**Archaeological, Historical and Ethnographic approaches to the study of sewn boats – past, present and future**

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**Abstract:**

Sewn-plank vessels have been a pervasive form of ship construction since antiquity. This paper provides an introductory overview of the current state of the field of sewn-plank studies, with a particular focus on the Indian Ocean. It describes the basic function of sewn-plank techniques, and then discusses textual references and historical approaches to the topic. The relevant archaeological evidence is reviewed, and prior ethnographic work relating to the topic is outlined. It summarises numerous experimental sewn-plank reconstructions that have been undertaken and concludes with a discussion of the current directions of the field and suggestions for the future.

**Introduction**

‘The technique of sewing planks was so widespread as to be nearly universal.’ (Prins, 1986: 11)

Boats constructed through the process of sewing wooden planks by inserting organic, fibrous materials inserted through holes drilled in the edges of the planks, have been identified in different time periods and in a variety of geographical contexts. As noted by Said (1991: 107) the distinguishing feature of Arab craft of the Indian Ocean and the Red Sea from antiquity through to the late 20th century, is generally agreed to be “the use of fiber, rather than nails, to sew the planks of hulls together”. Despite the observation by Prins (1986) above that highlights the complexity and reach of sewn boat construction, direct archaeological evidence for this particular type of wooden hull construction is often limited and disparate in most regions outside of the Mediterranean. As a result, studies of sewn boats have drawn on a variety of evidence types in order to understand the range and diversity of sewn boat construction.

This paper aims to establish the context within which sewn boats have been studied to date, and to explore the breadth and depth of sewn boat construction through archaeological, textual, iconographic and ethnographic evidence. It briefly addresses the strengths, weakness and gaps in the extant evidence and specifically notes the approaches to sewn boat technology in the Indian Ocean and by reference, to the Mediterranean Sea in antiquity. It is essentially an overview paper that provides a basis upon which we can attempt to analysis comparative sewn boat technologies and a context for the subsequent papers in this special edition. Ultimately, such an approach could provide a greater insight into the maritime traditions that utilise this specific, and in many ways, quite extraordinary solution to securing hull planks in the construction of boats.

The first modern, academic assessment of the universality of sewn boat construction was undertaken in November 1984, at a seminal conference hosted at the National Maritime Museum, Greenwich, UK (Prins, 1986: 11). The theme was sewn-plank boats, and the fruits of this meeting were subsequently published in the proceedings of the sewn-plank conference in 1985 (Kentley and McGrail, 1985). At the time, the conference assembled the leading experts of maritime sewn-plank technology studying a diverse range of sewn-plank watercraft. The geographical scope of the proceedings was broad, covering sewn-plank vessels in the Atlantic Ocean and Northern Europe, the Mediterranean Sea, the Indian Ocean, South East Asia and the Pacific. A year later Prins (1986) published his seminal work entitled *A Handbook of Sewn Boats: The Ethnography and Archaeology of Plank-built Craft*, also as part of the National Maritime Museum, Greenwich Maritime Monographs and Reports Series. This volume provided a summary of scholarship to date much of which had been presented in the Greenwich meeting (Kentley and McGrail, 1985). Prins however, further enhanced scholarly appreciation of this remarkable method of fastening planks by not only mapping out the geographical spread of sewn boat technology past and present, but by also assessing the taxonomy of boat building and sewing, comparing different approaches, and considerations of diversity and coherence. He also mapped out sixteen permutations of build and stitching (Prins, 1986: 28, table 2). Together, these two volumes present the most comprehensive works on sewn-plank boats from a global perspective, and are still considered the authoritative texts in the field.

However, there has been a significant amount of work conducted on sewn-plank vessels in the 30 years since the publication of these two seminal volumes, and the current special edition is intended as an update regarding the current state of the field of sewn-plank studies, in particular studies in the Indian Ocean (with reference to comparative techniques in the 1st millennium BC Mediterranean), through the multiple lens of archaeological, historical, textual, iconographic, ethnographic and experimental evidence.

Similar to Kentley and McGrail (1985), this edition is in fact a collection of papers, presented at the *Fibre and Wood: Sewn Boat Construction Techniques through Time* workshop, held at the German University of Technology, Oman, Feb. 14th-16th, 2015. Fifteen scholars attended two days of presentations on sewn-plank boats in Arabia, East Africa, India, Southeast Asia and the Mediterranean, as well as a one-day hands-on practical workshop at the Oman Maritime Traditional Boatyard in Qantab, to the south of Muscat, where the participants engaged in sewing wooden planks using different materials and techniques across the geographical and chronological scope of the conference focus. There was also a degree of continuity with the original Greenwich proceedings, as two of the original presenters of the Greenwich, Patrice Pomey and Pierre-Yves Manguin, also attended the workshop in Oman. The workshop, jointly organized by the authors, was funded by the German University of Technology (Oman), the Taipei Economic and Cultural Office (Oman), the Research Council (Oman), the Centre for Maritime Archaeology at the University of Southampton (UK), the British Museum (UK), and Oman Maritime, Ministry of Foreign Affairs (Oman).

This review of recent work conducted on sewn-plank vessels will primarily focus on efforts in Eurasia and Africa, most specifically the Indian Ocean. Important work is also being conducted in the Pacific, in particular with sewn-plank and partially sewn voyaging canoes of Oceania, but this region was not the focus of the workshop, and is outside of the authors’ areas of expertise, and thus, is not considered in this publication.

