The Drogheda boat and clinker boats of the Renaissance on Europe's western seaboard

Holger Schweitzer

Ph.D. thesis

submitted December 2013 to the University of Southern Denmark

Acknowledgements

The undertaking and completion of this thesis would not have been possible in the way it did without the support and help of a number of institutions and individuals. First and foremost the PhD project would have not been possible with the support and contribution of the University of Southern Denmark, the Deutsches Schiffahrtsmuseum (DSM) Bremerhaven, Germany and the National Monuments Service in Ireland. Many thanks to my supervisor Thijs Maarleveld for supporting my proposal from the beginning, as well as his invaluable advice, constant feedback, constructive criticism and motivation throughout the project. My sincere thanks for the support of Prof. Lars Ulrich Scholl and Dr. Ursula Warnke of the DSM who enabled funding and provided the greatest hospitality to utilise the Museums library and facilities. The study would not have happened without the unconditional support of my former colleagues of the National Monuments Service in Ireland. Ever since embarking on the excavation of the Drogheda Boat my colleagues of the Underwater Archaeology Unit Fionnbarr Moore, Karl Brady and Connie Kelleher who always gave their full support and advice. I also have to extend my appreciation to the senior management of the National Monuments service and colleagues. In particular thanks to Brian Duffy, Ann Lynch and Terry Allen for their continuous support during the Drogheda Boat project as well as Con Brogan for compiling a wonderful photographic archive.

Thanks are also owed to my friend and Department colleague Jens Auer for his support and constructive input through immense practical help and countless creative discussions. I would like to thank the staff of the Newport Medieval Ship project for their technical and scientific expertise and assistance. In particular Nigel Nayling, Toby Jones and Ben Jennings who contributed significantly by their immense knowledge and readiness to help. Furthermore the meetings and discussions with members of the Faro Rhino User Group provided advice and insight way beyond the technical aspects of 3D documentation and post-processing. I am furthermore indebted to Johan Rönnby and Niklas Eriksson for organising the MARIS Baltic Maritime Archaeological PhD Research Network. The exchange with fellow PhD students through this platform has been extremely fruitful and insightful.

I would like to extend my gratitude to all individuals who provided their help, enthusiasm and expertise to the Drogheda boat project and the resulting PhD path on social and scholarly levels. Their support and friendship has been indispensible throughout the years of working with the material. Many thanks to Rex Bangerter, Jimmy Lenehan, Frank Mallon, Erica McCarthy, Dominick Gallagher, Kieran Campbell, Brian MacSharry, Johnny Ryan, Chiara Buldorini, Stephen Davis, Ben Stern, Margaret Rutherford, Jennifer Harland, Charlotte O'Brien, Elizabeth Heckett, Aoife Daly, Angela Wallace, Pat Tanner, Sarah Fawsitt, Andrew Stanek, Tori Falck, Steve Allen, Morten Ravn, Mike Belasus, Damian Goodburn, Aidan O'Sullivan, Eric Rieth, Morten Gøthche, Tori Falck, Jan Bill, Ole Crumlin-Pedersen, Fred Hyttel, Alice Overmeer, Desiree Nævdal and Moira O'Rourke.

Thank you Nadine for your unconditional support and patience.

Abstract

The coastal fjords and estuaries of the western European seaboard were teeming with small watercraft during the Renaissance period. As diverse as their construction, appearance, rig and design may often have been, their use and purpose was largely similar, and not too different from our modern perception of small coastal watercraft. They served for example as fishing vessels, cargo carriers thereby facilitating short to medium distance trade, as well as lighters and ferries. Some were highly specialised towards one or two of the above fields of use while the versatility of others saw them being used for a variety of tasks depending on season, necessity or demand. Small coastal watercraft found employment in rural settings owned by local fishermen or peasants as well as in urban contexts where for example merchants could own a number of boats to assist with their trade operations. Overall workboats for coastal use were a fundamental cornerstone for sustaining and developing seafaring and trade on national and international levels in Renaissance Europe.

The current state of research indicates that clinker construction remained the predominant method of building for smaller vessels in north-western Europe into and through the Renaissance. The introduction of carvel building methods and the increased professionalization and specialisation of the workforce and production processes during the Renaissance certainly impacted on established boat building traditions. However, considering the relatively slow, non-uniform and diverse spread of carvel shipbuilding across western Europe, any developments owed to technological diffusion and changing socio-economic background cannot be assumed to be spatially and chronologically linear.

The above described abundance of small coastal watercraft sailing and operating the waters of the western European seaboard during the Renaissance is contrasted by a relative scarcity of boat finds. Yet, even within the small number of boat finds to date a well-defined north south divide between north-western Europe on the one part and the Iberian Peninsula and France on the other becomes apparent. The significantly higher number of known wrecks from north-western Europe, and Scandinavia in particular, is not only the result of a strong maritime archaeological tradition but also of much better preservation conditions and accessibility prevalent in the Baltic Sea in contrast to the Atlantic and North Sea. As a consequence the research surrounding the development of clinker boat building traditions in western Europe is heavily influenced by interpretational models and classifications based on the knowledge available from the north-western European context. Thus the current non-existence of archaeological evidence for south-western European clinker boat building traditions means that the general development and manifestation of clinker boat and shipbuilding techniques are by and large deduced from "northern" building traditions.

Even though small coastal watercraft of the Renaissance have moved more and more into the focus of attention over the last two decades, again particularly in Scandinavian research, they still remain overshadowed by research into the introduction and development of carvel shipbuilding along the European Atlantic seaboard. From a north-west European viewpoint the continuation of the well-established and predominant clinker boat and ship building tradition from the Middle Ages into the Renaissance provides the opportunity to investigate aspects of change and continuity during a period of drastic political, socio-economic and technological changes.

Using the mid-16th century Drogheda boat, found in 2006 in the River Boyne near Drogheda on the Irish east coast, as the main case study the objective of this dissertation was to investigate potential similarities and differences of clinker built coastal watercraft from a relatively unconventional perspective by using a twofold approach. In contrast to large oceangoing vessels made for long-distance journeys and to suit a variety of operational environments, coastal boats predominantly operate in a relatively narrow geographical range. As the area of operation for these vessels can often be closely defined not only geographically but also in terms of use, coasters possess the potential for displaying high degrees of specialisation regarding design, construction and rig. In acknowledgment of this potential, the geographical and environmental context and background of the various coastal regions in the study area are presented to establish a better understanding for the versatility in operational waters and demands on coastally operating watercraft.

Originating from the western fringe of the European Atlantic seaboard the Drogheda boat is currently unique with no immediate comparative boat finds in Ireland or in the wider British Isles. Nevertheless the high levels of preservation, including remnants of the cargo of cured herring kept in re-used wine barrels of southern French origin, provided a wealth of information. This allowed for the interpretation, and placing of the wreck within its historical and seafaring context even without addressing the question of building tradition. Furthermore as Ireland and Drogheda maintained close relations with south-western France and the Bay of Biscay throughout the Middle Ages and Renaissance the question arose as to what extent the structural makeup of the Drogheda boat might be influenced by contemporary south-western European clinker building traditions rather than assuming a purely Nordic descent. The aims of this study were therefore to firstly highlight the importance of viewing small coastal watercraft as standalone archaeological entities and secondly to attempt a transnational archaeological comparative analysis removed from the restrictions of conventional classification and interpretation models.

It is important to stress that historical research from an interdisciplinary research perspective could provide further and crucial information, particularly given that this study covers the by and large well-documented period of the Renaissance. However, comprehensive historical research undertaken as part of the analysis of the Drogheda boat yielded few useful results regarding contemporary Irish boat and shipbuilding and seafaring. Conversely the state of research in other countries such as the Netherlands and Denmark is well-established and highlights the value of combining archaeological and historical research. Nevertheless, given the wide geographical delimitations of this study, the integration of in depth historical research was not feasible. The primary focus of attention of this study is thus placed on archaeological analysis and interpretation.

The compilation of sites and finds for the comparative analysis gave 20 sites with a minimum of 40 represented wrecks across the study area reaching from Portugal to Norway. The extreme north-south divide quickly became apparent with only two wreck finds from the south-western regions and the remainder by and large having been found in the North Sea and western Baltic Sea. This result highlights the dangers in broadly applying research and interpretational results from this relatively confined geographic area to the entire western European seaboard.

Further limitations for undertaking a meaningful and comprehensive comparative analysis to the targets outlined above were placed by the nature of the compiled data. Quantity and quality of information available from the various boat finds varies drastically, depending on time and circumstances of discovery as well as preservation conditions and research effort. As a consequence the comparative analysis of structural and design elements was reduced to a number of key elements and dimensions.

From the Scandinavian material it is possible to draw from previous research, which suggest a general decline in build quality commencing in the Middle Ages and leading to a more homogenous structural appearance of clinker built vessels in conjunction with the appearance of new technological methods. Examples of deteriorating build quality are amongst others the disappearance of ornamental features, a tendency to more crudely finished hull elements and the use of lesser quality wood. While these observations are generally mirrored in the present study it also transpires that certain geographical differences in structural solutions remain. Although the limitations in the currently available boat finds prohibit secure interpretation, it is evident that a certain level of regionality in building methods can be suggested. Reaching similar conclusions for the introduction of new technological methods is currently not feasible to a similar degree. Nevertheless three wrecks in the studied assemblage display features indicating a conceptually more predetermined construction approach than commonly associated with medieval clinker boat and shipbuilding. Notably the three examples are spread across almost the entire studied geographical reach thus suggesting a certain degree of transformation in the organisation and nature of clinker boat building.

The assessment of the compiled boat finds in light of their environmental context comprises an analysis of structural and design elements to establish potential adaptations to their respective operational range and use. Overall the research stresses the immense potential of clinker built coastal watercraft, which is currently contrasted by significant deficiencies in the archaeological dataset. Notwithstanding the significant shortcomings in the knowledge base, the assessed dataset shows complex patterns in the nature and development of clinker boats across the western European seaboard.

Resumé

I renæssancen myldrede det med mindre fartøjer i fjorde og flodmundinger langs de vesteuropæiske kyster. Så mangfoldig som deres konstruktion, udseende, rigning og design sikkert ofte har været, så var deres anvendelse og formål ganske ensartet, og ikke langt fra vores moderne forståelse af små kystfartøjer. De tjente for eksempel som fiske- eller fragtfartøjer, hvorved de understøttede handel på kort og mellemlang afstand, eller også som fyrskibe og færger. Nogle var højt specialiseret mod én eller to af disse arbejdsområder, mens andre var mere bredt anvendelige, og kunne anvendes til en række forskellige opgaver afhængig af årstid, behov og efterspørgsel. Små kystfartøjer fandt anvendelse i landlige omgivelser, ejet af lokale fiskere eller bønder, men også i byerne, hvor for eksempel købmænd kunne eje et antal både som en del af deres handelsvirksomhed. Overordnet set var arbejdsfartøjer til kystnær brug en fundamental hjørnesten i opretholdelsen og udviklingen af søfart og handel på nationalt og internationalt niveau i renæssancens Europa.

Den aktuelle forskning indikerer, at klinkbygning forblev den fremherskende konstruktionsmetode indenfor småskibsbyggeriet i Nordvesteuropa frem til og gennem renæssancen. Introduktionen af metoder til kravelbygning, samt den tiltagende professionalisering og specialisering af arbejdskraft og produktionsprocesser gennem renæssancen, påvirkede utvivlsomt etablerede bådebygningstraditioner. I lyset af den forholdsvis langsomme, uregelmæssige og mangfoldige spredning af kravelbyggeriet gennem Vesteuropa, kan udviklinger med rod i teknologisk diffusion og samfundsøkonomiske forandringer dog ikke antages at være geografisk eller kronologisk linære.

Den ovenfor beskrivende overflod af små kystfartøjer i farvandene langs de vesteuropæiske kyster i renæssance står i kontrast til de relativt få bådfund. På trods af det til dato lave antal bådfund, tegner der sig dog et klart skel mellem Nordvesteuropa på den ene side, og den Iberiske Halvø og Frankrig på den anden. Det betydeligt højere antal kendte vrag fra Nordvesteuropa, og Skandinavien i særdeleshed, er ikke blot resultatet af en stærk marinarkæologisk tradition, men også af de betydeligt bedre bevaringsforhold, og den tilgængelighed der gør sig gældende i Østersøen i kontrast til Atlanterhavet og Nordsøen. Følgeligt er forskningen omkring udviklingen af klinkbygningstraditioner i Vesteuropa stærkt påvirket af tolkningsmodeller og klassifikationer baseret på tilgængelig viden fra den nordvesteuropæiske kontekst. Den nuværende ikke-eksistens af arkæologisk materiale fra sydvesteuropæiske klinkbygningstraditioner betyder derfor, at den generelle udvikling og manifestation af båd- og skibsbygningsteknikker på klink er mere eller mindre udledt af de 'nordlige' bygningstraditioner.

Selvom renæssances små kystfartøjer har tiltrukket sig mere og mere opmærksomhed i løbet af de seneste to årtier, specielt indenfor skandinavisk forskning, så forbliver de stadig overskygget af forskning omkring indførslen og udviklingen af kravelbyggeriet langs den europæiske Atlanterhavskyst. Fra et nordvesteuropæisk perspektiv giver forsættelsen af en veletableret og dominerende klinkbygningstradition fra middelalderen og ind i renæssancen mulighed for at undersøge aspekter af forandring og fastholdelse, i en tid med radikale politiske, samfundsøkonomiske og teknologiske forandringer.

Med Drogheda-båden fra midten af det 16. århundrede, som blev fundet i 2006 i floden Boyne nær Drogheda på den irske østkyst, som centralt casestudie, søgte denne afhandling at undersøge potentielle ligheder og forskelligheder i klinkbyggede kystfartøjer fra en forholdsvis utraditionel vinkel, under anvendelse af en tifoldig tilgang. I kontrast til større oceangående fartøjer, bygget til langfart og til at imødegå indsættelse i en række forskellige miljøer, så opererer kystfartøjer hovedsageligt indenfor et forholdsvis smalt geografisk spektrum. Eftersom fartsområdet for disse fartøjer ofte kan defineres ganske nøje, ikke bare geografisk, men også med hensyn til deres anvendelse, rummer kystfartøjerne potentiale for at udvise en høj grad af specialisering for så vidt angår design, konstruktion og rig. I anerkendelse af dette potentiale præsenteres den geografiske og miljømæssige kontekst og baggrund for de forskellige kystregioner inden for studiets område, således at der opnås en bedre forståelse for alsidigheden i forskellige fartsområder og kravene til deres kystfartøjer.

Med sit ophav ved den europæiske Atlanterhavskysts vestlige yderkant, er Drogheda-båden umiddelbart unik og uden direkte sammenlignelige bådfund i Irland eller mere bredt omkring de Britiske Øer. Alligevel har det høje bevaringsniveau, også omfattende rester af lasten i form af præserverede sild i

genanvendte vintønder af sydfransk oprindelse, givet et væld af information. Dette har muliggjort tolkning og placering af vraget indenfor dets historiske og søfartsmæssige kontekst, uden stillingstagen til spørgsmålet om bygningstradition. Eftersom Irland and Drogheda opretholdte tætte forbindelser til det sydvestlige Frankrig og Biscayabugten gennem hele middelalderen og renæssancen, opstod også spørgsmål om i hvilken grad Drogheda-bådes strukturelle komposition kunne være påvirket af samtidige sydvesteuropæiske klinkbygningstraditioner, modsat en rent nordisk afstamning. Målet for dette studie var derfor i første omgang at belyse vigtigheden af at betragte små kystfartøjer som selvstændige arkæologiske enheder, og derefter at forsøge en transnational, arkæologisk, komparativ analyse, befriet for begrænsningerne i konventionelle klassifikationer og tolkningsmodeller.

