The Ribadeo shipwreck (c.1600): can we identify the ship through a multidisciplinary approach?

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The Ribadeo Shipwreck (c. 1600):
Can We Identify the Ship Through a Multidisciplinary Approach?

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Abstract
During dredging works in the Ribadeo estuary of north-west Spain, in 2011, a large and well-preserved shipwreck was discovered. Construction features suggested a date for the ship in the late 16th century, making this wreck a remarkable find for Spanish heritage, as it is one of the best-preserved shipwrecks from that time ever found in Spanish waters.

Dendrochronological research on 29 samples retrieved in 2012 failed to produce dates for the timbers; consequently, the exact date of the ship and its possible construction location remained unknown. In 2015 additional archaeological survey works were planned for the site in order to document further exposed structures of the shipwreck, and to collect additional samples for dendrochronological research. Simultaneously, historical research was conducted in Spanish archives to search for documents referring to the wreckage of ships in the Ribadeo estuary in the 16th and early 17th centuries.

The results of this multidisciplinary research have led to the hypothesis that the shipwreck could be the Santiago de Galicia galleon built at Castellamare di Stabia, near Naples, Italy, in the late 1580s or early 1590s, and sunk in Ribadeo in AD 1597. Dendrochronological dates obtained for two planks date the construction of the ship after 1580. Construction features of the shipwreck have been compared to those reported in 16th-century documents for the Santiago de Galicia galleon; and, the potential limitations of our methods for identifying the shipwreck are discussed.

Keywords
Shipwreck, shipbuilding, forest resources, timber supply, dendrochronology

Introduction
In 2011 dredging works in the Ribadeo estuary of north-west Spain led to the discovery of archaeological remains of an ancient wooden vessel (San Claudio Santa Cruz et al. 2013). The Ribadeo shipwreck was found at a 4.6m depth in a strong tidal area. After observing numerous wooden remains exposed by the dredging works, archaeologists discovered the structure of the hull preserved in its original shape. The shipwreck corresponded to a vessel with a length of 32m and width of 9.38m, giving a length to breadth ratio of 3.41 (San Claudio Santa Cruz et al. 2013: 210). During the 2012 survey archaeological evidence suggested that it was a warship, as its hull was covered in lead, the ship carried artillery and stone shot, and had caulked decks below the waterline, that would enable the ship to float if shot below the floating line (San Claudio Santa Cruz et al. 2013). The planking thickness of the outer hull and the scantlings of the beams and futtocks also indicated that the ship was a large military vessel. All these features lead to the hypothesis that the ship may have been a galleon (San Claudio Santa Cruz et al. 2013). Samples were taken from different construction elements for tree-ring analyses, but these failed to provide absolute dates for the timbers. Therefore, the exact date of the ship, as well as the possible construction location remain unknown. However, structural and artefactual
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Information retrieved from the remains of the ship (stone shots, ceramics and breech loaders) suggested a possible date of late 16th or early-17th century.

In 2015 a new archaeological survey was carried out promoted by the ForSEAdiscovery project (www.forseadiscovery.eu) to further document the shipwreck, and obtain additional dendrochronological samples for tree-ring analyses. Concurrently, historical research was conducted at Spanish archives for information about 16th and 17th century shipwrecks in the Ribadeo estuary. The goal of this multidisciplinary approach combining history, maritime archaeology and dendrochronology was to attempt to identify the Ribadeo shipwreck (Figure 1).

The first lead towards the identification of the ship

In June 2015 the discovery at the Municipal Archive in Ribadeo (RMA) of a document dated 13 November 1597 provided the first clues about the possible identity of the shipwreck under study. According to the minutes of a meeting of the municipal council, ‘the Santiago galleon and two urcas from the royal navy’ had arrived in the harbour of Ribadeo, badly damaged and loaded with infantry and horses (RMA, Libros de Actas, 6 [1595–1611], fs. 49). The crew went to the village begging for food, so the municipal council resolved in this document to provide the infantry with bread. Two other documents in this archive, one from 20 February 1598 (RMA, Libros de Actas, 6 [1595–1611], fs. 56a-56r) and another one from 8 November 1599 (RMA, Libros de Actas, 6 [1595–1611], fs. 82r-84a) referred to the Santiago galleon as the ‘Santiago de Galicia’ galleon, in relation to the good deed of the village of Ribadeo in supplying the infantry with victuals.

