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Sailing Rock Art Boats

– A Reassessment of Seafaring abilities in Bronze Age Scandinavia and the introduction of the Sail in the North

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Thesis for the degree of Doctor of Philosophy

March 2015

Name of University	UNIVERSITY OF SOUTHAMPTON
Abstract	ABSTRACT
Faculty	FACULTY OF HUMANITIES
Discipline	Archaeology
Degree for which thesis is submitted	Doctor of Philosophy
Title	SAILING ROCK ART BOATS– A REASSESSMENT OF SEAFARING ABILITIES IN BRONZE AGE SCANDINAVIA AND THE INTRODUCTION OF THE SAIL IN THE NORTH
Full name of author	By Boel Katarina Bengtsson

This thesis examines the basis for the current belief that the introduction of the sail in the North occurred between the 7th or 8th and the 10th centuries AD, almost a thousand years later than on the British Islands and almost 3000 years later than in the Mediterranean.

The foundations for this reassessment of the potential timing and development in the use of the sail derives mainly from an examination of the Bronze Age rock art (1800–500 BC) in southern Scandinavia containing imagery of boats with attributes that can be interpreted as masts and sails. In combination with experimental sail trials in Bronze Age type boats and by comparing this material to available research on the transition from paddling to sailing in ancient Egypt and Oceania, the author argues that the use of sail as a complement to paddling would have formed an integral part of the formation of centres of power in Scandinavia in the early Bronze Age. This in turn would have permitted more frequent communication, helping to expand, maintain and control power.

The transitions from downwind sailing abilities to abilities to sail within a wider range might have occurred relatively swiftly between c. 1550–1300 BC, and might be directly linked to the expansion of Scandinavian centres of power during the same period, allowing for increased flexibility, both in terms of manpower, range and choice of routes with the use of a wider range of weather conditions. The emergence of the sail would primarily have been driven by increased needs for the movement of people and goods across short- medium- and long distances – a process where competition by rivalling chiefs might also have played part.

Furthermore, it is here suggested that the developments in sail and boat technology in the North were the result of incremental and gradual changes that eventually resulted in the boats and sails as used in the Viking Era.

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Rock carving boats with details that can be interpreted as masts and sails from Järrestad in Scania, Askum in Bohuslän and Himmelstalund in Östergötland on the Swedish south, west and east coasts. Photos: Boel Bengtsson, scan: Metimur in Gothenburg.

Academic Thesis: Declaration Of Authorship

I, Boel Bengtsson

declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

Sailing Rock Art Boats – A Reassessment of Seafaring Abilities in Bronze Age Scandinavia and the Introduction of the Sail in the North

I confirm that:

This work was done wholly or mainly while in candidature for a research degree at this University;

Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;

Where I have consulted the published work of others, this is always clearly attributed;

Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;

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Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;

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Bengtsson, B., & Bengtsson, B., 2007. Seglade man i skandinavien under bronsåldern? - om experimentella seglingsförsök i ” bronsåldersliknande” farkoster. *Marinarkeologisk Tidskrift* 2007(2—3): 14—17.

Bengtsson, B., & Bengtsson, B., 2011. Sailing Rock Art Boats – a report on sail trials in Bronze Age type boats. *Journal of Maritime Archaeology.* Vol. 6 (1): 37—73.

Signed: ………Boel Bengtsson (Bessemer Clark)………………………………

Date: …………30 March 2015…………………………………………..

Acknowledgements

I should first like to thank 'Längmanska fonden', 'Stig och Dagmar Saléns Stiftelse' and 'Iris stipendiet' for funding the experimental sail trials, and for enabling me to attend a conference by the McDonald Institute in Cambridge.

My co-Supervisors, Professor Jon Adams (Maritime Archaeology) and Professor Timothy Champion (Archaeology) have both been invaluable in the formulation of my research project, and their continued encouragement to the end. A special thank you is extended to Dr Lucy Blue for assistance, and to Pam Wake at Hartley Library for help with literature.

In Sweden I would like to thank Dr Ulf Bertilsson, for use of the RANE 2000 archives, Lars Bengtsson for use of the Vitlycke Museum archives, and Gerhard Milstrau at the Underlös Museum for an invaluable Rock Care course. In addition, I would like to thank Metimur in Gothenburg for help with scanning, Henrik Zedig at the Västra Götaland County Board and Staffan von Arbin, my old colleague at Bohuslän Museum, for help with literature. Furthermore, I would like to thank Fredrik Åstrand, North Sails in Gothenburg, for use of his sail loft and assistance with cutting the sail for the *Tilia*.

At the Viking Ship Museum, Roskilde, I thank Dr Anton Englert for facilitating contact with the Hjortspring Boat Guild, and Max Vinner and Erik Andersen for ecouragement, literature and Max also for proof reading of material related to the sail trials. In addition, I would like to thank Flemming Rieck for fruitful conversations, and Per Lysdahl at the Vendsyssel Historical Museum for helpful information at very short notice.

The Hjortspring Boat Guild, and in particular Knut Vagn Valbjørn, Niels Peter Fenger and Jørn Jensen, I would like to thank profusely for lending their support to the 'Tilia for sejl' project.

Lastly, I wish to thank my family, my brother Björn who has been an invaluable sounding board and without whom, in addition to my sister in law Vivian, the sail trials would have been impossible. Finally, I should like to thank my parents for their constant support and them and my sister Birgitta for endless proof reading. I should like to end by dedicating this thesis to my long suffering husband Andrew and our two children, Astrid and Henry.

List of Abbreviations

AD	Anno Domini
BC	Before Christ
c.	circa
cal.	callibrated
cf.	see, compare
et al.	and others
e.g.	for example
i.e.	that is
pers. Communic.	Personal communications

1. Orientation

A major problem inherent in the archaeological study of the introduction of the sail in Scandinavia or the 'North', is that few boats have been found, and that visible evidence of sailing as a means of propulsion is rarely preserved. In the North, the earliest boat find showing irrefutable evidence of having been sailed dates to the early 9th century AD (McGrail 2001:211). This lack of boat finds, along with a line by the Roman historian Tacitus (AD 98) wherein he describes the boats of a Baltic tribe, the Suiones, as not being moved by sail but by oars alone, has led many scholars to believe that the sail was not introduced in the North until the 7th or 8th century AD. In comparison, the sail was in widespread use in the Mediterranean by 2000 BC and around the British Islands by the 6th century BC (McGrail 2001:112, 211). Why then, not in the North? How is it that a seafaring society such as that of the North, with a boatbuilding tradition that can be traced back to the Bronze Age (Kastholm 2008; Kaul 1998), never took up the sail until shortly before attacking Lindisfarne in AD 793?

In the southern Scandinavian Bronze Age rock art, in time ranging between c. 1800–500 BC, there are boat carvings with attributes that can be interpreted as masts and sails. Some of this particular imagery has been long known of and yet completely omitted from any discussion on the usage of sail in the North. Could these images actually be depictions of sailing vessels? If so, how might a transition from paddling to sailing have occurred and for what reasons? Finally, how might a longer continuity in the use of sail affect our understanding of Scandinavian Bronze Age society?

In order to answer these questions, this thesis aims to:

(a) Place the rock art boat imagery within the context of the southern Scandinavian Bronze Age, where it can be linked to a society that would have been dependent upon boats in day-to-day life.

(b) Assess the available evidence which forms the bases for the current belief of a relatively late introduction of the sail in the North.

(c) Evaluate the rock art boat imagery that might attest to the use of sail (as well as other means of propulsion and/or steering) across southern Scandinavia.

(d) Conduct experimental trials in Bronze Age type boats while using methods and technology that can be argued might have been available in Scandinavian at the time, in order to assess whether such vessels could have been sailed.

(e) Asses any preconditions which might have facilitated or driven the emergence of the sail in two comparative regions, ancient Egypt and Oceania, and which might help explain how the transition from paddling to sailing might have occurred also in southern Scandinavia.

Ancient Egypt and Oceania are both regions where early use of sail is in evidence. Whereas ancient Egypt exhibits a rich iconographic source material beginning from around 3100 BC, for Oceania, it is mainly the vast distances between islands first occupied some 1500 years BC that convey the early use sails. Thus, these two areas are choosen as representatives not only of very different archaeological source materials, but also because of their different geographic preconditions.

In our present day society, where cars and aircraft are the norm, it is easy to forget a prehistoric world where boats and water would have been essential not only for subsistence but also for communication, and where water would have connected rather than divided society. Boats constitute, from an historical as well as probably a prehistorical perspective, the most technologically complex construction a society could produce (Muckelroy 1978a:3), and the processes involved in their conception, design, construction and use, would have been fundamentally linked to society as a whole (Adams 2003:17). For these reasons, boats have often had powerful symbolic functions being associated with communication and trade, warfare, the projection of personal status and political legitimization (ibid.). Boats can therefore be seen as a reflection of society and any changes in the way in which they are used might be interpreted as a reflection of changes in society. In this way, the use of the sail as a means to propel a boat could be regarded as a reflection of the technological knowledge and know-how a society might have as well as their needs in that it, for example, enables people to travel further using less manpower and to carry more cargo.

Maritime archaeology is best defined as the "*study of the material remains relating to human activities on the seas, interconnected waterways and adjacent locales*" (Adams 2002:228). Thus, maritime research is archaeology first and 'maritime' only in the sense of environment (Adams 2003:38). Whether the Scandinavian Bronze Age society as a whole might be described as a coastal or 'maritime' community or not, it left behind a rich source of evidence that constitutes material remains inspired by humans and their activities along coasts and inland waterways; namely the rock art imagery.

In the following chapter, I will introduce the rock art and various theoretical aspects through which it has been perceived, including the introduction of a maritime perspective. I will also discuss the concept of boats and change in society and provide a brief introduction of the main claims behind the current view of when the sail was first introduced in the North. This in turn will be followed by a general outline of the remaining chapters in this thesis.

The Bronze Age and the Rock Art

During the Bronze Age, societies become increasingly stratified and ranked and we see for the first time the emergence of aristocratic elites, specialised and skilled craftsmen, artisans and warriors (Kristiansen 2015; Kristiansen & Larsson 2005:52, 60). Commodities such as gold, salt, textiles and amber, but in particular bronze were highly desirable. Since many of these resources, such as for example tin and copper, the components of bronze, would only have been available at a few source areas widely spread across the continent, far reaching networks of communication and transportation now began to develop to satisfy the needs of the newly emerged elites (Kristiansen 1998:211; Kristiansen 2015:241; Larsson 1999b:51).

A glimpse of the emergence and scope of these links of trade and cultural interaction is suggested by the recent discovery of a rich burial not far from Stonehenge in Britain, containing the remains of a man in his mid 30s to 40s who, based on strontium isotope analysis of his teeth, is likely to have grown up in the Alpine region in central Europe and who has died around 2300 BC (Fitzpatrick 2002, 2013). He was buried together with the oldest golden objects yet found in Britain and copper arsenic alloy knives traced to Spain and France – perhaps reflecting the time when these networks would have started to develop (ibid.). This is around the same time as a new maritime technology, the sewn plank built vessel, first appear in the archaeological context around the British Islands, allowing for the building of large vessels capable of safe journeys across open water, while carrying bulk goods (Kristiansen 2015:241; Needham 2009; van de Noort 2003). Around 1300 BC and the onset of the Urnfield period, so named after the introduction of a new burial custom throughout eastern and central Europe, bronze production appears to have increased on a grand scale (Adams 2003:204; Champion et al. 1984:270—271). This is something that would have intensified the need for long distance waterbound transportation. Again, glimpses of these long distance transportation networks can be traced in Britain where at least two shipwrecks from this period, containing bulk cargoes of scrap metal from the continent that was possibly intended for reuse, have been found (Adams 2003:204–205; Needham et al. 2013; Muckelroy 1978b:151, 1981).

Exactly where the Nordic or Scandinavian Bronze Age culture, in time ranging approximately between 1800 and 500 BC, would have fitted into this system remains a mystery in general, and yet impressive quantities of bronze reached Scandinavia, the raw

Figure 1. The Revem bronze lures from Rogaland, south-western Norway, are beautiful examples of Scandinavian bronze artefacts of very high technological as well as artistic standard, able to play tunes that cover the entire scale (Bengtsson & Hygen 2000:163). The lures, each of a total length of 164mm, are made in two pieces, and were found not far from the Hafrefjord. Photo: Boel Bengtsson at the archaeological museum of Stavanger.

materials of which would have had to travel not only large distances, but at times across open stretches of water. Nordic Bronze Age society did not only acquire comparatively large amounts of bronze, with a significant increase in supply from around 1600 BC (Vandkilde 1996, 2014), but during a period between 1500–1300 BC (Montelius period II–III) it began to produce unique bronze artefacts, in artistry and quality equal with those of the Minoan/Mycenaean culture (figure 1)(Kristiansen & Larsson 2005:186). It is generally believed that the exchange networks supplying the Scandinavian bronze were based on personal alliances between high ranked individuals, supported by a retinue of warriors, in a down-the-line system, thus connecting Scandinavia with continental Europe (Kristansen 2015; Kristiansen & Larsson 2005:232–233; Ling 2012). More recently however, more direct long distance travels have been suggested, with Scandiavian warrior leaders potentially travelling as far as the Mediterranean, perhaps along the Atlantic coast (Kaul 2013; Ling & Stos-Gale 2015; Ling & Uhnér 2014). Thus recent research suggest a much more interconnected Bronze Age Europe than previously believed.

Throughout the Scandinavian Bronze Age, the dead were placed in mounds and cairns along the coasts and on islands in the archipelagos, and ship-settings, some of which contained the dead, were erected (Eskeröd 1970:14; Larsson 1989:30; Sigvallius 2005; Wehlin 2013). In addition to which, bronze finds in general appear to have a clear affinity with coastal zones (see e.g. Larsson 1989). It would only be natural to assume that the settlement sites would not have been too far away (see e.g. Borna-Ahlkvist 2002 and Ling & Cornell 2010:31). It would appear to have been a society where people travelled by boat along the coasts, for crossings between islands and along the main rivers and for exploiting natural resources such as fish and seal, but also to acquire the raw materials for the bronze

Figure 2. Night photo of details of a double line of cupmarks and parts of a boat from the Kåsen rock art site in Tanum, Bohuslän on the Swedish west coast. Photo: Boel Bengtsson.

as well as flint (Apel 2001). It is a society in which the boat would have been as important as a car is to us today, in fact, it has even been referred to as the first golden age of seafaring (Brøgger 1936:188—189).

The significance of the boat is emphasised through its focus within contemporary bronze artefacts, examples of which are the many grave finds of bronze razors either shaped as boats or with engravings of boats found within the region, and in particular, within the rock art, one of the most important archaeological records of Scandinavian Bronze Age society (Kaul 1995, 1998). Carved on the glacial-smoothened rocks of granite, gneiss and sandstone, boats are clearly depicted with people on-board – in the act of fishing, paddling or sometimes with warriors or 'chieftains' carrying weapons and shields (Bengtsson B 2003:10; Berglund 1991:19). Sometimes animals are present on-board, and other times the boats are furnished with symbols, drawn by animals or even carried by huge men, so called 'ship-carriers'. Thus, the imagery contains human figures, animals and weapons, as well as

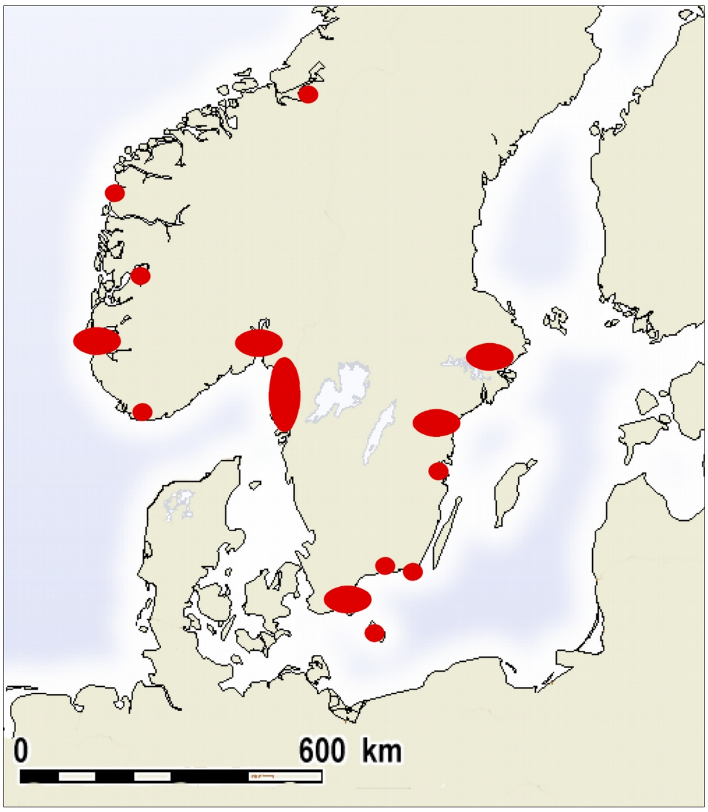


Figure 3. An overview of the main rock carving sites in southern Scandinavia.

foot prints, tools, wagons or chariots, sun discs, swastikas and various geometric designs (Nordbladh 1995:28). With the exception of the round hollow cupmark (figure 2), it is however the boat that is the altogether dominant motif. With boats and communication being such an important common denominator, it is of course interesting to take note of where the rock art is found – which is mainly in clusters along the palaeographic coast line and inland waterways (figure 3) (Bengtsson B 2003:29—30).

Historical and Theoretical Background of Rock Art Research

Few areas of Scandinavian research have attracted more interest than rock art over the years and since it was first documented in the 17th century, almost a hundred scholars have

Figure 4. A collage of rubbings taken at a rock carving panel at Litsleby, Bohuslän, Sweden (Tanum-75)(RockCare 2000).

tried to contribute to its understanding(Nordbladh 1995:29), a number of which has been further enhanced in recent years (Goldhahn 2006, 2008; Goldhahn et al. 2010).

The mid 18th century saw something of a golden era in the recording of rock art with large scale documentation work in the county of Bohuslän on the Swedish west coast and in the county of Östergötland on the Swedish east coast (Baltzer 1881–1908; Holmberg 1848; Nordenskjöld 1870–1873). Interpretations were many and colourful and in particular the age of the rock art was debated. While some argued that the imagery must have been carved with tools of iron, depicting stories from the Icelandic Sagas and therefore must date to the early pre-Christian Viking Era, others argued that they could have been carved with tools of stone and were so crude and distasteful that they must belong to the Stone Age (Brunius 1868:76—84; Holmberg 1848). No doubt this later opinion was coloured by prudery in relation to the sometimes explicit phallic attributes present in the rock art material (figure 4). The question of date was finally settled when a sword carved onto a particular rock carving panel in the parish of Ekenberg, Östergötland, was found to be almost identical to a similar artefact from the Museum of Ancient Remains, and thus firmly placed it in the Bronze Age (Hildebrand 1869:425).

Even today, the problem of dating the rock art remains very much in focus and it is believed that certain figurative elements, or types of motifs in the rock art have had a continuity ranging from the late neolithic well into the Roman Iron Age, but the general consensus is that the habit of carving imagery into the rocks peaked a couple of hundred years on either side of 1000 BC (Bengtsson B 2003:31; Hygen & Bengtsson 2000:182; Kaul 1998:110; Ling 2005, 2008; Nordbladh 1989:324).

Religion, Landscape Archaeology and Social Sciences

The 1920s saw the firm introduction of a religious perspective to the rock art and for many years the carvings were regarded as either part of a fertility cult associated with a farming society, or a death cult and the reverence of the deceased (Almgren 1927; Ekholm 1921). The religious theme and in particular Almgren's historical-religious views dominated the field until the 1970s (Bertilsson 1995:211). Religion has still not lost its appeal, but the religious perspective has broadened to include also shamanistic, cosmological as well as ritual or magical perspectives (Artelius 1996; Bolin 1999; Burström 1999; Helskog 1999;

Johansen 1991; Kaul 1998; Kristiansen 2010; Malmer 1971, 1993; Thedéen 2002; Widbom 1998; Wrigglesworth 2010).

Although efforts to document the vast rock carving material continued throughout the 1920s to the 1960s (Fett & Fett 1941; Gjessing 1939; Glob 1969; Marstrander 1969; Nordén 1925 to mention a few), it was the large-scale overviews that appeared in the 1970s, such as Burenhult's (1973b) records of the southern Swedish rock art, Fredsjö's (Nordbladh & Rosvall 1971, 1975, 1981) documentation of the rock art in the parishes of Bottna, Kville and Svenneby in Bohuslän and Kjellén's (1976) documentation of the rock art in Uppland that renewed the interest in them. This new documentation material resulted in a great number of different theoretical perspectives, developed within mainstream archaeology as well as within the social sciences being applied to the rock art, with landscape archaeology leading the way through putting the rock art and its location in relation to the surrounding landscape as well as other contemporaneous archaeological monuments or data (Bengtsson B 2003). Thus, instead of viewing rock art imagery of for example 'ploughing' scenes or fleets of boats in terms of its frequent location near what is now cultivated fields and as part of an agrarian fertility cult (to put it bluntly), Kjellén & Hyenstrand (1977), to use an early example, viewed the rock art in Uppland in relation to settled land, graves and settlements indicators (fire-cracked stones). In so doing, they discovered that figurative rock art was located lower down in the landscape near the shore and that cupmarks were generally located on slightly higher ground above which the fire-cracked stones would be found. Finally, the graves would be found on the highest ground as if almost defining the areas. This focus on space and territories have been applied to a whole range of other large scale spatial rock art studies, taking into account ever more variables including metalwork conglomerations, natural water sources or other natural resources as well as various figurative distribution patterns to mention just a few (Bertilsson 1987a; Burenhult 1980; Coles 2000; Gjerde 2002, 2010; Goldhahn 2010; Helskog 1999; Larsson 1986; Ling 2008; Mandt 1972; Nordbladh 1980; Nordenborg Myhre 2004; Sognnes 2001; Thedéen 2002; Welinder 1974).

In addition to this, rock art research has begun to be influenced by new trends deriving from the social sciences, including social anthropology, ethnology, structuralism, linguistics and hermeneutics leading to a plethora of interpretations (Bengtsson B 2003:12;

Bertilsson 1995:211; Bradley 1997:315—316; Tilley 1991). Nordbladh (1980) for example applied a combination of spatial and semiotic (Johnson 1999:194) ideas to the rock art in Kville, Bohuslän, by relating the rock art, which he interpreted as signs within a symbolic system, with the surrounding landscape. He suggested that the rock art, any surrounding contemporary archaeological finds and natural elements together created unique micro-landscapes where each component brought meaning to the other, and in which individual rock art images were constantly added or altered in response to changes in the surrounding landscape (Bengtsson B 2003:14; Nordbladh 1989: 324, 1999:18—19). The implications of Nordbladh's approach would of course be that it would be impossible to directly relate the rock art to anything 'real' within their contemporaneous world or indeed contemporaneous imagery on for example bronzes, or the raised ship-settings (Nordbladh 1980: 9). In addition, it would be impossible to apply any form of chronological studies to them, to me implying a rather limiting approach and one that would make any further studies of them quite futile.

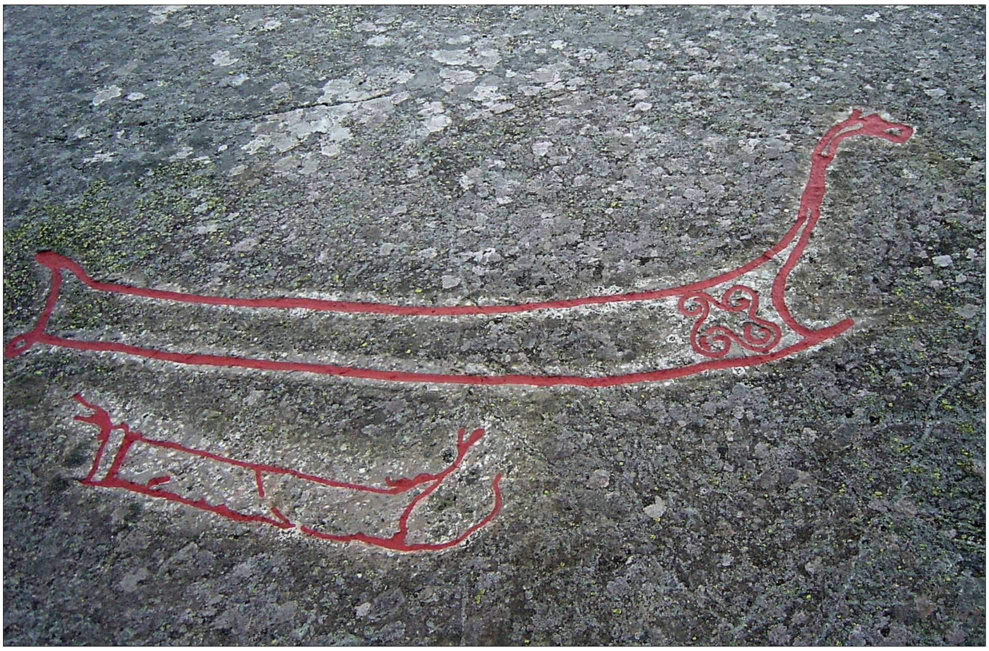


Figure 5. Rock art boats, painted in with a red colour to make them easier to see, from the Ekenberg site in Eastern Eneby on the Swedish east coast (Eneby nr 23). The top boat has a 'Celtic' sign carved on the bow section. Photo: Boel Bengtsson 2003.

The study of signs and individual rock art motifs or panels has also moved in other directions. A purely linguistic, 'narrative' approach has for example been applied to particular rock art panels across southern Sweden, based upon the assumption that the rock art reflects a society based upon an oral tradition (Fredell 2002:248, 2003). In such a society the rock art motifs on a panel would have been carved in an organised but repetitive way in order for the narrator (carver?) to better remember particular myths, rituals, important objects or even games. In this way variations in motifs and compositions that are found amongst different regions and localities, could be explained by the differences in how the oral tales would have been remembered or emphasised in different regional areas (2002:249). Hygen & Bengtsson (2000:95—96) have suggested that some of rock art might depict early versions of Norse myths about for example Thor and Oden. Many elements of the Norse mythology as we know of from the Viking Age, were shared also in other contemporary societies. This has led many scholars to believe it originated from a common Indo-European mythology, possibly dating much further back in time. Therefore, Hygen & Bengtsson (ibid.) argue that parts, or varieties of these myths might have existed already in the Bronze Age. A variation of this has been put forward by Skoglund (2010) who suggests that some scenes in the rock art are similar in lay-out to some of the later Gotlandic picture stones, and might represent narratives of myths about heroes carrying out fantastic deeds.

Others have focused on the meaning of individual signs such as for example the occurrence of 'Celtic' signs within the rock art material (figure 5) and interpreted them as part of a common late Bronze Age/Iron Age Celtic religious tradition (Görman 1987). Individual imagery, such as for example boats, 'warriors', acrobats, sun horses or the occurrence of 'twin' motives in the rock art, have also been studied in connection with similar imagery or ritual concepts known from contemporaneous Europe, and in particular Mediterranean Europe. Some scholars believe some of this particular imagery has been brought here on imported portable objects (Althin 1945:55; Malmer 1971:192; Olsson 1998). Others regard it as an indication of how symbols of particular significance and power travel across Europe to be used in Scandinavia by an emerging elite in order to acquire or legitimise power (Kristiansen 1999a:543, 548; Larsson 2002; Randsborg 1999; Winter 2002:218—219, 208—209). Thus, the imagery is regarded as indications of cultural interaction across large areas of Europe, and of perhaps shared cultural concepts (Nordbladh 1989:331—332). More recently, it has been suggested that the presence of what might be depictions of copper ingots within the southern Scandinavian rock art material might reflect direct contact between Scandinavia and the Mediterranean, and perhaps even the notes of a traveller having returned from such a voyage (Ling & Uhnér 2014; Ling & Stos-Gale 2015).

Other aspects that have been in focus include the relationship between the imagery and the rock as a medium with a 'soul' of its own, and ideas in relation to water filled rock art motifs, both of which might represent passages between different worlds (Hauptman-Wahlgren 1998:92—93; Helskog 1988, 1995; Kaliff 1995:126; Larsson L 1999:157—159). Yet other aspects include the experience of viewing or walking across the rock art, the actual act of carving it, or the relationship between the rock art and the material qualities of the rock surface (see for example Ahrrenius 1987; Adams 2003:205—206; Bengtsson B 2003, Bengtsson L 2002b; Bradley et al. 2002; Goldhahn 2002; Hauptman-Wahlgren 2002; Hultman 2010; Ljunge 2010; Lødøen 2010; Tilley 2008).

The above are but some of the influences that have affected Scandinavian rock art research in recent years but what is clear with all of these interpretations is that they are mainly based on the documented rock art within a particular region, a local area or even that of an individual rock carving panel, with few if any comparisons between one region and another. Yet, the imagery largely appears to be the same across all southern Scandinavia and even to a certain extent in northern Scandinavia (Bolin 1999:141; Kaul 1998; Nordbladh 1995:28). There are perhaps some differences in the amount of figurative elements between different regions, or in the technical style in which individual types of motif have been carved, which appear to vary from one coast to another, or even between one local site to another.

The Boat Motif

Looking specifically at the boat motif in the southern Scandinavian rock art, the imagery is largely very stylistic and has a shape that is readily recognised all across the region which makes it clear that the boat imagery belongs to a common tradition or culture (Kaul 1998). In addition to the simple stylistic figures, there will invariably be local or regional variations. For example, that which in older texts has been referred to as a typical Swedish 'east coast' type of boat (see for example Halldin 1952:86), does show some differences to the 'standard' boat depiction where in particular its more giraffe like bow extensions (figure 6) indicate a 'regional' or 'local' distinction.

Such differences have recently been explained in terms of artistic expressions of individual carvers, but it has also been suggested that the differences in style must have occurred because the individual carver was being influenced by boats that appeared in his or her own regional area (Goldhahn 1997:12, 14). An interesting aspect here is that even though it must be apparent that there are regional differences in the way in which many rock art boats have been depicted, suggesting different types of boats, the functional aspect of the boat itself is either downplayed or ignored in recent research (Adams 2003:205; Sognnes 2001). There are several instances where for example axes, shields or swords carved into the rocks can be directly related to the contemporary archaeological material culture (in addition to which different types of ards clearly have been identified) (Bengtsson & Hygen 2000:107; Bertilsson 1999; Kaul 1998), so why not the boats? The boat was needed not only for basic transportation but also for acquiring precious bronze and was therefore also a foundation for power and wealth throughout the Bronze Age (Burenhult 1980; Kristiansen 2002:67; Kristiansen & Larsson 2005; Larsson 1999a:10, 2002:111; Montelius 1874; Nilsson 1866; Nordén 1925).

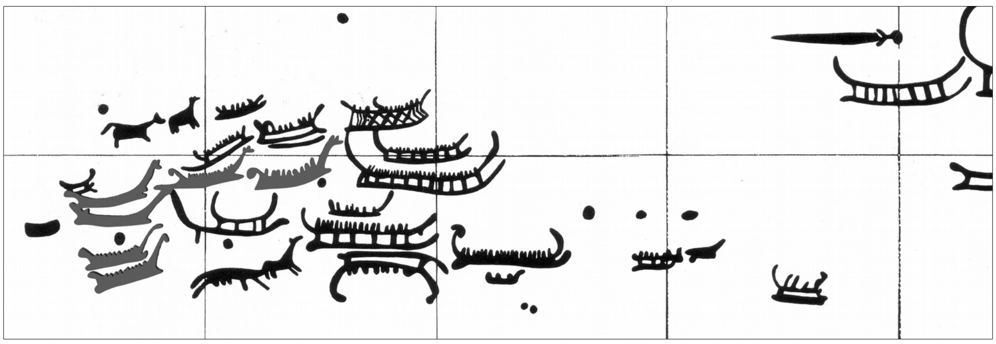


Figure 6. Rock art boats from the Himmelstalund site in Östergötland on the Swedish east coast (after Burenhult 1973b:112). Here the 'east coast' type boats are highlighted in grey which can be distinguished by their long giraffe-like extensions in the bow.

Both ethnographic and socio-anthropological research have shown that concepts that are central to the functioning of a society are often transferred into powerful symbols, that can be used to make the unknown or incomprehensible more understandable. In this way a boat can be used to illustrate the departure of a deceased from this world to the next, or its impressive capabilities in terms of speed, size, range and manoeuvrability be used to epitomize power (Artelius 1996:25; Bengtsson B 2003:37; Thrane 2001:552). The symbolic, religious, cosmological or indeed magical reasons there might have been for carving a particular boat image does not in any way contradict the fact that it might have had an important function or value as an object (Adams 2003:205; Bengtsson B 2003:75; Coles 1993:25; Thrane 2001:552). Did for example the people carving the Litsleby carvings in Tanum, Bohuslän (figure 7), where two boats that include very specific carved details between the extended 'horns' or 'beaks' in the bow and stern ends can be found, use the very type of boat that they depicted for their own purposes in real life?

The similarity in the shape of the sheer and the extended horns between these types of rock art boats and the Hjortspring boat find from Als, Denmark, is striking enough to make the

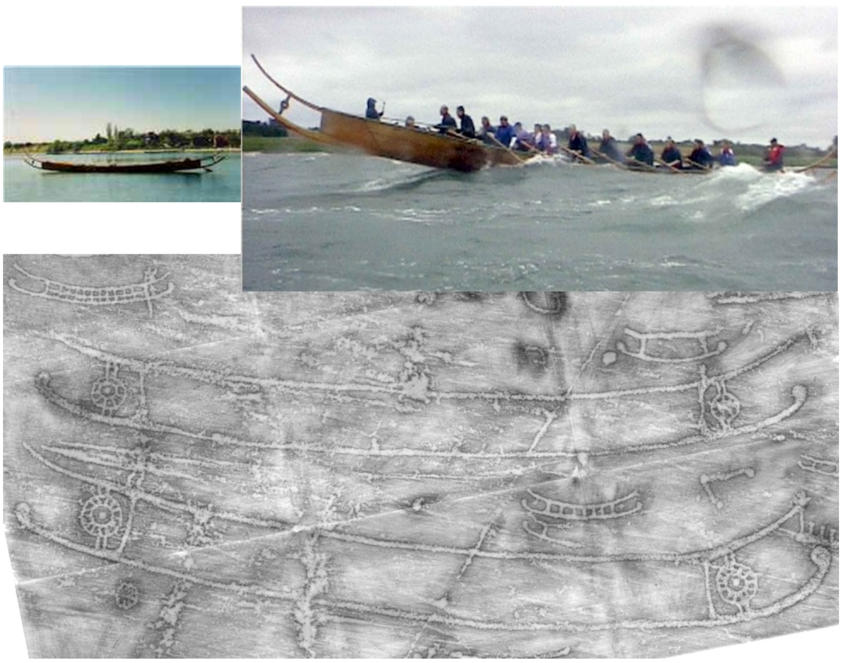


Figure 7. A rubbing of part of the Litsleby rock carving site in Tanum parish, Bohuslän (RockCare 2000), above which two photos of a recent reconstruction of the Hjortspring boat have been inserted illustrating the similarities in shape (Bengtsson B 2003:38, 46).

question relevant (and prompted the insertion of similarly carved details between the extended horns on the reconstruction of this boat even though these particular details were not found with the original find) (figure 7). Especially as the quality and the workmanship of this boat, although it postdates the end of the Bronze Age by about 150 years (Rieck 1994:49), makes it evident that it must belong to a long tradition of building such vessels and thus represents a boatbuilding tradition that possibly dates back as far as to the beginning of the Nordic Bronze Age (Kaul 1998:106, 2003; Kristiansen 2004; McGrail 2001:191; Valbjørn 1999:59; Wehlin 2013:150). A similar if not as direct question as the one posed above in relation to the Litsleby boats, has been asked by Adams (2003:205—206) with regard to the boat imagery at the Himmelstalund site in Norrköping on the Swedish east coast.

Reverting for a moment to the question raised above in relation to the rock art boats at Litsleby and whether they might reflect 'real' boats used for daily transportation or specific voyages, this is a subject that several scholars have touched upon in the past. Based on the occurrence of typical regional vessels within the rock art, Kristiansen (2002) has for example suggested that individual chieftains would have 'signed' the rocks with 'their' boat, which can be distinguished when a non-local boat appears on a rock art site. Thus he proposes that for example the likeness between a boat found at Torsbo in Bohuslän on the Swedish west coast and one appearing on a stone at Truehøjgård in northern Jylland in Denmark, is the result of a chieftain travelling directly between the two areas, who had the carvings made to mark the occasion (2002:69).

The exact nature of these boats has been heavily scrutinised, with scholars suggesting that they were anything from rafts to out-rigged logboats, similar to Oceanic out-riggers, or hollowed out logboats or plank built vessels along the line of the Hjorspring boat (Brunius 1839:80; Dahlgren 1932; Elgström 1925:293; Fors 1993; Halldin 1949, 1952; Köster 1934; Österholm 2002). The idea that they could be representations of hide boats has also been put forward which led to rather heated debates in the 1970s and 1980s as to the origin of the Nordic or Scandinavian boatbuilding tradition of later periods, and whether this had its origin in the hide, or umiak type, boat, or in the logboat (Brøgger & Shetelig 1971; Crumlin-Pedersen 1972:232; Hale 1980; Marstrander 1963:150, 450).

Today the debates have somewhat mellowed and most scholars seem to agree that plank built vessels, along the lines of the Hjortspring boat, probably existed throughout the Nordic Bronze Age, although other types of boats might have existed alongside. In addition to discussions about the types of boats represented in the rock art material, their propulsion and steering devices have also been of interest along with their potential size and crew distribution (Bengtsson B 2003; Bradley 2008; Bradley et al. 2010; Ellmers 1995; Halldin 1949, 1952; Kaul 2003a; Ling 2012; Wehlin 2013; Østmo 1992). The view that the rock art boats might also represent contemporary boats begs the question as to how far away from navigational waterways this type of imagery is found – along the coast as well as along inland waterways – and whether it is possible to relate rock carved boat images to areas where physical contemporary boats might have influenced the carver.

Rock Art and the Sea

As has already been mentioned, the majority of the rock art in southern Scandinavia is found along the palaeographic coast or along inland waterways but this is a relationship that is not always evident as many of the sites are found several kilometres away from the present shore. In order to explain this phenomenon, it is necessary to explain the factors that have caused this change in the landscape. At the height of the last glaciation period (the Weichselian period) some 20,000 years ago, large parts of the northern hemisphere including Scandinavia were covered in a heavy, up to two kilometres thick layer of ice (Påsse 2001:11). This ice, and the stones trapped within, would effectively grind the cliffs and create the smooth surfaces upon which the rock art is found, but the sheer weight of

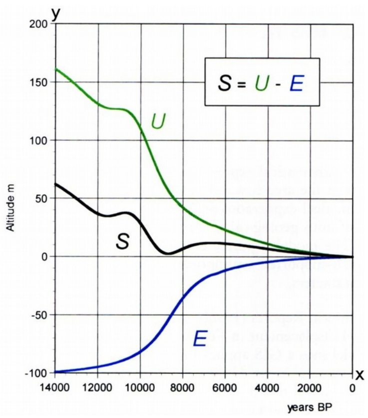


Figure 8. Graph illustrating the relative sea level (S) in Scandinavia as the result of rising eustatic sea levels (E) and glacio-isostatic land elevation or uplift (U) (Påsse 2001:8)

this mass would also cause the upper crust layer of the earth, to sink into the astenophere or low-velocity zone below (a layer on top of which the crust including all its continental plates is 'floating') (Påsse 1996a:1, 2003:32; Tarbuck & Lutgens 1993, fig.17.12).

When the climate changed and it became warmer at the onset of our present day interglacial period (the Holocene), the ice began to melt, which triggered two primary events, the most obvious of which was the rise of the global sea level. The second event was that the land or crust that had previously been weighed down by the heavy ice sheets began to rebound in response to the rapidly decreasing loads when the ice melted (Påsse 1996b, 2003:32). Thus, the relative sea level change in Scandinavia has foremost been

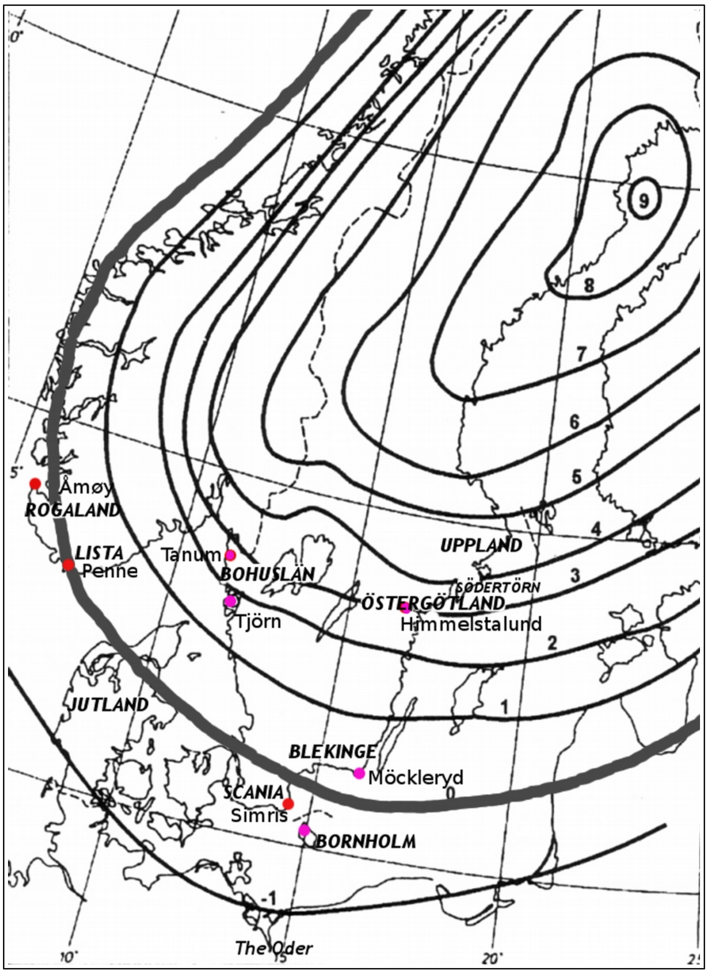


Figure 9. The recent relative uplift in Scandinavia (after Påsse 1996b:5) in relation to the places and rock art localities mentioned in the text. The thick grey line indicates where the current uplift is 0mm per year. The maximum rate of the uplift occur in the Gulf of Bothnia with 9mm per year.

affected by an eustatic (global) sea level change and a local isostatic uplift, both of which have been caused by the receding ice sheets.

The resulting relative sea level curve for Scandinavia, S in figure 8, shows how the two events have interacted since about 12,000 BC (Påsse 2001:8). Whereas the rise in global sea levels started to level out around 5000 BC, land elevation has continued in Scandinavia and is still in effect today with current uplift rates of up to 9mm per year in some areas along the north-eastern Swedish coast (figure 9) (Fleming et al. 1998; Mörner 1990; Påsse 1996b:5, 2003).

The above simplified account of land elevation is further complicated by tectonic crustal movements, induced by sudden release of weight (ice melting) or increase of weight (more water in the sea basins), as well as differences in the rate of the uplift on a more local scale due to variations in the thickness of the crust, which might be the case in a fissured landscape with lots of valleys. Because of these variables, the process of land elevation has been very different in different parts of Scandinavia, and consequently the rock art is situated at different heights above the former coast lines in different regions. In some areas where the effect of the land elevation has been relatively negligible since the rate of the eustatic sea level rise slowed down, as for example in southern and south-western Norway or southern Sweden, the positioning of the rock art in relation to the sea has changed relatively little since the Bronze Age (Bengtsson B 2003:56—57; Berglund 1974; Digerfeldt 1975; Kvalø 2000:43; Liljegren 1982; Ling 2008; Myhre 1980:101; Høgstøl & Prøsch-Danielsen 1999:13; Prøsch-Danielsen 1997, 2006; Prøsch-Danielsen & Bondevik 2003; Sørensen R 1999; Sør-Reime 1982:92).

Thus, the rock art in these areas is able to provide us with a more direct experience of how the rock art panels would have been located and visualized when they were originally carved, lying close to the shore or overlooking the sea (figures 10A-10C, marked with red dots in figure 9) (also see Bengtsson B 2003; Ling 2008:35). In other areas such as for example Bohuslän, where the land elevation has been up to 15 meters and thereabouts since the beginning of the Bronze Age, the relationship with the sea has obviously been less apparent (Bengtsson B 2003:55; Berntsson 2006; Bertilsson 1987:185; Ling 2008; Påsse 2003:40; Miller & Robertsson 1988:103).

The sometimes extreme rates with which the land is elevating around the Scandinavian coasts, with the sea being lowered some 15cm over a 20 year period, means that the land elevation as a phenomenon has long been known and already in 1868, Brunius for example, made an attempt to use this rate as a method for dating the rock art in Bohuslän

Figure 10. A) Rock art site with depictions of boats and axes on the sandstones of Simris on Scania's south eastern coast in southern Sweden. Here the coast line has largely remained the same since the Bronze Age and the site lies only a stones throw from the sea. B) Rock art panel at Melig, Åmøy in Rogaland, Norway, situated at stone's throw from the waters edge. C) The panoramic view from a rock art panel at Penne, Lista south-western Norway. Even thought the panel is located several kilometres away from the shore, the sea still manages to dominate the view and the experience of standing next to it. View to the west to west-north-west. Photos: Boel Bengtsson 2005.

(Montelius 1874:151, 159; Pirazolli 1987). In 1942, almost a century later, Hallbäck (1944) used the same method on the lowest situated rock carvings from the 'Vette Hundred' in northern Bohuslän to the 'Askim Hundred' just south of Gothenburg. He worked on the assumption that the carvings could not be older than the rocks upon which they were carved and since the rocks slowly rise from the sea it would be possible to determine their maximum age.

The result showed that the locations varied from around 18 meters above the sea level in northern Bohuslän down to about 8 meters above it in the south, providing an indication that there was a relationship to the sea. In short, the quicker the land elevation occurred (which happens to be in northern Bohuslän) the more quickly and higher up the rocks that were once on the shore were elevated in comparison to areas in the south, where the elevation rate had been lower. However, the investigation was only based on a few rock carving sites and Hallbäck (1944:54) himself failed to see any relationship, making the simple statement that some of the rock carvings must belong to the Iron Age and that the rock art was unlikely to have been placed at the waters edge. Bertilsson (1987) also denied that there was any such relationship when studying his rock art material in the parishes of Tanum, Sotenäs and Kville in Bohuslän. Instead he argued that the rock art, the majority of which was located between 15 and 45 meters above the mean sea level, clearly had more affinity with the arable land in the area (1987:185—187). He did, however, acknowledge that height above the sea does not necessarily equal distance from the sea, to which might be added navigable rivers (Bengtsson B 2003).

For other areas, Burenhult (1980:34) had earlier suggested that the majority of the rock carving sites in his investigation material (covering the Swedish rock art material from Östergötland down to Scania, but not including Gothenburg, Bohuslän and Dalsland), were located within 500 meters from the ancient coast line. This was particularly the case for sites with more figurative rock art of which Simris in figure 10A is a good example.

In other areas such as Uppland to the north of Östergötland, the relationship has been easier to establish even though the land elevation has been considerable. Whereas an affinity between the figurative rock art and the former shore line was mentioned in relation to the investigations made by Kjellén and Hyenstrand (1977), Coles (1994, 2000:99, 108) very convincingly demonstrated this relationship by simply observing that the majority of the rock carvings in the region were located around the 20 to 25 meter height curves in the landscape and subsequently inserted the sea level just below the 20 meter curve (figure 11). Thus, the often very strategic positioning of the rock art on promontories or next to sheltered bays and inlets was cunningly revealed.

Similar strategic locations to what Coles found with regard to the Uppland sites have been noticed for rock art situated along inland river systems, many of which have remained almost untouched by the sometimes dramatic changes the effect of the land elevation has caused in the coastal areas, but also in coastal areas where the impact of the ice have

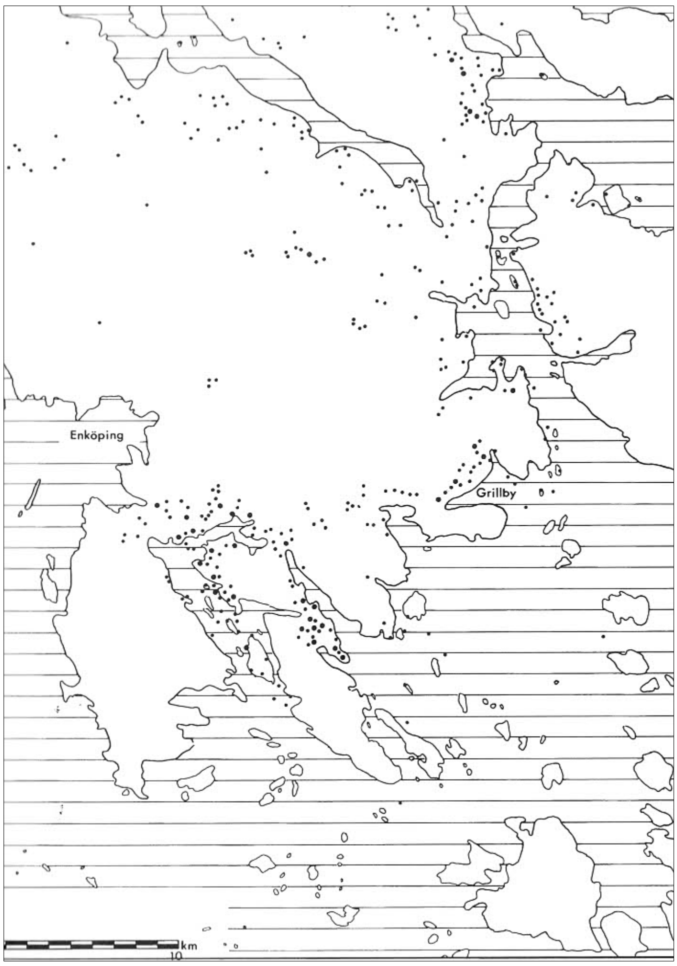


Figure 11. Rock art sites, marked with black dots, in the Enköping area in Uppland, Sweden, as they would appear with a 20 meters higher sea level (Coles 1994:9).

remained insignificant such as in the south-west of Norway. Here, the rock art has more naturally been discussed in relation to the importance of the river systems as arteries for communication and transportation, with sites often located at the entrance to the inland river systems, or at important thoroughfares within the river systems where the coast is linked to inner parts of the country (Nordenborg Myhre 2004; Mandt 1991,1995:279; Thedéen 2004:58–59; Weiler 1994:11; Wigren 1987:64).

Rock Art Boats and the Emergence of a Maritime Perspective

Despite the almost universal association between the rock art and the coast or inland waterways – a relationship which in fact was first argued already in 1869 (Hildebrand 1869:422), and which has been implied by many studies since – few attempts have been made to examine the possible link between the boat imagery in the rock art and the sea routes that undoubtedly existed.

The fact that the Scandinavian rock art is often found in clusters, present in one area while mysteriously absent in another (despite apparently very similar geological and geographic preconditions), has caused many scholars to believe that they represent a form of gathering places or central places where people would meet for different reasons including the performance of rituals or the exchange of goods (Arrhenius 1987:260—261; Goldhahn1997:14; Kaliff 1995:31; Larsson 1986:139, 141; Mandt 1995:279—280; Randsborg 1993:80—81, 1999:28—29). Sometimes, their locations have also vaguely been commented upon in relation to possible seafaring routes of communication and trade. So, for example, the southernmost cluster of rich figurative rock carvings on the island of Tjörn on the Swedish west coast has been set into relation with its location from where a sea voyage across to Jutland, Denmark, would have been the most direct (Pettersson 1982) (see figure 9).

Similarly, the location of clusters of rock art on the island of Bornholm and along the coasts of Scania and Blekinge in southern Sweden at roughly even distances, have been commented upon as possible stop-over sites that might have formed part of a coastal net-work for communication (Goldhahn1997:4). Others have made the suggestion that such sites might be places from where people (chieftains) set out on long distance sea voyages, and that the complex rock carving sites were carefully chosen strategic places where a specialisation in boatbuilding and longer sea journeys might be assumed (Bengtsson B 2003:19; Kristiansen 1998:92, 2002:68—69, 77—78, 2004:112). Conversely, however, it has been suggested that seafarers would “*sail across the Baltic Sea to south-eastern Scania where Simris and Kivik are located* “ from the mouth of the river Oder along which the large trading networks from central Europe would debouch into the Baltic Sea, again linking the clusters of rich southern Scandinavian rock art sites with trade and communication (Kristiansen & Larsson 2005:204—205).

Assuming boats were used for transporting goods and people back and forth to the various coastal rock art sites and, that they were indeed used as gathering or trading places, suitable landing places might not have been far away. Attempts to find such landing places have, for example, been made amongst the Södertörn rock carving sites in Södermanland, Sweden. Here, a similar approach to that of Coles in Uppland, was used whereby the 15 and 20 meter height curves were used to extract the possible deviation in the Bronze Age sea level (Kinberg 1998). The landscape thus retained revealed that many of the sites appeared to be located in sheltered bays that would have provided ideal landing places, as well as possibly having formed part of a coastal network of sea routes (Kinberg 1998:25). Coles (1990, 1994, 2000, 2004) was the first modern scholar to describe the landscape in which the rock art is situated as a seascape and directly associate them with the former sea, something he managed to do without the use of accurate sea level data, which, although his approach should appear very convincing, has taken a while for the rest of the rock art research elite to appreciate (see e.g. Bertilsson 2005).

However, as the brief description of land elevation as a phenomenon laid out earlier in this chapter would imply, improvements within the natural sciences have lead to much better understanding of the processes and individual factors contributing to this phenomenon. This, coupled with much improved methodological approaches for establishing local sea level curves, have in recent years led to the introduction of mathematical modelling programmes which are increasingly used for predicting past and future regional and local sea levels, in some areas within 2 meters (Bengtsson B 2003:55; Kearney 2001; Lambeck & Bard 2000; Påsse 1996b, 2001, pers. Communic. 2003). Whereas sea level curves should always be treated with caution, these improvements make it harder to ignore an affinity between the rock art and the sea (Bengtsson B 2003:53; Liljegren 1982; Påsse

2003:53; Risberg 1991; Åkerlund et al. 1996:73, 75). Moreover, the application of such data in many areas actually seems to confirm Coles' hypothesis regarding the favoured location of figurative rock art in a 'seascape' (1990, 1994, 2000, 2004), while at the same time providing far more convincing evidence as to the configuration of the past sea level than by merely demonstrating the location of the rock art around a particular height in the landscape and on the basis of that assume a past sea level not far below (Bengtsson B 2003:55—57; Påsse 1996, 2003).

It appears that the emergence of better tools for calculating past sea levels has opened the door for a maritime approach to the southern Scandinavian rock art, and for the ability to finally discuss the rock art boats in connection with their actual use in contemporary society. This should by no means be taken as a complete break with any 'agrarian' interpretation of the rock art as 'agrarian' as indeed 'hunting' scenes are often present on the same panels as boats, but at least opens up the possibility to apply such an approach. A first attempt to explore a maritime approach to southern Scandinavian rock art was made in 2003 (Bengtsson B), and was based on a mathematical modelling programme for calculating past sea levels in areas as geographically disperse as the parish of Tanum in Bohuslän on the Swedish west coast and Scania and Blekinge in the south and south east of Sweden, naturally with references to local sea level curves for these specific areas (Bengtsson B 2003:58—71; Påsse 1996a, 1996b, 2003).

The aim was to demonstrate an association between figurative rock art sites, in particular those containing certain types of boat imagery, and the palaeographic shore and/or navigable waters. This approach showed not only that an association could be established between the rock art and the former sea level in all three regions, but that rock art sites on higher ground could also be connected with possible coastal seafaring routes, thus, enabling us to more accurately pin point where boats might have been used in the contemporary Bronze Age society. It also showed that many of the rock art sites in for example Tanum, which Bertilsson (1987a) disregarded as having any association with the shore, are likely to have been located within easy access of the sea at the time of use and thus an association with the sea as to the use of boats would appear to be very logical (Bengtsson B 2003:59—61, 72).

A more comprehensive analysis of the rock art in northern Bohuslän, based on a more accurate local sea level curve for this area, has been presented in a recent Doctoral thesis by Ling (2008) and confirms both a close association between the rock art and the contemporary shore and navigational routes in this particular area. Ling (2008:69) was even able to show that some rock carvings must have been made by carvers operating from a boat as any other access would have been impossible (unless carved in the winter while standing on the ice), emphasising that many rock art sites were originally made to be viewed from the water.

It is clear that not only the same type of boat imagery appears across the southern Scandinavian peninsula but that the location of such imagery would have been positioned in more or less similar coastal landscapes – although some would have been placed on a more open coast (Norway and southern Sweden) while others would have been placed in relatively protected archipelagos (the Swedish east and west coasts and parts of southern Sweden). One primary question I would like to ask in regard to the rock art is why in this material there are boats furnished with what appears to be masts, yards, rigging details and even with sails? Nordbladh (1999:19) wrote that ...”*a wise research attitude would be not to ask about the meaning of the rock art but rather to extract meanings from the rock art*”. If the masts and sails are there, what meanings would we be able to extract regarding boats, communication and society as a whole? These are the main questions I am trying to explore in this study.

Boats and Social Change

We have seen that the boat dominates as a symbol in the material record from the Scandinavian Bronze Age where it appears on rocks, on bronzes, and in graves – as burials in small boats or in the form of raised stone settings – but also as ship models in clay and gold (Berntsson 2005:71—73). Even after the end of the Bronze Age the boat continues to be a fundamental symbol, and experiences a second period of intense use from around AD 500 until the end of the Viking Period. Despite the gap at the onset of the Iron Age in the symbolic use of the boat seen in the archaeological material, boats were still being used (figure 12).

The Nordic boat tradition, based on a shell first building technique of overlapping planks (Christiansen 1972:235—259; Crumlin-Pedersen 1972:208—234; Hasslöf 1972:27—72; McGrail 1987:102), produced very mobile and light vessels, and is a tradition which reached its peak during the Viking period (and continues to be used even today along the Scandinavian coasts). This Nordic boatbuilding tradition can be traced back to the light plank built Hjortspring boat, and largely appears to have been the result of an internal development (Adams 2003:59—60; Westerdahl 1995). The very same has been said about the development of the Nordic or Scandinavian type of sail and rig (Westerdahl 1995:43).

The sail however, is generally perceived to have had a much later introduction, emerging and developing in the relatively short time span between the 7th or 8th and the 10th centuries AD (Greenhill 1995:182; Haasum 1989:38; Varenius 1992; Westerdahl 1995:43). The reasons for this being a lack of firm archaeological evidence along with a single sentence by the Roman historian Tacitus. Thus within a period of merely 200 years the knowledge of the sail would suddenly have appeared and the know-how of its use be appreciated to the extent that it could be used for serious overseas journeys. This of course is contradicted by the potential presence of masts and sails in the much earlier rock art material. Therefore I propose that the sail has a much longer tradition than that which is apparent in the archaeological boat record alone, and that the sail would have slowly been developed and used on small vessels already during the Bronze Age, and from there on have been adapted

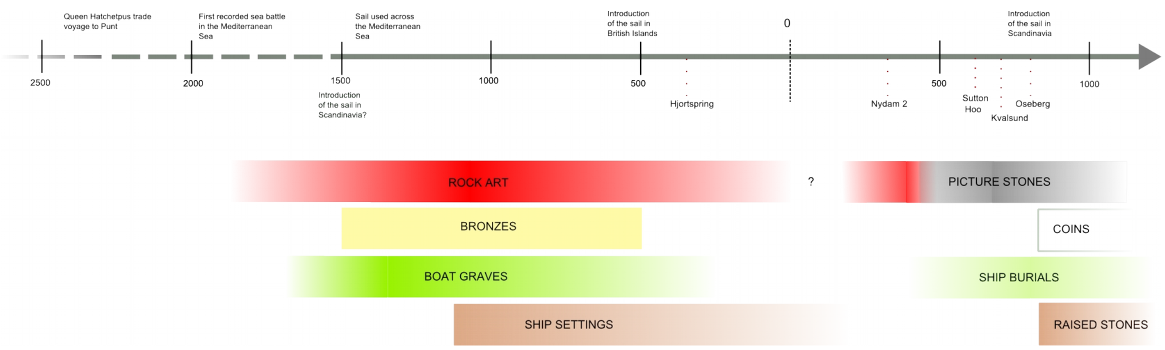


Figure 12. Approximate time line for different mediums in which the boat symbol features in southern Scandinavia: in rock art, on Gotlandic picture stones, on bronzes and coins, boat graves and ship burials, ship-settings and raised stones.

to increasingly larger vessels. Equally, I propose that the Nordic boatbuilding tradition developed in response to the increasing use of sail as propulsion.

The relationship between ship and society (as indeed between sail and society) has been explored by several authors in the past (Adams 2003; Larsson G 2007; Varenius 1992; Westerdahl 1995) with particular focus on the Viking Age. Varenius (1992:10), for example argues that "*beautiful, fast and seaworthy ships were of social significance in Viking society*" while providing colourful examples of how these aspects were hailed (as well as ridiculed if not fast or seaworthy) in the contemporary literature. One passage taken from 'Hafudlausu' by Óttarr Svarti (AD 1023) might illustrate this (free translation after Varenius 1992:10):

> *"You were not afraid of the sea,*
> *it was a wild sea you sailed across,*
> *no chieftain can have braver men,*
> *the ship was tested,*
> *because you, descendant of Harald, landed in the middle of Norway,*
> *but the ship often repelled the frothing waves"*

It is interesting to note how status and fame during the Viking Age were gained as a warrior, through travelling, through providing gifts (being rich), or through being a good seaman (reaching the right shore...also highlighted in the Saga above). In many ways the ideals about fame and fortune brought to a man owning a mighty ship with which to travel afar that we meet in the skaldic poetry of the Viking Era (Larsson G 2007:362), can be compared to Helms' (1988) ideas about the cultural importance of long distance travelling and exotic knowledge for enhancing and maintaining status which have so influenced recent Bronze Age research (Kristiansen & Larsen 2005; van de Noort 2006).

Returning to the symbolic value of the ship, Varenius (1992:131) based on iconographic evidence from the Gotlandic picture stones, runic stones, coins and seals dated between AD 500–1300, argues that its symbolic value would have been interlinked and interdependent with how society valued ships in general – as a gift among its leaders (as some of the Nordic epics tell about) as well as according to its technical and functional aspects. He also stresses that the more the ship symbol was used the stronger its 'value' as a symbol would become (ibid.). Consequently, the significance of the boat as a symbol cannot be understood purely from a functional perspective, but must also be understood in relation to society itself. A parallel to how the boat might have gained its symbolic power in Bronze Age society is not entirely far-fetched.

In a more recent thesis on Viking Age boatbuilding vis-á-vis Viking Society by Gunilla Larsson (2007), the interplay of ideological, functional, technological and societal aspects of ships and shipbuilding is explored based on empirical material (2007:23). The same thesis highlights the importance of “*knowledge by experience”* (ibid.) and the gains in knowledge achieved through experimental archaeology. The main conclusion is that there is a close association between technological and societal changes and that this relationship was mainly impelled by political intent (2007:381), a statement that is not really further elaborated. Rather, the view expressed is that the increase in trade between the fur-producing areas of the north and the areas in the south east from where silk, silver, spice and slaves could be retrieved was the result of the development within boatbuilding technology in combination with the introduction of the sail, which enabled long distance seafaring along “*shallow waterways with often occurring portages*” (ibid.). A very elusive interpretation indeed but interestingly, she sees the Late Nordic Iron Age as the cradle and the end of a truly maritime society, which died with the introduction of Christianity when the boat symbol was replaced with the feudal symbols such as the armed knight and horseman (2007:376).

