1

Introduction

Strings, cordage, or something that ties things together is such a fundamental part of everyday life that it is completely taken for granted.
(Hardy 2007: 271)

Making cordage is one of the greatest and earliest achievements of modern human development. Archaeological evidence, both direct and indirect, suggests that people have exploited fibre or animal fur to make strings since the beginning of the Upper Palaeolithic (Adovasio et al. 1996: 531; Stannard and Langley 2020: 2). Plant technology involving the twisting of fibres to make cordage produced the "unseen weapons that allowed the human race to conquer the earth" (Barber 1994: 45), enabling people to tie things together and boosting the development of composite technology (Hardy 2008: 272).

Strings and cordage have played a crucial role in many maritime activities, including fishing, boatbuilding and seafaring, and would have been essential in early migrations and the colonisation of islands (Balme 2013: 72; O'Connor et al. 2011). Ancient fishermen and colonisers could not have assembled and held together the buoyant elements, such as reeds, bamboo or wooden logs, that were required to make rafts without some sort of string or cordage. When maritime communities developed more complex vessels, they would have transferred this technology to more complex boats and ships, tying their planks together with cordage of various materials. Hence, it is no surprise that sewn-plank construction has been practiced throughout history and is found worldwide.

Sewn technology was predominant in the western Indian Ocean during the medieval period (Agius 2007a: 161; Bowen 1952: 202; Casson 1989: 63; Hornell 1970 (1946): 234; Hourani 1963: 92–97; Johnstone and Muir 1962: 59; McGrail 2001: 71–72; Mookerji 1912: 31; Moreland 1939a: 76–74, Prins 1986: 66–67). Sewn-plank ships that sailed in this region during the Premodern Islamic period (622–1500) were agents of trade, religion and culture. They connected the Indian Ocean and littoral Islamic world in significant ways, carrying people, goods and ideas back and forth between East Africa and China. Yet relatively little is known about them. The few textual references to sewn-plank boats in the region, for the most part, lack any technical detail or specificity. Instead, archaeological evidence provides the best information for us to deepen our understanding of these ships and the material culture they represent. This work undertakes a comprehensive and interdisciplinary analysis of Islamic-era sewn-boat technology in the Indian Ocean to date, with a particular emphasis on a collection of sewn planks from al-Balid and Qalhat, Oman (Belfioretti and Vosmer 2010; Pavan et al 2018: 226–229; Pavan et al. 2020: 190–194).

In this book, I provide a technical analysis of the al-Balid timbers within a comparative context. I have approached the study of these maritime findings from a material perspective, analysing the technical details of each plank and identifying their material composition. To achieve this goal, I have employed modern documentation techniques such as photogrammetry to create detailed technical drawings of each timber. These timbers are then compared with the broader textual, iconographic, ethnographic, archaeological and experimental archaeological evidence of sewn boats in the region. Collectively, this process contextualises these timbers within broader material networks in the Indian Ocean during the Premodern Islamic period.

1.1. Aims of the Book and Research Questions

This study contributes to the knowledge of maritime technology in the Indian Ocean in the Premodern Islamic period by providing a detailed and comparative analysis of sewn-plank ship timbers discovered on the Islamic sites of al-Balid and Qalhat with relevant archaeological, textual, iconographic and ethnographic data. Collectively, this places these timbers within the broader picture of material networks in the Indian Ocean during this period and deepens our understanding of the fundamental seaborne/maritime connections that the Islamic world enjoyed with the rest of the Indian Ocean. The main focus of the research is, therefore, to provide the most comprehensive interpretation for this set of evidence, and to achieve this purpose I formulated two leading research questions, which will be addressed throughout the book:

1. What can the al-Balid and Qalhat ship timbers tell us about the nature and development of sewn construction technology in the western Indian Ocean?

What can the materials of the timbers tell us about broader material networks in the western Indian Ocean?

In order to answer my leading questions, I formulated a series of subordinate questions:

a. Do the timbers indicate a single boatbuilding method or do they show any differences in technical patterns?
b. Are any technical features and changes over time evident through a comparative chronological analysis of the timbers?
c. What can the comparison of the al-Balid and Qalhat timbers with other timbers of the western Indian Ocean tell us about the emergence of a wider regional tradition?
d. What are the boatbuilding materials used in the Indian Ocean during the medieval period, and where did they come from?