During the research, significant progress was made in identifying three potential vessels that had sunk in the estuary within a narrow range of seven years (1597–1604). According to the historical data, the earliest vessel noted was the Santiago de Galicia, sunk in November 1597—a galleon built in Naples as part of the 12-galleon fleet of Pedro de Ivella and Estefano Dolisti (RMA, Libros de Actas, 6 [1595–1611], fs. 49). The second vessel was an urca sunk in December 1597; it arrived with the galleon San Francisco de Paula lost from the fleet of Aranburu (AGS, GYM, leg. 492, doc. 178). Finally, the third vessel was the caravel Santiago lost in October 1604 (RMA, Libros de Actas, 7 [1604], fs. 133a–133r).

Archaeological construction features of the Ribadeo shipwreck

In 2015 new archaeological survey and documentation works revealed that the wreck was very well preserved.
from the main deck downward. The diagnostic timbers exposed were measured: first or second futtocks are 24cm sided and 24cm moulded; the planking is 12–15cm thick; and the main wale 15cm sided. Inside the hull, all along the starboard side, is a girder attached to the frames with the same thickness than the planks, so that the hull planks, the frames, and the girder are around 54cm thick. There is no doubt that such thick planks provide a massive and solid structure for the hull and contribute to the robustness of the vessel. The planks seem to have been sawn tangentially, and they are pieces of great quality and good manufacture.

The most remarkable aspect of this site is the extensive preservation of construction timbers, mostly in their original positions. The hull is deeply buried in sediment, and the soft mud that filled the wreck immediately after the sinking contributed not only to the preservation of the structural timbers and archaeological artefacts, but also the original position of such elements in the ship’s structure. Such conditions allow the hull to be near vertical, and show the stem as if the shipwreck was ready to sail away. On this stem, the rabbot carved on to receive the hood ends of the hull planks is still visible.

One breast hook is still attached horizontally inside the bow. Directly over this breast hook lays the forward part of a deck, still covered with pitch and with its planks caulked exactly as Alvaro de Bazán the Elder indicated that ships for the crown should be constructed with a watertight deck below the flotation line (Fernández Duro 2007: 15). This deck feature, characteristic in Spanish ships of the 16th century, is documented in the construction of galleys and galleons (O’Donnell and Duque de Estrada 2003), although this is the first time that it has been empirically documented in a shipwreck. The forward part of the deck is carved to fit around the apron and the contact between them is also caulked.

Another remarkable characteristic is the presence of several transversal bulwarks. They are made of oak planks, almost all of which exhibit an ‘L’ shape along their longitudinal edges, most probably to ensure a close fit between adjacent planks in the bulwark. The planks are fixed with vertical shores, some of which are still attached, probably to the frames, under the sand in the bilge. In one case, one of the shores seems to be associated with a beam attached to the starboard side. Some beams are partially preserved and have been documented on the starboard side of the wreck. Not all of them were used to support a deck. Some beams seem to have been used more as structural reinforcements, as they are very close to but lower than those used as deck beams. All these structural elements, except for the bulwarks, were fastened using iron nails, although most of them have since corroded away; no treenails were found.

The hull below the waterline is lead-sheathed presumably to avoid biological fouling of the hull and to protect the timber from shipworm. The sheets are directly attached to the hull with square iron nails, most of which have corroded.

Between the central ballast pile and the stern, an assemblage of balusters was found, which maintain a peculiar spiral arrangement that seem to correspond to a spiral staircase, although this has not been confirmed. Manufactured from turned wood, these are very unusual elements in wrecks of the time because this type of fittings, being pieces of limited size and weight, usually do not survive a wrecking. On the other hand, they are elements widely represented in pictorial works and surviving contemporary models.

**Dendrochronological analyses on shipwreck timbers**

In an attempt to place the construction of the ship in an absolute temporal context, samples from different timber elements were collected in 2012 when the shipwreck was first discovered (San Claudio Santa Cruz et al. 2013). In that campaign, 29 samples were retrieved both from structural elements and from timbers from inner compartments, balusters and cargo. The majority of these samples (19) corresponded to framing elements and bulkheads made of deciduous oak (Quercus subg. Quercus), but the non-structural timbers were of very different species, including spruce/larch (Picea abies/Larix decidua; two fragments of a bulkhead and a post), silver fir (Abies alba; two planks from inner compartments), chestnut (Castanea sativa; two elements of banisters), Scots/black pine (Pinus sylvestris/nigra; one plank), poplar (Populus sp.; bulkhead), and beech (Fagus sylvatica; one barrel stave) (San Claudio Santa Cruz et al. 2013).

Fourteen samples presented more than 70 tree-rings, and although this number is below that which is considered optimal for dendrochronological research (80–100 tree-rings), the samples were analysed. The results only revealed relative cross-matching between two oak samples and two spruce/larch fragments that derived from the same parent trees. The absence of more relative cross-matching between the oak timbers suggested different procurement areas, and recommendations were made to target more timber elements in future campaigns.