Why then is the introduction of the sail perceived as being so important? Well, in addition to stating the obvious – that it would have enabled longer voyages over a shorter period of time, thus enabling larger cargoes and smaller crews – it seems that this introduction would have more or less suddenly given rise to new exciting possibilities for long distance trade and even trans-Atlantic voyaging. Whether the sail would have been favourable for voyages along shallow waterways with often occurring portages I will set aside for now, but it is very dubious that the simple and flexible rig of the Viking Age would have evolved for the use on the rivers to the east. More interestingly however is to evaluate a possible parallel between our knowledge of prehistoric Nordic society and a longer continuity in the development of the sail as well as the boatbuilding technology – from the Bronze Age until the Late Iron Age, when Christianity began to have a major influence on the Northern society. Jon Adams (2003:208) puts it: "*In a society where bronze retained its prominent role for so long, and where society seems to have undergone generally less traumatic change* [than the rest of Europe], *it may be significant that boat technology of considerable sophistication not only survived the transition to the Iron Age but developed into arguably the most widespread and long-lived northern boat building tradition of all: Nordic.*" The technological development in boatbuilding and the use of the sail together might help better recognise and understand the process highlighted by Adams.

The main standpoint for a late introduction of the sail is a lack of firm archaeological evidence; no boats showing irrefutable evidence of having been sailed prior to this period have been found in Scandinavia (McGrail 2001:212). The fact that the sail was known in the Mediterranean sea several thousand years earlier, and probably by the 6th century BC around the British Islands (McGrail 2001:112, 211), adds to the curiosity as to why people in Scandinavia would have 'chosen' not to adopt the sail despite undoubtedly having been in contact with sailed vessels perhaps as early as in the Bronze Age.

Over the years, iconographic material indicating that the sail was known and possibly used in Scandinavia in the Bronze Age and early Iron Age has emerged – mainly in the rock art – but the material has been scarce and generally presented in terms of individual occurrences on a local basis (Arturson 1987; Burenhult 1973a, 1987; Halldin 1952:75, 77; Humbla & von Prost 1937:71; Fett & Fett 1941; Sognnes 2001; Stöltig 1996), and has so far sadly been overlooked or ridiculed as an impossibility. Indeed, the ambiguity in the interpretation of rock art imagery in general is a concern as well as the unwillingness to accept these records as 'archaeological evidence'. Another obvious difficulty is the lack of understanding from scholars with regard to how small boats work under sail, and their general disbelief that it is possible at all to sail the type of boat that we understand to belong in the Scandinavian Bronze Age.

Thesis Structure

In this chapter (Chapter 1) I have introduced the Scandinavian Bronze Age society and its associated rock art. The chapter explains how increased knowledge in the land elevation phenomena has opened the door for a maritime interpretation of the rock art and perhaps even Scandinavian Bronze Age society itself, where the boats and their propulsion can be explored as an integral part of society as a whole. Furthermore, the chapter raises the issue of a possible continuity in society ranging from the Bronze Age through to the Viking Age, reflected in an enduring and locally evolved Nordic boatbuilding technology, along with a continuing use of the boat as a powerful symbol, as manifested in graves, as depictions on raised stones, on bronzes and on rocks.

The subsequent chapter (Chapter 2) presents the source material and its limitations, but also deals with the problems faced while undertaking the rock art research and the experimental sail trials described in Chapter 6.

In Chapter 3, the possible transition from paddling to sailing in two further areas – on the Nile in ancient Egypt and in Oceania – is analysed in order to be used as a comparison with the southern Scandinavian evidence.

Chapter 4 introduces the main problems with the current hypotheses regarding the introduction of the sail in the North, taking into account the archaeological boat material, the written source material, and the linguistic and iconographic evidence (excluding the rock art) available to date. This is followed by an in-depth analysis of the south Scandinavian rock art in Chapter 5, focusing on matters such as past research, the documentation and interpretation of rock art, before introducing the evidence possibly attesting to the use of sail, but also that of paddles, oars as well as different methods of steering.

In Chapter 6, I describe a series of experimental sail trials in Bronze Age type vessels, which aims to assess whether such boats could have sailed. These trials are initially conducted in the relatively sheltered waters of the Bohuslän archipelago on the Swedish west coast, with the use of a prototype boat exhibiting the main traits of a Bronze Age boat, as derived from the rock art and the 350 BC Hortspring boats (which is believed to belong to a Bronze Age boatbuilding tradition). The experience gained from these initial trials is then transferred to Danish waters and sail trials in a reconstruction of the Hjortspring boat.

Chapter 7, provides an assessment of the emergence and development of the use of the sail in Scandinavia and how this might affect our understanding of its Bronze Age society, taking into account seafaring conditions, iconographic material as well as experimental sea trials. This is followed by the summary and conclusions of this thesis presented in Chapter 8.

2. Sources and Limitations

This thesis relies on rock art imagery as its main source material, roughly dating to between 1800 BC and AD 400, but also on what is known about Bronze Age Scandinavian boats in terms of building material and overall shape, as derived from archaeological boat finds, ship-settings and graves. For an analysis of the evidence of the use of the sail in the North, I have relied on published sources on archaeological boat material, historical sources, as well as iconographic and linguistic evidence.

The manufacturing of boats and ships is constrained by the tools and material to hand as well as the environment in which they are to be used (Adams 2001). These are all aspects that can be tried, tested and evaluated. Also the technical performance of boats and ships can be tried and tested. As this aspect in many ways is governed by physical laws (see e.g. Marchaj 1982; Mott 1997:9–10), such analyses are often made and calculated on the drawing board. However, the drawing board is never 100% correct. Ancient boats are hand made and as a result, do not necessarily conform with the vessel on the drawing board. In addition, their performance will always be governed by the experience and level of seamanship of the crew testing them as well as the conditions during the actual trials. Experience and the ability to make quick decisions in a vessel is often the difference between success and disaster and is something that is particularly evident when sailing. Therefore, in order to demonstrate whether a certain type of boat might be sailed or not, one needs to undertake experimental sail trials with the aid of an experienced crew.

Consequently, in order to establish whether the type of boats we believe belong to a Bronze Age boatbuilding tradition, or Bronze Age type boat, might actually have been able to sail, I have primarily relied on my own experimental sail trials, described in Chapter 6. The basis for establishing valid experimental trials comes from my analysis of the rock art which is set against the archaeological record. I then focus on establishing certain technical aspects of a valid Bronze Age type boat and on the execution of experimental sail trials in such a boat, carried out in an authentic environment.

In order to assess a possible process for the transition from paddling to the gradual introduction of the sail, I use my assessment of means of propulsion and steering available within the southern Scandinavian rock art material, the knowledge gained from experimental on water boat trials, and comparative material from Oceania and ancient Egypt where a similar transition has occurred.

The Southern Scandinavian Rock Art

Traditionally, the Scandinavian rock art has been divided into a northern and a southern tradition. The northern rock art is generally less complex and varied and includes more animal motifs such as elk but on which interestingly the boat also remains an important motif. Because of the focus on animals, these carvings have been associated with hunting activities, as expressed by a hunter-gatherer society. In contrast, the southern rock art with

Figure 13. The highlighted area indicates the area belonging to the 'southern' Scandinavian rock art tradition

its more varied and complex motifs has been associated with farming and a southern agrarian society. As we have seen, this traditional 'agrarian' tradition has been questioned lately in favour of a maritime tradition (Ling 2008), but also the division between a northern and a southern tradition has been questioned (Baudou 1993:244; Bolin 1999:141; Nordbladh 1995:28). However, I have chosen to limit my main source material to the 'southern' rock art as it would otherwise have been too vast. As a result, the 'hunter-gatherer' rock art site at Nämforsen in central Sweden, for example, is not included, whereas several sites, deemed to belong to the southern 'farming' tradition at Stjørdal in central Norway are (figure 13).

In Denmark, with the exception of the island of Bornholm, the rock art material is generally less abundant (Glob 1948, 1969; Kaul et al. 2005). This is probably due to its very different geological history which has resulted in a landscape more dominated by sand than rock, leaving little material to carve imagery into. The same applies to present day north-western Germany. Instead the boat imagery here is found on bronzes. Boat depictions in rock art, on bronzes and as raised ship-settings are widely regarded as different mediums for presenting the same symbolic meaning (Kaul 1998, 2003; Kvalø

Figure 14. Detail of the rock art panel, Tanum-273 (Varlös) which has been splashed with water thus enabling the details to stand out better. Photo: Boel Bengtsson.

2000:20). The approximate extension of the area in which this common use of the symbol of the boat can be traced is highlighted in figure 13, and defines the southern Scandinavian society discussed in this thesis.

Problems

The rock art material available is vast and new sites are recorded every year making it hard to appreciate their total number (see e.g. Broström & Ihrestam 1994, 1998, 2000, 2007, 2010, 2011; Goldhahn & Broström 2011:5; Larsson & Broström 1999). A good example is the island of Bornholm in the Baltic Sea (part of Denmark) where about 180 sites were known in the 1980s, but where new investigations in recent years have increased the number to over 400 (Nielsen 2005:19—23). Not only are new sites continually found, but the focus in recent years to preserve the rock art which is quickly deteriorating due to acid rain and pollution, has laid an emphasis on preservation rather than publication. Visits to local museums have therefore been essential in order to gain an overview of the available material. Other difficulties when working with rock art arises from the different methods used for its documentation and the subjective input this has on the final interpretation of individual rock art motifs. The occasional 'disappearance' of some rock art panels due to natural changes in the landscape, due of overgrowth or because they were given the wrong coordinates when initially found must also be taken into account.

When rock art was first discovered the coastal landscape was very different to that which we find today – what was then an open landscape is today overgrown with trees and bushes. Not even when the panels are accessible are the individual rock art motives easy to detect. The chances of detecting the imagery increase if one pours water over them (figure 14) or if one visits the panels when the sun is low in the sky so that natural shadows appear across the carved lines. The rock art is probably best appreciated by night when illuminated by a torch held low so as to imitate a low sun. Therefore, I am very grateful to the Underlös museum in Bohuslän where, in 2005, I completed a rock art documentation course which was invaluable to me in preparing myself for this study and in gaining an appreciation for the difficulties involved in detecting, analysing and recording rock art.

As part of the research for this study I have visited the majority of the rock art sites mentioned in the text. This process has sometimes been made more difficult by some of the reasons mentioned above, but also because at times entire rock art panels have been either removed from their original location, or completely covered up as a measure to protect them. This has happened with three of the sites mentioned in this study; Askum-44 from Bohuslän Sweden, which is now stored in collections of the Gothenburg City Museum, and Harvaland-26 in Rogaland, now stored at the Museum of Archaeology, Stavanger, and Trosa-Vagnshärad-434 in Södermanland, now covered *in situ*.

In addition to published rock art material I have accessed unpublished documentation material, assembled by Torsten Högberg and kept at the Vitlycke museum in Tanum, Bohuslän. Included is also material from the Rane 2000 project, as available when accessed in 2005, along with rock art panels not published but listed in the Swedish sites and monuments register (FMIS). The documentation material consulted in relation to this thesis include material up until 2010. Thus, Högberg's unpublished documentation material on for example, Lökeberg has been examined, but not the recently published material on the same site by Andersson & Toreld (2012).

Experimental Sail Trials

I have already mentioned the need to carry out experimental sail trials in order to be fully able to understand the kind of boats that were used in the Bronze Age, as well as the technical challenges one would face when operating them under sail in a 'contemporary' environment. Obvious limitations for the trials were time and funding (and to some extent the weather which will discussed later). Time is crucial not least when dealing with volunteers limited to sailing on weekends, making thorough preparations vital, whereas limited funding puts extra focus on the choices of material and equipment.

Problems

Another limitation comes from the unwillingness to carry on with experimental boat trials once there appears to be a potential risk, especially when the boat is unique and priceless. This is the very reason why, when one is collaborating with and/or borrowing someone else's boat reconstruction, it is fundamentally important to prepare for any foreseeable problem in advance and discuss it prior to any trials. In the case of the *Tilia Alsie*, the reconstruction of the Hjortspring boat used for some of the sail trials described in this thesis, only two out of six planned days of on-water trials were carried out. The reason for this was that some pre-existent cracks in the stern section of the boat were found to have

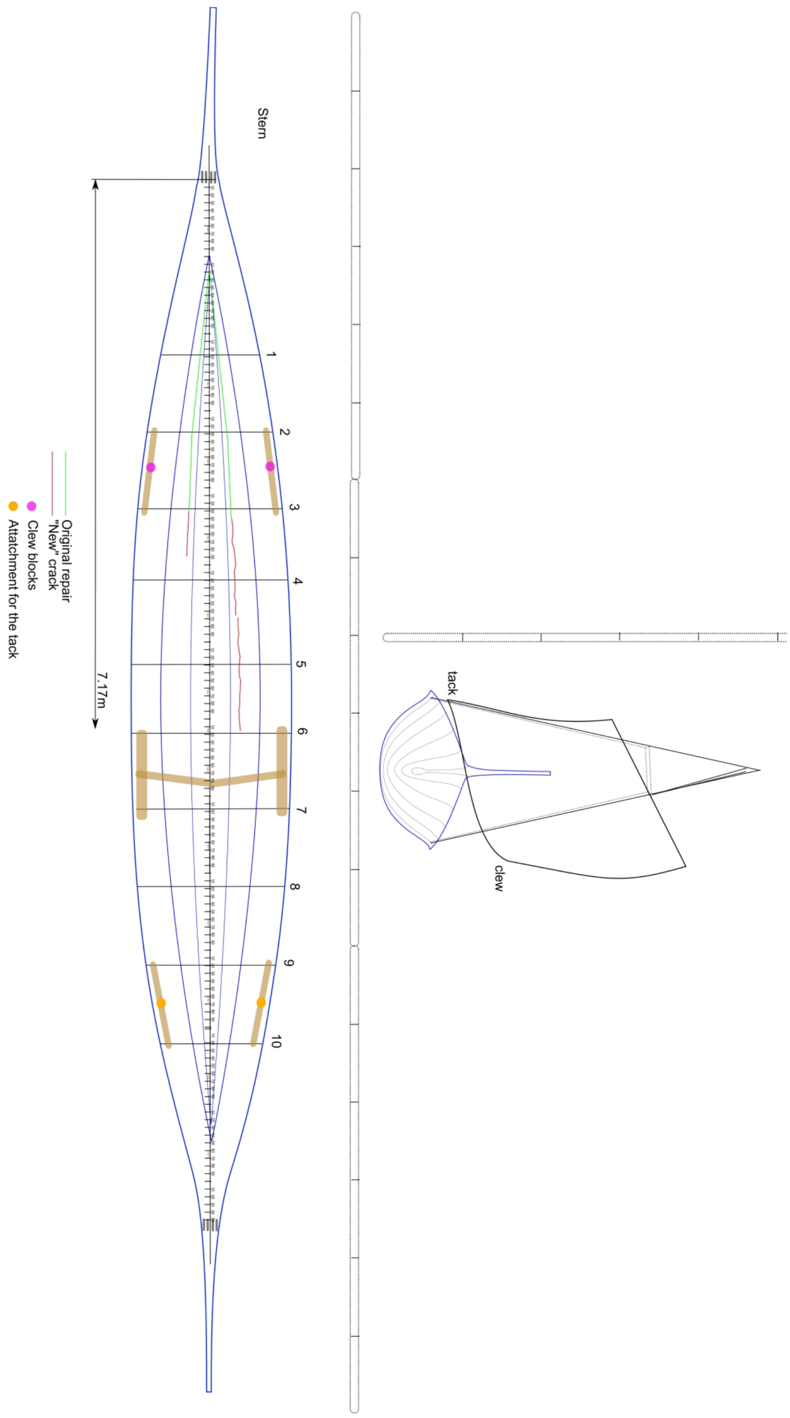


Figure 15. Plan view of the Tilia Alsie, brown tinted areas illustrating the positioning of attachments for the rig in relation to interior thwarts (after drawing by Fred Hocker, Crumlin-Pedersen & Trakadas 2003:136, figure 3.133).

grown lengthwise, causing it to leak (figure 15). These pre-existent cracks, which occurred when the tree the boat was made out of was felled, had been mended when the reconstruction was originally made, using the same technique found to have been used for a similar purpose on the Hjortspring boat (Valbjørn 2003b:52, 54—55).

The *Tilia Alsie* did not leak during the weekend of the actual sail trials and was even left in the water overnight. Only by the following weekend, after the boat had spent an entire week in dry shelter was the boat found to leak, which led to the discovery of the new cracks. It is unfortunate that the trials had to come to a premature end, as voted by a majority of the members of the Guild. The discolouration around the leaking cracks (figure 16) might in fact indicate that they had been developing throughout a prolonged period of time. Wood is not a static material and wooden boats that are taken in and out of water, causing the wood to expand or shrink, will inevitably develop cracks. Indeed, the need to

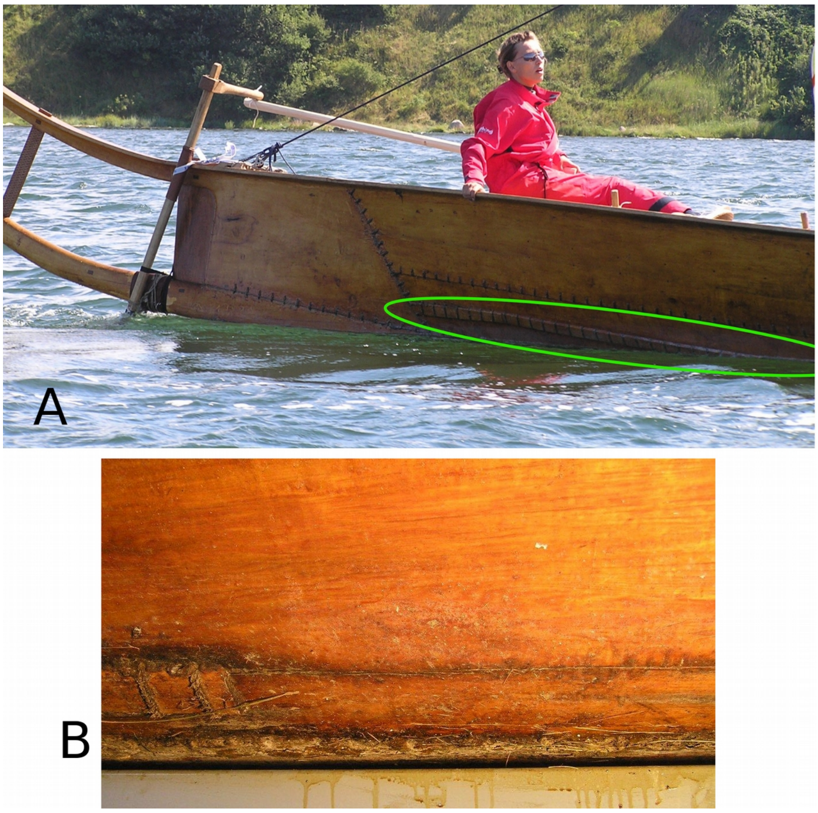


Figure 16. In figure A, the original mending of the cracks on the Tilia's starboard side can be seen. In figure B, the slight discolouration of the lengthening of the original cracks on the same side is noticeable. Photos: Knut Valbjørn and Boel Bengtsson.

repair wooden boats is nothing new but can be traced back in time for as long as boats have been used (cf. Dencker 2014).

It is also worth considering whether planks with pre-existent cracks, such as those used on *Tilia Alsie*, would have been used at all for the manufacturing of boats during the Bronze and Pre-Roman Iron Ages (given the choice). Given the considerable effort involved in building a vessel such as the Hjortspring boat, and that people's lives would have depended on it being sound and made to last, this is unlikely. Of more interest here is perhaps the fact that the stitching, actually holding the boat together, appears to have withstood any additional stresses that might have been incurred by the use of sail.

Terms and Definitions

The term Nordic or Scandinavian society is perhaps rather subjective but denotes a geographic area that shares certain traits and perhaps even beliefs, the most important of which is the dominance in the symbolic use of the boat (see figure 13). For the purpose of simplification, I sometimes use the terms the 'North' and 'Scandinavia', when referring to my area of investigation.

A boat is defined as a structure that derives its buoyancy through the displacement of water by a hollow watertight hull (Delgado 1997:67). A ship is a larger version of a boat that is usually decked and capable of sustained voyages at sea (ibid.). A vessel denotes any type of water transport, but in relation to the Bronze Age material the terms boats, vessels or watercraft are used throughout this study.

Hereafter I have shortened the name of the *Tilia Alsie* to the *Tilia*.

3. Sail: the Nile and Oceania

Before presenting and examining the Scandinavian material, I shall begin with presenting how the transition from paddle to sail is perceived to have evolved in two comparative regions, namely along the Nile, in ancient Egypt, and in the South West Pacific or Oceania. As stated in Chapter 1, the archaeological evidence for early sailing is very different for the two areas, as are the geographic preconditions. In addition, the Oceanic material offer valuable ethnographic insights and descriptions from the time when Europeans first came in contact with the region.

I will start with outlining the earliest evidence of watercraft and how the sail and seafaring is perceived to have developed for each area. It is hoped that the knowledge gained from

Figure 17. Map of the Nile (after James 2005:7; Landström 1970:10).

such an analyses might enable us to better understand the Scandinavian source material as well as the underlying factors that might have led to the early use of sail in Scandinavia.

Early Voyaging on the Nile

From the first Cataract of the Nile – the ancient southern border of Egypt – it is possible for a river craft to follow the current unobstructed all the way to the Mediterranean Sea some 1200km away (James 2009:15). The prevailing northerly wind would enable it to make the return voyage, against the current, by hoisting a sail (Casson 1995:11; Johnstone 1988:76). This unique feature appears to have favoured early river journeys above all other means of communication with, for example, early hieroglyphs depicting a boat with sail for expressing going 'south' or upstream, and a boat without sail for going 'north' or downstream (James 1983:21–22; Landström 1970:11–12).

Thus, in this narrow and fertile valley, today never extending more than some 16 km from the river, the Nile was the main route of transport (Ballard 1920:150; McGrail 2001:17). The first settlers appear to have come here c. 13,000 BC while farming is thought to have begun around 5000 BC (McGrail 2001:17; O'Connor 1980:128). A series of Predynastic cultures began to appear after around 4500 BC, the most important of which, the Badari culture, had well developed farming and stock-rearing, made fine pottery and possessed simple copper working skills (James 2009:30, 34). By the end of the fourth millennium BC a Bronze Age civilization had sprung up with two loose confederacies, Upper Egypt in the south and Lower Egypt in the north. Subsequently, by c. 3100 BC, these two confederacies were unified under the first king of the first dynasty, King Narmer (James 2009:36).

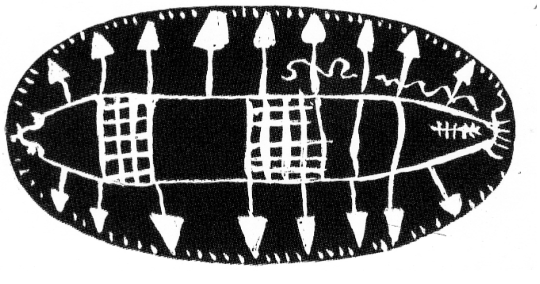


Figure 18. Craft depicted on Amratian oval plate seen in plan view (after Landström 1970:12, fig. 4).

The Earliest Egyptian Evidence of Water Transportation – from Reed to Plank

The first evidence of water transportation in the region comes mainly through iconographic material from Upper Egypt and Nubia, and dates to the late Neolithic/Early Bronze Age (McGrail 2001:17). The earliest appears during the Naqada I/Amratian period (c. 3500 BC), in the form of an oval plate on which a paddled/oared double ended boat or raft is painted in plan view (figure 18). The criss crossing lines have been interpreted by Landström (1970:12) as huts or cabins. A further two boat depictions on Amratian bowls have what Landström interprets as chequered framework lines possibly representing wooden crafts rather than bundle rafts – although this has been debated (Landström 1970:14–19, fig. 3–5: McGrail 2001:17). As for propulsion both Casson (1995:11–12, fig. 3) and Landström (1970:12–14) suggest these were rowed vessels. However, McGrail (2001:17–18, figure 2.3) points to the roughly contemporary depiction on a linen fragment from El-Gebelein to argue the opposite. Here a crew is seen holding oar like devices while facing forwards and not backwards as one would expect if rowing. Thus, it could in fact be paddles rather than oars that are depicted.

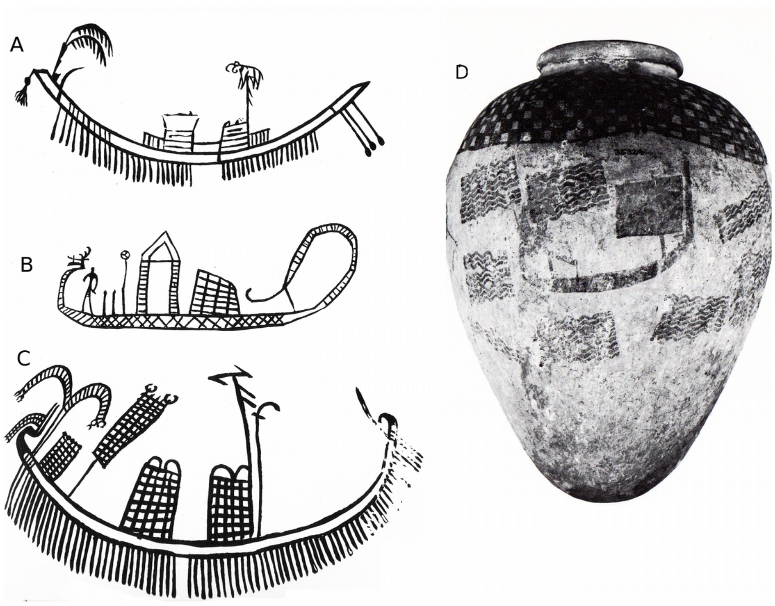


Figure 19. A-C: Craft depicted on Gerzean pottery, c. 3200 BC (after Landström 1970:13, fig. 10, 13, 14). D: Vase from Nagada showing a craft with a single square sail, c. 3100 BC (after Landström 1970:13, fig. 15).

From the Naqada II/Gerzean period (c. 3200 BC), there is a rich material of boat or raft decorated pottery. Here the most commonly depicted type of craft has a strongly curved and evenly thick hull from which a series of downward projecting lines are taken to represent paddles or oars, and in one case, three steering paddles/oars can be seen in the stern (A in figure 19) (Landstöm 1970:13; McGrail 2001:18). Amidships these vessels have structures that might represent cabins or shrines, next to which poles are raised carrying some form of emblem, whereas in the bow palm branches appear to be raised (ibid.). Within this pottery material there are also a few vessels with a straighter hull line which has lines across it and inwardly curved ends, possibly representing reed bundle rafts (B in figure 19) (Landström 1970:13:McGrail 2001:19). The raised palm branches in the bow have been interpreted as either providing shelter for a look-out, as a decorative feature or, as a sail (Fabre 2005:112, 114; Landström 1970:13; McGrail 2001:18). In one case (Boat C in figure 19) there is not only palm branches in the bow but also something reminiscent of an actual sail (Bowen 1960:117–120; Fabre 2005:114; Landström 1970:13).

The earliest depiction of a 'true sail' (McGrail 2001:19), dates to c. 3100 BC, and is found on a vase from Nagada. Painted on it is a square sail rigged on a pole which is stepped near one end of a vessel, possibly the bow end (figure 19D). The ends of the hull are high and sharply turned upwards and represent a shape which is similar to that of boat depictions found in contemporary Mesopotamia. This similarity has led some scholars to argue that these specific boat types might be foreign (for more on this see Landström 1970:13–16; McGrail 2001:19–20). Landström (1970:13) however, argues that the presence of this particular boat shape in grave paintings and in rock art might suggest it is just one of many

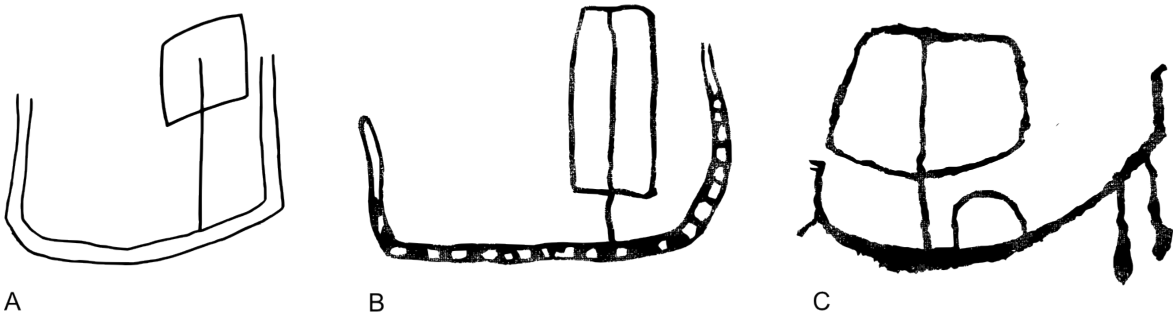


Figure 20. Predynastic petroglyphs from eastern Egypt: A) Boat with sail from Gebel Sheikh Yacoub, Sudan, (after Basch 1987:50), B/C, two boats from Wadi Hammamat in eastern Egypt/Nubia (after Landström 1970:16, fig. 31, 39).

local boat types of the predynastic Egyptian period. A couple of petroglyphs from the Nubian desert with the hull shape in question also carry sails (figure 20), and since the introduction of the sail appears to have occurred much later in Mesopotamia than on the Nile, McGrail (2001:20) suggests that "*it is unlikely that this feature [the sail] has been copied by Egyptians from Mesopotamian prototypes*", but that the hull shape probably existed independently in Egypt as well as in Mesopotamia.

During the First and Second Dynasties (c. 3100–2686 BC), the pictorial evidence of watercraft is curiously sparse, but from grave finds and paintings we know the basic tools for making planked vessels existed, carpentry had mastered the art of making locked mortice and tenon joints, (which was to become synonymous with Mediterranean ship building from c. 1500 BC until AD 1000) and that reed craft were sometimes decked with planks for harder use (Casson 1995:13; James 2009:188; Johnstone 1980:74; Landström 1970:23; McGrail 2001:23).

By the time of the Old Kingdom (c. 2686–2181 BC), stone architecture had developed which required the development of planked vessels, and the first indisputable evidence of this development comes with the Cheops ship (Casson 1995:13; James 2009:188; McGrail 2001:26). This decked vessel was found dismantled and entirely preserved in a sealed underground chamber on the south side of the Cheops pyramid in 1954, and dates to c. 2600 BC (Landström 1970:26; McGrail 2001:26; Morrsion 1995:131). The ship measures 43.4×5.9×1.8m, is keel-less with a nearly flat bottom and is built by joining together relatively short planks (c. 112cm long and 12–14cm thick) edge to edge with mortice and tenon fastenings (Morrison 1995:131: McGrail 2001:23). There are no pegs that reinforce the joints of the hull (the aforementioned 'locked' mortice and tenon) but instead v-shaped lashings run along the inside of each joint, thus invisible from the outside. The 12 internal frames are also lashed to the planking (Landström 1970:28–29; McGrail 2001:27). There was no evidence of mast or sail. Landström (1970:26, 33) has interpreted the ship as a royal barge (although unpainted) and as such, probably towed with the 12 oars that were found with the vessel used for steering. Morisson (1995:132) and McGrail (2001:28) on the other hand, prefer to see it as a rowed royal barge, with the latter suggesting it was steered with two oars on each quarter and rowed with the remaining five pairs.

Whichever the case, the size and complexity of the wood work of this ship along with the availability of necessary tools, seems to indicate planked vessels had been built for some time in Egypt, possibly since c. 3100 BC (McGrail 2001:23). The discovery in 2000 of 14 plank built boats at a royal cemetery at Abydos does not bring the manufacturing of plank built vessels back quite as far, but certainly by some 300 years from the Cheops ship (Pierce 2004; Ward 2006). The vessels were found with their prows pointing towards the Nile and have been interpreted as royal barges for the afterlife, possibly for king Khasekhemwy of the late 2nd Dynasty (Pierce 2004). The preserved timbers in the Abydos vessels, although in some cases affected by wood eating ants, reveal boats that would have been up to 22.8×3×0.6m with narrow prows and sterns, possible painted white and yellow, and with space for crews of up to 30 (Pierce 2004; Ward 2006:121, 123). The individual planks (each about 6cm thick) were made of a local type of cedar, called *Tamarix* (Ward 2006:125) and fastened with joints of unlocked mortise and tenon which were strengthened with ropes fed through the mortices and sealed with bundles of reed (Pierce 2004; Ward 2006:125). One of the boats appears to have been fastened with ropes only, run through L-shaped holes, and the boat building method in general seem to indicate a standardization that can be traced onwards for more than one thousand years (Ward 2006:124). None of the Abydos boats had any internal ribs (Pierce 2004).

Landström (1970:17, 19, 23–24), as mentioned earlier, believes that wooden boats were constructed even earlier (than 3100 BC) and Wachsmann (1998:9) agrees, suggesting advanced technology used on the Cheops ship must have developed over some thousand years. The apparent standardization in the boatbuilding methods used in the construction of the Abydos vessels mentioned above might provide further strength to this belief. There are several advantages of planked vessels over bundle reed raft, of which the ability to carry larger and heavier cargo has already been mentioned above. Another is durability, where a small bundle raft typically keeps afloat for about two months, and a large perhaps for a year (Landström 1970:18–19).

An important question in terms of when the sail might have first appeared is whether the for Egypt so particular bipod mast was first developed for use on bundle reed craft, as seems to be a general belief (Casson 1995:13; Hornell 1946:225–229; Landström 1970:19;

Poujade 1948:203–204; Washman 1998:9). Not least since the first iconographic evidence of the sail appears to be mounted on a single mast, but more on this later.

The Transition from Paddling to Sailing in Egypt

Returning to the question of how an early transition from paddling/rowing to sailing might have transpired on the Nile, Fabre (2005:113–114) believes this might have started with the realisation that palm branches placed in the bow helped catch a following wind, thus easing the work for the paddlers, as seen on the Gerzean vases (see also Bowen 1960:117–120; Landström 1970:12). Similar methods are known from Central Africa and in the Cameroon (Basch 1987:49, fig. 77) from Canada (Adney & Chapelle 1964; Waugh 1919:30), and Scandinavia (Eskeröd 1970:213–214), and has also been pointed out by McGrail (2001:18) as a viable way of travelling on water. However, by the end of the Gerzean period, Fabre (ibid.) suggests the first mast along with a simple sail made of woven reed was used (figure 19C) and that this concept quickly evolved into the single mast with a yard and much larger sail area, as seen on the Nagada vase and on the Nubian desert petroglyphs in figure 20.

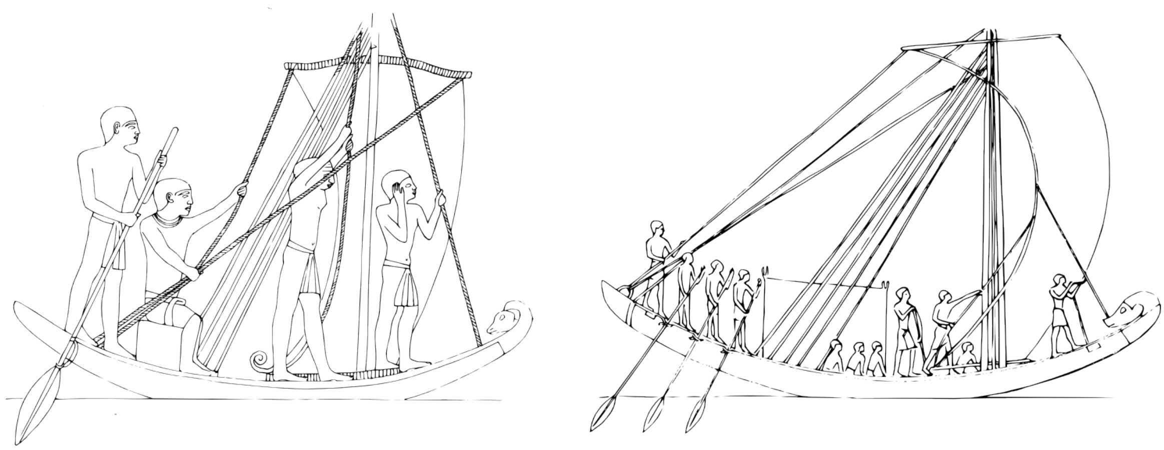
What is clear is that fully evolved sailing vessels were travelling on the Nile by at least c. 3100 BC. Woven reed would have been the most probable sail material and its use has been recorded on the Nile well into Roman times, but linen cloth – and by extension sails – would also have been a possibility as it was available already in predynastic Egypt (Landström 1970:23; Wachsmann 1998:253).

It is not clear when rowing became the main way in which larger vessels were propelled when not sailed, and McGrail (2001:30–31) maintains it is impossible to tell from the earlier Egyptian imagery as no obvious pivots are depicted (not least because rowing can be undertaken when facing forwards as well as backwards). Landström (1970:36) points out that no boat or ship depictions of the Fourth Dynasty appear to depict rowers, whereas a few of the Fifth Dynasty clearly do (Landström 1970:42, figures 111, 113). One of these depictions (113) shows a sailing ship with the mast down while being rowed.

The Development of Rig, Sail and Steering Devices during Predynastic, Dynastic and Old Kingdom

The predynastic imagery of sailing vessels appear to depict single masts stepped relatively far forward of amidship, whereas the size of the sails varies from relatively low and wide, to relatively tall and narrow. Steering devices are seldom depicted but there are some clear representations of what might be single steering oars, or indeed a loose paddle for steering (Landström 1970:13 –14, 16, figures 6, 17, 22, 32, 36, 35, 42; McGrail 2001:33). There is also, as mentioned earlier, a vessel with three visible steering devices from this period and, in one case, we can see a sailing vessel with what is most probably two steering oars (pairs?)(fig. 19A).

The pictorial evidence of sailing vessels is scarce as mentioned above for the early dynastic period (First and Second Dynasties), and the same applies to the Third Dynasty and the onset of the Old Kingdom (Landström 1970:35). The relatively few depictions from the Fourth Dynasty (c. 2613 – 2494 BC) appear to show boats with proportionally high masts, stepped relatively far forward, carrying tall and narrow sails – features which seem to continue through the much richer imagery of the Fifth Dynasty (c. 2498 – 2345 BC). This type of rig has by some scholars been described as perfect for catching the upper breeze when travelling between the many high-rising cliffs along the Nile (Casson 1995:19). Others have called them dangerously high (Landström 1970:40, 42–43, figure 104)



A B

Figure 21. Fourth Dynasty reliefs of sailing boats (after Landström 1970:35-37, figures 98 (A above), 99 (B above)). McGrail (2001:31–32) dates the same imagery to the Fifth Dynasty. Note that the perspective of the rig and sail of boat B is very confused, the leeward leach apparently running on this side of the mast but behind the back stay.

suggesting the sails must have been trapezoid shaped – wider at the top than at the bottom – in order to avoid the sail being caught in a wave and thus cause the boat to capsize in case it began to roll, as indeed suggested by some imagery. McGrail (2001:33) however, believes this is a matter of perspective. The sails appear to be built up of horizontal panels of material (Landström 1970:42, fig. 109; McGrail 2001:33).

As for masts, the majority of the images depict bipod masts, with only one image of a single mast (A in figure 21) – an image which is unique in the Old Kingdom before the Sixth Dynasty (Landström 1970:36). Landström (1970:35–36) dates this particular depiction to the Fourth Dynasty whereas McGrail (2001:31) places it in the Fifth. Its presence does however suggest that single masts were used alongside bipod and even tripod masts, all of which could be unstepped and stored on deck when not needed (Casson 1995:19, 21). No blocks/pulleys appear to have been used for hoisting the sail (although halyards could have run through greased holes), but sometimes multiple halyards appear to have been used which would have provided more weight and muscle power for the task.

Landström (1970:42–43) interprets some of the imagery here as depicting a lower yard laying across the back of the bipod mast at the height of the deck rail, which would have

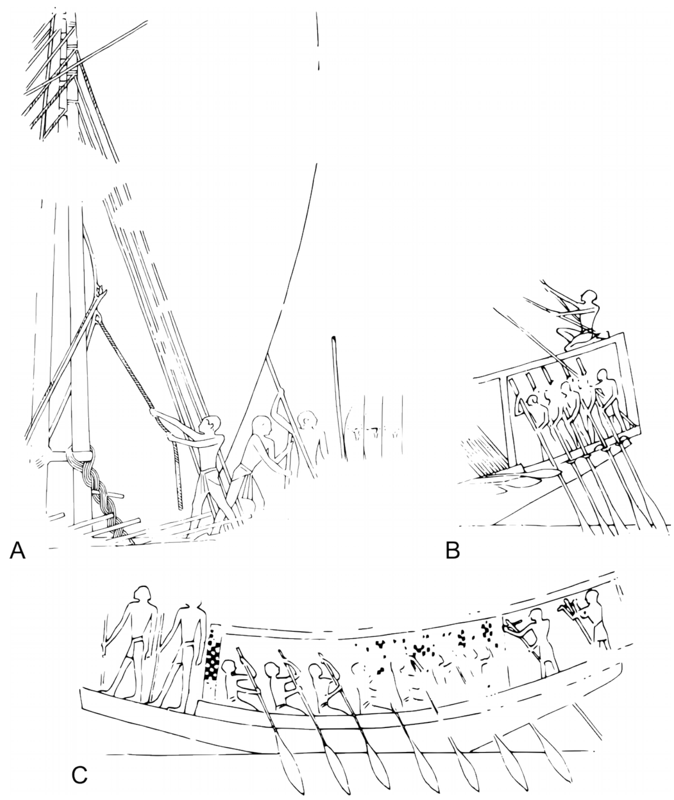


Figure 22. Fifth Dynasty reliefs (after Landström 1970:42-43, figures 116 (A above), 114 (B above), 111 (C above)).

been kept down in a gust by crew members sitting on it, and suggests that these were vessels primarily used for downwind sailing. However, the presence of braces and bowlines, as well as a pole with a forked terminal which could be used to hold the leading edge of the sail taut to the wind (figure 22A), indicate that these vessels could be sailed with the wind forward of the stern section, perhaps even with the wind on the beam, or straight from the side (Landström 1970:42, fig. 116; McGrail 2001:33). This would indeed have been necessary for sailing up the Nile in many places – since the river by no means runs straight but continuously meanders – but in particular when navigating the east-west section of the Nile just north of Luxor (figure 17). This, in turn, would have put extra focus on the steering, which might be why we often see multiple steering oars in use (McGrail 2001:33).

However, even plain downwind sailing would probably require more solid steering arrangements. Under sail, it is potentially possible to steer a vessel downwind with loose paddles but as soon as the boat veers up by any degree, be it by a change in the course of the river, a change in the wind direction, for avoiding navigational hazards, or simply to

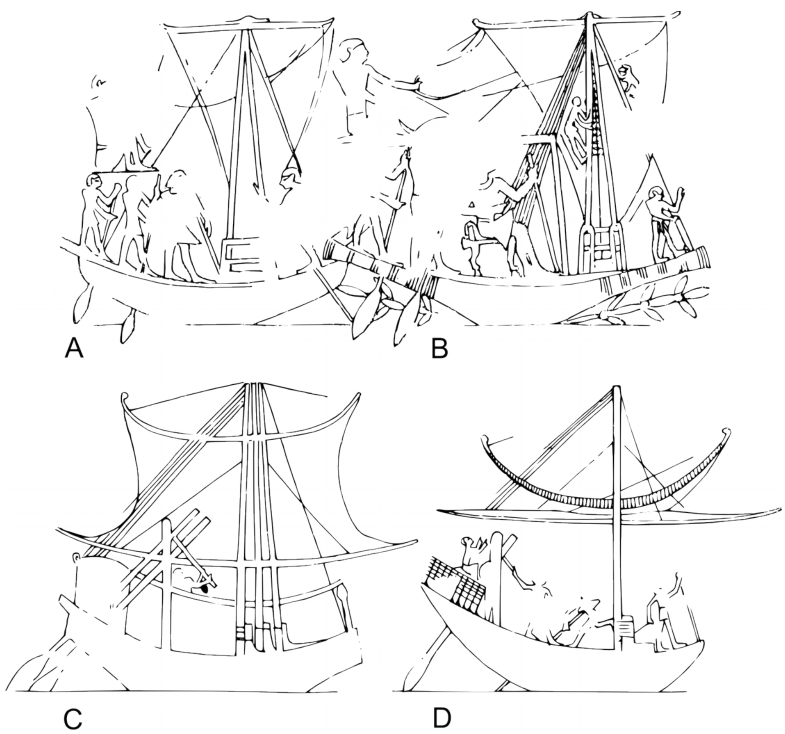


Figure 23. Sails and rudder arrangements of the Sixth Dynasty (after Landström 1970;48, 54 figures 131, 132, 152, 153). Note the absence of either bowlines or sheets in boat C. These would have been necessary for sailing but the Egyptian artists were often carefree in the amount of details.

navigate towards the bank at the arrival of a particular destination, the paddle would need to be strapped in and held firmly as the pressure on it would be too high to hold by sheer arm power (Mark 2012:89). By using several paddles, the lateral plane would increase and steering become easier, but it would probably be too difficult to hold and steer with the paddle even with a strap if it was attached to the windward side of the vessel. Therefore, steersmen and steering paddles were probably required on both sides in order to make the steering more reliable. From the Fourth and Fifth Dynasties larger river boats or ships generally carried between two and five pairs of steering oars, and in one exceptional case 13 (Mark 2012:84).

Exactly how the steering oars were mounted remains unclear (Landström 1970:46; Mark 2012:84). However, figure 21A above, appears to depict a steering oar tied on to the boat with a strap or grommet, and from which a loom-line runs down to just above the blade. In another depiction (figure 22B), one can see what is generally interpreted as crossbeams on one side of the steering oars – a more recent interpretation suggests these are thole-pins (Mark 2012:88–89) – and in a third image it is clear that the steering oar, or quarter-rudder, is mounted in such a fashion so that it could be twisted when steering (figure 22C). It is a

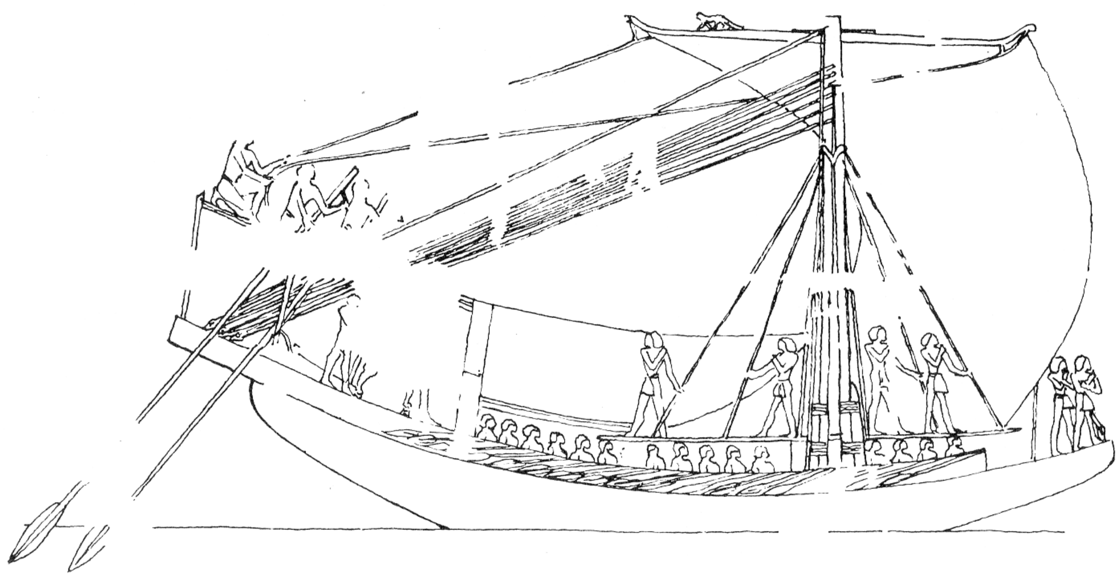


Figure 24. Sixth Dynasty sailing ship (after Landström 1970:47 figures 125). Note the absence of sheets and the fact that the steering oar at the far back can be twisted but lack any detail of how it was secured – both features that would have been necessary but have been omitted by the artist. See McGrail 2001:32, figure 2.18 for comparison.

common problem in all of the ancient Egyptian depictions that particular details are often omitted, or in case of several boat depictions in the same relief, present in one but in none of the others (Landström 1970:47). Therefore many scholars believe that when details are present, they are depicted such as the artist saw them, but it is clear that the emphasis of what the artist wanted to show and the choice of perspective employed make many of these images difficult for us to interpret today.

By the Sixth Dynasty (2345–2181 BC), mast and rig begin to change. Noted is the reappearance of the single mast alongside the bipod and tripod masts, which were now lashed to knees and not as previously, secured by trusses (compare figure 22A to figure 23C)(Landström 1970:47; McGrail 2001:33). At the same time the masts become shorter while carrying a lower and wider sail, with the boom, previously laying across the deck, suspended by lifts to a position well above it. Furthermore, the steering oars become larger and supported by an upright pole in the stern. This along with the presence of sails that appear triangular in shape suggest some sort of experimentation (Landström 1970:48–50 figures 131, 132).

Seafaring during the Old Kingdom: Byblos and Punt

Evidence of seaborne activities begin already during the First Dynasty with the import of cedar tree from Lebanon (Fabre 2005:91–92). A wooden carving depicting what might be seagoing ships, next to which the hieroglyphs for meru wood and Lebanon appear, also date to this period and suggest some sort of trade, although whether Egyptian or foreign ships are involved is unclear (Landström 1970:25, figure 80; Emery 1963:216–217). Pharaonic inscriptions found in Byblos, dating to at least the Second Dynasty, does however suggest import by Egyptian ships (Wachsmann 1998:9, 11).

The Cheops ship was built of imported cedar and it is also during the Fourth Dynasty that the first direct account of the importation of cedar and meru wood appears in the reign of Snefery (Landström 1970:35; Wachsmann 1998:11). The Palermo stone on which this account appears, recounts over 40 ships, in size between 40 and 100 cubits long (c. 20–52m long), as delivering the goods (Landström 1970:35; Wachsmann 1998:9). That it is Egyptian ships involved in this import is further suggested by the stray find of an Egyptian axe head, possibly the belonging of an Egyptian royal boat crew of Cheops or Sahure

(Fourth and Fifth Dynasty respectively), which was found in a river along the Lebanese coast just south of Byblos. By the Fifth and Sixth Dynasties, Byblos had become an established destination for the import of timber by Egyptian ships (Wachsmann 1998:11).

From the Fifth Dynasty, also comes the first definite pictorial evidence of an overseas expedition to the Levant, with a relief from Sahure's burial temple showing a fleet of ships leaving Egypt and then returning with Asian prisoners (figure 25)(McGrail 2001:34; Wachsmann 1998:12). From the Sixth Dynasty comes an account of Egyptian troop movements by sea. Uni, a military commander under Pepi I, was sent to a location that might have been just north of the Carmel mountains on the Mediterranean coast, in order to deal with an army of 'backsliders' (Wachsmann 1998:9–10).

One relief in Sahure's burial temple mentions that he sent ships to Punt, or 'God's land', which returned home with myrrh, electrum and valuable logs, possibly ebony (Landström 1970:63; McGrail 2001:34; Wachsmann 1998:22–23). Exactly where Punt was located is still very much debatable and although the prevailing view appear to favour a location

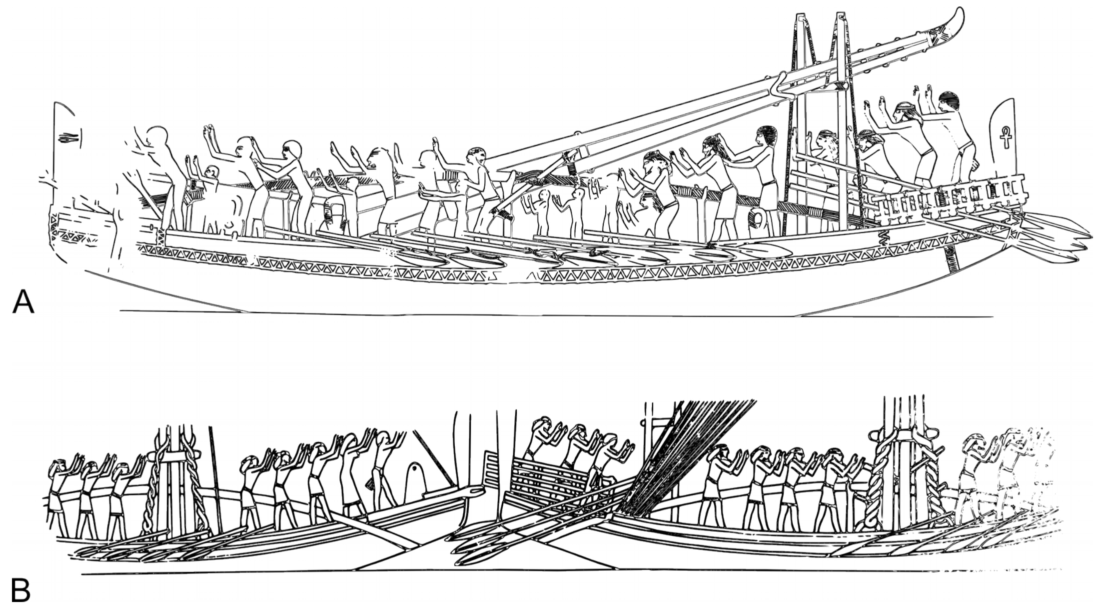


Figure 25. A) One of the seagoing ships on Sahure's relief (after Landström 1970:64–65, figure 191). B) More simply depicted seagoing vessels from Unas' burial temple, also Fifth Dynasty, the leftmost appears to be showing a stone anchor in the bow (ibid.). Wachsmann (1998:18) believes these vessels were probably larger than the reconstruction of about 17.5 meters Landström (1970) suggests – not least because of the much longer ships described on the Palermo stone but also because of the exaggerated size of the crew depicted on-board these ships, which would make them appear much smaller.

along the south eastern shores of the Red Sea, locations as far south as the southern or south-western shores of the Gulf of Aden have been suggested (Casson 1989:109; Horton 1997:748; McGrail 2001:34–35). The main argument against a location in the Gulf of Aden is the perceived windward performance of the Egyptian ships of the time (Ballard 1920; McGrail 2001:34; Sölver 1936).

Wherever its location, sea expeditions to Punt, or planned such voyages, are also recorded in several tombs dating to the Sixth Dynasty. For example, Meryre was sent on a naval expedition to Punt during the reign of Pepi I, whereas Enenkhet, an official of Pepi I, died while building a ship with Punt as its destination (Landström 1970:63: McGrail 2001:35; Wachsmann 1998:19). Further expeditions or visits are recorded in the tombs of Neferkare and Khui (in the latter both to Punt and Byblos) during the reign of Pepi II, and in the contemporaneous tomb of Harkhuf the reference to a dwarf brought from Punt appears (McGrail 2001:35; Wachsmann 1998:19). Sölver (1936:435) mentions an inscription from Assuan of a similar date which states *“I accompanied my master”....”to Punt eleven times. I returned safely after visiting those lands”*, adding that it would suggest a constant contact with Punt at this time. In addition to the above, James (1983:34) points out that the Egyptian need for copper and tin led to early trade with Cyprus and Asia Minor.

Thus, the ancient Egyptians were clearly not as in the words of Barnett (1958:223) “*not at home on the open sea, only on the rivers*”, but were seafarers from an early stage.

From Sailing on the Nile to Sailing on the Sea

When did the ancient Egyptians first use the sail as a mean for propulsion on the sea and how did they achieve this? The earliest evidence of seafaring appears as we have seen during the First or Second Dynasty, between c. 3000 and 2700 BC (see figure 26 for a time line). About 100 years later during the Fourth Dynasty, Sneferu sends his expedition to Byblos in what must have been a huge undertaking. The burial ship of Cheops (who succeeded Sneferu) provides some sort of indication as to how these early ships might have been built. However, the first reliable depictions of seagoing vessels do not appear until the Fifth Dynasty, in Sahure's grave temple of c. 2450 BC (Casson 1995:20; Fabre 2005:92; Wachsmann 1998:12–15). Similar types of seagoing vessels also appear in Una's grave temple (the last king of the Fifth Dynasty) (Wachsmann 1998:15) and it is also possible that the ship in figure 22A, probably also from a royal temple, is in fact a seagoing ship (Landström 1970:65).

These depictions appear to depict typical Nile ships, adapted for use on the sea in a number of ways: Firstly, the bow and stern ends are v-shaped so as to cut through waves more easily. Whereas the majority of the contemporary boat depictions and models appear to depict ships with cut-off endships, there are several examples of ordinary river craft with endships similar to the seagoing vessels of the Fifth Dynasty, as well as a Sixth Dynasty model, but the Cheops ship (which is 150 years older) also had slightly v-shaped ends (Landström 1970:30–31, 62–65 figures 87, 88, 186, 194; Wachsmann 1998:14–15). Secondly, the ships are strengthened with a trussing rope that runs from a loop around the hull in the bow, across crutches along the length of the ship on to a similar loop around the stern, which is then tightened with a lever like a tourniquet (Casson 1995:20). This is used as to avoid the hogging effect when the overhanging endships are lifted up above the water in waves, potentially threatening to break the ship in two. Landström (1970:64, fig. 180) suggests that similar systems were already used on contemporary riverine cargo ships, but there is of course nothing to say the system was initially developed for seagoing ships and then adapted for use on cargo ships on the river. Thirdly, a cable runs around the upper part of the ship just below deck level, like a girdle, presumably to ensure the deck timbers would stay put under pressure (Casson 1995:20–21; Landström 1970:64). Again, such girdles can be found on depictions of Fifth and Sixth Dynasty riverine cargo ships (Landström 1970:60 – 61, fig. 176, 179, 186).

What the above suggests however, is that the ancient Egyptians probably used ordinary river craft for their earliest seafaring ventures. These crafts were then slowly adapted to meet the challenges of sailing on the sea and the increase in size of such vessels (Faulkner 1941:4; Landström 1970:64). By the Sixth Dynasty it appears all seagoing ships, irrespective of destination, were referred to as Byblos-ships (Wachsmann 1998:19). Presumably, the first developments in building and fitting out seagoing vessels were made for ventures to Byblos but it might also be that some of these developments were taken up for use on river boats. Wachsmann (1998:18), for example, notes that the hogging truss would have meant that the booms, which on the river craft may have rested abaft of the mast and on the deck rail, must have been hung higher up and in front of the mast on seagoing vessels. It might be that the development towards a higher boom, and the use of lower and wider sails towards the end of the Old Kingdom, came about as a direct result of the adaptation of hugging trusses on Byblos-ships (ibid.; Landström 1970:68).

It is clear that by the Fourth Dynasty, if not earlier, the ancient Egyptians were capable of successfully planning and executing large sailing expeditions on the sea. Fabre (2005:89) believes only the Pharaoh would have had the political and technical needs, as well as organisational abilities for such undertakings. However, it is also clear that by then they must have had the necessary know-how and technical ability to do so. This includes knowledge about geography, wind and currents of the coasts en-route, the capabilities of the ships (including seaworthiness and sailing abilities), and finally seamanship of a standard capable of using this knowledge to get to an intended destination and back.

Sailing between the Nile and Byblos

As it is very probable that the earliest Egyptian seafaring abilities emerged for journeys to Byblos I intend to concentrate on this passage rather than the one to Punt which seems to have been the main focus of scholars in the past – despite (and perhaps because of) its unknown location (see for example McGrail 2001:34–36).

The sea passage between the Nile and Byblos would by no means have been easy (Fabre 2005:25). The mouth of the Nile itself is notoriously difficult to navigate. Once the vast quantities of sand carried with it loses its speed and settles, a continuous sand bank is formed, through which currents and waves cut ever changing channels (ibid.). Eyewitnesses from as late as Napoleonic times can attest to this and the reliance upon a skilled pilot for safe passage, and it is perhaps not strange that Herodotus, writing in the 5th century BC, tells us that pilotage was one of the seven Egyptian occupational classes (Fabre 2005:25; McGrail 2001:17). Clearly it is a skill that would have been necessary for even the earliest of Egyptian sea journeys. Travelling onwards, ancient texts let us know how treacherous the low lying north Sinai coast up until Jaffa (Tel Aviv) were for seafarers, making its outline difficult to follow, whereby ships might unwittingly come too close to land and run aground on either marshy shallows or a desert coast (Diodorus I, 31, 2–5 from Fabre 2005:25). In addition, this stretch of the coast had no natural harbours but instead seafarers would have had to make land on an open beach with waves continuously rolling in, leaving them at the mercy of the winds.

According to Fabre (2005:25), it is even so that sea journeys within sight of land was outright avoided by seafarers because of these dangers, who instead favoured routes that were further out at sea, or out of sight of land. It might of course be that the Egyptian navigators, as opposed to visiting merchants from other parts of the Mediterranean, were so skilled that they were not going to get surprised by involuntary landfall, and potential wrecking, when travelling along these low lying lands, but used the coastal route quite happily, but this scenario is quite unrealistic. Why take the risk? Nor is it unrealistic to believe that the ancient Egyptians would also have been able to navigate along a route out of sight of land, not least since the necessity to accurately predict the inundation of the Nile would have led to an early interest in astronomy (McGrail 2001:17).

Compared to the north Sinai coast, the west facing coast from Jaffa until Byblos would probably have offered easier navigation with a higher coast line and more natural shelters and landing places along the way. The currents along this route are generally weak and run in an anti-clockwise circle along the coasts of Egypt, the Levant and Turkey before it comes back south from the west of Cyprus (Pomey 1997:27). The strength of these currents would primarily be affected by the wind but are in effect negligible. The most

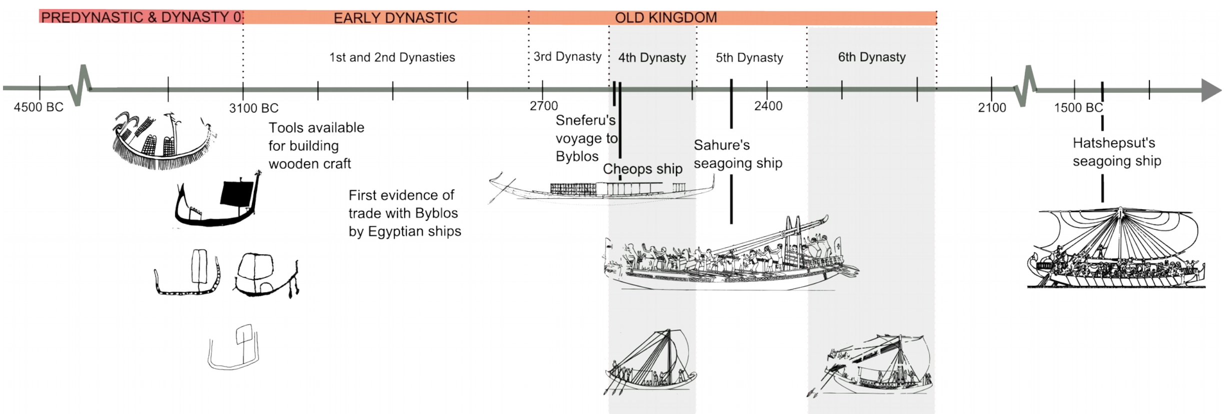


Figure 26. A time line of early Egyptian sailing boats/ships and seafaring events. Notice the gap in time between the first evidence of a seagoing ship in Sahure's grave temple and that of the second, from the tomb of Hatshepsut almost a thousand years later. It is also worth noticing the difference in the amount of overhang between the Cheops ship (after Landström 1970:30–31, figure 89) and that of an almost identical barge depicted in Sahure's grave temple. C. 1200 BC Egypt ceases to have an independent boatbuilding tradition and introduces radical changes to hull and rig (Casson 1995:22)

predictable winds appear during the summer months when the difference in temperature between land and sea is the greatest, creating a phenomenon called sea breeze during the day (with wind coming from the sea), and land breeze during early morning and late evening (with the wind coming from land), and which will affect seafarers out to about 20km from the coast (for more detail on this see Fabre 2005:20, but it is also referred to in relation to the experimental sail trials described in Chapter 6 and again in Chapter 7). On the northern hemisphere, this breeze will slowly veer to the right throughout the day, and again during the evening and early morning. In addition to this wind, there are more unpredictable winds, caused by large scale movements of high and low pressure systems. Locally, such movements can give rise to very violent winds or even storms, one of which, the khasin, blows from the Egyptian desert.

