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Shipwrecks in the Azores and Global Navigation (Sixteenth to Nineteenth Centuries): An Overview

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Abstract

The strategic importance of the Azores Islands resulted in the formation of a vast post-medieval underwater cultural heritage, consisting of shipwrecks and anchorages. This paper will discuss the scientific potential of this heritage through a presentation of the main shipwreck sites, specifically focusing on two historic ports of the archipelago's central group where archaeological activity has been particularly intense: Angra, on Terceira Island, and Horta, on Fayal Island. The former was the main port of call for Portuguese and Spanish navigation in the sixteenth and seventeenth centuries; the latter was an important Atlantic port for British navigation from the end of the seventeenth century onward and for American fleets during the nineteenth century.

Keywords Azores · Shipwrecks · Maritime archaeology

Introduction

The Azores archipelago includes nine islands located in the North Atlantic, at an average distance of around 1,600 km from the European continent and 3,400 km from the North American continent. Occupied from the fifteenth century onward by Portuguese settlers, the Azores played an important economic role in the production and export of agricultural products, initially cereals and dye plants in the fifteenth century, followed by oranges and wine from the eighteenth century onward. These islands also played an important role in early modern navigation, particularly with the advent of the Portuguese *Carreira da Índia* [India Run], which connected Lisbon to Asia on a yearly basis via the Cape Route, and with the beginning of regular connections between Castile and the American continent. The archipelago became an Atlantic support point for the economy of the Iberian kingdoms and an area of

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commercial and political disputes between the main European powers (Lima 1984; Matos 1983; Meneses, 1984, 1987; Rodrigues 1998:131-147). Indeed, the structural conditions of sailing were conditioned by the physical characteristics of the Atlantic and Indian Oceans, which constrained the fleets' departure and arrival times and forced ships in transit to head for the islands during their homeward journey, in order to resupply, receive orders from the metropolis and correct their course before heading back to the European mainland (Enes 1984:147-173; Guedes 1990; Matos 1985, 1987, 1988).

The strategic importance of the Azores Islands during the final stage of the sea routes to Europe, long recognized by Azorean and international historiography (Costa 2005; Duncan 1972; Enes 1984; Matos 1983, 1988; Meneses 1984), conferred an international dimension to their underwater and maritime cultural heritage; the written documentation records some 500 shipwrecks between the sixteenth and early twentieth centuries (Monteiro 2000).

Defining the role of the Azores Islands in Atlantic navigation is the basic question that frames this paper. The development of Azorean underwater archaeology in the second half of the twentieth century resulted in the discovery of several shipwrecks, which are a sample of the ships that operated in the Atlantic, and of anchorage sites, evidencing the maritime activities carried out here. Initially, these sites were affected by salvage and unplanned recovery actions. Notwithstanding, archaeological works conducted at the archipelago, mainly from the 1990s onward, produced an important body of data on the underwater cultural heritage of the Azores. The diversity of these sites, both in terms of chronology and typology, is reflected by the monograph studies already published.

In this paper we explore these sites from a regional analysis perspective, sometimes referred to as regional approaches or regional studies. Regional analyses have long been adopted in archaeology. In general, they correspond to research focuses that share an interest in how humans interact with, use, and modify space on a broad spatial scale (Kantner 2005: 1179). This approach has often used geographical tools inspired by a processual and interpretative perspective and has undergone significant changes with the development of new digital technologies and new theoretical approaches, such as landscape archaeology (Kantner 2008).

Regional analysis has not been widely applied to underwater archaeology, although it is ubiquitous in many studies. As a scale of analysis and scope of research, the concept of region is at the basis of research into maritime cultural landscapes, proposed and developed by Christer Westerdahl (1992, 2011), which has come to play a decisive role in maritime archaeology in recent decades (Campbell 2023). The concept of maritime cultural landscape involves physical and cognitive factors to study the culture of maritime peoples within a specific spatial context, integrating data from archaeology, history, and ethnography in the analysis of people's use and perceptions of the sea and other water bodies. A geographically extended scale of analysis also emerges in the work of Larry Murphy, who led or was involved in several surveys of underwater cultural heritage in areas managed by the US National Park Service. These surveys established a regional approach to the analysis of maritime cultural heritage, encompassing all the maritime cultures active in the vicinity of shipwrecks (Murphy 1993:374). This research approach,

later systematised in *The British Museum Encyclopaedia of Underwater and Maritime Archaeology* (Murphy 1997), influenced archaeological practice on several continents. In Australia, regional studies emerged as a complement or branch of the thematic studies that had been developing since the 1980s, owing to advances in the study of individual sites and the development of databases, supporting broader spatial scales designed to better understand the processes and events occurring within a particular region (Richards 2006: 45-46). Regional analyses have also integrated the concepts of Regional Maritime Contexts or *maritorium* in Latin America (Herrera and Chapanoff 2017), and despite their limited explicit use on research, they appear in several and very different shipwreck studies. For example, databases with the shipwreck distribution in antiquity enabled the study of Roman navigation in the eastern Mediterranean, contributing to the research on the maritime economy between the Roman world and Late Antiquity (Leidwanger 2017). Jonathan Adams and Jennifer Black (2004) have started from the individual study of a group of shipwreck sites and other medieval finds in St. Peter Port to analyze their relationship with Guernsey and the wider medieval world. Jun Kimura (2006) interprets the maritime cultural space through the utilization of GIS in the study of the spatial meaning of shipwrecks in the coastal waters of South Australia.

The present research considers the shipwreck sites identified up to now in the Azores, especially at Angra do Heroísmo, on Terceira Island, and Horta, on Fayal Island, where work was most intensive. The investigation is founded on the analysis of the archaeological record on a site-by-site scale, leading to an understanding at a regional level. In terms of this regional point of view, shipwrecks are understood as a sample of the maritime activities carried out in a given region: "Implicit in the meaning of region' is the assumption that a shipwreck concentration is not just an accidental, haphazard conglomeration of unlucky vessels. It is rather, to some degree, a representative sample of all maritime activity in a specific area over time that is structured by a complex interaction of natural and cultural factors" (Murphy 1993:374). The dates, provenance, and routes of the different shipwrecks addressed in this paper were determined based on an analysis of the shipbuilding construction features and material culture, using chemical analysis or specialized studies whenever possible. In most cases, the hypotheses are based on nonintrusive studies, which limits the data available. This paper also considers the regional historical context and the remains in anchorage areas but does not intend to analyze the maritime landscape that surrounds the shipwreck sites. As this is a synthesis paper, the references provide additional information. In the future, new archaeological and archaeometry data will certainly contribute to refining or revising some of the hypotheses now published.

The Historical Data

Historical data on shipwrecks in the Azores indicates that they are concentrated near the archipelago's main ports, heralding the main changes in the islands' port dynamics, which are clearly evidenced by the research on the region's economy (Fig. 1).

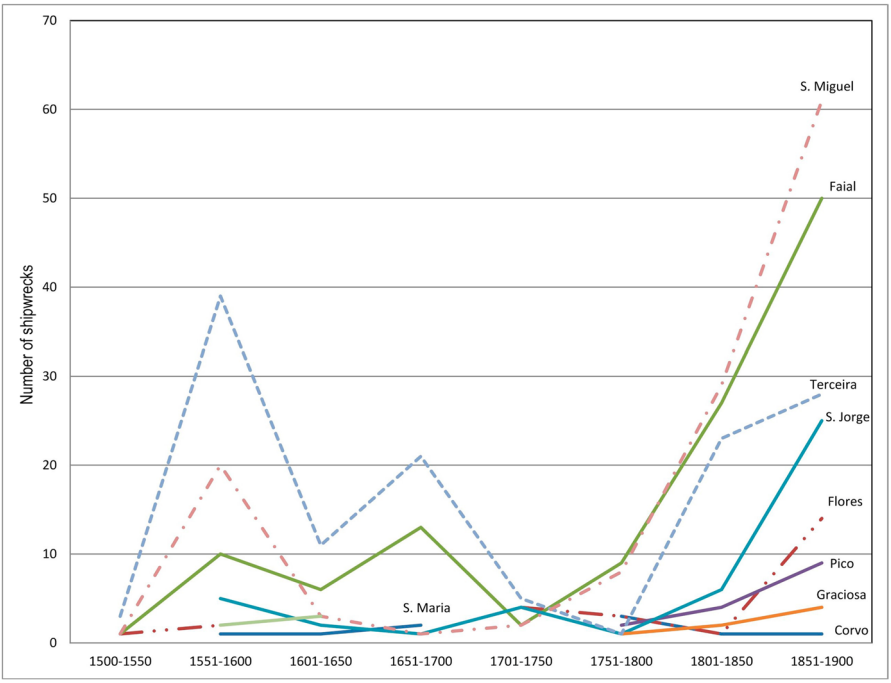

Fig. 1 Distribution of shipwrecks in the Azores archipelago, as recorded in written sources, by 50-year periods between 1500 and 1900 (after Monteiro, 2000; revised for Fayal, Pico, and Flores based on other sources reviewed by the author)

During the second half of the sixteenth century, there were more occurrences on the island of Terceira, documenting the importance of the port of Angra in supporting the Spanish *Carrera de Indias* or Portuguese navigation. This period was therefore marked by several shipwrecks in the bay, mainly Spanish, but also Portuguese (Monteiro 2000).