Det er vigtigt at understrege, at historisk forskning fra et tværfagligt forskningsperpektiv kunne bibringe mere og afgørende information, specielt eftersom dette studie strækker sig over den ganske veldokumenterede del af renæssancen. Dog har den omfattende historiske efterforskning, der blev udført som en del af Drogheda-bådens analyse, kun givet et magert afkast med hensyn til samtidig irsk båd- og skibsbygning og søfart. Omvendt er forskningsområdet i Holland og Danmark veletableret, og illustrerer værdien af at kombinere arkæologisk og historisk forskning. Alligevel har det, grundet studiets brede geografiske rammer, ikke været muligt at indarbejde nogen dybgående historisk forskning. Det primære fokus for dette studie er derfor placeret på den arkæologiske analyse og fortolkning.

Indsamlingen af områder og fund til den komparative analyse gav 20 områder med ikke mindre end 40 repræsenterede vrag henover undersøgelsens område, der strækker sig fra Portugal til Norge. Det udtalte skel mellem nord og syd blev hurtigt åbenlyst, med kun to fund fra de sydvestlige regioner, og næsten alle de restende fra Nordsøen og den vestlig Østersø. Dette resultat understreger farerne ved bredt at tillægge hele den vesteuropæiske kystlinje resultaterne af forskning og tolkning indenfor et relativet begrænset geografisk område.

De indsamlede datas karakter satte yderligere begrænsninger for en meningsfuld og omfattende komparativ analyse med målene beskrevet overfor. Kvalitet og omfang af tilgængelige informationer om de forskellige både varierer drastisk, afhængig af tidspunktet og omstændighederne for deres opdagelse, såvel som bevaringsforhold og forskningsindsats. Som en konsekvens blev den komparative analyse af strukturelle og designmæssige elementer skåret ned til et antal nøgleelementer og –dimensioner.

Fra det skandinaviske materiale er det muligt at trække på tidligere forskning, som antyder at en generel tilbagegang i byggekvalitet indtræder i middelalderen, og fører til en mere ensartet strukturel fremtoning i sammenhæng med forekomsten af nye teknologiske metoder. Eksempler på den forringede byggekvalitet findes blandt andet i fraværet af ornamentale detaljer, en tendens til grovere tildanning af skrogelementer samt brug af træ af dårligere kvalitet. Mens disse observation generelt er afspejlede i det forhåndenværende studie, så består tilsyneladende visse geografiske forskelle i de strukturelle løsninger. Selvom begrænsningerne i de tilgængelige bådfund ikke tillader en sikker tolkning, så kan en grad af regionalitet i byggemetoderne klart påpeges. Lignende konklusioner for introduktionen af nye teknologiske metoder er på nuværende tidspunkt ikke i samme grad muligt. Dog udviser tre af de undersøgte vrag detaljer, som peger på en konceptuelt mere forudbestemt tilgang til deres konstruktion end hvad normalt forbindes med klinkbyggeri i middelalderen. Nævneværdigt er også de tre eksemplers spredning over næste hele det behandlede geografiske spektrum, der antyder en grad af transformation i klinkbyggeriets væsen og organisation.

Vurderingen af de indsamlede bådfund, i lyset af deres miljømæssige kontekst, indeholder en analyse af strukturelle og designmæssige elementer i opstillingen af potentielle adaptioner til deres respektive benyttelse og aktionsafstande. Generelt understreger forskningen de klinkbyggede kystfartøjers store potentiale, hvilket på nuværende tidspunkt står i kontrast til væsentlige mangler i det arkæologiske datasæt. Det behandlede datasæt viser, på trods af disse betydelige mangler, alligevel komplekse mønstre i klinkbådenes væsen og udviklinger langs den vesteuropæiske kyststrækning.

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1. Introduction

1.1 Project background and delimitations

1.1.1 From main case study to project framework

At the outset of this study stands the discovery of a well-preserved 16th century clinker built boat in the River Boyne near Drogheda, Ireland. Found in 2006 during archaeological monitoring of capital dredging works, it was excavated in 2007 under the direction of the author on behalf of the National Monuments Service, Department of Heritage Arts and the Gaeltacht in Ireland. Structural details and presence of cargo showed that the boat was a locally built coaster, engaged in regional trade activities. It quickly transpired that knowledge on late medieval to early modern small cargo vessels in Ireland and Britain is extremely scarce. This stands in contrast to Scandinavia and Holland where small coastal watercraft are known through numerous ship finds as well as written sources. The unprecedented nature of the find in an Irish context made archaeological as well as historical contextualisation on a national level next to impossible. Although somewhat enigmatic in the archaeological record outside Scandinavian and Dutch context, it is well accepted that small watercraft formed a significant proportion of the overall number of ships and boats operating in coastal waters along Europe's Atlantic seaboard.

Archaeological interpretation of a so far singular find from the western fringe of Atlantic Europe can only take place against the background of comparable material from further afield. Traditionally medieval clinker built vessels from the various regions of north-west Europe are seen as belonging to the "Nordic" or Scandinavian boat building tradition. The conventional approach of interpreting a wreck like the Drogheda boat would thus entail seeking to identify is location within this overarching tradition. Although Crumlin-Pedersen stressed that the term "Nordic" is not to be seen as an ethnological marker, the underlying assumption is that most clinker building traditions along the Atlantic seaboard originate from a common Scandinavian tradition (Crumlin-Pedersen, 2004). Deviations from characteristic attributes of vessels built in the "Nordic" tradition are commonly seen as regional variations and expressions of the "parent" tradition (Crumlin-Pedersen, 2004; McGrail, 2004). Small clinker built watercraft have seen increased attention over the last two decades. Again this is particularly evident for Scandinavia where their potential as an archaeological resource to expand our understanding of technological developments has been recognised (see chapter 2). The concurrent importance of small watercraft for trade and communication throughout the medieval and into the early modern period was for example noted and described by Bill for small scale seafaring in southern Scandinavia (Bill, 1997a; Bill et al., 1997). Small watercraft provided the backbone of maritime societies for local, regional commerce, fishing and communication. Yet, due to their ordinary nature they mostly remain anonymous in the historical sources compared to larger vessels that were embedded in international trade and warfare and thus much more traceable.

Notwithstanding the scarcity of archaeological comparative finds outside Scandinavia, the aim of this thesis is to view and assess the Drogheda boat primarily as one of many workboats operating along the European western seaboard, built to suit environment and purpose rather than a representative of a specific building tradition. By choosing this approach the relevance of building traditions is by no means ignored or diminished. However, the geographical reach for this study is set this wide to highlight the transnational nature of small clinker build watercraft and with it the possibility that reasons for similarities and differences in building methods may not be simply explained by conventional classification and interpretational models (see chapters 5 and 6).

The primary goal of the comparative analysis of this study is therefore to identify potential regional similarities as well as differences in boat and shipbuilding technologies, which may be indicative for specific usage, introduction of new technologies, building traditions as well as adaptations to operational waters. The time frame under investigation covers the transition from the late Middle Ages to the Early Modern period, thus roughly the two centuries between AD 1400 and 1600. Considering the geographically imbalanced nature of the available dataset, the outcome of such a comparative endeavour can be tentative at best. Notwithstanding the limitations in achieving lasting and comprehensive results, this project nonetheless provides the opportunity to not only add to existing knowledge but also aims to offer incentives for future research and methodologies.

1.1.2 Chronological delimitations

As mentioned above the mid-16th century date of the Drogheda boat served as a starting point to delimit the chronological time frame for the comparative study. The Renaissance, spanning from roughly the 15th to the 17th century, thus provides a logical and inherently consistent time frame for the comparative study. Exact limits, however, are not easily defined. Beginning and end of the Renaissance as a historical period are ambiguous as it encompasses among the original art historical aspect many other facets of social, economical and political developments. The Renaissance saw e.g. the rise of new dynasties during the 14th and 15th century as well as the aspiring bourgeoisie, increasing importance of personal aptitude (virtù) and monetary based economy (Poeschke, 1995).

The choice of a relatively arbitrary chronological range from 1400 to 1600 encompasses the core of the academically agreed time frame of the Renaissance. Nevertheless the transition between the Middle Ages and the Renaissance is not clearly defined. A common definition used in archaeological contexts places the end of the medieval period around 1500 in line with historical events, such as the discovery of America by Columbus in 1492 or the start of Reformation in 1517 (Pitz, 1993). However, defining the transition between the Middle Ages and the Renaissance in such narrow parameters does not do justice to the slow and continuous transition on cultural, socio-economic and political levels. By using feudalism as a diagnostic attribute for medieval social and cultural structures, it transpires that crop failures and epidemics of the 14th century marked the transition to early capitalism and eventually enlightenment in the 17th century. In this sense the end of the medieval period can be seen as a gradual process occurring between the 14th and the 17th century (Hassinger, 1959). The 15th and 16th century pose thus a suitable time frame to investigate potential impact of wider socio-economic and cultural changes on boat building practices.

The influence and impact of cultural and economic developments on seafaring is immediately tangible in the archaeological record. The discovery of the new world and subsequent development of overseas trade alongside growing markets in Europe required suitable ships and boats to meet the hitherto unprecedented demands. This laid the ground for the spread of carvel shipbuilding across western Europe in the 15th and 17th century. Most likely originating from the Iberian Peninsula at the beginning of the period, it was not towards the outgoing Renaissance that the technique was well-established in northern Europe. Although technological diffusion from carvel shipbuilding into clinker boat and shipbuilding is a tangible and accepted phenomenon for Scandinavian clinker vessels of the late Renaissance (Lemée, 2006; Bill & Gøthche, 2006), the situation for western and southern European clinker vessels has so far found little attention. The aspect of technological diffusion and relationship between increasingly important and dominating carvel shipbuilding and clinker building traditions, is therefore of significant relevance.

1.1.3 Choice of geographical reach

Defining the geographical constraints for a comparative archaeological study, particularly when dealing with seagoing watercraft is challenging. The nature of seafaring means that national borders, past as well as modern, are of limited value as qualifying criteria. The inherent purpose of ships and boats as a means for transport and travel implicates that their final resting place, be it accidental or deliberate, may not necessarily be identical to their place of origin. Similarly the mobility and reach of seagoing watercraft meant that migration of ideas and technologies has to be seen as a strong influential factor on boat and shipbuilding traditions. As a result the current knowledge on ship and boat building traditions in Scandinavia for example shows that regional differences can be described as relatively small, thus showing that the unifying transnational nature of water and seafaring was stronger than dividing national borders (Bill, 1997a).

The Drogheda boat as a main case study thus provides the opportunity to approach a comparative analysis of small coastal clinker built vessels of late medieval/ early modern date from a wider geographical perspective. Although or rather because of its find location on the western fringe of the western European seaboard the Drogheda boat carries the potential to identify such regional or “national” differences. Furthermore the well-established trade networks of the British Isles with Atlantic Europe throughout the medieval period and the Renaissance, highlight the potential of potential influences not only from the well-researched Scandinavian clinker boat building traditions, but also from the largely enigmatic south-western European context. The potential importance of trade routes as catalysts for migration of ideas and knowledge transfer has been suggested by Westerdahl (1995). Although parallels in regional boat building traditions may be explained by descent from a shared origin, on a more pragmatic level they may reflect similar expressions of adaptations to requirements for the respective operational waters and be the results of other factors, such as socio-economic contexts.

Against this background the choice was made to focus on wrecks found along the Atlantic and North Sea seaboards as a shared environmental component. The Baltic Sea, although rich in well-preserved wrecks, is therefore by and large excluded from the geographical scope of this study. The only exceptions are the Kattegat and the Danish sounds and islands, which mark the entrance to the western Baltic Sea. This decision was taken since the operational reach of coastal watercraft from the western Baltic fringe may well have incorporated parts of the eastern North Sea. Notwithstanding the arbitrary and potentially restrictive nature of the chosen delimitations, it is believed that the research objectives set as part of this study are best met by focusing on the geographical scope as outlined above.

Despite the current lack of a broad body of comparative material from western and southern Europe, approaching a comparative study based on the vast geographical distance spanned by the western European seaboard from Portugal in the South to the North Sea in the North thus aims to offer a new angle to current scholarly consensus. The chosen geographical range not only allows to investigate and examine whether transnational boat building traditions can be observed, but also assess the role of external environmental and socio-economic factors. Finally the archaeological analysis and interpretation can be placed against a critical review of the nature and quality of the available datasets.

1.1.4 Size and constructional delimitations

Upon entering an archaeological study of watercraft from an archaeological context the question of how to define the perimeters in terms of size and qualifying attributes instantly arises. This is particularly true for an analysis of "small" seagoing watercraft. How big does a boat have to be before becoming a ship and to which extent is size the main qualifying factor for the definition between ships and boats? Definitions and delimitations of how small a watercraft has to be classified as boat or how big to be referred to as ship are arbitrary and are largely based on modern perception and vessel types.

For the purpose of this study the main reference perimeters are primarily set by the Drogheda boat, the main case study and starting point for the comparative analysis. With an overall length of c. 10m, two masts, an open deck and overall construction indicating a good level of seaworthiness, the main criteria for the wider study were set. In case of the Drogheda boat it was decided the overall length of just over 10m and lack of decking were seen as defining criteria classifying the wreck as a boat. However, the compilation of comparable wrecks showed a significance span in size from under 10m to over 20m. It furthermore transpired that no consistent differentiation between the term ship and boat exists. A good example for the arbitrary usage of the terms ship and boat is the Bredfjed ship. Although of very similar size to the Drogheda boat, no evidence for decking and two reconstructed masts, the vessel is presented as a ship (Lemée, 2000b; Bill, 1997a).

The dilemma in differentiating ships from boats is reflected in literature. The predominant view sees ships as large ocean-going vessels with three or more masts and complex rigging. However, even with this clear definition for watercraft from the age of sail onwards, the term ship could be applied to all types of sea-going vessels. Conversely boats are commonly described as small, open watercraft sailing predominantly in sheltered waters (Kemp, 1976; Falconer, 1815; Steffy, 1994). While such a division in terminological definition is almost self-explanatory from the early modern period onwards, the situation is more diffuse for the periods pre-dating the introduction of the fully rigged ship. Although lacking the diagnostic characteristics of the full rig, watercraft sailing during the later Middle Ages and the Renaissance equally comprised large bulk carriers designed for long distance trade just as well as smaller vessels operating in coastal environments. In absence of clear defining criteria, boundaries between small ships and large boats thus naturally blur (McGrail, 1993).

As a consequence it could be argued that defining comparative parameters solely based on more or

Boat *Small*		Ship *Large*
Local Haven		Ports at destinations
Range limited	Specific trips	Ocean Voyages
Weather limitations		Unrestricted
Little or no shelter	Minimal accomodation	Full housing
Open or part decked		One or more full decks
Carries a tender or is a tender to a larger vessel	May tow or carry a tender	Carries lifeboats or servicing craft
Owner operated	Locally owned	Remote owners
Supports her crew	Profit shared with owner	Owner pays crew

Table 1-1: Table showing classification of watercraft (after McKee, 1983 p.15)

less arbitrarily selected criteria would suffice for a comparative analysis, particularly as core criteria are supplied by the main case study. Such a purely technical approach, however, would fall short of the endeavour to increase knowledge and understanding of past cultures and societies. Conversely applying modern terminology and perception of qualifying criteria for ships and boats to watercraft, which were built and used by people with a different awareness and cultural background, has to be seen and used with caution. Yet, classifying wrecks as boats and ships in archaeological context is common practice and implies perceptions on aspects such as usage, size, seaworthiness and status.