Concerning the seaworthiness of the ships of the Old Kingdom, we know that they apparently returned from their intended destinations often enough to suggest continuous communication with both Byblos and Punt. This suggests their ships were deemed seaworthy enough at the time to take the regular risks involved with such journeys in terms of loss of men, ship and potentially very valuable cargo. However, some scholars in the past have deemed the seaworthiness of ancient Egyptian ships as very poor indeed (Ballard 1920; Sölver 1936).

In fairness, most of these accounts were written before the Cheops ship was discovered or properly examined, and are mainly based on the pictorial evidence from Queen Hatshepsuts (New Kingdom, c. 1480 BC) funeral temple at Der-el Bahri along with the evidence provided by the Middle Kingdom Dahshur boats, which although well built lack internal ribs (McGrail 2001:37–39, 41). Thus, they appeared to confirm Herodotus who stated that Egyptian ships did not have internal ribs (Landström 1970:26). It has also been noted that the Egyptian ships must have been exceedingly heavy (Sölver 1936:455) while equipped with such 'extreme overhang and elongation' of bow and stern that they would have been very difficult to handle in an open sea (Ballard 1920:151–152). In combination with their flat bottoms Ballard (1920:170) for example deemed the Egyptian boats incapable of sailing much higher than 135 degrees from the wind, giving them a 90 degree window for making way with the sail hoisted. For the very same reasons, these boats (as interpreted here) would have been impossible to row other than in dead calm conditions!

It appears however, that the amount of overhang in both pictures and in models of the time were exaggerated (Landström 1970:59; Wachsmann 1998:14). This becomes evident when comparing the Cheops ship to a depiction of an almost identical royal barge found in Sahure's grave temple (Landström 1970:38–39, 58–59, figures 89, 173, 174), and with a longer water plane the sailing abilities of the seafaring ships might improve considerably (as would the ease of rowing). In the other extreme, scholars such as Beaudouin (1967, from Fabre 2005:117–118) argue that Queen Hatshepsut's Punt ships would have been able to 'peak' their sails and head into a wind and tack, and Guillerm (1995:9 from Fabre 2005:119) believes their 'balanced rudders' (interconnected double steering oars) would have made such a manoeuvre quite possible despite the apparently simple set up of the rig. I would argue that this would be impossible to know unless more was known about the hull shape of these particular ships.

On the basis of Beaudouin's research Landström (1970:50–51) suggests that the Egyptian ships might have been able to sail at an angle of 90 degrees from the wind by the Sixth Dynasty, but as noted above by McGrail, much of the equipment normally associated with such relatively advanced sailing abilities were available already by the Fifth Dynasty, suggesting this would have been possible even earlier. Sailing within an angle of 90 degrees from the wind would have doubled the 'window' for making way with the sail hoisted to a radius of 180 degrees.

Although it is relatively clear that early Egyptian ships might not have been able to sail against (towards) the wind, it is possible that they at least by the Fourth or Fifth Dynasty could have sailed with the wind from the side.

After this examination of early watercraft and seafaring in Egypt it is time to have a look at another area: Oceania.

Early Voyaging in Oceania

In sharp contrast to the Egyptian material examined earlier in this chapter, there is no written record of seafaring in the South Pacific or Oceania until the arrival of the first visiting Europeans in the early 16th century onwards (Horridge 2008:85; McGrail 2001:329; Mondragón & Talaván 2007). Nor are there any datable rock carvings or other images pre-dating this time, and only very limited boat remains of which the oldest date from the 8th to 9th centuries AD (McGrail 2001:317).

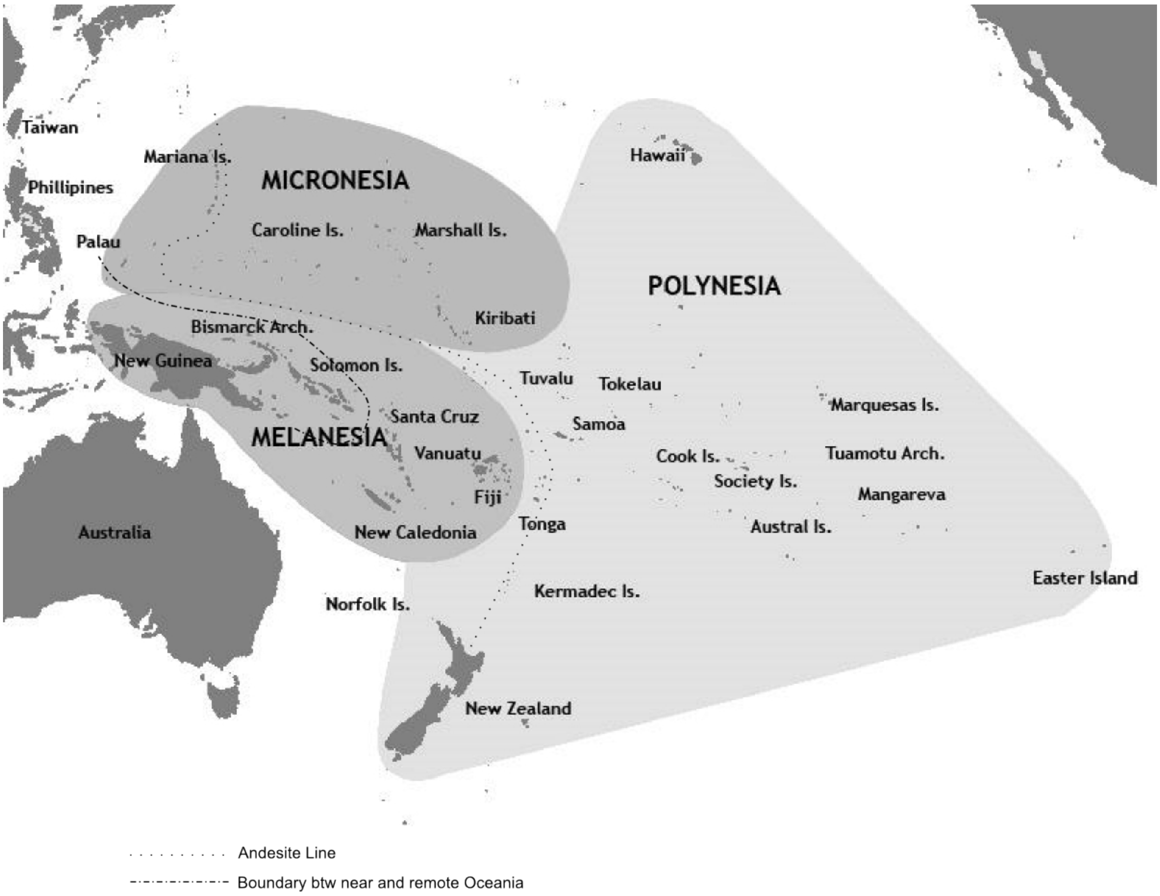


Figure 27. Map illustrating the Oceanic area with its three main cultural and linguistic groups: Melanesia, Micronesia and Polynesia. The Andesite line mark the western edge of the Pacific plate where it moves down under the continental plates of Asia and Australia. Indicated in this map is also the boundary between near Oceania and remote Oceania (after Irwin 2006:57, 60).

The islands of Oceania are culturally and linguistically divided into three main areas: Melanesia, Micronesia and Polynesia (McGrail 2001:311). Each of these areas is made up of thousands of islands which span across areas of between 3000–9000km in east-westerly direction. Geologically, the islands can be divided along the Andesite line (figure 27) which marks the western edge of the Pacific plate where it meets the continental plates of Asia and Australia, often forming strings of island arcs (Irwin 2006:56). To the west of this line we find Melanesia, including the Polynesian islands of Tonga and New Zealand, which are made up of remnants of submerged continents, and to the east the remaining islands of Polynesia and Micronesia which sit on the Pacific plate (McGrail 2001:311). As the Pacific plate slowly moves to the north-west across hotspots, chains of volcanic islands are formed, Hawaii being an obvious example (Irwin 2006:57). When these islands cool and shrink with age, coral reefs build up around their fringes with a lagoon forming inside, until only a low-lying atoll remains. Examples of the latter are the majority of the islands in Micronesia (McGrail 2001:311).

In terms of explaining early migration across Oceania, the region is generally divided into 'Near' and 'Remote' Oceania (Green 1991). The boundary between the two (see figure 27) runs across sea passages that were beyond the capabilities of the earliest human arrivals from south-east Asia about 40,000 years ago (McGrail 2001:311). So, for example, the open stretch of water of around 370km which separates the easternmost part of the Solomons with the Santa Cruz islands, and which include a stretch with no visible land, would have formed a natural barrier for these early settlers. Hence the area beyond this natural barrier is called Remote Oceania. In addition, from here onwards to the east, the islands generally become increasingly smaller and more remote with less natural land resources (Irwin 1992:18–23).

Near Oceania and the islands to its west towards mainland south-Asia, would have been the scene of some of the earliest water crossings in the world with movements of obsidian and even animals in evidence after c. 18,000 BC, at the height of the last glaciation period (Irwin 2006:61). The islands here are often large, lie relatively close together and are at some point inter-visible, with seasonal and predictable winds and currents that move in reversal direction depending on season. Thus this area has been described as a sheltered voyaging corridor for early settlers, and an area which would have acted as an excellent nursery for the gradual development of seagoing skills (Irwin 1990:90, 1992:31, 2006:61).

The first archaeological evidence of people moving into Remote Oceania comes with Neolithic settlements in West Micronesia around 1500 BC, probably from a source in the Philippines or East Indonesia (Irwin 2006:68: McGrail 2001:315). By about 1500–1300 BC, the Lapita culture, named after a distinct type of pottery, first appears in the Bismarck archipelago. From here it spread relatively rapidly, reaching eastern Melanesia and western Polynesia (including Tonga and Samoa) between 1100–900 BC (Irwin 2006:64, 67). With them, these early settlers brought taro, yam, breadfruit, banana and coconut as well as pigs, dogs and fowl (Bellwood 1987:34; Lewis 1994:7).

Thus, it is apparent that by 1500 BC ocean going technology, including that of sail (as the distances would otherwise have been impossible to cross), capable of moving people as well as plants and animals against the prevailing east-westerly winds had been developed. The fact that two separate migration events are recorded – one from the Philippines into west Micronesia and one from the Bismarck archipelago into eastern Melanesia – suggest these ocean going skills might have been widespread throughout the voyaging corridor for some time (Irwin 2006:68).

The Seafaring Vessels used in Near and Remote Oceania

Exactly what type of vessels were used by the earliest settlers of Near and Remote Oceania can only be speculated about, but the images and descriptions provided by the fist visiting Europeans, along with later compilation works of Oceanic seacraft, provide at least a starting point.

Oceanic Boats encountered by Early European Explorers

The type of craft described by the earliest European explorers include log rafts and three types of plank boats to use McGrail's definitions (2001:320–328), including single-hull boats (without outriggers), double-hulled boats and boats with outriggers (single as well as double ones). Of these, the log raft was noted in several places, the first as early as 1593 in the coastal waters off the Marquesas islands, whereas seagoing ones with sail were seen off

Mangareva in 1825 (both observations were made in eastern Polynesia) (Hornell 1946:77–79). Single-hull plank boats were noted by Cook on his first discovery visit to New Zealand, one of which was under sail in a following wind (Rienits & Rienits 1968:43), and another propelled by both paddle and sail (Best 1925:137). It is however the single- and double-hulled boats that feature the most prominently in these early accounts, and which appear to have been the two main types of seagoing vessels across the Pacific, with the single-hull outrigger recorded in Melanesia, Micronesia as well as Polynesia and its double-hulled cousin in Eastern Melanesia and Polynesia (Horridge 2008:90; McGrail 2001:320, 324, 328–321, 339). Therefore, these are the two types of craft I will focus on below.

The Single Hull Boat with Outrigger

The earliest observation made by European visitors in relation to Oceanic boats comes from Micronesia where an outrigger canoe, to use the more commonly used name for single-hull boats with outriggers, was noted in 1521 during Magellan´s circumnavigation voyage (Johnstone 1988:203). The canoe was described as being light, narrow with an asymmetric cross-section, and double-ended so that either end could be used as a bow, in addition to which a steering oar was available at each end (figure 28) (Best 1925:265;

Figure 28. Illustration of an outrigger canoe observed on Saturday 16 March 1521 during Magellan's visit to the Ladrone Islands, Micronesia (after Johnstone 1988:204, figure 15.1, Bibliothèque nationale, Paris).

McGrail 2001:329). It was kept steady in the sea by a light outrigger, described as being of equally light construction and basically a boom or pole running in the water parallel to the canoe and secured by transverse small poles. It had a sail, described as a 'lateen', or shaped as a 'shoulder of mutton', apparently set amidships, and sailed with great speed (ibid.).

It is fairly obvious from both the above excerpts of text and from details in figure 28, that the early European visitors described things they saw by comparing them with what they knew (McGrail 2001:331). Indeed that is what most people do, but this process is complicated when a different reference system is used – be it now obscured technical details of early European ships or different types of measurement systems – making the exact meaning of many references and comparisons more difficult to understand (see for example the description of the double-hulled canoes provided by Prado below and in its original version in Mondragón & Talaván 2008:16–19). Likewise, many of the illustrations were made according to contemporary European conventions, so that for example a 'lateen' looks like a square sail even when it obviously is not (McGrail 2001:333). Furthermore,

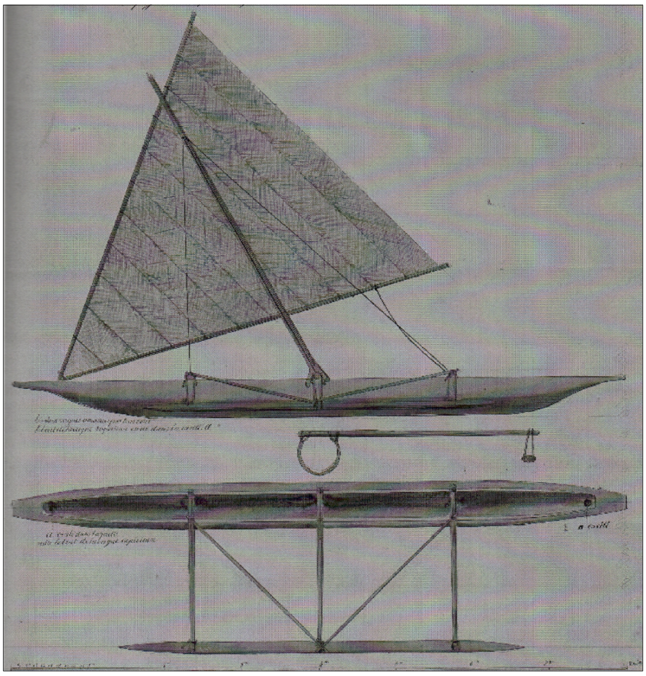


Figure 29. Illustration of an outrigger canoe observed in New Caledonia, Eastern Melanesia, by F-E Pâris in the 1830's (after Reith 2008:57, 61 , figure 13, drawn by Mr Amourous).

perspectives and scales often provide misleading information on, for example, hull shapes, the positioning of mast and crew, in addition to which details of several craft at times are incorporated into one image (McGrail 2001:331). This might also be true for the ancient Egyptian and the Bronze Age Scandinavian pictorial evidence as will be discussed later.

Nevertheless, the type of single hull outrigger canoe that was seen in 1521 was noted by subsequent European visitors in both 1686 and in 1742, in particular with reference to their great speed, and came to be known as 'flying proas' (Haddon & Hornell 1975:413–417; McGrail 2001:329). Dampier for example, noted during his visit in 1686, that these vessels were capable of speeds of up to 24 miles an hour (over 20 knots!), a statement many scholars seem to doubt (Johnstone 1988:204). A similar type of vessel, although observed much later in the 1830s in New Caledonia, eastern Melanesia, provides an idea how these boats were built and rigged while illustrating their similarities across the Pacific over time (figure 29).

The Double-Hull Boat (Canoe)

The earliest description of a double-hulled or paired canoe, was made by Mendana in 1595 when in Santa Cruz, Eastern Melanesia (Johnstone 1988:204). He described them as large and capable of carrying over 30 people with luggage to distant islands. The sail was described as being of matting, wide at top and narrow below, and the boats were apparently fast and turned well to windward (Best 1925:265). A few years later, in 1606, Quiró made landfall at the island of Taumako (Eastern Melanesia) while searching for Santa Cruz, which led to another long and detailed description of these types of vessels, made by the aristocrat and military engineer on-board Don Diego de Prado y Tovar (Mondragón & Talaván 2008:16–17).

Prado described the double-hulled canoes as capable of carrying up to 60 people with which they navigated using 'as much sail as one of our own vessels' (Mondragón & Talaván 2008:16). Each 'canoe' was described as a 'log', in length approximately 16.7m and between 5–5.8m in circumference (all measurments have been translated and converted by Mondragón & Talaván). Across these two hulls, lay a platform made out of 12 slender crossbeams (417mm in circumference) and approximately half the length of the double-hull, i.e. 8.3m (this is much wider in beam than later descriptions would have them – see for example McGrail 2001:324). On top of this platform there was an arched structure of poles tied together with sennit rope, very sturdy and resembling a half-dome (supposedly providing shelter for passengers and provisions). Above this arch was a further platform, square in shape and with a floor of cane (bamboo?), on which the crew tending the sail travelled. The floor of this platform was provided with a trapdoor by which people could enter the arched structure below. Inside the arched structure, at its centre, was a table on which food was carried. Water was stored inside hollow canes and secured onto the crossbeams. On these beams stones were also attached to act as ballast. Furthermore, emerging from each of the individual hulls were long poles which reached up the sides of the vessel to above the height of the upper deck, and onto which a sort of guardrail was secured, protecting passengers from falling overboard (Mondragón & Talaván 2008:17).

Prado went on to describe the mast (in a rather simplistic fashion), as being made of three thick bamboos, with a pulley and yard, placed in the centre of the vessel. At the very stern end were two high seats with two big oars placed above them, with which the boats were steered (ibid.). He went on to comment that with the wind from behind these boats '..must probably navigate well...' while with the wind 'from the side they are worthless' (ibid.). Furthermore, they required very little water depth, and the hulls had sticks and seats from which paddlers could propel the boat using long paddles (1.67m), and which were the same as those used 'all around these lands, from Borneo to the Malacas' (ibid.).

According to Mondragón & Talaván (2008:19–20), the boats described above have no exact matching correlation to any subsequently recorded vessels in the region, but appears to share many of the basic structural features common to long distance voyaging canoes from Western Polynesia and in particular from Tonga (such as a raised upper deck with railing and steering paddles resting atop a poop deck). It might also be a type of vessel that just happens to incorporate traits from many different canoes and which shortly after Padro's visit became obsolete for one reason or another (ibid.).

Another early sighting of a double-hulled canoe comes in 1616, when Le Maire and Schouten encountered one out of sight of land west of the Tuamotu archipelago in Polynesia (figure 30) (Johnstone 1988:204–205). According to this account, the mast was fixed in a step forward of the fore part of the starboard canoe, and the sail was triangular and made of matting, and "*attached to a yard which rested on the upper end of the mast, which was forked for this purpose*" (ibid.).

The Boats in General

From the above accounts it would appear that at the time of the first European contact in the early 16th and 17th centuries, the Oceanic boats were generally fast and very manoeuvrable – at least in comparison with the European boats – which later encounters in the 18th and 19th centuries also testify to (DiPiazza 2008:5). Accounts of speeds of up to 20 knots might be an overestimation but do not seem unrealistic (see for example an account by Hornell (1936) of a Gilbertese 'flying proa' said to have touched 17 knots (from McGrail 2001:337)). 18th and 19th centuries Polynesian double hull canoes and Micronesian outriggers, are estimated at having achieved an average speed of 4 to 6 knots in a fair wind, and a travel range of 100–150 nautical miles per day (Lewis 1994:71).

Furthermore, the vessels were clearly adapted for use in shallow warm waters with no harbours, in that they were light weight, easily righted when having capsized and having a shallow draught (Di Piazza 2008:5). Prado's description above shows that there were boats

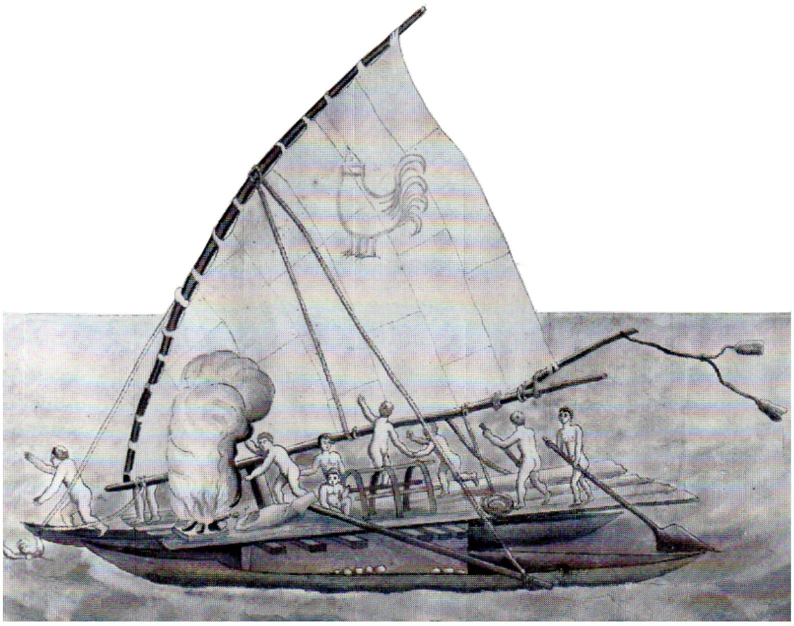


Figure 30. Illustration of a double hull canoe seen off the Tuamotu islands in 1616 (after Johnstone 1988:205, figure 15.2).

capable of carrying large numbers of people as well as provisions over long distances, although this particular account does not give any clear indications as to their sailing abilities. His comments of these vessels probably navigating well with the wind from behind, indicates in my view, that he might not have seen them under sail in person.

However, the Tongan double hulled canoe Mondragón & Talaván (2008:20) are referring above in comparison to Prado's description of the double hulled canoe he encountered in Taumako, was mentioned in a mid-19th century account in relation to both speed and seaworthiness (Best 1925:236). Here these particular vessels were described as being able to carry up to 150 people, and being able to sail in a strong breeze with such speed that every "*...timber...creaked, while the mast bent like a reed..*". Instead of going up and down waves, the double hull simply cut through them. They were also described as having been known "*to live through severe and long-continued storms*" and virtually unsinkable as long as they held together and did not capsize, "*owing to the strong platforms joining the hulls together*" (ibid.). Again, the angle to the wind of this canoe is not clear. (The above account also specifically mentions the big sail and the great steering-oars used while sailing.)

Lewis (1994:71–75, 269) believes that in general the Micronesian outriggers could point higher than the Polynesian double canoe, but that neither were sailed much higher than 75–80 degrees off the wind, with the sails full but not lifting or shaking. Lewis also believes that sailing any higher to the wind for any longer periods of time, is a product of modern day racing. This of course should not be taken as an indication that the ability to sail any higher to the wind was not seen as an advantage. If speed was what the seafarer was after he would naturally bear away a little, say 5–10 degrees, as going higher normally means going a little slower (Finney 1985:9). Needless to say, if covering long distances speed would be preferable whereas in tight areas in-between islands, in sounds etc. the ability to point higher is the difference between sailing through or taking the sail down and proceed under paddle.

The Development of the Oceanic Hull, Rig and Sail

Horridge (2008:88–89) describes the hulls of the Oceanic canoes as very conservative yet very diverse in detail, but essentially built in five parts using stone technology (figure 31). Thus they were generally logbased, i.e. built from a base of a hollowed out log, onto which two side strakes and bow and end pieces, the two latter hollowed out from tree trunks, would be sewn edge to edge. The individual size of these timbers varied across the region depending on the availability of wood. Thus in New Zealand, which had large trees, relatively wide beamed single-hull canoes were built, whereas in areas with no large trees available, any odd piece of wood would be used and carved to fit the construction, and sometimes even the logbase would be made up of one or more pieces (McGrail 2001: 322, 324).

For sewing, three-ply rope of coconut fibre might have been used, running through holes in the planking or through holes in wooden projections at either side of the planks (see Best 1925:84). Caulking was made of green coconut husk mixed with sticky breadfruit gum, or the pounded nuts of the putty-nut tree, and sometimes held in place by a horizontal lath or batten (Horridge 2008:90; McGrail 2001:322). The framing timbers supporting the planking as well as any crossbeams, be it for securing an outrigger or another hull, were lashed to clamps protruding from the inside of the wooden hull structure (figure 31) (McGrail 2001:322). This basic construction appears to have been almost identical in design, from Madagascar across Indonesia and throughout the Pacific to Tahiti and Hawaii (Finney 2006:106–107; Horridge 2008:89; Kirch 2000:9).

The sail, as we have learned from the above accounts, was made of matting. The oldest preserved Oceanic sail comes from New Zealand and was probably collected by Cook in the 18th century (Haddon & Hornell 1975:209). It was made of flax (*phormium tenax*), but

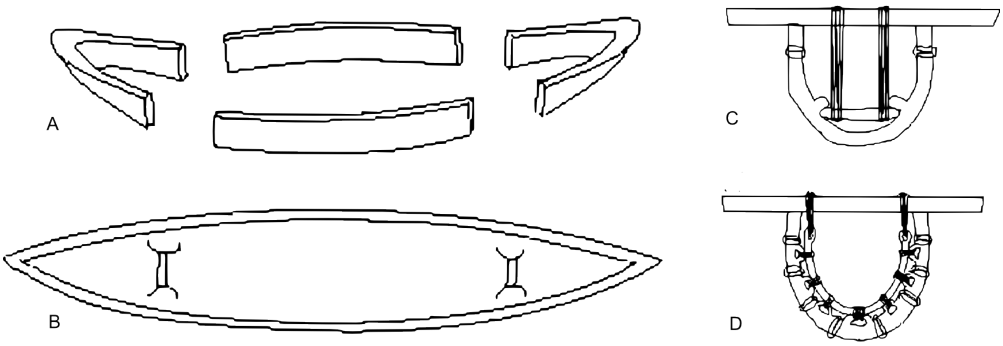


Figure 31. A) Stern and stem pieces and the two plank, B) the logboat base showing lugs by which a superstructure/crossbeam such as that in C might be attached. D) attachment of a crossbeam in a sewn planked canoe where the internal frames are lashed onto protruding clamps on the inside of the hull (after Horridge 2008:88–89, figures 3, 4, compare with e.g. Paris 1841, pl.127, fig. 4).

later records suggest the pandanus leaf and coconut palm-leaf were mainly used as material, individual strips of which were sewn together either across or along the length of the sail (Haddon & Hornell 1975:210, 261, 414; Rieth 1993:118–119, 160). McGrail (2001:334) suggests there is evidence of five types of sail, two triangular, two 'claw' and one 'half-claw' type sail (figure 32), as well as six types of rig. The five sail types are basically the same type of sail, but from a theoretical perspective constitute a progressive evolution as the claw sail is more aerodynamic than the triangular sail and would have allowed for less damage due to flapping, whereas the half-claw would have allowed for double sails and hence better steering capabilities.

As for the Oceanic rig, the oldest evidence from Eastern Melanesia and Micronesia indicates that the outrigger canoes were sailed with the outrigger to windward and with a canted mast while using a two boomed triangular sail (Horrdige 2008:90; McGrail 2001:328–329). When changing tack, a process called 'shunting' would be used, whereby the forward corner, or the tack, of the sail is manually carried across to the former stern, now to become the new bow, and secured there with the supporting canting mast pivoting around a central transverse pole (connecting the canoe hull with the outrigger), into its new position. Thus, the outrigger stays to windward whichever tack (Horridge 2008:93; McGrail 2001:332). The single outrigger canoes of Polynesia displayed more variety in

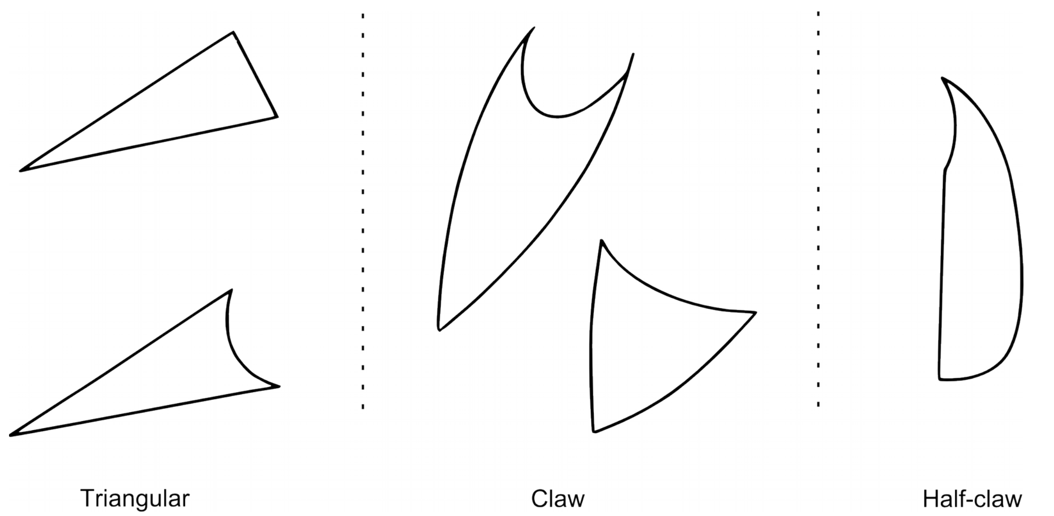


Figure 32. The three basic sail shapes of early Oceanic vessels according to McGrail (2001:334). They are all depicted as if the bow was to the left.

terms of the positioning of the mast as well as sail shape and depending on this would have been tacked instead of shunted (McGrail 2001:330–331). However, it is unclear whether these varieties constitute later alterations influenced by European visitors (Horridge 2008:98–99).

Horridge (2008), who has done extensive research into how the native Oceanic sail and rig might have been affected by outside influence, suggests that the oldest type of Oceanic rig is best described as mastless. He argues that it would have worked in the same way as a modern day windsurfer sail which uses tilting alone to steer, the rudders supposedly acting as a lateral plane alone (but there is nothing to say they could not have been used as both rudder and lateral plane, compare with Anderson 2000:29). The large delicate and, when wet, quite heavy sail, would have needed the support of two booms to avoid being ripped, and when setting sail, would have been pushed up and supported by a loose prop and a stay (Horridge 2008:86). When changing course into the wind, the tack of the sail would be moved back and down, and when going downwind the sail would be tilted forward and across the boat (2008:92). Because of the prop, this earliest type of rig would have tacked,

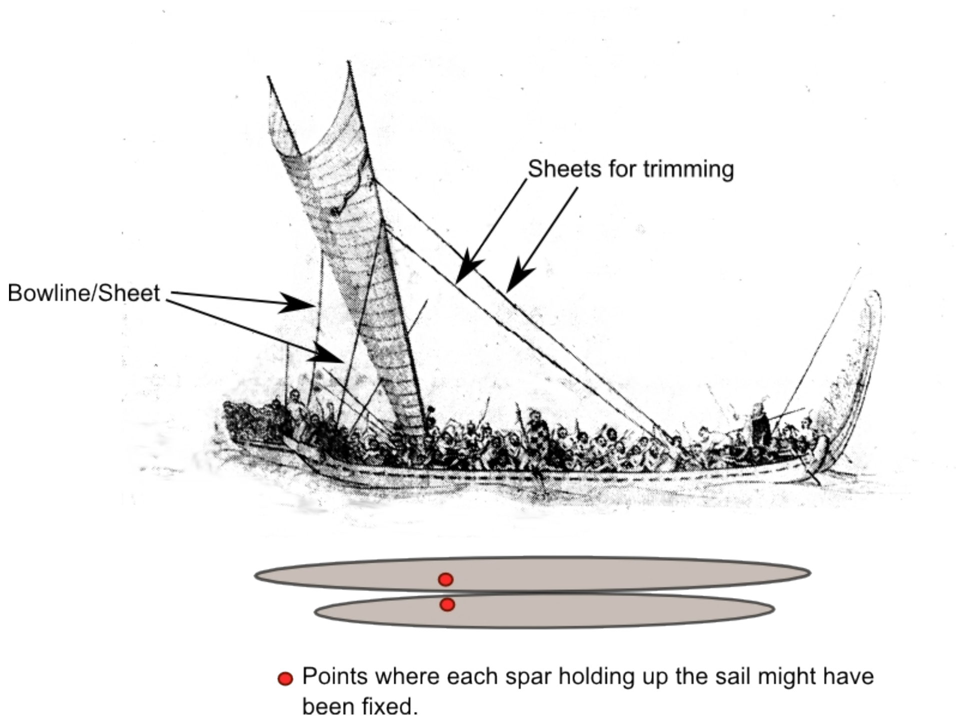


Figure 33. New Zealand double canoe with a sail, 1769 (after Anderson 2008:246, figure 1). If the two spars spreading the sail were anchored as suggested here, this 'archaic' sail might theoretically have been quite efficient and not only restrictive to downwind sailing capabilities only.

shunting and the central positioning of the mast coming later (Horrdige 2008:92; McGrail 2001:339).

It has been suggested that the earliest sails used for voyaging in remote Oceania must have been similar to the basic rig and sail first encountered by Cook in New Zealand in 1769 (Anderson 2000:33; 2003; Anderson & O'Connor 2008:244–246; Anderson et al. 2006). On the occasion, the mat sail hung transversely between two spars across the double hulls (figure 33), with one spar in each hull, fixed by a 'forestay' to the corresponding prow. Apparently it lacked the support of a mast altogether but was held up by wind pressure against sheets alone, suggesting downwind sailing ability only (Anderson 2000a:32–33). The archaic simplicity of this sail, which was also seen on a second occasion, has made Haddon & Hornell (1975:208) suggest it might either be a design that had survived in isolation, or a degenerate form of the two boomed Oceanic sail used elsewhere across Oceania. The only surviving sail from this period however, presumably collected during one of Cook's journeys, appear to have been intended for use on a two boom rig (Irwin 2008:18—19).

However, a closer look at the so called 'archaic' sail in figure 33, leads one to challenge the interpretation given by the early Europeans for several reasons. Firstly, the sail area depicted is so large that the belief it would have been held up by muscle power alone must be questioned. Even a slight swell would have made this quite impossible and whoever was trimming the sail would have needed to be able to lay the sheet around some form of cleat when the pressure increased. Secondly, it is doubtful that the Europeans who described these sightings would have had the experience of sailing small boats to the level necessary to have understood the rig in question. It is even more doubtful that the artist depicting it would have had the requisite understanding of sail and rig that would enable him to make a truthful depiction. These types of problems in relation to the interpretation of boat imagery and early accounts of sailing, have been discussed above in relation to both ancient Egypt and Oceania, and could just as easily apply to the interpretation of rock art imagery. Thirdly, it is theoretically possible, depending on the exact configuration of the rig and the positioning of the spars holding out the sail, that the depicted rig in figure 33 might have been quite effective through a wider sailing range. Thus, even though it appears very simple, it might still have allowed for a wider sailing range than downwind sailing capabilities only. Hence, even though the habit of using sail regularly in New Zealand might have ceased, the basic knowledge was still there and when the need suddenly arose the simplest possible method was employed.

From Near to Remote Oceania

As mentioned earlier, the earliest seacraft used to settle the islands in Remote Oceania were probably single outrigger canoes and/or double canoes. There has however been much debate in the past as to whether the first settlers came there unintentionally or not, or indeed whether such journeys were made by means of drifting or sailing (McGrail 2001:341). Computer simulations carried out on the feasibility of discovering new islands by either method seem to point towards intentional journeys, not mere chance (see for example Lewis 1994:16 and Levison, et al. 1973).

Irwin (1992:133–173) has put forward the hypothesis that these earliest settlers used strategies based on safety, whereby the foreguard would sail against the prevailing easterly wind in their search for suitable land, with the knowledge of being able to return swiftly with the wind behind them if unable to detect anything before food and water onboard were exhausted. In order to make such journeys more successful one could envision additional strategies, as for example that of security in numbers – used not least by the earliest European circumnavigation voyages and indeed the accounts of the aforementioned Egyptian trade journeys to Byblos during the Old Kingdom. It is also possible vessels could have formed inter-visible chains, so that at least one or two would always be within sight of land.

It is clear that in order to undertake such journeys against the prevailing winds, the crafts used would have had to be able to sail against the wind, at an angle of at least 75–80 degrees off the wind (McGrail 2001:338), thus not much lower than the crafts first encountered by the Europeans, as we have learned above. In addition, Finney (1985:11), points out that the winds were not always easterly, but that every summer the easterly trade winds on the Southern Hemisphere is weakened and often replaced by westerly winds (which in El Nino years become more prolonged events) – a phenomenon that was known and utilised by 18th century Polynesian navigators. In his view it shows how it might be why the Lapita culture spread from Eastern Melanseia to Polynesia and not from Micronesia.

In whichever case, navigation skills for sailing out of sight of land would have been required (McGrail 2001:338). The navigational skills of the Polynesians appear to have been most impressive. Cook gave the following description in the late 18th century: "*In these Navigations the Sun is their guide by day and the Stars by night, when these are obscured they have recourse to the points from whence the Wind and waves of the Sea come upon the Vessel*" (Beaglehole 1967:164), and in an account by Cook's chief scientist on the same journey, their astrological knowledge is further elaborated along with a comment on how the Polynesians excelled in predicting the weather (Hooker 1896:162). These accounts seem more than accounted for when compared to Micronesian non-instrumental navigation techniques which survived here and were documented in the 1960's (Lewis 1994) but in neither case it is known whether these skills would have been on an equivalent level to those of the earliest settlers of Remote Oceania.

McGrail (2001:343) believes this might have been the case, on account of several of these techniques being known to have had an early use in other parts of the world, whereas Anderson et al. (2006:2) agrees basic astronomical knowledge might have existed prehistorically in at least Remote Oceania. However, an indirect answer might be served by Irwin (1980:328–329), who points to the fact that communication between islands must have been sustained at relatively high frequencies even after the initial settlements, and for which such navigational skills would have been required (as well as relatively advanced sailing abilities). The Micronesian islands, for example, are generally too small to be viable in the long term without the continuous flow of trade goods and information (ibid.). It is also worth pointing out that most of the non-instrumental methods of Oceanic navigation as listed by McGrail (2001:342–345), would have been needed for some sea journeys within Near Oceania, as some passages here were also partly, although for shorter periods, without any sighting of land (see for example Clark 1991). Such passages might have been of enough length to allow for the development and honing of early navigation skills which would have made the step to venture into Remote Oceania less daunting and more achievable.

The above, however, suggests that the sail was widespread for some time prior to the initial first settlement of Remote Oceania. Exactly how the transition from paddle to sail might have transpired is and will probably always remain unknown. It is however generally believed that the earliest craft in Near Oceania and within Island South Pacific were bamboo rafts, bamboo being a readily available material that could have been easy to cut without an adze (Anderson 2000:15; Clark 1991:45; Irwin 2006:62). The adze, which would have enabled the making of dug out canoes, first appears in the early Holocene (c. 8000 BC), with fully-ground stone adzes recognized in coastal sites after c. 2000 BC (Irwin 2006:62).

There are today two schools as to the exact timing and process of the apparent widespread use of sail in the region by c. 2000 BC. One school advocates a slow and incremental development of both craft and later sail within the region of Island South Asia, suggesting the earliest sails might have evolved for use on bamboo rafts and later adapted for use on outrigger and double canoes (see e.g. Irwin 2006:56, 62, Finney 2006), with Horridge (1987, 2008) going as far as suggesting the sail first started to the be used here some 30,000 years ago. The other school (see e.g. Anderson 2000) proposes a relatively quick introduction of the sail from Taiwan/China by about 2000 BC, arguing a dispersal of the knowledge of the sail, potentially originating from Egypt.

Discussion

One immediate reaction after having considered all of the available evidence regarding early sailing on both the Nile and in Oceania is how fundamentally different the vessels and sails were in each area. It is clear that the craft and sail that evolved in these places did so, depending on the social needs and local preconditions, both in terms of available materials and tools, but also depending on geography and weather conditions. Another reaction is just how complex the available knowledge of early sails is and how many different views and interpretations it allows for.

One striking similarity between early craft in the above two regions and Scandinavia is that the early sailing craft lacked a keel. In Egypt it would appear multiple steering oars were used as lateral plane to help manoeuvre such vessels. In Oceania, steering oars in addition to a rig that might have facilitated steering by means of tilting it were used for the same purpose, whereas in Scandinavia as we shall learn in later chapters, it might have been the double steering oars – one in each end of the vessel – that might have been used for the same purpose.

The choice of sail material in each region shows that people made good what they had available. Thus, although linen was probably used as sail material on the Nile from predynastic time, it is generally thought to have been confined to 'royal' usage due to its expense (Landström 1970:23). Reed on the other hand was readily available and, as aforementioned, used for sails well into Roman times. Various forms of matting appears to have been the only available sail material in Oceania, which might have led to the development of a two-boom sail to ensure it would have lasted longer. It is possible the upper and lower yards used in ancient Egypt had a similar function to that of the Oceanic two-boom system.

As for Scandinavia, there would have been the possibility of many different types of sail material – different types of matting, skin, or textiles out of nettles or wool – and there is no reason why not all of these could have been used alongside depending on availability, resources and the specific need. As we shall see in Chapter 5, all these materials are suggested within the rock art material. (Nettle cloth was, for example, used for one of the *Wasa's* top sails (Bengtsson S. 1975) and appears to have been widely circulated across Scandinavia during the Bronze Age (Randsborg 2011), but also the importance of wool, and by extension wool textile, appear to have been greatly underestimated for this period (Bergerbrant 2007; Bergfjord et al. 2012; Wehlin 2013:187)).

That the iconographic and the archaeological source material attesting to early use of sail do not always match is a fact that is very noticeable within the ancient Egyptian material (figure 34). As later chapters will show, the same applies to the Scandinavian material.

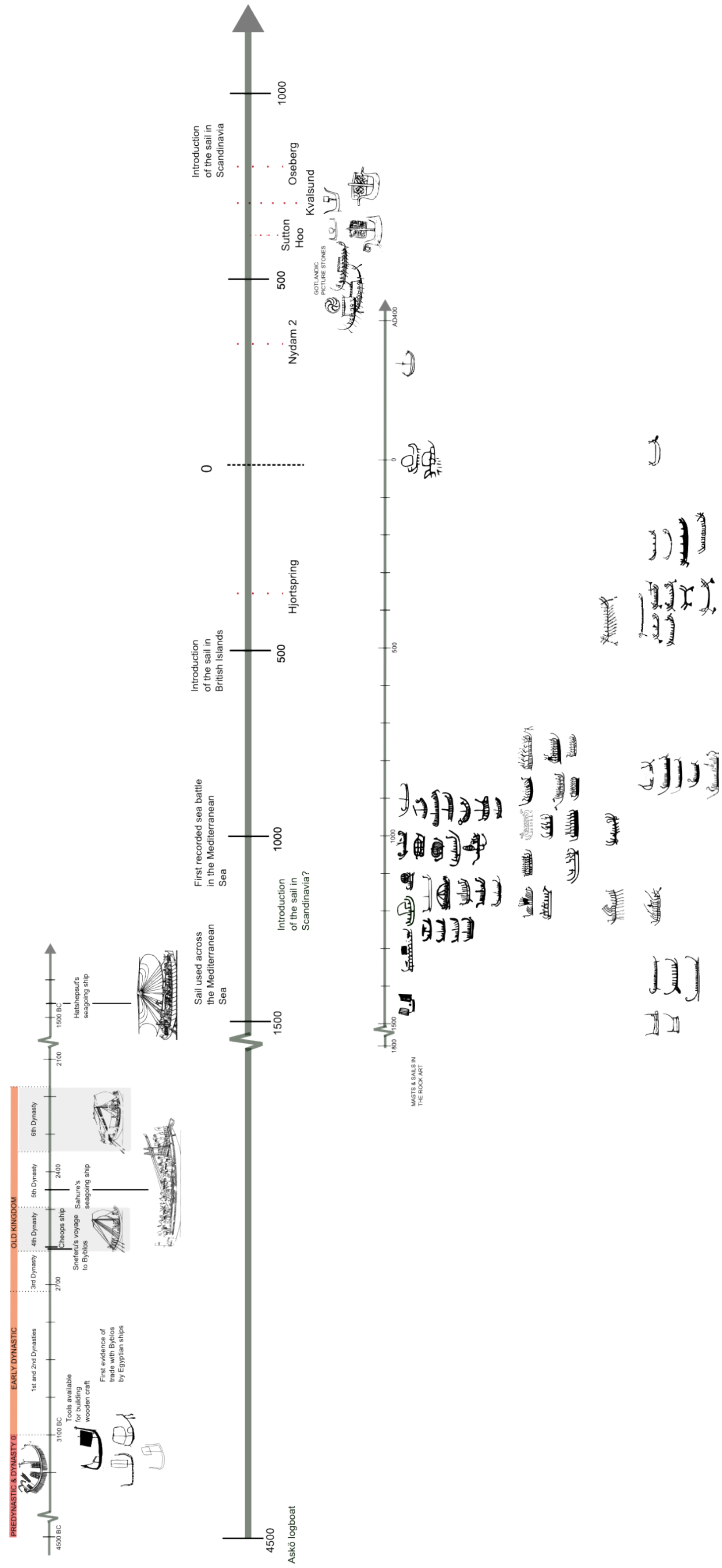


Figure 34. A comparison between the iconographic and archaeological source material in ancient Egypt and Scandinavia.

If we first consider the Egyptian material, the first irrefutable sail appears on a vase in c. 3100 BC by which time a widespread use of sail might be assumed. About one or two hundred years later, there are indications that trade with Byblos for the acquisition of cedar had begun, and with that seafaring proper – as this is the only way in which it could have reached Egypt (Fabre 2005:92). Thus seamanship, including navigational capacities, were at this stage of a sufficient level to ensure potentially direct importation of valuable commodities such as cedar. At least to a level where the gains were deemed to outweigh the risks (and this within a society often described as very traditional, self-content and uninterested in venturing 'abroad' for other purposes than of defence or acquisition of exotic goods (James 2009:11)). It is also interesting to note that in the iconography, the first seagoing ship does not appear until c. 2450 BC. This would suggest a period of some four or five hundred years during which river vessels were used for Byblos trade and during which time we might assume they became increasingly specialized for seagoing capabilities. But we will return to this issue later. Another interesting question which arises here is whether the first river craft to venture to Byblos were plank built or made of reed. Casson (1995:13), for instance assumes that craft would probably have been plank built due to the increases in buoyancy it provided, which was needed for the transportation of heavy goods, such as cedar logs.

As we have seen, one of the earliest direct archaeological evidence of any type of craft comes with the Cheops ship, dating to c. 2600 BC, which brings surprises on many levels. Firstly, it is a ship so large and built with such skill that many scholars believe it represents a boatbuilding tradition which must have developed over many hundred years, if not a millennium (McGrail 2001; Washmann 1998). In this light it is of course interesting to consider Landström's (1970:12) interpretation of some of the Gerzean boat iconography and a Badarian clay model as representing plank built vessels, which would potentially bring this technology back to about 3500 BC (which should be set against the apparent lack of suitable tools for finer wood working before 3000 BC, but then again, the stone technology might, as indeed Oceanian boats show, have been perfectly adequate). Secondly, the Cheops ship shows no indication of having been sailed (although, see Landström 1970:46), despite its use being attested to for at least 500 years, and the existence of a depiction of an almost identical vessel carrying sail from Sahure's grave temple. This offers a direct comparison to the many early Nordic boat finds which also appear to lack any evidence of having been sailed (see Chapter 4), whereas the fact that as a royal barge the Cheops boat did not need a sail, offer a comparison with the early rowed processional vessels on the Gotlandic Picture stones. It also shows that the same type of vessel might have been used for different tasks, depending on which they might have had been equipped with oars, paddles or indeed sail. This will be discussed again in Chapter 4.

The belief among many scholars that the Egyptian bipod mast first developed for use on bundle reed rafts, then transferred to plank built vessels, offers another potential discrepancy in that the earliest iconographic material only seems to depict vessels with a single mast. However, this whole debate might be meaningless as both single, bipod, and even tripod masts are depicted within the Old Kingdom iconographic material and probably existed alongside for the entire period and earlier – it might just be that the surviving predynastic source material happens to only depict the single mast. Thus the bipod mast might just simply be another example of one out of several ways in which a mast can be fashioned and which in Egypt continued to be used until, for some reason, the single mast began to take over completely in the Middle Kingdom. As McGrail (2001:31) rightly says, single masts can be erected on bundle, boat-shaped, rafts just as easily as bi- or tripod masts and irrespectively of type of mast, the sail could still have first evolved on such craft. What is interesting though, is the co-existence of several types of masts. For Oceania we know of the existence of various types of masts and rigs used from the 16thcentury AD onwards but the Scandinavian rock art material, as we shall see in Chapter 5, certainly seem to indicate that several different types of masts were used here alongside, and that they were being rigged in different ways.

Consequently, the above would indicate that:

- A keel would not have been a prerequisite for early sailing, as steering oars can be used as a lateral plane,
- It is very possible several different types of masts and rigs were used alongside when the sail was first being developed,
- Sails would vary depending on available materials, resources and needs, and different materials could have been used alongside,

- There are discrepancies between archaeology and iconography, the evidence of which does not necessarily overlap,
- Even where boat finds exist, these do not easily convey any evidence of sailing, even in areas where the sail is attested to.

Trying to put together the jigsaw of early sailing is much more complicated than many scholars would like to admit. In Scandinavia, as we will see, these discrepancies are even larger.

What, then, is 'sailing'?

What is Sailing?

I define 'sailing' in its truest sense as the ability to harness the wind in order to propel a watercraft forwards in a desired direction. However, over time the word 'sailing' has evolved to also describe the method of navigating a vessel, and the departure or time of departure of a vessel from a port, regardless of means of propulsion. This evolved meaning can sometimes lead to confusion, especially when used in a prehistorical context. For example, as mentioned in Chapter 1, Kristiansen & Larsson (2005:204—205), suggest that Bronze Age seafarers would “*sail across the Baltic Sea to south-eastern Scania*“. Here the authors might actually refer to the use of sails by the seafarers but could just as easily be interpreted as referring to their navigational skills.

The definition I use here could in its simplest form be achieved by raising a branch to catch a following wind, or even for a person to stand up – depending on the force of the wind and the lightness of the craft. In Scandinavia, and probably elsewhere, this method of 'sailing' has been used alongside more complex forms well into the 20^{th} century (Eskeröd 1970). Thus the earliest form of sailing used the wind to go downwind. As we have seen on the Nile, its meandering nature eventually provided an incentive for trying to expand on the sailing range but it is not until the 5^{th} Dynasty that we have imagery suggesting this range might have increased to about 90 degrees from the wind (with the wind coming from the side). Hence, if we assume the use of sail was widespread by c. 3100 BC (and perhaps had been in use for several hundred years), it would have taken a considerable time to develop this ability – perhaps as much as one thousand years!

In Scandinavia, the ability for a boat to sail towards the wind (i.e. less than 90 degrees to the wind) has been an important component and even a preoccupation with many scholars in regard to early sailing, with notions such as 'adaptation towards sailing' (Rieck & Crumlin-Pedersen 1988:139), 'full acceptance of sail' (Westerdahl 1995), and 'good sailor' (Haasum 1974, 1989) regularly meeting us in archaeological texts – all of which appear highly subjective and, in my view, put serious restraints on our understanding of early seafaring in this region.

To define sailing as the ability to sail against the wind, would be the same as saying that a glider does not fly. A boat may be able to sail, and in the right hands sail exceptionally well, but it does not necessarily mean that it is sailed only or indeed towards the wind, in the same way as a glider needs a height from which to take off. Why should this type of sailing be ignored? As will be described in Chapter 6, a craft can utilise the wind quite easily within a given day if the weather is predictable enough, and can therefore quite easily avoid sailing towards the wind. It is easy to see that with an increased ability to predict the weather and with increasingly better skills as to seamanship, the easier it would be to utilise the sail over increasingly longer distances.

If we consider the advantages of using a sail; a) less effort is needed in moving a watercraft from point A to point B in favourable conditions, b) there is increased communication and mobility, and c) heavier cargoes can be transported using smaller crews, it is clear that these advantages would not only have favoured communication over long distances, but also over short and medium distances. Therefore, we cannot delimit its use to long distance use, although, it is in long distance regular movement across open water we usually first detect the use of sail in the archaeological context.

We shall now turn to the Scandinavian material, beginning with an examination of the basis for the current perceived opinion on how and when the sail was first used in the region.

4. History on Sailing in Scandinavia

The question of when the sail first appeared in the North has been much debated in the past, but this is mainly because of the nature of the available source material, limited as it is to very few boat remains, and often obscure written and iconographic source material. The aim of this chapter is to introduce the archaeological evidence unveiled so far in respect of the use of the sail in the North as well as to explore the current hypotheses as to why and how the sail was adopted. The chapter begins with an account of the first appearance of a mast step on a Nordic vessel and from there moves back in time to our earliest boat find, namely the Hjortspring boat. In addition to this, written sources, iconographic material and circumstantial evidence will be evaluated and assessed.

The Archaeological Evidence and Written Sources

The Oseberg ship from Norway is the first Scandinavian boat find presenting irrefutable evidence of having carried a mast and a sail. This vessel is followed by a whole string of finds which together cover a time frame from AD 810 until the end of the 11th century. These include the Gokstad and Tune vessels from Norway, the Äskekärr boat from the Swedish west coast, and the Skuldelev boats from Denmark to mention a few (see table 1). Common features to all of these vessels are the appearance of a mast step for holding a foldable mast secured with shrouds and stays, prominent keels (see column for keel d/b in table 1), and, with the exception of the Oseberg and the Tune boats which are mainly regarded as vessels used in sheltered water, a freeboard suitable for sailing (Haasum 1989:12; McGrail 2001:211). All these features are generally regarded as essential for being able to sail vessels of the Nordic tradition.

From about the same period comes the first written records that include references to sailing; the accounts of the voyage of Othere, a Norwegian, along the northern coast of Norway, and the voyage of Wulfstan, whose origin is less certain, in the southern Baltic Sea (Bately 2007:26—27; Bately & Englert 2007; Lund 1984). Both these journeys were added to Alfred the Great's translation of Orosius' latin work *Historarium adversum Paganos Libri Septem* some time at the second half of the 9th century AD, possibly in the early 890s (Bately 2007:21). An interesting fact about the account of Othere's journeys is that King Alfred's English court appears to be much more interested in his journeys along the Norwegian coast than of any accounts of his North Sea crossing (which is altogether omitted from the tale), and which, according to Sawyer (2007:139), must be taken as an indication that such journeys had been made by many others before him and did not require description.

An even earlier account of the Norse and their sailing ships comes in connection with the attack on Lindisfarne in AD 793 (Haywood 2006:11), but even this early account cannot set a date for when the sail was introduced. Haywood (ibid.) for example believes that the Norse and their sailing ships were known to the Northumbrians in a more peaceful context well before this attack, and that the Vikings themselves must have been familiar with the Northumbrians long before they planned their attack. What is certain is that the above accounts all indicate a widespread use of the sail by this time, which possibly dates back well before AD 793. However, in the archaeological boat record, features indicating the use of sail are mysteriously absent.

To explain this absence, Westerdahl (1995) has put forward a hypothesis suggesting that there was no impetus for a change from the use of oars to sail in Scandinavia until the emergence of royal control of havens and coastal waters in the 8th century AD. The introduction of royal control would have ensured the safe conduct of the sailed cargo ship and explained the 'need' for far-reaching voyages for the purpose of exploration or settlement and the use of sail aided warships. Westerdahl puts forward the idea that the ledung system, known to have existed in Medieval times on the Swedish east coast, in fact, had its origin several hundred years earlier, and possibly 'held back' the introduction of the sail. This system, set up for the purpose of defence and for undertaking overseas raids, was based upon the number of rowing pairs in a vessel. This in turn determined the organisation of society itself into units depending on the number of able bodied men to be used on these vessels.

Thus, he argues, with no shortage of men and with individual leaders gaining prestige in manifesting the number of rowers, there would simply be no need for a sail, nor would an adoption of the sail be advantageous as it would have required significant structural alterations to the ship – it can only be imagined that these 'structural changes' would have involved a deeper keel, higher freeboard and the inclusion of a mast step.

Westerdahl's views, appear to be supported by two classical authors who make explicit references to the absence of sails – Procopius, a Byzantine working in the mid-6th century, and Tacitus, a Roman operating around the late 1st century AD (Their 2003:183). For example, the passage in Tacitus' Germania (44.2–3), where he describes the boats of the Suiones, a tribe originating in the Baltic Sea area; "*The form of their vessels varies thus far from ours, that they have prows at each end, so as to be always ready to row ashore without turning; nor are they moved by sail,..* ", has long been used as an argument that the art of sailing was not known in the North – at least not by AD 98 (Bruun & Lund 1974:78; Grane 2003:137; Marstrander 1963:92).

However, although some of the observations made in this particular work have proven consistent with archaeological discoveries, there are also many inconsistencies, which have been much discussed in the past (Mattingly 1948:29; Önnerfors 1969:20, for additional comments on Tacitus see Humbla & von Post 1937:70 and Rieck & Crumlin–Pedersen 1988:78–79, and on the whole problem of the geographical aspects of the work see Grane 2003). Therefore it is clear that this particular passage regarding such a specific and specialised subject as boats and their propulsion, provided to the author by secondary sources (read e.g. Greenhill 1995:14–15 on the difficulty of understanding the maritime world as an 'outsider' i.e. someone who is not accustomed to maritime terms and customs), cannot be taken as 'proof' that the concept of sail was unknown. Besides, it would be difficult to argue that the Suiones were the only tribe living in the North at this period or that their boats would have been representative of the entire region, or even represented the only type of boat used by this particular tribe. There is, for example, evidence of asymmetric boats possibly dating to around this time in the Scandinavian rock art (see e.g. Sognnes 2001:47, 54, type K and L, and I/J boats) and likewise asymmetric ship-settings, that were used for burials between 500 BC and c. AD 250 (Wehlin 2013:148–149). In addition, the ship-settings seem to indicate the presence of both long and narrow and relatively wider beamed vessels (Rausing 1984:79; Wehlin 2013), which clearly illustrates the presence of more than one type of boat in the region. In fact, the specific reference to the absence of sails on the boats encountered according to Tacitus, might simply be because they were unusual to the observer (Haywood 2006:36) or even because the observer did not notice the mast and sail lying furled up inside the boats while it was rowed to the shore.

As for Procopius, he tells us, presumably on the testimony of an Angle visiting Constantinople (Burn 1955:261), that one of the characteristics of the Anglians in the mid-6th century was that they did not use the sail on their ships but relied on oars alone. However, the same informant testifies that Britain was home to the souls of the dead and that horses did not exist there, which clearly shows that this account is unreliable (Haywood 2006:101—102; Their 2003:183). Thus, neither of these two authors should or could be taken as conclusive evidence that the sail was not known in the North by this time and shows how little substance this assumption is based on.

Earlier Nordic Vessels

This leads on to an examination of the archaeological boat material that has been used as an argument for or against sailing in the North prior to the 8th century, starting with Sutton Hoo 2. Although this boat find comes from East Anglia on the British Isles, its shape and build is reminiscent of the Nordic hull types of the period including that of the original homeland of the Anglian immigrants in Britain. The vessel is dated to AD 630 and was found in a grave as the mere imprint of the planking in the sand along with sand casts of frames and corroded remains of iron nails, which had been used to fasten the planks. Thus, despite not having any actual remains of the boat, its shape and much of its characteristics have been extremely well preserved, allowing for the reconstruction of a 27m long vessel, with space for 40 rowers (Bruce-Mitford 1974, 1975:350, 584—588, 678—682, 715—717; McGrail 2001:210—211; Rieck & Crumlin-Pedersen 1988:139).

Unfortunately, much of the centre of the boat has not been preserved because of the grave chamber placed here, thus making it impossible to tell whether it was equipped for sailing or not, since not only the bottom, but also the side strakes at the centre of the boat were heavily damaged (Åkerlund 1963:142). Therefore, no rowlocks have been located in this part of the vessel, potentially reducing the number of rowers to 14 pairs instead of 20 (Bruce-Mitford 1975:413—420; Haywood 2006:98). The lack of evidence of a mast or a rig in combination with the apparent lack of a prominent keel – although it was equipped with a side rudder and possibly even a steering oar (McGrail 2001:212) – has led many scholars to reject any interpretation that the vessel might have been sailed. Instead it has been stated that the light flexible hulls of the early Nordic ships, and to which Sutton Hoo 2 probably belongs, would not have been able to withstand the stresses incurred by the use of sail (Christensen 1996:79—84; Crumlin-Pedersen 1990:III, 1997:188). Nor, is it claimed, does the shape of the hull indicate that it might have been sailed (Rieck & Crumlin-Pedersen 1988:139).

However, the sheer size of the ship has in the past invited attempts of equipping the Sutton Hoo with 'imaginary' sails (Åkerlund 1963:141—142), and it has also been suggested that the centre of the vessel was kept clear of rowlocks for sailing tackle (Cameron 1982:321). As the Giffords (1996:133) point out, the removal of the rowlocks and some 64 nails in this area in order to accommodate the burial chamber would undoubtedly have left at least some traces and their absence therefore suggest a configuration similar to the rowed sailing vessels depicted on for example the Bayeux tapestry. Indeed, sail trials in a half-scale reconstruction of the boat shows it not only to have been capable of carrying mast and sail, but also that its hull shape and waterline might have compensated for the lack of a prominent keel. In addition to this, the relatively low freeboard appears to have been less of a concern than hitherto believed (Gifford & Gifford 1996:121, 127). However, half-scale reconstructions have been heavily criticised for not taking into account the consequences of a reduction in scale (Coates 1997:148; McGrail 1997:314—315, 2001:212), and thus, the question of whether the boat would have been able to withstand the stresses induced by a rig remains open, even though, in my opinion, it most likely would.