Subsequently, despite an overall increase of shipwrecks on all the islands, there was a decrease in the number of occurrences on Terceira Island from the first half of the seventeenth century onward, and an increase on Fayal and São Miguel Islands throughout the second half of the eighteenth century, with a peak in the nineteenth century. The higher number of occurrences on São Miguel is undoubtedly due to the scale of its economy, the main one in the archipelago (Meneses 2005).

The increasing number of shipwrecks recorded at Fayal from the second half of the seventeenth century onward may be related to the growing importance of the port of Horta. Initially, the port played a significant role in supporting British fleets, an assistance that later extended to American ships in the nineteenth century (Costa 2005). Thus, unlike Terceira in the sixteenth century, where there was a greater loss of Spanish ships, Fayal saw a predominance of American and Portuguese shipwrecks from the nineteenth century onward. For example, among the 29 losses that occurred between 1839 and 1862 in the harbor of Horta, there were 11 American, nine Portuguese, four English, three French and two Brazilian shipwrecks (Corsépius 2001).

The Archaeological Research

The Azores underwater sites have a long exploration history, running parallel to the practice of scuba diving in the archipelago since the 1950s. Occasional recoveries were undertaken on several islands, Santa Maria or São Miguel, for example, but little is known about them. The first documented remains correspond to a set of iron and bronze artillery identified in Fanal Bay (Angra do Heroísmo). Some were recovered between 1960 and 1963 by US Air Force divers from the Lages diving club (Aquaknights of Atlantis), in collaboration with Angra do Heroísmo Museum and a number of local institutions (Hoskins 2003; Shimkus 1963) (Fig. 2).

In the 1970s, two British teams conducted survey works on the island of Terceira. Little is known about these missions, which are recorded in a few newspaper reports or in a chapter written by Sydney Wignall (1982:114-149), the director of one of the teams. This archaeologist refers to the discovery of at least two shipwreck sites in the bay of Angra and a bronze gun, currently kept in the city's museum. However, he left no scientific paper and it is difficult to assess the impact of the field season he dedicated to Terceira Island's underwater cultural heritage, which was widely covered by the media, particularly in the local newspapers *A União* and *Diário Insular* (Bettencourt 2017).

Despite the interest of several institutions, specifically the Angra Museum (Rocha 2006), the exploration of Azorean underwater heritage was restricted until the 1990s. Up until this decade, there have been several attempts to legalize salvage, with the controversial Decree-Law 289/93 of August 21 being the last step in this political and institutional process. Once Decree-Law 164/97 was issued, the organized exploration of the Azorean underwater cultural heritage could only be conducted on scientific bases. The pioneering work of the Institute of Nautical Archaeology (INA), led by Kevin Crisman, was an important contribution, through the assessment of several shipwrecks known to divers on Terceira (Crisman 1999a; Crisman and Jordan 1999), São Jorge, Pico, and Fayal Islands (Crisman 1999b).

Around the same time, a new legal and institutional framework, with the creation of the former Portuguese Institute of Archaeology (IPA) and its National Centre for Nautical and Underwater Archaeology (CNANS), prompted the conduction of mitigation works, which resulted in the 1998 excavation of two seventeenth-century wooden ships (Angra C and D), located in the area where the new Angra do Heroísmo marina will be located (Garcia et al. 1999a, 1999b). In 2000, CNANS also conducted a partial excavation of the wreck site of the British frigate HMS *Pallas* (1783), on the town of Calheta, São Jorge Island, also as a preventive measure preceding the expansion of the local harbor (Garcia 2002).

The new millennium introduced a new institutional framework, with the publication of Law no. 19/2000 of August 10, which assigned the authority over the Azorean archaeological heritage to the Regional Government of the Azores, a long-standing ambition. This change had no significant impact on the previous dynamics. A year later, two more sites with remains of wooden ships, located within Angra Bay, were classified as fortuitous finds (Angra E and Angra F) (Bettencourt 2017).

by ROBERT SHIMKUS

Lost Cannons of Terceira

THIS REALLY began about 400 years ago, at the birth of several cannons. Cannons that would be used to protect the city of Angra and the southern coast of the island of Terceira in the Azores, against Spanish raiders. Hundreds of these cannons were put in a fortress by the Portuguese, in strategic positions to overlook the Fanal Bay and open sea. They kept protective watch, from their static locations for many years, unaware of the forces of nature that would bring them to their retirement at the bottom of the bay; a retirement which was caused by a huge tidal wave in 1893 that struck the Monte Brizal fortress and washed part of the southwestern fortification and at least eleven cannons into deep water.

The cannons remained at rest, despite the tries of many to find their exact locations, until 1959. A group of student divers on a marine-life expedition for an English University first sighted the lost relics.

In the summer and early fall of 1960, some Air Force divers volunteered to return the cannons to their rightful owner, the Portuguese government. With the help of the

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SKIN DIVER—October 1963

Fig. 2 Page from the *Skin Divers* magazine article of October 1963, reporting on the recovery of several cannons in the bay of Fanal, in Angra do Heroísmo (Terceira Island), the first international publication on the Azorean underwater heritage

In 2002 and 2004, works were conducted at the site of the Portuguese wreck *Nossa Senhora da Luz*, sunk in the bay of Porto Pim, on Fayal Island, in 1615 (Bettencourt 2005-2006). In 2004, the DRaC (Regional Directorate for Cultural Affairs) initiated a phase of fieldwork pertaining to the Azores Archaeological Chart Project, resulting in

the discovery of another shipwreck in Angra Bay (Angra G), as well as the French frigate *L'Astrée* (1796), on Santo Amaro do Pico, among other underwater remains on Terceira, Fayal and Pico Islands (Garcia 2023).

Since 2006, CHAM (Centre for the Humanities) has maintained its research on Angra Bay, revealing numerous scattered remains associated with anchorage operations and at least four other probable shipwreck sites (Angra I, Angra J, Angra L and Angra M), monitoring several known sites (Angra A, Angra B and Angra F), finishing the study of Angra D and starting the excavation of Angra B (Bettencourt 2011, 2013, 2017; Bettencourt and Carvalho 2009; Fraga and Bettencourt 2017). In 2008, two ships dating back to the nineteenth century were found at Ponta Delgada (São Miguel) - one made of iron and the other of wood. Works were conducted in the scope of impact mitigation related to the construction of a new passenger terminal (Bombico 2013; Coelho and Bombico 2008). Also in 2008, mitigation works in the scope of the Horta city seafront requalification and redevelopment project were started. This project included the construction of a new port terminal to the north of Horta Bay, where several remains were discovered, including a seemingly English shipwreck from the first half of the eighteenth century (Baía da Horta 1) and an American nineteenth-century shipwreck (Baía da Horta 6) (Bettencourt 2012, 2016; Bettencourt and Carvalho 2010; Bettencourt et al. 2017).

In recent years, as well as continuing to update the Archaeological Chart of the Azores, the Regional Directorate for Cultural Affairs (DRaC) has undertaken a series of actions aimed at inspecting contemporary shipwrecks to promote them as tourist attractions; these sites were recently listed in the Azorean Underwater Cultural Heritage Guide (*Guia do Património Cultural Subaquático dos Açores*) (Carvalho and Neto 2016). Concurrently, in 2016 the Azores Sea Observatory (OMA) and CHAM also began mapping several iron ships on Terceira, Pico, and Fayal Islands (Bettencourt and Silva 2017).