**What is a sewn boat? The evidence.**

First we need to be clear to what we are referring to when we discuss sewn boats or boats built of sewn construction. Sewing (sometimes referred to as stitching or tying), as opposed to a single stitch or lash (lashing) (Prins, 1986: 24, fig. 4), is a continuous process (Prins, 1986: 26, fig. 5). Sewing can take many diverse approaches dependent upon a range of factors from the type and thickness of the wood selected, to the size of the vessels, or chronological and geographical context in which the boats are constructed. It can also serve a variety of functions. For example, in hulls made of massive planks, sewing or stitching has primarily to resist tensile forces opening the seams in the region of the plank butts, such as in examples like the Bronze Age Ferriby boats discovered in NE England (Wright, 1976). In boats built of more numerous and flexible planks, the capacity of sewing to resist sliding movements of one plank on another is more critical (i.e. across and along the seams) (Coates, 1985: fig. 2.1). By the very nature of sewing the friction generated between the surfaces resists sliding (Coates, 1985: 16, fig. 2.5). The integrity of the hull is also reinforced by the insertion of wadding and/or a lath beneath the stitch that often extends along the entire length of the plank edges. Wadding, as well as other lubricants, such as grease, also reduces friction. Other common characteristics of sewn boats are wedged stitches using pegs or fibre plugs, stitches laid flush to the hull (i.e. recessed into the planks to facilitate reduced friction and increase longevity of the sewing fabric), as well as the use of dowels for additional fastening. Boats are sewn with both flush-laid planking and overlapping planking. Indeed, Prins noted in his classic volume (1986: 28, table 2) a total of 16 permutations by which planks were stitched together over time and space.

This paper highlights the diversity of sewing techniques, drawing primarily on a range of textual, archaeological, iconographic and ethnographic evidence. Occasional historical references describing sewn-plank vessels are found in a variety of written works, from travel accounts to geographical treatises. There is also limited archaeological evidence, including terrestrial boat finds, shipwrecks, and timbers discovered in reused contexts. Iconographic representations of sewn-plank vessels are referenced when appropriate. Finally, a key source of evidence is ethnography, as some contemporary sewn-plank boats share similarities with vessels that have long since disappeared. The evidence for these boats is provided by ethnographic research in the field, through proto-ethnographic accounts, boat models, and photographs, amongst others. Thus, the paper aims to provide an overview in order to give context to the more technical and detailed papers that follow in this special edition.

**Historical background**

There is a considerable amount of textual evidence for sewn-plank vessels in the historical record. Although early references to vessels held together with lashings and cordage exist from the Bronze Age, such as the Akkadian Ark tablet currently on display at the British Museum, the earliest textual references to sewn-plank boats is found in the classical period in the Mediterranean. Aesychlus refers to a ship as a “linen-sewn abode of wood” in the 5th century BC (Casson, 1971: 10, ft. 28).

The earliest verifiable textual reference of a ‘small’ sewn-plank vessel specifically in the Indian Ocean is found in the 1st century AD sailing guide of the Indian Ocean entitled *Periplus Maris Eyrthraei* (Casson, 1989: 141, 15.5.30). Reference is made to the town of Rhapta believed to have been located somewhere on the coast of present day Tanzania.

“Two days’ sail beyond, there lies the very last market-town of the continent of Azania, which is called Rhapta; which has it’s name from the sewed boats (*rhaptôn ploiariôn*) already mentioned; in which there is ivory in great quantity, and tortoise-shell.” (Prins, 1986: 20; Casson, 1989: 61, 141; Schoff, 1974: 28).

As the text notes, the town of Rhapta in fact derives its name from the Greek or Arab verb " to bind" or “to sew” (Ravenstein, 1898; Schoff, 1974: 28), in the manner in which the local boats were constructed.

In the final centuries of the first millennium AD, written descriptions of sewn-plank vessels in historical sources become much more frequent, in particular in the Islamic corpus of medieval geographical works and travel accounts. Western Indian Ocean mariners sailing on sewn-plank ships became integrally involved in developing maritime routes throughout the Indian Ocean and South China Seas, as Arab, Persian, African and Indian sailors sailed back and forth in search of economic opportunities, and writers commented not infrequently on this type of construction.

The most complete account of a vessel being sewn in the pre-modern period is found in the 10th-century second volume of the work *Accounts of China and India* (*Akhbār al-Sīn wal-Hind*). This geographical work compiled by Abu Zayd al-Sīrāfī describes Omani shipbuilders traveling to the Lakshadweep Islands to build vessels out of coconut wood in the following passage:

“Indeed, in Oman there are shipwrights who travel to these islands [the Lakshadweep Islands] where the coconut palms are, bringing with them carpentry tools and other equipment. They fell as much coconut wood as they want: once it is dry, it is sawn into planks. Next, using coconut fiber, they twist enough cordage to sew together the planks that they have sawn, and use them to build the hull of a ship. Then they hew masts from the coconut wood, weave sails from its fronds, and use its fibre to twist what they call *kharabāt*, which are cables in our parlance” (al-Sīrāfī, 2014: 119-21).

There are also a handful of less detailed references in other sources. For example, the Andalusian pilgrim Ibn Jubayr describes boats sewn with coconut-fibre cordage that carried pilgrims from ʿAydhāb in Egypt to the Arabian Peninsula, and comments on their flexibility when running aground on reefs in the Red Sea in the 12th century AD (Ibn Jubayr, 1907: 65; Hourani, 1995, 92; McGrail, 2001, 72). The Moroccan traveler Ibn Battuta also comments on the use of coconut fiber in sewing vessels together in the Maldives (Ibn Battuta, 1958-94: IV, 827).

There are also references in Chinese sources in the medieval period, such the following description by Hui Lin of sewn-plank ships from Malaysia (Khun Lun):

“They are fast and can transport more than 1,000 men, apart from cargo. They are also called ‘Khun Lun’ ships … With the fibrous bark of the coconut (tree) (yeh tzu), they make cords which bind the parts of the ship together. And they caulk them with a paste made of ko-lan, stopping up the openings and preventing the water from coming in. Nails and clamps are not used, for fear that the heating of the iron would give rise to fires.” (Needham *et al*., 1971, IV, 3: 459).