The conscious decision to refer to the wrecks assessed as part of this study as boats thus requires identifying delimiting factors for the establishment of a coherent and meaningful definition of the term boat. The dilemma in delimiting boats from ships was also recognised by McKee as part of his study of vernacular working boats in Britain (Table 1-1). Overall his differentiation between ship and boat follows largely the definitions outlined above and states that “*a ship has to be able to stay at sea in all weathers until she reaches her destination, while a boat can only make short trips when the weather allows*” (McKee, 1983 p. 14). He adds amongst others deckiwng and sleeping spaces as a defining criteria for ships. According to McKee, boats lack those attributes and are therefore limited in range and weather conditions they can operate in. Finally he identifies ownership as a characteristic criterion. In contrast to ships boats are believed to be the direct property of the user or more members of the crew. This not only has a bearing on usage and maintenance of the boat but also on financial and social interest of the owner when a boat is commissioned to be built (McKee, 1983). By refraining from including rig and number of masts from the defining list of criteria makes, McKee provides a solid yet flexible classification approach suitable for classifying vessels pre-dating the introduction of the fully rigged ship.

However, embarking on an archaeological comparative analysis of boats not only requires some form of physical delimitation on practical grounds but should also strive to provide definitions of the terminology used. The inherent difficulties in attempting to impose modern classification systems for the terms ship and boat on pre-industrial watercraft were e.g. recognised by McGrail for the interpretation of the medieval Dublin ship timbers. In an attempt to find a compromise between modern terminology and the archaeological corpus of wrecks he developed a classification approach based on the overall length (LOA) of vessels. By utilising the classification model of the modern International Regulations for Preventing Collisions at Sea as a basis and comparing these with known wrecks of medieval date, he constructed a terminological framework for the differentiation of boats and ships from archaeological contexts (Table 1-2). Of particular interest in this regard is his definition for vessels with 12m to 20m of overall length, which he describes as either large boat or small ship depending on hull structure and operational

LOA	Description
< 7m	Small boat
7m - 12m	Boat
12m - 20m	Large boat Small ship
20m - 24m	Ship

Table 1-2: Differentiation of boats and ships (after McGrail, 1993 p.21).

role (McGrail, 1993). By not committing to either class this approach leaves sufficient scope to take into account historical deviations in classification.

McKee's descriptive classification model alongside McGrail's differentiation system based on length overall provides a solid and transparent basis in defining the term boat as used for purpose of this study. While boats of lengths less than 7m are not present in the assembled dataset it was decided to concur with McGrail's approsch and use a maximum length overall of 20m as the upper limit. Initial investigations into comparative wrecks showed that vessels longer than 20m tendentially appear to be of heavier built compared to smaller watercraft thus pointing to more heavy duty use as long distance cargo carriers and better described as ships. The copper wreck found in Gdansk and the Skjernøysund wreck 3 are good examples of such vessels where construction and cargo indicate that the vessels were used as long-distance traders (Litwin, 1980; Auer & Maarleveld, 2013).

In summary the defining criteria to be fulfilled in terms of size and construction for this study are clinker built watercraft of maximum 20m overall length, built open decked to be used in coastal waters and propelled by sail.

1.2 Research aims and questions

1.2.1 Classification and typology

As outlined above the formulation of research objectives is largely guided by the Drogheda boat as main case study. The decisive factor for formulating the research focus of this study in conjunction with the already outlined comparative framework is the seemingly heavy bias on Scandinavian comparative wreck finds. This raises the question to which degree research results from a geographically separate context are transferable. Current scholarly opinion assumes that medieval clinker boats and ships in North-western Europe are part of a shared overarching building tradition known as Nordic or Scandinavian clinker tradition (Crumlin-Pedersen, 2004; McGrail, 2004). Considering the regional nature of coastal watercraft and the lack of evidence for clinker boat and shipbuilding from the south-west European Atlantic seaboard such an almost one dimensional explanatory model appears premature. Nevertheless small-scale seafaring and coastal watercraft in north-western Europe have received increased attention over the last two decades. This led to a recognition that clinker boat building in the northern perimeter of the European Atlantic seaboard were subjected to common pressures and influences during the later Middle Ages and Renaissance resulting in more uniform building methods (Bill, 1997a; Bill, 2009a). Even though current and recent research advances accredit and stress the complexity of factors influencing the development of boat building traditions and small-scale seafaring, the bias on northern European research traditions remains an unresolved issue.

Notwithstanding the apparent shortcomings in the archaeological dataset, the overall aim of this study is thus to broaden the view on interpreting small clinker built coastal watercraft of the Renaissance across the entire Atlantic European seaboard.

As alluded to above classifying and interpreting wrecks by regional boat building traditions is one of the most common and well-established methodological approaches in boat and ship archaeology. Since the majority of wrecks in the study have been published in the past, an interpretation regarding building tradition is in most cases provided by the excavators or researchers. Assessing the assembled wrecks with a view to potentially identify similarities or differences between regional boat building traditions therefore requires the integration and review of existing interpretations. A second strand of archaeological classification and interpretation, which seeks to match wrecks with historically known vessel types is of lesser relevance for small watercraft, such as the group of vessels under investigation. Nevertheless, the endeavour to bring boat finds in accordance with historically known vessel types can be observed and is therefore examined and discussed as part of the wider comparative analysis. The shortcomings and difficulties in applying current classification and interpretation methods to a wide geographical group of small clinker built watercraft as outlined above, furthermore require an assessment of their methodological suitability.

1.2.2 Change and continuity

Closely linked with the identification of characteristics of particular building traditions is the discussion of change and continuity in building methods. Indeed, by its nature tradition involves transferring cultural knowledge or elements from one generation to the next, thus ensuring a certain degree of continuity. Simultaneously knowledge transfer forms a complex and diverse affair. Oral and manual transmission as evident for medieval clinker boat building is restricted in the nature of knowledge that can be transferred. Furthermore a selective aspect in knowledge transfer comes into play. As Hasslöff recognised each individual passing on knowledge only transfers elements that are deemed important or are of personal interest (Hasslöf, 1972b). The element of personal choice in adopting "new" practices as well as decision on which constituent of the relevant tradition is thus of crucial importance for the discussion of the nature and development of boat and ship building traditions. Overall the concept of tradition as a static phenomenon is non-existent as some level of change is an inherent component of any cultural tradition. Nevertheless the introduction of new elements and practices using the example of boat and shipbuilding does not occur randomly but is part of wider socio-economic developments. The reason for technological changes and innovation may be explained by changing concepts of shipbuilding in society (Bill, 1997a). On the other hand slow and subtle mechanisms triggered by socio-economic stimuli but with no or little immediate impact on the conceptual basis of building traditions should not be discarded as reasons for change.

The transition from the Middle Ages to the Renaissance brought upon significant changes to many levels of political, economic and social life. In a maritime archaeological context this is probably most tangible in the emerging long distance and overseas trade in conjunction with continuously increased European trade volumes as well as the rise of dynastic states. The latter laid the foundation for the establishment of naval fleets, requiring purpose built warships. Simultaneously the overseas trade in particular acted as a catalyst for the rapid spread of the carvel built, fully rigged ship across the western European seaboard (Lemée, 2006). The development and organisation of small-scale seafaring and boat building therefore has to be seen against this wider historical and geographical background. Assuming that many of the small coastal watercraft were built on small, rural and family run boat yards, endeavouring to understand the interaction between pro-active willingness and imposed necessity to adopt new technologies should therefore be an overriding goal in any archaeological study of small watercraft.

Pursuing the aspect of external pressures as agents for change illustrates the complexity of the aspect of change and continuity in boat and shipbuilding traditions. For the period of the Renaissance it is commonly accepted that increased economic productivity and shipbuilding activity led to shortages in local building supplies, in particular ship and boat planks. General deterioration in build quality, new structural details and utilisation of either lesser quality or imported building material, are generally seen as an indicator of wider economic developments from the later medieval period onwards (Bill & Gøthche, 2006). Indeed, an apparent trend towards more standardised and uniform building techniques across Atlantic Europe are postulated on those grounds (Bill, 2009a). The role of technological diffusion from the increasingly dominating carvel shipbuilding into clinker boat building is still poorly understood, although evidence from southern Scandinavian wrecks appears to suggest a certain level of influence from carvel building methods, which are believed to have had their origins in Dutch carvel building traditions (Lemée, 2006; Bill & Gøthche, 2006). However, speed and manifestation of technological diffusion from carvel shipbuilding cannot be assumed to be linear, simultaneous and identical (Rosenberg, 1976; Basalla, 1988). It is thus endeavoured to assess the assembled wrecks with a view to potentially identify different strands or phases of technological influence from carvel shipbuilding despite the significant shortcomings in the dataset.

1.2.3 Adaptation to usage and operational environment

In line with the above outlined research questions it is the objective of this study to detach the research angle from conventional classification approaches and attempt to open other ways of interpreting small clinker built coastal watercraft. In contrast to large oceangoing vessels, which have to be designed to not only withstand heavy seas but also sail a variety of operational waters, coastal watercraft are destined to operate within much narrower geographica limits and are tailored much more to specific environmental conditions and vessel use. The wealth of early modern and recent vernacular traditional boats across Europe is a testimony to the complexity and cultural value of coastal watercraft (McKee, 1983; Mac Cárthaigh, 2008; Nielsen, 2005; Magalhães & Felgueiras, 2001).

High degrees of specialisation in design and construction of coastal watercraft are by no means a modern occurrence. Rising volumes in short and long distance trade in conjunction with general tendencies of specialisation in late medieval and Renaissance society, laid the foundation for higher degrees in specialisation in boat and shipbuilding. This manifested itself not only in an increasing professionalization of workforce and attitude, but also in a greater variety of specialised watercraft. Whether this development can be seen as a strife of general improvement of watercraft, as suggested by Unger (1980), can be disputed considering the apparent tendency in loss of quality in construction (see chapter 6). However, if improvement is defined in the sense of design and specialisation, the historical evidence for the Netherlands certainly shows great diversity in types of small watercraft operating around the Dutch coast from the outgoing medieval period onwards (Haalmeijer & Vuik, 2007). The historical sources appear to show a similar picture for the British Isles and Iberian peninsula, particularly for the Bay of Biscay and Brittany (Burwash, 1947). Conversely the term skude appears to have been used to broadly describe small watercraft in Scandinavian waters (Bill, 1997a). Even though many of the historically known vessel types may describe vessels made to operate in specific environments, the chances of identifying diagnostic characteristics in archaeological terms are frequently very small to non-existent. Lacking the knowledge on structural detail, types can describe vessels based on rig, construction, shape, size, function or multiple combinations of these attributes.

Nevertheless the recognition that small coastal watercraft are built in response and to suit particular environments and climatic conditions is of utmost importance for the endeavour of gaining better understanding of this complex and rich archaeological resource. The imbalanced and frequently sparse nature of the assembly of wrecks available for this study may not allow for comprehensive answers in this regard, but aims to expand our mindset on interpreting small coastal watercraft.

1.2.4 Conclusions

As outlined above, current research of late medieval and Renaissance small clinker built watercraft has largely focused on the analysis and interpretation of wrecks based on established classification and interpretation models. Boat finds are mostly placed within typological frameworks focusing on building tradition and strong geographical bias. As the number of known wrecks from north-western Europe by far outweighs the knowledge base from western and southern regions, the level of knowledge on development and nature of boat and shipbuilding for the former can be described as relatively solid. The difficulty arises when attempting to apply such regionally established classification frameworks over a wider transnational setting.

Although current research appears to indicate that construction methods in clinker boat building become increasingly homogenous from the later Middle Ages onward, the relationship between constructional uniformity and regional discrepancy are still poorly understood (see chapter 6). The well-preserved and nationally currently unique discovery of the Drogheda boat from Ireland thus provides the opportunity to attempt approaching the analysis of small clinker built coastal watercraft by expanding on conventional research approaches. By prioritising the regional character of seagoing clinker boats, in terms of construction, design and environment it is aimed to create unbiased datasets with a view to improve transregional comparability.

The Renaissance as a time of transition from the Middle Ages to the early modern period saw significant changes and developments in areas such as science, economy as well as society and culture. One of the most striking developments affecting ship and boat building during this period is the above-mentioned large-scale introduction of carvel shipbuilding methods. This involved not only considerable conceptual changes for regions where clinker building methods hitherto predominated, but also increased professionalization and advances in craftsmanship. Depleting local timber supplies together with modernised and rationalised production technologies imposed further pressures on boat timbers, which in turn find expression in the archaeological record (Bill & Gøthche, 2006; Warde, 2006).

Although the manifestation of influences owed to technological diffusion and socio-economic causes in small clinker built watercraft is well-known, potential variations in chronological appearance and geographical expression are still poorly understood. Technological diffusion as a theoretical principle is understood to be a slow process and by no means linear and uniform (Rosenberg, 1976). With this in mind small clinker built watercraft of the Renaissance provide the opportunity to investigate the process of technological diffusion and development on a dataset, which currently appears to be characterised by seemingly increasing homogeneity from the later medieval period onwards. This PhD project therefore aims to provide a starting point for the recognition not only of the complexity of clinker built watercraft during a known period of change, but also towards a better understanding of their spatial and chronological diversity. The continuity of clinker built boat building despite the introduction of carvel building methods is a clear testimony to the advantages and strengths of a successful and widespread boat building tradition in European Atlantic Waters.

Overall the presented research approach and interpretative models serve to provide a basis to improve future research and expand our knowledge on the, by comparison, mundane yet rich and complex subject of small coastal clinker built watercraft.

1.3 Methodology

1.3.1 Introduction

In order to answer the questions outlined above a methodological approach largely focusing on archaeological source material has been chosen. Notwithstanding the significant potential of investigating the topic of small-scale coastal watercraft through historical sources, such an endeavour would go beyond the scope of this project. In order to achieve meaningful and sustainable results, in depth historical and archival research in all countries covered by the study would be required. Such undertaking, however, was neither feasible nor the primary research focus of this project. The historical framework for this study is therefore covered on an introductory level providing essential historical background information. This is seen as relevant to gain a better understanding of the general developments during the later Middle Ages and the Renaissance. Furthermore general historical context on historic ship types, construction and design is discussed to supplement archaeological observations and in support to discussions on typology and classification.

However, with the Drogheda boat serving as a starting point the main focus lies in assessing comparability of archaeological data with a view to identify similarities and differences in construction and design. The archaeological methodology is therefore structured by first presenting the main case study with full archaeological results, discussion and interpretation. This is followed by the presentation of the compilation of reference sites. Prior to embarking on the actual comparative analysis of the archaeological data, the perimeters for the comparative framework are outlined and discussed. The comparative analysis in turn addresses the above-presented research questions and discusses the results.

1.3.1 The Drogheda boat and compilation of reference sites

In keeping with the main objectives as outlined for the study, the selection process of wrecks matching the comparative framework was to the greatest extent adhered to. Notwithstanding the possibility of including other boat and ship finds sharing many of the delimiting criteria on grounds of similarities in building traditions, size or date, it was seen of utmost importance that reference sites comply fully with the comparative framework to achieve meaningful results for such a narrowly defined group of watercraft. As a result the compiled data reflects the strengths and weaknesses of the currently known pool of wrecks of clinker built coastal boats dating between 1400 and 1600.

Both, the Drogheda boat and the assembly of reference sites are presented, described and discussed as exhaustive as possible. This serves not only to provide a sound comparative database but also to highlight the variations in quantity and quality of data from the various wrecks. Although a number of key criteria for classification and typological correlation of clinker built watercraft have been identified in the past (McGrail, 2004; Crumlin-Pedersen, 2004), the presentation of the full scope of available information aims to widen the comparative range not only for the study at hand but also for future research. The collected data therefore includes the full archaeological information known from the individual wreck sites, such as find location, construction details, wrecking details, dating and provenance of the wood used as well as other related information.