The aforementioned works and information provided by local divers are summarized in a table of the best-known underwater archaeological sites in the Azores that are over 100 years old (Table 1; Fig. 3). This inventory does not include sites lacking sufficient data to confirm the existence of submerged remains in context; sites identified during archaeological works but with little information or dating material (such as Angra H, Angra I and Baía da Horta 2 - BH-002) as well as several poorly known ones, such as the cannons of Baía das Águas, on Terceira Island, of Santa Cruz das Flores, on Flores Island, or the ones on the islets of Vila Franca do Campo, on São Miguel Island, which have yet to be assessed, were omitted. We also omitted isolated finds and occasional recoveries, such as those made at the hypothetical *Ravenswood* (1856) shipwreck site, on the island of Pico (Neto et al. 2022). The global navigation framework of the sites considered will be explored in the following section.

Table 1 Inventory of the most important underwater archaeological sites (between the sixteenth century and 1915) located so far in the Azores archipelago (locations on Fig. 3)

Map ID	Name	Type	Location	Dating	References
1	Angra B	Shipwreck	Angra Bay, Terceira	16th	Bettencourt 2011:220-226; Bettencourt 2013; Crisman 1999a, b
2	Canhões da Baía do Fanal	Undetermined	Fanal Bay, Terceira	16th-17th	Hoskins 2003
3	Angra E	Shipwreck	Angra Bay, Terceira	16th-17th	Bettencourt 2017
4	Angra F	Shipwreck	Angra Bay, Terceira	16th-17th	Bettencourt 2011:226-230; Bettencourt 2017
5	Angra G	Shipwreck	Angra Bay, Terceira	16th-17th	Garcia 2023
6	Angra J	Shipwreck	Angra Bay, Terceira	16th-17th	Bettencourt and Carvalho 2009
7	Cemitério das Âncoras	Anchorage	Angra Bay, Terceira	16th-19th	Chouzenoux 2012
8	Baía de Angra - anchorage	Anchorage	Angra Bay, Terceira	16th-20th	Bettencourt 2017; Bettencourt and Carvalho 2009
9	Baía da Horta - anchorage	Anchorage	Horta Bay, Fayial	16th-20th	Bettencourt 2012
10	Cemitério das Âncoras do Ilhéu	Anchorage	Vila Franca do Campo Islet, São Miguel	16th-20th	Carvalho and Neto, 2016
11	Angra L	Undetermined	Angra Bay, Terceira	16th-18th	Bettencourt 2017
12	*Nossa Senhora da Luz*	Shipwreck	PortoPim Bay, Fayal	1615	Bettencourt 2005-2006; Bettencourt 2008
13	Angra C	Shipwreck	Angra Bay, Terceira	17th	Garcia et al. 1999b; Phaneuf 2003
14	Angra D	Shipwreck	Angra Bay, Terceira	17th	Bettencourt 2017; Garcia et al. 1999b
15	Baía da Horta 1 (BH-001)	Shipwreck	Horta Bay, Fayal	18th	Bettencourt and Carvalho 2010
16	Baía da Horta 3 (BH-003)	Shipwreck	Horta Bay, Fayal	18th	Bettencourt 2012
17	*HMS Pallas*	Shipwreck	Calheta, São Jorge	1783	Garcia 2002
18	*L´Astrée*	Shipwreck	Santo Amaro, Pico	1796	Garcia 2023
19	Angra A	Shipwreck	Angra Bay, Terceira	19th	Bettencourt 2017; Crisman and Jordan 1999
20	Angra M	Shipwreck	Angra Bay, Terceira	19th	Bettencourt 2017
21	Baía da Horta 4 (BH-004)	Shipwreck	Horta Bay, Fayal	19th	Bettencourt 2012:333
22	Marina de Ponta Delgada I (MPDI)	Undetermined	Ponta Delgada harbour, São Miguel	19th	Coelho and Bombico 2008
23	Baía da Horta 6 (BH-006)	Shipwreck	Horta Bay, Fayal	19th	Bettencourt et al. 2017

Table 1 (continued)

Map ID	Name	Type	Location	Dating	References
24	Naufrágio da Baixa de São Pedro	Shipwreck	Ponta Delgada harbour, São Miguel	19th	Simplício and Vaz 2004
25	Baía da Horta 5 (BH-005)	Shipwreck (?)	Horta Bay, Fayal	19th	Bettencourt 2012
26	*Run-her*	Shipwreck	Angra Bay, Terceira	1863	Garcia et al. 1999a
27	*Canárias*	Shipwreck	Praia Formosa, Santa Maria	1871	
28	*Lidador*	Shipwreck	Angra Bay, Terceira	1878	Carvalho and Neto, 2016:39-41; Bettencourt and Silva 2017
29	*Luso*	Shipwreck	Porto dos Carneiros, São Miguel	1883	Carvalho and Neto, 2016:33-35
30	*Main*	Shipwreck	Porto Pim Bay, Fayal	1893	Bettencourt and Silva 2017
31	*Oakfield* - Marina de Ponta Delgada II (MPDII)	Shipwreck	Ponta Delgada harbour, São Miguel	1897	Bombico 2013
32	*Caroline*	Shipwreck	Ilhéus da Madalena, Pico	1901	Carvalho and Neto, 2016:79-89; Bettencourt and Silva 2017
33	*Maria Amélia*	Shipwreck	Baixa do Tufo, São Miguel	1905	Carvalho and Neto, 2016:36-37
34	*SS Slavónia*	Shipwreck	Ilhéu do Cartário, Flores	1909	Carvalho and Neto, 2016:103-105
35	*União*	Shipwreck	Cinco Ribeiras, Terceira	1911	Carvalho and Neto, 2016:51-52
36	*Bidart*	Shipwreck	Fajã Grande, Flores	1915	Carvalho and Neto, 2016:106-108

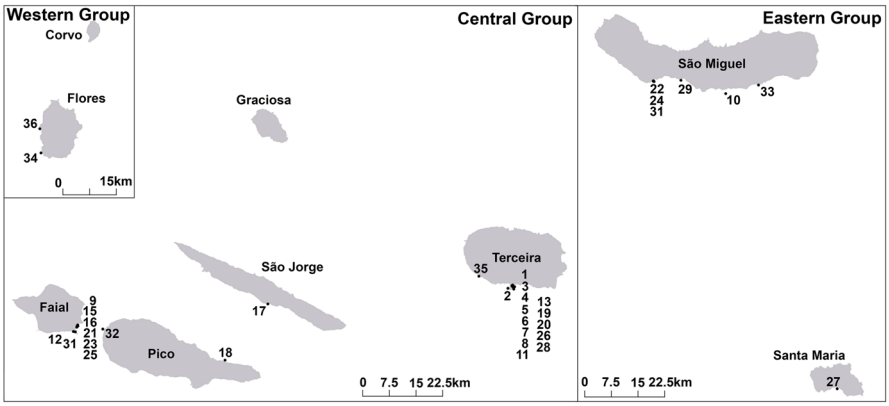

Fig. 3 Distribution of the most important underwater archaeological sites located so far in the Azores archipelago (inventory in Table 1) (Map: José Bettencourt)

Global Shipwrecks: Analysis and Discussion

On the Routes of the New World

During the sixteenth and seventeenth centuries, Angra, on Terceira Island, was the most important Azorean port for transoceanic navigation (Enes 1984; Matos 1983, 1985, 1988, 1990; Meneses 1984, 1987). This resulted in profound changes to the landscape, owing to urban development and port or maritime infrastructures, including a large-scale coastal defence system (Martins 2007:21-24; Meneses 1984:721-740).

This importance is also well documented in the underwater archaeological record, with at least six out of the 11 shipwreck sites confirmed in Angra so far dating from this period: Angra B, Angra C, Angra D, Angra F, Angra E and Angra J; this is the largest concentration of this chronology known in Portugal. This cluster also stands out because only Angra C has construction features from beyond the Ibero-Atlantic area. Thus, it may correspond to the remains of a Dutch ship lost at some point during the seventeenth century (Phaneuf 2003). The other sites are, most likely, Iberian ships that were involved in Atlantic navigation, particularly Angra B, Angra D and Angra F, for which we have more information, and which constitute an important sample for the study of post-medieval shipbuilding and the core subject of the author's doctoral dissertation (Bettencourt 2017).