My analysis of these ship timbers relies on a multidisciplinary approach. Although the emphasis is on maritime archaeology, this discipline is used in conjunction with textual, iconographic and ethnographic data. Between 2008 and 2019, I was privileged to work on several ship reconstruction projects and to conduct maritime ethnographic research in the western Indian Ocean, including the documentation of vernacular vessels from Oman, the UAE, Iran, Qatar, Zanzibar and southern India (Cooper et al. 2020; Blue et al. 2014; Weismann et al. 2014). Some of the experimental archaeology projects involved the reconstruction of sewn-plank vessels dating from the 9th to the 20th century. These reconstructions are *Jewel of Muscat* (Vosmer et al. 2011; Vosmer 2010), the al-Hariri Boat (Staples 2019), and *beden seyad* (Ghidoni 2019). Each vessel was built and sewn entirely with traditional materials and tools by skilled sewn-boat shipwrights from Kerala, southern India. My role in these projects consisted of documenting every aspect of a given vessel's construction. This involved photographing and measuring each component, precisely recording the various boatbuilding processes and techniques, and conducting detailed interviews with Omani and Indian boatbuilders.

These experiences provided me with the essential knowledge and technical skills to undertake this study. They made me familiar with the traditional tools, materials, and techniques used in building sewn vessels, and with the most common technical challenges encountered in their construction. Observing the activities of shipwrights and ropeworkers trained my eyes to recognize the subtle details of the al-Balid timbers and helped me to posit reasonable interpretations of the features I observed. But my experience is not limited to constructing sewn boats. In 2010 I sailed aboard *Jewel of Muscat* on a five-month voyage that gave me a much deeper understanding of the advantages and disadvantages of sewn-plank construction technology. Therefore, the many comments about technical details that I express in this book are rooted not just in my careful examination of the al-Balid timbers, but in my long and intimate association with sewn-plank vessels.

Finally, I believe that direct engagement with boatbuilders and their activities is crucial if we wish to gain a more accurate and detailed understanding of the design, construction, and operation of traditional sewn-plank vessels, and that maritime archaeologists should be encouraged to seek out this direct engagement whenever possible.

1.2. The Study of Boats and Ships

Why should we study sewn ships? One fundamental reason is their crucial role in the economic, social and cultural history of the Indian Ocean. Ships carried cargoes and people along numerous maritime routes intertwining throughout the Indian Ocean, bridging the various communities located along its coasts. Boats and ships also prove to be perfect candidates for revealing technological aspects of a society. Muckelroy underlines this (1978: 3) in his book *Maritime Archaeology* by stating that "in any pre-industrial society, from the upper palaeolithic to the nineteenth century A.D., a boat or (later) a ship was the largest and most complex machine produced." Because of their complexity, boats are good cultural indicators (Hasslöf et al. 1972: 164; Prins 1986: 14–15), and the study of their technical details has the potential to provide insights into the "mind of *homo faber*" more than other archaeological artefacts (Maarleveld 1995: 4). Vessels indeed retain the imprint of the people who made them and their activities on the sea (1978: 4). Shipwrecks and maritime assemblages yield information about their original shape and size, how shipwrights built them and with what materials, how sailors propelled and steered them, what cargo and passengers they carried, their functions and economic activities and, lastly, crews and their belongings.

Ship timbers

Differently from those of a shipwreck, the collections of timbers from al-Balid and Qalhat are only small fragments of the hulls of numerous ships, which are scattered around in a secondary and terrestrial context. Shipwrecks represent time capsules (Gould 2011: 12) and thus the association of their assemblage is the consequence of the same event, which is the sinking of the boat (Gibbins 1990: 377). The collection of timbers I discuss in this book are precisely the opposite, having been removed from their original context and recycled multiple times. Nevertheless, various studies of ship timbers have shown their potential in providing cultural information (Belfioretti and Vosmer 2010; Creasman 2010; 2014; Haldane 1988; Pomey 2012; Vosmer 2017: 200; Ward 2000: 107–128; Ward and Zazzaro 2010). In fact, the al-Balid and Qalhat timbers belonged to vessels that sailed in different periods, stretching over almost five hundred years. This represents an advantage because these pieces of material culture allow both synchronic and diachronic analysis. These timbers can hardly indicate how the vessels looked, and they provide limited information regarding the cargo or the route of the ships. However, by displaying a variety of techniques and materials, they offer invaluable information about different sewn boats and boatbuilding technologies over a considerable period of time, allowing speculation about changing trends and cultural influences

in construction techniques and technology. The advantage of a collection of planks from different vessels covering such an extended period also provide various materials, which, in turn, provides information about possible connections between the material used and construction techniques, boat size or typology; variations in wood species used for boat construction over time can offer interesting insights regarding material trade in the Indian Ocean during different periods.