This opportunity arose in the archaeological survey carried out in July 2015 by the nautical archaeology team. Following the recommendations proposed by San Claudio Santa Cruz et al. (2013), new wood samples were collected for dendrochronological analysis, this time selecting exclusively structural timbers.
Table 1. Results of the tree-ring analyses. Species: 1, Quercus subg. quercus; 2, Castanea sativa; 3, Fagus sylvatica; 4, Populus sp.; 5, Picea abies/Larix decidua; 6, Pinus sylvestris/nigra; 7, Abies alba; 8, Pinus sp. (possibly P. pinaster). Pith: present (+1) / absent (-); bark edge: present (+, LW: latewood, EW, earlywood) / absent (-) / estimated; MRW: mean ring width (mm); σ: standard deviation (mm). Shaded rows indicate pairs of timbers originating from the same tree.

<table>
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<tr>
<th>Sample number</th>
<th>Type of timber element</th>
<th>Species</th>
<th>Dendro-code</th>
<th>Nº rings</th>
<th>Pith</th>
<th>Sapwood</th>
<th>Bark Edge</th>
<th>MRW</th>
<th>σ</th>
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<td>+(LW)</td>
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<td>WK?</td>
<td>1.88</td>
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<td>0.83</td>
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<td>Stanchion?</td>
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<td>n/a</td>
<td>+(EW)</td>
<td>-</td>
<td>-</td>
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<td>Barrel stave</td>
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<td>n/a</td>
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<td>-</td>
<td>n/a</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>M26</td>
<td>Treenail</td>
<td>1</td>
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<td>16</td>
<td>-</td>
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<td>-</td>
<td>-</td>
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<td>Starboard plank</td>
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<td>0</td>
<td>-</td>
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<td>-</td>
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<td>38</td>
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<td>6</td>
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<td>?</td>
<td>?</td>
<td>-</td>
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<td>36</td>
<td>-</td>
<td>n/a</td>
<td>+(LW)</td>
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<td><strong>Samples collected in 2015</strong></td>
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<td>RIB01-001W</td>
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<td>1</td>
<td>RIB00011</td>
<td>195</td>
<td>-</td>
<td>14</td>
<td>2+/-1</td>
<td>1.34</td>
<td>1.00</td>
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<td>-</td>
<td>6</td>
<td>-</td>
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<td>33</td>
<td>*</td>
<td>12</td>
<td>+(LW)</td>
<td>4.45</td>
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<td>Beam</td>
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<td>RIB00040</td>
<td>81</td>
<td>*</td>
<td>10</td>
<td>-</td>
<td>2.50</td>
<td>1.31</td>
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<td>RIB00050</td>
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<td>-</td>
<td>13</td>
<td>-</td>
<td>1.98</td>
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<td>RIB01-005W-02S</td>
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<td>RIB00060</td>
<td>228</td>
<td>*</td>
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<td>2+/-1</td>
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<td>RIB01-006W</td>
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<td>0</td>
<td>-</td>
<td>1.38</td>
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<tr>
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<td>Plank</td>
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<td>RIB00080</td>
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<td>8</td>
<td>-</td>
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<tr>
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<td>RIB00100</td>
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<td>-</td>
<td>0.75</td>
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**Samples and dendrochronological methods**

In 2015 a total of 19 timber elements were sampled for tree-ring analysis. Samples were conserved in wet conditions inside plastic bags to prevent them from drying, then sent to the laboratory of botany at the University of Santiago de Compostela in Lugo, Spain.

A preliminary inspection was carried out to determine the suitability of these samples for dendrochronological dating. Ideally, samples should contain more than 80 to 100 rings to deliver statistically robust results, although samples with a lower number of tree rings can sometimes be considered suitable as well. However, given our objectives, which include the characterization of trees used during the early modern period for shipbuilding, some samples with as little as 30 rings were nevertheless selected as an exception for tree-ring analysis in order to acquire empirical data regarding growth rates of the trees used for specific elements of ships. To perform a ring count, the transverse surface of the samples was cleaned with razor blades from the inner to the outermost ring. The presence/absence of pith and sapwood were also recorded. Furthermore, this inspection served to identify some species that show distinct anatomical features in the transverse section, which make them distinguishable by the naked eye. Such is the case for example of the group of deciduous oaks (*Quercus* subg. *quercus*), which show large earlywood vessels placed in a ring-porous disposition and large multiseriate rays, or chestnut (*Castanea sativa*), which are very similar to the group of deciduous oaks, but lack these multiseriate rays (Schweingruber 1990). The identification of other species was done by cutting thin slices of wood with razorblades from the transverse, tangential and radial sections of the samples, and observing the anatomical features with an Olympus BX40 microscope. The identification key of Schweingruber (1990) was used to identify the species. Tree-rings were measured in selected samples with a TimeTable measuring device (University of Vienna) coupled with PAST5 software (SCIEM).