1.3.3 Comparative analysis and Interpretation

Introduction

Although structural features of the various wreck sites are compiled exhaustively, the significant differences in quantity and quality of information from the various boat finds naturally impose restrictions on the comparibility of the data. The comparison of technical and structural features of the wrecks in the dataset can therefore not be seen as finite but rather represents the current settings for comparative research. The analysis itself discusses construction details in relation to date, geographic distribution and usage of the vessels. The results in turn are assessed, interpreted and placed within the current state of research. The latter further involves a critical review on the suitability of applying established traditional ship archaeological classification schemes on the assemblage of vessels assessed as part of this study.

Considerations on interpretation of structural elements

Above deliberations show that the core of the archaeological interpretation is based on analysing and assessing the structural details available from archaeological fieldwork and data processing. While this as a methodological approach appears self-explanatory, the level of information recorded and noted on wrecks varies significantly. Accessibility or levels of preservation mostly dictate the degree of recording and which structural elements are recorded.

In numerous cases the level of recorded features and dimensions almost appears targeted to sufficiently place a ship find within established typological frameworks. Conversely meticulous and exhaustive documentation of structural details, dimensions and measurements was instigated by McGrail as part of his analysis of the medieval Dublin ship timbers. The nature of this assemblage of lose structural elements with no further indication towards size and type of the parent vessels formed the starting point for this approach. In this McGrail suggested that it is possible to identify the approximate size of the former vessel from key measurements and dimensions of individual structural elements. For the practical implementation he devised a complex and comprehensive documentation methodology, including e.g. calculating the products of moulded/sided dimensions as well as recording the curvature of the floor timbers, which is described by their enclosed angles (McGrail, 1993).

However, the difficulties in applying these classifications on medieval ships and boats in general lie in a constantly changing perception in relation to vessel type and size over time. Crumlin-Pedersen thus suggested a more simplified classification attempt, which although still based on the overall length of a vessel, allows incorporating individual factors of each site or find. Furthermore applying McGrail's method to determine the original size of the "parent vessel from" individual timbers, to e.g. the Skuldelev ships showed that no secure correlation between frame size and size of original vessel was apparent. The same was observed for the enclosed angles and the deadrise angle as indicator for a specific "parent vessel" type (Crumlin-Pedersen, 1997).

Despite the difficulties in applying McGrail's method to a wider body of archaeological material, his approach represents a valid attempt to extract interpretive information from wrecks based on hard evidence. The flawed nature of his approach, however, could only be detected through further comparative analysis. In absence of secure knowledge on level and character of required information for appropriate interpretation of boat and ship finds it is thus advocated that data collection is undertaken as comprehensive and unbiased as possible.

The role of historical source material in light of interdisciplinarity

Although the priority of this study lies in assessing and analysing the archaeological source material, both primary and secondary, this can and should not be done in isolation from the historical context. Consulting written and pictorial historical sources is an essential part in creating a comprehensive understanding of wreck finds. Given the set research framework of this study as outlined above, no in depth primary source material was accessed due to the prohibiting nature of the wide geographic scope of the project (see above). Historical background information providing information on appearance, structural features, design as well as rigging and usage is sourced predominantly from secondary sources. A review of the available secondary historical and iconographic source material follows in chapter 2.2. Further to the mentioning and depiction of boats and ships in historical documents, maps and other media, the interaction between scientific analyses and historical research becomes an increasingly important factor in ship archaeological research. Daly's research on medieval timber trade and usage based on comprehensive dendrochronological comparative analysis has become an indispensable tool for ship archaeological research and interpretation (Daly, 2007).

However, the scope of scientific analysis aiding archaeological practice goes beyond the widely recognised relevance of dendrochronological analysis. Environmental archaeological analyses of organic components, such as waterproofing, cargo or rigging, are of immense value for creating consolidated comparative datasets. The transnational comparative analysis of waterproofing remains undertaken on waterproofing material is a testimony to an increasing awareness of the importance of incorporating environmental archaeological methodologies into ship archaeological practice (Cappers et al., 2000). In acknowledgment of the potential and value of interdisciplinary research approaches, comprehensive environmental and dendrochronological analyses of building material, waterproofing and cargo was carried out for the Drogheda boat and its cargo (Daly, 2009b; Davis et al., 2009; Harland, 2009). The results, which are presented in more detail in chapter 3 clearly stress how the overall interpretation of a wreck find can profit from comprehensive research strategies.

2. Source review

2.1 Archaeological sources

2.1.1 Introduction

The aim of this chapter is to present an overview of the availability, quality and quantity of archaeological sources that are of relevance for undertaking a transnational comparative study as carried out for this PhD project. Investigating archaeological source material of such a quite specific nature as selected for this project, which further spans over a vast geographical area from the southern tip of Portugal to northern Norway, confronts the researcher with challenging difficulties. Variations in archaeological traditions and practices as well as topographical conditions are inevitable, thus leading to seemingly imbalanced representations in quantity and quality of data. As geographically diverging data quantity and quality poses a dilemma to reach meaningful conclusions, the responsible agents for such divergence require a brief discussion. Before delving into the discussion of the archaeological source material the background to the various national research traditions and geographical particularities are explored.

The review of archaeological sources, i.e. remains of clinker built watercraft of the Renaissance is then structured on a country-by-country basis. This decision was taken consciously as a result of the geographically heavily skewed representation of sites. Therefore wreck finds are presented and discussed according to the country of their discovery, even though actual original provenance of the individual vessels may vary. However, since the focus of the study lies on watercraft of more or less local and coastal use, the likelihood that origin and place of wreckage can be assumed in relative proximity to each other. This is in contrast to larger vessels designed for warfare or international trade. Not presenting and reviewing the wreck sites according to respective building traditions or typologies, thus further allows incorporating a more general review of quantity and quality of source material from the different countries. Arguably the archaeological source review also contains a number of early modern carvel built vessels, for which the described discrepancy between place of origin and wreckage differ. Nevertheless to maintain consistency in presentation and structure, all wreck sites are discussed by country of discovery. The only exceptions to this are a small number of wrecks, which have been found outside Europe. These have been included with their respective countries of origin or presumed provenance according to diagnostic ship constructional features.

2.1.2 Maritime Archaeology in Europe – Remarks on comparability of data and research

While borders of modern nation states may not necessarily have been an influential factor on ship building traditions and their development over time, archaeological level of research and knowledge certainly always has been dependent on a variety of related factors. These include political environment, availability of resources, individual or institutional interest as well as research focus and tradition. It is important to understand that differences in archaeological traditions are often closely linked and related with the modern political states they are or were embedded in (Trigger & Glover, 1981; Kohl, 1998). A key factor for the establishment and formation of modern nation states was and to some degree still is the creation of national identities. Cultural and/or ethnological historical backgrounds therefore aimed to serve the purpose of legitimising and forging national identities and ideologies. Archaeology was therefore a welcome tool to use or even abuse the past as a symbolic resource for this purpose (Fowler, 2008). The interaction between archaeology and nationalism is of a depth that it can even be argued that archaeology would never have developed without the rise and mechanics of modern nationalism (Kaesar, 2008). While the nature of the relationship between archaeology and a given state can vary drastically, the development of European archaeology cannot be seen in isolation from the formation of nations and political landscapes up until the 20th century. Kohl, for example, argues that archaeological practice and institutional structures vary according to country-specific histories and times of when national consolidation occurred (Kohl, 1998). The international variations in archaeological practice are therefore at least to some degree manifestations of adherence to political environments or cultural traditions as well as guided by the influence of individual scholars. As a result archaeology developed differently across different countries leading to the above-mentioned variations in research focus, archaeological data sets and provision of research infrastructure. In practice these differences in archaeological research and structure are reflected and visible in "regional traditions" often concurring with countries or geographical regions (Trigger & Glover, 1981). Spanish archaeology is hence different to the English tradition, whereas the similarities in research and approach justify speaking of a Scandinavian tradition shared between Denmark, Sweden and Norway.

As hinted above, it would be too simplistic and unwarranted to assume that archaeologists uncritically served and serve political agendas. By and large their interests as scholars aim to investigate and research past cultures unbiased and objectively (Kohl, 1998). Nonetheless, the significant negative political influence on and abuse of archaeology throughout history must not be forgotten; especially in relation to totalitarian and dictatorial political states and systems such as Nazi Germany or the former communist eastern block (Wiwjorra, 1996). Nevertheless, the advances and fields of research of archaeologists from the beginnings of the discipline have largely been motivated by objective scholarly curiosity rather than political or ideological objectives. For the countries relevant for this study archaeology has certainly detached itself from its often nationalist roots towards becoming national, i.e. archaeological research undertaken in given countries (Kohl, 1998). As discussing this matter in depth would be beyond the scope of this thesis the consistently close cooperation between Scandinavian archaeologists during times of political animosity between the 17th and 19th centuries (Klindt-Jensen, 1975) shall stand exemplary for the ambition of archaeologists to work freely and independently.

Returning to the field of maritime archaeology and the question on availability and quality of data of shipwrecks, again a drastic discrepancy between individual countries across Europe is apparent. Since maritime archaeology can be considered a relatively young archaeological discipline, the stigmas of nationalist or colonial archaeology may not be as tangible as in other archaeological fields. Nevertheless, maritime archaeology is rarely entirely detached from the traditions and institutions of a given country and therefore just as well embedded in "regional traditions" as described above. An example of how the focus of research can be drawn to a relatively narrow aspect is the frequent predominance of research of naval ships and shipping whilst neglecting the merchant aspect (Maarleveld, 1992). Equally the interaction between particular discoveries on the one hand and their effect on orientation and focus of maritime archaeological research must not be underestimated. While underlying present research interests may have served as catalysts for enabling following up and delving into certain wrecks, the results certainly again influenced the development of maritime archaeological research and institutions. Not surprisingly the most prominent discoveries of the 20th century can serve as examples, including the Skuldelev Viking ships, the so-called Bremen cog, the Hjortspring and Utrecht boats to name a few. The archaeological pioneering work surrounding these discoveries is undeniable. Yet, the repercussions on follow-on research and interpretation of the acquired data in relation to classification, typology and related aspects are profound. The impact of such funnelled research interest, however, goes deeper. Describing the situation in Denmark in the aftermath of the discovery of the Skuldelev ships, Jan Bill describes a clear disinterest in non-clinker wrecks post-dating the Viking period, resulting in a form of "discrimination" against them (Bill, 1997a). It could therefore be argued that the significance of "showcase" discoveries coincided on an objective cultural historical level with them carrying values of what can be considered "nationalistic" or at least contributing to building or solidifying national identity or cultural origin (Cederlund, 1997). The contexts of the Viking Age for the Skuldelev ships or the Hanseatic League for the Bremen cog highlight this aspect. The same could also be said for wrecks of royal warships, such as the *Mary Rose* in England and the *Vasa*, in Sweden.

The actual overall number of known shipwrecks from individual countries may vary just as well as represented wrecks of specific (pre-) historic periods, size, building traditions or other contexts. The phenomenon of diversity in quantity and nature of wreck finds was recognised by Crumlin-Pedersen and Bill who linked the frequency of finds with orientation of research traditions, small number of active researchers and provision of infrastructure and funding (Crumlin-Pedersen, 1985a; Bill, 1997a). Yet, seeking explanations for such phenomena purely on grounds of interaction between archaeology and politics, archaeological traditions, number of engaged scholars and provided infrastructure still does not tell the full story. Such variations in quality and quantity of data may equally reflect differences in personal interests of individual leading scholars or factors outside the control of archaeological research traditions or facilities. An aspect discussed by Bill stresses the complexity of the issue. His research showed a stronger representation of wreck finds from urban context, compared to rural or other contexts. He assessed the connection between shipping activity in urban ports or rural landing places on the one hand and the likelihood of deposition of specific types of watercraft in those places. This led him to the conclusion that seemingly skewed representations from our modern archaeological viewpoint may just as well have to be seen against the contemporary context of the find location (Bill, 1997a).

Regarding medieval ships and shipbuilding archaeological research was hence often influenced and guided by the ambition to either affirm or contradict theories on evolutionary and/or geographically diagnostic building traditions. The so-called cog and Nordic tradition befall key roles in the still on-going discussions. Both are more or less seen as diagnostic and native traditions to western and northern Europe (Greenhill, 1976; Hocker, 2004a; Crumlin-Pedersen, 2004; Crumlin-Pedersen, 2000; McGrail, 2004; Ellmers, 1999). With the arrival of the large carvel built ships starting in the 15th but strongly manifesting itself in the 15th century a shift in the maritime archaeological research becomes apparent. The question of how bottom-based and clinker traditions develop further appears to become largely redundant and replaced with discussions surrounding the time-scales and socio-economic contexts for the introduction of this “new” ship building method. The abundance of historic sources includes lines drawings and more detailed information of materials used, shape and layout as well as identities of the ship builders. As a result the discussions surrounding traditions and typology in shipbuilding can be held on a more informed level. There can be no doubt in validity and importance of dedicating thorough archaeological research towards these aspects. Nonetheless, it can be said that the seemingly over-represented research into carvel shipbuilding from the Renaissance onwards is again strongly linked to the historical socio-political contexts of the formation of modern nation-states. The nature and the impacts of the Renaissance in general can serve as a good example with European Monarchies seeking to increase their wealth and power by extending their reach overseas, fuelled by the achievements of the enlightenment in technology and science. In more specific terms the Dutch Golden Age and the rise of Portugal and Spain alongside an economic growth across Europe are indicative why modern national symbolism and identities still refer back to the 15th and 16th century.

2.1.3 Geography and maritime landscapes

As hinted above frequency and nature of wreck finds is not solely dependent on and result of archaeological research and its framework. The respective receiving environments, i.e. topography and maritime landscapes are further influential factors on frequency and preservation condition of wreck sites. Although subject of more detailed discussion in chapter 6, a brief discussion of the pertinence of both aspects is deemed crucial for a more holistic understanding of the archaeological source material.

The significantly higher number of known wrecks from the Baltic for example in comparison with the North Sea can be partially explained by the nature of the receiving environments. Being less hostile, more sheltered and with large shallow expanses, the Baltic Sea allows for better preservation conditions but almost more importantly better access and chances of discovery of wrecks. Beyond this archaeological dimension, the composition of the sea- and landscapes, including currents, climate and nature of coastlines inevitably impacts the interaction between man and sea. Different operational waters demand different naval architectural solutions, which in turn are dependent on political, socio-economic and cultural background of the people engaging with the sea in shape of trade, fishing or warfare.

Discussing the role and impact of maritime landscapes or seascapes can therefore not be separated from the inherent cultural dimension. Research and investigations into defining and investigating maritime cultural landscapes is strongly advocated by a number of researchers. In relation to Scandinavia Westerdahl has been on the forefront of this research with significant published work on this field (1992; 1994 and 1995).

2.1.4 General and comparative works

Before discussing general archaeological literature, some publications of what could be described as ethnological value are introduced. Although the main focus of this thesis lies in comparatively analysing archaeological data from specific watercraft, an understanding of construction and functions of contemporary vernacular boats is deemed essential as part of a meaningful analysis. McKee's "Working Boats of Britain" provides an excellent insight into the interaction between usage and operational waters on the one hand and shape and construction of small boats on the other (McKee, 1983). It clearly shows that both sides are closely intertwined and cannot be seen in separation. Another work of significant ethnological value is "Ships and Shipyards, Sailors and Fishermen: Introduction to Maritime Ethnology" (Hasslöf et al., 1972). Its various contributions mark pioneering research towards the relevance of living boat building traditions when attempting to investigate past traditions and occurrences based on fragmentary archaeological and historical evidence. Following on from the maritime ethnological approach a number of publications presenting and discussing contemporary vernacular watercraft have to be mentioned. For Denmark Nielsen's compilation of vernacular boat types provides a good basis (Nielsen, 2005). Again McKee's book provides useful information in this regard for the United Kingdom, while "Traditional Boats of Ireland. History Folklore and Construction" is a recent and comprehensive volume for boats from Ireland (Mac Cárthaigh, 2008). The difficulties in identifying origins and development of carvel boat and ship building in Ireland were recognized by McCaughan (McCaughan, 1991). Introductions into surviving boat building traditions in northern Portugal were formulated by Magalhães and Felgueiras and for Northern Spain by Alonso (Magalhães & Felgueiras, 2001; Alonso, 1991). For the Netherlands Haalmejer and Vuik as well as van Beylen produced good compilations of historical and contemporary vernacular sailing vessels (Haalmeijer & Vuik, 2007; Beylen, 1970).