A Multidisciplinary Approach

Unfortunately, as reminded by McGrail (2014: 133), no matter how well preserved a shipwreck is, archaeological evidence is always incomplete. This is particularly true in the case of the al-Balid timbers. Unlike other disciplines, such as ethnography, geography, sociology and economics, for example, archaeology cannot provide direct information about human behaviour but can only make speculations based on the artefacts created and utilised by the people of the past (Trigger 2009: 29). Therefore, the study of maritime archaeology should also draw upon "supplementary evidence", such as data provided by historical sources, both textual and iconographic, and ethnography (Crumlin-Pedersen and McGrail 2006: 55). This method of research has proven particularly valid for the study of the maritime Arab world, past and present, and more generally of the Indian Ocean (Agius 1999; 2002; 2005; 2007a; 2013; Belfioretti and Vosmer 2010; Vosmer 1996; 1999b; 2007; 2017; 2019). A multidisciplinary approach, such as that used in this work, can be a valid tool for the archaeologist to contextualise the excavated data by relating it to other sources through a comparative analysis (Hasslöf 1963: 132; Vosmer 1999b).

Ethnography and ethnographic analogies have a significant role in my work, due to the considerable scarcity of archaeological evidence of medieval boats in the region. Ethnography has played an essential part in maritime archaeology since the early years of its establishment as a discipline. Muckelroy (1978: 234) remarks that, because maritime ethnographic researches reveal traditions of present maritime communities, they can also provide archaeologists with insights into their past. Studies on traditional boats provide analogies that help researchers explain technical features of excavated assemblages, as well as their function (McGrail 1984: 149).

Ethnographic parallels also have the potential to yield clues for interpreting the social and economic context of the past maritime societies that built and used the boats (Gibbins 1990: 338). Experimental reconstruction projects of sewn ships in the region, such as *Sohar* (Severin 1982; 1985), *Jewel of Muscat* (Vosmer 2010; Vosmer et al. 2011) and the al-Hariri boat (Staples 2019) owe a great deal to ethnography. Experimental archaeology has often borrowed information from ethnographic studies, such as the case of *Jewel of Muscat*, a reconstruction of a sewn vessel based on evidence from the 9th-century Belitung shipwreck (Vosmer 2010; Vosmer et al. 2011). The wreck was not completely preserved and information from Omani traditional watercraft with similar shapes and construction techniques helped to fill in the gaps of the archaeological excavation (2011: 414). Moreover, ethnographic records, along with a team of boatbuilders from Kerala, southern India, where sewn boats are still used, built and repaired (Ransley 2009), proved to be essential during the construction of *Jewel of Muscat*, providing a wealth of information about the fastening process, materials employed and socio-economic context (Vosmer et al. 2011: 417). The Indian Ocean, with its rich maritime ethnographic resource and relative cultural unity, is also an appropriate candidate for the application of this procedure in the study of the al-Balid and Qalhat timbers.

This book is on relatively secure ground with regard to the use of ethnographic parallels. In order to avoid the "pitfalls of presentism" (Gould 2000: 15), interpreting the al-Balid timbers' technical features, such as the sewing-hole patterns, is relatively straightforward and accurate because of their striking similarities with modern sewn boats. As the efficacy of ethnographic parallels considerably decreases as we try to venture into the economic, social, political and religious spheres, the data from similar contexts in contemporary maritime cultures can only provide suggestions or ranges of possibilities rather than definitive explanations. As British archaeologist Tim Insoll remarked (2004: 113–116; 2006: 223), ethnographic analogies are crucial in broadening "interpretative horizons" rather than pursue direct similarities, or "indiscriminate projections of the present onto the past" (Wylie 1985: 105).

The range of interpretations provided by the ethnographic analogies can be then examined and refined in a comparative analysis with other sources. Scholars have remarked about the value of multiple sources (Hasslöf 1966; Vosmer 1999b; Wylie 1985: 105–106), and how both archaeological and ethnographic observations can often make historical sources more comprehensible (Hasslöf 1963: 169). Likewise, medieval textual documents, in concert with the study of the material culture of present maritime societies and technology, can help to further shed light on archaeological assemblages. To conclude, I believe that the "alliance" between maritime archaeology, experimental archaeology, ethnography and history (Vosmer 1999b) provides the most effective research tool for the study of the ship timbers from al-Balid and Qalhat.

1.3. Methodology

In order to complete my research and answer my related questions I have used a methodology that consists of different phases. The first consisted of rigorous documentation of the timbers. Various scholars remark that recording is the most vital step in the process of research and reconstruction of past maritime assemblages (Coates et al. 1995: 294; Crumlin-Pedersen 1977: 165; McGrail 1992: 354; Steffy 1994: 191). Therefore, my method follows Richard Steffy's guidelines for documenting

ship remains (Steffy 1994: 191–213), with some minor alterations and additions.