**Wood identification and dendrochronological results**

Seventeen samples were identified as deciduous oak (*Quercus* subg. *quercus*) and two as pine (*Pinus* sp.) (Table 1).

The oak sample RIB01-010W and the pine samples RIB01-014W and RIB001-015W were discarded for further research as they contained 13, 20 and 16 rings respectively.

On this occasion, ten samples presented more than 70 rings, and five presented the bark edge (last ring under the bark corresponding to the cutting year), or partial sapwood.

Combining these samples with the ones collected in 2012, the final dataset consisted of 48 samples, most of them representing structural elements made of oak. More than half of the samples (53%) contained 70 tree-rings or more, but only 19% surpassed the optimal number of 100 rings (Figure 2).

Cross-dating between the samples failed to produce internal crossmatches, which reinforce the hypothesis that the timber may have originated from different procurement areas (San Claudio Santa Cruz et al. 2013). This hypothesis is also supported by the disparity in growth patterns of the oak samples, with some showing...
The Ribadeo Shipwreck (c. 1600)

The mean ring widths of 0.65mm, and others as much as 4.45mm (Table 1). Using dendroprovenance to try to identify the place where this ship was built is therefore highly problematic.

The comparison of the oak, pine, spruce/larch and silver fir tree-ring series with European reference chronologies, including the newly developed oak chronologies for the Cantabrian Mountains, produced successful results for the silver fir samples, which cross-dated with chronologies of this species from Central Europe developed by Büntgen et al. (2011). The fir timber M17 (SGRW0161) dates to 1570 (outermost preserved tree-ring), whereas the outermost ring on timber M08 (SGRW0071) dates to 1580. None of the samples contains the last ring under the bark, therefore, these dates can only be considered as terminus post quem (date after which the tree was cut). The chronologies dating these samples represent wide areas in Central Europe, therefore, it is not possible to pinpoint the provenance of this silver fir wood. The oak, pine and spruce/larch samples remain, for now, undated.

Building up a hypothesis

At this point three scenarios were clear:

- Three ships sunk in the estuary between 1597 and 1604: the galleon Santiago de Galicia, an urca and the caravel Santiago;
- The shipwreck corresponds to a galleon based on the construction features and associated artefacts found in 2011;
- This ship was built after 1580 with wood from different sources, as inferred from the dendrochronological research.

Given this scenario, additional aspects were considered to develop a hypothesis. In terms of the time frame and considering some of the artefacts associated with the shipwreck, the wreck of Ribadeo seems to be connected with the failed fleet of 1596, which lost several ships off the coast of Galicia, particularly in the area of Finisterre. One of these ships is the Punta de Restelos shipwreck (Casabán Banaclocha et al. 2013) from which some breech loaders were recovered similar to those...
found on the Ribadeo shipwreck. Furthermore, some of the beech loadiers from the Ribadeo shipwreck perfectly fitted in cannons found in Punta de Restelos wreck, suggesting a similar context of origin and supply of the artillery for both ships (Casabán Banaclocha et al. 2013). Therefore, having considered all these factors and research findings, it has been hypothesised that the Ribadeo shipwreck is the *Santiago de Galicia* galleon.

### Historical research on the *Santiago de Galicia* ship

In order to reveal whether the identity of the Ribadeo galleon could be the *Santiago de Galicia*, further historical research was conducted at the Archive of the Museo Naval de Madrid (AMN) and the General Archive of Simancas (Archivo General de Simancas, AGS), in search of documents relating to the history and the construction of that specific ship.

#### How and where was the ship constructed?

Spanish primary sources and contemporary bibliography allowed us to cross-match historical information from data collected at Spanish archives and information published by other researchers, mainly Thompson (1976). The sources of Consejo de Guerra y Marina (GYM) and Contaduría Mayor de Cuentas (CMC) stored at the General Archive of Simancas (AGS), and those of the Archive of the Naval Museum in Madrid have been the primary historical sources researched in Spain.