Known since the 1960s, Angra B was recorded for the first time in 1996 by a team from the Institute of Nautical Archaeology (INA) (Crisman 1999a). Subsequent monitoring campaigns, carried out by CHAM between 2006 and 2011 revealed profound changes in the condition and exposure of the remains, requiring more careful recording and culminating in the excavation of the most exposed part of the remains in 2012. Before excavation, the remains of the wreck were dominated by a ballast tumulus about 16 m long and 7.5 m in maximum width, north/south oriented, and significantly higher than its surrounding area. The excavation revealed that the stone

Fig. 4 Overview of Angra B during the 2012 excavation (Photo: José Bettencourt)

ballast featured a variety of lithologies, including several blocks of dead coral, which is of the utmost importance for the study of the context, as it suggests that the ship called at ports located in warm water where this biotope is abundant (e.g. the Caribbean). Various archaeological materials were recovered among the ballast, mainly fragments of olive jars and tin-glazed tableware, bowls and plates, similar to the Andalusian ceramics that are quite common in sixteenth- and seventeenth-century Spanish shipwrecks. The ballast covered a significant part of the hull of a medium-sized ship, originally about 25 m long (Fig. 4), preserved from the keel to just below the first deck, showing Ibero-Atlantic shipbuilding features and paralleled above all by sixteenth-century ships built in shipyards from the region of Biscay (Bettencourt 2013, 2017; Bettencourt and Carvalho 2009).

Angra D was excavated in 1998 by a CNANS team, in the course of the impact mitigation required by the construction of the marina (Garcia et al. 1999a, 1999b; Monteiro 1999), and subsequently studied by CHAM as part of a project funded by the FCT (Bettencourt 2017). Located in front of the city, the site was dominated by a ballast mount that preserved a roughly 30-m-long hull, so far, the best-preserved ship ever excavated in the Azores. The excavation yielded a diversified assemblage related to different on-board activities and the ship's operation, including, for example, leather shoes, cooperage fragments, buckets, powder horns, mats, wicker baskets, and numerous ceramics. The chemical study of the ceramics revealed that the assemblage is dominated by Andalusian productions: olive jars, tin-glazed or Seville Blue on Blue tableware (Iñañez et al. 2020) (Fig. 5). These materials' characteristics

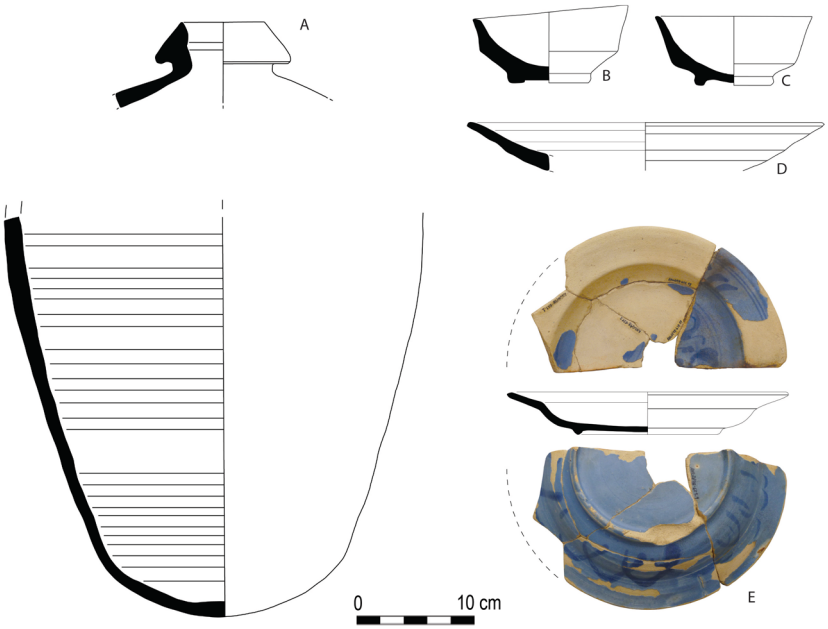

Fig. 5 Andalusian ceramics recovered in Angra D: A - olive jars; B-C - tin-glazed bowl; D - tin-glazed plate; E - Seville Blue on Blue plate (Drawings: Inês Pinto Coelho; Photos: José Bettencourt)

are indicative of a dating to the first quarter of the seventeenth century, which has been confirmed by Carbon–14 wiggle-match dating (WMD) of a ship's plank. Some evidence also suggests an American origin for this ship on its last voyage, such as the presence of coconuts and dead coral among the ballast (Bettencourt 2017; Garcia et al. 1999b). This hypothesis was confirmed by the study of faunal remains, which suggest that the Angra D crew ate fresh fish caught in America, including *Eugerres sp*. and *Centropomus sp*., probably fished in the Caribbean or the Gulf of Mexico (Beltrán González 2020). The study of insect faunas revealed the presence of the American cockroach, *Periplaneta americana* (L.), already spreading globally at the time (Panagiotakopulu and Garcia 2023). The analysis of the hull, which shows several features of the sixteenth- and seventeenth-century Ibero-Atlantic shipbuilding (Garcia et al. 1999b; Monteiro 1999), suggests that this was probably a 200- to 300-ton ship, built in Spain (Bettencourt 2017; Fraga and Bettencourt 2017).

Angra B and Angra D are therefore two Iberian ships from the late sixteenth century or the first quarter of the seventeenth century. Both feature material culture assemblages of Andalusian origin; we would highlight the use of olive jars for storing provisions and tin-glazed, everyday tableware. It is likely that both ships served commercial purposes and that, at some stage during their voyage, they sailed to the American continent, as shown by the presence of dead coral among the ballast, in the case of Angra B, or fish of American origin, in the case of Angra D. If so, these ships could be the direct evidence of Angra's role as a technical stopover for the *Carrera de Indias*, which provided a yearly connection between Seville and

the Viceroyalty of New Spain, calling at the Azores on the return journey (Matos 1983). The technical call of Spanish ships at Angra is documented at least 42 times between 1518 and 1598. On 18 of these occasions, the ships' safes were transported into the city for security reasons (Matos 1983:100-101). The Azores port of call for West Indies ships was afterwards plagued by food and equipment shortages, but this did not undermine Angra's strategic importance in the first half of the seventeenth century (Meneses 1987:315-318).

The other case study is very different. Angra F was classified as a fortuitous find in 2001, when its survey and assessment was also organised by the DRaC and INA, although the site was probably known since at least the 1970s. It was subsequently recorded, analyzed, and monitored by CHAM's team between 2006 and 2015 (Bettencourt 2011:226-230, 2017; Bettencourt and Carvalho 2009:478-479). The nonintrusive work conducted showed that the site's central cluster is about 15 m in length and 7 m in width, consisting of a tumulus that stands out slightly from the surrounding sandy seafloor. Part of the keel, keelson and the main mast step are visible among the ballast, as well as the top of floor timbers, futtocks, and outer planking showing small cross-sections (Fig. 6). So far, no archaeological materials that might support a dating have been found in association with the hull remains. However, the construction features of Angra F place it within the Ibero-Atlantic shipbuilding tradition (Bettencourt 2011, 2017), which can be dated to between the second half of the fifteenth century and the first decades of the seventeenth century; examples can be found in various contexts located in Europe or in colonial territories (Oertling 2005). Nevertheless, Angra F is mostly similar to the sixteenth-century ship Ria de Aveiro A, in terms of dimensions (of the floor timbers and futtocks, for example) and the overall features of the structure. Both ships are the smaller known examples of the Ibero-Atlantic tradition, which leads to issues related to the operation of smaller oceangoing vessels, a poorly known subject (Bettencourt 2017). The discovery of Angra F is therefore extremely important, as it was thought that vessels with such a small structure would be limited to coastal navigation (Alves et al. 2001:322, 342).

On the India Route

Historiography also emphasizes the importance of the Azores for the final stage of the Cape Route, during the return voyage of the shipping route between Europe and the Asian coasts via the southern tip of Africa, opened by Portuguese sailors at the end of the fifteenth century (Enes 1984; Matos 1985; Meneses 1984). The oldest shipwreck identified so far near the port of Horta, on Fayal Island, corresponds to the remains of the *Nossa Senhora da Luz*, the flagship of the Portuguese *Carreira da Índia* 1614 fleet, which sank in Porto Pim on November 6, 1615, on its way back from Goa, India (Guedes 1995).

