManamon, SJ, "At the Transition from Late Medieval to Early Modern," *International Journal of Nautical Archaeology* 39, no. 2 (2010): 334. On Native American participation in Iberoamerican shipbuilding, see Jones, 131–132.

123. Pérez-Mallaína, *Spain's Men of the Sea*, 66–68.

124. Pérez-Mallaína, *Spain's Men of the Sea*, 140; and Vázquez de Espinosa, 92, 94, 103. On shipboard smells in general (including the bilge), see Alain Corbin, *The Foul and the Fragrant* (Oxford, UK: Berg, 1986), 48–49, 105–106.

125. Guevara, 250. On fragrant, coprolithic ambergris, see Robert Clarke, "The Origin of Ambergris," *Latin American Journal of Aquatic Mammals* 5, no. 1 (2006): 7–21.

126. Salazar, 297. See also Torre, 64.

127. Keith and Simmons, 412; Roger C. Smith, Donald H. Keith, and Denise Lakey, "The Highborn Cay Wreck," *International Journal of Nautical Archaeology* 14, no. 1 (1985): 68–69; Mathewson, 63, 68; Oertling, 247; Cook, 93; Michael C. Krivor et al., *Archival Investigations for Potential Colonial-Era Shipwrecks in Ultra-deepwater within the Gulf of Mexico* (New Orleans: U.S. Department of the Interior, 2011), 47, 50, 58; and Royal and McManamon, 328, 330–331.

128. Keith and Simmons, 413–418; and William Reginald Lamb, Donald H. Keith, and Susan A. Judy, "Analysis of the Ballast of the Molasses Reef Wreck," *National Geographic Research* 6, no. 3 (1990): 302–304. Columbus mentions taking on Azores stone as ballast in preparation for the final leg of his return journey across the Atlantic in February 1493. Morison, *Journals*, 171. Some fifty years later, during a 1544 journey from Spain to the Americas, Tomás de la Torre describes taking on six loads of ballast stone in the Canary Islands. Torre, 70. For the (much later) use of coal as ballast, see On Barak, "Outsourcing: Energy and Empire in the Age of Coal, 1820–1911," *International Journal of Middle East*

Studies 47, no. 3 (2015): 425–445.

129. Samuel Eliot Morison, *The European Discovery of America: The Northern Voyages, A.D. 500–1600* (New York: Oxford University Press, 1971), 135, 542; and Arnold and Weddle, *Nautical Archaeology of Padre Island*, 19.

130. Keith and Simmons; Donald H. Keith, "The Molasses Reef Wreck" (Ph.D. diss., Texas A&M University, 1977); and Lamb, Keith, and Judy.

131. Thomsen, 81.

132. Ringer and Audy, 26.

133. Dennis A. Bratten, "Preliminary Analysis of the Emanuel Point Ship's Ballast," in *The Emanuel Point Ship: Archaeological Investigations, 1997–1998*, 66–71; Cook, 93; and Amanda E. Wohlberg, "Geoarchaeological Study of Ballast from the 16th-Century Emanuel Point No. 2 Shipwreck, Pensacola Bay, Florida" (paper presented at the Geological Society of America, Northeast Section, 44th Annual Meeting, 22–24 March 2009).

134. Miguel San Claudio Santa Cruz et al., "El pecio de Ribadeo, un excepcionalmente bien conservado pecio español del siglo XVI," in *Arqueología subacuática española: Actas del I Congreso de Arqueología Náutica y Subacuática Española* (Cartagena: Secretaría General Técnica, 2014), 208–221; Miguel San Claudio et al., "Ribadeo (1597)," Nautical Archaeology Digital Library, https://shiplib.org/index.php/shipwrecks/iberian-shipwrecks/spanish-armadas/ribadeo/; and José Luis Casabán et al., "El pecio de Punta Restelos: Un buque de la Armada de 1596," in *Arqueología subacuática española*, 233–243.