The outcome of this investigation revealed that in 1589, the Ragusan (Dubrovnik, Croatia) captains Pedro de Ivella and Estefano Dolisti, proposed to the Spanish monarch the construction and outfitting of a squadron of 12 galleons of 700 tons each, seven of which were already under construction in 'Ragusa, Gravosa, Isola de Mezzo, Castellamare et Vietri' (AGS, GYM, leg. 303, doc. 29). These captains had served in the fleets of the Spanish Monarchy since the 1560s. In return, Spanish King Philip II would pay in the realm of Naples the money that the Spanish Monarchy owed them (AGS, GYM, leg. 303, docs 10, 11, 13, 15). It is most likely that the King funded these fleets with revenues from the realm of Naples, although it is not possible to state whether the funding originated from incomes of the Kingdom of Naples, or from elsewhere. Probably a combination of both occurred. As the captains would own the ships, the King agreed in 1593 to pay them a fee and income for serving with those galleons within the royal fleets of the Spanish Monarchy (AGS, GYM, leg. 303, doc. 20).

Ragusans were skilled seamen in both the Atlantic Ocean and the Mediterranean Sea (Carter 1971), and in the spring of 1589 the Spanish Council of War discussed the possibility of accepting the offer of the captains to construct the 12 galleons (AGS, GYM, leg. 303, docs. 10, 11, 13–18). The Monarchy was willing to build warships in order to strengthen its naval power (Thompson 1976; Wing 2015) and the ministers were open to the suggestions brought by the captains. The Council of War agreed to construct and outfit a 12-galleon squadron, which would be composed of seven new vessels, completed with five galleons selected from the Ragusan fleet (AGS, GYM, leg. 303, docs. 11, 16, 27, 28). The Council planned to construct two light galleons in Naples ‘according to the measurements and features of the English’, and the remaining ships in Castellammare di Stabia, a shipyard located around 30km south of Naples (AGS, GYM, leg. 303, doc. 12).

In May 1589, the Council of War had stated that the fleet was ‘going to be one of the best squadrons of Your Majesty’s fleets’ (AGS, GYM, leg. 303, doc. 15), and a month later Philip II accepted the proposal. Around this time, Pedro de Ivella and Estefano Dolisti stated that seven galleons were under construction in ‘Ragusa, Gravosa, Isola de Mezzo, Castellamare et Vietri’ (AGS, GYM, leg. 303, doc. 29). In October the Council of War delivered the proposal of the Ragusan captains for constructing and outfitting these 12 vessels in more detail, stating again that seven of the 12 vessels should be new constructions (AGS, GYM, leg. 303, doc. 11, October 23, 1589). Disclosure and signature of the contract took place on the 20 February 1590 (AGS, GYM, leg. 303, doc. 20.), but the document stated that of the 12 galleons, only six instead of seven would be of new construction. The contract specified the duties and rights for both sides. The captains committed to the production of a squadron composed of twelve warships to serve the King for an initial period of five years. The construction contract ran from 1 January 1590 to December 1594, and the captains outfitted the fleet (including the artillery, rigging and recruitment of a crew of 20 people per 100 tons) within four months of having received the notification by the King’s officers being similar to other contracts (Goodman 1997: 30–32, 126–129; Thompson 1976: 200–205). Finally, the captains and their associates agreed on building six new galleons, instead of the seven they had offered initially (AGS, GYM, leg. 303, doc. 20, clause 11) and lease them to the King (Clauses 1, 2, 11). In return, Ivella and Oliste would be appointed general captain and admiral respectively of the squadron, under the command of the general captain of the fleet, and would receive a monthly income in Naples (Clauses 6, 12).

In October–November 1590 captain Ivella departed Madrid for Naples, from where he wrote letters providing information regarding the construction process. In January 1591 three galleons capable of sailing the Atlantic were launched, and construction of the remaining four was near completion. Trees were felled
for their timber during the waning moon of January 1591 and seasoned in February for the construction of the two additional galleons, following the English measurements, with the expectation that this design would produce vessels with an extraordinary sailing speed (AGS, GYM, leg. 317, doc. 194 and leg. 318, doc. 176). The construction of these ships continued in May, and finished by July of that same year (AGS, GYM, leg. 321, doc. 324). Thus, it is most likely that Pedro de Ivella and his partners constructed seven new galleons in 1591. By 1594, nine of the 12 galleons had been constructed or outfitted (AGS, GYM, leg. 303, docs, 470-471).

According to the historical sources stored in AMN, the wood used for the construction of the ships, including the Santiago de Galicia, was sourced in different places: Monte Gargano in South Italy, nearby Napoli, and Albania supplied construction timber, but the masts originated from Calabria in the South of Italy, and the Península de Istria (AMN, Colección Sans Baturell, Ms 396, art 5, nº 53, p. 225–226).