Medieval European travelers to the Indian Ocean also commented on sewn boats. Marco Polo visited Hormuz twice at the end of the 13th century AD and did not have the best opinion of the sewn-plank vessels he saw there. He describes the ships as ‘bad’ and states how ‘many get lost for they have no iron fastenings, being only stitched together with cord made from the husk of Indian nut’ (Polo, 1930; Johnstone and Muir, 1962). In the 14th century AD, Friar Odoric described sailing from Bombay to Hormuz in a similar ‘bark compact together only with hempe’ (Johnstone, 1988: 178).

There are also brief references in the Northern European record, such as the account from 1138 AD of how King Sigurd (r. 1103-1130 AD) had two Lapp-built ships made “bound with sinew, and not an iron nail was in them” (Prins, 1986: 40). The 10th-century AD geographer al-Masʿūdī also mentions the existence of a sewn-plank remains in the Mediterranean, which he states are usually only found in the western Indian Ocean (Al-Masʿūdī, 2005: I: 126-27).

Descriptions become more frequent during the Early Modern period, when European travelers during early colonial endeavors encountered sewn-plank traditions around the world and noted their use. A variety of Portuguese sources noted sewn-plank vessels when the Portuguese expanded throughout the Indian Ocean in the 16th century (Prins, 1986). The journal of Da Gama’s voyage in 1498 records sewn-plank vessels in East Africa, and subsequent Portuguese observers such as d’Almeida, Barbosa, and Monclaro provide more detailed descriptions of sewn-plank craft in the Indian Ocean (Ravenstein, 1898: 26; Prins, 1986: 67).

In the 17th century, the Dutch shipbuilder and traveler Nicolaas Witsen provides the most global referencing of sewn vessels around the world at time, referring to sewn boats in 17 different locations as diverse as Russia and Tahiti in his work *Architectura Navalis* (Naval Architecture) (Witsen, 1690; Prins, 1986: 19-22). By the 19th century, accounts of sewn-plank vessels multiply, and acquire much more depth and detail, as Europeans in their imperial expansion documented the cultures the encountered, including sewn-plank boats. Many of these accounts are very broad in their range, and provide a remarkable amount of detail. There is not enough space in the article to record all of these descriptions, but a few are particularly noteworthy. For example, François Edmond Pâris recorded a number of sewn vessels around the world in his *Essai sur la construction navale des peoples extra-européens* with both detailed drawings and textual notes describes the sewing materials and features as well (Paris, 1843; Reith, 1993).

In spite of these references, historical methods and textual analysis have been perhaps the least utilized method for understanding sewn-plank technology in recent scholarship. Most scholars mention briefly descriptions from historical sources such as Ibn Battuta and Marco Polo in their analysis of their archaeological and ethnographic studies, but due to the lack of technical detail in most textual sources, the primary emphasis is inevitably more focused on the physical evidence available to researchers. There have also been historical studies of sewn-plank vessels, or at least studies primarily relying on historical evidence to discuss sewn-plank technology. Several articles, such as those by Moreland (1939) and Hill (1958), have discussed sewn-plank technological developments from an historical perspective, most of which are from the first half of the 20th century, prior to the significant archaeological discoveries of sewn-plank vessel remains. Litwin (1985) in the *Sewn Plank Boats* proceedings highlights a textual source, Bogoslawski’s *On Merchant Shipbuilding in Russia, Inland and Coastal* from 1859 for understanding sewn-plank boats in Russia.

As for monographs, Hourani discusses sewn-plank boats in the Indian Ocean from an historical perspective in his work *Arab Seafaring*, an updated version of this work published with Carswell in 1995. Eric Reith (1993) in his examination of Francois-Edmond Pâris’ drawings and writings also discusses Pâris’ notes on sewn features in some depth. Agius (2002, 2008) in his examination of vessels in the Islamic world primarily focuses on describing sewn-plank vessels from a textual perspective. However, it is Prins in his interdisciplinary work *A Handbook of Sewn Boats* (1986), who provides perhaps the most extensive and broadest survey of textual accounts of sewn-plank vessels, citing extended quotations of descriptions of sewn-plank vessels in the Atlantic, Indian and Pacific Oceans from a wide range of periods and perspectives.

Nonetheless, historical studies of sewn boats have remained a minority in the field, and most researchers today primarily rely on archaeological or ethnographic methods to analyze sewn-plank vessels, only referring to historical sources for the requisite historical background for the relevant archaeological remains or vessels found in the ethnographic record. Further research into a truly global collection and analysis of all known historical references to sewn planks, building on the informative work of Prins (1986), would be a significant contribution to the field.

**Archaeological background**

The archaeological evidence provides further information with respect to the variety of sewn boat construction across the breadth of the Indian Ocean, but is also disparate in scope. Whilst new discoveries, such as the 9th‐century AD Phanom‐Surin shipwreck in Thailand (Jumprom, 2014; Guy, 2017), new research conducted at Butuan in the Philippines (see Manguin, this volume; Lacsina, 2015), and recent discoveries of Islamic sewn boat timbers recycled in buildings at the site of Al Balid, Salalah, Oman (Ghidoni, forthcoming), lend hope to the fact that new discoveries exist, the current evidence is limited.

**Where do we find sewn boats? Geographical and chronological scope**

As Prins observed (1986: 11, above), the widespread distribution of sewn boats is without question but their direct archaeological evidence is extremely rare particularly in the region of the world that forms the primary focus of this special edition, the Indian Ocean (Fig. 1).

