

Introduction

In the 16th century, Mediterranean shipbuilding was renowned throughout Europe. Master carpenters, particularly those from the Italian States, were sought after for the quality of their work and their high degree of technical knowledge. This technical culture inherited from centuries-old tradition passed down orally from generation to generation. But today it is largely unknown because in addition to the scarcity of written documentation, there is also a lack of archaeological documentation.¹ This observation has led Renaissance-period Mediterranean shipbuilding to become a research priority over the last thirty years.

The Mortella wrecks: a valuable source of information

In this context, the discovery of the Mortella wrecks (Bay of Saint-Florent, Upper Corsica) in 2005 and 2006 provides a valuable source of information that may significantly enrich this documentation on 16th century Mediterranean naval architecture.² This aim led the *Centre d'Etudes en Archéologie Nautique* (CEAN) to undertake an excavation programme on one of them—the Mortella III—between 2010 and 2015, which mainly focused on the study of the particularly well-preserved remains of the hull. This project, financially supported by the French Ministry of Culture and its *Département des Recherches Archéologiques Subaquatiques et Sous-Marines* (DRASSM) as well as by the Territorial Communities of Corsica (CTC), has been the subject of a scientific collaboration agreement with the *University of Paris-Sorbonne* and the *University of Corsica Pasquale Paoli*. It has been recently awarded by the *European Marie-Curie Programme* (MSCA, IF No. 843337) and supported by the *Spanish National Research Council*, CSIC.

More than ten years have passed since the site was discovered. This allows us to retrace the long journey of

a study that has been punctuated by doubts, questions, sometimes false leads, but also discoveries and answers to essential questions. It gives a perspective and maturity to the research work that justifies the writing of this book even if the excavation of the wreck of Mortella III is not yet fully completed. During the initial five years of excavations, the work objectives were defined in such a way as to try to provide answers to the major problems raised by the archaeology of Renaissance ships in the Mediterranean maritime space.

The issues addressed and the objectives of the study

Several issues related to shipbuilding processes and naval architecture are addressed in this book but it should be pointed out at the outset that all are linked to underlying spatial questions. From the end of the 1980s, influenced by Th. J. Oertling (OERTLING 1989 and 2001), archaeologists working on the Renaissance period, Brad Loewen among others (LOEWEN, 2001), sketched the features of the ‘Atlantic’ tradition. This was identified using common ‘traits’, in contrast to a ‘Mediterranean’ tradition. The work, carried out on the wreck of Villefranche-sur-Mer dated 1516 (GUEROUT, RIETH and GASSEND, 1989) has helped to identify certain specific ‘Mediterranean’ features that have been described as ‘architectural signatures’ (RIETH, 1998). As a result, the constructive and architectural study of the Mortella III wreck seeks both to situate it within the ‘Mediterranean nautical space’ to which it belongs, and also to define, as far as possible, the limits of this large and still somewhat loose concept, whose contours should be tightened.

Even if it is still too early to be able to link the construction of the Mortella III wreck to a sub-area of the Mediterranean maritime space, it shall initially be addressed from a spatial perspective. The first step is to identify and list the processes used, specifically the assembly of timbers, fastening methods and all the technical solutions applied to the building of the framework. Their inclusion in a tradition of Mediterranean-style building, primarily aims to confirm the ‘technical markers’, called ‘technical fingerprints’³ in our text, that have already been characterized, but also to identify new ones.

Two other issues addressed in this book concern the ‘architectural project’, in other words, they are related to the design of the hull. Their main objective is to contribute to the knowledge of hull design in the 16th century, which is essential to understanding the transition that took place

¹ The only 16th century wrecks of ‘Mediterranean construction’ whose architectural remains have been studied to date are: the wreck of Villefranche-sur-Mer (GUEROUT, RIETH, GASSEND, 1989) and the wreck of Calvi I in Haute-Corse (VILLIE, 1989, 1990 and 1991). The Ottoman wreck of Yassi Ada also contributes to the Eastern side of the Mediterranean (PULAK, 2005 and LABBE, 2010). Two other wrecks with high architectural potential have been the subject of excavation programmes: Gnalic (Croatia) in 2004 and since 2013 and Delta II (Cadiz, Spain) in 2012, but, to our knowledge, their architectural study has not been yet published. Two other 16th century Venetian wrecks found in Croatia, Sveti Pavao (Mljet Island) excavated between 2007 and 2016 (BELTRAME, GELISHI, MIHOLJEK, 2015) and the Brsecine wreck also seem likely to reveal architectural information.