The 18 metre long Kvalsund 2 boat from Norway, which is dated to AD 690 (Myhre 1980b; Shetelig & Johannessen 1929), has also in the past been equipped with 'imaginary' sails despite the fact that no signs of rigging were found at the time of excavation. The remains of the boat were found, partly cut up and partly burnt, in a bog, and have been reconstructed as a vessel with a round hulled mid-ship cross-section, but, it has been noted that the relatively long keel line and the sharp rise of the bow and stern sections might indicate an “*adaptation towards sailing*” (Reick & Crumlin-Pedersen 1988:139). Furthermore, Sawyer (1971:78) mentions that its rudder “*seems to be designed for sailing as well as rowing*”.

This leaves us, apart from the odd fragmentary remains, with only two more vessels in the Scandinavian/Nordic archaeological record; the Nydam 2 and the Hjortspring boats, dated to AD 320 and 350 BC respectively (McGrail 2001:209; Rieck 1994:48—49). Both these vessels were found in bogs in the context of offerings, where the weight of the overlying peat to a large extent had flattened out and distorted the boat finds – Nydam 2 less than the Hjortspring boat which was found heavily disintegrated and only about 40% of which has been recovered (Bojesen-Koefoed et al. 2003:47; Engelhardt 1865; Rosenberg 1937).

Nydam 2 was found together with the fragmentary remains of three other boats, called Nydam 1, 3 and 4 or A, C and D, depending on which author is consulted. The find was made in Schleswig in 1863, not far from the present day German-Danish border (Engelhardt 1863, 1865). In time, it represents a leap backwards by almost 400 years from the Kvalsund boats. It has been almost entirely reconstructed, revealing an impressive clinker built oak vessel, nearly 24 metres long and with space for up to 30 rowers, who would have worked their oars against individually made curved thole timbers lashed onto the top strakes. It was equipped with a steering oar and possibly also a side rudder (McGrail 2001:209) but no traces of mast or rig have been found. Interestingly though, the caulking within the plank laps has proven to consist of textile soaked in linseed oil (McGrail 2001:209; Rieck, pers. Communic. 2005), for the first time associating textile, and possibly sail material, within a marine context. Like Sutton Hoo, Nydam 2 has in the past been equipped with imaginary sails (Westerdahl 1995:41), but the attempts have been rejected based on the very same assumptions as the former. However, it appears a real attempt at sailing a reconstruction of Nydam 2 boat was made in the 1930s in a Nazi

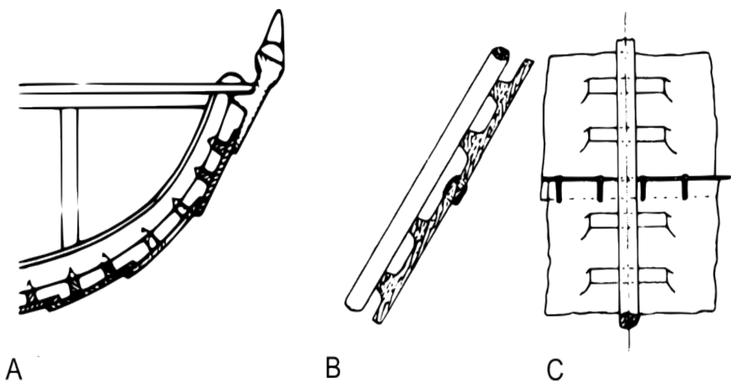


Figure 35. A comparison between the clinker built Nydam 2 (A), with overlapping planks and the bevelled overlap as found on the Hjortspring boat (B). Both the Nydam 2 and the Hjortspring boats had integral protruding clamps (C) onto which the internal frames were attached (after Rosenberg 1937 and Åkerlund 1963).

propaganda movie (Flemming Rieck pers. Communic. 2005), any published media of which appears to have been lost.

Of the remaining Nydam boats, only Nydam 3 or C (Rieck & Crumlin-Pedersen 1988:119), a smaller, c. 19m long boat built in pine, reveals any useful information about the boats of the period. Nydam 3 has the first T-shaped keel section, and, in comparison with Nydam 2, a much stronger construction of the scarf joints fastening the stem and stern posts, and finally a side rudder mounted on a boss on the side of the hull. The latter is the fist appearance of a fully developed side rudder that could be used for secure and effective steering, which presumably would have been essential for sailing (Haywood 2006:95).

Boats like Nydam 2 are believed to have been the type of vessel used by migrating Jutes and Angles to the British isles in the 5th century AD (Crumlin-Pedersen 1990:113; Randsborg 1991:20) and the find of two large ribs or frames from Kongsgårde on the east coast of Jutland, indicates the presence of still larger vessels (Crumlin-Pedersen 1990:111, 1997:fig 9.1.2; Haywood 2006:94; Rieck & Crumlin-Pedersen 1988:134). The rib is dated to c. AD 600 and indicates a width not smaller than the Sutton Hoo ship, i.e. over 4 metres broad and 1.3 meters high amidships.

The Hjortspring boat was found not far from Nydam, on the other side of the present German-Danish border on the island of Als, in 1922. Pre-dating Nydam 2 by more than 600 years, these vessels still share many structural details, for example the integral clamps/cleats on the inside of the bottom plank as well as the side strakes, for attaching the internal strengthening construction (incorporating ribs and thwarts), but also the use of bast rope. Apart from this, the Hjortspring boat is in shape and build very different; if Nydam 2 is a rowing boat, Hjortspring is interpreted as a war canoe that was propelled by paddles. Its hull is not clinker built but has a bevelled overlap (figure 35), and consists of a hollowed out bottom plank to which two side strakes on each side have been sewn, probably with the use of lind bast rope (Valbjørn & Rasmusen, 2003:64).

The fore and aft ends are hewn out of big trunks which are sewn onto the hull and from which two 'horns' extend from the bottom plank and gunwales, in a slight curve upwards (figure 36). On the top of each of the trunks, four clamps (cleats) are hewn out, the purpose of which are still unsure. In addition to this the boat was found together with two steering oars, one located at each end of the boat (Rosenberg 1937:86—88). The interpretation of the hull reveals a light boat built for speed, a trait it shares with the Nordic boatbuilding tradition in general, and the final impression expressed by Johanessen, the Norwegian naval architect who made the reconstruction drawing of the boat, what that the level of workmanship was of masterclass (Crumlin-Pedersen 2003:35—36; Humbla & von Prost 1924; Åkerlund 1963).

Based on Johannessen's reconstruction drawings (Rosenberg 1937), a full-scale reconstruction of the boat, called the *Tilia*, was built in a cooperation between the Roskilde Viking Ship Museum, the Centre for Maritime Archaeology at the National Museum of Denmark, and the Hjortspring Guild (Crumlin-Pedersen & Trakadas 2003). During sea trials in this reconstruction many interesting facts were deduced, one of the more important being that the boat could handle far rougher conditions than earlier believed. This has quite changed our view on just what these kind of boats were capable of. In addition to this, it was suggested early on that, given the lightness of the boat and the fact that it appeared to be so sensitive to the wind, it was likely that people using the Hjortspring boat might have noticed the advantage of the wind and used it (Valbjørn 1999:56).

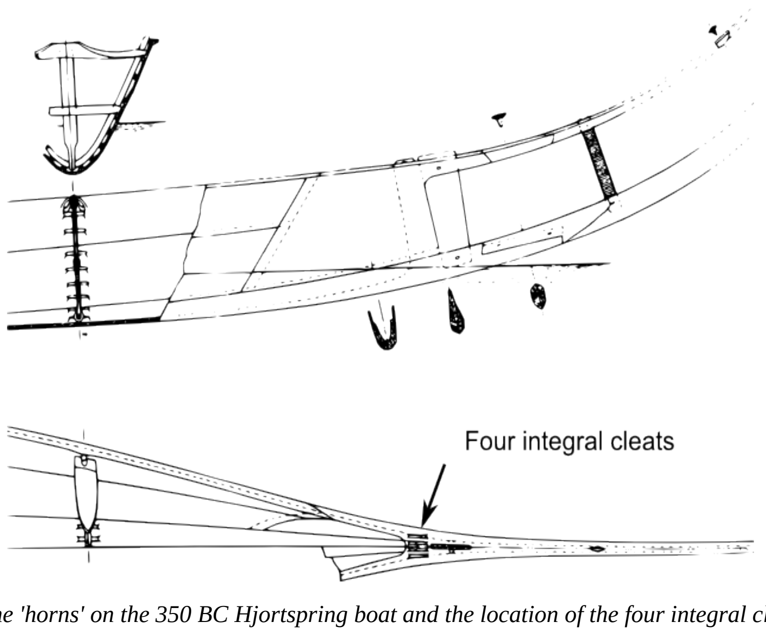


Figure 36. One of the 'horns' on the 350 BC Hjortspring boat and the location of the four integral cleats located at either end of the vessel (after Rosenberg 1937).

Vessel	Date	Overall L×B×D (m)	L/B	L/D	B/L	Keel d/b?	Average frame spacing (m)	Mast step	Fastening/ integral cleats?	Type of rudder	Paddlers/ Oars	Find context	Type of vessel
Hjortspring	350 BC	14×2.04×0.71					1	-	Sewn/ integral cleats	Steering oars	2×20 (paddles)	Bog offering	War canoe
Valderøy	AD 245±105	-	-	-	-	-	-	-	Sewn	-	YES	Boat grave	?
Nydam 1 (A)	AD c. 190	Longer than Nydam 2	+	+	+	+			Sewn / Int. cleats			Bog offering	
Nydam 3 (C) Pine	AD 290s	18.8×3×1.1				0.35			Iron rivets/ lashed/ int. cleats	Side rudder	2×11–12	Bog offering	?
Nydam 2 (B)	AD 310–320	23.7×3.7×1.2	6.3	19.7	3.1	0.14	1.00–1.10	-	Clench-fastened/ int.. cleats	Side rudder / steering oar	2×15	Bog offering	War ship
Björke	AD c. 320		–						Iron nails/ int. cleats				Extended log-boat
Halsnøy	AD 335±65	-	-	-	-	-	-	?	Sewn	-	YES		?
Sutton Hoo 2	AD 630	27×4.5×1.5	6.0	18.0	3.0	0.35	0.91	?	Clench-fastened	Side rudder / steering oar?	2×14 or 2×20	Boat grave	Royal barge?
Kvalsund 1	AD 700	9.6×1.5×0.5	6.4	19.2	3.0	1.25	1.05	?		Side rudder / steering oar?	2×10	Bog offering?	
Kvalsund 2	AD 700	18×3.2× 0.8	5.6	22.5	4.0	1.80	1.30	?				Bog offering?	
Oseberg	AD 810–820	22×5.2×1.6	4.2	13.75	3.3	1.27	1.00–1.10	YES		Side rudder	2×15	Boat grave	
Gokstad I	AD 895	24×5.2×2.2	4.6	10.9	2.6	2.40	0.90–1.05	YES		Side rudder	2×16	Boat grave	
Tune	AD 910	20×4.5×1.3	4.4	15.4	3.5	1.80	1.00	YES		Side rudder			
Klåstad	AD 800–1000	21×4.8×1.7	4.4	12.4	2.8	1.33		YES					Cargo
Äskekärr	AD 955–960	15.8×4.5×1.9	3.5	8.3	2.4	1.10		YES		Side rudder			Cargo
Skuldelev I	AD 1000							YES		Side rudder		Sea defence	Cargo
Skuldelev 6	AD 1026							YES		Side rudder		Sea defence	
Skuldelev 3	AD 1030s							YES		Side rudder		Sea defence	Cargo
Skuldelev 5	AD 1040s							YES		Side rudder		Sea defence	
Skuldelev 2	AD 1060–1070	27×						YES		Side rudder		Sea defence	War ship

Table 1. Data of selected Nordic vessels dating from the 4th century BC until the 11th century AD. Sources: Andersen et al. 1997; Crumlin-Pedersen & Olsen 2002; Crumlin-Pedersen & Trakadas 2003; Larsson 2007:172; McGrail 2001:208-211, table 5.1, 211; Rieck 2003:298—307; Westerdahl 1995; Åkerlund 1963:95, 98.

The Gotland Picture Stones, the Karlby stone and other Iconographic Material

Leaving aside the rock art imagery which will be addressed in Chapter 5, the earliest iconographic evidence we have that indicates the use of sail for propulsion in Scandinavia, is the Gotland picture stones. About 65 of these include depictions of boats (Varenius 1992:82), which are typically divided into five groups (A-D) (Lindqvist 1941:108—123). The earliest (group A) depict rowed vessels, in shape very similar to Nydam 2 (figure 37). These are dated to the 5th century AD, or perhaps even the 4th century as indicated by the similarities between the whirl ornamentation on some of these stones and ornamentations found on Nydam 2 (Rieck 2003:302—303). The second group (group B), is typically dated to between the 6th and 8th century AD (Imer 2004:47; Nylén & Lamm 2003; Rieck & Crumlin-Pedersen 1988:129) but a 7th to 8th century AD date has been suggested by Varenius (1992:82). This group includes depictions of boats with small rectangular sails hoisted onto masts placed somewhat close to the centre of the boats (figure 38), and, together with the axe or mushroom shaped details that some scholars interpret as sails, forms the largest of the groups. Within this group, the shapes of the hulls are rather different, showing longer and straighter 'keel' lines ending in abrupt, angular stems. The remaining groups (C-D) have been dated to the 8th–12th century and depict boats with

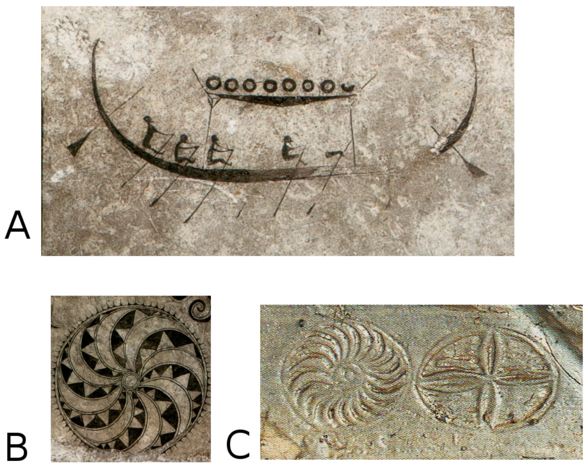


Figure 37. A) Example of a rowed bean shaped vessel and B) whirl ornamentation that can be found on some of the early (group A) Gotlandic picture stones. C) Whirl ornamentation found on the Nydam 3 ship (after Rieck 2003:302—303).

sails that appear to become increasingly intricate in design, something which has been interpreted by some as a development towards more 'advanced' types of rigs (Christensen 1979:192; Nylén 1987:81—82) whereas others regard it as a mainly iconographic development, having to do with fashion in the lay out and shape of the stone and/or picture rather than an 'evolution' of the actual rigs themselves (Varenius 1992:84, 141).

Although the Gotland picture stones are a local phenomenon confined to this island, there is little doubt that the island during this period belonged to the same cultural tradition as the remainder of Scandinavia. This has been very convincingly demonstrated by Anders Andrén (1993). He points to the fact that in other parts of Scandinavia boats appear in the form of boat graves or ship-settings and that imagery on a whole, boat imagery included, probably was far more commonplace than the archaeological records allow us to see for the simple reason that such imagery more often than not was made on less durable material than Gotlandic stone.

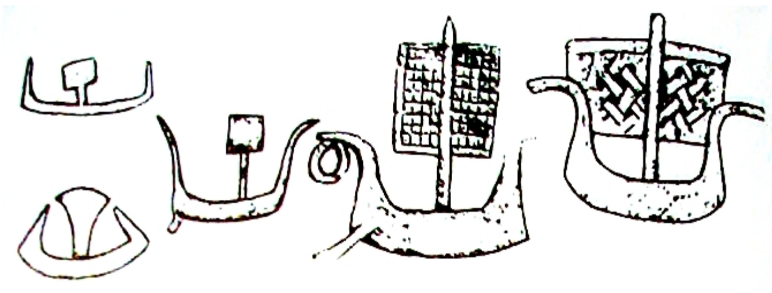


Figure 38. Group B boats from the Gotlandic picture stones. (after Nylén & Lamm 2003).

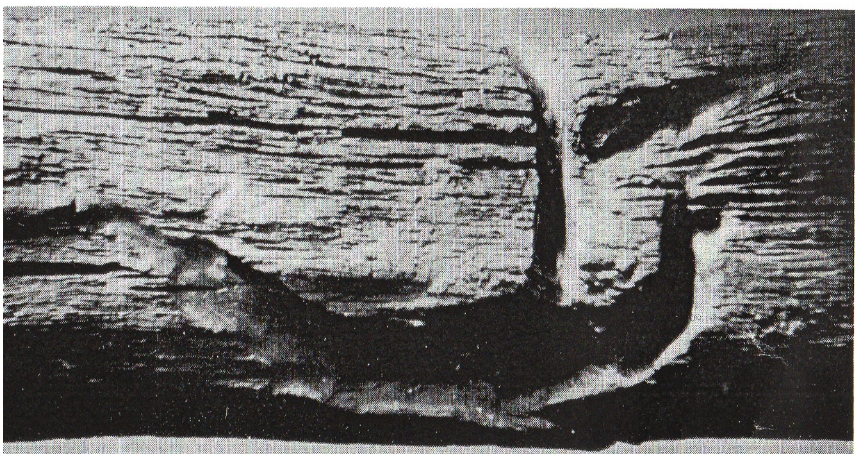


Figure 39. Boat carved onto a living tree c. 1550 BC (cal.) and found in a bog near Vendsyssel, Denmark. Sören Nacke-Krogh (1987:3) interprets the vertical line as a standing person but a more plausible interpretation would be that of a mast, located just forward of the centre of the boat. In addition, this boat is decorated with what looks like a beautifully carved horses head in the prow. (Photo: Sören Nancke-Krogh 1987:3).

A prime example of this is the early Bronze Age boat depiction (figure 39) from the Lundergård bog near Vendsyssel in northern Jutland, which was found carved into a tree trunk during peat harvesting in 1940 (pers. Communic. Per Lysdahl, 2015). The boat is in shape similar to many rock art vessels, is 39cm long (Marstrander 1963:350) and includes a vertical line which Sören Nancke-Krogh (1987:6) interprets as a stylised human figure. An alternative interpretation is of course that the vertical line represents a mast. Although of a much older date, the find shows that also the Bronze Age imagery was not only limited to rock art, bronzes and graves, but was also probably far more commonplace (Marstrander 1963:352).

Thus, even though the boat image in Scandinavia as a whole only becomes a more widely spread symbol in the 9th century AD (Varenius 1992:82), it cannot be assumed that images of boats did not exist elsewhere, nor can it be assumed that boats and sails were not used elsewhere when the earliest Gotlandic picture stones were made. This line of thought is further strengthened by the stray find of a stone in Karlby, Jutland in 1987, on which a boat with a hull shape very similar to that of Nydam 2 and Sutton Hoo, has been engraved and which carries a square sail (figure 40)(Rieck & Crumlin-Pedersen 1988:129—133). Because of the lack of datable context of the stone, proposed dates are very conservative, ranging between the 6th and 8th centuries AD (Westerdahl 1995:42), but the carving of an elk on the opposite side of this stone might indicate an even earlier date – not least since the combination of a boat with a sail and an elk can also be found within the Bronze Age rock art (Askum-44, see Chapter 5).

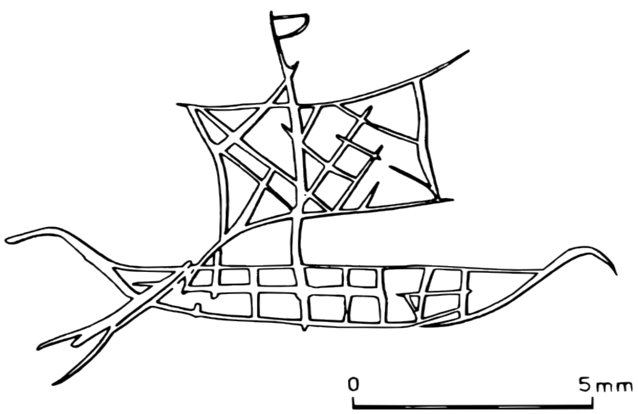


Figure 40. The Karlby boat carving (after Rieck & Crumlin-Pedersen 1988, drawing after W. Karrasch, National Museum, Copenhagen).

Based on the differences in the hull shapes on the early Gotland picture stones and the Karlby stone, Rieck and Crumlin-Pedersen (1988:132—133) have suggested the adaptation towards sailed vessels took two different paths in Scandinavia – one western and one eastern. In the east, this early adaptation is seen in a change from the rounded towards the angular type of fore and aft stems, thus providing a longer, or even extended, keel line as to enable more 'grip' in the water and avoid leeward drifting, while at the same time retaining a relatively shallow keel (which would make it possible to land the vessel on an open coast). In the west however, only the rounded fore and aft stems appear to have been used. As the picture stones of younger date suggest, the angular and curved stems were used alongside during this time, but so far vessels with angular stems have not been found in the archaeological record and might never be found as such stems might simply be the consequence of the artists attempt to draw a boat from an angle or a hull as it floats in the

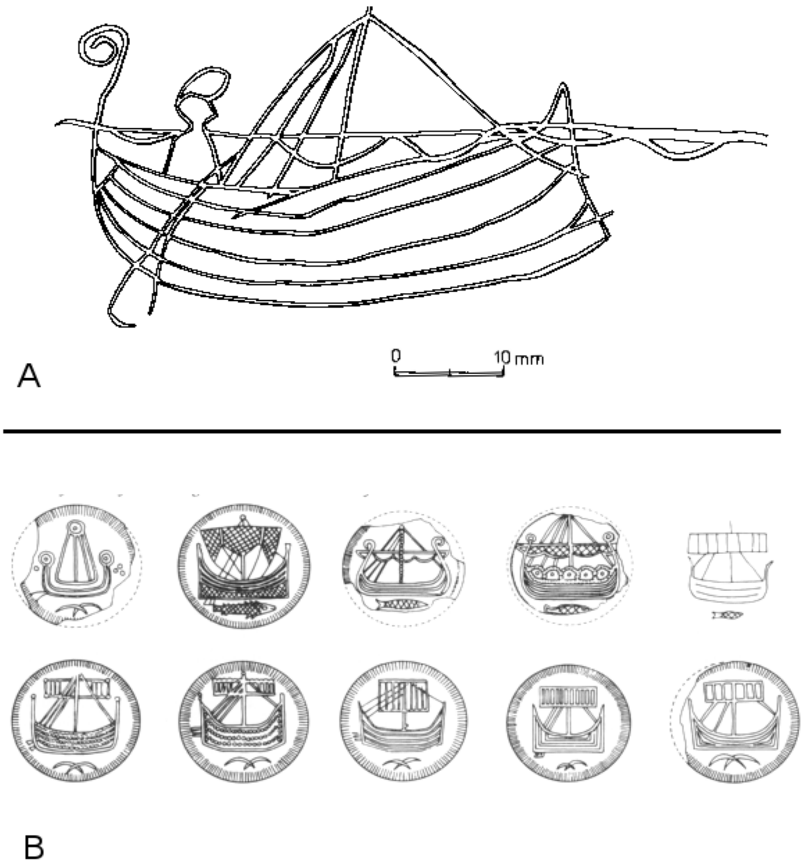


Figure 41. 9th century AD boat depictions. A) Boat carving from Löddeköping (after Rieck & Crumlin-Pedersen 1988:143, drawing by W. Karrasch, National Museum, Copenhagen) , B) Boat depictions on Hedeby coins (after Malmer 1966).

water (Adams pers. Communic.). They also suggest that the period represented by the early Gotlandic picture stones depicting sails (group B), together with the sailed vessels depicted on the 9th century coins from Hedeby, the 9th century boat carving from Löddeköping (figure 41) and the Karlby stone, suggest an intensive period of experimentation of different types of rigs and sails, which together with structural changes to the hulls of the vessels used, transformed the previously rowed vessels used in the North to the sailing vessels we know from the Viking Era. These changes included the wood technology and construction, the shape of the hull and sail, and the balancing between boat, cargo and steering (Rieck & Crumlin-Pedersen 1988: 130—131, 142).

Based on the above iconography, many scholars conclude that the sail was introduced in Scandinavia in the 6th and 7th centuries AD (Rieck & Crumlin-Pedersen 1988:127; Larsson 2007:27; Nylén & Lamm 2003:163), thus 100–200 years earlier than what has been proposed by for example Greenhill (1995:182), Haasum (1989:38) and Westerdahl (1995:43).

The Linguistic Evidence

The linguistic evidence of the origin and possible introduction of the sail in the North is neither clear nor comprehensive. It appears that the words used for sail in Europe can be divided into three distinct groupings that might have evolved quite independently; the Mediterranean, the Germanic and the Finnish-Sami (Bågenholm 2002:104). If concentrating on the origin of the Germanic word 'segel', which was and is used in Scandinavia, the general view is that this word might have been adopted from the Celtic word 'sekló'. According to some scholars this might have occurred well before the first century AD and any first encounter between the west Germanic world and the Romans (Haywood 2006:37; Their 2003:186—187). As for the relationship between West Germanic and Norse, the word for sail is shared whereas some key terms for parts of rigging appear to be dramatically different. This might indicate that the ways in which the sail developed in the west Germanic world and in Scandinavia in parts followed independent routes (Their 2003:188). Thus, the linguistic evidence appears to be consistent with an earlier introduction of the sail in the North than hitherto accepted.

There are a number of other hypotheses regarding the introduction of the sail which look to the north and east for inspiration while using linguistic and iconographic source material (Bågenholm 2002:105; Larsson 2007:97—99). Whereas Bågenholm suggests that the sail might first have been used by the Sami, sewn for mountain lakes and Arctic Sea winds, Larsson bases her hypothesis by linking the word 'skaut' frequently used in the account of Othere's voyage and which supposedly denotes a triangular sail (Jesch 2001:162—164), with the occurrence of triangular or mushroom shaped sails in the iconographic material ranging from the island of Gotland to Staraja Ladoga and Pskov in Russia and from there to the Mediterranean. She proposes that the sail was introduced from the Mediterranean via the rivers in the east. However, the fact that the Gotlandic picture stones are older than both the Russian or Byzantine material she draws on, makes the whole hypothesis very unlikely.

Problems with Current Views

Apollinaris and the Anglo-Saxon Migration Period

John Haywood's (2006) extensive research into Anglian and Saxon seafaring activities during a period ranging between AD 280–450 and onwards until their migration and settlement in Britain in the 450s to 600s AD (Haywood 2006:89), seems to indicate activities that in range and brutality were equal to those of the Viking Era. The range of the activities and the hit and run methods used raises the question whether sails were not used. Indeed, a letter by Sidonius Apollinaris of c. 473 includes specific references to the Saxons' use of sail on the Gallic coast and recounts how the Saxons made human sacrifices "*when...ready to unfurl their sails for the voyage home from the continent and to lift their gripping anchors from enemy waters*" (Haywood 2006:104). Haywood has also pointed out the difficulties the Saxon and Anglian immigrants would have faced during the migration to Britain, if half of the crew would have had to leave the newly arrived families, women, children and animals included, in order to row back for more immigrants.

The extent and number of people involved in the migrations of the Angles and the Saxons (and the Jutes) in the fifth and sixth centuries, where classical authors such as Gildas (1978:22–24 from Haywood 2006) and Bede (1969:II. 5, II. 9, IV. 26 from Haywood 2006) indicate large scale settlements and displacement of the original population, has been much debated in recent years. Whereas Y-chromosome and DNA studies provide ambiguous evidence in the matter (e.g. Capelli et al. 2003 and Weal et al. 2002), archaeological studies indicate some form of continuity and assimilation of new customs rather than destruction and displacement (e.g. Davey 2004; Hamerow 2005), in addition to which the exact nature and dating for these early settlements remains obscure (Haywood 2006:79–84). It is clear however, that the new settlers came across the sea by boat. Moreover, had sails been used, any return voyages would have been much quicker, leaving more men on the shore for defence, unless of course the immigrants arrived in fleets so large that there was no need to make any further journeys (Haywood 2006:104).

Whichever the case, there appears to be circumstantial evidence to an earlier introduction of the sail, which has even been confirmed by one highly reliable written source – that of Apollinaris – whose description of the vessels used by the Saxons as "*curving pirate galleys*" also seem to match profiles of the Nydam and Sutton Hoo ships as well as the ship depiction on the Karlby stone (Haywood 2006:104) and, even the earliest boat depictions on the Gotlandic picture stones. In light of this, it is worth noting the difference in the character between the rowed vessels of the early Gotlandic picture stones compared to the later stones on which the first sails appear. The early ones, give the impression of being depictions of ceremonies, possibly burials, whereas the later ones seem to depict either a very stylistic boat with a mast and sail or crews involved in long-distance sailing. It could therefore well be that the type of depictions mirror a difference in fashion rather than the evolution from rowed to sailed vessels.

In addition to the testimony provided by Apollinaris, the historian Amminanus Marcellinus, described the Saxons a century earlier, as going wherever the wind drove them – strongly suggesting their use of sail (Haywood 2006:104).

Keel Before Sail...?

The presence of a fully evolved keel has long been stated as a prerequisite for a vessel of the Nordic type to be able to sail (Haasum 1989:12; McGrail 2001:211). Apart from providing important longitudinal strength its depth provides leeway resistance so that the force induced by the wind in a sail propels the boat forwards and not sideways. Current hypotheses seem to suggest that the keel came first, and only once this was fully developed could boats begin to be sailed. One could of course argue about what exactly is a fully developed keel as some authors are of the opinion that the T-shaped keel of Nydam 3, dated to the AD 290s (see table 1) is the first fully evolved keel in the North (Haywood 2006:95; Åkerlund 1963:98). In respect of this it is also worth taking note of the aforementioned sail trials in a half scale reconstruction of the Sutton Hoo vessel (Gifford & Gifford 1996, 2004). These trials show, without a doubt, that a keel is not a prerequisite for sailing and that the shape of the hull in itself can have a similar function to that of a keel. The critique that half-scale models do not take into account the effect a reduction in scale have on, for example, the longitudinal strength of a hull (Coates 1997:148; McGrail 1997:314—315, 2001:212), was in this case largely compensated for by an increase in the distance between the internal frames (Gifford & Gifford 2004:68, 70). The trials also show that a vessel can be very seaworthy and be able to sail without a prominent freeboard. In all, the Giffords have proven the importance of carrying out sail trials in reconstructions rather than making assumptions based on drawings and calculations alone. This in turn questions the validity of the very foundation of current mainstream hypotheses regarding the introduction of the sail in the North, namely the prerequisite of a fully evolved keel.

If a prominent keel is not essential for sailing, it is more likely that such a feature evolved as a result of vessels being sailed. The comment regarding the Kvalsund 2 vessel, that it shows “*an adaptation towards sailing*” (Rieck & Crumlin-Pedersen 1988:139), illustrates just how ludicrous previous assumptions regarding the keel have been, as it begs the question as to why there should be an adaptation towards something that was not used. This however, will be discussed more in detail in Chapter 6.

How to Detect Mast and Sail...?

Another, more obvious prerequisite for sailing is the presence of a mast step, secured with shrouds and stays. Unfortunately, these are remains that seldom survive in archaeological material. All the rigging details on, for example, the Oseberg vessel were organic which in a burial site with less favourable preservation conditions might have disappeared altogether. A telling example of the consequences of this is the Ladby ship, dated to the mid tenth century and found in a grave in Denmark (Sørensen A 1999; Thorvildsen 1975). This ship was interpreted as a sailing vessel solely on account of four heavy iron rings that were positioned on each side of the boat along the gunwales close to the middle of the boat, the only explanation for which was that they were used as shroud rings for the support of a rig (Thorvildsen 1975:22). Other reasons why these remains elude us is because masts and rig might have been reclaimed to be used on other vessels when the boat we find in the archaeological context was abandoned or sacrificed. The Skuldelev boats, for instance, which like the Ladby ship were discovered in Denmark, were found stripped of their masts and rigs, indicating that when a boat was discarded, this equipment was thought worth reclaiming to be used again (pers. Communic. Max Winner 2005). Given the fact that only two boat finds pre-date the AD 820 Oseberg ship, the Hjortspring and the Nydam boats, the chances of finding traces of a rig on archaeological boat finds are infinitely small. In addition to this should be added the uncertainty as to what type of traces such a wear would leave behind, and in which particular parts of the boats one could expect to find them, given our lack of knowledge about these early forms of rigs. In this respect, it is clear that the 'minimal solution' concept as advocated by Sean McGrail (1994:283) for interpreting archaeological boat material, and, in particular the early vessels pre-dating the Viking Era, presents problems.

Discussion

As the above accounts imply, there is enough circumstantial evidence at hand to question current hypotheses as to how and when the sail first appeared in the North. The hypothesis regarding the development of the sail in Scandinavia as proposed by Westerdahl (1995) is certainly interesting but will automatically lead to further questions such as how and why the knowledge and skill involved in sailing 'appeared' so suddenly in the 8th century. Who adapted the boats and the rigs to the bigger boats, and how quick was this process, especially given the linguistic evidence suggesting an internal development of the sail in the North? When would the inevitable experimentation that would have been required for such a development have occurred – in the spare time of the able men when the use of oars were not required? If, as Westerdahl suggests, the sail developed independently in Scandinavia in the same way as the Nordic hull is believed to have evolved independently, with no or little influence from outside, would it not be plausible that the mast and rig, as well as the knowledge and skill of using it, would have taken as long to develop as the hulls they were rigged onto? Sailing is a skill, and in order to sail a boat you would need to have profound knowledge of that boat, its balance, its behaviour under different types of sea, wind and weather, and sail it accordingly – something which is even more important when travelling across unknown waters and beyond the horizon with no land in sight, which the Vikings habitually did.

Therefore, whereas a certain set of socio-economic reasons might lie behind the sudden expansion of the Vikings, is it not more likely that the sail, which made this expansion possible, developed well before this period? Is it not far more plausible that the knowledge and skill needed to sail, evolved through the experimentation in smaller vessels where the effects of the wind would have been much more immediate and on which the pressures induced by a rig would have been much smaller, and that such rigs evolved in sheltered waters for everyday tasks, like catching the early breeze to go out fishing and catching the evening breeze to go home?

An obvious problem for answering these questions is the lack of archaeological boat remains pre-dating the Viking Era but also the 'minimal solution' approach in the interpretation of such remains. This 'minimal solution' approach advocates very stringent standards for the documentation and description of boat finds to a level where other solutions might "*theoretically be possible but would involve more conjecture*" (McGrail 1994:283), the aim being the avoidance of too imaginative and possibly unrealistic interpretations (Crumlin-Pedersen 2003a:217). This approach does not for example take into account the possible bending or stretching of building material during the boatbuilding process, something which several authors have claimed they have found evidence for — as for example in planks from Ferriby 1 in the British isles (Wright 1994:31—32) and for the Slusegård boat graves in Scandinavia (Crumlin-Pedersen 1991:177—182; 2001:31—34). Perhaps the best example to illustrate this problem is the radical difference between McGrail's 'minimal solution' interpretation of Brigg 2 with a box shaped flat hull and short, almost vertical sides, in comparison to the round hulled vessel proposed by the interpretation of Roberts (figure 42) (McGrail 1981, 2001:187—188; Roberts 1992, 1995). The main difference between the two interpretations is that Roberts has considered the slight tapering of the bottom planks towards the ends of the vessel and the possibility that the original stitching here would have loosened after the vessel sunk and was flattened out

(Crumlin-Pedersen 2003a:217). The end result of the two lines of interpretations are two fundamentally different vessels.

Another example concern to the 1780 BC Ferriby 1, one of the earliest sown plank built vessels in Britain (Wright et al. 2001), where questions have arisen as to whether it represents the remains of a two- or three-straked vessel and whether its hull was rockered or not (Coates 2004:25, 2005a:39, 41—42, 2005b:526; Crumlin-Pedersen 2003a:214; McGrail 2007:255—256; Wright 1985). Both options were presented by Wright (1990:90, figure 5.17, 1994), who was in charge of the excavations, but in his final assessment he concluded that the boat must have had a curved or 'rockered' profile. However, it is mainly the first, the two-straked version with a flat bottom that has since become accepted in mainstream publications as the *"minimum reconstruction compatible with the excavated remains"* (McGrail 2001:186), along with the comment that it is unclear whether the rockered keel on the second "*radically different reconstruction*".. … "*may be an unnecessary embellishment*" (ibid.) or not.

The main problem however arises when, as Crumlin-Pedersen (2003a:217) so aptly puts it, "*a minimal solution is presented as the scholarly, responsible answer to the question of the original appearance of the vessel rather than as one out of two or more alternatives that should be analysed in parallel*". The very same argument applies to far too stringent interpretations of sailing vessels, which are based solely on the fact that the vessels found so far in the North show no signs of having carried sails and that therefore the use of sail cannot be presumed. The truth is that the boat record is far too limited to enable any

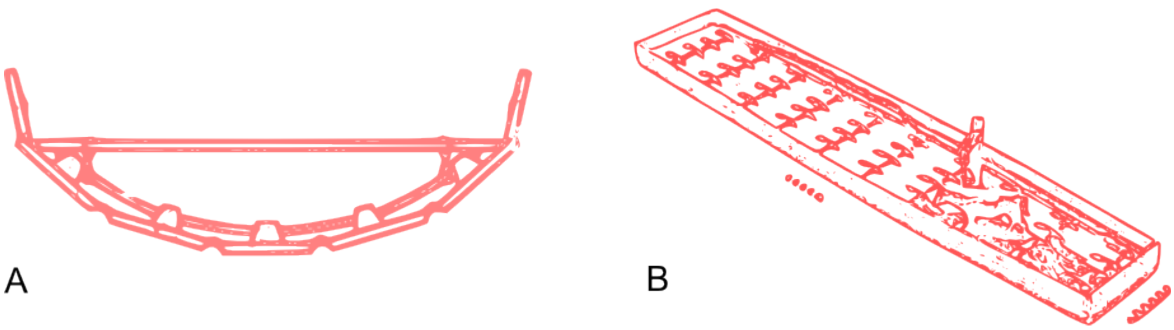


Figure 42. Brigg 2 or Brigg 'raft' is a c. 800 BC plank built vessel found on a former tidal creek of the Humble river on the British Isles (after McGrail 1987:127, 2001:187, 2007:254). A) Robets' interpretation of the Brig 'raft' as a round bilge boat (after Roberts 1992) B) The official interpretation of Brig 'raft' (after McGrail 2001:188).

conclusive remarks on this issue and that it might not even be representative of the boats used, limited as it is to Nydam 2 and Hjortspring, which, although uniquely preserved, have been very mishandled by distortion and different conservation methods that even if we knew what types of rigs might have been used and the kind of wear this would have caused, might be lost forever.

In addition, there is of course the possibility that the same type of vessel could have had many different functions. Hence, just as the Cheops boat (see Chapter 3) might not have been equipped with sail due to its function as a royal barge, the early rowed processional vessels on the Gotlandic Picture stones might reflect merely one function out of many. A similarly bean shaped boat to those on these early Gotlandic picture stones, and which is undoubtedly furnished with a mast, exists within the Scandinavian rock art material (see figure 59B, Chapter 5) (Sognnes 2001:51) and provides clear evidence of such a possibility. The same problem has been discussed by Dahlgren in relation to the boats on the Novilara stele, referred to in Chapter 5. Therefore, when it comes to the interpretation of prehistoric vessels, more than one interpretation must be allowed for, and the potential use as a sailing vessel be taken into account. A further example comes with the aforementioned Ferriby 1 boat, which has two sets of 'saddle-features' (Gifford et al. 2006:61), one amidships and one forward, the purpose of which might have been for the support of a mast. Without any other supporting evidence for use of sail during the period, and probably because the sail trials were carried out in a half-scale reconstruction, these trials have never been published in full. This problem will be discussed again in Chapter 6.

I am turning now to the Bronze Age and the rock art boat imagery of southern Scandinavia to see what new inputs these might add to the question of the sail in the North.

5. Rock Art Boats and the Sail

New Interpretation of Evidence

Although there are no actual boat finds in the North dating to the Bronze Age, there is certainly no lack of iconographic material of boats dated to this period. The total number of boat images is hard to appreciate but in Bohuslän on the Swedish west coast alone, the richest rock carving area in Scandinavia, there are more than 10,000 boat images (Hygen & Bengtsson 2000:92). The artistic quality of these boat carvings varies immensely and will be discussed in more detail below. For now, it is sufficient to say that whereas the majority of these boat carvings are extremely stylistic or fragmented, and therefore tell us very little about contemporary seafaring activities, there is enough material across the region to allow for more detailed analysis of, for example, possible means of propulsion, and in particular, the use of the sail.

What little is known about Bronze Age boats in southern Scandinavia comes, apart from rock art depictions and to a certain extent ship-settings, from the remains of the Hjortspring boat described in previous chapter: trials with a reconstruction of this boat show that double steering oars, attached at the bow and stern, would have been fundamental for handling these types of boats under any types of conditions other than periods of calm (Vinner 2003:104—106). This would apply regardless of whether paddled, oared or indeed sailed.

The intention of this chapter is to:

- Provide a review of past research into the boat imagery with what can be interpreted as masts and/or sails
- Evaluate the problems of documentation and interpretation of the rock art in question
- Re-examine the present rock art imagery in order to detect the use of sail

- Compare the frequency of boat depictions indicating the use of sail with those depicting other methods of propulsion such as paddling or rowing, as well as the fundamental use of steering oars,
- Evaluate possible reasons for any variation in such frequencies, taking into account aspects of time and location,
- Establish a tentative chronology for the types of rig and other means for propulsion available in the southern Scandinavian rock art.

Past Research

I am not the first to propose that the sail was known and possibly used in Scandinavia as early as in the Bronze Age. The presence of what appear to depict mast and sails on rock art boats have been pointed out by many scholars in the past (pers. Communic. Staffan von Arbin, 2008; Artursson 1987; pers. Communic. Lasse Bengtsson, 2005; pers. Communic. Ulf Bertilsson 2005; Bugge 1923:29; Burenhult 1973a:157; Coll 1901, 1902; Dahlgren 1932; Eskeröd 1970:207; Fett & Fett 1941; Fors 1993; Halldin 1952:66; Humbla & von

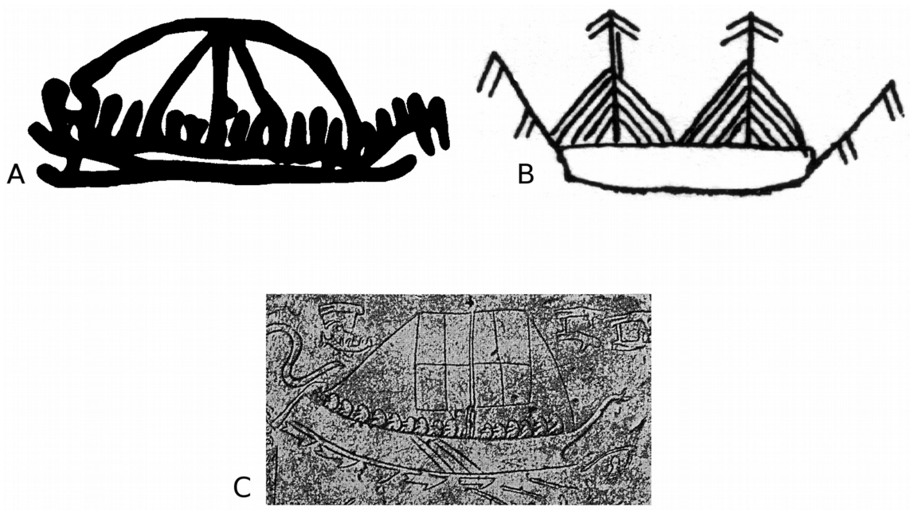


Figure 43. A) Rock carving from Järrestad-13 in Scania, southern Sweden (after Burenhult 1973a), B) Detail of boat engraved onto an ornamental belt in bronze found in Scania and dated to Montelius period VI (Althin 1945:79, Abb. 36 after Montelius 1917, Abb. 1475), C) Detail of a sailed vessel on the 7th century BC Novilara Stele from northern Italy (after Althin 1945:55, Abb. 20)

Post 1937:72—73; Malmer 1981:51, 53; Nordenborg Myhre 2004:230; Rausing 1994:71, 78; Sognnes 2001; Stöltig 1996:32, 1999:273).

Despite this, past research into rock art renderings of boats with mast or sail-like attributes has been scarce. In several cases it is limited to the expression of a mere possibility in relation to an isolated find, with few or any references to carvings in other regions. Such has been the case in, for example, Eva and Per Fett's (1941) study of the rock carvings in south-western Norway, or Sognnes' (2001) more recent study on the rock art at Trøndelag, also in Norway, in both cases of which boats with masts or sails were identified. However, Sognnes does go as far as to raise doubts about the current view of the history of the sail in Scandinavia (2001:53).

Another prominent rock art researcher, C.-A. Althin (1945:55), also commented upon the presence of boats with masts when recording and studying rock art material in Scania, southern Sweden, at a site called Järrestad (Järrestad-13) (figure 43A). Drawing on what he considered to be a similarity between some of the boats here and the contemporary boat depictions on the Noviliara Stele from northern Italy (figure 43C), he argued that the former must be copies of contemporary boat depictions originating from the Mediterranean region. A similar origin was suggested of an engraving on a belt buckle in bronze, also found in Scania, depicting what could be interpreted as a boat with two stayed masts (figure 43B). In Althin's opinion such imagery could have reached Scandinavia on portable objects such as textiles or pottery.

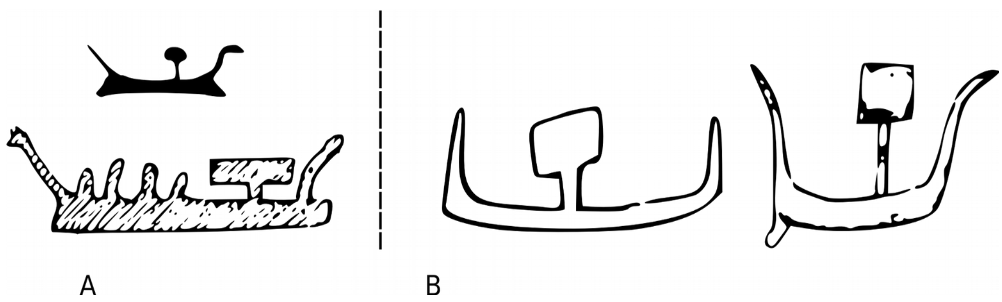


Figure 44. A – two rock art boats from Himmelstalund, Ö. Eneby-1, by Dahlgren (1932:47, pl 7) identified as having possible masts (after Nordén 1925:50, fig. 39, 291-Pl LI). B – two early boat depictions from the Gotlandic Picture stones, currently dated to approximately the between the 6th and 8th century AD (after Nylén & Lamm 2003).

Some years earlier, J. Dahlgren (1932), attempted a wider analysis of what he referred to as the 'primitive ships' in the rock art, offering comparisons with early boat imagery from Bretagne as well as the Mediterranean region. He was of the opinion that the majority of rock art boats in Scandinavia were depictions of vessels with a high freeboard, thus suitable for sailing, and managed to identify two boat depictions as stylistic representations of sailed vessels carrying small and low sails (figure 44A). In his view such small sails would have been the norm in which to depict sails at this time (also reflected in the early Gotlandic picture stones shown in figure 44B), but claimed that even without the presence of sail, the hull shapes in combination with the impressive size of many of the rock art boats, should be taken as enough evidence that these types of vessels could have been sailed (Dahlgren 1932:46). The hypothesis however, was based on only two boat depictions, both recorded by the same documenter and located at the same site, and never received any wider recognition.

Dahlberg was followed by another early researcher into the technical aspects behind many of the boats depicted in the rock art, Gustaf Halldin (1949, 1950, 1952). In addition to examining rock art boats in relation to contemporary foreign boat depictions, he went a

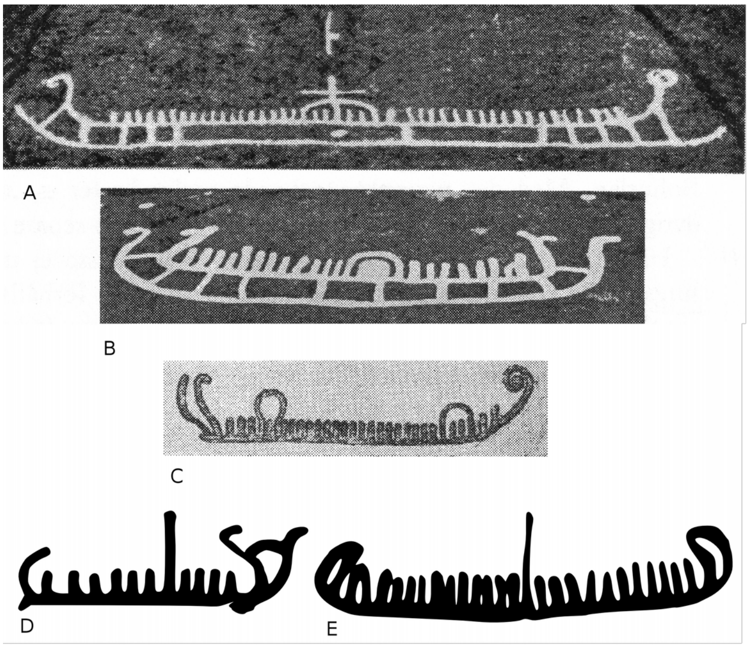


Figure 45. Some of the imagery analysed by Halldin (1952:75,77). A – Haugene, Sandeherred, Norway (Coll 1901:45). B – Solberg övre, Skjebergs parish, Norway (Gjessing 1939, pl. XXII). C – Kville, Kville parish, Sweden (Baltzer 1881—1908:II, 22:1) D – Vese Bro, Brastad parish, Sweden (Baltzer1881—1908 :I, 14, 15:1). E – Möckleryd, Torshamn parish. Sweden (Anderbjörk 1943:98; Burenhult 1973a).

step further incorporating a much more thorough analysis of the then available rock art material in southern Scandinavia and the past interpretations, including those of the Fetts' mentioned above and even earlier research by Coll (1901, 1902).

Halldin (1952:73, 76) concluded that details of masts and sails were no doubt present in several rock art images across the region, using boat depictions at Vese Bro (Brastad-1) in Bohuslän and Möckleryd (Torhamn-11) in Blekinge (D and E in figure 45), but also imagery at the earlier mentioned Järrestad-13 site (see e.g. figure 43A), as examples. Furthermore, Halldin agreed with Coll (1901, 1902) that symbols such as those seen midships on boats A and B in figure 45 might be interpreted as sails, possibly depicted at an angle of 90 degrees to show the sail properly. However, the arched symbols as seen on boat C, were also suggested by Coll to be depictions of sails, whereas by Halldin they were regarded as too ambiguous for such a firm categorisation, mainly on account of similar figures by Almgren (1927:19) having been interpreted as horn blowers. A similar approach was taken to the mushroom shaped symbols seen on boat imagery on bronze razors that some researchers had also labelled as sails (figure 46).

In all, Halldin identified nine rock art boat depictions, four of which he argued carried masts, whereas the remaining five were interpreted as clear depictions of sailing vessels. Importantly, he pointed to the fact that several contemporary Scandinavian ship-settings incorporate details that can be interpreted as a mast stone or even a bipod mast – with a single raised stone in its centre, or two larger stones, raised at the centre of each of the sides of some ship-settings (Eskeröd 1970; Halldin 1950, fig 114, 126, 1952:73; Rausing 1984). In comparison to previous research, Halldin offered much broader material to

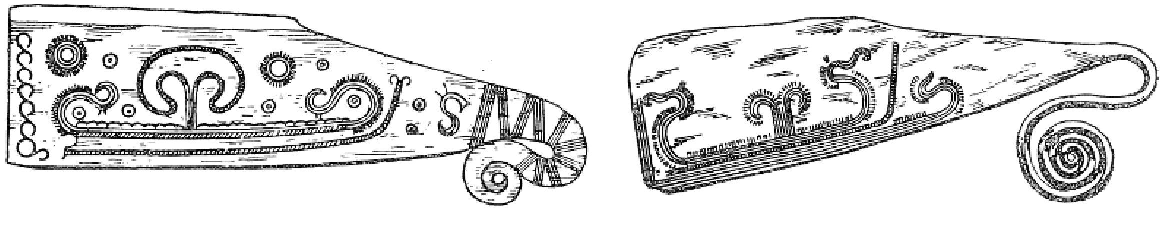


Figure 46. Two bronze razors depicting boats with mushroom shaped symbols (after Madsen 1872, pl. 24:15 and 24:14 respectively). Past interpretations, apart from sails, include axes or symbols of heaven (see e.g. Kaul 1998b:28; Malmer 1971:191—192).

suggest an early introduction of the sail, relying not only on the indications of masts and sails in Bronze Age rock art located in south-western Norway and along the south and west coasts of Sweden, but also on such indications in the contemporary ship-settings. In his view, the only explanation for these occurrences must be that knowledge about the sail existed at the time and suggested, like Dahlgren (1932:76), the use of primitive rigs for long voyages in fair conditions. In view of Halldin's research, Eskeröd in his 1970 overview of the history of the Scandinavian boat, considered it very likely that the sail was in use already in the Bronze Age (Eskeröd 1970:207—208).

In the early 1970s Göran Burenhult (1973a, 1973b) came across the boat imagery while carrying out his vast documentation work on the rock carvings of southern Sweden, identifying no less than 38 boats with masts (Burenhult 1973a:157, 1980:55, 59, table 14). His line of reasoning was simply that in the absence of any other known function, a vertical pole positioned centrally in a boat would normally symbolise a mast for carrying a sail (Burenhult 1973a:157). He commented on the unusually high concentration of masts found in Blekinge, 11 in total, 10 being at the earlier mentioned Möckleryd site. Outside his own recording areas, Burenhult identified the Vese Bro boat depiction earlier mentioned as mast bearing, seemingly independent of Halldin (figure 45D). He also suggested that two other then newly discovered boat depictions at Aspeberget in Tanum, Bohuslän, carried 'stirrup shaped sails with booms' (figure 47). Unlike Halldin, Burenhult never entered into any discussion as to the technical aspects of these rigs (Burenhult 1973a:160, fig. 6).

In order to explain the existence of the masts Burenhult suggested the following three options; a) that the art of sailing was known considerably earlier than normally accepted, b) that the carvings themselves were of a later date than normally accepted, and the final and then in his eyes most likely explanation c) that they represented copies of Mediterranean originals (Burenhult 1973a:159).

Following Burenhult's documentation of the rock art, archaeology students began to take notice of the boat and mast imagery resulting in several Bachelors' dissertations (see e.g. Artursson 1987; Fors 1993). Of these, in particular that of Artursson (1987) is interesting as he focused on aspects such as lay out and carving quality of the rock art imagery itself. Thus in addition to trying to establish whether a mast appeared to have been carved in a different technique in comparison to the image as a whole etc., he included very stringent prerequisites for an acceptable tilt of a mast or a yard, and for the comparative length of the mast in relation to so called 'crew-strokes', while excluding any depictions where any form of ambiguity might exist due to superpositions (Artursson 1987:21—26). Focusing primarily on Burenhult's documentation material, he agreed that 14 rock art depictions could be interpreted as sailed vessels, six of which in his view with all probability were representations of sailing vessels (Artursson 1987:50).

Also Siegfried Stöltig (1996) has taken note of Burenhult's documentation material of the masts and from there has proceeded to re-examine the individual depictions while adding a previously unnoticed rock art image from Fredsjö's documentation work in Svenneby parish in Bohuslän. In his view, a more thorough analysis of the majority of the imagery identified not only by himself but also by others such as Burenhult and Halldin, proves that they might indeed represent masts (Stöltig 1996:33).

Figure 47. A more recent rubbing of the two boats carvings by Burenhult identified as having 'stirrup shaped sails and booms' (RockCare 2000).

Discussion

It is clear that the rock art boat imagery incorporating details of masts and sails has long been known. The reasons for their existence however, have been very controversial and have to some degree been summed up by Burenhult above. While Burenhult agrees that the details on the rock art boats he has recorded must be masts, he initially chose to adhere to Althin's view that the material must be copies of contemporary imagery that reached these shores on portable objects, a view that has been echoed by another prominent rock art researcher, Mats Malmer (1971:192) and possibly coloured the view of more recent rock art researchers as a corpus.

Interestingly, Burenhult (2001:63) has later changed his view, claiming that the knowledge about sailing must have existed here at the time these types of carvings were made. Malmer, has also reconsidered his initial statement. He suggests instead that any similarities between Scandinavian and Mediterranean boat imagery might not exist because the former were downright copied, but instead might reflect an influence from the Mediterranean region "*stemming from a shared intellectual, cultural and social sphere in which boats and trade were central concepts*" (Malmer 1999:40—41). Thus, he hints at a much more sophisticated reason for their existence where one could perhaps even expect direct interaction between the two spheres.

Returning to the second reason for the existence of masts mentioned by Burenhult, namely that they might be of a later date than generally considered for the southern Scandinavian rock art, this has generally been ruled out by many recent rock art researchers (see e.g. Sognnes 2001). The dating of rock art has focused on the boat imagery, mainly because of its frequency in rock art as well as on bronzes throughout the Bronze Age, with several chronological boat classification systems being developed as a result (Glob 1969; Kaul 1995, 1998; Ling 2005; Malmer 1981; Rostholm 1972; Sognnes 2001). Therefore it is apparent that details such as masts appear not only on different regional types of boat carvings, but also that the imagery in time is likely to span almost a thousand years (Artursson 1987:50—51; Bengtsson B 2003:47; Stöltig 1996:35).

Even if it transpired that in some instances masts and/or sails had been added to an early or mid Bronze Age rock carving in, say the late Bronze Age, one still has to ask why? That it indicates the use of sail is of course a possibility. Thus, where such details appear to have been added in a different carving technique, this is not enough to withhold any of its possible significance. In some instances runic inscriptions have been found in connection to rock art panels, possibly dating to between AD 200–500 (Nilsson P 2010:164), whereas most 'graffiti' that has been discovered among the Scandinavian rock art mainly constitute 19th or 20th century names, dates or comical caricatures carved with metal tools (see e.g. Tanum-600 and Tanum-283 in Milstreu & Prøhl 1999:107, 110).

This leads to the first possible explanation outlined by Burenhult: that the art of sailing was known at the time the rock art was made. Dahlgren (1932:45), despite working from a meagre two images, both of which Burenhult interprets rather differently (figure 48), cleverly used the Novialara Stele as a parallel to his argument. Of the five boats depicted on this Stele only one carries mast and sail (figure 43C), but, as there is no difference in the shape of any of the hulls, Dahlgren concluded that the absence of mast or sail on four of the boats cannot be taken as an indication that these vessels could not also have been sailed. Such an argument in relation to the Nordic rock art, would naturally pre-suppose a technical ability to build and use a sailing vessel during this time in the first place. Halldin

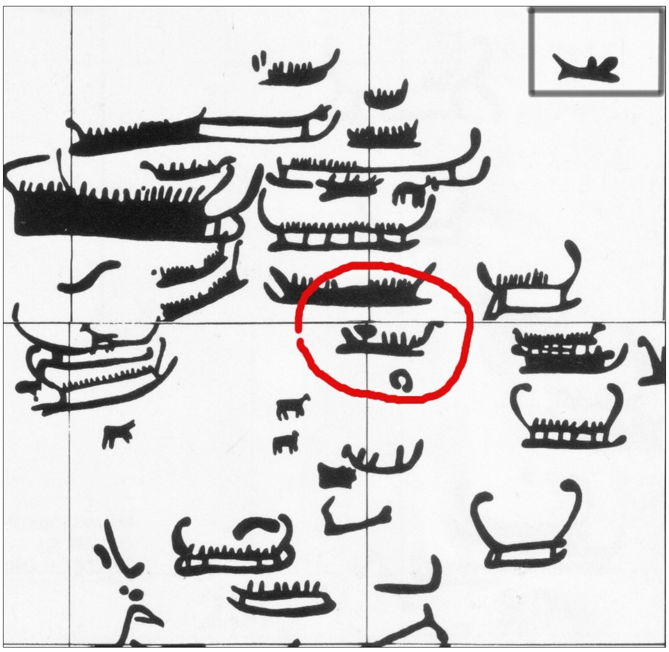


Figure 48. Nordén's two mast bearing rock art boats as interpreted by Burnehult (1973b). The vessel in the main frame could still be interpreted as some form of sail (Burenhult 1973b:113), whereas the 'sail' on the other boat - inset in the right hand corner (Burenhult 1973b:109) – is impossible to interpret. Each square equals 1x1m.

(1952:76) whose material was far more convincing reasoned that although the imagery in question was scarce, so was any imagery of boats being paddled or steered, and therefore there must be other reasons why such details were so rarely included in the rock art.

As for the technical ability to build and use sailing vessels during the Scandinavian Bronze Age, several scholars believe, based on what appears to be boats with masts and sail in the rock art, that this might have been in place (Bengtsson & Bengtsson 2007, 2011; Rausing 1984; Stöltig 1996:35). Gad Rausing (1984:71,79) for example, in his *Prehistoric Boats and Ships of North Western Europe,* sees the rock art imagery as clear evidence that the design principle employed in both the Hjortspring and the Nydam vessels must ultimately have derived from sailing vessels of the Bronze Age (during which time he assumed that two types of vessels existed – the paddled war canoe and the sailed merchantman).

Documentation of Rock Art

Before proceeding with a re-evaluation of the rock art imagery discussed here, we need to consider the various recording methods that have been used and how these might have affected their interpretation. This is evident not least by the above example of Dahlgren's interpretation of two possible mast bearing boats at the Himmelstalund rock art site based on documentation work by Nordén.

Early documentation work was made in daylight through direct field measurements, which, in combination with weathering, explains why such work can sometimes vary considerably from later documentation work. Baltzer (1881–1908) for example, when working in Bohuslän, would simply trace the outline of the rock art figures he could detect with chalk, create a square system around them, place a chair and a drawing board above them and proceed to draw them in. Despite this seemingly simple set up, his work is considered to be surprisingly accurate, at least where he has managed to discover the imagery in question (pers. Communic. Lasse Bengtsson, 2005; Milstreau & Prøhl 1999:11).

The same technique was used by Nordén (1925:7—8) in Östergötland with less satisfying results. Nordén admitted as much himself and actually went back to his source material to acquire striking off samples of particularly interesting or complicated images (see e.g. figure 44A) – a technique he was not entirely satisfied with either as it proved very inconsistent. In fact, Nordén's work has been shown to vary considerably compared with for example that of Burenhult, which has cast doubts on its scientific value (compare figure 44A with figure 48) (Burenhult 1973c:1—2). Thus, in addition to being regarded as far too subjective for being of scientific value, the direct field method in general has been criticized for not providing an exact location of individual rock art figures in relation to each other nor an understanding of the nature of the rock art face upon which it is carved (ibid.).