The problems of the 1614 armada started shortly after leaving Goa. The fleet, which also included the *São Filipe* and the *São Boaventura*, left Goa late, only on February 15, after the flagship and the *São Filipe* had docked there to unload excessive and poorly stowed cargo. The events of the first part of the voyage included

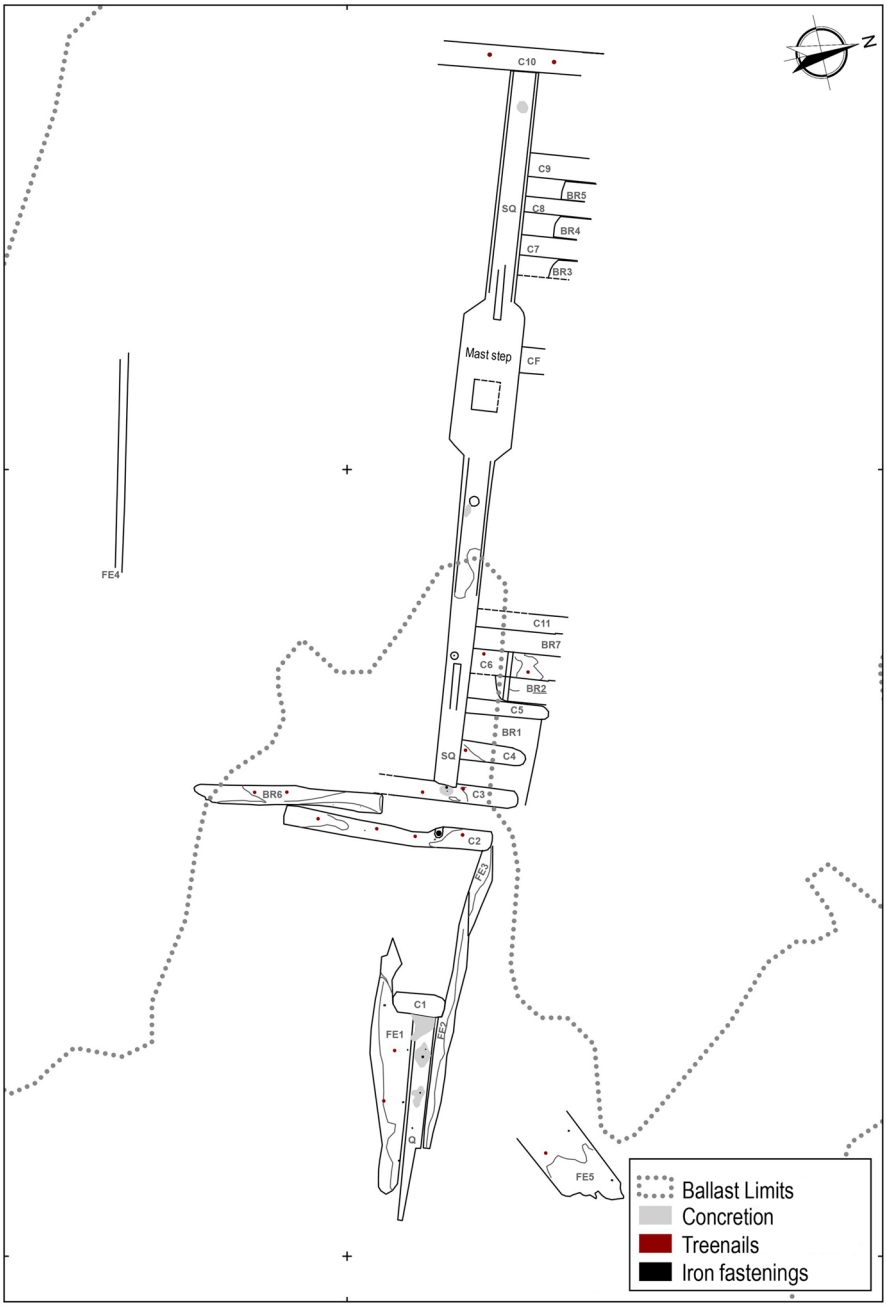

Fig. 6 Overall plan of the Angra F wreck site's structure, as recorded through observations made between 2006 and 2015 (Map: José Bettencourt)

the abandonment of the *São Boaventura*, whose hull was leaking, near the Maldives, and a stopover in Angola, where the ships were supplied with food and water (Bettencourt 2005-06; Guedes 1995). The last stage of the voyage, already in the Atlantic, went smoothly until the Azores, when the *São Filipe* broke away from the flagship, about 150 leagues (58 km) southwest of Terceira Island. The *São Filipe* headed for Angra, where it was assisted offshore on November 5 and 6, and then headed for the Portuguese mainland (Bettencourt 2005-06). The *Nossa Senhora da Luz* sought shelter on Fayal, where it arrived on November 6, with the artillery and part of the cargo already jettisoned and water in the holds. During the night, the intensity of the storm that was battering the islands increased, driving the ship ashore at the entrance to Porto Pim Bay. Around 150 people died in the shipwreck, including passengers and crew, and a significant part of the cargo was lost, and partially recovered in the following weeks by officials and divers sent by the Crown (Bettencourt 2005-06; Guedes 1995).

The remains of this ship were discovered in 1999 by a team from the National Centre for Nautical and Underwater Archaeology (CNANS) and subsequently studied as part of a research project and the subject of a master's thesis in archaeology (Bettencourt 2005-06, 2008). The archaeological site extends over a vast area of Porto Pim Bay, where small, scattered remains can be found embedded among boulders and outcrops. Hence, the wreck was seemingly deeply disturbed by post-depositional processes, in an extremely adverse environment for the preservation of the archaeological record, although a small fragment of the hull was found in 2022 (Fig. 7) (Bettencourt 2005-06, 2008:86-101).

Nonetheless, the integrated study of historical and archaeological documentation revealed data on the material culture related to this ship on its last voyage. The analysis of the lists of goods recovered after the shipwreck suggests that the cargo included large amounts of raw cloth or finished garments, predominantly cotton products such as *beirames* (fine cotton cloth), *beatillas* (very fine linen or cotton cloth) and *cannequins* (thick cotton cloth). The ship also carried other goods, in lesser quantities, such as precious stones, spices (pepper, cinnamon, and nutmeg), carpets, porcelain, furniture, beads, and ivory objects, some of which were recorded at the wreck site (Bettencourt 2008:102-130).

The ceramics recovered at the site include porcelain (Fig. 8) and stoneware. The porcelain corresponds mainly to plates and bowls with white-enameled surfaces and blue-painted decoration, commonly known as *kraak-porselain* or *kraakporselein*, mostly made in the workshops of Jingdezhen. The stoneware materials include Chinese, Tradescant, Martaban, and possibly Thai jars, which may have been used on board to store goods, provisions, and water. These productions were widely marketed in Europe and therefore appear at several underwater sites from the same period, specifically Spanish, Portuguese, and Dutch ships (Bettencourt 2008:131-134).

Cowrie shells - a gastropod mollusc of the species *Monetaria moneta* (Linnaeus 1758), known in modern documentation as *búzios da Índia* (Indian whelks) - were also recovered. Until the end of the nineteenth century, these shells had important monetary and symbolic functions, especially in the African and Asian continents, and were therefore frequently carried aboard during the return voyage from India (Bettencourt 2008:131-134).

Fig. 7 The hull of the *Nossa Senhora da Luz*, as identified in 2022. The image shows hull planks, fastened with iron nails (Photo: José Bettencourt)

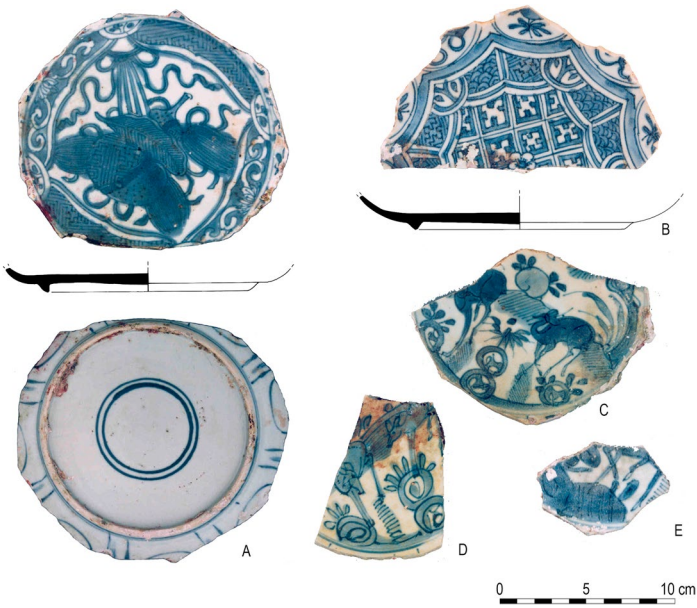

Fig. 8 Chinese porcelain recovered from the *Nossa Senhora da Luz* shipwreck site: A - plate decorated with symbolic motifs; B - plate decorated with symbolic and geometric motifs; C-D-E - plates with fallow deer depictions (Drawings: Carla Fernandes; Photos: José Bettencourt)