² The sites of the Mortella owe their name to the Genoese tower of the same name located at the western end of the Bay of Saint-Florent, which is the closest geographical reference point. The 16th century wrecks discovered in 2005 and 2006 were named Mortella II and III. The site of Mortella I is a mooring place located at the foot of the tower where ceramic shards attest to its activity over the past centuries.

³ We borrowed the word ‘fingerprint’ from O. Crumlin-Pedersen (CRUMLIN-PEDERSEN, 1991).

during this period between architectural design inherited from rules of the Middle Ages, and the definition of new criteria characterizing the ship of the modern era. The work presented here addresses three major issues related to ship design. They are studied in relation to spatial dynamics and, in this context, we have sought to highlight ‘architectural markers’—called ‘architectural traits’—that could constitute Mediterranean specificities.⁴

The first issue concerns the proportions of the ship. The written sources depict the 16th century as a significant period of transition in the field of naval architecture, with the evolution of the old ratio rule ‘*As-dos-tres*’.⁵ During the Renaissance this became generalised and produced very ‘round’ seafaring ships, built using more efficient proportions intended for Iberian navigation dated from 1580-1590 onwards.⁶ This question of ships’ proportions is an essential field of study in naval architecture because it determined, to a large extent, their shape and nautical specificities. However, archaeology has not yet given much attention to this theme. In order to situate the wreck of the Mortella III in the context of contemporary technological developments, it seems important to us, at the end of this study, to set out as precisely as possible the proportions of the ship and to draw conclusions about its nautical characteristics.

The second issue is related to her shape, and in particular that defined by her master-frame, which French manufacturers referred to as a ‘*figure*’. This is the founding element of the ship’s geometry, as is the case with all those—like the Mortella III—designed according to a transversal principle specific to the ‘frame-first’ construction. The study of the shape of the master-frame is carried out with particular attention to its design method and to the shape of its floor-timbers.

Finally, included in the study of the ship’s design, the excavation of the remains of the hull of the wreck of the Mortella III has been carefully observed in order to identify traces of the design method used to build the structure. During the Renaissance period, the Mediterranean method of predesigning the geometry of the frames located between

the tail frames was widely used. Archaeologically, it has been documented in the Mediterranean with the wreck of Cala Culip VI, which gave the oldest evidence of it (RIETH, 1998), or with that of Aveiro A, for example, for the Atlantic area (ALVES *et al.*, 2001). The studies carried out in this field and over our period suggest moulded frames were used in the construction of the structure of the Mortella III wreck. Some observations made during the excavation have already led to remarks to this effect, particularly with regard to the nailing of the frame’s timbers. But a complete dismantling of an important part of the structure would have been necessary to find surviving traces of this moulding method, as far as it could be detectable. Unfortunately, this task was not possible in the programme of our excavation.

We address the issues that have been mentioned, relying on technical data and considerations, but also on documentary and historical references: This work seeks above all to contribute to the definition of the contours of technical culture and know-how highlighted by the excavation. The results of this study should therefore shed light on the constructive and architectural characteristics of a large 16th-century ship in the Mediterranean during a particularly important period of transition. The architecture of the Mortella III ship carries both the rules and architectural characteristics inherited from the Middle Ages as they are currently highlighted by archaeological research (see, among others, RIETH, 2016), and potentially the technical innovations that prefigured the modern era.

Over time and during excavation campaigns, a delineation of this very general objective has gradually taken place and it is ultimately the profile of a Genoese commercial ship from the first third of the 16th century that has emerged, even if some of the conclusions that lead to this portrait still need to be refined. Finally, this study aims to place the ship in an Italian typology during a period that is now well circumscribed, and attempts to recover its essential nautical characteristics.