Comparative or general archaeological publications and research efforts surrounding small seagoing watercraft of the late medieval to early modern period are scarce. Introductory works to medieval ships and shipbuilding highlight this shortcoming (Hutchinson, 1997; Friel, 1995). From the 15th century onwards the research focus shifts towards the introduction of carvel-construction. The research agendas over the last decades left the seemingly less relevant group of vessels largely unobserved. Yet, with maritime archaeology maturing and a growing body of data available, increased interest and attention can be attested. From an archaeological perspective the most comprehensive analysis of small coastal watercraft to date was undertaken by Bill as part of his PhD dissertation "Small Scale Seafaring" (Bill, 1997a). In this he compiled an archaeological catalogue of small coastal watercraft from archaeological contexts in Denmark with a view to assess whether the material allowed a socio-economic interpretation in relation to peasant seafaring in medieval and early modern Denmark. Despite focusing on wrecks from Danish contexts, Bill places his material against a wider north-west European background. In doing so he proposes certain trends in the development of building traditions throughout the Middle Ages into the Renaissance. Building on the results from this study Bill published a series of articles investigating specific constructional research questions as well as discussing broader socio-economic aspects surrounding small watercraft in late medieval and Renaissance southern Scandinavia (Bill, 1997b; Bill, 2009a; Bill, 2009b; Bill, 1998).

Research on early carvel built vessels has been much more a focus of attention over the years, particularly in relation to the discussion surrounding the arrival and spread of this new technology in a south-north movement (Hutchinson, 1997; Lemée, 2006). However, it is less the origins and surrounding processes of the introduction of the carvel technology that are of interest and significance for the present study. It is rather its manifestation in different construction methods, which have been identified as diagnostic for regional or national ship building traditions. Based on a comparative study of a number shipwrecks Oertling was able to identify a group of vessels of Iberian origin sharing certain constructional features, which he sees as the representatives of an Iberian-Mediterranean sub-tradition of shipbuilding. The typological concept of the Atlantic Vessel as initially proposed by Oertling has since become generally accepted among scholars (Oertling, 2001). Nevertheless in her recent article discussing regional characteristics of the Iberian-Atlantic tradition, Loureiro for example calls for a critical revision of the diagnostics as defined by Oertling (Loureiro, 2012). Moving northwards research over the years has shown that a Dutch ship builders devised a characteristic way of building carvel ships, now known as "Dutch-Flush". Its development and characteristics have been discussed for example by Maarleveld (1994) who also compiled a comprehensive comparative review of construction diagnostics of early modern merchant ships built along the Atlantic coastlines of Europe (Maarleveld, 1992). Adam's contribution to ships and shipbuilding of the transition period between late Middle Ages and the Renaissance is extremely valuable and significant. Through assessing carvel built ships from north-western Europe and the Baltic of this period against the background of building traditions and contemporary societies, he explores the interaction between social and technological innovation (Adams, 2003). The investigations of several Renaissance carvel built ships from Copenhagen led to a comprehensive historical-archaeological study of early modern ships and shipbuilding in Denmark. Although to a certain degree site-specific and geographically limited, the detailed research undertaken for this project shows the validity but benefits of cross-disciplinary approaches for carvel built ships from the early modern period onwards (Lemée, 2006).

The scientific discourse on origins and development of ship and boat building traditions is a consistent component in maritime archaeology. Since the currently accepted theories and typologies will be discussed in chapter 6, a brief summary of the key sources in this regard are presented. The previous paragraph already introduced two important typological concepts in relation to carvel built ship in Atlantic Europe. It also needs to be seen in connection with some of the works mentioned above for maritime ethnological research (Hasslöf et al., 1972). Despite its publication date in 1958, Hasslöff's discussion of nature and origin of the carvel construction technique is still a well-founded and well-presented introduction to the topic (Hasslöf, 1958). The principles of shell-first versus skeleton-first construction have influenced archaeological interpretation of ship archaeology from its beginning. From early on and heavily influenced by contemporary finds, scholars such as Heinsius, Ellmers, McGrail, Greenhill and Crumlin-Pedersen defined terminologies and the typological landscape for medieval ships and boats (Heinsius, 1956; Ellmers, 1984; McGrail, 2004; Greenhill, 1976; Crumlin-Pedersen, 2004). At the core of the typological scheme is the distinction between the "Nordic shipbuilding tradition" and the cog tradition. The difficulty in matching vessels with flat carvel built bottoms and clinker built sides with shell first or skeleton first methods formed the basis of a PhD thesis written by Hocker (Hocker, 1991). In his thesis he allocates vessels of such construction to a third, independent construction method, which he calls bottom-built construction. Hocker's work is therefore of crucial importance for understanding the inherent problems of classification and typology as discussed in chapter 6. Building on the results of his PhD research, Hocker together with Ward compiled contributions from leading scholars on philosophical and conceptual approaches on ship building (Hocker & Ward, 2004). Further recent and important contributions to the topic of classification and typology include for example van de Moortel's article on the development of ship building traditions in the North Sea region from the early to the late medieval period (Van de Moortel, 2011).

2.1.5 Ireland and the United Kingdom

Although not entirely politically correct, both countries are presented in combination considering that they share a similar geographical environment on the western fringe of the western European seaboard. Furthermore certain similarities in archaeological traditions are evident providing a comparative basis for both countries.

Nonetheless, a significantly higher number of shipwrecks of medieval to early modern date have been excavated and/or recorded in the United Kingdom. Fully excavated clinker built wrecks include the 13th century Magor Pill medieval wreck (Nayling, 1998) and the 15th century Newport medieval ship with post-processing and analysis currently still on-going. Yet, both finds are not directly relevant to the comparative study due to Magor Pill being too early and the c. 30m long Newport ship substantially too large (Trett, 2010). However, the Newport ship is not the only known example of a large and heavily built clinker ship. Six wrecks found in the 1980's in the harbour of St. Peter Port, Guernsey also belonged to large and heavily clinker built ships (Adams & Black, 2004). Initially discovered in 1898, the clinker built boat from Kingsteignton, Devon, remained more or less neglected until it was re-examined between 1995 and 1999. Results of this 14th century wreck were published as an interim report, which also includes useful, albeit limited, descriptions and analysis of structural features (Dudley et al., 2001). Another wreck, which remained more or less without investigation upon discovery are the remains of a large 14th century clinker built ship discovered at Sandwich, Kent in 1974 during sewerage works (Trussler, 1974). The remains of the wreck were revisited in the late 1990's comprising a detailed documentation and analysis, also including dendrochronological analysis of the ship timbers (Milne, 2004).

As the aim of this thesis is also to assess potential tangible impacts of carvel construction in small clinker watercraft of the Renaissance, archaeologically known and recorded carvel ships have to be taken into consideration. A prominent and obvious example for this is the Mary Rose, for which archaeological analysis of the hull remains have been published relatively recently (Marsden, 2009). Another recently discovered wreck of a Tudor vessel is the so-called Gresham wreck, of which the bow section was recovered from the Thames estuary in 2004. It provides interesting insights into overlapping clinker and carvel elements on an overall carvel built ship dating to the 16th century. Preliminary results on its construction have been published (Auer & Firth, 2007) and a full excavation report is currently in preparation (J. Auer, pers. comm.). Of further importance regarding early modern ship building methods the Woolwich ship is of some importance. The wreck is believed to be the *Sovereign*, which was built for Henry VII in 1488 and appears to have been originally built in the clinker fashion with the outer hull later converted to carvel (Friel, 1995; Adams, 2003).

Other early carvel built shipwrecks dating to the 16th century are represented by the Cattewater wreck, which has been fully published as part of the BAR series (Redknap, 1984) and the Rye Vessel A, Sussex (Lovegrove, 1964). Finally two carvel built vessels of 15th century date have to be included when reviewing shipwrecks of the Renaissance in England. The first wreck was comprised of an assemblage of disarticulate ship timbers from Camber, East Sussex (Goodburn, 1990) while the last example, the Studland Bay wreck, dating to between 1475 and 1550 was found near Poole, Dorset (Hutchinson, 1991; Thomsen, 2000).

Archaeological material of immediate relevance to this study derives almost entirely from urban waterfront excavations with waterlogged conditions. The second volume of remains of ships and boats found in excavations at London port presents the material dating from the 12th to the 17th century, which also comprises a number of articulated hull sections of boats (Marsden, 1996). Notwithstanding an abundance of information regarding ship building methods from the Middle Ages into the early modern period, the London port material overwhelmingly belongs to flat bottomed watercraft. These appear to have supported the riverine and estuarine infrastructure of the harbour activities rather than being engaged in coastal trading or fishing. Excavations at the waterfront of Poole brought to light an assemblage of compass timbers, i.e. framing timbers, keels and stem posts. The site was interpreted as belonging to a shipyard at the foreshore dating to the late 14th or early 15th century. A good account on the timbers was published Hutchinson, who proposes that the shipyard was specialised to producing small undecked coastal watercraft (Hutchinson, 1994). The Poole ship timbers are therefore of immediate interest and relevance.

Looking at the history of research in Ireland, archaeological discoveries and subsequent research to date are solely based on finds of individual boat and ship timbers or articulated hull sections from urban waterfront excavations rather than in-situ wreck finds. McGrail undertook pioneering work in this regard by recording and analysing the ship timbers from the excavations in Dublin from the 1960’s to the 1980’s (McGrail, 1993). Credit has to be paid to the attempt to extract a maximum of information with a view to draw as many conclusions as possible to the original parent vessel. Further material of similar nature was discovered in excavations at Winetavern Street, adding to the overall known data from Dublin (O’Sullivan, 2000). Waterfront excavations from Waterford and Drogheda further produced boat and ship timbers largely dating to the Middle Ages and partially into the later Middle Ages (McGrail, 1997b; O’Rourke, 2006). Prior to the excavation of the Drogheda boat hardly any full excavation or documentation of shipwrecks was undertaken either from maritime or wetland context. Two vessels discovered from inland freshwater context are more or less the exception to the otherwise scarce archaeological dataset. These are the Iron Age boat from Lough Lene, Co. Westmeath (OhEailidhe, 1992), a flat bottomed craft with mortise-and-tenon fastened side planks, and the poorly preserved remains of a late 15th century clinker built rowing boat from Lough Lannagh, Co. Mayo (Nolan, 2009).

In contrast to the United Kingdom, archaeologically excavated and documented wrecks of the period in question is scarce and by and large not Irish. Well-known examples of such wrecks are the numerous ships of the Spanish Armada that wrecked along the Irish coastline in 1588 in the aftermath of Philip II’s attempt to invade England. Although some of those wreck sites are known, not all are easily accessible or of good level of preservation. An example of early maritime archaeological work for Ireland is the wreck site of the *Trinidad Valencera*, originally a Venetian merchantman requisitioned for the Spanish king in Sicily. The wreck site, which provides excellent preservation conditions was excavated during the 1970s and 80s. The preliminary excavation results were published by Martin in IJNA (1979) and integrated into a wider study of Spanish Armada wrecks (Martin & Parker, 2002). As the focus of the excavation of the Trinidad Valencera was to confirm the identity of the wreck and recording wreck as found, alongside recovery of artefacts, very little information regarding ship construction was obtained.

Three further Armada ships stranded in Streedagh Bay, Co. Donegal have been surveyed in 1985 and an interim overview of the results published (Birch & McElvogue, 1999). The identities of the wrecks appear to be known with all three having been requisitioned by the Spanish crown for the Armada. One vessel, the *La Lavia* was of Portuguese origin, requisitioned in Lisbon, while the other two were Italian vessels from Sicily (*La Juliana*) and Naples (*Santa Maria de Vison*) (Birch & McElvogue, 1999). Several more vessels had been requisitioned for the Armada from various countries as on occasion even hinted in their names, e.g. *Barca de Amburgo* (Hamburg), *Barca de Anzique* (Danzig) and *El Gran Grifón*, which had been built in Rostock, Germany (Martin, 1975; Martin & Parker, 2002). The diverse composition of the Spanish Armada of 1588 therefore highlights the enormous potential for tracing and identifying diagnostic ship architectural features. The recent discovery of a shipwreck near Burtonport, Co. Donegal may be the remains of a previously unknown Armada ship and poses the opportunity to expand our knowledge in this regard. The wreck was excavated and recorded in 2011/ 2012 and post-processing and analysis of the excavation results is currently still on-going (Brady et al., 2012; Kelleher, forthcoming). A number of other ships, such as the *Santa Maria de la Rosa*, have been surveyed, excavated and recorded. However, these mostly post-date the period in question for this study (Martin, 1979; Martin, 1975).

2.1.6 Spain and Portugal

Compared with northern Europe the Iberian Peninsula is a somewhat blank spot on the archaeological map of medieval and Renaissance small clinker built watercraft. The scarce data of clinker built vessels is contrasted by significantly more wrecks of carvel built ships from the 15th century onwards. This unbalance in data is therefore reflected in the Iberian research focus and literature available.

To the knowledge of the author only a single clinker built wreck has so far been discovered in Portugal. The Ria de Aveiro G wreck, dating to the 15th century was discovered during dredging works and could not be surveyed or recorded in detail (Alves & Ventura, 2005). The situation for Spain is almost identical with again one known wreck of medieval date and clinker construction known to date. The Urbieta boat, found near Gernika in the Basque country was quite well preserved and preliminary results on the vessel have been published recently (Rieth, 2006).

The existence of the above-described so-called Iberian-Atlantic tradition for carvel shipbuilding demands an assessment of these vessels to potential impacts on clinker construction at a transnational level. Acknowledging the importance of this tradition the International Symposium on Archaeology of Medieval and Modern Ships of Iberian-Atlantic Tradition was held in Lisbon in 1998. The proceedings of this symposium are extremely valuable as they contain contributions on a variety of wreck sites and other aspects surrounding the topic, some of which have already been named above (Alves, 2001). For wrecks from Portugal the publication contains a wealth of papers, such as the 14th century Corpo Santo shipwreck, Lisbon (Alves, Rieth & Rodrigues, 2001), the Ria Aveiro A shipwreck (Alves, Rieth, Rodrigues, et al., 2001), the Angra D shipwreck, Azores (Garcia & Monteiro, 2001) and the Cais do Sodré, Lisbon (Rodrigues et al., 2001; Rodrigues, 1998), all dating to the 15th century.

The 16th century Basque whaling ship from Red Bay is equally represented (Grenier, 2001). Moreover the exhaustive final publication on this wreck comprising five volumes has since been published (Grenier et al., 2007). A further wreck from the Azores, known as Angra C, dates to the early 17th century and deserves attention as a potential Dutch construction has been postulated for this vessel (Phaneuf, 2003), an identification contested by e.g. Maarleveld (Maarleveld, 2013). Further wreck finds of vessels from the Iberian Peninsula discovered overseas or other parts of the Atlantic could be added to the list. This includes the previously mentioned Spanish Armada wrecks as well as Spanish and Portuguese ships found overseas. However, discussing this in detail would go beyond the scope and parameters of this study and a reference to good summarising accounts on these wrecks shall suffice for the purpose of this study (Maarleveld, 1992; Oertling, 2001; Adams, 2003).