In the 1930s and 40s the tracing method took over as the preferred documentation method. Here tracing paper is used to identify and record the rock art, which is then transferred to graph paper – a process often aided by the use of a raking light (at night). This method was used, for example, by Gjessing (1939) and Fett & Fett (1941) in Norway and by Althin (1945) in Sweden. Another pioneer of this method was Åke Fredsjö, whose work in Bohuslän to this day remains an incredibly important and detailed source of information for rock art research (Nordbladh & Rosvall 1971, 1975, 1981). Fredsjö would painstakingly record exactly which lines were carved, which incorporated natural ice furrows, whether a line was deep or faint and where the rock face had been weathered etc. (figure 49). Also Fett & Fett's (1941) documentation work appears to have withstood time in comparison to more recent work (Høgestøl et al. 1999:21). Tracing can be said to be a first step towards a more 'objective' method for the study of rock art, but the technique does

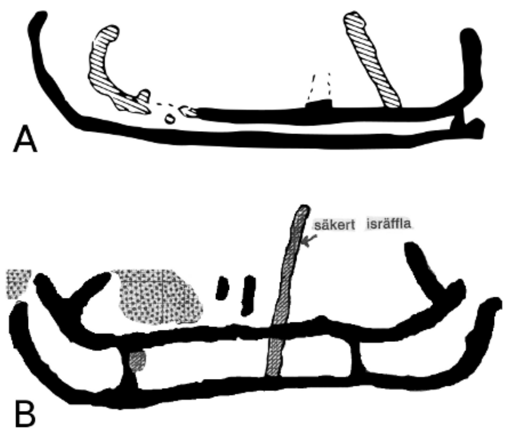


Figure 49. Two rock carved boats from Bohuslän recorded by Åke Fredsjö. A) Kville-170, where a possible mast and the forward gunwale are less clearly carved (after Nordbladh & Rosvall 1971), B) Svenneby-39, where a natural ice furrow forms part of the composition and which could possibly be interpreted as a mast (after Nordbladh & Rosvall 1971).

not allow the more faintly carved or severely weathered imagery to be detected (Burenhult 1973b:2).

A further step towards anything close to 'objectivity' came with Burenhult (1973b), and the application of a method originally developed by professor Emanuel Anati (1977) in Italy. Following careful cleaning, the panel is painted in with a water-soluble white paint. The panel is then wiped with a damp but firm sponge, leaving the white paint in cracks and carved areas alike, thus revealing even the faintest of carvings. The carvings are then covered by large transparent plastic sheets and traced in full scale whereupon the sheets are cut up in squares of one square meter and photographed. Thereafter, the imagery on the plastic sheets is simply projected onto the corresponding negatives and a prepared square system in scale 1:10 (Burenhult 1973c:2—3). A main critique of Burenhult's work concerns the small scale in which he has published his documentation work which makes some of his figures appear rather crude (compare for example figure 50A and B).

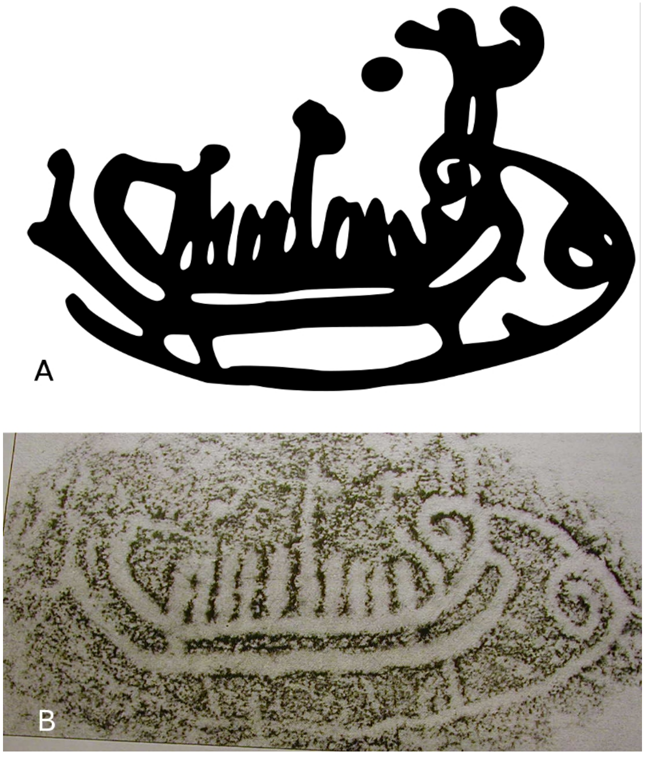


Figure 50. A) Boat with possible mast from the Lösen-26 site in Blekinge (after Göran Burenhult 1973b), B) The same boat as recorded (and published) by Siegfried Stöltig (1996).

Today however, the rubbing method has become the dominant and world wide accepted recording tool (Milstrau & Prøhl 1999). Here the cleaned rock panel is covered in sheets of paper that are carefully rubbed using a tightly rolled linen towel or similar lined with carbon paper, thus revealing an imprint of the rock surface below. Like Burenhult's method described above, the technique allows for even the faintest of carved lines to be detected, but the main difference lies in the fact that the rubbing provides the imprint of the rock surface as well as the rock art, which can be scanned and preserved for future reference. In this way, the rubbing provides an 'objective' documentation, which, in turn, can be studied and interpreted (painted in) by the individual researcher, often in combination with night photography and raking light (Milstreu & Prøhl 1999:24—25). For the purpose of publishing the interpretations, two methods are used; the technique of copying the painted rock art onto an overlaying plastic sheet as described above, or by simply photographing the panel once it has been painted and transferring it digitally into a black and white image (Bengtsson 2002:4).

Various forms of 3D-documentation, including laser and light scanning and photogrammetry (see e.g. Johnasson & Magnusson 2004; Reitz 2012) have been experimented with in recent years and have the advantage of creating a sense of the location and topography of the rock art panels as well as providing carving depths of individual imagery. However, due to costs and bulkiness of equipment, these methods have so far only been used on specific panels and individual motives. An example is provided in figure 54.

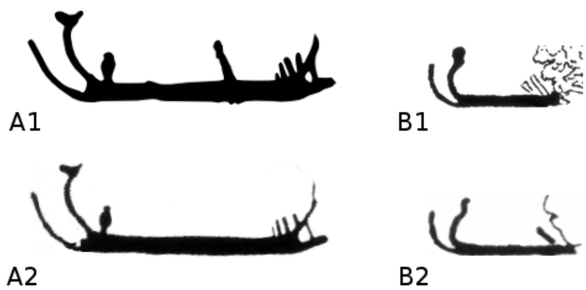


Figure 51. Boats A and B from Tanum-262 in Bohuslän, Sweden. A1 and B1) as interpreted by Milstreu & Prøhl (1999:85—87), where boat A has a mast like device midship whereas a similar device on boat B, just before it is damaged by weathering is merely marked as indeterminable. A2 and B2) The same boats as interpreted by Torsten Högberg (unpublished, Vitlycke museum). Contrary to Milstreu and Prøhl's interpretation, boat A now has no device midship whereas boat B has one. In both examples a rubbing has been used as a basis for the interpretation.

Interpretation

What is clear with the study of rock art is that regardless of which method is used and however 'objective' this method might be, there will always be an element of interpretation involved. Hence, even where the same recording technique has been used, these might result in slightly different 'final' interpretations, at least where finer details are concerned. In figure 50 for example, Stöltig has chosen not to include the possible human-like figure in the bow of the boat in his rubbing of a boat at the Lösen-26 site in Blekinge, something that Burenhult's interpretation reveals. However, both the rubbing and Burenhult's interpretation reveal a possible mast at the centre of the boat (as well as a possible helmsman holding on to what one might interpret as a rudder!). In another example (figure 51), two boats from a site in Tanum have been interpreted independently with the use of

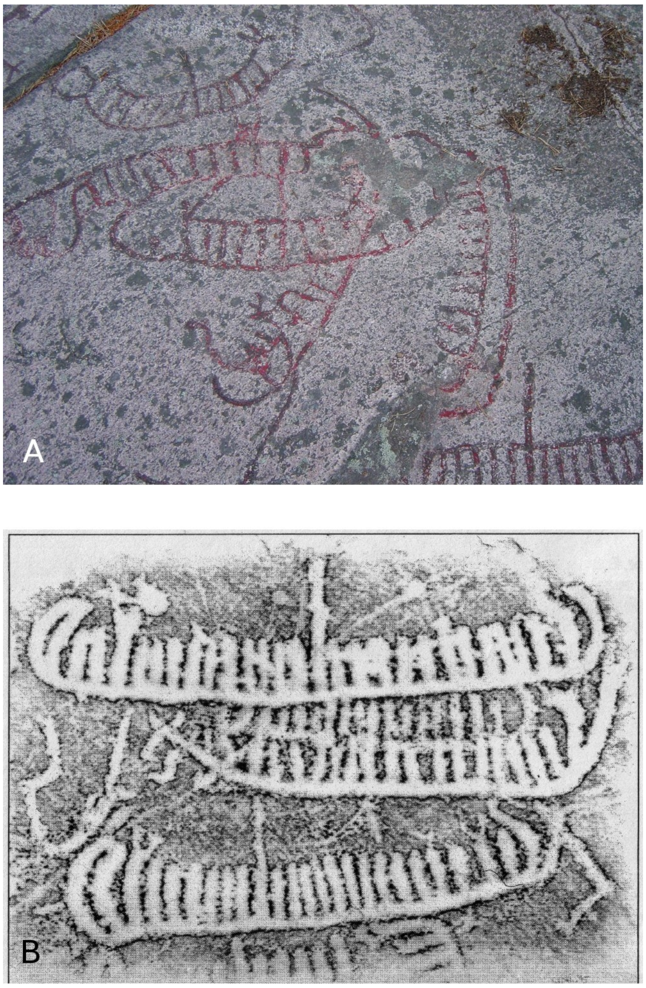


Figure 52. A) Photo of boats, seemingly carved on top of each other at random and of which three appear to carry masts. Torhamn-11, Blekinge, Sweden (Photo; author). B) Rubbing of four boats, two of which mast bearing, from the same site (Stöltig 1996).

the same rubbing technique and yet, the details at the centre of the boats are interpreted quite differently.

The judgement of what details should form part of an interpretation largely depends on past experience and a feel for when, for example, a natural furrow has been used to form part of a composition (as they appear to have been in both carvings in figure 49). Other aspects that might affect interpretation are superpositions, where images have been carved on top of each other, often randomly (figure 52), or the not unusual occurrence of imagery having been left unfinished (pers. Communic. Lars Bengtsson 2005). A good example of where it is quite obvious that a furrow line has intentionally been used in the creation of a boat carving is Himmelstalund-1 (figure 13).

Examples such as these are important to bear in mind when studying rock art. However, if enough interpreted material exhibits similar mast and sail-like characteristics, it raises legitimate questions about the received opinion that the sail was unknown in the Scandinavian Bronze Age. In light of the number of such images, we must ask whether these aspects can be mere coincidences or misinterpretations or whether they are intentional representations of specific attributes? If so the possibility that the sail was used as well as known must be taken seriously.

Introducing the 'New' Evidence

As the above overview of past research of rock art boat imagery with mast and/or sail in southern Scandinavian indicate, their interpretation is not always straightforward. With a first serious compilation and analysis by Halldin in the 1950s and the new material identified by Burenhult in the 1970s it gained the attention of Eskeröd (1970) and Rausing (1984). However, in mainstream academic debates on the origin of the sail in the North they have been ignored. This might stem from a combination of a lack of tangible archaeological evidence (see Chapter 4), leading to a current belief among maritime archaeologists that the sail appeared much later, and perhaps the fact that the masts have never been taken seriously by the rock art research community itself. Whether the latter stems from a general lack of understanding of boats and sail among rock art researchers is hard to know, but it is clear that rock art research as a field is both complex and to some extent isolated from other archaeological fields of research (see e.g. Hauptman-Wahlgren

2000:67; Nordenborg Myhre 2004:42). Consequently, whatever research has been done has so far been all too easy to disregard as too imaginative to be taken seriously.

The imagery presented below demonstrates the most convincing depictions of a) boats carrying sails, followed by b) boats furnished with masts and stays, c) masts and yards and finally d) single masts. Rock carvings from Sweden are named according to their number in the national sites and monuments records (FMIS), which is usually the name of the parish followed by a number. Norwegian and Danish sites are named according to whatever system was chosen in respective documentation material the particular image is collected from.

The Askum Sailing Boat

One of the earliest and most clearly depicted sailed vessels in the rock art is the Askum-44 carving from the parish of Askum in Bohuslän on the Swedish west coast (figure 53). This particular rock carving was first published in 1937 (Humbla & von Post), and later referred to by Halldin (1952:77), but has since remained absent from any debate on either rock art or the origin of the sail in the North. The reason for this is most certainly its removal from its original location in 1933, to what is now the state museum of Gothenburg. This would have ensured that it escaped the attention of later documentation work in the area – in fact, it was only 'rediscovered' when a firm specialising in advanced scanning technique did some testing on the slab where it lies in the storage room of the museum, as part of the Rane 2000 project (pers. Communic. Ulf Bertilsson, 2005). In 2005, the same firm kindly agreed to rescan the entire slab thus providing a second basis for interpretation in addition to a rubbing of the original (figure 54).

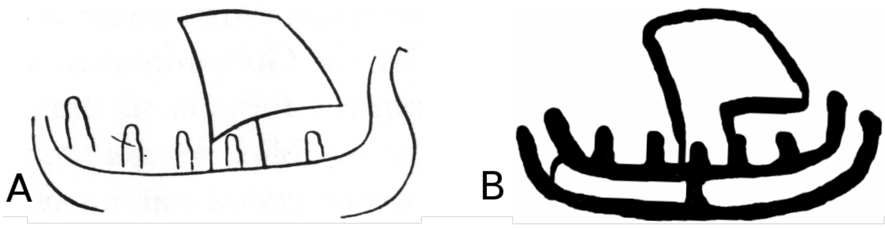


Figure 53. The Askum-44 boat. A) as interpreted by Humbla & Post (1937:71, fig 34), B) as interpreted by the author.

The boat carving is 345×200mm, and clearly cut in 15mm thick groves, the outline of the boat being slightly deeper cut than that of the sail. The sail is of a rectangular low aspect ratio shape, 140×100mm. As is fairly obvious to the eye, the more recent interpretation of the hull and the sail varies slightly from that of Humbla & von Post (1937:72), but the overall image of a boat with a square sail remains the same. As a carving, the image is quite unique for Scandinavia in that the sail appears so vivid – not as stylistic as we are used to see the boat renderings. Indeed, this vividness led Humbla & von Post to interpret the boat as sailing along by the wind on port, with the helmsman standing in the back, possibly holding on to the rudder. Although tempting, this is perhaps to stretch it a bit far.

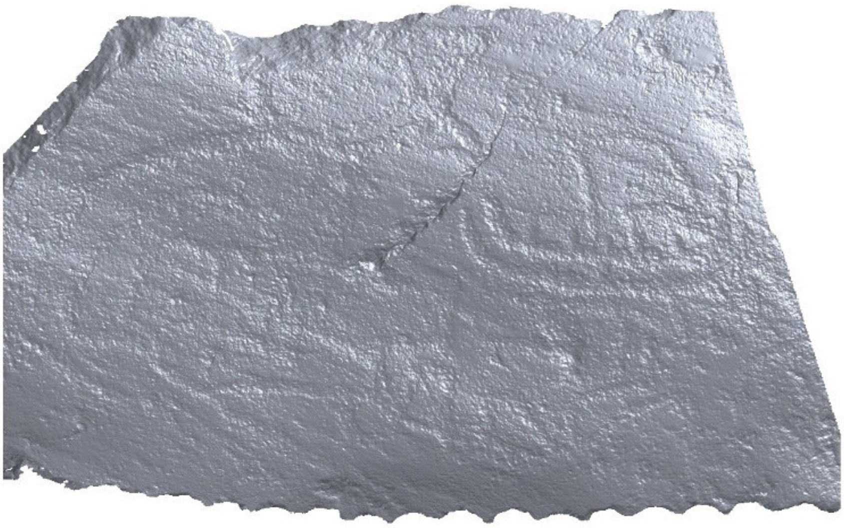


Figure 54. Two recordings of the entire Askum-44 slab made in the autumn of 2005. Top picture – a scanned version made by Metimur, Gothenburg. Bottom picture – a rubbing made by the author. The boat is 345mm long and 200mm high, sail included.

Another unique aspect of this carving is the animal, possibly an elk, located to the left of the sailed vessel which invites a comparison with the Karlby pebble mentioned in Chapter 4, which has a depiction of a sailing vessel on one side and an elk on the other. Humbla & von Post (ibid) place this boat in the early Iron Age, primarily based on their interpretation of the hull shape and because it appears "*less primitive"..."and therefore more easy to understand*", than other rock art boat images. The more recent interpretation however, shows that the hull is of a typical Bronze Age type which in relation to for example Kaul's (1998:88) boat chronology would place it in Montelius' period III (1300–1100 BC).

The Sailing Boat at Himmelstalund

Another impressive boat rendering can be found at the site of Himmelstalund, Östra Eneby-1, in eastern Sweden, where it is carved onto a smooth rock face along with a rectangular figure, the positioning and shape of which gives the impression of a sail (figure 55) (Burenhult 1973b:104; Nordén 1925:53). The sail (220×140mm), is placed at the

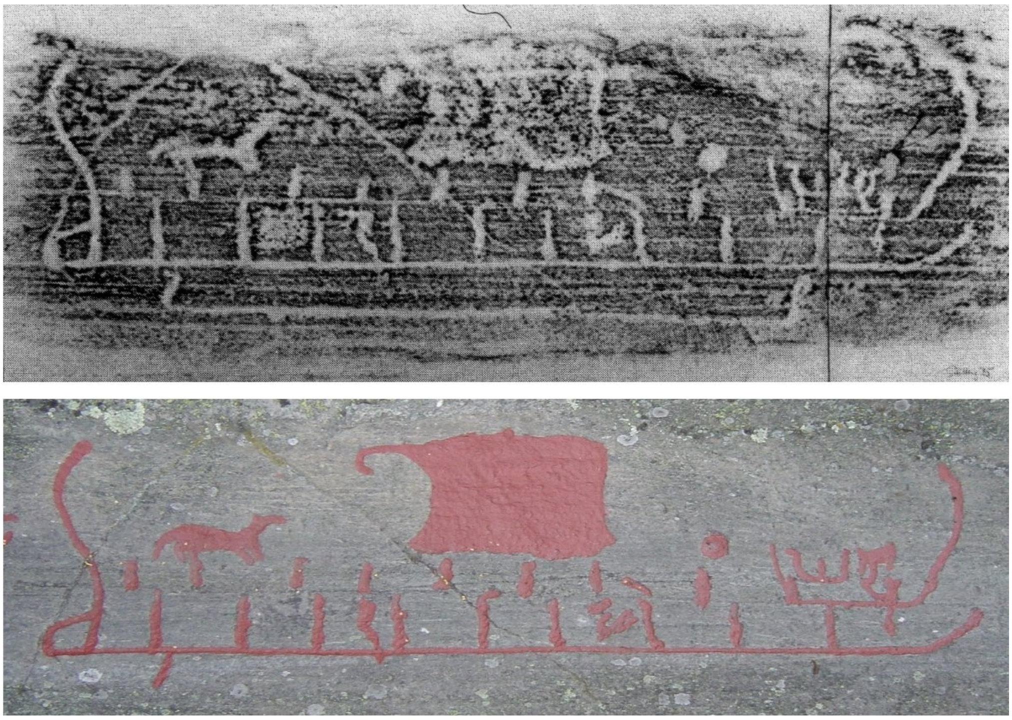


Figure 55. Top picture; rubbing of the sailing boat from Himmelstalund (after Stöltig 1996:31). Bottom picture; the Himmelstalund boat as it is interpreted on site (2005). Here the 'tap' at the top of the sail is visible. Photo: Boel Bengtsson.

centre of the boat precisely where it would have been expected, and like the Askum-44 boat, appears to be filled by the wind. That the two components are to be viewed as a composition is further suggested by the fact that they appear to be carved with the same carving technique (Artursson 1987:35). Stöltig (1996:33) is also of the opinion that this must be a sailing vessel, despite the lack of a connecting line between the sail and the boat, something which in the past has been enough to abandon the possibility. In fact, Artursson (1987:35) argues that the small upward projection visible at the top of the sail in figure 55 is indicative of a mast.

However, regardless of whether this could be argued to represent a mast or not, the nature of the composition is enough to at least raise the possibility that this is a rock art boat under sail, with a low aspect ratio rig (the mast is about ¼ of the total length of the hull). As for a possible date, the slightly inwardly turned extensions of the hull in the bow and the stern, suggest this vessel belongs to the same period as the Askum-44 boat, i.e. Montelius' period III, in addition to which it shares its characteristics of a low aspect-ratio sail.

The Harvaland Pair of Sailing Boats

This interesting constellation of two boats (figure 56), half mirroring each other and to a certain extent sharing parts of the hulls, might possibly be interpreted as rowed sailing vessels. This view was aired by Eva and Per Fett (1941:83–84), who recorded the carving and who deemed it to be something quite extraordinary amongst north-western Norwegian rock carvings. The carving is made on a slab of stone, quite weathered but still fairly distinct, and is today removed from its original location and stored in the historical museum of Stavanger (ibid.).

Figure 56. The Harvaland Stone with the two boats, 1 and 5, as they are carved to the left and separated to the right. (after Fett & Fett 1941, pl 40).

Admittedly, the interpretation might be considered bold, but is nevertheless shared by Halldin, and should not be rejected out of hand, at least not until there is clear evidence against such an interpretation. If these boats carry sails, they are most likely to be square sails, one low and wide, the other slightly narrower and higher. Based on the occurrence of sails alone, Fett & Fett (1941:84) place the two boats in a period after the end of the Bronze Age. A similar date is acquired based on the 'J'–shaped hull of boat number 1, which in accordance with Sognnes' (2001:45–48) boat classification system would place it

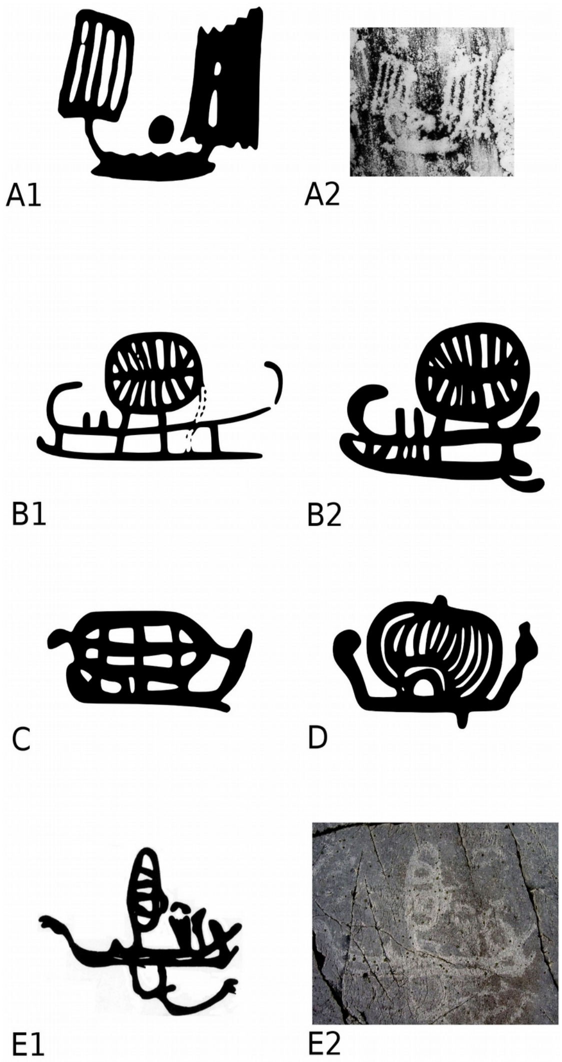


Figure 57. A1) Tanum-833, from Bohuslän on the Swedish west coast (Bengtsson & Olsson 2000:77), A2) rubbing of Tanum-833 (Högberg, unpublished, Vitlycke museum). B1) Herrebro-59, from the Norrköping area on the Swedish east coast (Nordén 1925), B) the same boat as recorded by Burenhult (1973b). C) Skälv-18 from Norrköping (Burenhult 1973b), D) Skälv-41 from Norrköping (Burenhult 1973b). E1) Boat with plume like sail from the Järrestad-13 site, Scania (Burenhult 1973b:24—25), E2) photo of the same boat (Photo: Boel Bengtsson).

in the transition between Pre-Roman Iron Age and early Iron Age – especially if taking into account the slightly different shape of the hull of boat 5.

Other Possible Sails in the Rock Art – the Lattice or Kite Sail

In addition to the imagery of boats carrying possible sails described above, some additional carvings are worth mentioning, all of which carry what could be interpreted as some form of lattice or kite sail. Starting off with a boat rendering from the parish of Tanum, located almost on the doorstep of the Vitlycke Museum in Bohuslän, this particular rock carving depicts an early Bronze Age boat with two squares, possibly sails – attached to each of the stems of the boat (A1 and A2 in figure 57). This image is not only of an earlier date than the previously described depictions, but indicates the existence of sails that might have been of a more rigid construction, in this case depicted in some form of perspective.

There are many different ways in which to accomplish such a construction that would function as a sail – a simple light frame of some sort, perhaps with supporting battens, covered by a fabric or plaited reed – that is raised onto the bow and stern sections and controlled by two to four sheets (figure 58). The main disadvantage with such a system is its bulk when not in use, something that might have been solved by a kite type of sail, where the frame structure is held in tension, stretching out the fabric or reed. Thus, when not in tension, the whole structure would have been possible to fold for easier storage.

Several other boat renderings equipped with what could be interpreted as lattice or kite type sails are found in the Norrköping area in Östergötland, eastern Sweden, where they are concentrated to the parish of Borg. Starting with the boat rendering at Herrebro (B1 and B2 in figure 57), this boat was first recorded by Nordén (1925:98) and later by Burenhult (1973b:159), both of whom describe it as a 'net' figure. The two interpretations vary slightly, but the oval sail-like device remains the same, and the two connecting lines between the 'sail' and the hull of the vessel seem to indicate either some form of mast, perhaps a bipod mast or a sheet of some sort. The same idea has been raised by Artursson (1987:36) who suggests that the sail might have been made of plaited reed, which then might be rolled up and stowed to the side when not used.

A further two possible lattice or kite sails can be found on boat carvings at Skälv, where the first, C in figure 57, appears quite similar to the Herrebro boat rendering. The following figure D has by Burenhult been described as a boat with a 'concentric circle' (1980:51), but might actually symbolise a sail. The main arguments against such an interpretation is the relatively faintly carved, and to a certain extent weathered 'hull' in relation to the 'sail', and that possibly, the two are carved in different carving techniques (Artursson 1987:42). However, as the hull and the sail appear to form an entity this might be more important than the possibility that either is of a later date for reasons already discussed and can therefore not be ignored.

The last of the boat renderings that could be said to belong to this group is from the county of Scania and the Järrestad site (E1 and E2 in figure 57). The 'sail' on this particular boat rendering at first appears to be very different to the oval sail shapes of Östergötland, as it is higher and more narrow, but could also depict the sail so that the viewer saw it at an angle

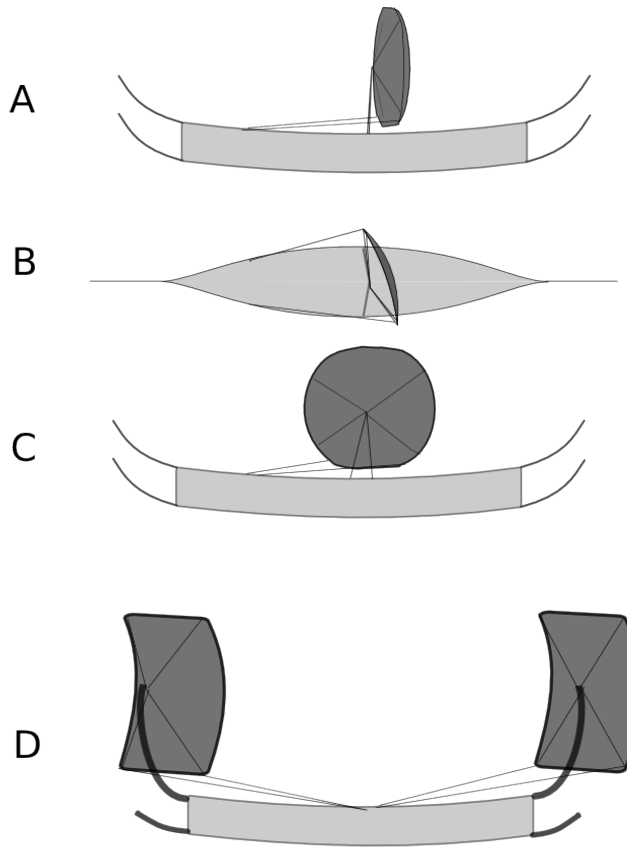


Figure 58. Examples of how a lattice or kite type of sail might have worked. A), oval type sail seen from the side, B), the same sail as seen from above, C), as it might have been depicted in the rock art, D), two square sails as seen at Tanum-833.

(see for example figure 58A). Thus, whereas the former depictions show a sail as it might have appeared from the bow or stern, the Järrestad rendering might depict it as it would have appeared from the side. Judging from the earlier described sail depictions at Askum, Himmelstalund and Tanum, where some sort of perspective appear to have been used, such an interpretation might not be altogether strange. The boat itself is very clearly and evenly carved across earlier depictions of two knife shafts, which have been used to make up the 'bottom' and shear lines (Burenhult 1980:98–99). Although the boat in itself does not reveal any datable features, being of a rather indeterminable shape, Burenhult (1980:120) dates it to Montelius' period IV, (1100—900 BC) based on the different carving techniques used in the superpositions.

Masts with Yards or Stays

Present in the rock art is a whole range of depictions of boats with details that can be interpreted as masts with yards as well as masts with rigging details such as stays and/or shrouds. Of these, masts with yards constitute the most interesting group as such a combination is less likely to be a coincidence and at the same time represents an obvious depiction of a sailing vessel (pers. Communic. Vinner 2006). In the present rock art material there are at least three certain and a further two rock art boats with such details. Of the more certain figures, Lösen-26 and the one of the many mast furnished boats at Möckleryd (A and C in figure 59) have both been recognised by Burenhult (1973a:157) as masts furnished with yards. Furthermore, they have been investigated by Artursson (1987:28–29), who regards them as clearly cut and obvious depictions of square rigged sailing boats. Artursson even suggests that the absence of any stays or shrouds indicate such rigging details were not needed, instead referring to the habit of sailing on the 'tree' which was common in Norway as well as Bohuslän well into the 19th century as has been described by for example Humbla & von Post (1937:93–94). Also Stöltig (1996:33) is of the opinion that this can only be interpreted as masts.

The boat at Stuberg 1 in Stjørdal in western Norway (figure 59B) has been recorded by Sognnes (2001:51) who regards it to be a boat with mast and yard. In his opinion the hull of this particular carving has many parallels within the Norwegian rock art material, in addition to which the same carving technique is used as on other panels in the vicinity.

Based on this, Sognnes firmly places this rendering of a sailing boat within a southern rock art tradition and rejects any notion that it might have been a copied detail from any foreign object (ibid.).

The dating however is not entirely straightforward as the hull shape appears within a relatively long time span, ranging from approximately 500 BC until AD 400, albeit with a strange gap. Whereas the Bronze Age rock carving tradition seems to cease at the end of the Pre-Roman Iron Age, it surprisingly re-emerges on an erected stone over a grave dated to AD 400 from Austrheim in Gloppen (Skjelsvik & Straume 1957). Here, a bean shaped boat, similar to the one at Stjørdal, appears carved on one side. It is however questionable whether this particular rock carving represents a continuation from the Bronze Age or a 'new' short lived rock carving phase (Kaul 1998:109; Sognnes 2001:52). In the case of the Stuberg 1 boat carving, its mast, along with the presence of a side rudder on similar hull

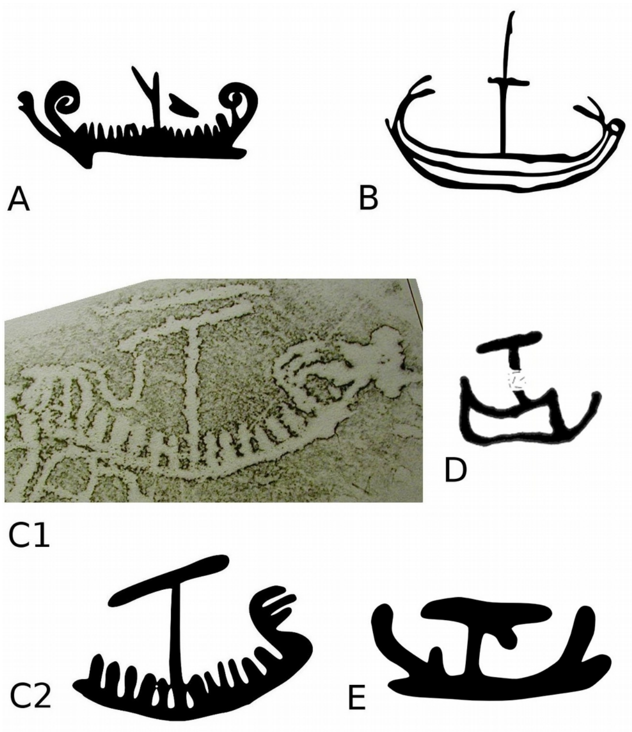


Figure 59. A) Boat with mast and yard from Lösen-26 in Blekinge (after Burenhult 1973b:76—77). B) Bean-shaped boat with mast and yard from Stjørdal (after Sognnes 2001:51). C1) Rubbing of boat with mast and yard at Möckleryd (Torshamn-11), Bekinge, (after Stöltig 1996), C2) an interpretation of the same boat (after Burenhult 1973b), D) a slightly damaged boat with mast and yard (?) from Kville-212 in Bohuslän (after Nordbladh & Rosvall 1981:276), E) boat with mast and yard at Ekenberg-23 in Östergötland (after Burenhult 1973b).

shaped boat in the vicinity, makes Sognnes lean towards a date around AD 400. This relatively late date is primarily based on the current belief that the sail was not introduced in the North until around AD 700 and the fact that the side rudder first appears in the archaeological record with Nydam 2 and 3, dated to around AD 300 (Rieck 2003:301).

As for the rig at Ekenberg-23 (E in figure 59), this is relatively less clearly cut, perhaps indicating that it is a later addition, but the overall impression is that of a mast with a yard (Artursson 1987:42). Even if the rig is a later addition, it does not move away from the fact that someone actually added it to the vessel, deeming it important. The same uncertainty applies to the Kville-212 (D in figure 59) rendering from Bohuslän, where the main difficulty lies in the fact that the stone has been exposed to weathering, removing parts of the 'mast' (Nordbladh & Rosvall 1981: 276). However, yet again, the impression is that of a small boat with a mast and a yard and, like all of the boat depictions with a mast and a yard, there are no visible shrouds or stays. A possible fifth mast with a yard is the earlier mentioned boat from Haugene (see figure 45).

What appear to be mast bearing boats with stays and possibly shrouds can be found at the Järrestad-13 site in the county of Scania, where three such renderings exist (figure 60). The carvings are distinctly carved into the smooth sand stone, and although one of them (A in

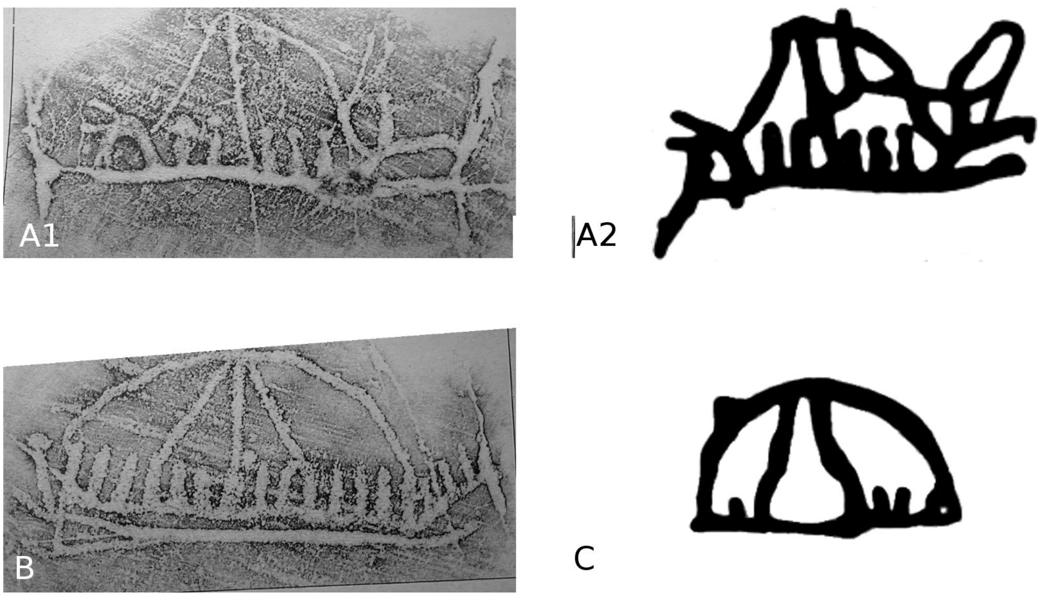


Figure 60. Järrestad-13, Scania, Sweden. A1) Rubbing of boat with mast and stays (Stöltig 1996:34), A2) the same boat as interpreted by Burenhult (1973b), B) rubbing of boat with mast, shrouds and stays (Stöltig 1996:34), C) boat with shrouds and stays (after Burenhult 1973b).

figure 60) is slightly confusing, it still shares the same main traits of a boat with possibly people on board and a mast with flapping stays and shrouds. In fact, the rubbing made by Stöltig (A1) is much easier to understand than Burenhult's interpretation (A2). The boat rendering in figure 60B, is less confusing and is undoubtedly the one which has attracted the most attention in the past. Burenhult (1973a:160) for example, does not hesitate to label it a sailing ship while seeing important typological agreements with for example the contemporary Novilara stele (see figure 43C), mainly because of its outwardly arched stays.

The Boat Renderings with a Single Mast

Left to discuss is the boat imagery furnished with what can be interpreted as a single erect mast or pole; the vertical line, centrally located in a vessel. The main functioning of a mast is to support a sail but undoubtedly, when imagery is concerned and in particular rock art, such an interpretation is not as simple as that, especially when the sail or yard is missing. The main reason for this is that there are more than one possible explanation for the presence of such a vertical line on a rock art boat rendering such as for example that of a stylised human, or a pole raised to support a wheel/sun cross or similar – not necessarily a sail. Below we shall look into each and one of these possible interpretations.

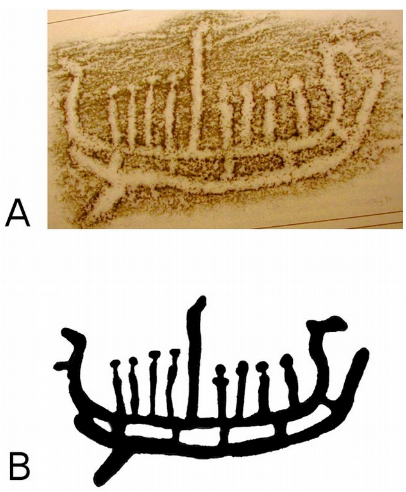


Figure 61. A) Rubbing of Svenneby-17, Bohuslän, Sweden. (Stöltig 1996:32), B) Svenneby-17 (after Nordbladh & Rosvall 1971:39).

Mast or 'Human Figure'?

One of the more interesting of the boat depictions in question can be found at the Kyrkestigen site in the parish of Svenneby (Svenneby-17) in Bohuslän, Sweden (figure 61). This particular rendering was first discussed by Fredsjö (1948:72—73), with a focus on the so called 'crew-strokes'. In his view it is obvious that such vertical lines, furnished with a knob, are in fact stylised members of the crew, the knob indicating the head, connected to the 'body' by a 'neck'. In Fredsjö's interpretation it is even possible to see the 'shoulder' of the crew member just forward of the mast, which is harder to distinguish on a later rubbing. Indeed, there are several depictions in the rock art material where the crew is depicted in this way and where the 'bodies' are defined more clearly, making such an interpretation very reasonable.

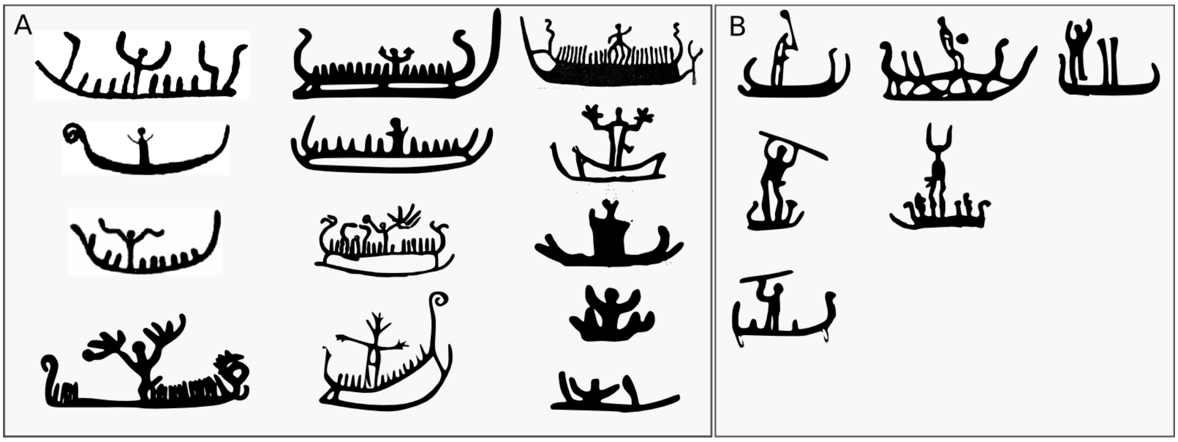


Figure 62. Rock art boat renderings where a relatively tall and central figure is clearly depicted. A) Adoration figures, columns from top left (1); Askum-70 (Bengtsson 2003:30), Tanum-236 (Bengtsson & Olsson 2000:45), Tanum-236 (ibid.), Torhamn-11 (Burenhult 1973b). (2): Kville-86 (after Nordbladh & Rosvall 1981:155), Askum-9 (after Bengtsson 1997:18), Kville-159 (after Nordblad & Rosvall 1981:185), Litslena-230 (after Kjellén 1976:172). (3): Østfold (after Kaul 2005b:140, fig. 157), Kville-146 (after Nordblad & Rosvall 1981:171), Bottna-74:2 (after Nordbladh & Rosvall 1975:38), Bottna-74:2 (ibid.). (4): Tanum-223 (after Bengtsson & Olsson 2000:21), Askum 65:1 (after Bengtsson 2003), Prestegård Nr 014313 (Vogt 2000:34—35), Östra Eneby-1 (Burenhult 1973b). (5) Askum-66:2 (after Bengtsson 2003). B) Other types of central figures, columns from top left (1): Tanum-406 (Högberg 1998:23), Tanum-242 (after Högberg 1998:5) Tanum-410 (Högberg 1998:32), the legs of an unfinished human figure on a boat at Tanum-422 (after Högberg 1998:48). (2): Kjenne Vestre Nr 014802 (Vogt 2000:85), Bottna-382 (after Nordbladh & Rosvall 1975:147), Tanum-488 (after Bengtsson & Olsson 2000:72), Tanum-408 (after Högberg 1998:30).

The tall vertical line in the centre of the vessel is not commented on per se, and in comparison to the shorter crew-strokes this taller line has no neck or pronounced knob – if one can say that there is a knob at all. In fact, it could just as well be a depiction of a mast. Fredsjö does move on to argue that also simple straight lines (without the 'knob') could possibly be depictions of a crew member (ibid.). It is not entirely unjustified to draw such a conclusion either as there are instances where one crew member, often furnished with some sort of equipment such as a helmet, shield or sword, is standing tall on a vessel that has crew strokes, but in these depictions, the lone tall person or persons are generally standing either near the aft or close to the bow or the boat, not in the centre.

There are of course exceptions and in the southern Scandinavian rock art material there are some twenty five cases or so where indeed a tall central, possibly human(?) figure can be found standing in a boat. In the majority of these, this central figure appears in the so called adoration position with its arms stretched out empty handed (A, figure 62). Adoration figures are sometimes interpreted as some form of god which in the context of being located in the centre of a boat, at a spot where one would normally find a mast and sail, could indicate that this god has something to do with catching the wind, almost as if to provide the depicted boat with power (see e.g. Zavaroni 2007).

At Möckleryd (figure 63), we find a potentially very powerful such adoration figure (with full erection). The presence of a yard on one of the masts here makes it hard to interpret the remaining central vertical lines as anything other than masts, especially as they are very

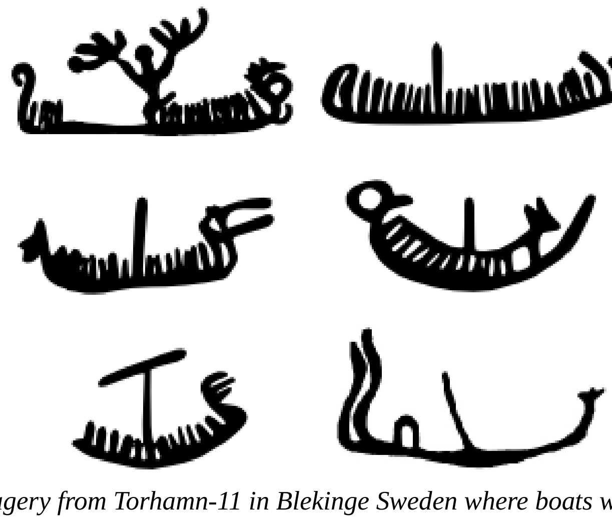


Figure 63. Rock art imagery from Torhamn-11 in Blekinge Sweden where boats with a central adoration figure and with mast-like features are present (after Burenhult 1973c).

distinct and lack the 'knob' that might have indicated a human figure. Instead, might it not be the adoration figure that indicates the power of the mast and sail, the power with which to move without having to paddle or row, which must have seemed like an invisible, godlike force? In one depiction from Bottna it is even possible to see the cloak this god is spreading out to catch the wind (figure 62).

From the above it is clear that the interpretation of whether the central vertical line in a boat is meant to represent a mast or a human figure is not straightforward, but most importantly, the possibility that these vertical lines are meant to symbolise masts cannot be excluded.

Mast or 'Pole'?

Another possible interpretation of the vertical mast-like line is that it is a pole, used to raise or hoist for example a sun disc, or that it is meant to represent a raised axe, spear or similar. A collection of such depictions is presented in figure 64. Here the three vessels on the left (1—3) are easily interpreted as being such depictions, whereas the others (4—9), are

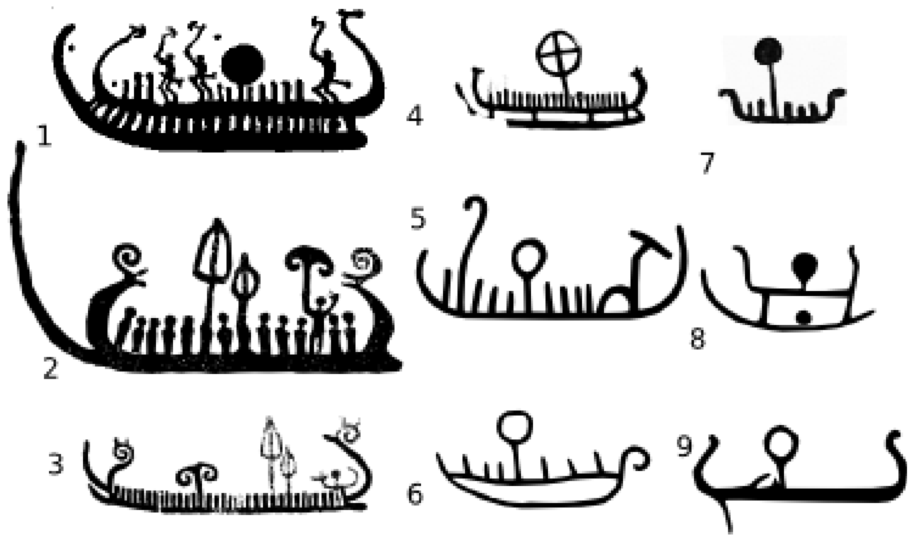


Figure 64. Depictions of boats with what appears to be raised objects, sun crosses, spears and axes. 1) Svarteborg-13, Bohuslän, Sweden (Baltzer 1901, pl 1—2:1—3); 2—3) Tossene-73, Bohuslän, Sweden (unpublished, Vitlycke museum); 4) Bottna-4, Bohuslän, Sweden (after Nordbladh & Rosvall 1975:102); 5) Ods, Jægersborg, Denmark (Glob 1969:25, fig 10); 6) Allinge, Sandvig, Bornholm (Kaul 2005a:60); 7—8) Svarteborg-3, Bohuslän, Sweden (Broström & Ihrestam 2000:4—5); 9) Kville-86 (after Nordbladh & Rosvall 1981:151—156).

perhaps more ambiguous. The usual explanation is that these represent sun-crosses or circle signs, raised on a stand or a pole that is being held up on board a boat (Kaul 2005d:80—81). However, when contemplating for example the boat rendering at Svarteborg-3, such an interpretation might be questioned. Here, the cupmark or circle at the top of the vertical line is too large to be a 'head', and it is in fact quite uncertain whether the cupmark/sun-circle might not just as well be something hoisted onto a mast. It is the ambiguity between what constitutes a 'pole' and whether this 'pole' could not just as well be a mast that is interesting here as it in effect is impossible to tell – especially since masts with all probability were not permanently fixed.

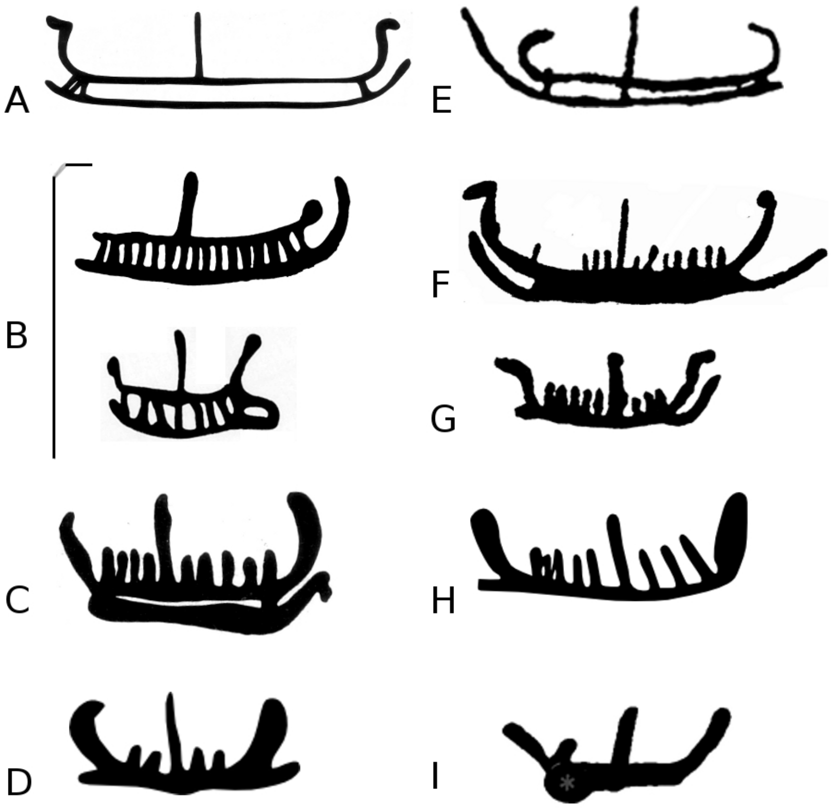


Figure 65. Rock art boats with masts-like features. A) Västra Tollstad-21 (after Burenhult 1973b:101), B) Torhamn-11 (after Burenhult 1973b:67, C) Skälv-31 (Burenhult 1973b), D) Ekenberg-23 (Burenhult 1973b), E) Svenneby-11 (Nordbladh & Rosvall 1971:24), F) Trosa-Vagnhärad-434 (after Broström 2003, FMIS), G) Svenneby-17 (after Nordbaldh & Rosvall 1971:24), H) Sør Sunde (after Fett & Fett 1941:71—72, Pl 33B), I) Kville-74 (after Nordbladh & Rosvall 1981:111).

The 'Mast' Interpretation

The final line of interpretation of the central vertical line is that it is meant to represent a mast and nothing else, and that all of the single vertical poles discussed above might in fact be such devices. The presence of yards on some masts in particular justify such a view, with three rock carving sites displaying boats with both masts and masts and yard, including Torhamn-11 and Lösen-26 in Blekinge, and Ekenberg-23 in Östergötland.

Other sites where boats with a single mast can be found are the earlier mentioned Vese Bro (Brastad-1), Askum-10 and Svenneby-17 sites, all of which are located in Bohuslän, and the Möckleryd (Torham-11) and the Lösen-26 sites in Blekinge (Artursson 1987; Bengtsson & Bengtsson 2007, 2011; Burenhult 1973b; Eskeröd 1970; Halldin 1952; Rausing 1984; Stöltig 1996). Further imagery/sites are presented in figure 65, where boats E, F and H in particular stand out. In all three depictions a mast is carved distinctly at a position just forward of the centre, making the interpretation of mast bearing vessels easy. Also boat I is fairly straight forward. On boat G however, the mast is unusually thick – something that should probably be viewed in relation to the uneven and granular granite surface on which it was once carved and which has affected the character of the rest of the vessel (making any finer artistry difficult).

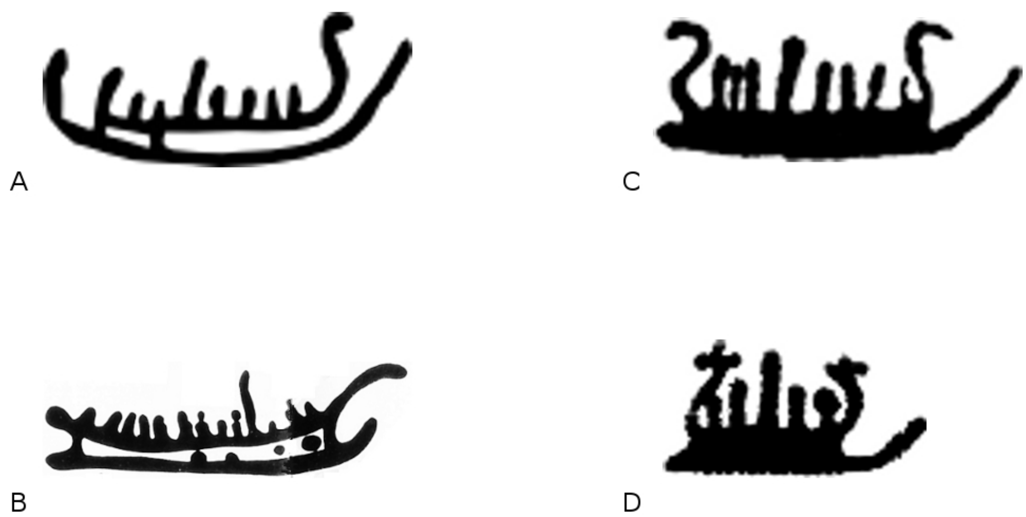


Figure 66. Examples of rock art boats with so called 'crew-strokes' along with a relatively short mast-like vertical line. A) Penne-13, Lista, Norway (Fett & Fett 1941:99—101, pl 44), B) Ekenberg-23, Sweden (after Burenhult 1973b:137—40), C) Onsøy-01481 (Vogt 2000:93, fig. 144), D) Tanum-406, Bohuslän, Sweden (Högberg 1998:23—24).

Of boats A-D in the same figure, the two B-boats come from the already mentioned Möckleryd site whereas the remaining come from Östergötland on the Swedish east coast, and have previously been discussed by Burenhult and Artursson, where the former regards them all as mast bearing. Artursson (1987:24, 42) however, does not agree that the boat from Hästholmen in Västra Tollstad carries a mast. The reason for this is his application of a set of strict 'rules' for what can be considered to be valid bases on which the interpretation of mast might be made. Thus, according to these 'rules', a mast must have a length of at least 30% of that of the total length of the boat on which it is carved, leaving the Hästholmen 'mast' just short of that.

A major problem in applying such a rule is that it presumes an understanding of the relative width of the depicted vessels on which these masts are located, something the differences in the relative width between for example the Hjortspring boat and some of the ship-settings dated to the Bronze Age simply does not allow for. Bearing in mind that the more narrow or unstable the boat, the shorter the mast must be in order for sail power to be used safely, arbitrary rules such as this one, might seriously limit any exploration into the process of how sail power was first harnessed in the North. For this reason, Artursson's stipulation that for a vertical line to be considered to be a mast, it must be at least twice as high than any other lines or crew strokes on-board, also appears unconvincing, even though it might have been stipulated with good intentions. Examples of boats in the rock art with such crew strokes and a relatively short mast-like device amidships can be seen in figure 66, all of which might depict masts.

Returning to boat A from Hästholmen in figure 65, this particular carving has been documented more recently by Broström (2007), who boldly states that previous interpretations have all been flawed by incorrectly taking into account an ice furrow, thus his interpretation effectively removes the 'mast' altogether. Looking at a photograph of this boat image (Broström 2007:27, figure 19), the furrow appears quite dominant and one has to ask why the carver would have chosen to carve his boat here if not intending to make use of this natural feature. Natural features are often incorporated into the rock art, which is seen not least in the use of a natural crack in the composition of the boat depictions in figure 55 from Himmelstalund, but there are many more examples (pers. Communic. Lasse Bengtsson 2005). Burenhult clearly interprets the ice furrow as intended to form part of the composition and in light of other cases of what appears to be mast-like devices centrally positioned in rock art boats, such an interpretation does not seem unreasonable.

Summing up the Potential Sailing Vessels in the Rock Art

Despite the inevitable possibility that some of the imagery discussed above might have been erroneously interpreted, the above show that the number of boats carrying a potential mast or sail in the southern Scandinavian rock art material, is far higher and more varied than previously believed. Furthermore, in many cases, these carvings have been subject to more than one round of documentation and subsequent interpretation, sometimes entirely independently of earlier attention.

In total, boat depictions with what can be interpreted as masts with yards, shrouds or sails can be found at over thirty sites across the region on a vast variety of different boat types. Some, but not all of these are presented in figure 67.

The occurrences of possible sails in the southern Scandinavian rock art are spread across four regions; south-western Norway, the north-west coast of Sweden, Scania in the south of Sweden and in the area around Norrköping on the Swedish east coast. In three of those areas a square sail can be recognised, the two earliest possibly dating to Montelius' period III and the latest to the early Iron Age. Of the group of lattice or kite type sails, where also the Skälv-41 boat is included, at least two or possibly three different types of sails are found; the oval sail in the east, a similarly shaped or alternatively higher and more narrow sail in the south, and finally, the double square sails in western Sweden.

Boat carvings with what can be interpreted as masts with a yard and/or masts with shrouds or stays can be found at some seven different sites across the region, in time ranging from possibly period III or IV until the Iron Age, and constitute perhaps the most evident indications of sails and masts in the southern Scandinavian rock art material (pers. Communic. Max Vinner 2006). Also the single masts present in the material indicate big variations in set up ranging from relatively high to low masts, with the rig sometimes located just forward or aft of the centre, other times near the bow or even the stern. Some masts are straight whereas others have a tilt. There are also potentially double masts, with a mast at each stem or further in towards the centre or the boat.

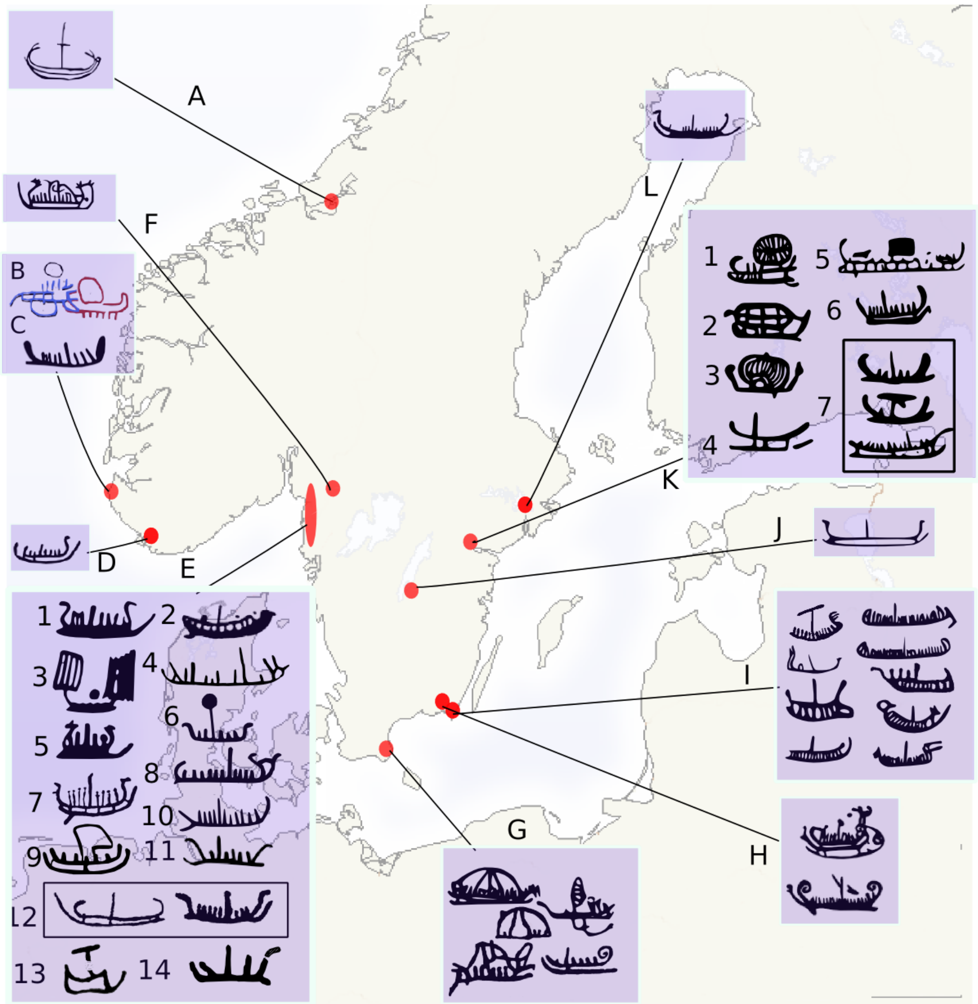


Figure 67. An overview of boat renderings with mast-, rig- and sail-like features in the southern Scandinavian rock art. (Additional mast-like renderings are described in the text.) A) Stuberg I (Sognnes 2001:166); B) Harvaland-26 (Fett & Fett 1941, pl. 40); C) Sør-Sunde-40 (Fett &Fett 1941, pl 33b); D) Penne-44 (Fett & Fett 1941, pl 44); E1) Onsøy-014801 (Vogt 2000); E2)Bottna-80 (Nordbladh & Rosvall 1975:16); E3) Tanum-833 (Bengtsson & Olsson 2000); E4) Tossene-10, (unpublished, Vitlycke museum); E5) Tanum-406 (Högberg 1997, unpublished); E6) Svarteborg-3 (Broström & Ihrestam 2000); E7) Svenneby-17:1 (Nordbladh & Rosvall 1971:39); E8) Bro-26:1 (Baltzer 1881, I, pl 14); E9) Askum-44; E10) Tossene-23 (unpublished, Vitlycke museum); E11) Tossene-49 (unpublished, Vitlycke museum); E12) Svenneby 11:1–2, (Nordbladh & Rosvall 1971:24); E13) Kville-212 (Nordbladh & Rosvall 1981:276); E14) Bottna-45 (Nordbladh & Rosvall 1975:131); L) F) Ronarudden-15 (Rex Svensson 1982:38); G) Järrestad-13 (Burenhult 1973b:24–25); H) Lösen-26 (Burenhult 1973b:76–77); I) Torshamn-11 (Burenhult 1973b:67); I) Hästholmen-5 (Burenhult 1973b:101); K1) Herrebro-59 (Burenhult 1973b:159); K2) Skälv-18 (Burenhult 1973b:171); K3) Skälv-41 (Burenhult 1973b:171); K4) Leonardsberg-84 (Burenhult 1973b:149); K5) Himmelstalund-1 (Burenhult 1973b: 104–106); K6) Skälv-31 (Burenhult 1973b:164–165); K7) Ekenberg-23 (Burenhult 1973b:138–140); L) Trosa-Vagnhärad-434 (Broström 2004, RAÄ).