The limits of the archaeological study

Once the outlines of the ambition of this work have been defined, it is immediately necessary to specify its limits. It must be said there were unfortunately many, which often acted as a brake, and sometimes a source of frustration, in the desire to go deeper into the study of the remains of the Mortella III wreck, and to draw further conclusions using archaeology. Here are the two main ones we faced:

- First, the technical (and related financial) difficulties that have arisen in order to methodically excavate a wreck the size of the Mortella III in nearly 40 meters of water are enormous. The constraints posed by decompression and safety issues, the very short working times imposed by the hyperbaric environment (maximum 50 minutes per person per day) constituted a major limitation to the archaeological excavation. This prohibited, for

⁴ We use the word ‘architecture’ in its original meaning, which links it to a notion of design to clearly distinguish it from construction techniques: ‘Ship architecture is the art of designing ships...’, Michel Benicourt, definition given in the article in the *Encyclopedia Universalis*.

⁵ The so-called ‘*As, dos, tres*’ is a rule of proportion whose origin dates back to the Mediterranean Middle Ages. It establishes a principle of proportionality between the beam (*As*), the keel length (*dos*) and the total length of the boat (*tres*). It was summarized in 1611 by the Spanish shipbuilder Thomé Cano (CANO, 1611) as follows: ‘...all the Spanish, Italian and other masters of shipbuilding have the practice of giving to one ‘*codo*’ at the beam, two to the keel length; and to another ‘*codo*’ at the beam, three to the overall length, and to three ‘*codos*’ at the beam, one to the flat wide; and for the depth of hold, three quarters of the beam.’ The rule of ‘*As, dos, Tres*’ is detailed in Chapter I of this book and the question of the proportions of the Mortella III wreck is addressed in Chapter V.

⁶ This movement, which was born in Spain under the impetus of manufacturers such as Juan de Veas or Rodrigo Ramirez, is known as ‘*Nueva Fabrica*’. Of Atlantic constructive origin, it leads to proportions that will be institutionalized in the Spanish Ordinances of 1607, 1613 and 1618 and which generate ships with more elongated shapes with a width/length ratio between 3 and 4.

example, the dismantling of the structure—except in very specific cases—and observations as exhaustive as those on sites located in shallow waters. Thus, the architectural study is based on partial observations that cannot be compared with sites where all the structural parts have been brought to the surface and recorded ashore.

- A second major limitation to archaeological analysis is the product of the fire that destroyed the ship before it sank and the combustion of the dead-works. In underwater archaeology, wrecks often lie on the seabed leaning on one of their sides. If the conservation conditions are good, it enables the study of a high percentage of the hull. This was the case for significant 16th century wrecks such as that of Villefranche-sur-Mer (France, 1516) for the Mediterranean or that of Red Bay (Canada, 1565) or also that of Mary-Rose (United Kingdom, 1545) for the Atlantic. In all three cases, the study of the remains made it possible to reach at least to the third futtock of the frames. This is not the case for the Mortella III wreck. Although the anaerobic conditions of the sediment allowed it to be well preserved, the ‘flat’ position of the wreck on the seabed and, above all, the combustion of the dead-works prevented our access to the remains of the frames beyond the first third of the second futtock. This limits our confidence in hypothetical reconstruction of the ship’s hull form, which instead must be estimated according to several hypotheses above the waterline.

Once these caveats have been made, the work in the next few pages are organized as follows:

Before getting to the heart of the archaeological study of the Mortella III wreck, it seemed desirable that the first two chapters of this book be devoted to:

1. A more detailed and in-depth presentation of the problems generated by the remains of the hull that were briefly mentioned above. The aim is to provide as complete an overview as possible of the various questions currently raised by the excavation of a ship from this period and to consider the answers—or elements of answers—that the wreck of Mortella III is likely to provide. These questions serve as an opportunity to survey the field of Mediterranean shipbuilding and architecture in the 16th century.
2. The general presentation of the site to help the reader to visualise it and fully understand its organization, chronology and dynamics. This general overview references the site of Mortella II, which we now know with certainty is linked to the same historical event as that of Mortella III.⁷ Although not very abundant and somewhat tangential to the present discussion, the artefacts of the Mortella III site are also

briefly reviewed. These are essential to pinpoint the chronology of the ship and without which any attempt at a constructive and architectural study would be in vain. The section on chronology also presents the 2013 dendrochronological study which achieved a precise dating of the ship.