135. And as Tom Cummins pointed out to me at the 2014 RSA meetings, the late-eighteenth-century streets of Charleston were paved with ballast stones: one kind of transportation technology being repurposed for another (https://historymyths.wordpress.com/tag/ballast-paving-streets/). Since many ballast stones originally came from rivers (water-smoothed contours being less likely to damage the hulls of ships), the poetics of lithic movement extend even further. Lamb, Keith, and Judy, 293.

136. See also Lewis, 199–200. On imagining the northwestern Atlantic as an "annex" of the Mediterranean, see Braudel, 224. On the North and Baltic seas as a "northern Mediterranean" and the Caribbean as "a trans-oceanic Mediterranean," see Abulafia, "Mediterraneans," 77, 82. In contrast is José de Acosta's claim about the absence of any Mediterranean in the Indies (quoted on the title page of Braudel, *Mediterranean*).

137. Baltasar Vellerino de Villalobos, "Luz de nauegantes," 1592, in Biblioteca de la Universidad de Salamanca, ms. 291, 23r–24v; "Derrotero uniuersal desde el cauo de sa[n] bicente por todo el mar mediterraneo," in Biblioteca Nacional de España, ms. 9367, 115v–159r (for a variant copy, see AMN, ms. 183); and Poza, 2:21r–22v. Vellerino de Villalobos is focused on the Caribbean, the "Derrotero uniuersal" on the Mediterranean, and Poza on the northeastern Atlantic (although with final sections on the Mediterranean and even a route to China). On watery *caminos*, see Pérez-Mallaína, "Los libros de náutica españoles," 480.

138. Vellerino de Villalobos, 30r–32v; and "Derrotero uniuersal," 159r–169v.

139. Jones, 217; and Vellerino de Villalobos, 11r, 33r. Vellerino de Villalobos appears to provide more details for routes traveling *east* across the Atlantic (often a more difficult journey: Pérez-Mallaína, *Spain's Men of the Sea*, 153), but he still says very little about the open-water portion of the journey: his instructions focus on initial navigations by the coast of Florida and the Bahamas (26v–28v).

140. Antonio Rumeu de Armas, *El tratado de Tordesillas: Rivaldad hispano-lusa por el*

dominio de océanos y continentes (Madrid: Editorial MAPFRE, 1992), 276; Sandman, "Spanish Nautical Cartography in the Renaissance," 1,108–1,109; de Bruyn, "Uneven Seas," 97; and Tamar Herzog, *Frontiers of Possession: Spain and Portugal in Europe and the Americas* (Cambridge: Harvard University Press, 2015), 17–32.

141. Both aspects of de Bruyn's concept of political geometry are at play here: "actual lines and figures, whether drawn upon the earth or a pictorial surface," as well as "the spatial formations of sociopolitical forces as they emerge and transform themselves within history." De Bruyn, "Beyond the Line," 25. See also Luís Adão da Fonseca, "Portugal e o Mediterrâneo, entre Castela e Marrocos: A formação da fronteira marítima nos séculos XIV–XV e a noção de espaço político descontínuo," *População e sociedade*, no. 17 (2009): 45–60.

142. Rumeu de Armas, 283. The complex terrestrial/aqueous relations in the treaties of Tordesillas resonate with de Bruyn's comments on land and water in "Uneven Seas," 86, 93–99.

143. For concrete, ground-up political and jurisdictional theory in early modern Europe, see Peter Sahlins, *Boundaries: The Making of France and Spain in the Pyrenees* (Berkeley and Los Angeles: University of California Press, 1989); and Helen Nader, *Liberty in Absolutist Spain: The Habsburg Sale of Towns 1516–1700* (Baltimore: Johns Hopkins University Press, 1990).

144. Andrew C. Hess, *The Forgotten Frontier: A History of the Sixteenth-Century Ibero-African Frontier* (Chicago: University of Chicago Press, 1978), 37–42. The vicious circle of Christian and Muslim slave-raiding would endure for centuries: one way to free a captive was to acquire a captive from another faith in exchange. Daniel Hershenzon, *The Captive Sea: Slavery, Communication, and Commerce in Early Modern Spain and the Mediterranean* (Philadelphia: University of Pennsylvania Press, 2018).

145. Rumeu de Armas, 283.

146. Hess, 40–41.