Furthermore, it is clear that the rock art indicates the existence of different configurations of, for example, rig and sail, including multiple masts and round as well as square sails (see table 2). What is interesting here and important to bear in mind whatever opinions or preconceptions we might have today of what is a sensible set up of a rig and sail, is that we cannot rule out that people in the Bronze Age experimented with lots of different configurations, all of which might have worked in one way or another. Thus, slowly, the most efficient and safe way of carrying a sail took over as time went by and the boats evolved.

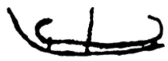
Examples of positioning of the mast		
Amidships 	*Towards the bow or stern of the boat* 	*Two or more masts* 
Torham-11	*Leonardsberg-84, Bottna- 55, Järrestad-13*	*Tanum-833*
Types of sails		
Square 	*Round* 	*Dragon form (?)* 
Askum-44	*Herrebro-59*	*Järrestad-13*
Types of rig		
Stays and/or shrouds 	*Bipod mast* 	*Mast 'on the wood', or stays/shrouds not depicted* 
Järrestad-13	*Järrestad-13*	*Svenneby-11*

Table 2. Different rig and sail set ups recorded in the southern Scandinavian rock art.

Paddlers and Rowers in the Rock Art

It has been argued that it is not only masts and sails that are scarce in the southern Scandinavian rock art material, but that other types of propulsion are just as scarce (Halldin 1952:76). Surprisingly, this argument still holds true. Boats that are clearly being

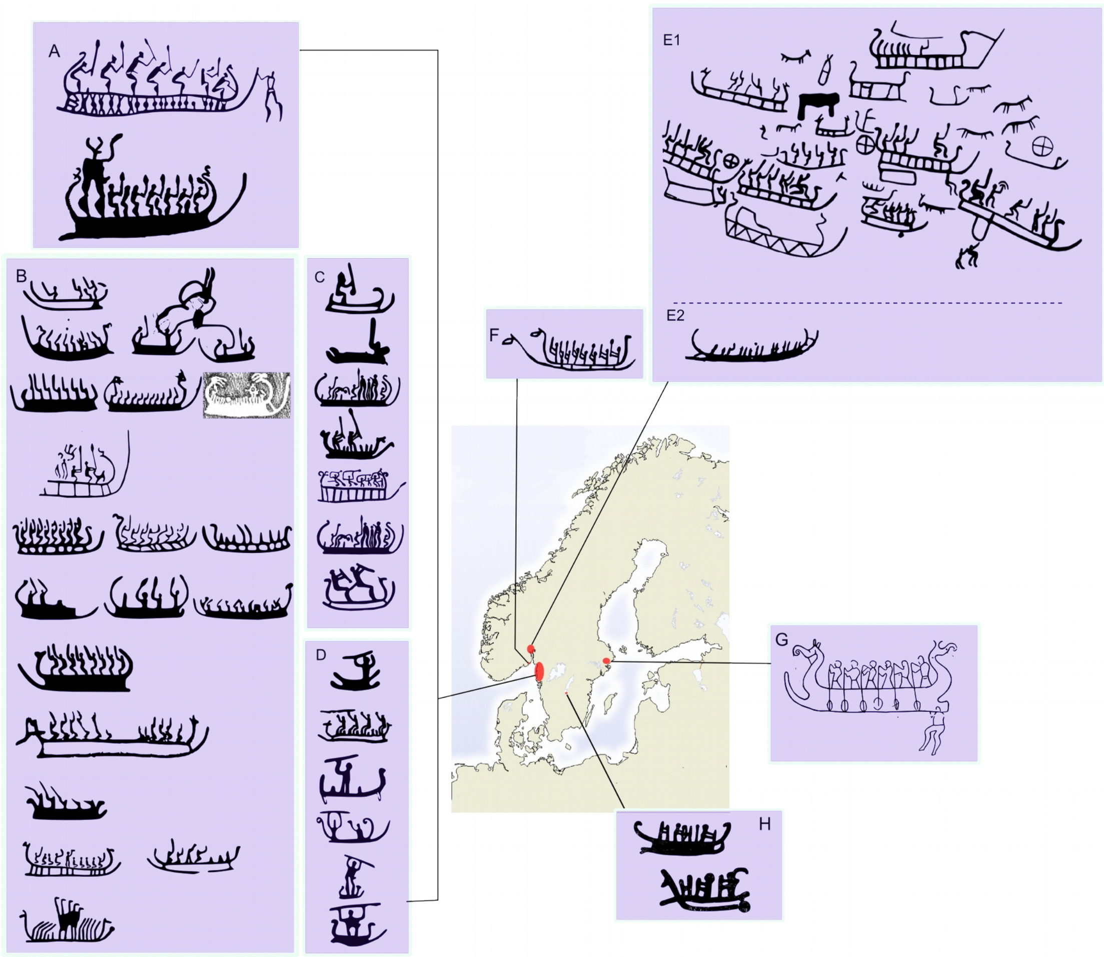


Figure 68. Rock art boats depicting paddlers. A) Skee-1539 (after Broström & Ihrestam 1994), Tanum-325 (Bengtsson & Olsson 2000:44), B) From the top: Skee-1539 (after Broström & Ihrestam 1994), three boats from Tanum-325 (Bengtsson & Olsson 2000:44), three boats from Tanum-192 (Bengtsson 1995:64–78, Ellmers 1995:233), Askum-60 (Bengtsson 2003:23), three boats from Askum-697 (Bengtsson 1998:26), three boats from Tanum-405 (Högberg 1998:21—22), Tanum-322 (Bengtsson & Olsson 2000:42), Tanum.-1 (Högberg, unpublished, Vitlycke Museum), Tanum-330 (Bengtsson & Olsson 2000:47—8), two boats from Tanum-158 (Högberg, unpublished, Vitlycke Museum), Askum-75 (Bengtsson 2003:35). C) From the top: Skee-1539 (after Broström & Ihrestam 1994), Tanum-255, Tanum-247, Kville-92, Tanum-155, Tanum-275. D) From the top: Tanum-33, Kville-100, Tanum-410, Tanum-197, Tanum-406 (after Högberg 1998:24), E1) Kalnes, Tune (Hagen 1990:10), E2) Niels Jules gate 13, Oslo (Østmo 1990:66-67, pl. 12), F) Bergheim, Gjerpen, Telemark (Mastrander 1969:82), G) Boglösa-109 (Coles 2000, fig.36), H) Västra Tollstad-21 (Broström 2007:15).

paddled can be found at sites such as Skee-1539 and Tanum-325 in Bohuslän and at the well known Boglösa-109 site in Uppland (see A and G in figure 68). Apart from these three, there are also a number of images that depict what with relative certainty can be interpreted as the representations of paddlers, with the paddlers holding the paddle up in the air in front of them. Sometimes this action is depicted in a very stylistic fashion as seen at for example Askum-75, and Tanum-158 and -322 in figure 68. In other depictions the interpretation of what is being held is less clear and could for example represent poles, punts or spears (boxes C and D in figure 68).

In total there are some 40 instances of such imagery within the southern Scandinavian rock art material of which strikingly, only five sites outside Bohuslän. Remarkable is also the difference in the way in which the paddlers are depicted, with raised paddles on the west coast, while in the east as if actually paddling. If examining the number of potentially rowed vessels within the same rock art material, the number becomes even lower. In figure 69 it is clear that two boat depictions – from the Bærum-88 and Tanum-95 sites in south-east Norway and western Sweden respectively – are being rowed. Of these two depictions, Bærum-88 can be placed in the Pre-Roman Iron Age (Østmo 1992) whereas Tanum-95 is probably older. Based on the relatively short elongation of the lower 'horn' in the bow end

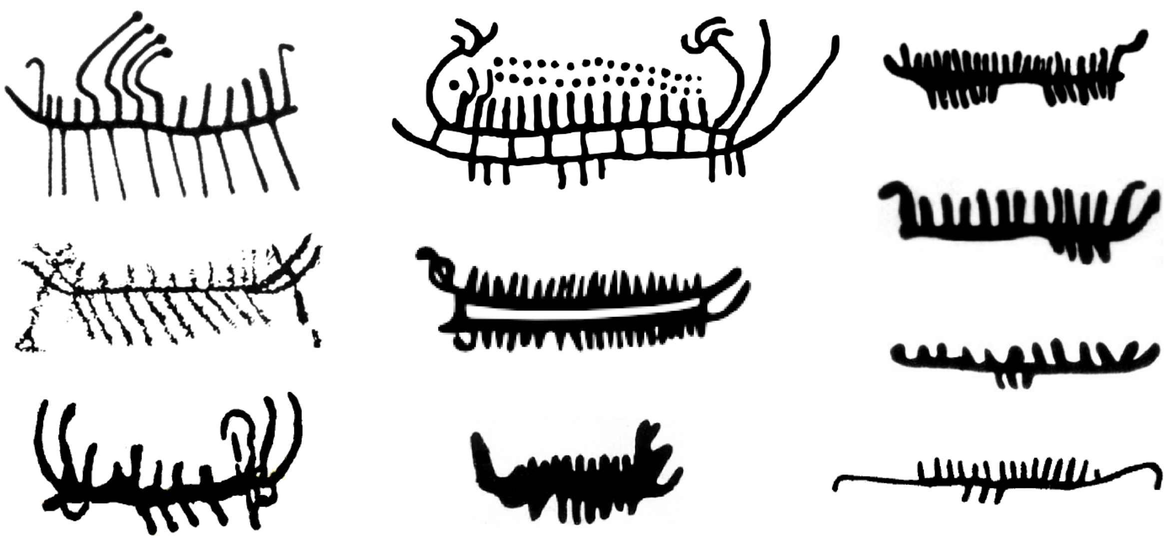


Figure 69. Examples of rock art boats that could be interpreted as being rowed. Columns from the top left; Tanum-95 (Högberg, unpublished, Vitlycke museum), Bærum-88, Dalbo II (Østmo 1992:11—14), Bottna-61.1 (Nordbladh & Rosvall 1975:44), Bottna-43 (after Nordbladh & Rosvall 1975), Östra Eneby-1b (Burenhult 1973b:109), Östra Eneby-4 (Burenhult1973b:114), Husaby (Burenhult1973b:88), ibid., Torhamn-11 (Burenhult 1973b:73), Åmøy-3 (Fett & Fett 1941, pl. 21).

of the boat, it may date to Montelius period III. The two boats from Östra Eneby in Norrköping, are harder to interpret. Some scholars suggest that the vertical lines sticking out from the 'bottom' line indicate the paddlers sitting on the opposite side of the boat. Another interpretation is that it could be representations of the paddles or very short oars.

In the boat depiction from Bottna-43, the vertical lines along the 'bottom' line are more spread out and are probably less likely to symbolise paddlers sitting on the far side of the boat whereas on the remaining boats, which include a very strange looking boat from Åmøy-3, could represent either paddles or oars. Apart from these seven depictions, it has been suggested that the two boats from Harvaland discussed earlier (figure 56), have oars as well as sail (Fett & Fett 1941). Thus, even if we are more liberal as to what might represent oars, the number of oared vessels in the southern Scandinavian rock art material is very limited with perhaps two more certain depictions and another seven or so that are less so.

Steering Oars

In the introduction of this chapter, the fundamental use of double steering oars for handling the type of boats we believe belong to the Scandinavian Bronze Age, whether paddled, oared or sailed, was mentioned, (the reason for this will be argued more in depth in Chapter 6). In the rock art however, the number of boat depictions where both steering oars are clearly visible are as scarce as those of any other technical detail discussed so far, but some confirmation of their use can at times be detected in other ways such as, for example, through the positioning of the crew or crew-strokes (Ellmers 1995, Østmo 2005).

The most commonly depicted steering device, at least for boats belonging to the early Bronze Age, can in particular detail be seen at examples from Litsleby (Tanum-60) and Fröstorp (Tanum-238) in Bohuslän (figure 70). Past interpretations of these details include the possibility that they depict some form of fin, of a similar design to that invented in the 19th century for the use on Greenland kayaks (Marstrander 1969; Petersen 1986:68). However, the sheer size of the carved boats in addition to experiences from the reconstructed Hjortspring boat make such an interpretation highly unlikely. Instead, it might be some sort of steering oar that is indicated (the difference between an oar and a paddle being that the former is attached at one or two points and used as a pivot, or in case of steering by twisting, whereas the latter is simply held and handled freely by a crew member). A similar view is held by Kastholm (2008:187—188) who argues that these details should indeed be interpreted as graphic attempts to depict steering oars.

The rubbing from Litlseby (B in figure 70) for example appears to show the blade of a paddle in the stern, whereas the two boats from Fröstorp are more intricate. Here, at least on the second boat, it appears to be some sort of line or lines, depicted as arched curves, that run from the helmsman in the stern to something that could be a steering oar lying loose in the water surface as if ready for landing or departure. This particular boat depiction is interesting for a second reason as it shows a crew of 20 paddlers in ten pairs, in addition to one single crew member at each end of the boat – as if in charge of each of the two steering oars. Ellmers (1995:231—232), has made a similar interpretation of the crew of the boat engraved on the Rørby sword in bronze from Sjælland in Denmark, dated to the first half of Montelius period I (c. 1700–1500 BC) (Kaul 1998a:74), on which 16 pairs of paddlers are depicted in addition to the single crew member at each end. Ellmers (1995:232—233, 239) has argued that the same type of indication of a helmsman in both ends, can been found on boats dating also to the late Bronze Age, at for example sites at

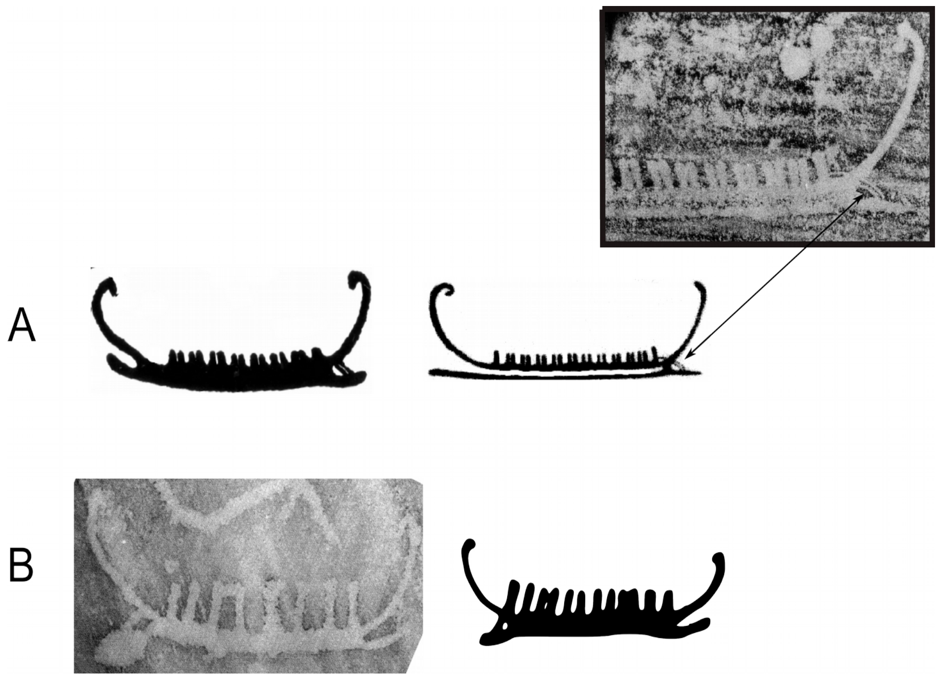


Figure 70. Examples of steering devices on boats dated to the early Bronze Age. A) Two boats from Tanum-238 at Fröstorp, Bohuslän (Bengtsson & Olsson 2000:28—29, inset rubbing Högberg, unpublished, Vitlycke museum), B) Two boats from Tanum-60, Litsleby in Bohuslän (Bengtsson 1995:20—21).

Boglösa, Uppland, at Ryland and Smörsten in Bohuslän, and at Björnstad in Østfold. The Smörsten rock carving (Tanum-192), seem to actually show these two helmsmen with their paddlers raised perhaps indicating that steering might have been at least one of their duties (ibid.).

Another site that might be interesting in this respect can be found in Tanum in Bohuslän (Tanum-262, figure 71). Here boats A, B and D have what looks like a human figure in the

Figure 71. The lower part of Tanum-262 (after Högberg, unpublished Vitlycke Museum). The four highlighted boats A,B, C and D might be interpreted as having one or two helmsmen, one of which in the bow.

bow of the boats possibly indicating a bow helmsman, of which boats A and B also have clearly outlined steering oars in the stern. The possibility that the single crew members in bow and stern might indicate the helmsmen has also been proposed by Johan Ling (2008, 2012:474).

One of the most obvious testimonies to the existence of double steering oars in the rock art can be seen on the potentially rowed vessel from Dalbo II (B8 in figure 72), in addition to which it offers a direct comparison to the double steering oars seen on rowing vessels of some Gotlandic picture stones of the 5th century AD – almost a thousand years later (Ellmers 1995:234; Østmo 1991, 1992). Apart from this rendering there are perhaps another eight boat depictions where the use of double steering oars are fairly obvious to the eye (in columns B and C in figure 72). In one of those renderings, from Rixö, Brastad in Bohuslän (B1), stylistic but obvious human figures are positioned in stern and bow areas. One of these figures has been left unfinished whereas the other is holding onto a steering oar which in shape looks much like a modern oar. A similar interpretation might be possible for the two boat depictions below from Askum (B2 and B3).

Figure 72 offers a compilation of boat depictions where some form of steering device appears to be indicated. Note that not all depictions of what might be an indication of a rudder are included. This is in particular true for boats belonging to the Early Bronze Age such as Tanum-60, in figure 70. Other boats, already discussed previously in this chapter and which have features that can be interpreted as some form of rudder include Östra Eneby-1 (figure 55), Skälv-41 (figure 57D), Svenneby-17 (figure 61), Bottna-80 (figure 58E2) to name a few.

What is interesting though is how seldom we find these types of details in the rock art. For example, I have only been able to find ten depictions where one can actually see a helmsman holding on to a rudder (see column A and B in figure 72). Generally, single rudders in the rock art are placed in the stern end of the boat or, where we cannot tell which end is which, we assume that end is the stern. There might be one exception, namely the boat from Boglösa-138 (D7 in figure 172). Here instead there appears to be a raised steering oar in the bow of the boat.

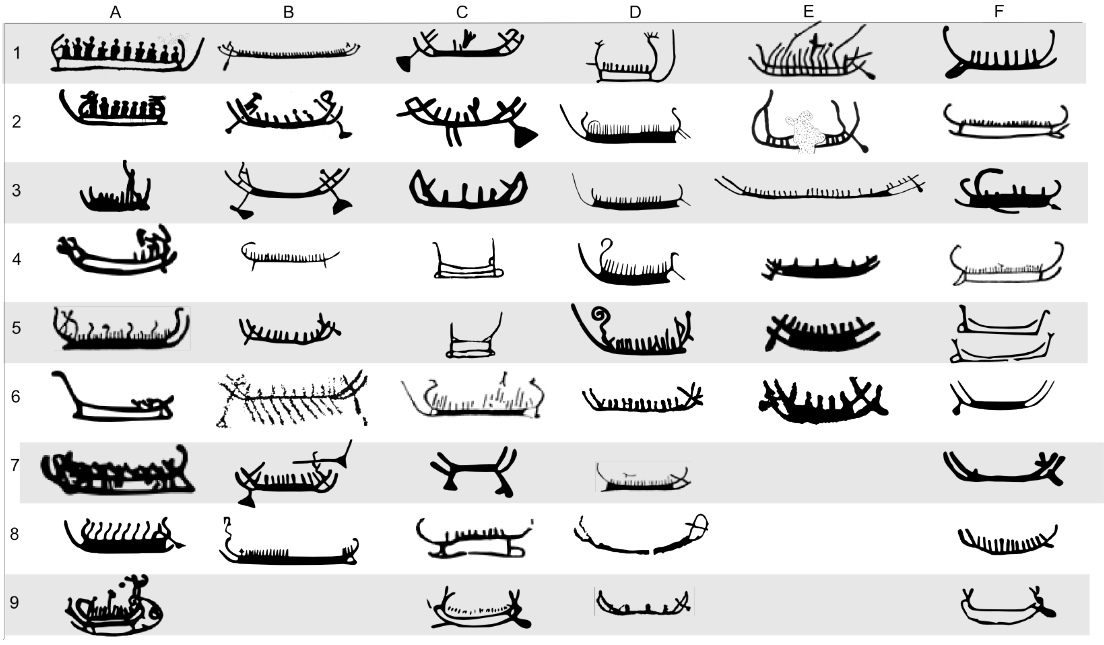


Figure 72. Examples of boats in the rock art where a helmsman, steering oar or steering oars are indicated in southern Scandinavia. Column A) <u>Possible helmsmen</u>; (A1) Kville-47 (Nordbladh&Rosvall 1981:73–74), (A2) ibid., (A3) Kville-100 ((Nordbladh&Rosvall 1981:147–151), (A4) Lösen-26 (Burenhult 1973:76–77), (A5) Enköping-176 (Coles 2000, fig.65A), (A6) Östra Eneby-84 (Burenhult 1973:149), (A7) ibid., (A8) Tanum-326 (Bengtsson&Olsson 2000:45) (A9) Lösen-26 (Burenhult 1973:76). Column B) <u>Double steering oars indicated</u> (B1) Rixö (after Hallbäck 1944:57), (B2) Askum-42:7 (Bengtsson 1997:38), (B3) Askum-17:5 (Bengtsson 1998:14), (B4) Askum-60 (Bengtsson 2002:23), (B5) Tanum-273 (Milstreau&Proøhl 1999:102-3), (B6) Bærum-88, Dalbo II (Østmo 1992:11—14), (B7) Askum-15:1 (Bengtsson 1998:11, (B8) Tanum-262 (Högberg, unpublished Vitlycke Museum). Column C) <u>Double steering devices, one in each end of the boat indicated?</u> (C1) Askum-15:1 (Bengtsson 1998:11), (C2) ibid., (C3) Dalbo I (Østmo 1990, pl. 5), (C4) Strand 41 (Fett&Fett 1941:25, pl.3), (C5) ibid., (C6) Boglösa-51 (Coles 2000, fig. 93). (C7) Askum-15:1 (Bengtsson 1998:11, (C8) Åmøy, Meling 3 (Fett & Fett 1941, pl.6), (C9) Bjørngård II (Sognnes 2001:176–177). Column D) <u>Raised steering device visible in stern or bow</u> (D1) Askum-60 (Bengtsson 2002:23), (D2) Post Hornes (after Marstrander 1969, pl.2), (D3) ibid., (D4) ibid., (D5) Tanum-326 (Bengtsson&Olsson 2000:45), (D6) Barstad (author), (D7) Boglösa-138 (Coles 2000, fig. 48B), (D8) Dalbo I (Østmo 1990, pl.5), (D9) ibid. Column E) <u>single steering oar visible.</u> (E1) Tossene-10 (Högberg, unpublished, Vitlycke Museum), (E2) Askum-17:1 (Bengtsson 1998:12), (E3) Hammer, Beitstaden (Gjessing 1936, pl. LIV; Hagen 1966), (E4) Bjørngård II (Sognnes 2001:176-7), (E5) ibid., (E6) Leifall III (Sognnes 2001). Column F) <u>rudder or steering oar</u> (F1) Tanum-57 (Bengtsson 1995:20), (F2) Hegre VII (Sognnes 2001:175), (F3) Tanum-254 (Högberg, Vitlycke museum, see also Milstreau & Prøhl 1999:70-71), (F4) Enköping-280 (Coles 2000, fig.88), (F5) Tanum-835 (Högberg, Vitlycke museum), (F6) Askum-15:1 (Bengtsson 1998:11), (F7) Tanum-273 (Milstreau & Prøhl 1999:102–103), (F8) Tossene-10 (Unpublished Vitlycke museum), (F9) Bjørngård II (Sognnes 2001:176–177).

That it is not always easy to tell which end is which, is illustrated by one of the boats from Tanum-158 picture in box B in figure 68, in which the crew appear to be facing the stern, or are they facing the bow?

Also side rudders appear within the rock art context, with two examples from Bjørngård II and Stuberg I (9C and 9F in figure 72). These appear on type K and L boats which by Sognnes (2001:51–52) dates to the Iron Age as has already been discussed in relation to the mast bearing boat at Stuberg I. It is clear however, that an earlier date for these types of boats might be a possibility.

Discussion – The Evolution of the Sail in the Rock Art

As we can see from the above, boat depictions with what can be interpreted as paddlers, oarsmen or steering devices are equally rare in comparison to those depictions that might provide evidence of early sailing. Of particular interest is the relatively few depictions of paddlers, which are found at only five sites outside of Bohuslän, and with only one site on the Swedish east coast – that of the famous Brandeskog boat. Also in the south, including for example Scania, Blekinge and Bornholm, the depictions of visible paddlers are absent. The same absence applies to western Norway. Instead paddlers in general appear to be represented as lines, the so called 'crew-strokes'. The same appear to apply to the sail which is usually symbolised in the rock art by a mast line. Just like the paddlers are sometimes depicted holding stylistic paddles, the mast are sometimes carrying a yard. Only rarely do we see the details of the crew – with the Brandeskog boat in the east and Skee-1529 in the west as prime examples. Again, there is a direct parallel with the number of boat depictions clearly showing a yard or a sail. The main difference though, lies in the fact that the depictions of masts and sails appear in most of the major rock carving areas (see figure 67).

Let us then consider how this imagery compare over time. In figure 73, above the time line, we find individual boats or types of boats as dated according to Kaul (1998:88, 97), Sognnes (2001:45–48, 54) and Ling (2008:105, 2013). I have touched upon the subject of the dating of rock art earlier in this chapter but to briefly explain these chronologies, they are all based on Bronze Age boat imagery with an emphasis on the shape of the bow and stern sections (see Bengtsson B 2003:34—36). The Kaul chronology is based on over 400 securely dated bronzes with engraved boat imagery, the study of which seems to indicate that the fashion in which the bow and stern sections were carved, happened all across southern Scandinavia, and is detectable within the archaeological context within a mere 100–200 years. Recent studies of boat imagery in both Bohuslän (Ling 2008) and Uppland (Ling 2013) in relation to the shore displacement curves for these regions appear to validate this chronology (Goldhahn 2006:23–24). Thus the imagery in the Ling chronologies let us know when a certain type of boat first could have been carved.

Returning to figure 73, the boat imagery with mast and sail like attributes that can be categorised according to any of these existing boat chronologies have been inserted below the time line. If we then look at the possible dates for the masts and sails, we can see that the imagery appears to concentrate around Montelius periods III and IV, with two possible sailing vessels already in period I and II – in Bohuslän and the area of Norrköping in Östergötland respectively. After period IV the depictions of boats with what can be interpreted as masts and sails appear to cease before reappearing again, now in western Norway around the transition between Pre-Roman Iron Age and Iron Age – a gap in time of some 800 years.

While the majority of boat depictions with mast and sail like attributes appear to show the mast positioned close to the centre of the boat, there are other possible configurations as listed in table 1, all of which could have been in use at the same time. A main problem in trying to set out a possible chronology for this type of imagery is of course the aforementioned possibility that details such as a mast or a sail might have been added onto pre-existing boats – even if this might still have been done during the Bronze Age. Skoglund (2010) has for example recently suggested that the Järrestad panel in Scania has been used and reused from about 1700–200 BC and the same has been suggested for a number of other rock carving sites (Bengtsson et al. 2005; Haupman-Wahlgren 2002:146—153). For this reason, Lundergård boat carving with its vertical line reminiscent of a mast from northern Jylland (described in Chapter 4) is of particular interest. This carving has been interpreted as having been made on the trunk of a living tree (Marstrander 1963:351–352), and the vertical line, or 'mast-line', is therefore highly unlikely to have been added after the tree was felled. The 40 innermost of a total of 150 tree rings of the trunk on which the carving appear have been C^{14}-dated to 3470±100 BP (Tauber 1968). Calibrated (Bronk

Ramsey 2009) this data indicates that the tree fell c. 1550 BC. This would suggest that the mast like imagery appeared right from the beginning of the Bronze Age. Furthermore, the fact that the imagery appear within most of the major rock carving regions on a range of different types of boats, as well as suggesting the use of different types of rigs and sail materials, is indicative of a long period of experimentation where the sail might have been used for a number of different purposes as part of every-day activities.

As for any indications of the use of double steering devices which would have been needed in order to practically manoeuvre any boat similar to the Hjortspring boat whether paddled, rowed or sailed, this can probably also be traced back to the very beginning of the Bronze Age. Sometimes it is indicated by a single crew-stroke at either end of the boat as seen on on, for example, one of the boats from Tanum-238 at Fröstorp (figure 70) or indeed the aforementioned Rørby bronze sword. At other instances, we can actually see the two steering oars/devices depicted, and although these types of depictions seem to increase during the Pre-Roman Iron Age, they are indicated already on two boats from Strand (C4 and C5 in figure 30) possibly dating to Montelius period I or even earlier.

The side rudder first appears in the rock art around AD 300, but this date is based on its first appearance within the archaeological context with Nydam 2 and 3, and an earlier date cannot be excluded.

Ling (2012:478) has recently suggested that the reason why paddlers so seldom are evident in the rock art might be because it is not the act of propelling the boats which is intended to be depicted, rather “*poses and performances*” which might be linked to military and ceremonial events. Whether this might be true or not, it is clear that evidence of propulsion are present within the rock art material and that it is only by studying the rock art material across all of southern Scandinavia that is it possible to fully appreciate the range of details attesting to forms of propulsion (sail included) and steering throughout the Bronze Age. The presence of this imagery legitimises the question of whether the sail was not only known but also used here at the time they were made. This leads on to Chapter 6, where I will try and assess whether the types of vessels we believe belong to the Scandinavian Bronze Age might indeed have been able to sail.

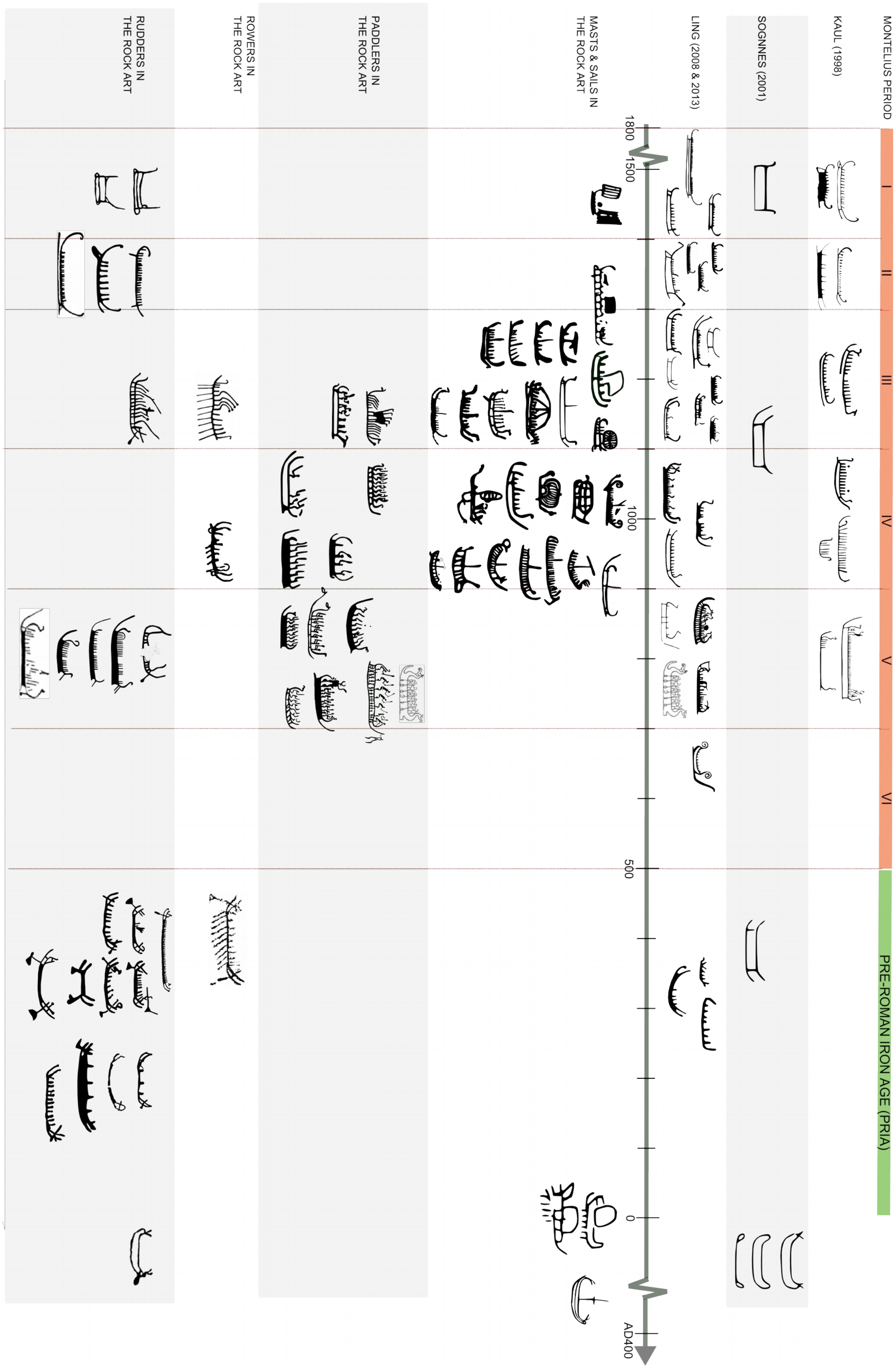


Figure 73. Tentative chronology of rock art boats featuring means of propulsion and steering.

6. Testing a Hypothesis

In the previous chapter we have examined the presence of boat imagery within the southern Scandinavian rock art tradition which has left us with the following facts; in Scandinavian rock art images there are many images of boats with a straight pole, positioned close to the centre line where a mast would normally be expected to be positioned. In some cases, these poles are furnished with yards which makes it hard to explain them as anything but masts designed for the purpose of carrying a sail. In addition to this, the presence of shrouds and even sails, further emphasises the existence of sailing boats. This imagery is found all across the southern Scandinavian region in most of the major rock carving areas and, in terms of age, appear to span the entire Bronze Age and well into pre-Roman Iron Age and early Iron Age, thus making it difficult to argue that they are either 'coincidences', 'exceptions' or 'imports'. When studying the rock art boat images across the region it becomes quite obvious that boats are being used for a whole range of activities and purposes from the transportation of goods, animals and people, to fishing and different ceremonial activities. The majority of images are extremely rudimentary but nevertheless, there is enough material across the entire region to provide us with glimpses of how boats were steered or propelled – and which not least include evidence of the use of sail.

This leads on to the question as to how the type of boat we believe belongs to the Scandinavian Bronze Age could have been sailed, starting with the boat itself.

The Scandinavian Bronze Age Boat

We know very little about what Bronze Age Scandinavian boats looked like but have to rely on various forms of indirect evidence, which aside from the rock art include images on bronze artefacts and a few ship-settings.

The rock art in combination with the ship-settings tells us that many different types of boats existed for a variety of activities, possibly alongside each other, and that some of these might have been of considerable size (Bradley 2008; Capelle 1995:71, 75; Goldhahn

1997:12; Goldhahn & Broström 2011; Rasuing 1984:70; Sognnes 2001:47; Wehlin 2013:157).

The only real indicator as to the shape or form of these vessels comes with one important find; the aforementioned Hjortspring boat (see Chapter 3). This 18m long symmetrical sewn canoe was found in a bog along with 16 paddles and a steering oar positioned at each end of the boat (Rosenberg 1937:70–71, 86–89). The boat has been dated to 350 BC, but despite postdating the end of the Bronze Age by about 150 years, its astounding likeness with many of the boats found in rock art, which share the same shape of the sheer line as well as the distinct 'beaks' or 'horns' in each end of the boat, makes it clear that the Hjortspring boat belongs to a Bronze Age boatbuilding tradition – a tradition which can be traced back to the c.1600 BC Rørby sword (Crumlin-Pedersen 2003a; McGrail 2001:191; Kastholm 2008:166; Kaul 1995:88, 1998:73–74; Ling & Uhnér 2014:36; Rieck 1994:49; Stöltig 1999:277). The same symmetrical shape and even 'horns' that this vessel possessed can be found within the rock art material, on bronzes, and is also mirrored in ship-settings (Kaul 1998:47; Wehlin 2013:269)

Skin or wood?

As briefly mentioned in Chapter 1, there has in the past been a vivid debate as to whether the Scandinavian Bronze Age boats were made of skin or wood, and therefore, whether the Scandinavian boatbuilding tradition had its origin in the umiak or the logboat (Crumlin-Pedersen 1972:112; Eskeröd 1970:23; Hale 1980:119; Marstrander 1969:150, 450; Zedig 1998:22-25). Of these two schools the latter has gained prominence today, supported not least by the recent dating of a piece of boat plank from Norway to the Pre-Roman Iron Age (Sylvester 2006:97, 2009). The possibility that the Bronze Age boats were made of plank is further suggested through the invaluable knowledge gained by the Hjortspring Guild while making the *Tilia*, a full-scale reconstruction of the Hjortspring boat, which suggests that the skills required and craftsmanship involved in building such a vessel are those of specialists with a long experience to build upon. It has been proposed that the original was most likely made in a boatyard as one in a long line of similar vessels (Valbjørn 1999:59).

Whether one can say that such boatyards might have been present in the Bronze or early Iron Ages or not, the skilled craftsmanship displayed by the Hjortspring boat certainly provides additional strength to the argument for a boatbuilding tradition originating with the logboat. Evidence that this type of boat was in more widespread use is further suggested by a pine plank, in shape similar to a Hjortspring upper crossbeam, from western Norrland in Sweden and dated to c. 220 BC or Pre-Roman Iron Age (Jansson 1994; McGrail 2001:191).

Capabilities of the Hjortspring boat

The Hjortspring boat is estimated to have weighed around 530kg, and has an underwater hull shape designed to minimise friction with the water, which indicates that already at this time some Scandinavian boats were made for lightness and speed. Sea trials, the records of which were published in 1999 (Valbjørn) and 2003 (Crumlin-Pedersen & Trakadas), have shown the reconstruction of the Hjortspring boat to be far more seaworthy than previously believed, coping with winds of up to 12–14m/s and waves of up to 1m (Vinner 2003:112–113). With a capacity of about three tons, including ballast of about 600kg and a crew of 20–25, the boat could manage a speed of 5 knots for short periods of time and an average of 4 knots over longer distances (Valbjørn 1999:56). It is estimated that on a calm day, the boat might have had a radius of travel of some 40 nautical miles (74km) (Vinner 2003:117–119).

Sensitive to Wind

In the early trials it was noted that the boat was very sensitive to wind, which, when blowing from behind the boat increased its speed by almost one knot, and the question was raised as to whether the advantage of using this extra force, for example by raising a few spears and spreading a cloak to catch it, would have been apparent to its original crew (Valbjørn 1999:56). It is clear that not only that this type of vessel would have been sensitive to wind, but also that any person standing up in it, or raising a pole, be it for ceremonial purposes or not, would have gained an understanding of the impact of the wind and its effect on the boat. This obvious speed difference coupled with the rock art imagery of boats with possible sails raises the question whether a concept of a temporary rigging device with some sort of wind catcher was employed to take advantage of this, especially if the boat was travelling over longer distances.

Developing a Concept for Sailing a Bronze Age Type Boat

The typical Scandinavian Bronze Age vessel was most probably a symmetrical round hulled sewn canoe built of wood, with double extensions or 'horns'. It had no keel and being a canoe, was less stable than the average boat we are used to today. How then, can such a vessel be sailed and what possible solutions are there for sail and rig?

One interesting aspect in this respect is the rock art sail depictions (assuming this is what they are) from Himmelstalund and Askum (see figures 35–36, Chapter 4), both of which depict sails that are wider than they are high, i.e. low aspect ratio. Similarly, many of the mast like attributes on some of the rock art boats appear to be relatively low, such as, for example, Järrestad-13, Svenneby-17 and Trosa Vagnhärad-434 (see figures 42, 43 and 47F, Chapter 4). The same sail shape is found on the much later Gotlandic picture stones from the 6th or 7th centuries AD (Nylén & Lamm 2003; Varenius 1992). These shapes would be a better solution for putting a sail on a relatively narrow and unstable boat, providing a lower centre of gravity than a sail with a high aspect ratio, i.e. higher than they are wide. A similar origin might lie behind the foldable rig solution of the boats of the Viking Era, the earliest rigs we know of in Scandinavia. The need to quickly take the rig down before the arrival of a squall, when approaching land or when navigating in coastal areas with sudden wind changes (as is common on mountainous coasts), would have been imperative in a narrow boat. In such conditions the ability to take the mast as well as the sail down would have been vital for reducing wind resistance and facilitating paddling or rowing.

Given the lightness of the vessels used and the relatively small forces a low and moveable rig and sail would impose on such a vessel, it is not very surprising that so few of the boat finds so far have shown signs of having been sailed, as the earlier described example of the Ladby and Skuldelev ships provide evidence of.

This leads to another aspect of a sailed vessel, that of a keel and a stable steering device. The presence of a keel has often been cited as a pre-requisite for the ability of a vessel to carry a sail, but, and this is an important but, there are other alternatives to a keel such as for example the use of double steering oars in each end of a vessel which could actually provide a double function as a lateral plane or 'keel'. This concept has even been adopted for use on America's Cup boats, a famous example being NZL-20 in the 1992 challenge in

San Diego. The very fact that the Hjortspring boat was equipped with two steering oars shows that this concept was known and used already in the Pre-Roman Iron Age if not earlier.

As discussed in Chapter 5, several rock art boats are equipped with double steering oars. Kaul (2003b:199) has placed these in the Pre-Roman Iron Age, claiming that this would indicate that double steering oars were not used prior this period, whereas Østmo (1992:38) quite contrary argues the possibility that double steering oars were already in use at the very beginning of the Bronze Age. When considering the sea trials in the reconstruction of the Hjortspring boat under Max Vinner (2003:104—105), which strongly suggests the double steering oars to be fundamental for a boat of this type to be practically manoeuvred and steered in a straight line with the wind across the hull, Østmo's hypothesis appears the more likely option. As will be discussed more in detail in Chapter 7, dead calm conditions generally only occur for about 11% of the time in Scandinavian waters during the summer. It is therefore highly unlikely that a boat intended for use over any longer distances would have been restricted to such moments in time.

Based on the above it is possible to set up the following criteria for undertaking valid experimental sail trials in order to try and assess how boats we believe belong to a Bronze Age boatbuilding tradition might have been sailed;

- Type of boat
  - round hulled canoe-like vessel with no keel
- Means of steering
  - steering oars in each end, acting as a 'keel' or lateral plane
- Type of rig
  - simple, easy to take down in response to changeable winds and to ease paddling
  - leaving few or no marks on the vessel
- Type of sail
  - low and wide, low centre of gravity, reducing the tilting moment

In addition to the above criteria, it is necessary that the boat is sailed by someone who is used to this type of boat such as, for example, a dinghy sailor. The reason for this is easy enough to explain. The full potential of a boat can only be deduced by someone for whom a canoe is more of a norm than say a Viking Age boat. In short, someone who understands how to use the 'instability' of a boat as an advantage just like the Bronze Age people, for whom this type of boat was the norm.

Putting the Concept into Practice

The application of experimental maritime archaeology as a means to try and answer questions regarding ancient seafaring, and its relevance, has been a matter of much discussion in the past (see e.g. Coates et al. 1995; Coles 1977; Crumlin-Pedersen 1995, 2006; Crumlin-Pedersen & McGrail 2006; Edberg 1995; Gifford et al. 2006; Goodburn 1993; McGrail 1992, 2006; Ravn et al. 2011; Weski 2006; Westerdahl 1996). Whereas many scholars agree that experimental maritime archaeology has provided a fundamental tool for the understanding of certain technical aspects of ancient boat remains, such as building techniques and the resources required for the manufacturing and maintenance of such vessels (Crumlin-Pedersen 2006; Goodburn 1993; McGrail 2006), there is still some disagreement as to how other aspects of ancient boats and their role in their contemporary society is best understood and studied, especially with regards to the building and testing of full-scale recontructions (see e.g. Crumlin-Pedersen 2006). Nor is there, as yet, any overriding guidelines, or rules, on how best to gain scientific knowledge and data from such experimental archaeological studies or projects – something which was called for as early as the 1970s (Coles 1977; McGrail 2006).

Crumlin-Pedersen (2006) has, for example, listed a whole range of problems that have to be overcome during the course of experimental projects, including how to interpret the original archaeological, iconographic or textual evidence, the standard and craftmanship maintained during the building process, and the seamanship of the crew testing the final craft – all of which have great significance for the conclusions drawn. In considering the interpretation of original archaeological boat remains, it is clear (as discussed in Chapter 4), that the 'minimal solution' (McGrail 1994:283) approach in many way limits the whole range of potential knowledge gained. In a more recent paper (Crumlin-Pedersen &

McGrail 2006), it has been suggested that the 'minimal solution' approach might be widened to that of a 'minimal reconstruction', whereby one or more skeleton models or drawings of the original boat remains are presented, taking into account variations in distortion, displacement and shrinkage. Any gaps in these skeleton models would then be 'filled in' using verified archaeological evidence and presented to a multidisciplinary panel for an open and unprejudiced discussion on how best to achieve one or more hypothetical reconstructions (Crumlin-Pedersen & McGrail 2006:57). This would include a ”*minimalistic*” way to determine *”the most likely means of propulsion and steering for the vessel”* (ibid.). Given the almost complete lack of evidence on how, for example, efficient steering was achieved in prehistory (excluding the possibility that such devices were simply handheld), and gaps in our knowledge of rig types and other potentially important equipment (also for relatively late boats dating to the Viking Period (Crumlin-Pedersen 2006:3)), it would, in my view, seem sensible to also consider more than one form of propulsion or type of rig if the archaeological material lends itself to more than one interpretation for such devices.

For example, it cannot be ruled out that a vessel such as the Hjortspring boat could actually have been sailed – the presence of rock art boats with details that might indicate the use of sail during the period, the presence of 'mast stones' in several Bronze Age ship-settings, perhaps indicating single or bipod masts (pers. Communic. von Arbin 2004 and see e.g. Halldin 1950:81 fig. 126; Manneke 1967:43–52; Nylén & Manneke 1961; Rausing 1984:49; Zerpe 1998b, 2002) in combination with the presence of four integral cleats at the top of each each end of the actual vessel, as well as the potential lateral plane that might be provided by the two steering oars in the bow and stern end – might suggest otherwise and would need to be fully considered before forming any such judgement.

How then might the above mentioned criteria of how to sail a boat of a Bronze Age boatbuilding tradition, and by extension a boat such as the Hjortspring boat, be tested? In a comprehensive paper on principles and methods of experimental boat archaeology by John Coates and nine British colleagues (Coates et al. 1995:294), it is argued that if the aim of a project is limited to certain aspects of performance of a boat, a suitably ballasted plastic hull of the authentic shape would do for carrying out such tests, since it would clearly be governed by physical laws and therefore relatively easy to simulate and test. This 'hypothesis-and-testing' approach has been criticised by Crumlin-Pedersen (1995, 2006:2–4) for not allowing for all the conceivable variables that inevitably would apply to the testing of a vessel built with the use of ancient boatbuilding methods and materials (and which might affect the outcome of such a test with perhaps misleading results). Thus, Crumlin-Pedersen (2006:4), believes such an approach is incompatible with a research project such as that of, for example, *Roar Ege*, but he does concede (1995:305) that certain "*physical properties*" of a vessel, such as its stability and speed potential, might be successfully assessed out of its original context. Where money is limited and the availability of full scale reconstructions of ancient boats are scarce, perhaps a combination of these two approaches might be the answer for testing the hypothesis that Scandinavian Bronze Age boats might have been sailed. The stability of a vessel rigged with a relatively low and wide sail and the usefulness of two steering oars as a lateral plane are clearly two aspects governed by physical laws, whereas the ability to manoeuvre and sail such a vessel would be governed by the ability of the crew. It is, however, also clear that, ideally, the concept should be tested on an 'authentic' vessel as well as in an 'authentic' environment allowing for a comparative assessment.

In fact, the two approaches might actually not only be compatible but also work in conjunction and thereby facilitate an understanding of how ancient vessels might have been used in their contemporary society. The so called 'hypothesis-and-test' approach might successfully be applied not only to testing aspects of boats that are governed by physical laws, but also to other types of equipment in cases where it can be verified that modern substitutes are equivalent and not better than ancient materials of the relevant time (Crumlin-Pederson 2006). With this in mind, the aims of the below experimental boat trials are three-fold;

1) to test the validity of the concept of sailing a 'Bronze Age type vessel' as outlined in the criteria above, using the simplest possible methods and technology that can be argued might have existed in the Scandinavian Bronze Age

2) if the concept is proven valid, test the practical use of such a concept in an authentic environment,

3) transfer and carry out similar tests on the reconstruction of the Hjortspring boat to see how well this boat responds, given the fact that Bronze Age boatbuilding technique resulted in flexible hulls that might not cope with the additional stresses of a sail.

Boat and Equipment

The first on-water experiments to test the concept were carried out in August and September 2005. Originally, the idea had been to try and assess the whole spectra of sail types and mast positions that some of the rock art imagery seem to indicate (see Chapter 4). However, this was quickly abandoned as it would have been too time consuming but also because it does not really provide any additional 'evidence' as to whether or not the boat could actually sail – how a boat is rigged and what type of sail is used is a secondary issue to whether it can sail at all.

Therefore, the emphasis of the trials were to evaluate the concept whilst at the same time keeping it time and cost effective. This makes planning extremely important as well as the understanding of what factors or parameters are important in order to assess the 'accuracy' or 'authenticity' of a sail trial. For example, one question that arose was what was more important, the material of the sail or the ability of a crew to control the sail? Needless to say both are important. Fabric used for sailing should be as light and air tight as possible but there are many different solutions to this problem as has been proved by many an experimental sail trial in the past (Gifford & Gifford 2004; Johnstone 1972; Nylén 1986; Österholm 2002). However, sailing, by definition, is the ability to harness the wind as a means of propulsion, which in essence means the ability to control the sail according to the wind in a desired direction. The same thing can be said about a paddle; a paddle will work as a means of propulsion irrespective of its shape, although its efficiency might vary.

The Boat – a Canoe

As an alternative to the more expensive and time-consuming construction of a purpose-built hull, a survey was conducted to identify a boat with a hull form similar enough to that of the Hjortspring boat for the purposes of experiment. After considering several alternatives, a half fabricated Canadian canoe was chosen, a type of vessel which had incidentally been cited in the past as probably being very similar in both shape and dimensions to the Scandinavian rock art boats (Strömberg & Strömberg 1989:15). This particular boat, however, was made of glass fibre reinforced plastic (GRP) and came straight from the mould, making it easy to configure to our requirements.

Although the hull shape of the canoe in question was slightly more U-shaped than that of the *Tilia*, thus perhaps a little more stable, the L/W-ratio (table 3) and the slight V-shape in the bow and stern ends, perhaps the most important determining factors for assessing stability, were similar enough to make a valid comparison (certainly in view of the inevitable variability there must have been in Bronze Age watercraft). The stability of a vessel under sail can be likened to a person's stability when riding a bike. Although, due to different mechanisms, a narrow boat is similarly less stable when paddled, or rowed at slow speed, but more stable as speed is increased.

Data	**Canoe**	**the *Tilia***	**The Hjortspring boat (Johannessen)**	**Sources**
Length of hull	5.05m (p to p)	15.5m (from paddle to paddle -p to p)	13.61/18.6 – 19.6 (horns included)	Crumlin-Pedersen 2003b:36; McGrail 2000:192; Rosenberg 1937:92, part III
Length of waterline (L)	4.7m	9.5m (empty), 14m (crew-1400kg + 600kg ballast)	12.5/14.5	Crumlin-Pedersen 2003b:36;; Rosenberg 1937:92, part III; Vinner 2003:105
Width (W)	0.85m	1.9m (wash strakes not included)	2.04m (including wash strakes)	McGrail 2001:192; Rosenberg 1937:92, part III
Depth (D)	0.313m	0.7m	0.71m	McGrail 2001:192; Rosenberg 1937:92, part III
L/W-ratio	5.56	5 (empty)/ 7.37 (with crew + ballast)	7.1	
L/D-ratio	15	13.6 (empty) / 20 (with crew + ballast)	20.4	
Weight (hull)	40kg	c. 530kg (it has never been weighed)	c. 530kg	Vinner 2003:105

Table 3. A comparison between the canoe used for initial sail trials and the Tilia, a full-scale reconstruction of the Hjortspring boat. Johannessen's original measurements are also included.

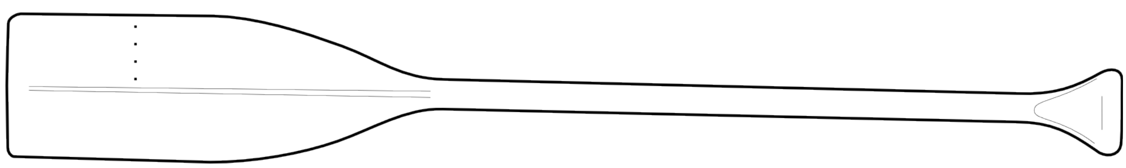


Figure 74. The standard pine paddle used for the sail trials in the canoe. The blade is 47.5x16cm from the end of the shaft down.

The 'Steering Oars'

In order to be able to attach steering oars in a manner similar to how the oars might have been secured on the Hjortspring boat (tied onto the side of the 'horns'), the canoe was equipped with 'horns' cut out of plywood to imitate the upper horn and small retaining hooks just above the waterline to correspond with the lower horn.

For steering oars standard wooden paddles of pine that can be bought in most boat chandleries in Northern Europe were used (figure 74). The forward oar was tied in order to be kept completely straight and was not used for active steering during the trials whereas the aft steering oar was equipped with an arm, again cut out of plywood and extended with a naturally curved stick so as not to interfere with the stay. The reason for this simply being that it would not have been practically possible to do it in any other way as the helmsman has to sit on the floor in the stern of the boat.

Rig

The parameters for the rig dictated something lightweight that would be easy to raise and secure without leaving marks on the hull and which could be easily taken down and folded away (figure 75). This in addition to the need to quickly be able to move the positioning of the mast in order to find the proper balance between sail and steering during sail trials, made the use of a bipod mast the simplest choice. This would also reduce the need to attach extra fittings to the boat, or shrouds to support the mast athwart. For material, several kinds of wood could have been used but bamboo (c. 2cm in diameter) was chosen as it was easily cut to the right size and shape and secured with twine, thus vastly reducing preparation time. The same material was used for the yard.

The Hjortspring boat is equipped with a series of four integral cleats located on the upper part of each of the stern and fore ends, each with a rectangular hole about 25×10mm running through it, and large enough for holding more than one rope (see figures 18 and 85D)(Rosenberg 1937:75; Valbjørn 2003a:74–75). The exact purpose of these cleats is not known but according to one hypothesis they could have served as attachment points for a trussing rope, used to increase lengthwise stability. This is what they were used for during the initial sea trials in the *Tilia* (Valbjørn 2003a:74). However, the hypothesis has not been

Figure 75. The foldable bipod mast used for the canoe sail trials. Top picture, Björn standing on the pontoon with the canoe and its bipod mast up. Bottom picture, the canoe pulled up on land with the rig folded away. Photos: Boel Bengtsson.

convincing as the trussing rope, which is tightened through twisting with the end of a stick, consistently became slack by the end of each day on the water (Valbjørn 2003a:82) and also proved a hindrance for the crew in moving from side to side in the vessel, although it was found to ease movement forwards and backwards as something to hold on to for less experienced passengers. However, an alternative use for these cleats, and for which they appear to be perfectly positioned, is as attachment points for stays, holding up a temporary mast. Therefore, the canoe was equipped with similar attachment points.

As for ropes and fastenings, the criteria was to use something that in terms of handling would have been similar to what would have been available in the Bronze Age; examples of possible materials would have been yew, linden bast (bark fibres of the small leaved lime *tilia cordata*) and nettle.

Linden bast is excellent rope material in a wet environment and actually shrinks a little when wet, making it more resilient than most modern ropes, although its breaking load is considerably smaller. This does not seem to have been a problem as it was used on Viking rigs (Magnus 2006:28–29). Samples of ropes made of bast were also found with the Hjortspring find and, although only imprints were preserved of the rope used to sow the boat together, two corded ropes of linden bast has since been used to great effect for sowing the *Tilia's* hull together (Valbjørn & Rasmussen 2003:64–65; Fenger & Valbjørn 2003:95). Indications such as these show that the ropes available in the Bronze or early Iron Ages with all probability would have been strong enough to be used for a rig or for tuning a sail. Furthermore, tests made by Southampton university show that ropes made of yew are equal to, for example, modern 8-plait pre-stretched polyester ropes both in terms of strength and elasticity (Gifford et al. 2006:59). Therefore, the use of modern substitutes for ropes appear to be of little significance for the outcome of the sail trials described here, especially given the relatively small dimension of the rigs and sail in question and hence the relatively small forces involved.

The Sail

There is no doubt that sail material was available to Bronze Age Scandinavian society, wool and nettle (Randsborg 2011; Wehlin 2013:187), leather as well as different types of matting, and if it was possible to make clothes it would also have been possible to make sails. Considerable research has gone into the materials of early sails, mainly at the Viking ship museum in Roskilde, where for example it has been proven that wool impregnated with the right amount of sheep-tallow or horse-fat together with a mixture of birch bark, can be made as efficient and durable as sail cloth made of cotton or duradon (Andersen E 1995:255—256, 258; 1997:210—211; Vinner 1997:256—257). Therefore, for the purpose of the initial sail trials in the canoe, a square shape from a well used dinghy sail was cut out, resulting in a completely flat and shapeless sail.

The shape of a sail makes a fundamental difference to its effectiveness. Anyone who has sailed a dinghy with a sail trimmed the wrong way can testify to this. A flat sail will not allow the wind to flow around it and, instead of creating a force that can be used to propel the boat forwards, has a tendency to create turbulence, which will slow the boat down as well as making it hard to trim (see e.g. Marchaj 1982). A cloth that is softer and more elastic than the modern fabric we used might actually be more effective in this respect as it would automatically get a shape from the pressure of the wind. Thus, it can be argued that the choice of fabric had little significance on the outcome of the experiment described here.

In order to attach the forward clew of the sail without having to drill any holes (thus leaving marks) a stick, very similar to a beitáss, was used, which could be secured by holding it down against the sheer line (Åkerlund 1956). At the end of this stick, a notch was made into which the rope, where it was attached to the clew, was placed. This proved to be a perhaps overly simple way of securing the clew, but it worked. However, once the right position for the clew was identified it became easier to attach a simple hook onto the sheer strake for the same purpose. One has to bear in mind that a similar solution on the Hjortspring boat would be much easier as it has so many natural attachment points with its many integral cleats and thwarts.

Sailing the Canoe

The sail trials in the canoe were carried out in the archipelago on the Swedish west coast, just to the north of Gothenburg. This landscape is very similar to that in which the rock art was carved and the stone cairns and barrows were built in the Bronze Age, and the shallow and sheltered waters, with a tidal range of only 20cm and relatively small currents, create an ideal nursery for early experimentation with sail. In fact, several large stone cairns can still be found at the highest points of the peninsula from where the picture in figure 76 was taken. In the Bronze Age, when water levels were some ten metres higher than today, these cairns were situated on small islands so it would have been an environment through which early Bronze Age seafarers certainly travelled by boat.

The configuration of the canoe was already during the very first on-water trial found to be usable, whereupon the aim shifted towards getting a feel for balance, boat handling and manoeuvring, and then to assess its performance on different tacks. For this purpose a series of short sailing trips of 10–20 minutes were made. This is a very efficient way in which to carry out sail trials as each trip can be evaluated and the necessary changes made before beginning the next trial and so on. Once the boat became more familiar, a longer four hour sailing trip was made further out in the archipelago to assess the practicality of the set up, the changing from sailing to paddling and vice versa.

Figure 76. Picture from the top of the Lilla Överön, overlooking the area where the sail trials in the canoe were undertaken. The photographer is standing in front of a Bronze Age cairn looking to the west. Photo: Björn Bengtsson.

For recording purposes, a GPS was carried on-board to record the course but wind direction and wind force were assessed through past experience rather than exact measurement while sailing (this is based on over 15 years of competitive sail racing on high international and Olympic level). Thus, there was no need to record either true or apparent wind.

Balance

Trying to balance a canoe with a depth of 30cm and a sheer line that is only some 15cm above the sea level is hard to appreciate before having actually experienced it. However, despite limited space, and no halyard, the act of hoisting the sail proved not to be as difficult as anticipated (figure 77).

Once the wind filled the sail, the canoe became very steady and on a set course never felt unstable. Throughout the trials the crew sat on the bottom of the boat trying to keep the bodyweight low, but never had to lean their bodies sideways more than vertically to compensate for any heeling, not even in winds of 10–14m/s which was a surprise.

Figure 77. Setting the sail in the canoe. Photo: Vivian Leke.

Performance and Manoeuvrability

An important aspect of the rig is that it is so low, with a centre of gravity a mere 1.4m above sea level. The closer the wind is to the water, the more friction it will be subject to, which explains why modern sails are made increasingly higher to catch the stronger and more stable wind higher up. This means that the actual force on our sail is relatively smaller than a sail of higher aspect ration or one that is hoisted higher on a mast. Despite this, the performance of the boat under sail was far from bad, although, given the fact that there is generally less wind closer to the water, a much larger sail area could probably have been carried which potentially would have increased the boat speed considerably. For example, in near ideal paddling conditions, with a light breeze of about 3–4m/s, which, due to increased friction would result in an equivalent wind speed of around 2–3 m/s at the height of our sail, the speed achieved under paddles was 3.7 knots (table 4). For how long this speed could have been maintained is uncertain as we are no paddling specialists, but by hoisting the sail a speed of 2.5 knots could be maintained without having to work at all.

The point is, with a larger sail, this speed difference could easily have been made much smaller without the risk of the boat being overpowered. For most other wind conditions, unless of course the wind comes from around the very direction to which you wish to travel, using a sail will bring you there more quickly and without the need for any physical exertion.

Test run	Wind strength	Max. Speed beat/run	Tacking angle	Paddling speed (max)
1	4–7m/s	2.5 knots	52.5 degrees	3.7 knots
2	5–6m/s	2.8–3.5/4.9 knots	45–50 degrees	-
3	8–10m/s	2.8–3.8/6.3 knots	-	-

Table 4. Data for three of the test runs made in the canoe.