Finally, the general description of the layout of the Mortella III site allows us to reflect on the elements that contributed to the shipwreck, and ends with a presentation of the research programme with its various lines of research and the methodology of the excavation work.

The study of the hull structure—which remains at the core of this book—is approached through consideration of construction methods and techniques, on the one hand, and the architecture of shapes and proportions, on the other. These two approaches are discussed in separate chapters. From a methodological point of view, it seemed important to separate everything related to construction and what F. Braudel defines as ‘this long series of human gestures that are at the root of what is called technical culture’ (BRAUDEL, 1979), from what is part of the ship’s architecture itself. In other words to make a clear distinction between what falls within the scope of the building technics (scarfs, fastening, caulking and all the technical solutions to the problems posed by the construction of a wooden structure intended for navigation in general) from its architectural and design concepts (geometry of its shapes and proportions) that set out the nautical characteristics of the ship. The notions of architecture and construction techniques are in constant interaction and, in fact, their boundaries are sometimes tenuous. But if we take them in their original sense as mentioned in Note 4, they touch on two conceptually different themes: design and manufacture.

Construction techniques

Construction techniques are covered in Chapters III and IV. Chapter III deals exclusively with hull structures. A study of transverse and longitudinal structures is carried out. In particular, the following are examined:

- The types of connections used to join the timbers, the types of scarfs used in the extension of longitudinal and transversal structures; the way in which the pieces are joined, etc.
- The systems for fastening the timbers, and in particular of the planking to the frames, alongside the nailing and pegging methods.
- The caulking and sealing products used.

We have also opted to address the ‘attributes of the hull’, in a separate chapter, Chapter IV. These are three architectural ensembles which are not formally part of the hull *stricto sensu*, but which are physically associated with it and which are closely linked to it considering their function:

⁷ Apart from their geographical proximity and similarity of artefacts, proof of the link between the two wrecks was provided by the lithic study of their ballast, which revealed that it shared an identical geological make up (see Annex VI)

1. The mast-step which is, as we will see, a remarkable structure in many respects.⁸ This is a work of art related to the movement of the hull.
2. The water removal system. It is represented by the remains of the ship's pump. We are dealing here with a device related to the hull's flotation.
3. The rudder. This steering system is essential; its function is to control the direction of the hull.

The architecture of the ship

Next, the architectural question is addressed. Its aim is to return to the architectural project, using the study of the shapes and proportions of the ship to highlight what could constitute its Mediterranean characteristics, thereby moving beyond construction techniques. At this level, attention is focused on:

- Questions of proportions: trying to approach the point of view of the builders of the time, particularly studying the relationship between the maximum breadth, the length of the keel and the total length of the ship.
- The rising of the floors and the form of the hull. This will focus on the shape given to the master-frame and the way in which it is designed. This one is decisive in the general shaping of the hull and is at the heart of current issues in naval architecture.

Archaeological sources

To achieve the mentioned research objectives, the archaeological data available for the Mediterranean—beyond those provided by the Mortella III site—have been considered, in particular that of the wreck of the presumed *Lomellina* (1516). This was excavated in the bay of Villefranche-sur-Mer by the GRAN ('*Groupe de Recherche en Archéologie Navale*') between 1979 and 1988 under the direction of Max Guérout (GUEROUT, RIETH and GASSEND, 1989). It is one of the few Mediterranean wrecks of our period that has been the subject of an architectural study. Alongside a similar chronology, there are many commonalities between this wreck and the Mortella III ship. These make the Villefranche wreck an essential reference point to base a comparative account that allows many parallels to be drawn and considerably enriches archaeological reflection.

In the same comparative perspective, this study is also based on documentation from the excavation of the wreck of the presumed Basque whaler *San Juan* (1565) carried out in Red Bay (Labrador, Canada) by the Parks Canada team between 1978 and 1985 (BERNIER, GRENIER *et al.*, 2007). The use of a large volume of archaeological data recorded on this 'Ibero-Atlantic' technical tradition wreck, which has been given a prominent place in the architectural

study carried out by Brad Loewen, is very useful to characterize the construction methods and Mediterranean-style architectural design of the Mortella III wreck.