2.1.7 France

Archaeological publications relating to medieval or early modern ship finds are even rarer along the French Atlantic coastline compared to the Iberian countries. This is partly due to the discoveries being few and far in between, but also a result of the somewhat seemingly "insular" nature of French maritime archaeology. With the exception of a number of scholars it appears that the discipline is undertaken more or less "self-sufficient" and not as active in transnational exchange and dissemination as in other countries. This is by far not to diminish the value, quality and achievements of maritime archaeology in France. Nonetheless, no vessels fully fitting into the parameters of this PhD study are currently known from France.

The medieval Aber Wrac'h wreck, Brittany, although as a long distance trade vessel too large for the comparative analysis, was built as a clinker ship and certain constructional elements and features are therefore of relevance for the study. Discovered in 1985, the wreck was investigated in the following years and results published in preliminary report format (L'Hour & Veyrat, 1989; L'Hour & Veyrat, 1994). Using the Aber Wrac'h wreck as a main case study, Alexandra Grille currently researches large clinker ships from the mid-14th to the mid-16th century in Northwest Europe as part of a PhD project (A. Grille, pers. comm.). The EP1-Canche wreck, Pais-de-Calais dating to the 15th century is of bottom based construction and therefore of lesser but auxiliary importance for the research questions of this PhD project. Yet publication of preliminary investigation results do provide some useful information regarding the vessel's construction (Rieth, 2012).

Similarly very few 15th and 16th century carvel built ships on the French Atlantic coast have been discovered or at least archaeologically investigated to the knowledge of the author. One of these is the Trélevérn wreck dating the late 15th or early 16th century, of which preliminary results have been published in the annual report series of DRASSM (L'Hour et al., 2006b). Further the Chambrette 1 wreck, Gironde, a well-preserved small carvel-built coaster dating to the late 16th century has been published in the same series (L'Hour et al., 2006a). Both accounts are in very preliminary format and fall short of useful detailed analysis of the hull remains.

2.1.8 The Benelux countries – Belgium and the Netherlands

The review of archaeological sources from Belgium and the Netherlands has been combined in one chapter as they share a geographically similar coastline but more importantly due to the lack of relevant archaeological data from Belgium. Information on wrecks from Belgium is more or less confined to a small number of finds from the River Scheldt, Antwerp. These include for example the two so-called cogs Doel 1 and 2, both dating to the 14th century. Recording and analysis of these wrecks is currently on-going but preliminary results through conference paper abstracts have been published (Vlierman, 2006; Vermeersch & Lenaerts, forthcoming) and fragments of a clinker built vessel found near Linkeroever, which has been C14 dated to c. 1470-1670 (Moortel, 1998).

In contrast to the situation as described for Portugal, Spain, France and Belgium, the Netherlands can draw from a strong maritime archaeological research tradition as well as a wealth of archaeological data leading to a wealth of archaeological data across the historical periods and construction methods. The impact of the advances of trade, art, science and the military of the Dutch Golden Age during the 17th century have certainly shaped the national identity of the Netherlands and helped to establish a strong national maritime cultural identity.

Therefore it comes as no surprise that a wealth of archaeological data and research can be attested. This is particularly true for the period of the 16th to 18th century. Nevertheless a certain spatial bias in the dataset is evident and has to be pointed out and is elaborated below. Current and past research relies heavily on archaeological finds from the Ijsselmeer polders and inland waterways whereas wrecks from North Sea coastal areas are rather limited. As the research objective of this thesis is set quite narrow, much of the available research data is therefore somewhat outside the defined geographical limits but can also not be reviewed in full. Especially ship finds and related research regarding early modern Dutch ship construction are only utilised insofar as relevant to the subject.

As mentioned above the vast majority of the known and researched wreck sites are located in the IJsselmeer, particularly in the areas of land reclamation, the polders. Over 400 wrecks are known from this region where significant amounts of fieldwork and research have been undertaken to date. Overview and summarising works on clinker built wrecks in the Netherlands include van Holk's Master thesis (Holk, 1987) and his more recent summarised and updated account of medieval shipwrecks from the Netherlands (Holk, 2003).

However, the vast majority of wrecks are either carvel built or of mixed construction. Particularly bottom-based vessels are highly represented for which summarising accounts have been presented by Reinders (Reinders, 1982; Reinders 1985; Reinders & Oosting, 1989) and more detailed discussions by van de Moortel (1991). Conversely only a single wreck of good levels of preservation, the 13th century Rotterdam 1 wreck, was found outside the IJsselmeerpolders, highlighting the bias in the archaeological data set (Holk, 2003).

Despite many of the IJsselmeer wrecks dating to the 15th and 16th century being of bottom-based construction, seven clinker vessels have been found, excavated and published. Most exceed the size parameters set for this study but are important for the wider maritime archaeological context for the study of small seagoing watercraft. A PhD thesis undertaken by Overmeer investigates clinker ships in the Netherlands from the period between 1400 and 1600 based on clinker built ship finds in the IJsselmeerpolders (Overmeer, 2008). A well preserved example out of this group is wreck U34, for which preliminary excavation and research results are published (Overmeer, 2008). Preliminary results on wreck M11, also belonging to the group of seven clinker vessels, have been published by Wynia as part of the 1993 Glavimans symposium proceedings (Wynia, 1994). A comprehensive description in report format of wreck B36 is published as part of the Grondsporen report series of the University of Groningen (Overmeer, 2009).

Another group of clinker built vessels is represented by the so-called *waterships* (Dutch: waterschepen). These vessels are historically well-known and were a common watercraft in the Zuiderzee throughout the later Middle Ages up until the 19th century. Although several wrecks have been found and investigated, such as the wrecks MZ22, NZ74, published detailed structural analysis is scarce (Reinders, 1985). Archaeologically excavated and published examples dating to the 16th century are e.g. the clinker built watership ZN42 and the carvel built OW 10 wreck (Reinders et al., 1986; Pedersen, 1997). Another carvel built example is the watership VAL7, which served as a comprehensive case study to assess changes in construction and design of waterships from the later Middle Ages into the early modern period, including the vital change from clinker to carvel construction (Verweij et al., 2012).

Several of the many wrecks of bottom-based construction found in the Ijsselmeerpolders have been excavated and researched. Some shall stand exemplary for the large number of wrecks sharing key elements of this construction method These include the well preserved wrecks NZ43, Almere Wijk 13 and Medemblik Zeebad (Moortel, 1991; Hocker & Vlierman, 1996; Maarleveld, 1984). Albeit flat-bottomed, the late medieval wrecks N5, K73/74 and B55 deserve mentioning as they belong into the category of a bottom-based and mixed planking construction method (Reinders et al., 1986).

The well-documented presence of bottom-based vessels in the Netherlands is of some importance. It indicates a well-established tradition of building ships with flush-laid bottoms in a shell first technique; a method re-occurring in and seemingly diagnostic for early modern Dutch carvel shipbuilding (Maarleveld, 1992; Maarleveld, 1994). This has been observed and documented at a number of known 16th and 17th century Dutch wreck sites, such as Scheurrack SO1 and T24 as well as Inschot/Zuidoostrak (Maarleveld, 1994; Maarleveld et al., 1994).

The rich documentary and art-historical sources for the early modern period lend further strength to the archaeologically observed construction details (see chapter 2.2). Notwithstanding this wealth of archaeological and historical knowledge on Dutch boats, ships and shipping, it cannot be ignored that the archaeological data for small watercraft almost exclusively derives from the Ijsselmeerpolders. Accrediting the possibility that small watercraft in particular were designed and built to suit operational waters and usage, the possibility remains that small watercraft predominantly operating on the Dutch North Sea coast differed from their Zuiderzee counterparts.

2.1.9 Germany

The geographic reach chosen for this study means that archaeological sources from the Baltic coastline of Germany are essentially exempt from the study. Nevertheless it should be noted that the sheer number of wreck finds from the German Baltic coast significantly outweighs the known wreck sites from the North Sea coast. Again, as alluded to earlier, the reasons for this imbalance are mani-fold and will be discussed in more detail later. A comprehensive catalogue of wreck finds of medieval date in German waters is contained in Förster's monograph "Große Handelsschiffe des Spätmittelalters", which otherwise focuses on two medieval wrecks in the Baltic Sea (Förster, 2009).

Notwithstanding the importance of the so-called Bremen cog and its impact on maritime archaeology over the decades, its date and construction method place it somewhat outside the parameters set for this study. Nevertheless, since the Bremen cog served somewhat as a "role-model" for defining the characteristics and diagnostic elements for vessels of the cog tradition, reverting to the Bremen cog cannot be avoided (e.g. Steffy, 1994). Albeit not archaeological in the sense of an excavated find, the Ebersdorfer ship model has to be mentioned in the context of potential cog finds from Germany. The model of unknown origin is believed to date to c. 1400. Original interpretation and assessment of the model were strongly influenced by attempting to matching and placing in the context of cog-like vessels (Streusloff, 1983). Since then it has been often used as a comparative example for the interpretation of vessels from archaeological contexts (Bill, 1997a).

Interestingly none of the medieval to early modern wrecks that made their way into the archaeological record was discovered as an "undisturbed" site on the seabed. In case of the Bremen cog, which was found in the tidal section of the River Weser, it was the eroding foreshore banks that had exposed the remains of the vessel. Another important factor is dredging, construction and/or building works in or near riverfronts of the former hanseatic cities. Again Bremen serves as a good example were a number of wrecks of various construction and periods were found over the years (Rech, 2004). The remains of two late medieval clinker built vessels were discovered in this way in Bremen. One wreck discovered in 1978 at the Teerhof in Bremen was recovered as part of development led archaeological investigations. However, no detailed documentation was undertaken and only sparse information on the wreck is available (Brandt, 1979; Brandt, 1994; Rech, 2004). Unfortunately the wreck was not kept ruling out re-visiting and recording the vessel. Remains of another clinker built vessel of similar date came to light during construction works in 2007. The wreck, known as the "Beluga ship" was fully excavated and recorded and detailed accounts of the results were published in article format (Zwick, 2008; Zwick, 2010).

Archaeological source material on early modern carvel built ships is equally poor. Currently only two vessels of 16th to early 17th century date are known from the North Sea coastline of Germany. The Wittenbergen wreck was found in the early 20th century during River maintenance works in the River Elbe near Hamburg. Finds and ship timber subsequently came to light over the decades and the material was presented in preliminary report form during the 1980s (Bracker, 1986). Recognising the potential and importance of this wreck site, a MA thesis by Stanek attempted to extract further information from the ship timber assemblage, coming to the result that the construction of the vessel bears diagnostic features comparable to these found on Dutch ships (Stanek, 2011).

A second wreck of potential Dutch origin and 16th century date was excavated and recovered near Uelvesbüll, Schleswig-Holstein. The comprehensive approach of the excavation, which included conservation and public display of the wreck alongside the production of a full excavation publication, deserves credit (Kühn, 1999). Finally the wreck found near the Island of Mellum, Niedersachsen deserves mentioning as it represents the only other example of an excavated and published shipwreck from the German North Sea. The vessel, a flat-bottomed carvel built ship of 18th century date and likely of Dutch provenance, was fully recorded (Eckert, 2008). However, its date and construction place it outside the remits of this study.

2.1.10 Denmark

The phenomenon observed for Germany, where wrecks from the Baltic Sea appear overrepresented compared to the North Sea, certainly also holds true for Denmark. Known wrecks from the North Sea coastline of Jutland are scarce to almost non-existent, whereas an abundance of wreck sites is known from the Danish Baltic Sea. The biased research focus towards boats and ships of the Viking period as outlined above led to a seemingly unbalanced representation of wrecks across the ages. Notwithstanding such skewed academic interest and groundwork several wrecks from the later Middle Ages and the early modern period were found and recorded throughout the last century. The Vestre Skarholmsrende wreck is an excellent example for the biased research tendency. Discovered in 1937 during tilling initial excavations were carried out by the National Museum. However, upon discovery that the vessel was "non-Viking" the investigations were stopped and the site backfilled. Re-excavation of the wreck in 1994 only unearthed poorly preserved remains of the vessel (Hansen, 1973; Bill, 1997a).

Much credit regarding research on vessels of post-Viking date is owed to Bill, whose work is of significant pertinence to this study. Recognising the importance and potential of small watercraft from this period, he compiled an exhaustive catalogue of such vessels for his aforementioned PhD thesis, which aimed to assess whether peasant seafaring could be traced in the physical remains of small watercraft (Bill, 1997a). In this he discusses construction and development of small clinker built watercraft mainly from Southern Scandinavia but also placed his findings against a wider north-western-European archaeological background. Among others, two of the key sites for Bill's research were the Bredfjed ship, a late 16th/ early 17th century clinker built vessel and the 14th century Gedesby ship.

A good and comprehensive overview of Renaissance ships and shipbuilding in Denmark, also taking into account archaeologically known vessels, has been compiled by Mortensøn in Renæssancens Fartøjer (Mortensøn, 1995). Similarly a volume of Maritim Kontakt dedicated to Renaissance ship building and shipping (Gøbel & Lemée, 2006) shows that this subject has been in the focus of attention of Danish Maritime archaeological scholars for some time. One of the contributions was compiled by Bill and Gøthche. They discuss the topic of Renaissance clinker boat building in Denmark based on archaeological material, which also includes additional information on the Bredfjed Ship (Bill & Gøthche, 2006).

Nonetheless the state of affairs of research regarding clinker built wrecks of late medieval to early modern date for Denmark should not stand unquestioned. The research driven by dedicated scholars has established a knowledge base, which is by far superior to many other European countries. However, interpretational models regarding nature and development of constructional details, associated building traditions or typologies are not unproblematic, a point further discussed in chapter 6.

Turning to individual wreck sites of clinker vessels from the later Middle Ages to the Renaissance a certain discrepancy in dissemination quality can be observed. It can be argued that this is to be expected with a relatively large data set available. Nonetheless, reasons for these discrepancies have to be investigated and reviewed. Firstly a division between data obtained from development led projects on the one hand and investigative research surveys and excavation on the other is apparent, albeit not necessarily as one would expect. Secondly the time of discovery can be an important factor, particularly for wrecks found prior to the availability of scientific analyses, such as dendrochronology or environmental research. Therefore wrecks of good documentation and publication standard are reviewed first, followed by sites where documentation and available information content is currently of lesser quality.

Albeit some centuries older than the investigated date range of this study, the Skuldelev wrecks found in the Roskilde Fjord have to be mentioned (Crumlin-Pedersen, 2002). The discovery of this assemblage of Viking Age ships in many ways initiated and defined the nature and orientation of maritime archaeology in Denmark for many decades (Bill, 1997a). Yet, the archaeological information contained, extracted and published provides a wealth of information for maritime archaeological research. Regarding later medieval wrecks, two of the numerous sites have already been mentioned, i.e. the Bredfjed and the Gedesby ships. For the latter excavation and research results were published in 1991 shortly after the wreck's discovery and excavation (Bill, 1991).

Further constructional and typological aspects were addressed by Bill in an article, which aimed to discuss aspects of boat typology (Bill, 1998). For both ships replicas were built based on the archaeological data. Processes and methodology for reconstructing the Bredfjed ship have been described by Lemée (Lemée, 2000b; Lemée, 2000a; Lemée, 2001). The comprehensive data available on the Gedesby ship is further supplemented by published environmental analysis results (Robinson & Aaby, 1994). During construction works for the Opera house in Copenhagen in 2001, the remains of four clinker built vessels dating to the 15th century were subjected to initial documentation and analysis (Gøthche & Høst-Madsen, 2001; Høst-Madsen, 2007). Nevertheless a detailed constructional discussion of the ship remains was not done despite comprehensive documentation of the wrecks. Wreck 3, which was the best preserved of the wrecks, was re-assessed and researched as part of a Master Thesis at the University of Southern Denmark in 2012 (Nielsen, 2012).