	Length of mast (m).	Length of yard (m).	Weight of mast (kg)	Weight of yard (kg)	Sail Area (m^2)	Width of sail (m)	Height of sail (m)
Canoe	1.58 , ¤1.38	2.57	0.8	0.4	3.25	2.5	1.3
the ***Tilia***	4.35	7.5, *5	24	8	20, *15	5	4

*Table 5. Data for rig and sail. ¤ the initial height of the mast used for sail trials in the canoe. *indicates what was used during the trials in the Tilia. The weight of the rig used for the canoe was insignificant*

During the test runs recorded in table 3, a shorter, 1.38m high mast was used (table 5), but when the wind increased to above 8m/s the sail was found to be harder to control, and the boat had a tendency to slide sideways rather than accelerate in the gusts. Therefore, the mast was lengthened by 20cm. This new set up enabled a tighter forward leach and better control of the sail, a difference that was especially noticeable when it was windy, enabling sailing in winds of up to 12–14m/s (see top image in figure 78) without losing control.

Figure 78. The top image show the set up of the sail with a 20cm taller mast which made the sail much easier to control in comparison with the set up on a lower mast, shown in the bottom image. Photos: Vivian Leke and Britt Bengtsson.

Unfortunately, the GPS was not on-board during this last test run, but it is very likely that the boat would have had an even higher maximum speed than the 6 knots plus previously recorded. The difference in the set up of the rig is easy to detect when comparing the two images in figure 78.

The highest speeds were achieved on a broad reach (see maximum speed in table 4) which was no surprise but interestingly, after the initial familiarisation, the boat was found to be able to sail towards the wind, with an angle of 60–63 degrees to the wind. This is evident by the GPS readings of the two test runs in figure 79.

Once the rudders were firmly attached, steering became very easy, but it was apparent that double steering oars were necessary, even for steering on a dead run. It is possible, had the rig been placed further forwards on a run, that a forward steering oar might have become redundant, but this was certainly not the case with the rig just forward of centre of the boat. Sometimes in the gusts, the aft steering oar lost its 'grip' or steering ability. This did not happen very often and only for a second or two, and steering was always regained without any accidents. A possible explanation for this phenomenon is the shape of the paddles which, from a hydrodynamic perspective, were far from ideal.

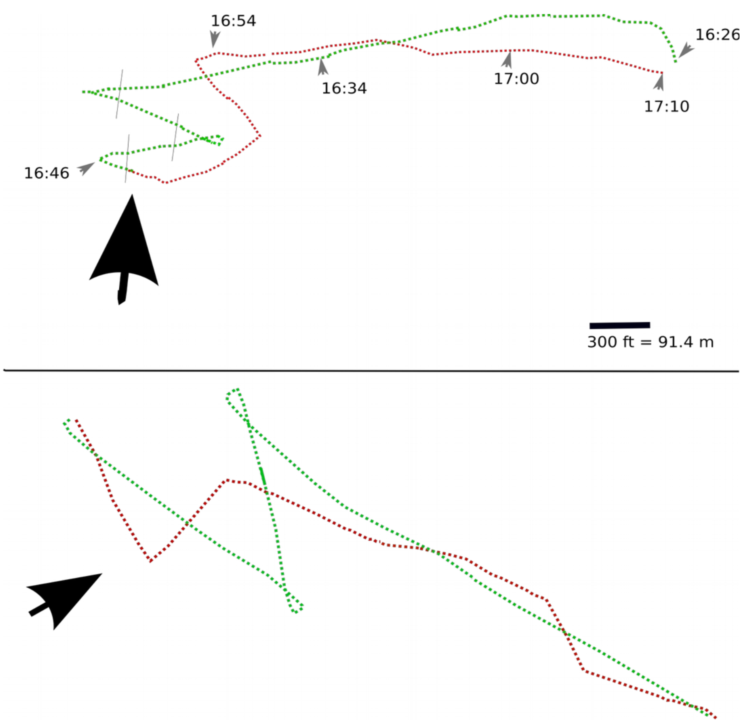


Figure 79. The GPS tracking for two of the test runs in the canoe. The back arrows indicated the direction of the wind.

Initially, a lot of ground (up to 14m) and speed was lost in the tacks, but with better timing and by using a paddle to help the bow through the eye of the wind, this was greatly improved (as can be seen on the GPS data in fig. 79). Generally, less speed and ground was lost tacking through the wind than when 'gybe tacking', i.e. bearing away from the wind, gybe, and coming up again on a new tack.

As part of the evaluation, a longer sailing trip was made to the outer part of the archipelago and back, with a simple goal; to get back to the starting point without having to paddle more than absolutely necessary in a wind of about 3–4m/s. The voyage out was easy, with the wind coming from the south east (see the green line in figure 80). Coming back, the rig was taken down in order to paddle through a narrow gap between two islands and then quickly raised again to continue on a starboard tack. During this beat (sailing upwind), the wind veered slightly to the right (to the south), which was noticeable on the following tack

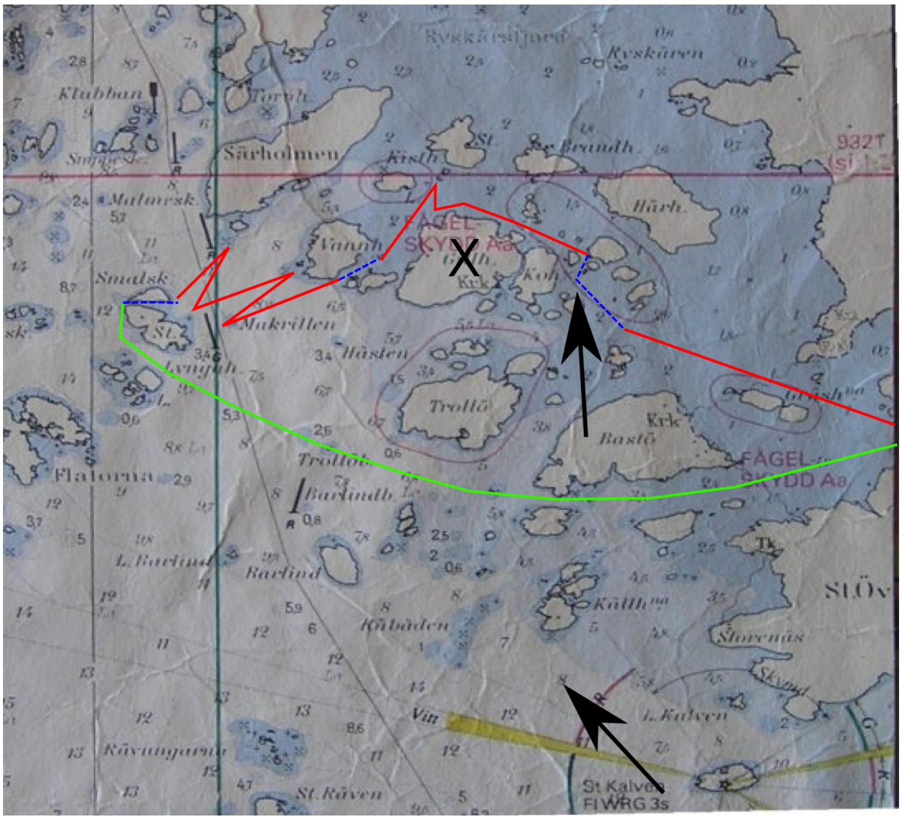


Figure 80. Chart of the area in which the sail trials in the canoe were undertaken, on top of which the GPS tracking of the long sail journey is superimposed. The black arrows indicate the wind directions which veered during the course of the day from the south east to the south. Green line indicate the journey out and red lines, the journey back. Blue dotted lines indicate where the canoe was paddled.

back on port. Approaching the islands around Gillholmen (marked with x in figure 80), the wind became very light and gusty and finally disappeared completely behind the islands. This made it necessary to recommence the paddling until the wind returned, when the sail was set anew. At this point, the wind had continued to veer to the south (right) and paddling had to be resumed in order to get through some further narrow gaps between the islands. This time, the paddling was kept up until a point from where it was possible to sail all the way to the point of departure some 4 hours earlier was reached.

Sometimes it felt almost unreal to sail past the type of smooth cliffs that on higher ground are adorned with rock art boats (figure 81). However, for two 21st century sailors the temptation to keep the sail up for as long as possible was obvious and on at least one occasion we stubbornly tried to keep on beating instead of taking the sail down and beginning to paddle. This was one of the greatest insights of this trip – the need to think in a manner that was unusual for sailors used to modern equipment and modern methods of sailing in order to use the available technology to its full potential. Over time, and with more experience of when to paddle in order to keep the sail up for longer distances, this approach to sailing would no doubt have become much more natural.

Figure 81. Sailing along close to the glacially smoothed cliffs in the archipelago of the Swedish west coast. Rock art imagery has been superimposed to create a feel for how it might have been experienced in the Bronze Age when the sea level in this area was some ten metres higher. Photo: Britt Bengtsson.

When it was time to land, both steering oars had to be loosened so as to avoid running aground, and therefore it became necessary first to take the rig down. Perhaps this is the reason why we so seldom see boats with the sail up on the rock carvings, or why the few boat images where we can see the steering oars almost without exception show them in a position where they are ready for landing or departing.

Transferring Results to a 'Bronze Age Type Boat'

The conclusion from the above sail trials is that the concept that was set out to be tested works and that, using only very basic technology and equipment, it is possible to travel long distances by sail with relative ease within the sheltered waters of an archipelago. The next step was to transfer the same concept to a full-scale copy of a 'Bronze Age type boat'. With this in mind, the Viking Ship Museum in Roskilde was contacted, who in turn made the introduction to the Hjortspring guild who had built the *Tilia,* a reconstruction of the Hjortspring boat. After an introductory meeting in December 2005, the guild agreed to help and preparations began for the '*Tilia* for Sail', project. An initial date for on water trails was set for August 2006 on the primary condition that the safety of the *Tilia* was in no way to be compromised, a matter which the guild was to have full control of.

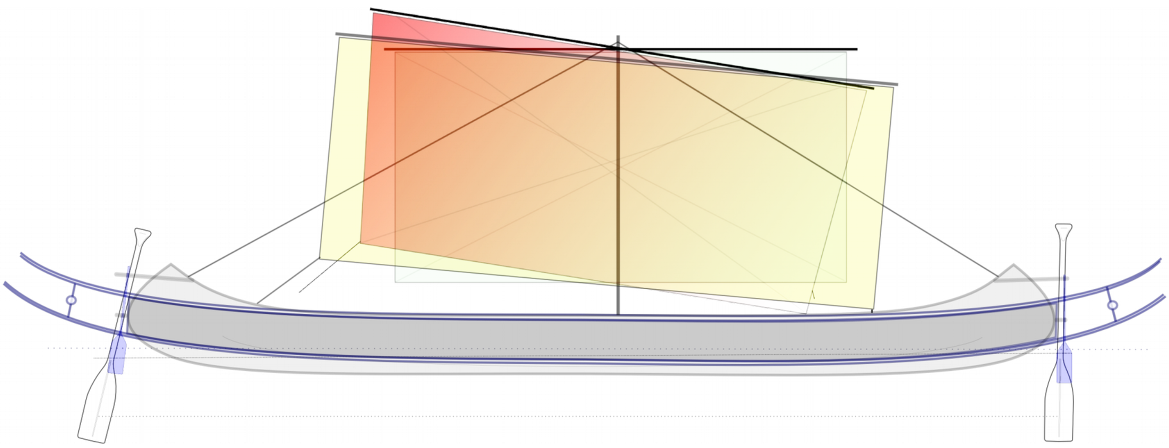


Figure 82. Johannessen's drawing of the Hjortspring boat projected over the canoe. The larger steering oars represent the ones used during the sailing trials in the canoe, whereas the smaller represent the ones on the Tilia. Also notice the difference in the size of the sails, where the two smaller represent the smaller sail used on the Tilia, whereas the larger sail represent the size used on the canoe.

The data from the trials in the canoe were transferred by simply projecting the canoe over the Hjortspring boat, which provided the equivalent lengths for the rig and an approximate size of the sail (figure 82, table 1). This data was analysed and discussed whereupon modifications were decided jointly. Apart from these aspects, we agreed to provide a sail, ropes, documentation material along with three experienced dinghy sailors to lead the actual sail trials, whilst the guild were to build the mast and yard, as well as provide a crew and a boat to act as a tender.

Main Differences

The main differences between the Hjortspring boat as Johannessen sketched it and the *Tilia* is that the latter has a much more curved profile (Fenger 2003:91). This means that the *Tilia* has a much shorter water line and that less of its v-shaped hull sections at the stern and bow are below the water line where they could act as a 'keel' or lateral plane. Therefore, the sailing ability of the *Tilia* might potentially be worse than that of a reconstruction of Johannessen's boat or the canoe, both of which have a straighter sheer line.

Another important difference concerns the size of the steering oars in relation to the overall size of the two vessels, where the steering oars used on the canoe are proportionally much deeper and wider (figure 82). The steering oars made by the guild are based on Johannessen's drawing which depicts them with shafts that are 3.4cm in diameter, and blades that are 23cm wide and 53cm deep, but only 36cm from the widest points down (Rosenberg 1937:86-88). The guild has made theirs with slightly deeper blades, 53cm from the widest point down, 75cm in total, but with the same thickness. Of the original steering oars, four pieces were found, including a 10×10cm piece that has not been able to be joined together with any of the other pieces (Crumlin-Pedersen 2003b:33, fig. 2.16; Rosenberg 1937:86–88). This leaves some room for interpretation, in particular regarding the overall length of the blades. Thus, overall size of the steering oars used for the sail trials are within the margin of error, but could be regarded as small for the task at hand.

Working with a Model

In order to determine the positioning of rig and crew in relation to the practical aspects of hoisting and tuning a sail, a rig model at a scale of 1:10 of the size of the Hjortspring boat was built; in effect a piece of plywood on which the outline of the Hjortspring boat was drawn, equipped with a miniature rig made of wooden plant sticks, thin twine for ropes and a sail made of the thinnest fabric available (figure 83). This enabled the testing of sails and manoeuvres through all wind directions by means of an electric fan.

Using the model, it was estimated that in order to sail the boat without prior experience of the vessel, a minimum of seven people would be ideal; two for the steering oars, one for hoisting the sail and taking it down quickly in an emergency situation, two to secure the clew of the sail in the forward part of the boat (the heaviest job on-board) and one person on the yard. Furthermore, one person would be needed for trimming the sail who would also give the orders on-board – a natural pairing of tasks as this person directly feels the power in the sail and quickly can relay this to the rest of the crew. The crew number needed for sailing compares well to the numbers needed for paddling as paddling trials had shown that a minimum of eight people would be needed to master it satisfactorily when carrying a ballast of 600kg (Vinner 2003:108, table 3.4).

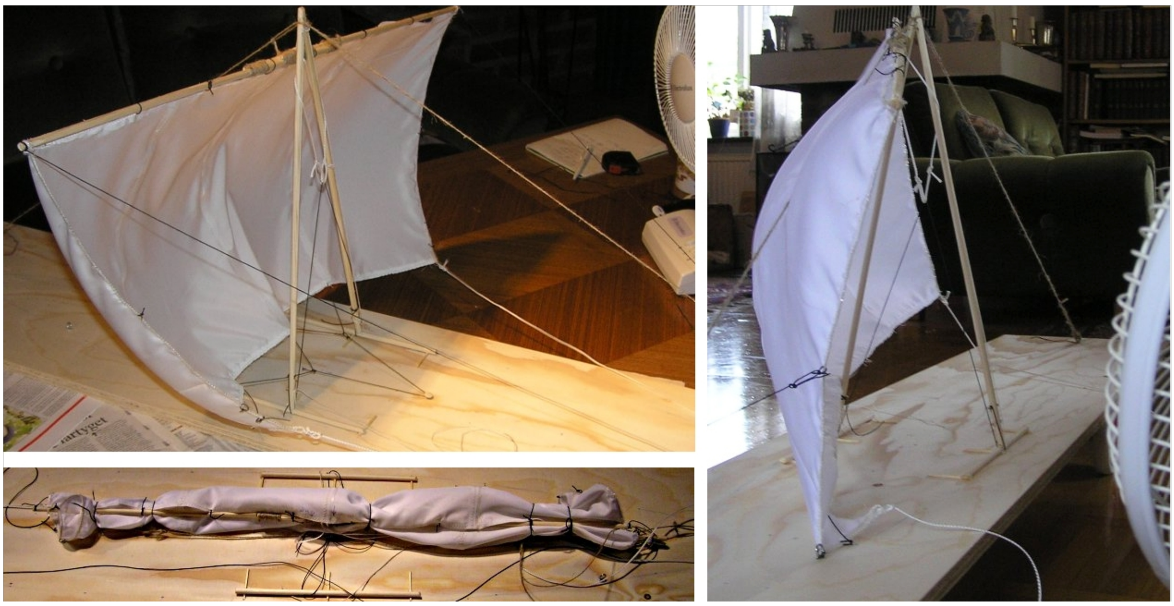


Figure 83. The 1:10 rig model of the Hjortspring boat that was used to prepare for the sail trials in the Tilia. Here the largest sail area of 28m² was tested. For the actual on water trials a smaller 20m² sail was used. Photos: Boel Bengtsson.

The Sail and Rig

In order to gain an appreciation of the kind of forces the wind would exert on different size sails rigged onto the *Tilia*, a sail maker (North Sails in Gothenburg) as well as a Nasa website (http://www.grc.nasa.gov/WWW/K-12/airplane/foil2.html and) on aerodynamics were consulted. The result is presented in table 6, with given wind intervals on the left hand side and the size of the sail at the top. For the smaller size sail the effect of a lower yard, i.e. a lower aspect ration and centre of gravity is included in the calculation. The formula is based on a crew of six people with a total weight of 420kg and no ballast, and relies on an active crew for balancing the boat by moving all the way to the windward side when necessary, resulting in a righting moment of 4120Nm when fully used. If then, the *Tilia* is allowed to heel up to 8 degrees, the righting moment would increase to about 4920Nm (figure 84). Based on this the following criteria were set up as to how the *Tilia* should be sailed keeping maximum safety margins:

Always be sailed entirely upright, without any heeling.

1. When heeling occurs it should only be allowed for short moments – crew responding immediately.

	$28m^2$	$24m^2$	$20m^2$	$16m^2$
6m/s	**2566Nm** 885N×2.6+885×0.3	**2047Nm** 758N×2.4+758×0,3		
8m/s	4375Nm	3491Nm	**2695Nm** 1078N×2.2+1078×0.3	**2242Nm** 862N×2+862×0.3
10m/s			4362Nm	3653Nm
>10m/s				

Table 6. The coloured areas indicate the following:

***Medium Grey/Green**: The sail area is probably safe to sail with and provides enough force for sailing towards the wind.*

***Light Grey/Yellow**: The sail area is getting a little harder to use and requires a more skilled crew.*

***Dark Grey/Red**: The sail area requires a coordinated crew for the given wind strength. The loads are high.*

***Black**: There are no safety margins even for a skilled crew for the given wind force.*

2. Sideways lateral balance is sustained through;

    a) transferring the weight of the crew

    b) easing the sheet while trimming the sail

3. When the entire crew is positioned to windward and the sheet must be eased more than momentarily to maintain the balance, the sail should be reefed.

4. In unstable and gusty wind conditions the sail should be trimmed for the strongest gusts.

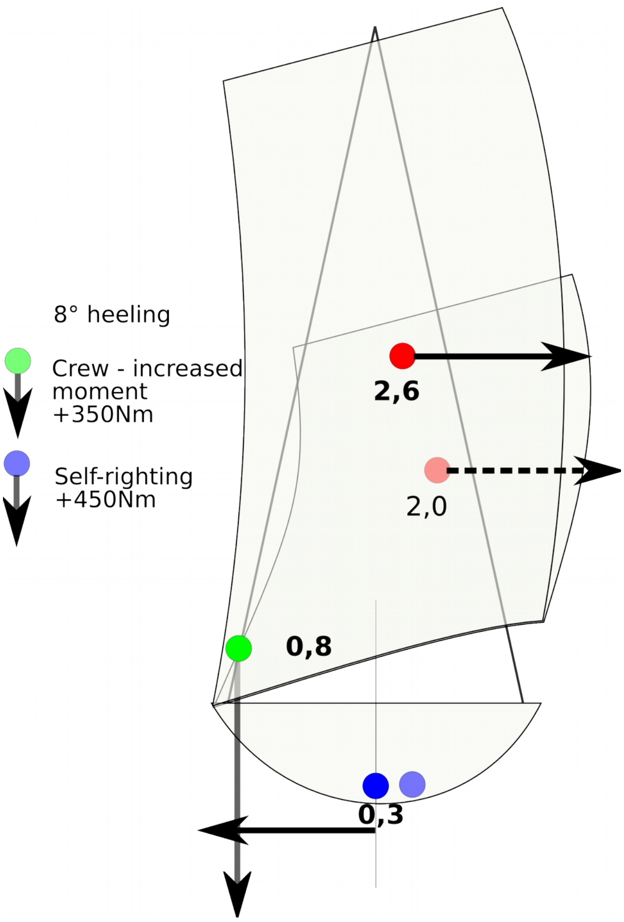


Figure 84. The estimated forces exerted on the Tilia under sail which serve as a basis for the calculations in table 6.

In table 6, the calculation is based on the force at 90 degrees onto a sail area of 16–28m^2, with a depth of 13%, trimmed to provide maximum force i.e. just about overpowered but never stalling (letting power out of the sail by steering into the wind). The fact that some of the force is directed straight forward is not taken into consideration.

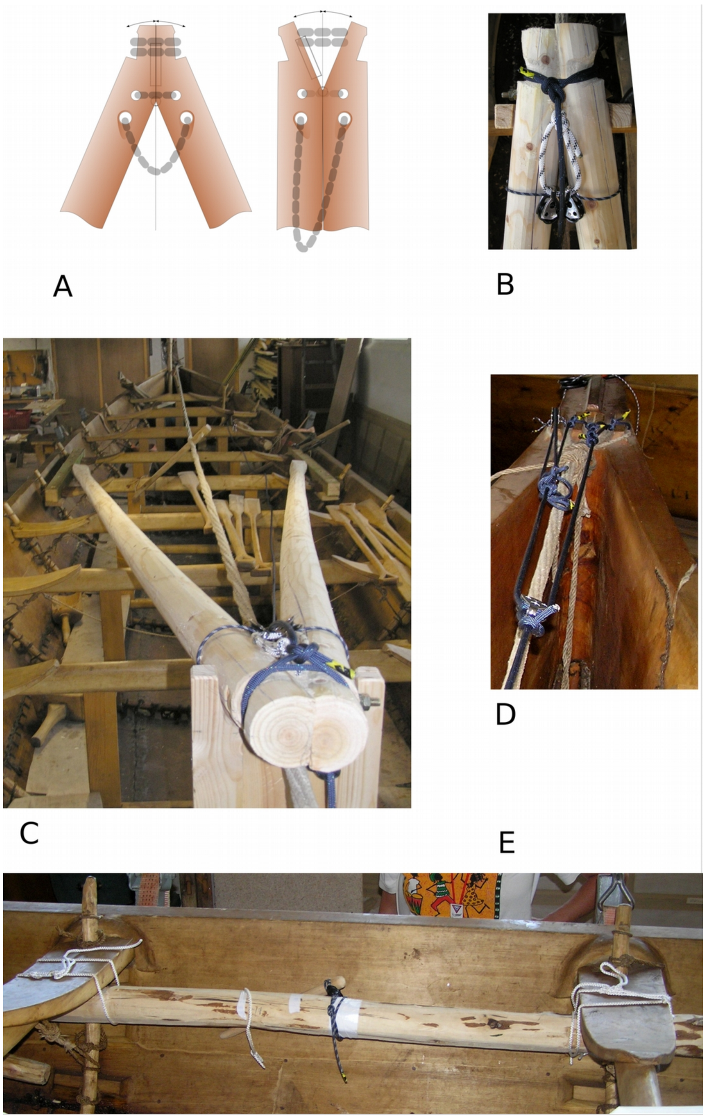


Figure 85. A) the initial drawing made of the top of a foldable bipod mast including a main halyard; B) the bolted version used for the actual sail trials.; C) the mast in its resting position. Note the square planks to which each mast foot is attached, which distribute the weight and force across two of the internal frames; D) the white trussing rope and the blue forestay are both attached to the same four integral clamps on the upper part of the stern and fore end of the Tilia; E) the arrangement for fastening the clew, again distributing the forces across two internal frames. The wooden peg attached to the middle is simply inserted into the clew of the sail and secured flushed to the log with a looped string. A solution both simple and safe. Photos: Boel Bengtsson.

Due to safety concerns the size of the sail was reduced from the original estimated size of $28m^2$ to $20m^2$ – in the hope that a larger sail might be used in further trials. In addition to this, reefs were sown in to enable further reductions. In contrast to the sail used on the canoe which was entirely shapeless, it was decided to include some shape for the sail used on the *Tilia* (13% depth), mainly because this would make the initial trials safer due to easier handling and trimming. The sail cloth and leach rope were the cheapest on the market in addition to which the simplest possible reefing system comprising of a row of two strings attached on each side of the cloth, parallel to the foot of the sail was inserted.

The mast, consisted of two pieces of larch-tree, 8cm in diameter and with a total weight of 24kg. The yard was of slightly less diameter and tapered towards the ends with a total weight of 8kg. This means that the mast in itself was quite over dimensioned as well as being heavy. Having so much weight high up in the rig might affect the stability and balance of the *Tilia* but it was decided to give it a go rather than trying something that would prove too weak, especially for early trials. For the purpose of these early trials the

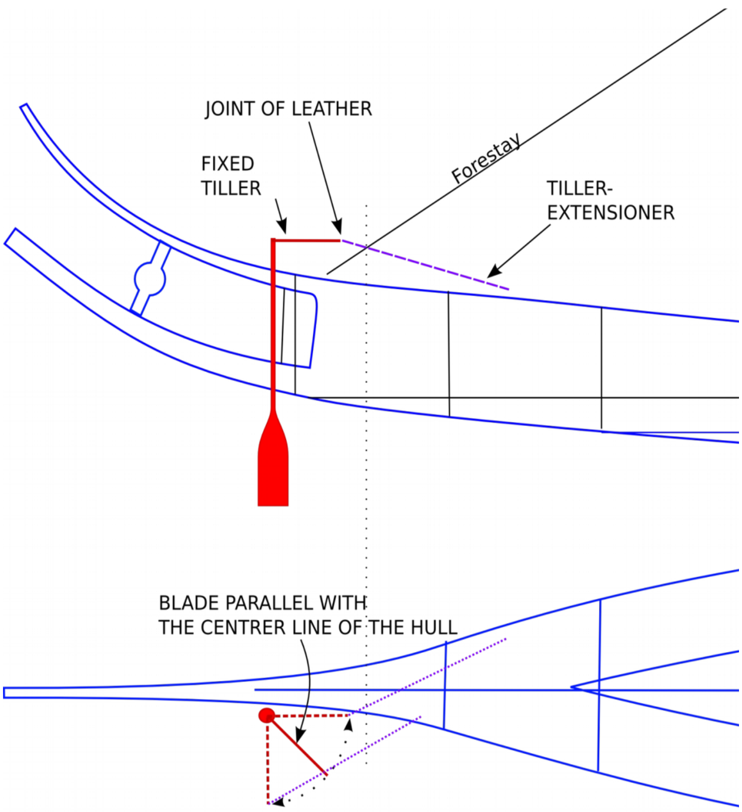


Figure 86. The principle of the tiller extensions used for steering.

bipod mast was bolted together to a rigid construction instead of the fully flexible mast as initially decided on (A and B in figure 85).

As already guessed the *Tilia* offered many more natural attachment points for a rig than the canoe had. It was found to be quite easy to distribute the weight and potential forces incurred by a rig across several of the existing internal frames (C in figure 85), and, interestingly, the integral clamps that have also been mentioned, could fit not only the trussing rope that the Guild was unwilling to remove, but also the stays (D in figure 85). The arrangement for the clew also proved relatively easy to secure (E in figure 85).

The Rudders

Although many rock art depictions appear to show the person steering as actually sitting on the horns, it is very unlikely this would have been the case in reality as such a position in any kind of sea (other than dead calm) would be very unsafe. It is more likely that such depictions show that someone was in charge of them (steering) or climbing out to fasten or unfasten them. Earlier trials in the *Tilia* seem to verify such a theory (Vinner 2003:105). Therefore, in order to enable safe steering from a position inside the boat, a similar

Figure 87. Dry sailing the Tilia in May 2006. Here the full size of the 20m² sail is shown without the reefs. The reefing system can be seen as a horizontal line across the lower part of the sail. Photos: Boel Bengtsson.

approach to what had been used on the canoe, that is, tiller extensions, were used. The principle of this system is shown in figure 86. Apart from using extensions, the steering oars proved very easy to secure tightly to the horns using only a simple string.

Dry Sailing

Two months before the date set for the first on-water sail trials, the newly manufactured rig and sail were put together and raised on land for the first time (figure 87). This provided an opportunity to ensure that every detail – from the hoisting and lowering of the sail and rig, the fitting for attaching the clew of the sail, to the lengths of the various ropes – worked. It also gave an opportunity to mentally prepare for new situations which might arise due to an untrained crew or unfamiliar equipment.

Sailing the Tilia

The on-water trials took place during two days in August of 2006, at Dyvig on the island of Als (Vinner 2003:103, fig. 3.95). This is the island where the Hjortspring boat was originally found and happens to be where the *Tilia* was built and tested during earlier on-water trials (Crumlin-Pedersen & Trakadas 2003). The aim of the sail trials was simply to ensure familiarisation with the boat and crew, and, once it proved able to sail, to learn some basic boat handling.

Carried on-board, were a digital compass for taking accurate readings of the heading of the boat every two minutes, and a GPS to track the journey. Wind readings at regular intervals, photographs and towing assistance were provided by the accompanying tender boat.

The pre-conditions for the trials were as follows:

Wind – on day one there was a fresh gusty north-easterly wind (4–9m/s) with shifts of up to 40 degrees, which on day two mellowed somewhat to a north-north-easterly (3–6m/s) with shifts of 20–30 degrees. Thus, it is fair to say that the wind conditions were not the easiest for carrying out good sail trials and certainly not for familiarisation with a new type of boat.

Sail – due to the unstable conditions and unfamiliar crew it was agreed that one reef was to be taken in, thus decreasing the sail area to about 15m². This smaller sail area was used throughout the trials.

Crew – 11 crew members were used throughout the trials of which seven were actively involved in sailing the *Tilia*. The active crew had a very mixed sailing background, from

Figure 88. Top: Here some of the active crew can be seen standing while controlling the sail. The passive crew is comfortably seated on the thwarts. Bottom: A crew member is adjusting the forward steering oar on the water which shows the relative ease with which this might be done. Photos: Knut Valbjørn.

Olympic dinghy sailing to cruising and Viking boat experience, all of which ensured basic on-board sailing skills. It did however, lack any form of coordination prior to the trials.

Ballast – 500kg water ballast was carried on-board as safety in an effort to increase stability.

Performance and Manoeuvrability

Due to the rather erratic wind conditions and the fact that most of the sail trials were made in Dyvig harbour where trials were confined to sailing only short legs whilst having to keep a close look out for passing boats and anchored yachts, the conditions for learning to sail the *Tilia* were difficult. Despite this, a satisfying level of sailing was achieved.

One of the main concerns before these trials was that of the stability of the *Tilia*. The boat had been thought to be very similar to a canoe or an Olympic dinghy, that is, very unstable and easily tipped over. In comparison however, the *Tilia* felt quite stable and instead of having to place the crew on the floor boards as had been thought would be required, especially considering the extra weight of the rig, the crew members were easily able to stand in the boat or sit on the thwarts (figure 88). It was also found very convenient to climb onto the horns in order to adjust the steering oars (figure 88). As for finding the overall balance of the rig, this was achieved through raking the mast (and centre of effort) forwards, by simply adjusting the length of the stays (figure 89A). The very fact that the boat could lie in the water over night with the rig up, provides some sort of indication as to its stability (figure 89C).

In addition to the *Tilia* being far more stable than previously believed, the vessel heeled a lot less than anticipated when hit by a gust and, throughout the sail trials, it was sufficient to use one person alone to compensate for this. Furthermore, the vessel could heel a considerable amount without feeling unstable or close to a capsize and, in the lighter winds of the second day, the boat could be sailed much like a dinghy, slightly heeled in order to let the wind fill the sail more easily (figure 89B).

The two steering oars proved a challenging new way of steering, which, given the length of the vessel and the fact that the two helmsmen could not communicate, would have required a lot more practice and time on the water to perfect. However, after some initial problems

Figure 89. A) The Tilia on the second day of the sail trials in the light wind of Dyvig harbour. The balance of the boat has been adjusted by tilting the rig forwards through adjusting the lengths of the stays. B) The Tilia is heeled in order to help the sail fill, again on the second day of the trials. Here the reef could probably have been taken out. C) The Tilia was left in the water by the pontoon overnight with the mast up which indicate how stable she is. Photos A, B: Knut Valbjørn., C: Boel Bengtsson.

finding the right balance of the steering, this was much increased once the right balance of the rig was found and could also be controlled through active heeling of the boat. Once the steering was synchronised it worked beautifully and despite the small blades, the boat responded very well, causing surprisingly little leeway. The few times when the rudders were not in harmony turbulence occurred and hence sideways drifting. Once this happened, it was very hard for the helmsman to feel which way the blade of the steering oar was turned, forcing the aft helmsman to turn around and look rather than feel.

Interestingly, had the shafts had a slightly square shape just above the point at which the blade changes into the shape of the shaft, which indeed the original steering oars found with the Hjortspring boat appear to have had (Rosenberg 1937:88), this would have been easier to avoid as the helmsman immediately could have felt when the blade was squared.

The basic handling of the rig and sail, such as hoisting and taking down the yard or gybing (bearing away from the wind and following through with the manoeuvre until the wind fills from the opposite side) proved relatively easy and worked smoothly (figures 90A and B). However, the fact that the crew was not very coordinated made any attempts for more advanced sailing hazardous. Thus, no attempts to tack through the wind were made, nor any gybes in winds of 7m/s and above. When the wind increased and the boat was sailing close to a dead downwind (with the wind almost straight from behind), the sail started to move from side to side a couple of times, something which a more experienced crew would have been able to stem more quickly by tightening the sheets (ropes that control the sail) and perhaps by letting two people control the sheet.

Figure 90. A) Photo sequence of the sail being taken down on day two. B) Day one, paddling through the Steg gap and hoisting the sail. Photos: Knut Valbjørn.

An inexperienced crew, lack of time and unfavourable conditions makes it impossible to draw any definite conclusions regarding the overall performance of the boat. However, by studying some of the GPS sequences recorded during the sail trials and comparing them to the on-board compass readings as well as the wind readings from the small accompanying motor boat, it is possible to get a taster for what might be possible.

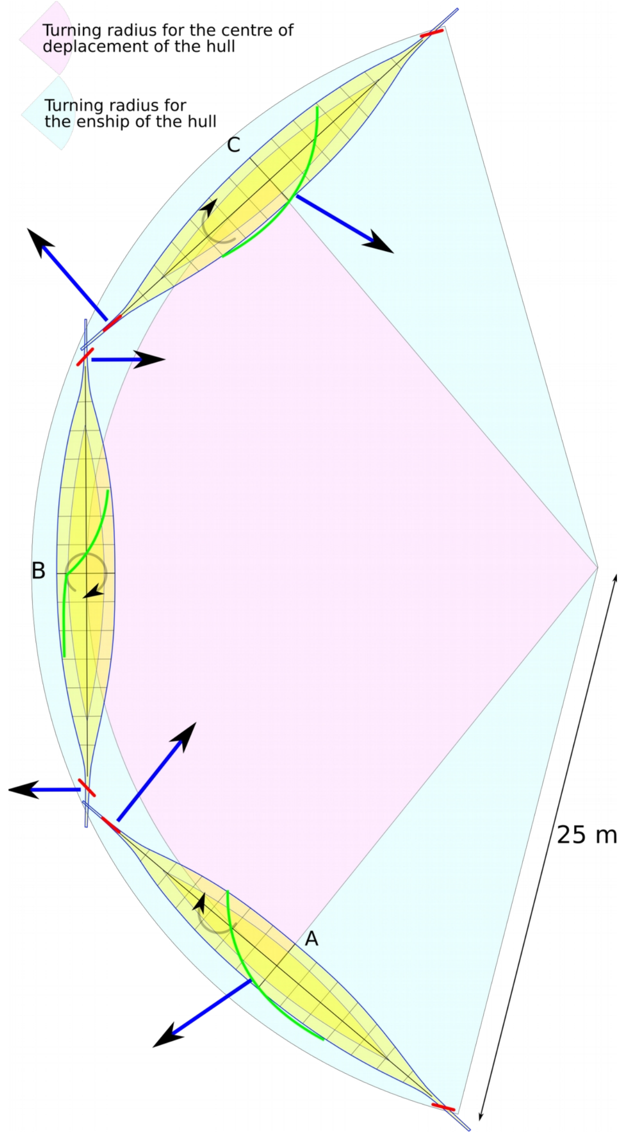


Figure 91. A hypothetical drawing of the turning radius of the Tilia using two active steering oars. Even though it was made prior to the on-water trials it proved very accurate. Initially intended to illustrate the turning radius of a tack it can just as easily illustrate that of a gybe. Position A; initiating the turn. Position B; performing the turn. Position C; terminating the turn.

Beginning with some of the early manoeuvring of practising gybes from the first day on the water, the *Tilia* was found to loose about 50 metres of height in each gybe (figures 91—92). In-between these gybes it appears that the vessel is able to sail at a 90 degree angle to the wind. This angle to the wind is further demonstrated by another GPS-sequence (figure 93), also from day one just after having paddled through the Steg gap into the more open waters of Stegsvig (where the wind shifts would still be significant but where we could sail longer legs). Just before this sequence the top speed for the week end of 6.2 knots had been recorded, after which the *Tilia* proceeded on a starboard tack with a compass reading of between 270 and 288 degrees. Meanwhile, the wind had a direction of about 330 degrees but slowly veered about 20 degrees to the right throughout the following 30 minutes.

The GPS track in figure 93 is marked in yellow and the on-board compass readings provided together with little black arrows. Surprisingly, there appears to be very little leeway, which some of the photographs taken during this sequence seem to be verifying

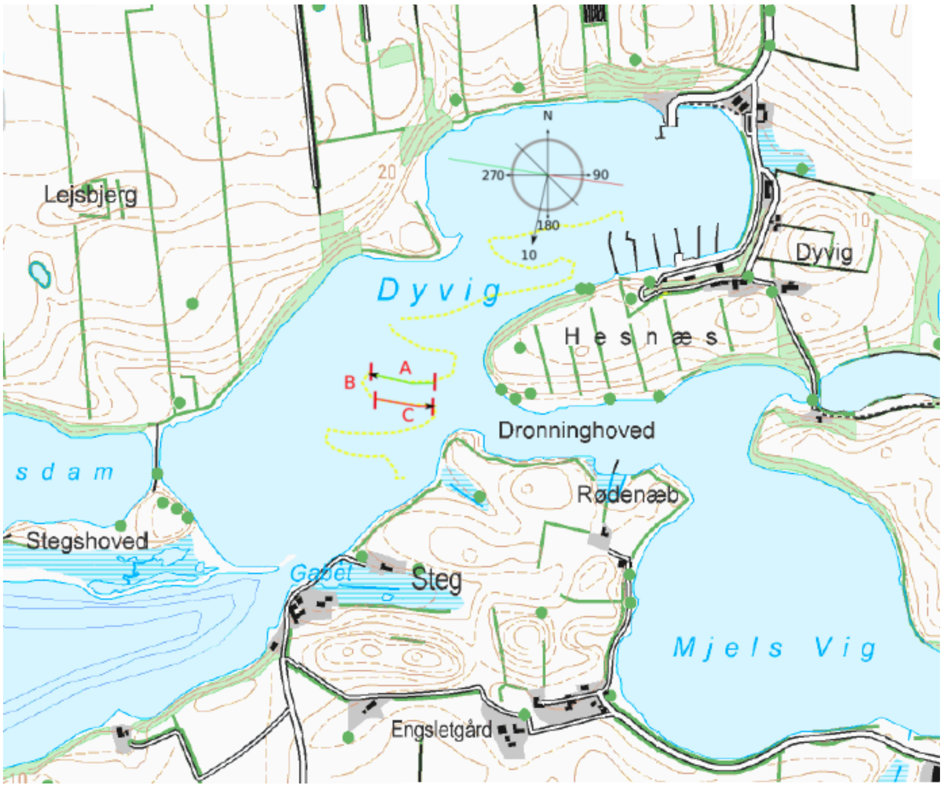


Figure 92. The GPS data for a sequence of gybes on the second day of the trials, marked in yellow. The green and red lines in points A and C are overlain onto the wind compass in corresponding colours. Given a wind direction of about 10 degrees at the time of the manoeuvre the boat must be sailing at approximately 90 degrees to the wind. The height lost in the gybe is about 50 metres.

(figure 94). There were times when the boat from the outside (from the motor boat) appeared to be sailing towards the wind but this is impossible to tell based on the GPS data, primarily because it was so hard to take accurate wind readings from the motor boat. However, it is clear that the boat can sail without much effort at an angle of at least 90 degrees to the wind.

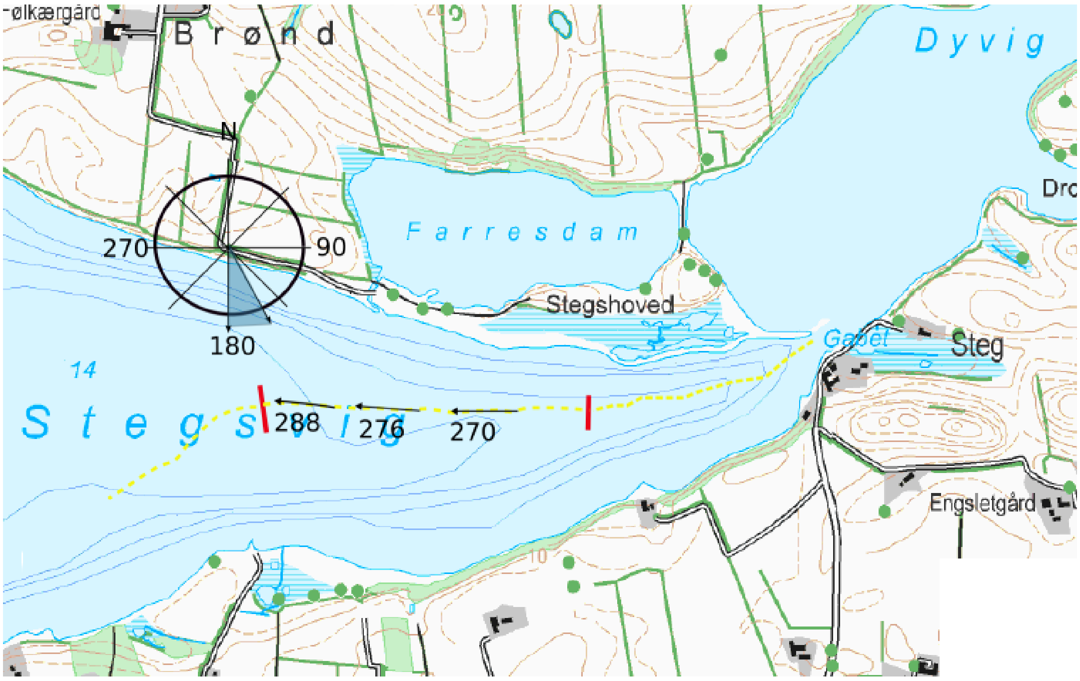


Figure 93. The course of the Tilia is indicated with black arrows on top of the dotted yellow line of the GPS data. The wind, indicated with the grey area within the wind compass, slowly veered to the right from about 330 degrees to about 360 degrees during the course of the sequence indicated between the red vertical lines.

Figure 94. Outside the gap on day 1. A gust hits the boat in picture three of this sequence. Notice the bubbles in the water caused by the turbulence around the steering oars which can be used to detect leeway. Photos: Knut Valbjørn.

Conclusions

Even though the sail trials in the *Tilia* left us without any conclusive information regarding her performance under sail, they left us with little doubt as to whether she can sail or not. The size of the sail used was well within any safety margins, which was proven by the fact that not at any time more than one member of the crew was needed to keep the boat level. Furthermore, the technology of rigging a boat through spreading the extra load of a mast and sail, is clearly one that the people who built the Hjortspring boat would have been familiar with, as demonstrated through the use of integral cleats to spread the loads of thwarts and internal frames. The four integral cleats at the top end of each of the end sections of the Hjortspring boat appears to have been strong enough to have been used not only for a trussing rope but also for attaching stays for the support of a temporary rig. Thus, it is clear that a sewn vessel such as the Hjortspring boat can take not only the additional load from a rig and sail, but also that a foldable rig can be handled with relative ease and without leaving easily detectable marks.

Perhaps the most intriguing result of the trials is the fact that steering oars with relatively small blades can be used successfully as a lateral plane when sailing a long and narrow vessel. They would have functioned as an early type of keel which, when used correctly could have been very effective. It is also clear that fastening the steering oars onto the horns or beaks works beautifully when attached tightly (which can be made with a simple piece of rope), and that they are easy to detach. The ability to easily fasten and unfasten the steering oars would have been vital in preparation for landing or taking off, which not least the trials in the canoe described above show, and also seem to be depicted in some of the southern Scandinavian rock art. If attaching the steering oar on the horns as suggested here, the forces when sailing would be the largest where it is attached to the lower horn. A square form of the shaft such as indicated by one of the steering oars found with the Hjortspring boat, would provide extra strength at this point and it is possible that a square form might also have made it easier to feel the direction of the blade when steering. It is likely that this was indeed the way in which the steering oars would originally have been fastened.

In addition to successfully demonstrating that it is possible to sail a Bronze Age type boat, these trials show that the concept can be transferred from a very small vessel to a full scale copy of the Hjortspring boat – the closest we have to a Bronze Age type vessel. This despite the uncertainties regarding the curvature of the hull and size of the steering oars.

The fact that the *Tilia* could be sailed without effort at an angle of 90 degrees to the wind, an angle that might easily be improved upon if using a more experienced crew with more hours in the boat, indicates that the boat could have been sailed within a relatively large sector of a given wind direction facilitating the choice of route. If the wind changed in direction or speed, the rig could easily have been taken down and the boat could have been paddled, perhaps to a point from where it would be possible to continue by sail as was done during the longer canoe trip in the Gothenburg archipelago described earlier. In a similar manner, the masts of the Viking ships would have been taken down in favour of oars when the wind failed over a thousand years later.

In view of the above it might not be altogether strange to imagine that the sail might have been used and experimented within Scandinavia as early as perhaps by the early Bronze Age, as indeed suggested by many rock art boat images here. The sail might not have been a way of travelling all the time, but could certainly have been seen as an important complement to paddling, providing resting time for a fatigued crew, in particular over longer journeys across open waters.

This leads on to Chapter 7 where I will put the possible use of sail into the context of the Scandinavian Bronze Age society.

7. Sail in Bronze Age Scandinavia

Both rock art imagery and the Lundergård carving from Vendsyssel seem to indicate that the history of the sail in Scandinavia can be traced back to the early Bronze Age, e.g. some 2000 years further back than currently accepted. This is an astonishing length of time even by archaeological standards, but as demonstrated in previous chapters, certainly not impossible. On the contrary, I have shown that the archaeological boat evidence that previous hypotheses have been based on has been too limited for any conclusive

Figure 95. Jutland, the Danish islands and the southern Swedish coasts. Along the Swedish coast, the appearance of rock art with mast and sail like features coincides with sheltered archipelagoes or lee coasts. The boat carving from Lundergård, Vendsyssel in Jutland is located in-between a lee coast and Limfjorden which would have offered similarly sheltered waters for the early use of sail.

interpretation of the matter. These hypotheses are further contradicted by hitherto disregarded direct and indirect historical accounts, as well as circumstantial evidence, which, combined, suggest a widespread use of sail by for example Angles, Saxons and Jutes by the 5th century AD.

In addition to this, the potential evidence provided by the rock art has generally been completely overlooked or shrugged off as 'exceptions', 'copies' or even fanciful interpretations. I have demonstrated that rock art boats with mast- and sail-like features are present in most of the major rock carving regions in southern Scandinavia, where they are likely to be truthful depictions of contemporary boats. That this might be the case is further suggested by experimental sail trials demonstrating that Scandinavian Bronze Age boatbuilding technology, with all probability, would have been compatible with the use of sail. It is therefore justifiable to consider the use of sail in Bronze Age Scandinavia.

As suggested in Chapters 5 and 6, the Scandinavian archipelagoes would have provided a near ideal environment for early experimentation with sail, offering a relatively favourable conditions for such experimentation. It is also within these archipelagoes that we find the earliest evidence of sail in the rock art – in the Bohuslän, Blekinge, Östergötland and Stockholm archipelagoes on the Swedish western, southern and eastern coasts (figure 95). The Bohuslän archipelago, extends northwards into the county of Østfold in Norway and southwards towards the Onsala peninsula in the county of Halland, to the south of Bohuslän. You could also argue that, for example, the lee coasts along the Swedish south-east and east coasts, are relatively sheltered, as are the waters surrounding the Danish Islands in the Sound (Öresund) and the Great and Little Belt (Stora och Lilla Bälten).

The aim of this Chapter is to assess how a much longer continuity in the use of sail in Scandinavia might affect our understanding of potential seafaring abilities during the Bronze Age as well as our perception of the contemporary society itself. It also aims to explain what underlying factors might have been necessary for the sail to emerge. Below I will begin with an assessment of the general sea conditions Bronze Age seafarers would have faced, along with an outline of the potential 'evolution' of the use of the sail in Scandinavia based on the pictorial evidence. I will then seek to illustrate how the sail might have been used, using the example of a well established route between Bohuslän on the Swedish west coast and Jutland in Denmark.

In order to assess the underlying factors for the emergence of the sail, I depend on a comparative analysis on the emergence of the sail along the Nile and in Oceania as presented in Chapter 3. Finally, I will put the use of the sail into the context of Bronze Age Scandinavian society.

Winds, Tides and Currents

The way in which global weather systems manifest themselves (see e.g. Taesler 1972:32—35), suggest that large scale weather patterns have remained fairly similar in the past 7000 years (Björck 1996), allowing for a direct comparison with meteorological data for more recent years. It is however important to bear in mind that the Bronze Age climate was generally warmer and drier than today's, with cooler and wetter conditions appearing around 1000 BC (Berglund 1991:73).

The Danish Islands and the Swedish west, south and east coasts are mainly dominated by westerly winds (see figure 96), which are characterised by a higher frequency of storms during the winter months between September and March, and by more local sea breeze

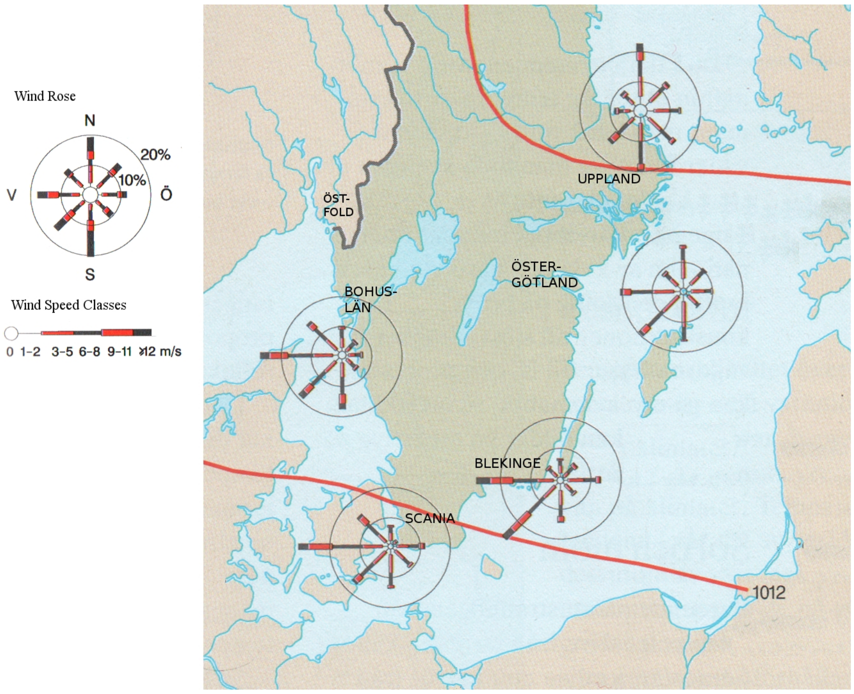


Figure 96. The average wind speeds recorded at five weather stations along the Swedish coast, for the month of July in the years between 1961–1989 (after Josefsson & Wedin 1992:41). The wind is measured for ten minutes, four times at equal intervals every 24 hours (day and night).

phenomenon during the warmer spring and summer months when the differences in temperature between land and sea are the greatest. Clouds and cloud systems can often be used to predict the weather, sometimes hours in advance (see e.g. Øi 1987:44—45). Thus it is possible to avoid, for example, thunder storms (with gale force winds and heavy rain), which sometimes develop over land in the afternoons during hot and humid summer days, as these systems seldom reach the outer archipelagoes.

Average wind data for southern Sweden, collected between 1961 and 1989, indicate that the wind strength during the summer months generally varies between 3—8m/s (6—16 knots), with the sea breeze typically varying between 5—10m/s (Josefsson & Wedin 1992:40—42). As can be seen in for example figure 96, the wind rose for one of these weather stations (Vinga outside Gothenburg) on the Bohuslän coast, shows that, statistically, during the month of July, which is the warmest summer month, winds directly from the west occur for about 25% of the time, i.e. approximately one day (and night) in four, or seven days during the entire month. If the south-westerly and north-westerly wind directions are added, these wind directions together account for 60% of the time, while winds from the south account for some 17%. We can also see that ideal/suitable conditions for sailing and paddling, with wind speeds of less than 6m/s, occur some 41% of the time, whereas dead calm conditions (with less than 2m/s) which are ideal for paddling (and rowing) only apply to some 11% of the time. Generally, the most common wind directions during this month appear to range from south, south-west, west and north-west – a range of some 135 degrees – but importantly all wind directions are represented. The same roughly applies to the sea regions along the Swedish south and east coasts although the prevailing winds here seem to come from the west and south-west, where, again, winds from all directions are represented (see figure 96).

As for surface water temperatures, these typically go from 0°C in the winter to 4—8°C in April and to 14–20°C at the height of summer in July, with generally the warmer waters along the Swedish west coast (Andersson, L et al. 1992:58—59). The heat built up over the summer months is released relatively slowly so that by October, surface temperatures remain around 10–12°C (ibid.). It is reasonable to assume that short boat journeys would have been made even in cold weather as long as it was regarded as safe and the crew could wrap up in warm clothes.

As already mentioned, the tidal sea level variations along the Swedish coasts are small, with some 0.2m along the west coast and even less in the Baltic Sea. Apart from this, the water level is mainly a function of the weather systems, low and high-pressures as well as the direction and force of the wind. In the Baltic winds from the north or south during long periods of time can cause water variations of up to two metres at either end, whereas on the Swedish west coast it is dominant westerly winds that may cause the largest variations in the water level with differences of up to one metre (Andersson, L et al. 1992:64—65).

In the Baltic Sea the currents are weak and move in a mostly anti-cyclical patterns, but are also affected by wind variations, sometimes making them variable. In the straight between the Danish Isles and the Swedish coast, the currents are also generally weak (<1 knot), although strengths of up to 4 knots are recorded at times (these are created when, for example, a low or high pressure over the Baltic causes a sea level difference with the North Sea). In the Kattegat, the weak Baltic surface current dominates the outflow of water to the North Sea, again variable due to winds (Andersson, L et al. 1992:66—67; Lindahl 2001:4).

In comparison, seafaring conditions along the south and south-western Norwegian coast are more challenging with stronger currents, and not least a generally more exposed coast line, in particular from Lista and up towards Stavanger (see e.g. Kvalø 2000:45—47; Nordenborg Myhre 2004:69—70; Øi 1987:35—36, 159—171).

On the assumption that the sea conditions of today are comparable to those in the Bronze Age (with the exception that the sailing period during the Bronze Age might have been a few weeks longer due to the slightly warmer climate), the Bronze Age seafarers would have experienced sea conditions with generally weak, wind induced currents and predictable winds in relatively sheltered waters. Whereas the most dominant wind direction would have come from the west (even if the frequency of westerly winds might have varied slightly (Lamb 1985)), seafarers would have faced winds from a wide range of directions during the scope of a week or even a day. The sea breeze for example, briefly explained in Chapter 3, would have provided a land breeze during early morning (blowing from the direction of land), before petering out and regaining its strength from the direction of the sea. On the Swedish west coast, the sea breeze builds up from around mid-day, starting from the south-west where small clouds over the sea would herald its arrival, and ending to the north-west in the late afternoon. On an east facing coast, the sea breeze would veer instead from the north-east to the south-east, and on a south facing coast from the south-east to the south-west. Then in the evening, the sea breeze peters out and the evening breeze takes over with wind coming from land. Although this is an example of a very predictable phenomenon, which generally occurs during the months of May through to September, it is important to bear in mind that the wind is never static but oscillates, and that it is also affected by topography so that it might funnel around land formations such as a head land, or in channels, or suddenly die in the lee of an island. These effects are clearly demonstrated by the sail trials in the Gothenburg archipelago described in Chapter 6, the knowledge of which would have been built up naturally by seafarers operating in these waters – also when using paddles (see e.g. Vinner 2003:108, 112–113, on the effects of the wind on a the *Tilia* under paddle, but also see Gordon 2001:68—73).

It is difficult to assess the maximum wind strength early sailors would have chosen to venture out in, but in the sheltered waters of the Gothenburg archipelago (just north of the northern arm of the Göta Älv river – see figure 95 and the snapshot in figure 97) which was used for the initial sail trials described in Chapter 6, winds of up to 10m/s were of no concern, mainly because the sail was so close to the water and so small. Venturing into bigger waves in more open waters would probably have been more risky, at least in such a small vessel as the one used here, with a freeboard of only some 15cm. In addition, during the sail trials in the *Tilia*, relatively strong winds were encountered with gusts of up to 9m/s. Throughout these trials the boat felt entirely safe, and only one crew member was ever needed to balance the boat to keep it level without easing the sheet while trimming the sail. During sea trials under paddle in 2001 (Vinner 2003:112), the *Tilia* was found to be able to operate well in waves as high as 1 metre and there is no evidence to suggest the boat could not have handled the same conditions with the use of a low aspect ratio sail.

It is obvious that the more sheltered the environment is, the smaller the waves will be, and consequently the more wind can safely be handled. This clearly illustrates the advantage of sailing in a sheltered archipelago or off a lee coast, but also that for venturing out into open seas such as those the Skagerrak has to offer (see e.g. Øi 1987:38, table 2), a bigger boat with a proportionally higher freeboard might be preferred to a boat the size of the Hjortspring boat. The existence of such boats in the Bronze Age is suggested by both rock art boat carvings, ship-settings and boat engravings on bronzes (see e.g. Bradley et al. 2010; Ling 2008:191—192, 2012; Rausing 1984:71,79; Wehlin 2013:152).

The Development of Sailing According to Pictorial Evidence

Returning to the rock art, the majority of the datable boats with mast and sail like features appear to have been carved between 1300–900 BC. This would suggest that the sail was widely used across southern Scandinavia by this stage. The rock art does not, however, provide a definite date for when the sail might first have emerged. The Lundergård boat carving, found in the Vendsyssel region in northern Jutland, an area with high concentrations of Early Bronze Age grave finds (Jensen 1992:141), might date the first use of the sail as far back as c. 1550 BC. This is around the same time as, according to Kristiansen & Larsson (2005:186, 204), the first centres of power or 'chiefdoms' in Scandinavia started to expand on a grand scale.

As mentioned in Chapter 3, it is possible that the earliest sailing boats were used for downwind sailing only and thus equipped with a mast located far forward in the boat, and in addition, that such boats might have been used alongside vessels capable of sailing across a wider wind range for some time. There are several examples of these forward mast locations within the Scandinavian rock art material presented in Chapter 5 (table 2). Thus, although the location of the mast on the boat carving from Lundergård, along with the central location on many of the mast bearing boats within the rock art indicates an ability to sail with the wind from at least the side (at 90 degrees angle from the wind), certain boats could still have been used for downwind sailing only.

The problem with positioning the mast far towards the bow in a boat is that it makes it very difficult to veer the boat towards the wind, when for example avoiding an obstacle. In a round hulled vessel without a keel, this action would be almost impossible, and, if using two steering oars (one in either end) would also lead to a lot of pressure being applied to the forward steering oar. This is something which the earliest sailors on the Nile (see Chapter 3) might have solved to some extent with the use of multiple steering oars, some of which might have been moved across to the bow in order to aid the steering process. This might also have been achieved by intentionally flapping (spilling wind from) the sails momentarily while steering in the desired direction, which, in the opposing current which exists on the Nile, would have allowed the boat to 'glide' sideways, but not to steer with any precision (by steering slowly in a boat that is big or heavy enough to provide enough momentum for this to work – compare with e.g. Marchaj 1982:425—428). It is difficult, of course, to know exactly how these early sailors solved this particular problem, but what is certain is that somehow they must have overcome it. At any rate, a mast located far forward does not allow for a great range of motion other than the direction of the wind. Therefore, it is likely to have been used mainly for straight line sailing, under particular conditions and circumstances, in the same way as raised branches to catch a following wind is recorded to have been well into our days (Eskeröd 1970, see Chapter 3).

The advantages of being able to go closer to the wind when sailing within an archipelago, with its many rocky islets, skerries and sunken rocks, would probably have been more obvious than would necessarily have been the case when the sail was first being used on the Nile (see Chapter 3) for several reasons:

- Firstly, the wind along the southern Scandinavian coasts comes from a broader range of directions allowing for a quicker understanding of its impact while travelling. For example, if the sail is first being used when the wind blows in a direction whereby you could reach a particular destination using a sail suitable for downwind only, the fact that less effort is needed in getting to this particular destination might provide an incentive for trying to get there with the wind on the quarter and eventually from the side. Along the Bohuslän coast for example, it would be a natural incentive to try and use the predominantly westerly wind so that a sail could be used more regularly for travelling up or down the coast, i.e. with the wind from the side.

- Secondly, the many islands would have allowed for more potential routes of choice for travelling between points A and B, and as has been discussed earlier in Chapters 5 and 6, the ability to carry the sail past a point from where you would be able to use it continuously, might in certain circumstances be preferable to taking the sail down, paddling up to that point and then putting the sail up again. Again this might have provided an incentive for improving sailing abilities.

- Thirdly, the Scandinavian Bronze Age technology of double steering oars, one fastened in either end of the boat, would certainly have allowed for a relatively short transition between being limited to sailing downwind only, to then being able to sail within a relatively broader wind range. This was aptly demonstrated by the sail trials in Chapter 6 where for example a boat such as the *Tilia* was able to go 90 degrees to the wind without effort even with the use of steering oars with relatively small blades – despite having a crew with limited experience of sailing her.

It is possible the Tanum-833 carving of a boat with what appears to be two sails, one in either end of the boat, might indicate a search for wider sailing angles as this set up would have made it easier to steer the boat. Other options for increasing the sailing range would be to start moving the mast around or simply to tilt it in order to find the right balance (between the centre of force in the sail and on the rudder(s)) needed to increase steering ability and sailing range – both of which would have been relatively simple given how small these early rigs and sails must have been. Based on the Tanum-833 and the Lundergård carving, this transition from downwind sailing to sailing within a broader range might have occurred in some places around Scandinavia already by c. 1550 BC.