Other wrecks such as the Calvi I, dated from the end of the 16th century, and the Cala Culip VI (RIETH, 1998, PALOU *et al.*, 1998, PUJOL I HAMELINK *et al.*, 1994) of an older period (early 14th century) are used as references for 'Mediterranean construction'. For 'Atlantic shipbuilding', there are more wrecks and the *Mary Rose* (1545) (MARSDEN, 2009), is of course used as a reference. In addition to the Red-Bay wreck mentioned above, the milestones offered by the Ibero-Atlantic wrecks selected by Oertling are consulted, in particular those whose chronology is close to Mortella III, such as the Cattewater wreck, dated early in the 16th century (REDKNAP, 1984). Nevertheless, wrecks of older or more recent chronology, such as those of *Nossa Senhora dos Martires* dated 1606 (CASTRO, 2005) or Aveiro A (ALVES *et al.*, 2001), dated from the 15th century, which have been meticulously studied, also provide very useful reference points and comparisons for the archaeological analysis of the remains of the wreck of Mortella III.

Documentary sources

Beyond the shipbuilding study, research into the literature has been based on written sources, construction treaties of the period and, when it has been possible, on iconography.

As archaeological and historical studies suggest the wreck of the Mortella III to be of Italian origin, it seems appropriate to give priority to its architectural analysis in the light of Italian written sources. Unfortunately, these are not very common for the 16th century. An important resource for this century, however, is the '*Instructione sul modo di fabricare galere*' by the Venetian Pre Theodoro de Nicolò published in 1550 (PRE THEODORO, 1550). It is also worth mentioning the discovery, about ten years ago, of the manuscript of the treatise of the Ragusan (Dubrovnik) Nicoló Sagri, *Il Carteggiatore* (SAGRI, 2010), dated from the second half of the 16th century, found in an American library, which sheds new light on shipbuilding in the Western Mediterranean but also on navigation and life on board.⁹

Apart from the Sagri Treatise, Mediterranean references must be drawn essentially from Venetian sources of the 15th century. There are four main texts, which are primarily

⁸The mast-step of the main mast is a good example of a device that could be analyzed from a technical and constructive point of view as a technical system participating in the ship architecture. This is the first meaning we have given priority to, considering that it does not directly influence its nautical characteristics.

⁹Nicoló Sagri (1538-1571) was an officer of the Ragusan Navy (now Dubrovnik) in charge of training the personnel on board, a role that motivated the drafting of his treaty. This is a 105-folio document recently found in the United States in the James Ford Bell Library at the University of Minneapolis. Although it was lost, its existence was known because of its evocation by Bartolomeo Crescentio in his treatise *Nautica Mediterranea* (CRESCENTIO, 1607). In fact, this text, which is of great value for the knowledge of Mediterranean shipping and shipbuilding in the 16th century, had been sought in vain in Italy for years by Augustin Jal (JAL, 1840, Vol. I, 25). The Treaty of Sagri—written in Italian—provides an overview of Italian-influenced shipbuilding, with Ragusan shipbuilding being considered as a regional variant in the same way as Venetian, Genoese or Neapolitan shipbuilding.

concerned with ships of the galley family. The first two are dated from the first third of the 15th century. First, the '*Fabrica di galere*' (ANONYMOUS, 1410) which is mostly a copy of Michele da Rodi's '*Libro*' (MICHELE DA RODI, early 15th century.) Then the third text, dated from the middle of the 15th century, is the '*Libro*' by Zorzi Trombetta da Modon (ZORZI TROMBETTA, 1445). Finally, the '*Ragioni antique spettanti all'arte del mare et fabriche de vasselli*' (ANONYMOUS, 15th century) written towards the end of the 15th century. These texts have sometimes been likened to inventories of 'technical recipes' for shipbuilding. But in fact, there is very little mention of construction techniques in these texts. While it is true that they follow the same model, setting out long lists of austere measures, their merit is to draw a portrait of ships of their time through relating all these measures. This information, which is sometimes very detailed, provides useful information on the dimensions, proportions and shapes of the ships and, in short, provides a profound insight into Italian, or more precisely Venetian, naval architecture.