Another relatively well-preserved 16th century clinker built wreck was excavated at Amager Strandpark near Copenhagen. The wreck was subsequently fully recorded and the results, including a good discussion of the constructional details, published as initial excavation report (Gøthche, 2004) and again updated IJNA (Ravn, 2011). The investigations and published research on the Vedby Hage wreck, dating to the 15th century, are equally of a good standard and useful for comparative studies (Gøthche & Myrhøj, 1996; Myrhøj, 2000). Two late 16th/ early 17th century wrecks near Lundeborg on the island of Fynen seem to have been largely ignored in the general discussion of small watercraft in Southern Scandinavia ever since their discovery by sport divers in the early 1970s. The wreck were excavated and recorded in cooperation with Langeland Museum in the years following discovery and the results published in preliminary format. One of the wrecks proofed to be quite well preserved, including a cargo of tiles (Skaarup, 1979; Thomsen, 1982). Although relatively well published, the level of detail regarding construction and dating is quite limited and would certainly warrant revisiting the site.

Further to the already mentioned wrecks, more vessels or parts of wrecks were found during building works in various places around Denmark throughout the last century. Due to the nature of development led excavations and depending on preservation conditions, the quality of the captured data varies significantly. Some wrecks have been excavated as far back as the 19th century, such as the Køge wreck (Bill, 1997a).

Others again were discovered as part of construction works have often not been fully excavated or were relatively poorly preserved. This includes for example remains of two 16th century clinker built vessels from Copenhagen, neither of which were fully recorded and comprehensively published. The first was discovered in 1962 during construction works for the Danish National bank headquarters and only parts of the assemblage were recovered (Bill, 1997a). The second wreck was found during ground works for the Copenhagen metro in 1996 (Bill, 1997a; Gøthche, 1996). I

n the course of construction works for an underground car park, again in Copenhagen, the remains of eight ships, all but one of Renaissance date were found. Two of these were seemingly discarded vessels of clinker construction. The results of the comprehensive analysis and research of this large maritime archaeological project are published in Monograph format (Lemée, 2006). However, not all finds comprised well-preserved or at least partially articulated remains of wrecks. The late medieval ship timbers recovered during the excavations at Tårnby are a good example for disarticulate ship timbers from rural wetland contexts. A good account of the ship timbers has been published as part of the excavation monograph (Myrhøj, 2005).

Despite a much better basis of research, achieved by a small number of individual scholars, a certain shortcoming in the archaeological data can still be attested for wrecks investigated over the last three decades. Viewing the data just presented this may sound odd. Nevertheless the level and standard of dissemination is not equal to the numerous seemingly well-preserved wrecks, which have been investigated and surveyed. The available information is frequently in a very preliminary format and the level of factual detailed information can often be described as sparse and of limited value for an in depth archaeological interpretation.

The late medieval/ early modern wrecks found in Knudsgrund (Dencker, 1998a; Dencker, 1998b), Vejdyb (Rieck, 1986) and Grønsund (Dencker, 1996) fall into this category of wreck sites, although Bill was able to extract and add more information through his research (Bill, 1997a). Another example is the 14th century date Kerteminde 1 wreck, which otherwise never found its way into publicly available published form, but the scarce information is presented in Bill's PhD dissertation (1997a).

Further to fully clinker built vessels a number of ships of bottom-based construction have been discovered and documented. As described for bottom-based watercraft from the Netherlands, they are not integral to the study but rather serve a supplementary purpose. One of these is the 14th century wreck from Vejby. It was never comprehensively published but preliminary research has shown that the vessel may have originated from

Poland (Crumlin-Pedersen, 1979; Bill, 1997a).

Wreck finds of carvel ships dating to the Renaissance from Danish waters are an interesting topic. Firstly the already discussed bias towards clinker ships and boats of the "Nordic" tradition a certain hurdle to overcome from a modern research perspective. Nonetheless the historic accounts show that on a national or more appropriately royal level carvel ship building was an alien method and introduced during the 16th century by employing Dutch shipwrights to construct naval ships (Lemée, 2006). The above-mentioned large scale excavation of eight ships, mostly dating to the Renaissance, accompanying the construction works of an underground car park at Christianshavn in Copenhagen in 1996 represents the most comprehensive archaeological work undertaken on the subject to date. Five of the ships are carvel built Renaissance vessels and provided an excellent basis for investigation. A holistic analysis of the wrecks including historical background research on early carvel ships and shipbuilding was subsequently published by Lemée (2006).

A wreck of a carvel built ship dating to the 16th century was found near Stinesminde in the Mariager Fjord by sports divers in 1970. However, it was not until 1989 that the wreck was subjected to an archaeological survey and test excavation. The vessel was found in good condition and relatively intact, including main deck planking and rigging, albeit largely embedded in silt. Parts of the deck and the rudder were exposed during the excavation. Despite the excavation results giving limited insight into overall construction and shape, a reconstruction of the hull and typological classification was undertaken (Gøthche, 1991).

One wreck where identity and origin are known is the Danish naval ship Gideon, which was built in 1584 by the English shipwright Hugo Beda for Frederik II. Only the bottom shell of the ship is preserved and the limited excavations show that it was built in Double Dutch manner, i.e. a shell first principle for carvel ships. Unfortunately relatively little detail regarding the ships construction is published (Probst, 1994; Lemée, 2006).

An important and to date regrettably often overlooked find is a 16th century carvel built wreck found in Vejle on the east coast of Jutland. The wreck known as Vejle Hafnia wreck shows features usually seen as diagnostic for the clinker construction on the one hand and Dutch shell first tradition on the other. Despite only the bottom part of the hull surviving and stem and stern missing the excavators found the wreck to be of Dutch origin with original hull shape reconstructed and typological identification presented (Crumlin-Pedersen, 1985b; Cederlund, 1983). Again a summary of the constructional features as known was compiled by Bill for his PhD dissertation (1997a).

2.1.11 Sweden

Similar to Germany and Denmark, several wreck sites have been excluded for the purpose of this study as the focus of research lies on wrecks along the Atlantic coast, including the contact zone between the Baltic and the Atlantic. Therefore no wrecks found along the eastern Baltic coast of Sweden are included in the study. Again wrecks from the eastern Baltic to date outnumber known sites from the western coast of Sweden. Finds from the Baltic that historically played or play important roles for the discussion of archaeological ship typology and building traditions are referred to but are not an integral part of the comparative study as such. This includes e.g. the large number of late medieval wrecks found in Kalmar (Åkerlund, 1951).

Similar to the situation described for Denmark and Norway, a number of wrecks were discovered during construction works thus potentially lacking the comprehensive amount of detail of recording due to the individual circumstances. This includes for example the Helsingborg harbour wreck dating to the mid-14th century, of which the lower sections of the hull could not be excavated (Löfgren, 1991; Bill, 1997a).

Increased research activity along the Scanian coastline is noticeable over the last decade with maritime archaeologists of the regionally responsible Bohuslän Museum taking initiative to investigate, record and disseminate information on already known or new wreck sites. The well-preserved remains of a 17th century clinker built vessel were discovered during construction works for the Götatunnel in 2001. A useful account on construction and analysis of the wreck was published recently (von Arbin & Olsson, 2006).

The state of affairs regarding wrecks found by sport divers or during surveys can be described as unsatisfying as far as the balance between wreck discoveries and dissemination is concerned. While wrecks matching the criteria set for the study have been found, even frequently well preserved, the level of recording and analysis of the wrecks remained largely minimal. Gathered information often consists of rough descriptions, dimensions and measurements alongside a typological interpretation of the slim record of data. The so-called “Brick-wreck”, named after the cargo found in the hull, near Skanör is such an example. Found and recorded during archaeological harbour survey it appears to have been quite well preserved as the starboard side is reported to have been preserved up to the gunwale level (Jakobsen, 1994; Hörberg, 1995; Bill, 1997a).

A more recent discovery is the 15th century wreck of Skaftö, which has been partially excavated and surveyed in 2003. Its general dimensions indicate a vessel exceeding 20m in length and therefore outside the parameters set for this study. As the survey of the wreck was largely non-intrusive the amount of recorded constructional detail is naturally limited. However, the otherwise well presented data and analysis of the wreck appears strongly dominated by attempting to typologically interpret the wreck (von Arbin, 2010; von Arbin, 2012). The results and research of the Skaftö wreck further instigated the re-assessment of a wreck find from the early 1980s, the so-called Mollö-cog, which was discovered on the northern part of Sweden’s west coast. As original dating was inconclusive, the material was subjected to dendrochronological dating, giving a late 14th century date. The project further included a re-evaluation and interpretation of the preserved structural remains (von Arbin & Daly, 2012).

Regarding early carvel built ships, the situation in Sweden is similar to the one described for Denmark. Archaeological evidence for small carvel built vessels from the Renaissance is to date non-existent and may be a result of the general introduction and development of carvel ship building in Scandinavia. As the clinker tradition appears to have been predominant and well-established, the demands for naval fleets and ships of modern design only became apparent with the rise of Nationality in the course of the Renaissance. Again it seems that status and political interest were the primary factors for change and innovation. Since knowledge on carvel ship construction was not available from within, foreign master shipbuilders, initially from England were employed to build up the Swedish Navy with the first ships built from the 1530s onwards (Adams, 2003). Consequently current archaeological knowledge on early Swedish carvel shipbuilding is confined to wrecks of naval vessels.

The following two early carvels from this period have been well presented and discussed by Adams (Adams, 2003). Firstly the remains of such an early carvel built naval ship, known as the *Kravel* were found in the Nämdöfjärd and excavated and recorded during the 1990’s. Adams interpreted the constructional features to be northern European, albeit with a certain Iberian and Mediterranean influence. A second vessel of the period is the wreck of the *Elefanten* built in 1559, which sank near Kalmar. Despite certain differences Adams sees the closest constructional comparison in the *Mary Rose* (Adams, 2003).

2.1.12 Norway

The northernmost country of this study has the best prerequisites for high quality and quantity in archaeological data. As all Scandinavian countries Norway can look back on a strong maritime archaeological research tradition from the 19th century onwards with the discovery of the Oseberg and Gokstad ships. Furthermore the rough coastline characterised by endless inlets, fjords and islands has always been a challenging sailing environment with many vessels across the periods having found their demise in the cold Norwegian waters. Conversely these circumstances are beneficial for preservation of wooden ship remains and consequently many preserved wrecks from the medieval period onward are known. Yet only few are investigated thus providing enormous potential for future research.

Working to the disadvantage of this study, the just mentioned Norwegian research tradition shows the same bias as observed for Denmark, i.e. a strong and overwhelming focus on ships and boats of the “Viking” or Nordic tradition. Although over 20 medieval clinker built wreck have been found over the years (Nævestad & Kolltveit, 1999), the lack of investigated vessels of later medieval to early modern wrecks remains striking. Nevertheless several wrecks of clinker built vessels of similar date and size have been documented over the last century. All date to the 14th century and were between 20m and 30m in length thus belonging to larger types of watercraft as set for the perimeters of this study. However, discussing these wrecks is not only required for gaining a better understanding of the traditional orientation of research and dissemination, but also to identify potential similarities in constructional details with smaller clinker built watercraft.

One of these discoveries is the Bøle ship, which was brought up and heavily damaged by dredging works in the 1950s. However, it was not until quite recently that the vessel was re-visited and subjected to in depth research and analysis. While this provides more comprehensive information on the wreck as a whole and its wider context, the archaeological focus lay more on typology and classification without presenting detailed constructional features of the vessel (Daly & Nymoen, 2008). Another ship of late medieval date is the Foldrøy ship dated to the 15th century, for which preliminary results were published in 1965 (Thowsen, 1965). Considering that the ship was discovered at a time when ship archaeology in northern Europe was still a relatively young discipline, the wreck is extremely well presented and even includes comparative analysis with known wreck sites of the time. Equally the preliminary report on the Avaldsnes ship dating to the turn of the 13th/14th century contains relatively comprehensive levels of detail (Alopaeus & Elvestad, 2004).

Although rather well analysed and researched, including hull reconstruction, the degree of published constructional detail for the 14th century Sørenga 2 wreck is limited (Paasche et al., 1995; Nævdal, 2001). Similarly the short account on investigations of a medieval wreck at Hundevika provides good basic information but lacks in depth analysis. In this context it should be mentioned that two more medieval wrecks are known to be located in the same bay (Teisen, 1994).

Finally the late medieval Skjernøysund wreck 3 in Langvika was excavated and a report published based on the excavation results. Although the investigations were non-intrusive a comprehensively described and analysed dataset was made available (Auer & Maarleveld, 2013). The Langvika wreck, amongst others of many medieval wrecks across the study area, is a reminder that presenting shipwrecks by place of discovery can be inappropriate. The timbers originate from the Vistula area in Poland and a Polish origin for the vessel is postulated, thus identifying the vessel as a long-distance merchant ship (Auer & Maarleveld, 2013).

However, as observed for other countries in the study, a trend towards research approaches less discriminating against certain vessels of certain date and building tradition can be observed. The discovery of 15 early modern wrecks built in the clinker construction at the so-called “Barcode” site in Oslo in 2008 certainly has brought younger boats more into the focus of attention. Dating to the late 16th and early 17th century the vessels, which were mostly found in good preservation condition, are all clinker built but show a great variety in size and constructional details (Gundersen, 2012). Due to the scale of the project and volume of material recovered, detailed recording and analysis of the wrecks is currently still on-going. As no preliminary reports on any of the wrecks have been published to date, the wealth of information contained in the wrecks from the Barcode site is not available for this study. Several wrecks of medieval to early modern date have also been discovered at Sørenga over the years, all built in the clinker tradition. The Sørenga vessels 5 and 6, dating to the second half of the 17th century, were discovered during road construction works and fully excavated. The original vessels were between 10m and 15m long and would therefore be excellent comparative examples. While the excavation report provides certain details regarding constructional aspects (Bækken & Molaug, 1998), a more comprehensive and detailed descriptive account would have been helpful.

Similarly the remains of a small clinker built vessel from Portør and a wreck found at the main train station in Oslo in 1966 have only been published on a very preliminary basis (Christensen, 1985; Christensen & Molaug, 1966). Two very recent reports on development led excavations of late medieval shipwrecks are a good example of a change in dissemination style. Both reports contain comprehensive information on constructional detail and discussion of the respective wrecks. The first is the documentation report for the early 15th century clinker built boat Vaterland 1, which provides a good basis for comparative analysis (Daly, 2011). The excavation report on the mid-17th century wreck Sørenga 7 also stands due to the exhaustive level of detail presented (Falck, 2012).

The above section shows that a large number of clinker built wrecks from Norway are not only known but also researched and discussed. However, in contrast to other countries many of these wrecks are only presented as unpublished and internal excavation reports rather than being disseminated in national or international journals or monographs. This poses a certain hindrance when it comes to gaining access or even knowing nature and quantity of researched material. Online dissemination of such project reports, however, is becoming increasingly widespread, thus improving the research conditions vastly.

To date no early modern carvel boats or ships have been found archaeologically. Constructing boats and ships in the clinker method appears to have been very strongly established with little incentive to adopt building carvel ships and boats. In fact even up to contemporary vernacular boat and ship building a preference for building vessels in the clinker fashion can be observed with ships often built with a clinker built underwater hull and carvel above (Hasslöf et al., 1972).