The archaeology of *Nossa Senhora da Luz* reflect two aspects of navigation that are worth highlighting. On the one hand, the contents of her cargo document the globalization and vastness of the Portuguese trade network in the East. The written sources directly mention products from the East African coast, Persia, the Indian regions of Sindh, Kashmir, Malabar, Coromandel, and Bengal, as well as China and Japan, although goods made in other areas can be identified, such as musk, produced mainly in the Capelangam Mountains and Cambodia; amber from the Maldives or the East African coast; benzoin from Siam or Malacca and cinnamon from Ceylon (Bettencourt 2008:96-101). On the other hand, the location of the shipwreck embodies the role of "providential port of call," a last resort, which the port of Horta took on during the sixteenth and seventeenth centuries (Costa 2011:69-80), particularly for the India Run ships. In most cases, these ships sought protection there under bad weather conditions, due to their structural integrity or the presence of enemies around the islands. For example, in 1644, the ship *Nossa Senhora da Penha de França*, which was short of water and supplies and at risk of enemy attack, remained at anchor in the harbor of Fayal Island for a short time; part of her cargo was unloaded and subsequently transferred to Terceira Island. In 1645, the vessels *Santa Maria da Atalaia* and *Santo António* disembarked the sick, were supplied with water, wine, and other foodstuffs and then sailed to Terceira Island, where they were repaired. The same happened in 1649, when the galleon *Santo André* anchored for a short time and was eventually escorted by five ships to Angra, where she was provided with men and supplies (Bettencourt 2008:37-38).

On the Routes of the British Empire

The "providential port of call" function of the port of Horta changed in the following centuries, as evidenced by the archaeological record. The port of Horta would become the main port of the archipelago. In fact, while other remains from the sixteenth and seventeenth centuries are scarce on Fayal, being limited for now to a few fragments of Portuguese coarse redwares from the Aveiro-Ovar region or Portuguese faience, recovered in the Horta Bay anchorage area, evidence from the eighteenth century is very significant (e.g., Baía da Horta 1 [BH-001] and Baía da Horta 3 [BH-003], two possibly British eighteenth-century shipwrecks).

The first remains of BH-001 were discovered in 2008, and the site was partially excavated between April 2009 and June 2010 as part of the mitigation measures required by the construction of a passenger terminal. These are the remains of a shipwreck, scattered over a vast area at a depth of between 8 and 11 m, which yielded ship's gear, household, and personal items and part of the cargo (Bettencourt and Carvalho 2010). These materials support dating this context to the first decades of the eighteenth century, because they include fragments of glass or stoneware bottles from the same period and jars for storing liquids, known in Anglo-Saxon literature as "large oil jars," made in Montelupo (Blake and Hughes 2017), with parallels in materials recovered from the *Queen Anne's Revenge* (1718) (Cames-McNaughton 2008) or *La Natière* 1 ship, probably the remains of the French ship *Dauphine,* lost in 1704 (L'Hour and Veyrat 2000:85) (Fig. 9).

These artifacts also suggest a British connection for the ship. For example, among the ceramics, pipes are the most diagnostic group, including dozens of unused pipe bowls, a cargo of English manufacture, bearing the mark of one of the members of the Manby family, named Richard (Fig. 10), whose production is well documented in London in the first half of the eighteenth century (Pearce 2013). The glass bottles also correspond to well-known British productions, and among the metals there is a cufflink bearing the Tudor Rose and a silver coin minted during the reign of Charles II of England, between 1660 and 1685 (Bettencourt and Carvalho 2010:143-145).

The most significant find concerns ca. 100 ivory elephant tusks, bearing the same incised mark on one side, related to ownership control (Fig. 11). The artifact assemblage and molecular and spectrometric analysis suggest that the ivory cargo has a probable African origin (Bettencourt and Carvalho 2010:146-148; Costa et al. 2023).

This hypothesis evokes issues related to Atlantic navigation in the eighteenth century, when the ivory trade was often associated with slave traffic on triangular routes connecting Europe, Africa, and the American continent (Bettencourt and Carvalho 2010:148-152). This site also documents the new role played by the port of Horta, which gained prominence as a port of call for British ships involved in transatlantic trade, seeking supplies and refitting, without ruling out the commercial advantages of exchanging manufactured goods for regional products (Meneses 2008:302-303).

The same applies to the Baía da Horta 3 site (BH-003), an area of Horta Bay where between 2009 and 2012 14 cannons, scattered and deeply buried (about 3 m), were recovered during the archaeological monitoring of dredging works. Trial

Fig. 9 The ceramic assemblage from BH-001 site: A - Rhenish blue and grey Stoneware; B - brown salt-glazed English stoneware; C – Montelupo large oil jars (Photos: José Bettencourt)

excavations did not reveal any well-preserved deposits or structural remains, but some lead bullets, a pewter buckle, and a coin weight were recovered, suggesting that the cannons were part of a shipwreck that ran aground on the beach in front of the Bom Jesus Castle (Bettencourt 2015). The analysis of the assemblage revealed the existence of cannons with the design of the Armstrong- model, adopted by the British forces from 1725 onward (Lavery 1987: 94). The guns also bear marks of British origin, such as the P (for proved), proof of testing and approval, or the weight in British pounds. These features suggest that BH-003 may correspond to the

Fig. 10 Most pipes were produced by the same manufacturer, identified by an R-M mark in relief, a letter on each side of the heel (Photos: José Bettencourt)

remains of a British ship that was probably wrecked in the second half of the eighteenth century, since the Armstrong model was replaced by Blomefield guns in the late 1780s or 1790s (McConnell 1988: 82).

The importance of British navigation is also documented by the wreck of the frigate HMS *Pallas*, sunk in 1783 in the port of Calheta, on São Jorge Island, while escorting a convoy traveling between Halifax and England. The site was surveyed by the INA in 1998 and in 2000 two iron cannons were salvaged and test pit surveys were conducted as a measure to mitigate the impact on heritage resulting from the expansion of the port of Calheta. Two clusters of metal masses emerged among the wreckage, one made up of iron ingots and the other a compact mass of concretions containing cannonballs. The recovered materials include sounding leads, several musket bullets, bronze pegs, and some ceramics. The *Pallas* was published as one of the first experiments in the use of a copper sheathing for protecting the hull, a technique that was perfected throughout the second half of the eighteenth century (Flynn 2006; Garcia 2002).

Copper-Sheathed Ships

Several remains of nineteenth-century wooden ships protected with copper alloy sheathing have been found on the islands of Terceira, São Miguel, and Fayal (see Table 1). Since the 1990s, archaeological works have been conducted on two of these hulls: Angra A and Baía da Horta 6 (BH-006).

Angra A was one of the first shipwreck sites found in Angra Bay; it was recorded by an INA team in 1996 and subsequently monitored and recorded by CHAM between 2006 and 2015. Located at a shallow depth (between 5 and 7 m), this archaeological site features a stone ballast tumulus, roughly 40 m long (Fig. 12). The

Fig. 11 Elephant tusks: A – general view; B - chop marks; C -ownership mark (Photos: José Bettencourt)

ballast, consisting of heterogeneous granite blocks, covers a wooden hull, partially observed in several areas of the site; the bow is north-oriented. Both surveys showed that the ship's frames were U-shaped, suggesting a hull designed to maximize the payload. Furthermore, the outer planking was fastened to the frames using wooden treenails and copper alloy nails; the sheathing plates used to protect the hull were also made of copper alloy. These features indicate that Angra A should not be older than the early nineteenth century and could most probably be dated to the 1830s, when the use of copper alloy sheathing and nails became common (Bettencourt 2017; Crisman and Jordan 1999).