The performance of the squadron (1591–1597): from the shipyards to the seabed

The new squadron was most likely made up of 12 warships. However, in 1591 the ships were mainly used as merchantmen to carry wheat, wool and other commodities (AGS, GYM, leg. 324, doc. 213, 3 August 1591, Naples). In the ensuing year, it seemed that the ships remained inactive in southern Italy, a circumstance that Ivella could not afford because he needed funding, both to maintain associates close to him and also to ensure the economic viability of the squadron. Thus, in April 1593 he offered his ships to the Spanish Crown when he realized that the Merchant Guild of Seville (Casa de Contratación) had set up negotiations with the Genovese to build galleons to protect the Indian trade (AGS, GYM, leg. 387, docs 610–612, Naples 9 April 1591). Ivella channelled his pretensions through the Duke of Medina Sidonia who backed the captain by writing a long report supporting the convenience of electing the squadron of Ivella to protect the trade (AGS, GYM, leg. 387 doc. 609, 30 May 1593). In the meantime, Ivella continued offering the service of the squadron to the King. During the winter of 1594 Philip II issued orders to his viceroy of Naples to extend the original contract signed in 1590 with Ivella (AGS, GYM, leg. 388, doc. 301).

Consequently, the King had at his disposition a nine-galleon squadron, including the galleon Santiago de Galicia, which was acknowledged as the ‘Almiranta’ of that squadron. Jacome Juan de Polo was the captain and owner of the vessel. The economic records of the ships, stored in Simancas, clearly state that Jacome Juan de Polo was enlisted by contract with the Galleon Santiago [hereafter CMC], 3º época, leg. 2556). From the outset of 1595 to July 1596 the captain received considerable funds from different hands in Naples, Seville and Lisbon to pay the crew, supplies and transportation of materials. During June and July 1596 carpentry works were carried out in Lisbon. In the accounts of these works many materials were specified such as 36 planks from Prussia, 96 planks of ordinary pine from Flanders, 12 squared pine sticks, two oak planks of 28 codos (a codo was 57.46cm), and 24 small pine bars. Don Rodrigo de Cieza, who held the office of tenedor de bastimentos in Lisbon, also provided a significant volume of pine and oak timber from July to October 1596. Amid others, the Spanish Monarchy paid 150 reales for ‘an old pine from Corcubión of 33 codos in height and half wide’ another 276 reales for ‘a new pine, 30 codos long and two thirds of a codo wide, six from the feet, and six with half an elbow from the top’ 150 reales for ‘another new pine, 27 codos long and a third wide, measured at six codos from the top and six codos from the cos’ (AGS, CMC, 3º época, leg. 2556). According to the economic records it is most likely that in October 1596 Juan Jacome Polo sailed from Lisbon to Galicia with the ships because that month in 1596 he received 220 ducats ‘del pagador por cuenta de libranza del Adelantador Mayor de Castilla, pagador general de la armada.’ The Crown paid another 2.176 maravedíes for the carpentry works (maestranza) undertaken in El Ferrol (Galicia, Spain) from 6 to 27 April, 1597. Similar payments were made for further maestranza works undertaken in Ferrol from 28 April to 17 May, 30 June to 20 July and 10 to 30 August 1597 (AGS, CMC, 3º época, leg. 2556).

Jacome Juan de Polo outfitted the ships in Lisbon, and they were consequently re-measured as they had been originally in Naples (AGS, GYM, leg. 303, doc. 20, clause 2).

In 1597 the galleon Santiago de Galicia was sailed through a huge storm, which dispersed a large part of the fleet that Philip II had sent out against England (AGS, GYM, leg. 490, doc. 431, 1597). The Santiago de Galicia was acknowledged as a very sturdy vessel and appointed to carry 91,000 ducats (Fernández Asís, 1943: 338). Afterwards Bernabé de Pedroso documented that the Santiago had reached the Eo estuary, together with two urcas, ‘...so damaged that it is likely a miracle, people on board came badly and ill as a result of the hard work they have had...’ (AGS, GYM, leg. 491, doc. 190). Later it was learned that the galleon Santiago de Galicia had encountered four enemies and fought against the Flemish and English under their musketeer’s fire (AGS, GYM, leg. 491, doc. 139). Damaged by the naval battle and fighting the storm, the Santiago de Galicia hit the sandbanks at Ribadeo and was beached although it was not considered lost by the authorities. The Crown sought to recover the coins and some of the supplies that were
on board. It is most likely that this was done as some of the ministers of Philip II praised the cooperation of Ribadeo’s inhabitants (AGS, GYM, leg. 491, docs 146, 226, 335). In November 1597 there were delivered payments in Ribadeo like the 1500 reales ‘que Tomás Blanco capitán de este galeón recibió en la villa de Ribadeo de los dineros del cargo del pagador general Juan Pascual por mano de Lope García de Tinoco’ (AGS, CMC, 3ª época, leg. 2556). In a letter sent to Philip II, Jacome Juan de Polo blamed the officers governing the vessel for their bad seamanship, which had led to the loss of the ship (Casabán Banaclocha 2015): ‘Due to poor governance, the officers lost her in the village of Ribadeo.’