Finally, in terms of Italian sources, mention should be made of two later texts that clearly set out the method of pre-designing the frames. These are: The '*Visione*' by Baldissera Quinto Drachio (DRACHIO, 1594) written in 1594 which describes the method of designing a 43-metre galley and Bartolomeo Crescentio's later treatise of 1607, (CRESCENTIO, 1607), which describes the features of a galley. In fact, all the texts we have quoted are less concerned with describing the characteristics of sailing ships than with those of rowing ships, such as galleys, a likely reflection of their primacy in the 16th century in the Mediterranean, at least in Venice.

But our understanding of 16th century naval architecture would be fragmentary and incomplete solely using Venetian texts. When studying the wreck of the Mortella III, even if we focus upon the Mediterranean, the Iberian texts of the 16th and early 17th centuries, which refer to an 'Atlantic design' of shipbuilding, remain essential to understanding and interpreting its architectural remains.¹⁰ There are about ten of them, among which we would like to mention three Spanish treaties, three Spanish Ordinances and three Portuguese treaties:

For Spain, Thomé Cano's treatise, '*Arte para fabricar... las naos*' (CANO, 1611) and Juan Escalante de Mendoza's, '*Itinerario...*' (MENDOZA, 1575) are significant. These shipping and shipbuilding treaties are part of the '*la nueva fabrica*' movement mentioned above. It is also worth mentioning Diego Garcia Palacio whose treatise, although published after Escalante's, reflects an older and less innovative conception of Spanish shipbuilding (GARCIA PALACIOS, 1587). Moreover, the Ordinances

of 1607, 1613 and 1618 are of great importance in understanding 16th century shipbuilding. We may be criticized for the consistency of our references to these texts, which chronologically date back to the beginning of the 17th century. It should be noted, however, that the latter codified the Laws of Spanish shipbuilding with an unprecedented level of precision and constructive detail. Their importance in the study of 16th century shipbuilding is immense because they constitute a remarkable synthesis of its evolution and the choices made by the promoters of the '*nueva fabrica*' movement, which originated in the second half of the 16th century. Their richness lies in the fact that they enable the identification of the evolution of construction, but also the 16th century design principles caught between the Middle Ages and carrying the seeds of modernity of which '*la nueva fabrica*' is an indisputable vector.

On the Portuguese side we will mention three scholarly texts, now well known: Father Fernando Oliveira's '*Livro da fabricas das naos*' (OLIVEIRA, 1570), João Baptista Lavanha's '*Livro primeiro da arquitectura naval*' (LAVANHA, 1610) and finally, later, Manoel Fernandes' '*Livro de traças de carpintería*' (FERNANDES, 1616).

All these Portuguese and Spanish texts form an Iberian corpus of early modern shipbuilding that contributes to the definition of an 'Ibero-Atlantic' type of ship. As for the Venetian texts, albeit through a somewhat simplistic regional prism, they nevertheless make it possible to sketch out a 'Mediterranean' vision. The architectural study of the remains of the hull of Mortella III wreck cannot be carried out without constant reference to these documents.

The sources of the historical perspective

Finally, this work ends with an historical contextualisation that remains at the core of archaeological study.

This is the purpose of Chapter VI, which deals with historical issues, first with the aim of attempting to identify the ship of Mortella III, but also with a view to contextualising this ship within its historical period. The basis and nature of this work remains an archaeological work and, from this point of view, a resolutely technical study. It is nevertheless true that the intimacy of the links between archaeology and history would not allow a complete, intelligible and satisfactory analysis to be carried out without incursions into the field of historical sciences. The historical analysis is limited to an approach that pursues a double objective.

The first concerns the study of the various historical episodes likely to identify the wreck and its origin. This work is based on the results of literature research carried out in Italian, French and Spanish archives and libraries since 2005. As pointed out at the end of this study, there is a body of evidence suggesting that the wrecks of the Mortella are of Genoese origin and the documents located today enable us to link them to an episode from 1527 which

¹⁰ A particularly comprehensive technical study of these texts and Iberian shipbuilding was recently published by Cayetano Hormaechea (HORMAECHEA, 2018). On a more historical side, a collective publication led by David González Cruz (GONZÁLEZ CRUZ *et al.*, 2018) also provides an in-depth insight into the topic.