The same type of hull protection was recorded at another shipwreck from the same period, located in Horta Bay (Fig. 13). The intervention was conducted in 2013 during the final phase of the archaeological mitigation works required by the construction of the passenger terminal. The remains located at BH-006 include two clusters disturbed by dredging. The main structure preserves part of the hull over a maximum length of no more than 12.5 m, featuring double frames cut from oak

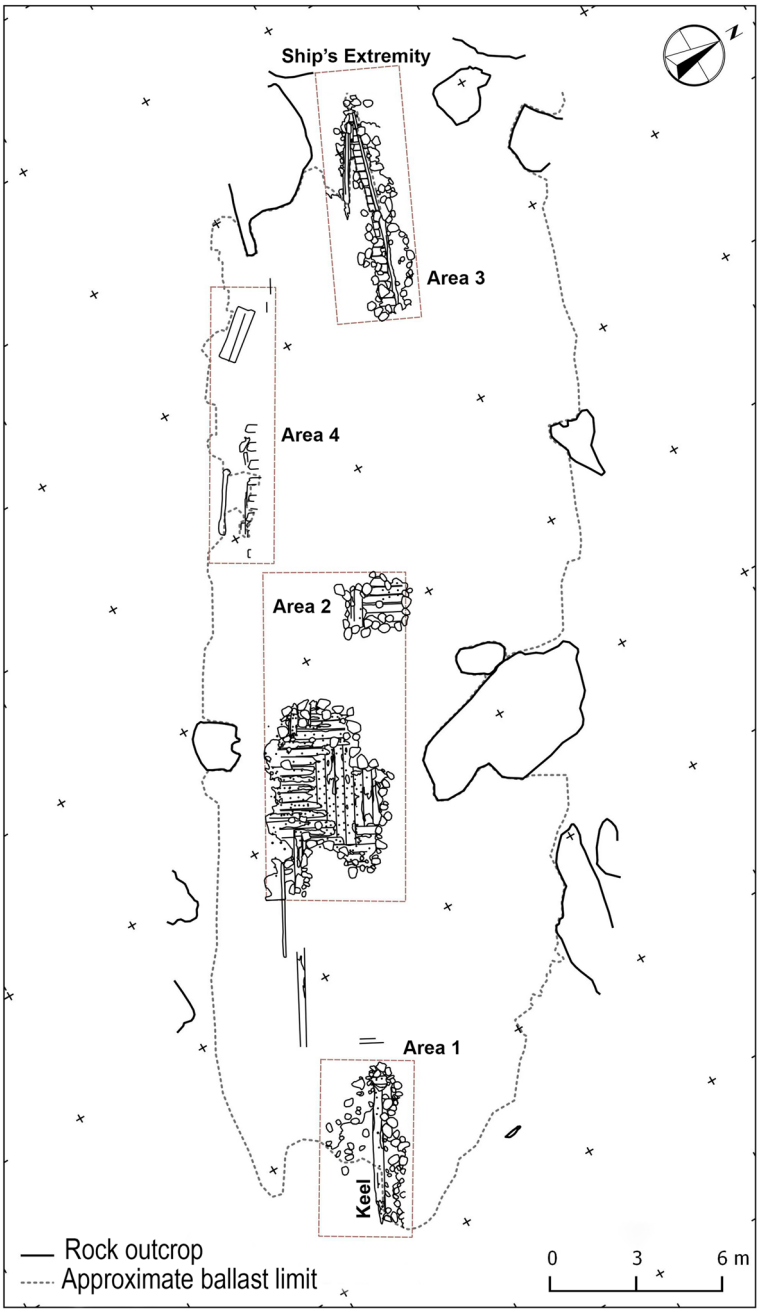

Fig. 12 Overall plan of Angra A with the location of the ship's structures visible in 2015 (Map: José Bettencourt)

Fig. 13 Main section of BH-006 during the 2013 works. The preserved part of the hull consists of one side, without the keel. The photo shows the outer planking, protected by a copper alloy sheathing, the frames and part of the outer planking. The yellow circles indicate the position of the wooden treenails. The scantlings of the frames suggest that the area on the right was closer to the ship's axis (Photo: Friederike Kremer-Obrock)

trees. The ceiling and planking were made from various types of pine and attached to the frames using treenails and copper alloy nails, in accordance with the copper alloy sheathing that protected the ship's hull. The material culture associated with the hull is scarce and does not allow for the study of the ship's origin or route. Moreover, American wood (*pinus strobus* and *pinus lambertiana*) was used for a peg and a dowel, which suggests a North American construction for this ship (Bettencourt et al. 2017).

If we consider the historical context, this hypothesis puts us on the trail of the frequent transit of American ships in the port of Horta during the nineteenth century. The historical record of shipwrecks confirms this stopover. In fact, of the 29 shipwrecks that occurred between 1839 and 1862, 11 are American ships, mainly whalers (Corsépius 2001). It is therefore possible, albeit with considerable caution, to hypothesise that BH006 corresponds to the remains of an American whaler. The call of the American whaling fleet was a crucial phase in the consolidation of the port of Horta and the Azorean identity, marked by the emigration to America or the introduction of coastal whaling by the end of the nineteenth century (Costa 2012).

The Age of Iron Ships and Steam Navigation

The transition between wooden shipbuilding and iron shipbuilding, and between sail and steam, which underwent a decisive increase during the second half of the nineteenth century, is also evidenced by several shipwrecks that occurred on the Azores slands, inventoried in recent decades (see Table 1). Archaeological research at these sites is still scarce, mainly concerning contexts at risk or of tourist and cultural interest. The most noteworthy are the *Lidador* (1878), on Angra do Heroísmo, the *Main* (1892), on Horta, the *Oakfield* (1897), on Ponta Delgada, São Miguel Island, and the *Caroline* (1901), on Madalena, Pico Island.

The steamer *Lidador* was built in London in 1873 for the Brazilian Company of Transatlantic Navigation. Although it also sailed to New York and Cuba, its activity was particularly important between Brazil and the Azores in the fulfilment of the contract signed with the Brazilian imperial government. This Brazilian company had to transport 10,000 emigrants a year, mainly rural workers, and artisans, which is why the history of the *Lidador* is linked with Azorean emigration and the Dabney family, who organized six voyages between the Azores and the port of Rio de Janeiro between 1874 and 1878 (Carvalho and Neto 2016:39-41). In 1997, the *Lidador* was preliminarily recorded by means of a geophysical survey carried out by INA and in 2016 it was recorded using photogrammetry, aiming at mapping it for tourist purposes (Fig. 14). With a length of 76 m, the *Lidador* is oriented with its stern to the northwest, parallel to the coastline. Both ends are well preserved, with the propeller shaft at the stern and the bow up to the top. Various structures can be seen throughout the site: in the center there are the remains of the two steam boilers and part of the frames and in the bow, there is the stone ballast occupying the entire hold. The port side is split and collapsed eastward but preserved up to the ship's board in some areas.

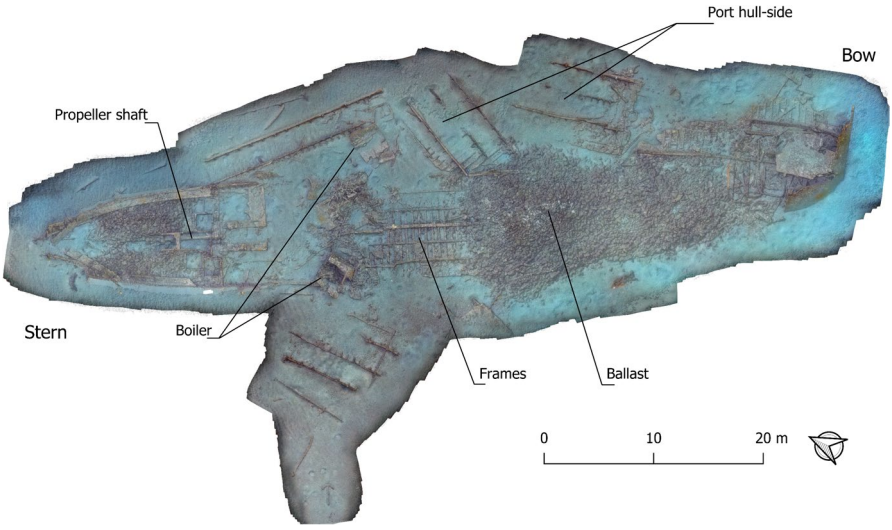

Fig. 14 The *Lidador*, as recorded in 2016 (Map: José Bettencourt)