Communication between Bohuslän and Jutland during the Early Bronze Age – an Example

In order to demonstrate how the sail might have been used for long distance journeys, I am going to use the example of a route which is well established within the archaeological material; the c. 200km long sea journey from Bohuslän on the Swedish west coast across to Jutland, Denmark (figure 97). Bohuslän has the largest concentration of rock art in northern Europe (Bertilsson 1987), and is believed to have been an important transit area for coastal journeys northwards towards the Oslo fjord and onwards, as well as southwards, but also inland through the Göta Älv river to lake Vänern and the rich areas of Västergötland (see e.g. Kristiansen 1999b:89; Ling 2004, 2008; Marstrander 1950:78; Weiler 1994:111; Østmo 2005). Large concentrations of flint daggers and flint sickles in Bohuslän, as well as bronzes, suggest that communications with Jutland must have been intense during the Early Bronze Age, and that regular communication might have begun already during the Late Neolithic Period (Apel 2001; Kristiansen 1999b; Ling 2008:223).

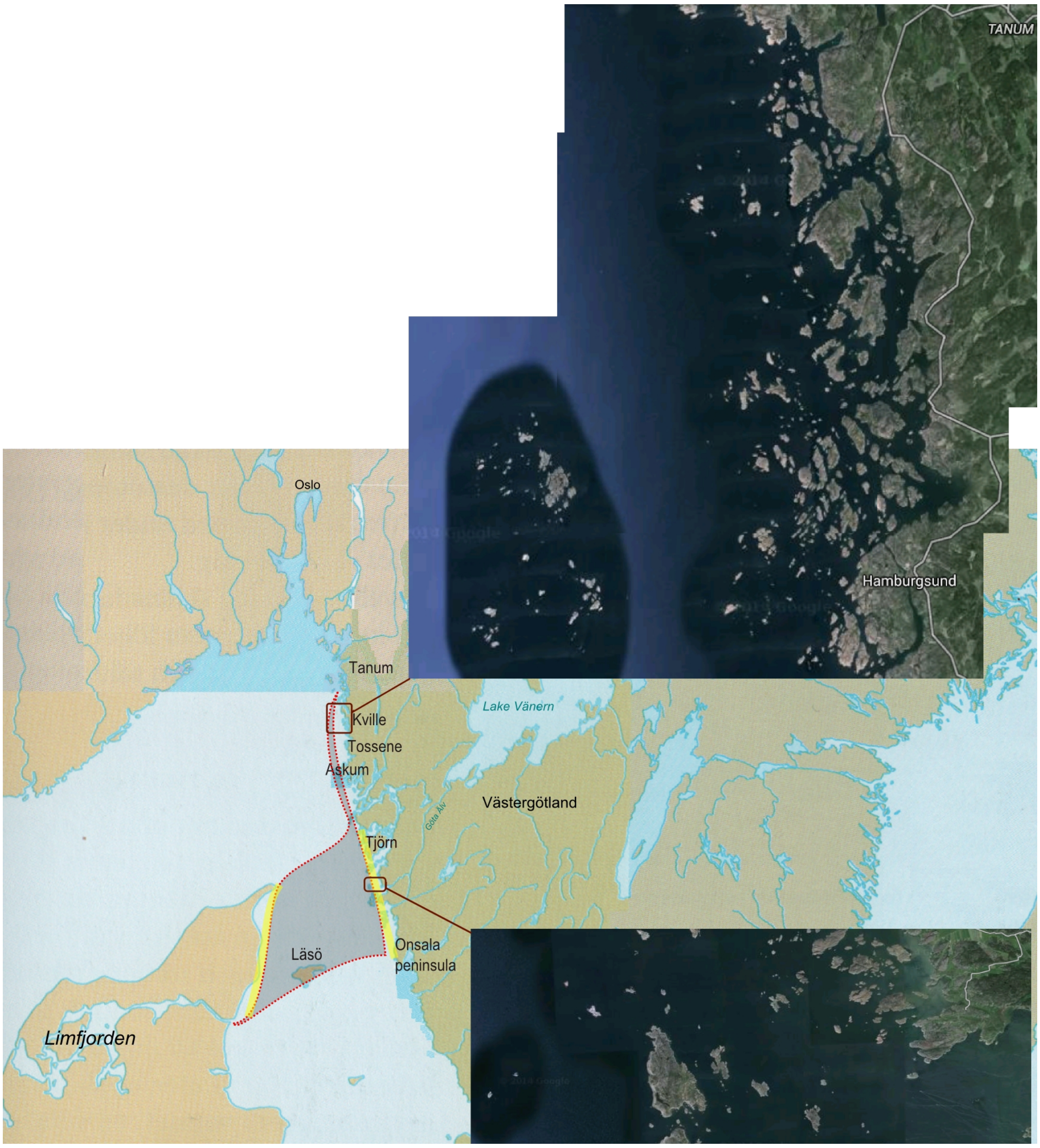


Figure 97. A map highlighting, in grey, the safest areas for boat journeys between Bohuslän and Jutland. Snapshot pictures from Google Map are provided for the archipelago between the two major rock carving areas of Kville and Tanum to the north, and of a section of the archipelago just north of Gothenburg (where the northern arm of the Göta Älv river debouches into the sea), where the canoe sail trials, described in Chapter 6, were conducted. These snapshots show the depth of the protective 'shield' provided by the many islands within the archipelago, which can be used to find shelter from winds and waves. This protective 'shield' stretches southwards to approximately the Onsala peninsula, after which the Swedish west coast becomes less protected. The land elevation means that the coast today has a different configuration compared to what it had during the course of the Bronze Age, but it's protective 'shield' is fully comparable (Bengtsson B 2003:59—62; Ling 2008). The yellow areas show where boats could have positioned themselves with relative safety in search of favourable winds for making the crossing to Jutland (and back).

Initially, communications between these two areas would have been made in boats using only paddles. The journey might have begun somewhere around the Tanum area and from there proceeded south within the natural 'shield' from waves and winds provided by the archipelago, down to the island of Tjörn (Petterson 1989), or the Onsala peninsula where the archipelago ends (see figure 97). This is a journey of some 100—150km. Using the estimated range for the *Tilia* of c. 74km per day in calm conditions, it is possible that a crew of 30 (as used for the long distance paddling trials in 2001, which included people able to relieve tired paddlers, personal equipment, food and water for a day, in total weighing around 2500kg including extra water and cargo), might have been able to cover this distance in two days using muscle power alone (Vinner 2003:114—117). This would assume a cruising speed of 4 knots including a one hour break for every 6 hours on the water, and winds below 2m/s (Vinner 2003:117). Using a smaller crew might have meant more frequents stops for rest, as would indeed changes in the strength and direction of the wind, by making paddling more strenuous. This would naturally have an effect on the cruising speed. Only with a tail wind would speeds increase.

For travelling across to Jutland, a crew such as the one used for the long distance trials in the *Tilia*, mentioned above, might have aimed for a route via Läsö, which lies about 45km west from the Onsala peninsula, as this would provide a natural stop over point as well as possible shelter. For this passage the crew would probably hope for a tail wind (from the east) or lie in wait for a high pressure system to arrive, ensuring calm conditions. In such conditions, this part of the journey might have been made in about 5 hours, assuming an accurate heading was maintained. From Läsö, the onwards journey towards the mouth of the eastern entrance to Limfjorden, might have taken another 5 hours, again depending on the winds.

Using downwind sailing capabilities only, the same journey along the coast from Tanum, would have been initiated with the help of a northerly wind, allowing for at least some of this passage to be taken without muscle power involved. This would reduce the number of breaks the crew would have to take since it would enable rest *en route*. It is important to stress that even long distance journeys under paddle alone, would probably have only been initiated when the weather conditions were favourable, in order to avoid harder work than necessary. Such conditions would include calm weather with winds of 2m/s or below, or, a tail wind (Vinner 2003:117).

If we assume the ability to sail with an angle of 90 degrees to the wind, which might have been possible by c. 1550 BC (as suggested by the Lundergård carving), but certainly by c. 1300 BC (as evident from the rock art), the wind range that could have been used to increase both speed and resting time for the crew, would include winds from the west, north-west, north, north-east and from the east – a total range of 180 degrees. This would make a significant difference in terms of regular communication, a comparison of the average wind speeds and wind directions in the region provides a clear indication of this (figure 96).

For the journey across to Jutland, using this kind of set up of sail as a complement to paddling, it is likely that the boat and crew would have positioned itself within the yellow shaded area along the Swedish west coast as indicated in figure 97, within which shelter from winds and waves would be easy to find and where they could await winds that might bring them across to Jutland. Thus, in, for example, a north-westerly wind, the boat might leave the coast off the island of Orust, just north of the island of Tjörn, and sail across the entire distance with ease. Should the wind veer towards the west, the boat might head towards Läsö and lie in wait for the wind to drop or change direction so that the journey could be continued. Another option would be to head back towards the archipelago with the wind from behind, or to simply take the sail and rig down and paddle directly towards Jutland (and the wind) to a point from which the sail could be raised again. In short, there would be many more options available to the crew using a combination of paddle and sail, than there would be if only paddling.

It is clear that the sheltered waters provided by the archipelagoes would have been of great importance for navigation along the coasts and that, in fact, they would have been the natural 'highways' of the Bronze Age. Given the nature of the Scandinavian archipelagoes, with thousands of small islands which from a distance look like a continous landmass, is also clear that profound knowledge of these waters would have been essential for anyone venturing through them by boat (compare with e.g. Farr 2006). Even someone with such profound knowledge might easily get lost in poor weather conditions, making clear landmarks essential. It has been pointed out that the cairns situated along the coastlines might have had the dual purpose of nautical landmarks (Dahlgren 1941; Kranz 1940; Kvalø 2000; Ling 2008; Selinge 1969). These cairns, many of which would have been situated on small islands, date to the early Bronze Age and are built up of round boulders (Claesson & Munkeberg 2004; Gerdin 1999). Along the Bohuslän coast alone, there are some 2000 such cairns, some of which are up to 40 metres in diameter and up to two metres high (Anderson 1980:128; Bertilsson 1986:69: Selinge 2000). The very fact that some of these stones, if not all, would possibly have had to have been moved to the island in particular, in addition to the clearly nautical positioning of the dead in this landscape where people would have had to come by boat for the burial itself, is a testimony to the importance of these waterways. Perhaps the use of the cairns as markers was aided by other visible structures such as beacons made out of, for example wood, and maintained by the local community, for use not only by themselves (in bad weather) but also by seafaring visitors.

How and Why Might the Sail Have Evolved in Scandinavia?

What might be the underlying factors be that led to the development of the sail in Scandinavia? When looking for answers for this, I will begin by discussing whether there are any particular environmental, physical or social circumstances that might have favoured early sailing.

In Chapter 6, I suggested that the sheltered waterways within the Gothenburg archipelago would have offered an ideal nursery for early experimentation with sail, arguing that the preconditions for starting to use sail in such an environment would have been relatively favourable, with little tidal range, relatively weak currents and predictable weather conditions. The same conditions would have been present in the entire Bohuslän, Östergötland, Stockholm and Blekinge archipelagoes which coincidently exhibit a higher concentration of rock art boats with masts or sails. Irwin's hypothesis for how early sailing might have evolved in South Island Pacific/Near Oceania is based on similar assumptions (see Chapter 3), describing the area as a voyaging corridor offering predictable winds and weather (the area lies outside the cyclone zone) which would have functioned as a nursery for early sailing. Similarly, it is assumed that the predictable northerly winds and north going current along the Nile would have offered equally favourable conditions.

It is important to keep in mind that the above conditions would be regarded as ideal for any short, medium or long journey in any type of craft, whether sailed, rowed or paddled. As for skills, the ability to make accurate weather predictions and basic seamanship would have been equally important whether a craft was paddled or sailed. Just as the ability to predict the weather and identify the correct times for sowing or harvesting, weather predictions would have been fundamental for boat journeys – and increasingly so the longer the planned trip. As for seamanship, this would include the knowledge of how to handle a particular boat in foreseeable and unforeseeable conditions (and increase the likelihood of survival in harsh weather) along with a basic understanding of how to get the craft from one point to another, i.e. basic navigation. These are skills that would have been built up naturally by a population dependent on boats in its day-to-day life, as boat journeys became increasingly longer, and would probably have been essential knowledge before the development of the sail could begin. As we have learned in Chapter 3, seamanship and the ability to make accurate weather predictions were greatly admired skills in the 18th century Oceania, and seamanship was also phrased in the Nordic Sagas (see Chapter 1). In ancient Egypt pilotage, a profession that would also require such skills, were held in similar esteem. These two aspects of early seafaring were probably more important than anything else, as evident by the fact that the same boat can be sailed with very different results depending on the seamanship of the crew. Thus seamanship can make up for many shortcomings in terms of the *perceived* seaworthiness of a vessel. I use the word *perceived* here as it is important to bear in mind that what we judge as seaworthy or stable depends on our own experiences – thus in the right hands an 'unstable' vessel might actually be very stable, which not least the sail trials in Chapter 6 illustrate.

Many scholars like Fabre (2005), and Valbjørn (1999), suggest that sailing must have come about with the realisation of how wind affects a waterborne object. However, Anderson (2010:7) argues that such a realisation would have been apparent "*always and everywhere*", and therefore cannot be the only reason why it developed. In this he is right, as even when paddling one would quickly realise that it would be easier to paddle with the wind (and waves) rather then across or against it. However, I would argue that such a realisation would have been essential, but so would the necessary skills (predicting weather and seamanship) to take advantage of it. What primarily would have been necessary is a need that outweighed any perceived risks or disadvantages. Risks might include capsizing whereas other disadvantages might include the extra time needed before and after a journey with hoisting and lowering sails as well as the drying and caring for wet sails after each journey. Such a scenario might arise when you have a continuous population, dependent on boats in its everyday life, going backwards and forwards between islands or along a coast or a river such as the Nile, and where people increasingly need to transport heavy goods for longer distances.

Putting aside the use of branches that could easily be erected as a primitive sail and discarded after each use, at what range would a sail start to be an obvious advantage? Whereas for the layman, the rigging of a boat might seem difficult and time consuming, regular use would have made this aspect of sailing seem like a natural part of things (I compare this with the endless time spent rigging and preparing boats in my days of competitive sail racing). However, before this would have seemed 'natural', or even after, there would have been an obvious threshold for when to use sail rather than muscle power. I would argue, based on my own experience and experiments in a small canoe in the part of the Gothenburg archipelago described in detail in Chapter 6 (during which no extra cargo at all was carried), that once sail and rig were available this threshold might lie in the region of two kilometres for smaller vessels or for journeys longer than say 30—40 minutes. This might also have been about the length of journeys for which the sail was initially used.

McGrail (2001:33) suggests that the increase in the amount of changes to the Egyptian mast, rig and rudder positions towards the end of the Old Kingdom (as evident by the iconographic material), might reflect a phase of increased experimentation and a search for better windward performance that can be linked with the documented increase in Egyptian trade and overseas expeditions at this time. In doing so he makes allowances for a) an artistic lag in the knowledge of the latest trends in ship design and b), potential inaccuracies in the precise dating of the iconographic material (ibid.). The potential link between trade and experimentation in sailing abilities is very interesting and might in fact be one of the reasons why sail developed in the first place.

Putting this into context, communication by river craft along the Nile for example, would have provided a fundamental link between people upstream, downstream and across to the opposite bank. The need for communication and flow of goods (=exchange and trade) would have increased as populations grew and became increasingly sedentary. As we know, the Nile offered very predictable weather conditions as well as a steady current running against the prevailing wind direction, thus the threshold for regular use of watercraft would have been low. The need for accurate predictions of the weather and the water flow of the Nile would have intensified with the onset of farming, which began c. 5000 BC. We know that by c. 3500 BC well developed stock rearing and farming existed along the Nile and at the same time there are increasing evidence of cultural homogeneity throughout the Nile Valley. Recent discoveries suggest that already by c. 3250 BC these appear to have developed into kingships with an associated hieroglyphic script language and trade of luxury goods such as wine (James 2007:36–37).

Thus, it may well be that it is within the time frame of c. 3500—3250 BC that the Egyptian sail first emerged, the development of which was driven by emerging trade. The lag between such a date and the first pictorial evidence of a sail on the 3100 BC Nagada vase could stem from a whole range of factors. While the earlier Gerzean depictions for example, do indicate an understanding of the forces of the wind onto a waterborne craft, the style of these vessels implies some form of procession (Bass 1972:13). Thus, even though early forms of sails might already have been in use, these would not have been used for this particular purpose, and hence, would not have been depicted. Variations in fashion in the style, medium and choice of motif could be the reason why, for example, boat depictions were so uncommon during the First and Second Dynasties – a period during which we know for sure that the sail existed and was used.

As for Scandinavia, while the boat motif appears continuously in some form or other throughout the entire Bronze Age and into the Viking Age – a period of almost three millennia – here there are similar hiatuses, both in medium and choice of motifs (figure 34).

Hence, it is possible that the sail evolved due to a combination of factors, the most important of which were:

- An environment offering relatively advantageous conditions for experimenting with sail, with e.g. a small tidal range, relatively weak or at least predictable currents as well as predictable weather conditions
- A long continuity of a population dependent on boats in everyday life, some of whom possessed well developed seamanship and the ability to successfully predict the weather
- A desire to improve speed and cargo capabilities, the incentive of which might come with an emerging trade and an increased need for the transportation of people, animals and goods.

Accordingly, it is clear that the introduction of the sail cannot be described as, in the words of Andersen (2010:7), a "*revolution in mobility*", but, that given the right environmental and social circumstances, it could have developed in many different places at different times – just like for example the domestication of plants appear to have developed multiple times in multiple places around the world whenever the right circumstances arose (Bellwood 2005).

When Anderson (2008:240, 2010:7) suggested that a sudden increase in the range of seaborne contacts might indicate the use of sail, he mainly referred to an apparent six-fold increase in the range of sea passages whence people started to migrate into Remote Oceania. In ancient Egypt evidence suggests sea journeys proper might have begun just before the unification of the two kingdoms of Upper and Lower Egypt, c. 3000 BC. This might have been driven by a need for exotic materials such as wine and cedar, as indeed suggested by Fabre (2005), but it seems very probable that the first ships involved in such trips were not specifically adapted for sea journeys. According to the iconographic material which we have seen flourished during the Old Kingdom, such vessels do not occur until c. 2500 BC. Thus, over a 500 year period, the river vessels would slowly have been adapted for seafaring use, which by itself suggests an incremental development over many generations. Consequently, the passages to the Levant might initially have been made by 'inferior' river vessels (compared to the Byblos-ships), the successful passages of which would be based on seamanship and perhaps safety in numbers (using fleets of ships who could help each other if needed).

In Chapter 1, I argue for an incremental development of the sail suggesting rig and sail might have evolved in conjunction with developments in boatbuilding techniques, something which seems to be confirmed by the rock art. Ethnographic studies highlight the conservative and often secretive aspects of traditional boatbuilding, which were often linked with rituals (Hasslöv 1972; Horridge 2008; Malinovski 1966). Ritual maritime aspects have also been linked to many rock carving sites situated near the Scandinavian palaeographic shore line (Cornell & Ling 2010; Ling 2008) and given the investment in terms of time and effort in making a boat, and the fact that the lives of the people travelling in such boats might depend on how well it was built, this is not surprising. The value of even the simplest logboat is attested by the recent c. 4500 BC Askø find near Zealand in Denmark, which had evidence of having been repaired before it was abandoned (Dencker 2014, cited in The Copenhagen Post Sept. 3). This conservatism is also reflected by, for example, the longevity of the Nordic boat tradition in general, its trait of overlapping planking being traceable from today back to the Nydam boat – a period of almost 2000 years (McGrail 2001:205). Considering the value of boats to prehistoric society and the conservative nature of boatbuilding this would further support an incremental rather than sudden development of the sail in southern Scandinavia.

It is interesting to note that the 'horns' of the Scandinavian Bronze Age boat disappear within the iconographic material towards the end of the Pre-Roman Iron Age, the use of which might have included the fastening of steering oars. At the same time the side rudders appear in the rock art, although in the archaeological record it is first detected with Nydam 3, and yet, the use of double steering oars are yet again in evidence on the Gotlandic picture stones a few hundred years later (and a second steering oar might have been used on Nydam 2). This suggests that both types of steering arrangements co-existed for quite some time, and the existence of both types on, for example, Nydam 2 clearly illustrates this. During the same period we start to detect the keel, again most notably on Nydam 3 and it would appear that the overlapping nature of the Nordic clinker hull now developed (it is first noted within the archaeological record with Nydam 1, the trees of which were felled AD c. 190 (Rieck 2003:299)), would have assisted steering (Gifford & Gifford 1996) and increasingly reduced the need for two steering oars. In this respect, the two rock art boats from Harvaland (figure 56, Chapter 5) are especially interesting since they seem to depict sailing vessels with both the horn and the new bean shaped bow present. This represents a hybrid which illustrates a new development in Scandinavian boatbuilding, where the sail appears to be utilised – and which could have been one of the driving forces behind these changes.

This leads to the question of whether the Nordic sail first appeared independently or arrived through direct or indirect contact with other areas. As mentioned in Chapter 4, it is generally believed to be the result of an internal development, which is further suggested by the fact that it might be traced back to the early Bronze Age, when the square sail was probably one of many different forms of sail in use.

That the sail is easily diffused and, with the right skills, can be adapted for use on practically any type of vessel cannot be argued. Native Americans living on the north-west coast who were skilled seafarers with no prior knowledge of the sail, apparently picked up the skill within a few years following their first contact with Europeans in the 18th century, adapting it to their dug-out canoes using woven cedar bark or canvas for sails (Drucker 1955:67; Johnstone 1981:224—231). However, these sailing canoes never appear to have evolved any further and could only sail with the wind (Drucker 1955:67). There is nothing that indicates whether the very first inspiration to put a sail on a Nordic vessel might have come through direct or indirect external contact, but it is clear this happened by the Early Bronze Age and that further developments, eventually leading to boats with sailing abilities that we can recognize today, were most probably internal.

The Sail and Society

The above assessment of the basic seafaring conditions in southern Scandinavia, the potential development and underlying reasons for how, why and when the sail might have begun to be used as a complement to paddling, have provided the foundations for the evaluation of how the sail might have been used. How then would the ability to use the sail as a complement to paddling fit into our perception of Scandinavian Bronze Age society?

Communication, mobility and trade are considered to be strong characteristics of the Scandinavian Bronze Age. The distribution of bronzes and other valuable materials in Scandinavia provide evidence of this (see e.g. Larsson 1986; Thrane 1975), as does the clear similarities in social organisation across the region during the Bronze Age (Artursson 2005, 2009; Kaul 2004b; Kristiansen 1998). It is also evident through the apparent consistency in the use of the boat symbol throughout the period, and in the fact that changes in the way in which boats were depicted can sometimes be detected within a mere one or two hundred years across the entire region, as illustrated by the boat chronologies establised by for example Kaul (1995, 1998) and Ling (2008, 2010). Other indications comes through the speed with which, for example, the Nordic razor (a one-sided bronze razor with a handle decorated with a horses-head) was adopted by a Scandinavian male elite within less than a generation just before and around 1400 BC (Kaul 2013:461–462, 470). In addition, Kristiansen and Larsson (2005:32—33), have argued that the lack of major dialects within the Nordic language during the Iron Age and the Viking period (as indicated by the runic inscriptions from these periods), might also apply to the Bronze Age, which again would suggest a highly mobile population. All of these traits are consistent with the use of sail as a complement to paddling and would more convincingly explain such mobility of a population than the use of paddles alone.

The Bronze Age is also a period which heralds increasingly complex social structures as seen in, for example, grave goods (Larsson 1999; Ling 2008:253; Vandkilde 1996), as well as increased levels of specialisation, the production of bronze being an obvious example, but also perhaps that of boatbuilding (see e.g. Bengtsson B. 2003; Kristiansen 1987:33; Kristiansen 2015; Kristiansen & Larsson 2005:186). In order for specialisation of a particular craft to emerge and become sustainable, communication and mobility would have been essential. It has been argued that increased social stratification, specialisation and direct exchange over long distances had already begun to develop during the Late Neolithic period (Apel 2001; Artursson 2005, 2009; Lekberg 2002; Varberg 2005). This indicates that the necessary pre-conditions for beginning to use the sail, as suggested earlier in in this chapter using the combined evidence from ancient Egypt and Oceania (and Scandinavia), would all have been in place in Scandinavia by the early Bronze Age.

Whether the sail arrived in the North through travelling visitors (in either direction), or as a result of knowledge handed down the line through existing exchange networks, or whether it was adopted here entirely independently is difficult to tell. As mentioned above, all three scenarios are possible. Important questions one might ask in relation to this is how distinct the boundaries between different cultures were in the Bronze Age, and under what circumstances would people have been willing to adopt new knowledge from foreign cultures? The double horns at each end of the vessels which enabled the use of double steering oars, and their potentially light build – both of which are clearly very local Nordic traits – have, for example, not been found elsewhere. This might suggest that such vessels were not suitable for seafaring conditions and environments outside of Scandinavian waters (and indeed *vice versa*). It might also (and more likely) reflect that the way in which boats were built was so fundamental and ideologically rooted in Scandinavian society that its boatbuilders generally resisted any fundamental changes in how boats were built (compare with e.g. Hasslöv 1972; Horridge 2008 as discussed above). So what is it that makes people begin to use 'new' technology? Perhaps the fact that this new technology might be adapted to existing and more fundamental technology already in place (such as already existing boats)?

Renfrew (1986:146), in relation to the development of new commodities, has, for example, suggested that in most cases so called 'new' technology might have been known of and even used on a small scale well before it was fully accepted by society as a whole. The generally favourable sailing conditions and the presence of technology that might have enabled the use of sail, along with a population for whom waterborn transportation was part of everyday life, might suggest that the wind was utilised at a very early stage along the Scandinavian coasts. As a result, it is very possible that the sail was 'adopted' (van der Leeuw & Torrence 1989:3) here entirely independently for use during relatively short journeys, before its use in faraway places was heard of, or indeed came to be observed. The variation in the types of rigs and sails the Scandinavian rock art seem to indicate, might further justify such a view.

There are different types of needs that might provide an incentive for the further development of the sail, that of long distance exchange of goods being the most obvious one. Long distance exchange networks coupled with marriage alliances have long been linked to the early developments of Scandinavian Bronze Age society, and in particular with the formation of centres of power in the seventeenth and sixteenth centuries BC (Kristiansen & Larsson 2005:204—205). Whereas smaller centres of power might have covered an area of 20—40 kilometres in diameter, larger ones ”*characterised by inter-*

chiefly alliances” are estimated to having been in the range of 100–200 kilometres in diameter (Kristiansen 1991:27, 1998:70). Exactly how these early centres of power might have formed and been maintained is not known for sure. However, ethnographic studies (Helm 1988), emphasising the importance of travels to far away places, the acquisition of exotic goods, new crafts and skills, and the ritualisation of such skills and knowledge, have been highly influential as an allegory for how this might have transpired in the Bronze Age, and are often cited in direct comparison to Bronze Age Greek mythologies such as that of Odysseus or the Argonauts (see e.g. Cornell & Ling 2010:38; Berntsson 2005; Kristiansen 1991, 1998:23, 2002:67, 2004; Kristiansen & Larsson 2005:40–41; Kvalø 2000; Ling & Cornell 2010; van de Noort 2003). Thus, an innovative individual or aspiring leader might have risen in society through personally bringing home exotic goods, new ideas or skills, and, presumably, the more exotic the goods being brought home, the longer and more dangerous the journey, the more prestige it would bring. Add to this the possibility that certain goods such as, for example, amber, might have been perceived as providing their owner with magical or sacred powers which might have become lost through the use of middlemen (see e.g. Beck & Shennan 1991; van de Noort 2003:407), and we might find yet another dimension for the need for direct long distance travels and trade to exotic destinations.

The ability to travel afar would not only have depended on an ability to manufacture boats capable of making such journeys (which, considering the combined effort in time and resources involved in building such boats, would suggest a considerable investment (see e.g. Valbjørn 2003a on the time and effort involved in building the *Tilia*)), but also on having access to people with the necessary weather prediction abilities and seamanship to carry out such journeys (including navigational skills). These are skills that would have been fundamental for an aspiring leader to gain control of as, without a boat and crew, the journey would not be made, and there would be no means to make a name for oneself or to build up a power base (compare with e.g. Ling & Cornell 2010; Kristiansen & Larsson 2005:54; Kvalø 2004). Thus the actual act of making a journey would also have been of great significance and equivalent to that of any highly desirable skill, including that of, for example, metallurgy (compare with e.g. van de Noort 2003). In this context, the knowledge of the sail and the seamanship required for its use would have provided an even more desirable skill, as it would have provided advantages on many levels including:

- The sail would constitute a new skill which would emphasise seamanship and weather prediction abilities on a higher level than propelling a boat under paddles alone.
- Using the wind effectively might seem like the force of a god aiding the boat forward (see Chapter 5), thus reflecting power on the person controlling it.
- The sail would have meant increased flexibility and mobile range, both in terms of choice of routes, but also in terms of crew numbers.
- The sail would mean that a smaller crew could be used for short- medium and long distance journeys, leaving more men at home maintaining production when needed (or for defence). Moreover, the use of smaller crew might increase the ability to keep control over an individual 'chiefdom', but also increase the range across which alliances with other centres of power could be established, maintained and controlled, since the frequency in communication would potentially increase. Thus, even if such alliances were initially based on personal connections (meaning leaders themselves travelled), alliances could also have been maintained through trusted representatives.
- The use of sail might also have prolonged the active life of a seafarer since the need for high endurance capabilities (=long distance paddling) would be less vital, whereas navigational and weather prediction abilities might increase with experience gained over a longer life.
- Lastly, the use of sail would potentially provide a leader with advantages over rivals, who he might be on bad terms with (for evidence on warfare see e.g. Coles 2005; Fyllingen 2006; Kristiansen 1986; Thrane 2006), and which in turn might have led to increased competition in the further development of boats as well as rigs and sails.

The potential example of a seafarer who might have been killed while on a long distance journey comes from the skeletal remains of a man in his 50s, originating from eastern

Scania, but found at Granhammar not far from the rich rock carving areas of Enköping, i.e. some 600 kilometres away from his home region (Lindström 2009:500, 518—519; Oldeberg & Gjeberg 1959). Jonathan Lindström (2009:60, 532, 538) has recently suggested that the man might have died in a sea fight in the 8th century BC while on a friendly merchant trip – possibly as a result of an encounter with 'pirates' (as suggested by the fact that the man appeared to have been killed while wearing his knapsack with all its everyday contents). Furthermore, the half worked sheep bone the man carried in his knapsack, which suggests it was still soft enough to work on, indicates that the man set out on his journey only one or two weeks before his tragic end (Lindström 2009:451—452, 521). Lindström (2009:520) goes on to suggest that the relatively advanced age of the 'Granhammar' man, might be a testimony to his navigational experience and knowledge of the route, but in a note he also suggests that the relatively swift journey as well as some of the tools the man carried on him, might suggest the use of sail (Lindström 2009:544). This might be a direct evidence of the prolonged active life a seafarer might have had as a consequence of the combined use of paddling and sailing, as indeed previously suggested.

A boat the size of the Hjortspring boat, would have needed a minimum crew of eight when being paddled (Vinner 2003), but to do so would have been hard work, especially in a side or head wind, and would probably be limited to short journeys. A similar crew number was calculated for sailing such a vessel (see Chapter 6), and it is even possible that a smaller crew than this might have been able to sail such a vessel if required. The point is, however, that the minimum crew needed for long distance journeys using sail as well as paddling, would be considerably less than that which would be required for the same journeys proceeding under paddle alone. In fact, the crew of a boat the size of the Hjortspring boat could easily be reduced by more than half, if propelled by a combination of sail/paddles instead of paddles alone.

Estimates of the size of the Bronze Age population in southern Scandinavia suggest that the mobilisation of crews of more than ten, might have been difficult to assemble on a regular basis (see e.g. Artursson & Björk 2007; Berntsson 2005:86—93). This assumption also seems to compare well to the average number of 6—14 crew-strokes for rock art boats (where such lines are present), which have been studied in the parishes of Kville, Svenneby, Bottna and Tanum on the Bohuslän coast, and on which seven strokes appear to be the most commonly occurring (Ling 2008:191—192). Similar studies concerning the Blekinge and Småland rock art boats, have provided similar averages in terms of the number of crew-strokes (Bradley 2008:177—181). If indeed the number of crew-strokes in this way can be related to an actual Bronze Age crew, this would suggest a crew of seven might have been the norm. Since most long distance journeys would probably have lasted for more than one week, (depending on chosen route and destination, while allowing for changes in weather and other unforeseeable events), this is of particular interest, in the light of which the combined use of paddle and sail would have provided an obvious advantage.

There are many other advantages in using a small crew besides allowing one to leave more men at home. For any long distance journey, one would assume the crew would bring not only equipment for repairing all aspects of the boat and for preparing food (see e.g. Kaul 2003:155—160 regarding such equipment found with the Hjortspring boat), but also personal belongings, and the larger the crew, the more such personal belongings would have to be brought along, taking up space that might otherwise be used for cargo. The point at which this would become a problem would naturally depend on the length of the journey and what barter was used, but also what cargo was intended to be brought back home. If bronze was the only cargo, intended to be exchanged for e.g. bits of gold, silver or amber, this might not have presented a problem, but if more bulky items were brought, such as, skins, hides, furs, wool, textiles, lind bast (for making ropes), fish, cereal, cattle, sheep or even slaves (see e.g. Bergfjord et al. 2012; Kristiansen 1999b:91; Larsson 1989:27; Ling 2008:221—222; Wehlin 2013:188, and see Malmer 1992 and 1999 for evidence of Bronze Age weight systems), space might have been of essence. Other advantages of a small crew are of course the size of provisions needed, as the larger the crew is, the more food and water would be needed. If paddling without the help of a sail, one would envision even more provisions needed to sustain not only a larger crew but also a harder working crew engaged in full days of paddling (see e.g. Østmo 2005:72).

It is evident also that boats designed for the specific purpose of raiding or warfare might have found the use of the sail helpful, especially if such expeditions were planned for relatively long distances. Furthermore, if the expedition was a failure a sail might allow a heavily reduced crew to make a quick escape. The experimental sail trials in the *Tilia*

(Bengtsson & Bengtsson 2007, 2011), for example, indicate that a 'war canoe' such as the Hjortspring boat (Rosenberg 1937; Randsborg 1995; Kaul 2003a, 2003b), could easily have been sailed, and that such boats might even have been equipped with cleats, serving as attachment points for stays supporting a temporary mast.

It is clear that the advantages in terms of mobility and communication as offered by the combined use of sail/paddles and later sail/oars as opposed to the use of paddles or oars alone, would have far outweighed any perceived risks or disadvantages (compare with e.g. Westerdahl 2014:12). These advantages were obvious already for the people of the early Bronze Age. Whereas the sail might have been used at a very early stage for the purpose of straight line downwind sailing, certain aspiring leaders might have understood what was required to sail through a wider range of wind directions already by c. 1550 BC, if not earlier. This new technology might have other implications for our understanding of Nordic Bronze Age society, namely the nature and scope of direct travel at sea.

In a recent paper by Ling & Uhnér (2014), 'foreign' influences found within the Scandinavian rock art is discussed and set in relation to potential trade routes as suggested by lead isotope and trace element analysis of excavated Scandinavian bronzes. The authors propose an early influence from the British isles from around 2000–1600 BC, which can be studied in eastern Scania with the presence of, for example, an Anglo-Irish inspired flanged axe within the Fjälkinge hoard (Vandkilde 1996) and several depictions of such axes at a rock art site in Simris (Ling & Uhnér 2014:26). They also cite the presence of other types of axes depicted in the rock art of this area, some of which carry a strong reseblance with similar depictions found at Stonehenge (ibid.).

Around 1600–1300 BC, the appearance of rock art imagery with a connection to ritual concepts or actual artefacts from contemporary Mediterranea, such as, for example, the conical hat and the oxhide ingot, is set in relation to the presence of several excavated bronze tools with a copper content probably originating in Cyprus and Greece (Ling et al. 2014:123–124; Ling & Stos-Gale 2015:195; Ling & Uhnér 2014:26–27). Of interest here is of course the aforementioned Nordic razor, which Kaul (2013:469–470) considers to be the result of 'active diffusion', with aspiring leaders actively travelling to eastern Mediterranea and consciously picking up and adapting the Minoan/Mycenean concept of the 'warrior aristocrat' which included the razor (Kristiansen & Larsson 2005:225), to further their own position back home. Also Ling & Stos-Gale (2015:206) argue for direct communication, suggesting that the oxhide ingots in the rock art might represent a traveller's tale of such adventures. Other interesting direct links with eastern Mediterranea is the 290 glass beads that have been excavated in Danish graves dated to c. 1400 BC, and which originated from ancient Egypt and Mesopotamia (Varberg et al. 2015).

The signatures of the copper and tin contents of the Scandinavian bronzes, suggest that from around 1500 BC onwards, the majority of the copper arriving in Scandinavia did so along the Atlantic seabord with tin originating from Cornwall, and bronze from sources in western Mediterranen (Ling et al. 2014; Ling & Stos-Gale 2015:206; Ling & Uhnér 2014:30–31) – a trade route probably established already by the Neolithic 'Beaker' groups (Cunliffe 2001)

The above opens the door for the very interesting prospects of young aspiring leaders from Scandinavia, using plank built boats and sail for journeys all the way to the Mediterranean and back, perhaps as early as the mid-15th century. Such long distance journeys might have become increasingly important with increased technical capabilities and knowledge of distant seafaring conditions.

8. Summary and Conclusions

The main issue this thesis aims to reassess is the question of how and when the sail was first introduced and developed in Scandinavia, and how a potentially longer continuity in its use might affect our understanding of Scandinavian Bronze Age society.

The sail is currently thought to have emerged and developed in Scandinavia, or the 'North', between the 7th or 8th and 10th centuries AD. This should be set against the widespread use of sail in the Mediterranean by c. 2000 BC and by at least the 6th century BC around the British Islands. The main reason for a belief of its relatively late introduction in Scandinavia is a lack of firm archaeological evidence of boat remains attesting to its use. Nonetheless, in southern Scandinavian rock art, in the period ranging from approximately 1800 BC to AD 400, there are boat carvings with attributes that can be interpreted as masts and sails, suggesting that the art of sailing was known and possibly used here much earlier than currently accepted. Some of these particular images have been long known and yet completely omitted from any consideration of the usage of sail in the North. Instead, one line by the Roman historian Tacitus where he describes the 'Suiones' as lacking sail has (see Chapter 3), despite its questionable accuracy, been established as truth that the sail was not known in the North before AD 98.

The aim of this thesis is to challenge the current view of when the sail was first taken up in Scandinavia on several different levels:

- By placing the rock art and its associated boat imagery within the context of the southern Scandinavian Bronze Age, and establishing it as a reflection of a society dependent upon boats in the everyday lives of its people.
- Through assessing the evidence upon which the belief that the sail had a relatively late introduction in the North is based, while questioning the 'minimal solution' approach to the interpretation of many prehistoric boat finds, in particular in relation to the early use of sail.
- Through evaluating the rock art boat imagery attesting to the use of sail in southern Scandinavia.

- Through experimental trials on Bronze Age type vessels, for the purpose of assessing whether such vessels could have been sailed using methods and technology that might have existed at the time.
- Through examining the transition from paddling to sailing in ancient Egypt and Oceania – two different geographic regions, each of which provide clear evidence of the early use of sail based on very different archaeological source material – in order to evaluate whether there are any pre-conditions that would have facilitated or driven the emergence of the sail, and which might help explain how this transition might have occurred also in southern Scandinavia.

Summary of Chapters 1–7

Chapter 1

The Scandinavian Bronze Age, ranging from c. 1800 to 500 BC, is perceived to have seen the emergence of an increasingly stratified society, with specialised craftsmen and warriors, where the aristocratic elite would gain status and prestige through the control of exotic and rare commodities. The acquisition of many of these commodities, and in particular that of bronzes, would have depended on boat transportation.

From the distribution of graves and rock art on islands and along the paleogeographic coasts and inland waterways, it is obvious that southern Scandinavian society at the time was dependent on boats in its everyday life. The importance of waterborn transportation is further emphasised through the enduring symbol of the boat itself which, throughout the Bronze Age, appeared in one form or another, on bronzes, as graves (ship-settings), in graves and, in particular, within the rock art where it remained the altogether dominant motif.

Even though actual boat finds dating to this period are scarce, southern Scandinavian rock art displays a wealth of different types of vessels, used for a whole range of activities, some of which appear to show regional variations. This variety of imagery suggests the depictions are based on real contemporary boats. Some of this rock art material depicts what can be interpreted as vessels with masts and sails, pre-dating the accepted view of when the sail was first introduced in Scandinavia by some 2000 years.

The symbolic importance of the boat coupled with the fact that the iconography of boats in rock art is located in proximity to places where boats would have been used, suggests that boats played a key role in Scandinavian Bronze Age society. This in turn would allow for boats and their propulsion to be explored as an integral part of society as a whole. The continuous use of the boat as a powerful symbol from Bronze Age through to Viking Age, as manifested in graves, as depictions on raised stones, on bronzes and on rocks, might reflect a continuity in the Nordic society as a whole. This continuity is further reflected in the locally evolved Nordic boatbuilding technology which in the archaeological boat material can be traced back to the 350 BC Hjortspring boat but which in the iconographic material might be traced back to the very beginning of the Bronze Age. A similar continuity might also apply to the emergence of the Nordic mast and sail, also believed to have evolved locally, and begs the question of whether the use of the sail might have been one of the driving forces behind the changes in Nordic boatbuilding technology.

Chapter 2

The main source material for this thesis, the rock art, is for practical reasons limited to the 'agrarian' rock art tradition of southern Scandinavia. The entire southern Scandinavian region is defined by the common symbolic use of the boat as seen not only in the rock art but also on bronzes and in graves such as ship-settings. This chapter also explains the importance of experimental archaeology when studying ancient boat material, as well as practical problems encountered in relation to the research of the rock art, and in connection with the experimental sail trials described in Chapter 6.

Chapter 3

In Chapter 3, the available evidence on boats and the emergence of the sail in ancient Egypt and Near/Remote Oceania is presented. This indicates that a keel would not have been a prerequisite for the development of the sail but that a lateral plane can be achieved with the use of one or multiple steering oars. Furthermore, a direct comparison suggests the parallel use of several types of rigs, steering equipment and even sail types and sail material, depending on usage, resources and availability.

Other parallels between the evidence from ancient Egypt and Bronze Age Scandinavia, are a) the possibility that fashion might have dictated the choice of imagery (whether, for example, masts or even boats are being depicted within the iconography), and b) the obvious discrepancies between the archaeological and the pictorial evidence of early sailing. The Cheops ship for example, one of the earliest archaeological boat finds in Egypt, does not reveal any traces of the use of sail and yet, sail had been used for at least five hundred years prior to this ship having been built. In addition, an almost identical ship within the iconographic material from the same period, clearly exhibits a sail. Not only does this suggest that the same type of boat could have had different functions depending on need, but it also highlights the inherent problem of finding evidence of sail within a limited archaeological source material.

Finally, the chapter discusses the term “*sailing*”, defining it as the ability to harness the wind in order to propel a watercraft forwards in a desired direction. In its simplest form this can be achieved by a person standing up in a boat for going downwind only, and rejects the common preoccupation of many Scandinavian scholars that a sailing vessel must be able to sail towards the wind. The latter would in effect disregard many hundreds or even thousands of years of early development and use of sail. Furthermore, it is clear that the advantages of sailing would apply not only for long distance waterborne journeys but also for relatively short journeys.

Chapter 4

In Chapter 4, I introduce the archaeological, iconographic (excluding the rock art), linguistic and written source material upon which the current hypotheses regarding the introduction of the sail in the North is based. Westerdahl has, for example, suggested that before the emergence of royal control around the 8th century AD, there was no impetus for a change from the use of oars to sail in Scandinavia, and that people here would simply have chosen not to use it prior to this time. The point at which the sail was finally taken up, would have coincided neatly with the fully developed keel (which would have provided the necessary strength to the hull for supporting the perceived increases in forces incurred by the use of sail, as well as providing the necessary leeway resistance allowing the boat to move forwards rather than sideways), along with the mast-step and a freeboard suitable for sailing. This in turn would have allowed for the hit and run methods employed by the Vikings and first recorded with the attack on Lindisfarne in AD 793 – allowing for a surprisingly short period of time for these alterations to the boats and the developments of rig and sail to have occurred.

Both Tacitus (1st century AD) and Procopius (6th century AD) appear to support this late introduction, but a closer examination reveals that both authors rely on secondary sources for their observations, and that there are sufficient grounds for questioning their reliability. Procopius is further contradicted by a primary source – a letter by Apollinaris who makes a specific reference to the use of sail among the Saxons in the 5th century AD. There is also the circumstantial evidence to consider assembled by John Haywood (2006) which points towards a widespread use of the sail among the Angles, Saxons and Jutes by this time.

The earliest iconographic evidence of boats (excluding the rock art) appears on the Gotlandic picture stones, dated to between the 5th and 10th century AD. The earliest boat depictions within this material depict what appears to be bean shaped vessels that are rowed as if in a procession, and steered with the use of two steering oars, one mounted in each end of the vessel. The first sails, on the other hand, appear on stones dated to the 6th or 7th century AD and lack any processional appearance. Although this imagery is confined to Gotland, it belongs to the Scandinavian cultural tradition, within which the imagery/symbol of the boat was probably far more commonplace than the archaeological material allows us to see. The c. 1550 BC Lundergård boat carving found on a log indicates that the same logic might apply to the Bronze Age. In addition, this particular boat carving has what might be interpreted as a mast. The wider use of boat imagery is further seen in the stray find of the Karlby stone, which, although lacking datable context, has a representation of a bean shaped vessel reminiscent of hulls shown on the early Gotlandic picture stones and of the Nydam boat (and also reminiscent of bean shaped boats in the rock art of a similar age). Despite the similarities in the hull shapes, the fact that the boat on the Karlby stone carries a sail has resulted in it being conservatively (and in my view, perhaps erroneously) dated to between the 6th and 8th century AD.

Based on the Gotlandic picture stones, many scholars have suggested that the sail was first developed in the 6th and 7th centuries AD and that the variations in how the rigs are depicted might indicate a period of experimentation of this new device. However, although these picture stones are generally interpreted as being the hallmark of a transition from rowing to sailing, I would argue that the difference in the character from the earlier processional depictions to the later sailed vessels, might stem from a change in fashion in the type of motives (and the choice of medium for a particular type of motive) rather than an evolution from rowing to sailing.

The linguistic evidence in relation to the introduction of the sail in the west Germanic world is neither clear nor conclusive, but seems to indicate a date well before the first century AD. This evidence also suggests that the ways in which the sail developed in the west Germanic world and in Scandinavia followed two independent routes, supporting the theory that the Scandinavian sail developed independently. This is consistent with an earlier introduction of the sail than hitherto accepted.

There are not enough actual boat remains pre-dating the Oseberg ship (with its preserved mast step) available to make any categoric statement regarding the exact timing of the introduction of the sail in the North. The Sutton Hoo boat, generally believed to have belonged to the Scandinavian boatbuilding tradition, had for example a grave chamber positioned in its centre, effectively removing any traces of a rig had it existed, and the Kvalsund 2 boat, although exhibiting features that might indicate an "*adaptation towards sailing*" (Rieck & Crumlin-Pedersen 1988:139), also lacked any indications of a mast or rig. This should be set against the fact that the 10th century AD Ladby ship was interpreted as a sailing warship solely on account of four iron rings on either side of its gunwales, which suggest a use as shroud rings for the support of a rig. This clearly illustrates how difficult it is to find elements attesting to the use of sail in the archaeological material, not least since it appears rig and sail were generally removed and possibly reused when the boat itself was discarded. Thus, the chances of finding evidence of sailing in the only two remaining boat finds, Nydam 2 and the Hjortspring boat, would seem very small, especially when considering that we do not know what the early rigs looked like nor what traces they might have left behind. In this respect it is clear that a 'minimal solution' interpretation of these early vessels presents problems.

As for the question of what constitutes a fully developed keel, this appears to be very subjective; some scholars argue that the fragmentary remains of Nydam 3 (AD c. 290) displayed the first signs of a proper keel, along with the first side rudder that might have been suitable for sailing. In addition to this, sail trials in a half-scale reconstruction of the Sutton Hoo ship indicate that the shape of the hull and its length could have a similar effect to that of a keel, and that therefore a keel alone is not a pre-requisite for a vessel to be able to sail. This demonstrates the need for carrying out experimental boat trials on water rather than relying on desktop analyses alone when assessing pre-historic vessels.

This chapter clearly shows that there is no irrefutable proof that the sail was not used in Scandinavia prior to the 6th or 7th centuries AD and indeed that there is in fact enough circumstantial evidence to suggest an earlier introduction.

Chapter 5

Chapter 5 discusses the evidence of propulsion and steering present in the southern Scandinavian rock art. Rock art boats with details that can be interpreted as masts and/or sails have been noticed and commented upon since the beginning of the 19th century by some 20 scholars. Many of these observations have been made in relation to singular boat depictions, and rarely across more than one region. It is only with the increased accessibility of rock art in more recent years– not least in terms of documentation, interpretation and publication – that any wider research into this imagery has been possible.

The nature of rock art, with images sometimes carved one on top of the other, or incorporating natural structures such as cracks or ice furrows etc., can often lead to slight variations in how individual images are interpreted. When it comes to the imagery of boats furnished with mast and sail-like attributes, such imagery has not only been identified by many different scholars, but can be found at over thirty sites in some eleven regions. Furthermore, such attributes appear on a range of images of different types of boats during a period from approximately 1500 BC until AD 400. This raises the legitimate question as to whether the sail was not only known but also used here at the time when these images were carved.

In comparison, there are perhaps forty images of boats in which one can say with relative certainty, that paddlers have been included, but outside of Bohuslän, this imagery only appears at four other sites. The representations of rowers are even more scarce and can only be found at two or three sites in the entire region. This clearly indicates that the primary purpose of the rock art boat imagery was not to display how it was propelled, but also that the boat imagery that can be interpreted as masts and sails are just as scarce as that indicating the use of paddles.

Returning to the boat depictions with features that might be indicative of the use of sail, these have been divided into four groups: boats with visible sails, boats with masts and stays, boats with raised yards and, finally, boats with single masts. Of these, the boat depictions with what appears to be a single mast have perhaps been the most controversial in terms of interpretation, as some scholars argue that such depictions might be the representations of a standing member of the crew and not necessarily a mast. There is, however, enough available rock art material to support the interpretation of a mast, not least because such single masts are sometimes shown carrying a yard. Just as the crew are sometimes represented by a simple upwards projecting vertical line and are only rarely seen holding paddles, the mast is generally represented by the simple mast line, which is only rarely elaborated with the addition of the actual sail, yard or standing rig.

The available rock art material seems to indicate the use of different types of rigs, including single and bipod masts which are sometimes supported by stays and shrouds, but there is also evidence that two masts might have been used. Furthermore, the mast is sometimes positioned towards the bow or stern depending on how the boat has been depicted and later interpreted. Also the form of the sails present in the rock art varies, from what appears to be square sails made of perhaps leather or cloth, to square or round lattice (or kite) type sails. Most of these variations appear alongside each other with a marked concentration in the years from 1300–900 BC. This is indicative of a period during which the sail was experimented with until the most efficient and safe way of carrying a sail took over and boats evolved. This in turn supports the idea that the sail developed independently in the North and that boat and sail evolved together.

On-water trials in a reconstruction of the 350 BC Hjortspring boat, called the *Tilia*, indicate that the manoeuvring of this vessel under paddle would have been greatly improved with the use of two steering oars, one positioned at either end. Such steering oars were found at each end of the original vessel at the time of excavation. The use of double steering oars is also visible within the southern Scandinavian rock art material – for example, an image of one boat at Bærum in southern Norway appears to be rowed while being steered with a steering oar in each end (see figure 51). Together with the experiences from paddling the *Tilia*, this suggests that double steering oars were habitually used during the Bronze Age, although in the rock art we only see them clearly depicted on boats dated to the Pre-Roman Iron Age. For earlier periods their use can be detected through the positioning of the crew, with one single crew member positioned at either end as if in charge of steering, and can be traced back to the very beginning of the Bronze Age on, for example, the Rørby sword. The side rudder can also be detected in the rock art, the appearance of which is currently set against its first appearance within the archaeological boat material on the Nydam vessels around the 4th century AD. It could, however, be older.

Chapter 6

In Chapter 6, a series of experimental sail trials in Bronze Age type vessels are described which aim to assess whether such boats could have been sailed using methods and technology that are likely to have been available at the time. The basis for what such a vessel might have looked like is primarily built upon evidence provided by the rock art (Chapter 4), the features of the 350 BC Hjortspring boat (which appears to belong to a Bronze Age boatbuilding tradition), ship-settings, as well as previously published data on sea trials in the *Tilia (*the reconstruction of the Hjortspring boat). Combined, this suggests that the criteria for undertaking valid experimental sail trials might include the use of:

- a canoe-like boat with a round hull and no keel,
- double steering oars, one at each end of the vessel, which would have functioned as a 'keel', or lateral plane, as well as providing a means for steering,
- a simple rig which would have been easy to raise and take down in response to changeable winds and to ease paddling, while at the same time, leaving few or no marks on the vessel,

- sails that were relatively low and wide, with a low centre of gravity in order to reduce any tilting moment,
- a crew with advanced sailing experience who could use the relative instability of this type of vessel as an advantage and for whom such vessels were the norm – just like the Bronze Age people.

Using this concept, initial trials were made in 2005, using a modern Canadian canoe with the use of a bi-pod mast, a flat square sail and ordinary pine paddles for use as steering oars. The sheltered waters of the Gothenburg archipelago where Bronze Age cairns still adorn the tops of many islands, was chosen to be as authentic an environment as possible. The results of these trials showed that the implementation of the criteria listed above would have functioned exceptionally well for sailing in this kind of environment. In winds ranging from 2–10m/s, the canoe was never close to capsizing nor did any equipment come anywhere near to breaking. Furthermore, the trials demonstrated the ease with which the sail could be used as a complement to paddling, allowing for comfortable journeying across relatively long distances.

The experiences gained from these initial sail trials were subsequently transferred onto the *Tilia*, to assess whether a sewn vessel would have been able to sail and sustain the extra forces incurred by this form of propulsion. In order to increase safety margins and make initial sail trials easier, the sails used for these trials had some depth (shape) sewn into them and were made relatively smaller, in addition to which a reef was used throughout the trials. Using an active sailing crew of seven, an inactive crew of four and 500kg of ballast, the *Tilia* was found to sail with ease on the waters off the island where the Hjortspring boat was originally discovered.

In addition to demonstrating that this type of vessel could have sailed and manoeuvred well even with the use of steering oars with relatively small blades, the trials showed that the Bronze Age technique of spreading the forces of the thwarts and internal ribs also proved an efficient way of spreading the forces induced by sailing, while at the same time offering many natural attachment points for mast and sail, including running rig and clew. The four integral cleats on the top of each of the stern and fore ends were, for example, found to work well for attaching the stays. The steering oars were found to be very easy to attach and remove – something which would have been essential when landing on a beach. Furthermore, the square shape of the original steering oars just where the shaft turns into the blade, would not only have added strength to this point but would also have facilitated steering, adding force to the hypothesis that one of the functions of the 'horns' might have been for the attachment of the steering oars.

Chapter 7

Chapter 7, considers how the sail might have been used and evolved in Bronze Age Scandinavia. The location of the rock art exhibiting what might be interpreted as boats with masts and/or sails within the sheltered archipelagoes and along more sheltered stretches of coastline, implies not only the importance of these waterways in the Bronze Age, but also the possible advantage such relatively sheltered areas might have had for the early development of the sail. Average wind data, speed as well as direction, clearly implies the advantages the use of a sail in combination with paddling would have had on early communication compared to the use of paddling (muscle force) alone.

As for why the sail might have evolved in Scandinavia, the comparative analysis with ancient Egypt and Oceania suggests this might have occurred due to a combination of environmental and social factors, including: (a) a relatively low-risk environment for experimenting with sail, with e.g. a small tidal range, weak or at least predictable currents as well as predictable weather conditions; (b) a long continuity of a population dependent on boats in its everyday lives, some of whom possessed well developed seamanship and the ability to successfully predict the weather; and (c), a desire to improve speed and cargo capabilities, the incentive of which might come with an emerging exchange system and an increased need for the transportation of people, animals and goods. Thus, given the right environmental and social circumstances the sail could have evolved at different places at different times.

The sail might initially have been used for relatively short water journeys of up to 2km or of some 30—40 minutes length in time. With increased needs, seamanship and weather prediction abilities, the sail would have been developed for use on increasingly larger vessels and longer journeys. The comparative analysis further suggests the earliest sail was used for downwind sailing only, but that the sailing range expanded with increased needs in terms of mobility and trade, which in turn might have driven the search for new technology. The pictorial evidence sets the date for the use of the sail as far back as c. 1550 BC. The same evidence suggest that at this time vessels might have been able to sail with the wind from the side.

Put into the context of what is currently known about southern Scandinavian society during the Bronze Age, the use of sail as a complement to paddling would more convincingly explain the level of mobility and communication recorded within the archaeological material at large.

Conclusions

Within southern Scandinavian rock art, dating between c. 1800 BC and AD 400, there clearly exist boats with mast and sail like attributes. Despite this evidence the rock art has hitherto been omitted from any discussion on the introduction of the sail in the North. Instead the received opinion appear to conclude that the sail did not arrive here until between the 7^{th} or 8^{th} and the 10^{th} century AD.

By examining the evidence of propulsion within the rock art boat material, in combination with experimental sail trials in Bronze Age type boats, and by comparing the knowledge gained from this with what is known about the transition from paddling to sailing in Ancient Egypt and Oceania, this thesis argues that the sail was used in Scandinavia in the early Bronze Age and that its use, as a complement to paddling, was widespread by c. 1300 BC. The driving forces behind its development was emerging exchange networks along with the early formation of centres of power in the seventeenth and sixteenth centuries BC, which together would have intensified the need for mobility and communication over increasingly larger distances. The sail would have been a vital tool for the formation and development of these early centres of power, as the combination of sail/paddles would not only have allowed for more frequent long distance journeys through a wider range of weather conditions, but also increased flexibility in terms of the choice of routes and requirement for less manpower. In addition, the sail and the understanding of its use might have further enhanced the status of an individual leader.

The emergence of the sail would also help explain how communications across such a large geographic area as southern Scandinavia, could be maintained at a frequency that allowed for a distinct Nordic tradition to develop and change in relative unison throughout the entire Bronze Age – a period from c. 1800–500 BC.

This thesis suggests that the sail would first have been experimented with in the relatively sheltered archipelagos around the Scandinavian coasts, which would have offered a near ideal environment with negligible tide, weak and predictable currents as well as relatively predictable weather systems. Here a population used to boats in its everyday life and which had built up the necessary skills for experimentation, including seamanship and the ability to successfully predict the weather, would have started using the sail for relatively short trips. Although initially at least, it is likely that the sail would have been used for downwind, straight line purposes only, the sailing range would probably have increased relatively quickly to at least 90 degrees to the wind in response to increasing needs for mobility and trade. The evidence suggest this transition might have begun already before c. 1550 BC and that it can be put in direct relationship with the peak of the early Bronze Age 'chiefdoms' between 1500—1100 BC (Kristiansen & Larsson 2005:204), during which time also increased competition between rival chieftains might have offered a direct incentive for trying to expand on existing sailing abilities.

The early sails would have been made of different materials such as textiles, hides or types of matting, depending on availability, resources and specific need. These sails would have been relatively low and wide so as to create a low centre of gravity, and the rigs would have been simple constructions that left few or no marks and which would have been quick and easy to take down in response to changeable conditions. A major problem inherent in the archaeological study of the introduction of the sail is that few boats have been found, and that visible evidence of sailing as a means of propulsion is rarely preserved. Thus, if the sail, as suggested here, evolved on small boats where the forces incurred by the wind would have been relatively minor, the traces that are so rarely left on larger vessels would be even harder to trace. In this respect it is clear that a 'minimal solution' approach to the study of ancient boats, is problematic. Experimental sail trials in Bronze Age type boats, i.e. round hulled canoe like vessels with no keel, show that the contemporary boatbuilding technique of using protruding integral cleats in individual strakes, for attaching internal frames and thwarts, would have functioned equally well for spreading the loads induced by such early forms of rig and sail, and would also have allowed for many natural attachment points for the rig. The experimental sailing trials also show that the use of double steering oars, one in each end of the vessel, as evidenced by the 350 BC Hjortspring boat as well as Bronze Age rock art, would have functioned as a keel or lateral plane, allowing for this expansion in sailing range. It is possible too, that one of the functions of the typical 'horns' or 'beaks' as seen on many rock art boats might have been for the fastening of these steering oars.

The rock art suggests that these 'horns' would have disappeared once the new clinker technique of building boats appeared by the late Pre-Roman Iron Age/early Iron Age, allowing for hull shapes facilitating steering as well as an embryonic keel, in combination with the side rudder. Archaeological boats finds and iconographic evidence suggest, however, that both methods of steering were used alongside, or in combination, for several hundred years. This clearly indicates a continuity in boatbuilding technology from Bronze Age into Iron Age and supports the notion of an internal and incremental development. This is further supported by the fact that boats were being propelled by a combination of paddles or oars and sail well into the Viking period. It is very likely these changes in the means of steering and in boatbuilding technology, were driven by the continuous development of the sail in response to increasing needs of communication and trade.

Thus it appears the sail was the result of a gradual and incremental internal development rather than the sudden development current hypothesis suggests – a process which started already in the early Bronze Age. Finally, in considering the use of the sail in Bronze Age Scandinavia, we might conclude by observing that rather than requiring a rethink of how that society functioned, it actually makes far more sense of our current knowledge of it.

Glossary

Centre of effort **–** often referred to as the 'centre of pressure' i.e. the point at which the combined aerodynamic force of the wind acts on a sail.

Centre of gravity **–** affects a boats stability. The higher up the centre of effort is on the sail (i.e. the higher the sail is), the less stable the boat will be. On a small and narrow boat, a low centre of gravity is preferred. This can be adjusted by members of the crew sitting to windward, counteracting the effect of the wind or, as in Oceania, by widening the boats with the use of e.g. outriggers.

Cleat **–** an object (often T-shaped) that is attached to a boat and around which a rope can be tied.

Clew **–** a lower corner of a sail, here referring to the windward corner.

Crew-strokes **–** a series of upward projecting lines on a rock art boat interpreted as stylistic representations of a crew.

Flapping *[a sail]* **–** the act of spilling wind from a sail by letting go of the sheet or through steering up towards the wind without taking up slack on the sheet. The primary cause for fatigue of the sail.

Jybe **–** the action of changing course by swinging the sail across a following wind.

Lateral plane **–** also referred to as the 'centre of lateral resistance', the geometrical centre of the submerged body of a vessel.

Tack **–** the action of changing the direction of a boat through steering into the wind and continue this movement until the wind fills the sail again from the opposite side. A ***gybe tack,*** is when, instead of steering into the wind, the boat steers away from the wind down to a dead run with the wind from behind and then up again so that the sail is filled from the opposite side.

Trussing rope **–** a rope that runs from bow to stern of a ship or boat and which can be tightened in order to provide extra longitudinal strength.

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