Some of the earliest evidence for the sewing of planks comes from the Mediterranean region with the discovery of the Cheops boat c. 2600 BC (McGrail, 2001: 23-8; Ward, 2000), a 43m long, cedar built boat found in a tomb next to the Great Pyramid at Giza. The distinctive nature of the Cheops sewing is unlike all other sewn boat discoveries, in that the stitching that held the boat together extended not from bow to stern along the edges of the planking, but transversally across the breadth of the boat. A second ship of similar date, has recently been investigated by a Japanese team in an adjacent tomb (<https://www.natureasia.com/en/nmiddleeast/article/10.1038/nmiddleeast.2017.109> accessed 05.06.19; Ward 2000: 61-68). There is also evidence for timbers held together with fibre cordage from archaeological excavations of the Bronze Age site of Ras al-Jinz in Oman, dating to the third millennium BC. A bitumen fragment, assumed to be the remains of a vessel’s waterproof coating, contains an imprint of three wooden planks lashed together (Cleuziou and Tosi, 2000). Currently, the prevalent interpretation is that the planks were lashed with discrete single lashings rather than continuous stitching (Vosmer, 1996: 229). Vosmer has extensively documented these vessels as part of his doctoral thesis (Vosmer, 2005, this volume) and presents a summary of our current state of knowledge of Arab sewn boats from prehistory to the modern era in this volume (Vosmer, 2019).

Further physical discoveries have been made in the Indian Ocean, although less ancient than the Ras al-Jinz finds. Sewn-plank ships timbers have been found at the medieval Islamic site of al-Balid, also located in Oman in the southern modern-day port of Salalah. The majority of these timbers were originally ships’ planking that were then re-used for terrestrial construction. Belfioretti and Vosmer documented the initial seven timbers found in 2007 to 2009 (Belfioretti and Vosmer, 2010), but subsequent excavations have located over 50 timbers in total (Ghidoni, forthcoming). The majority of the timbers are dated to the 11th to the 15th centuries AD, representing a variety of timber species, and clearly indicate sewn-plank construction. Collectively, they provide considerable technical detail regarding the range of timber, techniques, and scantling dimensions of sewn-plank vessels from this time period (Fig. 2).

Discoveries at the Medieval Islamic site of Quseir al-Qadim on the Red Sea coast of Egypt (Peacock & Blue, 2011:181-184; Blue, 2006) and al-Balid also afford direct archaeological evidence for the construction of both sewn and iron nailed plank-built vessels of the Indian Ocean. The timbers recovered from Quseir al-Qadim broadly date to the end of the 12th and the beginning of the 15th centuries AD. The sewn plank-built boat timbers are reused and display holes along the plank edges that are stitched with coir and pegged (Fig. 3). The planks are subsequently covered with bitumen on the outer side.

Archaeological discoveries of other ship-timber collections in the extended Indian Ocean are essentially limited to some fragmentary timbers reused in the ceiling of the guard house of Fort Jesus in Mombasa, Kenya. These plank sections measure 2.5 metres by 4.5 metres, and the visible surface of the timbers shows a complex planking pattern, with recesses for the stitching, as well as dowels and frame lashings (Prins, 1986: 87-89). In the 19th century the coast of East Africa was navigated by a sewn plank vessel known as an *mtepe* (Sheriff *et al*., 2006). The *mtepe* was commented on by all, and was iconic amongst the vessels of the Indian Ocean, yet besides these passing references, direct evidence for the original vessel is virtually absence (Prins, 1982).

Probably the best source of physical evidence for pre-modern sewn vessels in the Indian Ocean, is the Belitung shipwreck. A sea-cucumber diver first discovered the wreck off the Indonesian island of Belitung in 1998, and the commercial salvaging company Seabed Corporations subsequently salvaged it in 1998-2000 and then sold the cargo in bulk to the Singapore government. It contained over 60,000 artefacts, mostly Chinese ceramics dated to the 9th century AD, but a significant portion of the hull also survived, including the hull planking, stem post, keel, keelson, framing, ceiling planking and through-beams. The construction features of the hull were clearly sewn-plank, with a predominantly double-wadding method of stitching, and the sewing cordage was tentatively identified as hibiscus, with paperbark (Melaleuca) wadding (Flecker, 2011: 117). The timbers were subsequently identified as *Afzelia africana*, *Afzelia bipindensis*, teak (*Tectona grandis*), rosewood (*Dalbergia* sp. Or *Pterocarpus* sp.), and African juniper (*Juniperus procera*). The combination of both African and Asian wood species in the vessel strongly suggested that it had been built somewhere between East Africa and South Asia (Flecker, 2000, 2001, 2008, 2011), although this conclusion has been recently challenged (Haw, 2019). To date, this is the most complete sewn-plank shipwreck remains that have been documented and published in the Indian Ocean, in spite of the fact that a significant amount of the information and context was lost during the salvaging operation.

However, the recent discovery of the Phanom-Surin shipwreck in Thailand appears to provide a more complete example of a sewn-plank ship than the Belitung shipwreck. This wreck, discovered in 2013, has been dated by radio-carbon to the 9th century AD. The vessel displays the standard edge-sewn Indian Ocean construction, with wadding deployed on both the inner and outer sides of the planking, and the frames lashed to the hull. The cordage is sugar palm fibre and the wadding paperbark (Jumprom, 2014; Guy, 2017; Komoot, forthcoming; Vosmer pers. comm.). This represents an important addition to the repertoire of sewn boat discoveries considering the easterly location of the find in an area commonly associated with a somewhat different form of ‘sewn’ boat construction (see the China Sea below) and yet the materials used to build and fasten the vessel appear on first impressions, to be locally sourced. We await further analysis of the important sewn boat find.