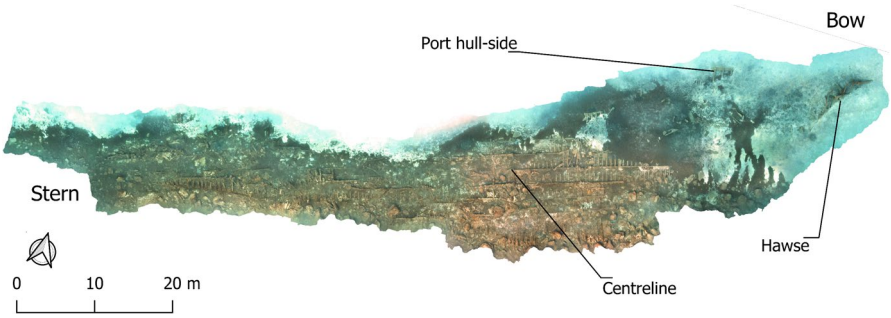

Fig. 15 The *Main*, as recorded in 2022 (Map: José Bettencourt)

The wreckage of a large iron ship has long been known to exist in front of the old whale factory, where the Porto Pim Aquarium is now located, on Fayal Island. This wreck, visible from the surface on days with good visibility, has been identified as the remains of the steamer *Main*, which sank there on November 25, 1892, while sailing between New Orleans and Liverpool. Carrying a cargo of cotton, cattle, and other American products, the ship sailed into Horta Bay with a fire aboard and was eventually transferred to Porto Pim - where it was lost - by the Portuguese authorities in order to prevent the ship from sinking. Despite the shallow depth of the site, less than 5 m, it is still possible to observe a coherent part of the ship's side, built in 1868 by Caird & Company Greenock (1,805 ton, 101.2 m long and 12.2 m wide). The mapping conducted in 2016 and 2022 revealed that the remains of the *Main* extend for more than 100 m, including the stern, part of the starboard side, and the bow. The port side is probably buried to the north and was perceived in the sandy bottom by an alignment of deck beams tops (Bettencourt and Silva 2017) (Fig. 15).

Archaeological works conducted in 2008, during the construction of the Ponta Delgada cruise terminal, led to the identification of the remains of the 1,748-ton English steamer *Oakfield*, almost 80 m long, which ran aground at Calhau do Laguim on January 22, 1897. Besides the ship's hull, the site yielded tools, bricks, and other materials related to its operation and cargo, many bearing marks that hint at a complex and well-organized industrial production line. We would highlight a cluster of bricks used in coal combustion structures, labeled as having been manufactured by the Scottish Cumbernauld Fire-Clay Company. This was the first chronological indicator available for the site. Other items were recovered, such as the copper alloy plate (Fig. 16) from one of the engines manufactured by Oswald Mordaunt & Co. Engineers & Shipbuilders, of Southampton, which built the ship in 1883 for Burrell & Son, of Glasgow. Among the cargo remains there were sacks with inscriptions indicating that they contained sugar from Demerara, in British Guiana, the ship's port of departure when it called at São Miguel Island to purchase oranges and pineapples (Bombico 2013).

The last site considered are the remains of the *Caroline,* which document the last phase of large-scale sailing ships made of iron or steel, with four masts, rigged as clippers or barques and capable of speeds up to 16 knots. Built in 1896 at the Ateliers et Chantiers de la Loire shipyard in Nantes, the *Caroline* sailed several times

Fig. 16 Copper alloy plate from one of the *Oakfield*'s engines, constructed by Oswald Mordaunt & Co. Engineers & Shipbuilders, of Southampton (Photo: Hermano Noronha)

between France and Chile for the French transport company Compagnie Bordes (A-D Bordes or Bordes et Fils). The connection to Iquique, in northern Chile, on the Pacific coast, supplied Europe with saltpeter (sodium nitrate), used as an agricultural fertilizer and in the manufacture of gunpowder. On its eighth voyage, she ended up sinking at Meia Broa, on Madalena, Pico Island, on September 3, 1901, due to an error in the navigation instruments. Its wreckage, in poor condition, was mapped in 2016 and occupies a vast area, over 90 metres long, with the bow oriented to the

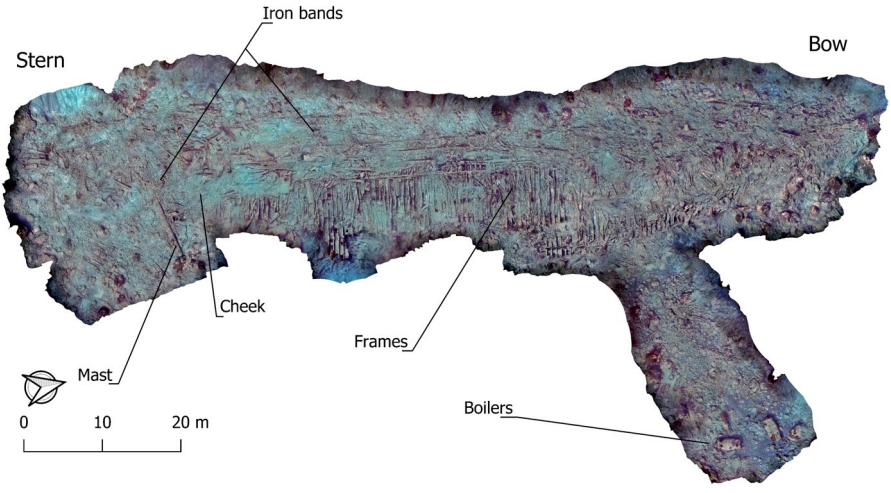

Fig. 17 The *Caroline*, as recorded in 2016 (Map: José Bettencourt)

northwest, showing several beams of the first deck (Fig. 17). The site also features a section of the frames, several iron bands, and two boilers, isolated to the east of the main section (Bettencourt and Silva 2017; Carvalho and Neto 2016:79-89).

Closing Remarks

The Azorean underwater cultural heritage is suited to multiple scientific approaches, at regional or international scales of analysis, and is suggestive of circulation patterns that have long been heralded by historiography, but which are evidenced in greater detail by the archaeological record. On a regional scale, the remains located so far enable studying the archipelago's port dynamics and its geostrategic role on the Atlantic. There is a greater concentration of shipwrecks and other nautical remains from the sixteenth and seventeenth centuries in Angra, on Terceira Island, when this port played a decisive role in supporting Spanish and Portuguese navigation. The shipwrecks from the eighteenth and nineteenth centuries are mainly located in Horta, on Fayal Island, and in Ponta Delgada, on São Miguel Island, although knowledge of the latter port is more limited. This new pattern reflects Horta's role as the main port of call since the end of the seventeenth century and the economic importance of São Miguel in the same period.

The oldest sites, dating from the late sixteenth and early seventeenth centuries, correspond to Portuguese and Spanish ships, particularly those involved in the Spanish *Carrera de Índias* (Angra B and Angra D) or the Portuguese *Carreira da Índia* (*Nossa Senhora da Luz*), for example. The Angra Bay ships are particularly important for the study of sixteenth- and seventeenth-century Iberian shipbuilding, including medium-sized vessels such as the Angra B and Angra D, and small ships such as the Angra F, which operated in the Atlantic. The wreck of the *Nossa Senhora da Luz* records the widespread scale of Portuguese Asian trade at the beginning of the seventeenth century and emphasises the strategic position of the Azores during that stage of oceanic navigation.

The eighteenth-century shipwrecks emphasize the dominant role of British navigation (BH-001, BH-003 and HMS *Pallas*), the leading maritime power of that time. BH-001 is particularly noteworthy, probably documenting British commercial traffic in the Atlantic during the first half of the eighteenth century and highlighting the role of the African continent, particularly regarding the ivory trade.

The nineteenth-century remains herald important changes in global navigation. The finds associated with wooden shipwrecks from this period are scarce and do not support analyzsing the ships' routes. However, BH-006 is the first archaeological evidence of the presence in the islands of the new emerging global power, the United States of America. The more recent iron ships reflect the profound changes in shipbuilding in the second half of the nineteenth century, also related to the development of steam, but they also reflect the ongoing geostrategic role of the Azores in sea routes, mainly originating in the American continent, and constitute a considerable touristic asset.

To sum up, the Azorean cultural heritage holds a universal value and constitutes a unique resource for the study of issues related to navigation in the early modern

worlds and the economic, cultural and social dynamics of the islands, as well as a means of scientifically displaying the Azores abroad.

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Declarations

Conflict of Interest The author states that there is no conflict of interest.

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