The al-Balid ship remains are currently stored in the Museum of the Frankincense Land in Salalah, Oman. I selected forty-six of these timbers according to their size and features, and I measured, documented and photographed them during four field trips carried out between April 2017 and April 2019. During the same period, I also documented three ship timbers from the Islamic port of Qalhat on the eastern coast of Oman. It is not the intention of this work to provide a comprehensive study of the material culture from Qalhat, but rather provide a preliminary analysis. The dataset is still very limited compared to that of al-Balid and, at the time of writing this book, only comprises a few timbers, although a further brief survey at the Qalhat site in April 2018 showed a considerable number of timbers, allegedly from boats, still in situ within the masonry of the buildings. Documentation of the timbers has aimed to extract as much information from every relevant piece and place it within a comparative context with the available textual, iconographic, archaeological, ethnographic and experimental archaeological evidence on sewn boats.

The data collected were then incorporated into a spreadsheet to carry out a quantitative analysis of the timbers' main features with the aim to answer my research questions regarding a possible classification of the timbers. This method allowed identification of similarities and differences in the timbers' main features and, possibly, determination of correlations between the overall measurements of the planks and the size of their other elements, such as hole diameters, dowels and frame lashings, as well as their arrangement. The database also served to compare the timbers with other relevant archaeological finds, as well as with more recent ethnographic records from the western Indian Ocean, and data from experimental reconstruction projects carried out in the region.

A detailed photographic documentation of the timbers was carried out using multi-image photogrammetry, a documentation technique that has proved to be particularly suitable in the maritime field (Cooper et al. 2020; Martorelli et al. 2014).

Archaeometric and Botanical Analysis

The next phase of the work consisted of the extraction of wood, fibres and bitumen samples from the most relevant timbers for archaeometric and species identification analyses. The former includes radiocarbon dating analysis (^{14}C) carried out by Beta Analytic on a selection of timbers. Archaeometric analyses, such as Gas Chromatography-Mass Spectrometry (GM-MS) and diffractometric (X-Ray diffraction) were also carried out on substances adhering to the surface of the timbers, such as bitumen. These analyses have proved to be vital tools for the study of archaeological bitumen in the Persian/Arabian Gulf[1] and Oman, from the Neolithic to the medieval period (Connan 1999; Connan et al. 1998; 2005; Connan and Carter 2007; Connan and de Velde 2010; Stern et al. 2008), to determine the source of the bitumen, and whether this was pure or mixed with other substances.

The use of species identification analysis on a selection of timbers also proved to be crucial for my study, and in enabling me to formulate hypothesis about the material trade and fundamental connections in the Indian Ocean. This method is an essential stage in the study of wooden artefacts and is widely employed in maritime archaeology (Belfioretti and Vosmer 2010: 111–112; Flecker 2000: 215–216; 2008; Gale and der Veen 2011; Tomalin et al. 2004: 257; Vosmer 2019: 311). In this book, botanical analysis was not limited to determining the wood species of the timbers themselves, but also of other components such as plugs, dowels and fibre cordage. These analyses can give an insight into which materials boatbuilders used in construction and into geographical areas involved in the material network, as well as a range of possible places where they repaired or built vessels.

Tool marks analysis

One of the aims of my research is to recognize and interpret any marks left on the al-Balid timbers by the shipwrights' tools during the building or repairing of the vessels. These tools are an essential part of boatbuilding, and the evidence they leave behind tells us not only about the technological level of society at the time of a boat's construction, but it also reveals information about the individual men who wielded the tools during the building process.

Maritime ethnographic studies and experimental reconstruction projects in the western Indian Ocean reveal a certain uniformity of boatbuilding practices and tools (Agius 2002: 139–144; Agius 2007a: 144; Johnstone and Muir 1964; Salimi and Staples 2019; Severin 1985: 281–285; Vosmer 2007: 360–365; Vosmer et al. 2011: 422; Vosmer 2017: 185–186). Shipbuilders used a few simple but effective tools to transform rough logs into finely shaped vessels capable of sailing across the ocean. Their typical "tool kit" includes:

- *Saws* of different sizes to cut timbers into general shapes.
- *Adze* to rough- and fine-shape various components of the vessel, particularly curved members such as frames.
- *Chisels* of different sizes for fine-shaping boat parts such as plank seams and complicated joineries. Chisels are always used with a *hammer*.
- *Bow drill* to bore either the sewing- or nail-holes into the hull planking.

Although none of these tools survived in the archaeological record from the medieval period, they nevertheless left specific marks on the surfaces of the timbers, and these marks provide information about the type and, in a few cases, the size of tools used by the shipwright (Figure 1.1).

[1] Hereafter called the Gulf.

Figure 1.1. Boatbuilding tools and their marks on timber: (A-B) saw, (C-D) adze and (E-F) chisel. Photo (D) courtesy of J. P. Cooper.

Sewn boats also require specific tools to carry out the sewing activity, but, unfortunately, these tools leave no visible marks on the timbers. Consequently, stitching tools, which I will discuss in Chapter 6, have been scarcely documented in ethnographic records and are rarely mentioned in sewn boats studies in the region. However, like those used for woodworking, they are simple and highly effective in the hands of a skilled shipwright.