**Construction features and proportions of the Santiago de Galicia galleon**

An historical document describing the dimensions of the ship was found in the Archivo del Museo Naval de Madrid (AMN, Colección Sans Baturell, Ms 396, art 5, nº 53, p. 226–227) (Table 2, Figures 3 and 4). Dimensions given in this document are provided in codos. The measurement conversion used here is based on the 16th-century codo de ribera from northern Spain. This unit of measurement was the equivalent of 57.46cm (Casado Soto 1988: 58–67; Grenier et al. 2007: III, 17).

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Codos</th>
<th>Metres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keel</td>
<td>44.50</td>
<td>25.36</td>
</tr>
<tr>
<td>Weather deck</td>
<td>61.00</td>
<td>34.77</td>
</tr>
<tr>
<td>Carling</td>
<td>60.00</td>
<td>34.20</td>
</tr>
<tr>
<td>Beam</td>
<td>20.50</td>
<td>11.68</td>
</tr>
<tr>
<td>Depth</td>
<td>13.50</td>
<td>7.69</td>
</tr>
<tr>
<td>Flat of the floor timber</td>
<td>7.25</td>
<td>4.13</td>
</tr>
<tr>
<td>Aft Runs</td>
<td>7.50</td>
<td>4.27</td>
</tr>
<tr>
<td>Fore Runs</td>
<td>2.00</td>
<td>1.14</td>
</tr>
</tbody>
</table>

Table 2. Measurements of the galleon Santiago de Galicia as reported in the historical document.

According to the document, the 12-galleon fleet combined measurements from different origins following English, Bizcayan and Ragusan shipbuilding traditions. This means also that these shipbuilding traditions influenced the shape of the hull. In particular, the proportions of the Santiago de Galicia had a beam to keel ratio of 2.17, a length to beam ratio of 2.93, a depth to length ratio of 4.44, and a depth to beam ratio of 0.66.

In trying to find an archaeological example of a caravel to figure out what the dimensions of the caravel Santiago sunk in Ribadeo could have been, the first scholar to propose the concept of Iberian-Atlantic ships, Thomas Oertling, agreed that ‘it was something of a disappointment to discover that the difference between a caravel or a nao, a nao and a galleon, and so on, could be not discerned based on the construction features’ (Oertling 2004: 133).

**Matching the historical and archaeological data**

In order to test whether the wreck found in 2011 could be that of the Santiago de Galicia we combined in an innovative way a photogrammetric model that was created during the archaeological campaign in 2015 and a 3D model based on ancient shipbuilding
The Ribadeo Shipwreck (c. 1600)

documents drawn from the measurements mentioned in historical documents for the Santiago de Galicia. The aim of this method was to test whether the shipwreck layer matched the historical measurements. The archaeological remains and the hull lines on the seabed were used to match the reconstruction of the shipwreck in the photogrammetric model providing a hypothetical shape and size. In 2015, the main wale of the ship was observed as located at the height of the main deck or first deck on the widest point of the ship. The height of the main deck offered a reference for where to place the 3D model and up to what height the ship was covered by the sand and silt in the estuary. From this data, the 3D-model reconstruction was developed based on historical documents (Figure 3).

On the starboard side, the original measurements were very similar to the reconstructed hull lines and composed of the frames in the wreck, represented in Figure 3. In Figure 3, the starboard side frames and hull line can be seen, with the bow of the ship pointing northwards. The hull line matched the reconstructed 3D ship at the height of the widest deck (Figure 4) or the first wale, and the frame lines along the starboard side of the wreck.

In the reconstruction in Figure 4, different parts of the ship can be seen coloured depending on the source used for interpretation. From top to bottom we have: the bow and stern castle decks in brown, based on the Spanish Ordenanzas from the early 17th century, which represent an estimate of the potential height of the ship in these upper structures; in green, the weather deck; the lower gun deck, in the middle showing the widest point of the ship or beam, as inferred from the measurements reported in historical documents for the Santiago de Galicia; and underneath, in blue, the orlop deck and the bilge at the very bottom (in blue on the sides, black in the middle), which was estimated taking as reference the measurements in green, such as the turn of the bilge line, the height of the first beams and possible height of the ceiling of the bilge. The transom panel can be seen at the right (in brown) and was inspired by how the transom panel is calculated in the Spanish Ordenanzas. The stern post at the left (in blue) was also an estimate from the measurements in the historical document (in green). The turn of the bilge line is marked at the very bottom of the hull in a curved blue line. The keel is situated underneath the bilge area, in green. The stern post is on the left side, in brown. The reconstruction and relationship of these elements were carried out based on archaeological publications and historical data on 16th-century shipbuilding and some of the early 17th-century Ordenanzas and treatises (Escalante de Mendoza 1985; Grenier et al. 2007: III, Hormaechea 2012: 246–294).