Archaeological finds of sewn boats are not however, restricted to the Indian Ocean region. Some of the earliest and most extensive finds come from NW Europe, in particular the British Isles. To date fragmentary remains of ten Bronze Age sewn-plank boats have been found in England and Wales, including Ferriby 1, 2 and 3, the Kilnsea boat and the Brigg ‘raft’ (McGrail, 1981; Wright and Wright, 1939; Wright, 1985; Wright, 1990; Van de Noort *et al.*, 1999). Besides the remains of the Dover Bronze Age Boat (Clark, 2004), three sewn-plank boats have also been discovered from the Severn Estuary region (Bell, 1993; McGrail, 1997). These vessels broadly date to the 1st millennium BC and the sewing fibre is generally recessed into the timber and stitched through rounded holes. Cleats were also used to reinforce the integrity of the hull (Van der Noort *et al.*, 2014). However, the sewn-plank boat tradition of NW Europe was not limited to the shores of the British Isles. Other finds have been discovered from Scandinavia, notably Finland (Forssell, 1985), through to the sub-Arctic (Prins, 1986: 63, fig.40; McGrail, 2001), dating from the 4th century BC onwards, where sewn planks were added to a log-boat base. Essentially, these examples formed part of the early development of the clinker-built boat tradition of NW Europe, which continued through the Viking to the modern eras. Sewing extended along edges of the planks through drilled pairs of holes in overlapping strakes, and was caulked and secured with pegs (in some cases battens placed over the seams were observed) (Prins, 1986: 19, figs. 18 & 19; McGrail, 2001; Arnold, 1996).

In the Mediterranean, a sewn-plank tradition has been documented throughout the 1st millennium BC with recent discoveries that extend across the length of the Mediterranean Sea from Marseille in southern France to the Levantine coast (Pomey, 1985; Kahanov & Pomey, 2004; Pomey and Boetto, 2019). The planks of these vessels were guided by dowels and secured by stitching that passed through trapezoidal holes. The stitching was recessed on the outer surfaces to accommodate and protect the sewing. Gradually, mortise and tenon joints became the predominant form of fastening, with sewing only visible at the vessel extremities. The latest summary of this material is presented by Pomey and Boetto (2019) and summarized in the volume (see Pomey & Poveda, 2019, this volume).

**Ethnographic background**

Until recently, there were still a number of examples of stitched vessels in use around the shores of the Red Sea and Indian Ocean, including the *kambārī* of the Dhofari coast of Oman (Vosmer, 1997; Alian, 2006; Weismann, this volume); the *sambūq*/*ʿibrī*/*hūrī* of the Yemen (Bowen, 1952: 212; Prados 1997); and the *masula* and *vallam* of India (McGrail and Kentley, 1985). A number of these vessels are displayed in museums in the region (Figures 4 & 5).

The sewn-boat traditions of Southeast Asia craft in both the Indian Ocean and South China Sea have been well documented, predominantly by Manguin (1985, 2000). An up-to-date summary of our current knowledge with respect to ‘sewn’ boats of SE Asia both stitched and lashed, is presented in this volume (Manguin, this volume), so there is no need to elaborate further in this summary text. However, it is worth noting that archaeological evidence supports the identification of sewn and lashed-lug boats from the region, specifically the South China Seas from the 3rd – 4th century AD. Over time, the vessel fastening changed from a dependence upon sewing and lashing, predominantly through lugs, to be eventually replaced by planks guided by a system of dowels and lashed over battens (for the sequence of change, see Manguin, 1985: fig. 20.6 A-E; Horridge, 1978: 51).

In India, the picture is quite different. Until quite recently, a variety of sewn boats could be observed along the southwest and eastern coast of the sub-continent. Their historical depth is without question as evidenced in references in the 1st century AD *Periplus Maris Eyrthraei* (Casson, 1989: 141, 15.5.30), and images of sewn boats that may date from as early as the 2nd century BC (Mookerji, 1912: 32; Deloche, 1996, 2009). In historical times, notes and sketches by proto-ethnographers such as Bowrey in the 17th century, have proved a wealth of information for the continuity of sewn-plank built production (Bowrey, 1905) (Figure 6). The boats of the east coast, known as *masula*, were extensively documented by Kentley (1985, 2003) (Figure 7), who not only observed the flat-bottomed nature of these surf boats, supported by a series of cross beams but no frames, but also undertook a very detailed documentation of the stitching system. Again these vessels are sewn together with coir and palm leaf-stalk strips, *dammar* (gum tree) was used for resin, and fish oil (shark) and lime to seal the hull. Kentley’s detailed description also comments of the process of sewing, requiring a pair of rope workers guiding the coir with the use of fishing line, through symmetrically drilled and evenly spaced holes, from inboard to outboard. They started amidships and worked towards stem and stern, sewing over the dried-grass wadding laid in place internally along seams to keep the hull watertight. He also observed similarities between other sewing techniques in the region, noting how, to the north, the sewing pattern was a double-wadding method, similar to that found on the Belitung shipwreck, and, to the south, the single-wadding technique had more in common with Arabian sewn boats such as the *kambārī* and those documented in Sri Lanka (*yatra dhoni, maha oru,*  *madel paruwa*) (Kapitan *et al.*, 2009; Kentley, 1985). Single-wadding sewn boats have also been documented on the southwest coast in both Goa, known as *revechem hode* or *revechem odam* (Shaikh *et al*., 2012; Fenwick, 2015; Shaikh, this volume) and in Kerala known as *Kettuvallam* (tied boat), the latter of which had coir wadding on the inside only and recesses on the outside to protect the stitching (Ransley, 2012; Rajamanickam, 2004: 68).