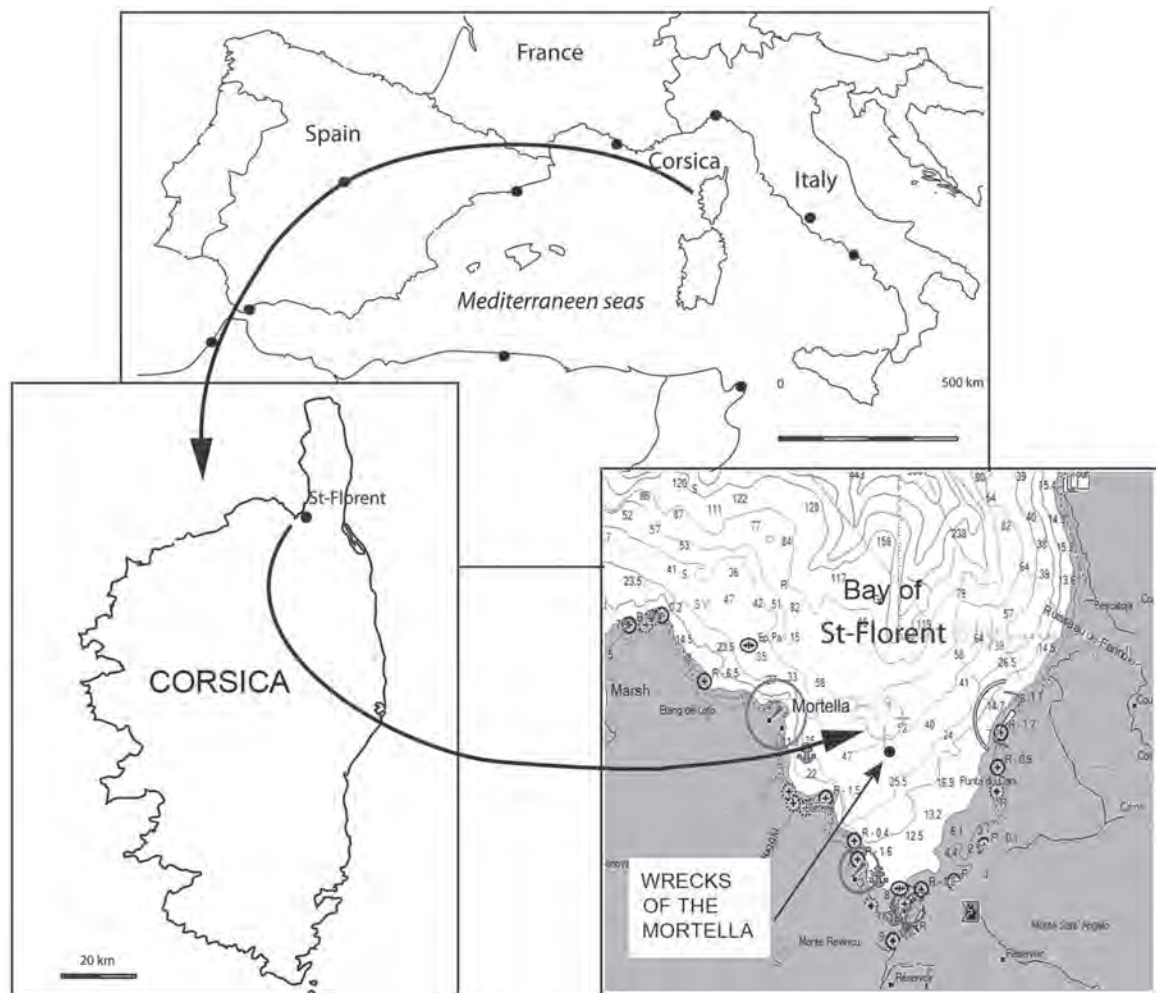


Figure 1. Geographical location of the Mortella wrecks (Illustration: Arnaud Cazenave de la Roche).

remains the main historical hypothesis favoured to date. These conclusions are essential to place the architectural remains in their geographical and chronological context, a crucial step for the construction methods and architecture of the ship to take on their full meaning.

Once this chrono-geographical framework has been defined, the second objective of the historical approach is to place the shipwrecked vessel in the geopolitical and economic context of its time. As we will see, the latter can be helpful in understanding certain options chosen by the builder, both in terms of the constructive characteristics of the ship and its shapes and proportions.