Once the photogrammetric model and the 3D reconstruction were completed at the same scale, they were superimposed and we observed that both the dimensions of the wreck itself and the estimates from the historical reconstruction were very similar. Although these theoretical reconstructions cannot serve to state with certainty that the shipwreck is the Santiago the Galicia, at least they do not rule out the ship as a potential candidate.

Have we identified the ship with a multidisciplinary approach?

Our multidisciplinary research has led to the hypothesis that the Ribadeo shipwreck corresponds
to the *Santiago de Galicia* galleon of Ivella’s fleet, built in Castellamare di Stabia, nearby Naples, Italy, around the early 1590s. According to the historical sources, the *Santiago de Galicia* galleon sank in Ribadeo in AD 1597. The artefacts found around the shipwreck together with the archaeological data—measurements and construction features—indicate that the ship was very likely a galleon. A crosscheck of the archaeological data and the measurements provided by historical sources for the *Santiago de Galicia* ship does not refute the hypothesis that this is the galleon that sunk in Ribadeo. As noted, the economic records of Juan Jacome Polo demonstrated that in November 1597 the ship was in Ribadeo (AGS, CMC, 3ª época, leg. 2556). However, there are several aspects to consider that hamper the identification of the shipwreck with certainty.

We have not found in historical documents information about the measurements and dimensions of the *urca* and the caravel *Santiago* that sunk in the estuary respectively in 1597 and 1604. Conceptual approaches trying to find consistent ‘ship types’ have proven to be problematic and there has been a great terminological confusion. In this case, the *Santiago de Galicia* is defined in historical documents as a galleon. However, to determine whether the Ribadeo shipwreck was a galleon, a caravel or an *urca*, would be rather difficult due to the lack of fully preserved examples to be compared and we can only speculate in light of the associated artefacts. The words *caravel, urca and galleon* were used in different languages, but they did not represent a coherent and consistent shape of vessel through time and space. The lack of documentary information hampers carrying out the construction of a theoretical model for both ships to be crossmatched with the archaeological reconstruction we have made for the shipwreck. Therefore, those ships cannot be ruled out based on actual historical documents, and only if the shipwreck is fully excavated would we be able to improve our model and assess whether its dimensions correspond to the ones reported for the *Santiago de Galicia* galleon.

Dendrochronological research on 48 samples has resulted in the dating of two silver fir planks from the inner structure to after 1580. The natural distribution of this species comprises mostly central Europe, the Pyrenees, Balkans and Carpathian mountains, therefore this wood could have been available in Adriatic, Central and Western Mediterranean shipyards as well as in North European ones. Consequently, the provenance of this wood cannot serve as an indicator of the shipyard in which the ship was built. The absence of matches between oak samples collected in both campaigns suggests that the wood from the Ribadeo shipwreck originates from different areas. This would be in agreement with the information found in historical sources about the different provenance of the wood used to build the *Santiago de Galicia*. However, the lack of well replicated oak reference chronologies for the historically identified areas (southern Italy and Albania) impedes establishing the date and provenance of the oak timbers by dendrochronological methods. More samples should be collected from the shipwreck in order to achieve mean curves from different timber elements, as they have higher chances to be crossmatched with reference chronologies over individual samples. Furthermore, future dendrochronological work should focus on collaboration with Italian researchers and on the development of tree-ring reference chronologies for Albania and the rest of the Balkans—one of the remaining gaps in European dendrochronology.

These findings are the preliminary conclusions of an ongoing investigation and offer many potential lines of research inquiry for the future. The archaeological campaigns carried out so far have only involved prospective works. An archaeological excavation would be the desirable step forward to finally confirm the identity of the ship. After the 2015 study, the wreck was covered by a mesh that proved to be effective against the estuary’s currents. However, such temporary preservation interventions cannot be considered lasting. The preservation of the shipwreck is incompatible with the present activity of the harbour, and is constantly challenged by the mechanical influence of strong tidal currents, merchant traffic and biotic organisms that affect its integrity. Short-term action is needed to protect the wreck in this endangered area. In this way, not only the shipwreck but its full history can be preserved as valuable heritage and as source of data for future research.

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