Sewn boats have also been documented in the Americas, from Chile in the south, through Mexico to Chumash, the *tomol* sewn boat tradition ofCalifornia. First documented in the 16th century AD, the presumption is that these boats were also in use in the pre-colonial era. They are essentially constructed with narrow planks lashed with deer sinew and waterproofed with bitumen, and had no frames. There is no direct archaeological evidence of these craft, only ethnographic observations, but Prins reminds us of the process when quoting a Polynesian boat-builders song that outlines the sequence and rhythm of sewing.

‘Thread it from inside, it goes outside

Thread it from outside, it comes inside

Tie firmly, bind it fast.’ (Prins, 1986: iii).

Further west, the region of Oceania or the Pacific Ocean constitute the last substantial corpus of sewn boats. The Polynesian *proa* is a shell-first, sewn boat, essentially based upon a hollowed log, the sides are extended by edge-to-edge fastened planks secured by stitching passed continuously through holes along the planking edges (Goddard, 1985).

**Experimental reconstruction**

The field of experimental boat or ship reconstruction involves the building of a vessel that existed in the past, using archaeological, iconographic, historical, and ethnographic information to reconstruct a hypothesis of how an historic vessel was actually constructed (McGrail, 1992; Crumlin-Pedersen and McGrail, 2006; McGrail, 2009; Ravn *et al*., 2011). This discussion includes vessels that are specifically classified as experimental archaeological reconstructions, as well as other types of experimental reconstructions that rely primarily on iconographic or ethnographic data rather than archaeological assemblages for the design and reconstruction process. Although the vast majority of experimental reconstructions to date have been European and North American vessels fastened with nails, mortise and tenon joinery or rivets (Bennett, 2009), there has been significant progress since the last sewn plank proceedings in 1985 in the field of sewn-plank experimental reconstructions worldwide.

The only paper in the 1985 that was specifically devoted to physical reconstruction in any depth was Severin’s discussion of *Sohar*. This was a hypothetical reconstruction of a medieval sewn-plank merchant vessel of the western Indian Ocean. Funded by the Omani government, Tim Severin and a team of Indian shipwrights built *Sohar* in 1980 in the port of Sur, Oman, and then in 1980-81 sailed the vessel from Muscat, Oman to Ghuangzhou, China with an international crew. Severin wrote a popular account of the project in *The* *Sindbad Voyage* (1983), as well as the more brief and technical paper in the 1985 proceedings. At the time, it was the only major sewn-plank reconstruction that had been built and had undertaken a significant voyage.

Since 1985, experimental reconstructions testing a variety of sewn-plank traditions in the Atlantic, the Mediterranean, and Indian Ocean have multiplied. For the sake of brevity, this paper will also only discuss half-size or full-size reconstructions in Afro-Eurasia of continuously sewn-plank vessels, rather than the considerable amount of scaled models of sewn-plank vessels, or lashed vessels found in museums and collections world-wide (Dixon, this volume).

It is no surprise that European countries has conducted the most sewn-plank reconstructions to date, given the institutional support for maritime archaeology in the region. In Northern Europe in particular, there has been considerable efforts to better understand the remains of sewn-plank vessels found in the archaeological record of the Bronze and Iron Ages through the construction of hypothetical models. In the United Kingdom, two boats have been built based on the finds of the partial remains of three sewn-plank vessels in North Ferriby, Ferriby 1 (1880-1680 cal BC), Ferriby 2 (1940-1720 cal BC), and Ferriby 3 (2030-1780 cal BC). (Wright 1990). The first is the *Oakleaf* a half-scale model of a Ferriby boat based on the Wright and Coates drawing (Gifford & Gifford, 2004; Gifford *et al*., 2006). The second is *Morgawr* a full size construction, named after the Falmouth Harbour sea snake, exhibited in the “2012 BC: Cornwall and the Sea in the Bronze Age” in National Museum Cornwall (Van der Noort et al., 2014), which the builders classified as a floating hypothesis. This project had a variety of documentation and educational goals, including social media, video interviews, but largely explored the decisions that were taken in the process of construction and specifically the replication of a ‘hypothetical reconstruction of a complete sewn-plank boat’ of Bronze Age, drawn by Ted Wright and John Coates (Wright, 1990: 85-116). (Fig. 8) The Bronze Age Dover Boat is a half-scale model of a Bronze Age sewn vessel excavated in Dover, England. The vessel was built for the ‘Boat 1550 BC’ exhibition, and was named *Ole Crumlin-Pedersen* in honor of the prominent maritime archaeologist who worked on the project (Crumlin-Pedersen, 2006; Darrah, 2004, 2012).

Interestingly enough, although there is considerable evidence for sewn-plank vessels in the Mediterranean, only one sewn-plank vessel, the *Gyptis*, has been built to an academic standard of experimental reconstruction. The *Gyptis* is a reconstruction of Jules-Verne 9, one of two vessels built by Greek colonists from the 6th century BC that was discovered in Marseille in 1993 and later excavated. Only 5m of the hull remained, but the remains clearly indicated that it was sewn with linen thread and linen wadding. The reconstruction, built of pine, oak and evergreen oak, was built in 2013 under the supervision of Patrice Pomey. Since its launch, the *Gyptis* vessel has undergone a series of extended sea trials, and is still undertaking trips at sea at the time of publication, providing a wealth of extended data regarding the handling and performance of linen sewn-plank vessels (Pomey and Poveda, 2018). It has also provided data regarding the issues of maintaining such vessels over an extended period of time. This is perhaps one of the most completely scientific sewn-plank archaeological reconstructions to date, with a significant portion of archaeological remains excavated according to best practices, following an extensive process of design, a strong educational ‘knowledge transfer’ component, and extended series of sea trials, all of which has been published in academic publications (Also see Pomey and Poveda, 2018, this volume).

**Indian Ocean reconstructions**

There has also been significant progress with sewn-plank experimental reconstructions in the western Indian Ocean, and in Oman in particular, since the construction and journey of *Sohar* in 1980. Four reconstructions have been undertaken, but only one can be considered an experimental archaeological reconstruction in the true sense of the word. The others, although they refer to archaeological data, are primarily more correctly classified as iconographic or historical reconstructions made for museum exhibition. This is largely due to the fact that although the historical evidence clearly indicates the predominance of sewn-plank vessels in the region, to date there are surprisingly few shipwrecks or timber collections from the region.

The first is the reconstruction of a *mtepe* named *Shungwaya* for the Dhow Culture of the Indian Ocean exhibit that was formerly displayed in the House of Wonders Museum in Zanzibar. The *mtepe* was a Swahili vessel that used to sail in East African waters from at least the 19th century until its disappearance in the 1930s. It was one of the last survivors on the western shores of the Indian Ocean of a sewn-plank vessel. Limited textual evidence in the *mtepe* indicates that some were as large as 30 metres in length, with a tonnage of up to 180 tons, primarily built with mangrove planking. The few models in museums in Zanzibar, Kenya and Europe provide some detail, but do not appear to be accurate representations. (Prins, 1986: 76, fig. 45; Sheriff *et al*., 2006) (Figs. 9 & 10). This reconstruction was built in 2003 under the direction of Abdul Sheriff, and the vessel is 14 metres in length and 3.5 metres in beam, representing a half-size model of a *mtepe* captured in 1877 whose measurements were recorded. Due to the shortage of sufficiently large mangrove timber, it was built frame-first with *mtondoo* wood (*Calophyllum inophyllum*), a teak (*Tectona grandis*) mast, and doum palm sails (Kirknaes, 2005; Sheriff *et al*., 2006).

In 2007-2010, Oman and Singapore, in a bi-government initiative, constructed a vessel, *Jewel of Muscat*, based on the remains of the 9th-century AD Belitung shipwreck, and sailed it across the Indian Ocean from Muscat to Singapore (Flecker, 2000, 2001, 2011). The reconstruction is 18.6 in length, built under the direction of Tom Vosmer with *Afzelia africana*, teak (*Tectona grandis*), sidr (*Ziziphus spinachristi*), and poona (*Canophyllum inophyllum*) timber. It was sewn with coconut-fiber cordage using a double wadding method with 37,731 holes, and 120,000 stitches. All of the sewing was documented through a series of stitching histories, as well as with extensive photography and film. In 2010, it sailed on a 6-month journey from Muscat, Oman to Singapore, and now is exhibited in the Maritime Experiential Museum and Aquarium (Vosmer et al., 2011; Vosmer, 2011; Staples, 2013, 2019) (Figs. 11 & 12).

The other two experimental reconstructions were also subsequently built by the Oman Maritime construction team at the Qantab boatyard, which was comprised of the core members of the *Jewel of Muscat* project. Both can be considered iconographic reconstructions, meaning that both relied on illustrations rather than archaeological remains as the primary source of evidence, and both were built for display in museums in Oman (Fig. 13). The first, is the “Beden Seyad”, a 19th-century sewn-plank fishing vessel based on a construction plan that the French naval officer François-Edmond Pâris drew when visiting Muscat harbor in 1838, and which he refers to as “beden seyad” (a fishing badan) (Pâris, 1843; Reith, 1993). This was part of a larger joint Omani Ministry of Foreign Affairs-Ministry of Heritage and Culture project for the National Museum, and is now the central display for the museum’s Maritime History Gallery. This vessel is closer to a replica than a hypothetical reconstruction, since it is based on a relatively detailed construction plan. The boat is 9.34 m long, and 1.34 m in beam. It is a very different type of vessel than *Jewel of Muscat*, being much smaller and simpler in some ways with no frames, and large five planks, based on the construction plans drawn by Pâris during his visit to Oman in 1838. Ghidoni discusses its design and construction in this volume (Ghidoni, this volume).

The other is the *al-Hariri Boat*. This is an experimental reconstruction of a medieval sewn-plank merchant vessel of the western Indian Ocean, primarily relying on a drawing from a 13th-century AD manuscript of Abu Muhammad al-Qasim al-Hariri’s *Maqamat* from Iraq, that portrays a convincing example of a double-ended vessel with paired stitching (al-Hariri, 2003; Hourani, 1995, 92, plate 7). The reconstruction was commissioned to be a central display for the Museum of the History of Islamic Science at the German University of Technology in Muscat, Oman. The Oman Maritime construction team built the vessel in 2013. The boat was a three-quarter scale reconstruction, 13m in length due to the limitations of the size of the display space. It was built with teak (*Tectona grandis*), *sidr* (*Ziziphus spina-christi*), *qarat* (*Acacia nilotica*), and *iroko* (*Milicia excelsa*), and was sewn with coconut fibre in the single-wadding method predominantly found on the planking at the site of al-Balid, in Dhofar, Oman, as well as in the Omani *kambārī*, and the sewn-plank boats of southwest India and Sri Lanka (Figs. 14 & 15). It relied on similar principles of documentation as those developed during *Jewel of Muscat* project, but without the 3-D scan and the documentaries. The vessel is currently on display in the museum. In addition to its educational function as an exhibit, significant research value resides in the data derived from the documentation of the single-wadding sewing method (Staples, 2019).

As a whole, these experimental sewn-plank vessels constructed for educational and research purposes have significantly added to our understanding of the methods and materials relating to sewn-plank technology. Individually, they represent an evaluation and reinterpretation of specific sets of archaeological, iconographic, and ethnographic evidence in practical settings in a wide variety of geographical areas. Collectively, they illustrate the significant diversity of sewn-plank vessels, from small Bronze Age sewn-plank canoes to ocean-going vessels sailing 3,800 nautical miles through a variety of weather conditions, including the edge of a cyclone. These reconstructions have experimented with a wide variety of materials, and have illustrated that a wide range of timber and fibers are effective for sewing planks to one another, from yew ligatures stitching oak timbers together to coconut fiber fastening teak and *Afzelia africana* planking in place. They also illustrate that a diverse range of techniques were used to sew planks together in the past, and allude to the creative ingenuity of sewn-plank shipwrights as they came up with a diverse set of solutions to fasten planks to one another, ranging from large double-wadding technique of the early Islamic Indian Ocean to the much more complex version of sewing planks with linen used on the *Gyptis*. They have also provided scholars with insight into the sailing performance of sewn-plank vessels in a variety of sea conditions, such as the passage of *Jewel of Muscat* across the Indian Ocean, as well as the amount of upkeep required to maintain sewn-plank vessels, in particular those such as the *Gyptis* which have been in continuous use since construction and launch. Many of these projects have also refined and improved methods of documenting the process of sewing the planks, providing more information for scholars to analyze the challenges involved and the amount of time taken to sew boats together. Perhaps most significantly, they have also educated the public about the existence of sewn-plank vessels in the past. Most of the vessels mentioned above were built for museum exhibitions, and now sit in exhibits were thousands of visitors view them on a yearly basis. It is hoped that future reconstructions of sewn-plank vessels will provide even more data in a comparative context regarding the diversity of sewn-plank technology available in the archaeological and historical record.

**Conclusions/Future directions**

All of this activity illustrates that significant advances have been made with respect to knowledge surrounding sewn-plank technology since 1985. New discoveries expand our understanding of the detail of sewn boat construction, providing insight into the extended geographical reach of sewn boats, and highlighting how techniques have changed over time in different regions of the world. Besides exciting new site-specific discoveries, a number of comprehensive overviews such as the work of Vosmer (2005, this volume) and Manguin (this volume), also provide a more refined appreciation of the place of sewn boats within regional boat building traditions. At the same time, research still references the pioneering work of the early scholars and in particular the approach adopted by Prins that presented the first comprehensive evaluation of sewn boats, drawing on ethnographic, historical, archaeological and experimental reconstructionist perspectives, determining geographical spread, taxonomy of boat building, and sewing technologies, comparing approaches, diversity and coherence through time (Prins, 1986: 28, table 2).

However, besides purely functionalist discussions concerning the technical attributes of sewn-boat construction, we are now able to reflect on critical aspects of their broader context, presenting more nuanced interpretation of boat biographies. Increased knowledge enables more confidence in identifying regional diversity of sewing traditions, and how these change and merge over time. It also reflects on the significance of timber selection in different regions but also the binding materials or cordage, such as coconut coir, that secure the planks. We can begin to discuss through scientific analysis, how truly ‘flexible’ sewn boats were, and how different stitching variations, and the application of wadding and battens etc., contribute to the resistance and flexibility of these vessels (Marlier, 2005, 2006). We can also begin to ask questions about how the environment and different operating contexts influence the approaches to build, the function, and the arena of use of the vessels, and what impacts the change and scale of build and technological choices over time. Most importantly, we can begin to provide context to these vessels, situated within and reflecting the culture, ideologies and traditions in which they were built (Adams, 2010; Blue, 2003).

The workshop in Oman in 2015 simulated extensive discussion, but also identified gaps and recommendations for future research as the field moves forward. A few are outlined here:

1. As Prins (1986: 160-66) proposed in the concluding sections of the *Handbook on Sewn Boats*, more comparative collaboration between scholars specializing in different regions would expand our understanding of sewn-plank technologies considerably. Currently the corpus of research represents a series of excellent studies from a variety of perspectives focusing on regional sewn-plank traditions, but regional barriers are still very visible. One of the goals of this workshop was to create a dialogue between those studying and experimenting with Indian Ocean sewn-plank vessels with those working on sewn-plank vessels in the Mediterranean. Some of the most revelatory moments of the entire workshop in Oman were when specialists and practitioners of sewn-plank technology in the Indian Ocean witnessed the Mediterranean method.

2. A set of guidelines of best practice for the documentation of sewn-plank experimental reconstructions should be established in the field that can be regularly updated. Documentation is essential for evaluating the process of experimental reconstructions, and much more collaborative work needs to be done to share and disseminate the knowledge and data derived from these projects. This will allow for a much greater degree of comparative study amongst different sewn-plank projects, and will establish a common standard for work being conducted in different regions.

3. The workshop was successful in terms of its stated goal to gather the current generation of scholars and provide an update for the field since 1985. However, the issue with individual workshops and conferences is that they often fail to establish long-term research communities. It is recommended that a sewn-plank vessel organization be established in which any person involved or interested in sewn-plank boats in any part of the world can join and share their work, creating an institutional venue for communication amongst a group of scholars and practitioners that are often much more regionally focused.

Overall, whilst this volume cannot answer all the questions we have concerning the development of global sewn-boat technologies, we believe that the papers presented help to fill some of the ‘evolutionary’ gaps both chronological and geographical, and begin to address more meaningful typologies, particularly of sewn boats of the Indian Ocean. They also recognise that similar approaches can be adopted in other contexts, such as was noted in the workshop, between 1st millennium BC Mediterranean stitching and the sewing patterns of the Indian Ocean, and place sewn boats within their broader cultural and traditional contexts.