2.1.13 Conclusions

In a general cross-national comparison two main observations and divisions can be made. On the one hand a geographic north-south division is clearly evident whereby the state of research and known archaeological sites in the southern countries from the Iberian peninsula to as far as Germany can be described as minimal compared to the rich archaeological resource available in the Scandinavian countries. The reasons for this division are mani-fold and complex. Nevertheless strongly varying research traditions in connection with diverging geographical and environmental conditions can be identified as the most prominent catalysts for this unbalanced and skewed state of research.

The second observation relates to developments and trends in traditions of archaeological research. It becomes apparent that as maritime archaeology as a discipline matures, researchers and scholars slowly free themselves of established research questions and approaches. This is particularly apparent in the Scandinavian countries were wrecks, which do not fall into the classic categories of "Viking" and "Nordic" have started to attract interest and attention.

2.2 (Art-) Historical Sources

2.2.1 Historical Sources

Taking into account the wide geographic reach and main research objective of this thesis, investigating and researching primary documentary source material was not deemed feasible and immediately necessary. Consequently solely secondary sources were used for the purpose of placing small seagoing watercraft of clinker construction against the general historical background. Furthermore the wide geographic reach of the study prohibited detailed socio-economic historical research for each of the represented regions and countries. Subsequently the selected source material reflects that the historical aspect is addressed on a more general and overarching level.

A number of scholars have investigated the nature and development of ships and maritime trade throughout the Middle Ages and into the early modern period. Scammell certainly has to be named as one of the leading historians on this subject for England but also in relation to Europe in a wider sense (Scammell, 1995). As with the archaeological record, the historical aspect of medieval and Renaissance maritime Denmark can be described as well researched. Mortensøn's Renæssancens Fartøjer (Mortensøn, 1995) and the first volume of Dansk søfarts historie (Bill et al., 1997) provide good overviews over the topic.

Much ground-breaking and stimulating research is owed to Unger, whose work showed a strong link with archaeological concerns regarding the development of merchant ships against the background of socio-economical driving factors, both on a wider European scale (Gardiner & Unger, 1994; Hattendorf & Unger, 2003; Unger, 1989; Unger, 1998; Unger, 2006; Unger, 2011b) but also with a specific interest in Dutch maritime history (Unger, 1978; Unger, 1985). Wider aspects of Renaissance Holland, including the Herring fisheries have been for example been covered by Tracy and Poulsen (Tracy, 2005; Poulsen, 2009). Development and impact of overseas and colonial powers in Europe have are e.g. well discussed by Davis (1973).

A more detailed level of background research is used for Ireland and partially the United Kingdom in response to the Drogheda boat being the main case study. In this regard Bernard's historical research on medieval and early modern shipping and trade not only in French waters but also on trade between Britain, Ireland and France is of importance (Bernard, 1968; Bernard, 1980). In depth historical research into shipbuilding and national and international maritime trade in Ireland was undertaken by Buldorini (Buldorini, 2010). The results of this research are hugely beneficial for this study as its research incorporated primary as well as secondary sources on the topic. However, it has to be pointed out that primary sources dating to the medieval and early modern period in Ireland are extremely scarce. Maritime trade and shipping in Ireland and against an international economic background have been compiled by O'Neill (1987) and Picard (1995). The detailed publication of the later medieval custom accounts of Bristol provide an excellent source for researching nature and volume of traded goods as well as size and origin of the trading vessels (Flavin & Jones, 2009). Burwash's research on English merchant shipping in the 15th/16th century is of useful nature also in light of ships of the period (Burwash, 1947).

Secondary sources for shipbuilding in the Renaissance largely deal with historical accounts of carvel shipbuilding and are of lesser importance for this study. Construction methods for the 16th century have been collected and discussed for England by Barker (1998) and even more comprehensively by Hoving who compiled a comprehensive volume on shipbuilding in the Dutch Golden Age (Hoving, 2012).

2.2.2 Art historical sources

Iconographic sources, such as depictions, city seals and paintings of or containing ships and boats are often used as comparative source to affirm or dismiss interpretations reached through archaeological interpretation. The traditional approach of associating depicted ships and boats with historically or archaeologically defined ship types and vice versa can be seen in a discussion of late medieval ship graffiti and depictions based on a wooden Norwegian calendar of 1457 (Liebgott, 1973).

The repercussions of combining various strands of sources, such as depictions, historical accounts and archaeological data with a view to achieve valid typologies and classifications are discussed in more detail in chapter 6 of this dissertation. Notwithstanding the typological dimension of utilising pictorial evidence to enhance our understanding of historic watercraft, it is the author's opinion that the realism of early modern art can help in increasing our understanding of small watercraft, be it seagoing or river craft. In particular marine art of the Dutch Golden Age provides a wealth of information on all sorts of watercraft sailing the Dutch coast but also depicting ships and the activities they were engaged in.

As with the historical research, an in depth research into depictions of small watercraft would have been beyond the scope and outset of this study. Therefore the utilised depictions have been sourced primarily from exhibition catalogues on marine art of the period. For Dutch marine art these include "Mirror of Empire" (Keyes, 1990), "Zeilschepen" featuring prints from Dutch marine art to the modern day (Groot & Vorstman, 1980) as well as the catalogue for the exhibition "Turmoil and Tranquility" (Gaschke, 2008). Marine paintings in the style or to the detail are unparalleled and unique for the European Renaissance. English marine art was heavily influenced by Dutch masters, especially due to the influence of the van de Velde's who moved to England during their lives. Among others Taylor has collected paintings and prints of the early phase of English marine art, which only really commenced in the 18th century after the peak of Dutch marine art (Taylor, 1995).

For the other European countries the situation is much more difficult and depictions occur not as frequently in paintings and prints of harbour views or on maps. Overall the evidence can be considered as extremely scarce and it is hoped that further research may bring to light more depictions of watercraft. Overall depictions of small coastal watercraft from outside the Netherlands are very infrequent but have been used by maritime archaeologists for interpretation (e.g. Lemée, 2006; Falck, 2012).

3. The Drogheda boat

3.1 Introduction and background

3.1.1 General introduction

The outset and main case study for this thesis project is the so-called Drogheda boat, a 16th century clinker built vessel of c. 10m length, named after its find location in the River Boyne near the town of Drogheda in Ireland. More detailed information on the geographical setting and project background is provided below. However, before continuing some general introductory comments aim to give a better understanding to the structure and format of this chapter.

The high level of preservation of wreck and cargo in combination with provision of resources for detailed recording and analysis enabled the compilation of comprehensive archaeological data allowing for a holistic interpretation of this wreck find. The role as project director entrusted the author with the responsibility of steering the interdisciplinary research aspect as well as personally undertaking the archaeological analysis and interpretation of the wreck. This then allowed the author to expand the scope of research on an international level presented in this thesis (see chapter 1.1). Therefore the results of the interdisciplinary analysis, research and interpretation are described in detail below, particularly with a view to establish a meaningful basis for the subsequent comparative study. Starting by providing necessary background information the descriptions follow largely the sequence of the archaeological investigations. The chapter commences with the physical remains of the wreck and continues with reconstruction and interpretation to finally placing the vessel in its regional to national historical context. In keeping with the research questions of the overall thesis the focus is laid on the wreck itself rather than its cargo. The latter is only described in so far as relevant to the overall interpretation and understanding of the vessel.

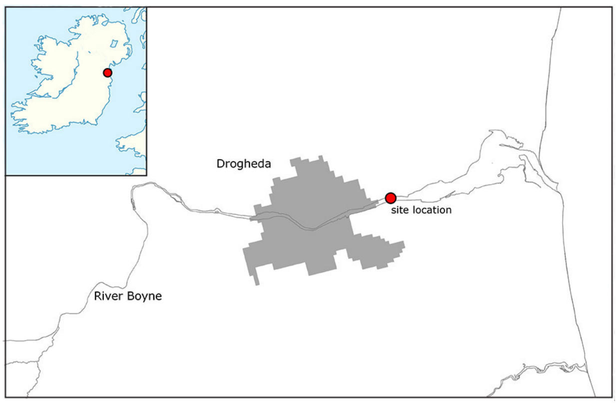

Figure 3-1: Map showing the find location of the Drogheda boat (Schweitzer 2013 after a map by MacSharry 2011)

3.1.2 Project background

The Drogheda boat was found in November 2006 during Archaeological Monitoring of a capital dredging scheme for the Drogheda Port Authority. The modern town of Drogheda has a population of c. 40,000 and is situated around both shores of the River Boyne in County Louth, 56km north of Dublin (Fig. 3-1). Drogheda was a Norman foundation of the late 12th century with currently no evidence that a settlement existed prior to this in the same location (Bradley, 1997). As one of the five original Anglo-Norman royal towns in Ireland the town flourished during the medieval period and for times even competed with Dublin in terms of trade and commerce before going into decline during the 16th and 17th century (Bradley, 1995).

The estuary of the River Boyne widens c. 2km east of Drogheda into the Irish Sea and the strong tidal shifts of the Irish Sea reach almost 4km into the Boyne Valley and approximately 2km upstream of the town of Drogheda. As a result the section of the Boyne exposed to the tides has improved navigability at high tides but is also exposed to higher currents and flood risks than the river further inland. Archaeologically the River Boyne has been of high significance throughout prehistory and the Middle Ages being one the largest natural waterways in Ireland and flanked by fertile lands relatively far inland. This is highlighted by historical records whereby it was mapped by the Greek geographer Ptolemy in the 2nd Century AD. The high density of significant archaeological sites and monuments along its course from prehistory all the way through to modern times are further testimony to the importance of the river. The Megalithic complex Brú na Bóinne, of which

Newgrange is probably best known, Mellifont Abbey, Trim, the Hill of Slane and the Battle of the Boyne battlefield site, are probably some of the best known sites.

This rough and brief historical and archaeological background is important to know not only in relation to the context of the wreck find itself but also for the circumstances under which the vessel was discovered. In contrast to many or even indeed most other wrecks of similar date and nature, the Drogheda boat excavation falls under the category of development led archaeology.

Irish archaeological monuments are protected under the National Monuments (Amendment) Acts 1987 and 1994, which also covers wrecks older than 100 years. The "Developer Pays" principle as established in the Valetta convention 1992 was implemented in Ireland from the early 1990's and requires the developer to cover the costs for all archaeological work arising from the development plan (DoAHGI, 1999). On a practical level planning and pre-planning related applications are assessed by the National Monuments Service from where relevant archaeological recommendations are issued towards the developer and executing archaeological consultants. The Underwater Archaeology Unit, established in 1999, has the responsibility of dealing with all planning proposals regarding underwater and marine related developments in Irish territorial waters. The UAU is also in the process of compiling a GIS based inventory of known shipwrecks around the Irish coast. The aim of this inventory is to provide a database of shipwreck sites but also to serve as a tool for highlighting areas of high underwater archaeological potential informing planning and preparation of developments along the Irish coast.

The Drogheda boat was discovered as part of such a development when Drogheda Port Company (DPC) filed a planning application in 2006 to deepen and widen the navigation channel from the Boyne estuary to a fuel silo compound near the port berths. Prior to granting planning permission, a desk based assessment, sidescan survey and foreshore survey of the planned route was undertaken. No features of archaeological significance were identified in the footprint of the development during this stage of the project and dredging commenced under the condition that all dredging works would be carried out under archaeological monitoring. The works consisted of backhoe dredging using a 360° excavator and the excavated river sediments were dumped into barges. The dredged material was disposed at dedicated offshore dump sites. A number of smaller artefacts and two logboats were discovered during the archaeological monitoring in late 2006. The monitoring archaeologist stopped the dredger after several ship timbers and cask staves came up in the dredger bucket 2km downstream of Drogheda. The potential for more in-situ material was recognised and an exclusion zone of 20m by 20m placed around the find spot (Campbell & Boland, 2006). A dive survey carried out sub-

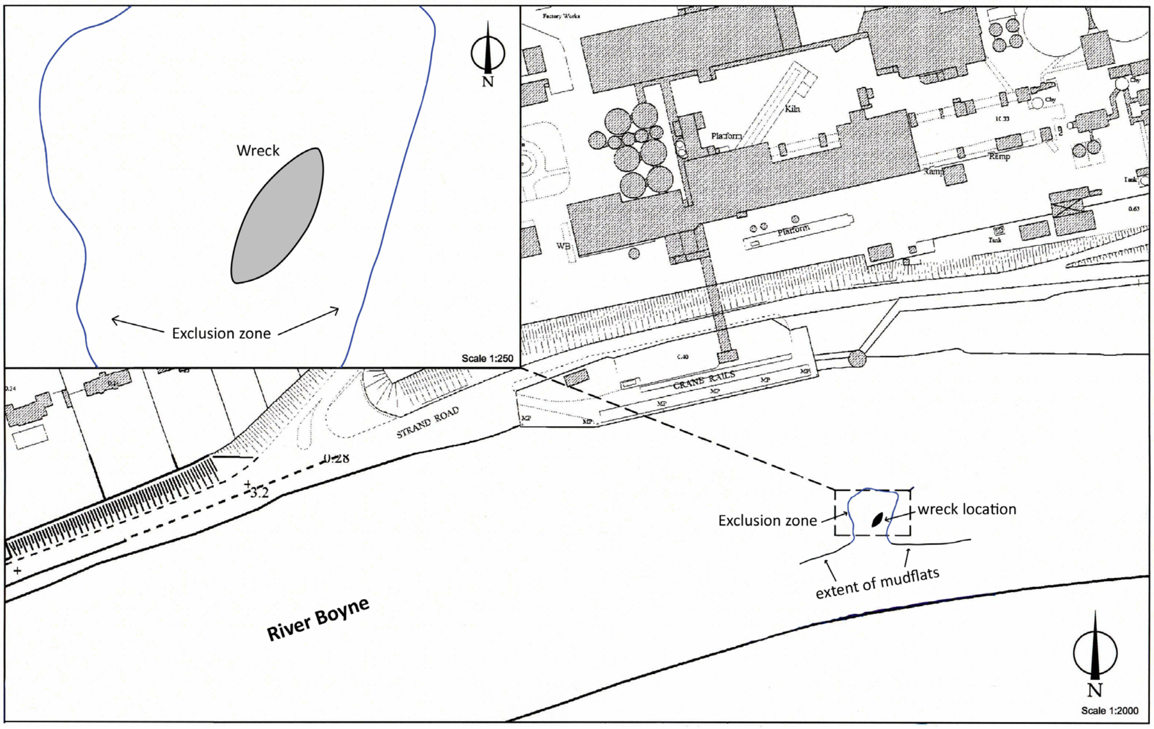

Figure 3-2: Location and orienation of the Drogheda Boat in the River Boyne (Schweitzer 2013 based on a location map by Bangerter 2010)

sequently confirmed the presence of articulate remains of a clinker built vessel.

The wreck was located c. 2km east of Drogheda near in the southern half of the river in a rough north-south orientation with the bow-facing south (Fig. 3-2). It had come to rest on its starboard side and the preserved remains were c. 9m long and 3m wide (Fig. 3-3). Initial assessment of the timbers seemed to point towards a medieval date for the wreck with the implication that it fell under the protection of the National Monuments Act as described above. Since the vessel lay in the required footprint of the proposed navigation channel, preservation in-situ was not feasible and full excavation and recovery required. Subsequently an agreement was reached between DPC, the National Museum of Ireland (NMI) and the National Monuments Service (NMS) to undertake this project together with shared responsibilities. DPC was to provide infrastructure and logistical support, the NMI was to look after conservation related issues and the Underwater Archaeology Unit of the NMS was to undertake the excavation and recording of the wreck. The project direction was given to the author, a member of the Underwater Archaeology Unit at this time. Excavation commenced in January 2007 and the wreck was fully recovered by July of the same year. Recording and specialist analysis of the wreck and its cargo started more or less immediately after the wreck was lifted.

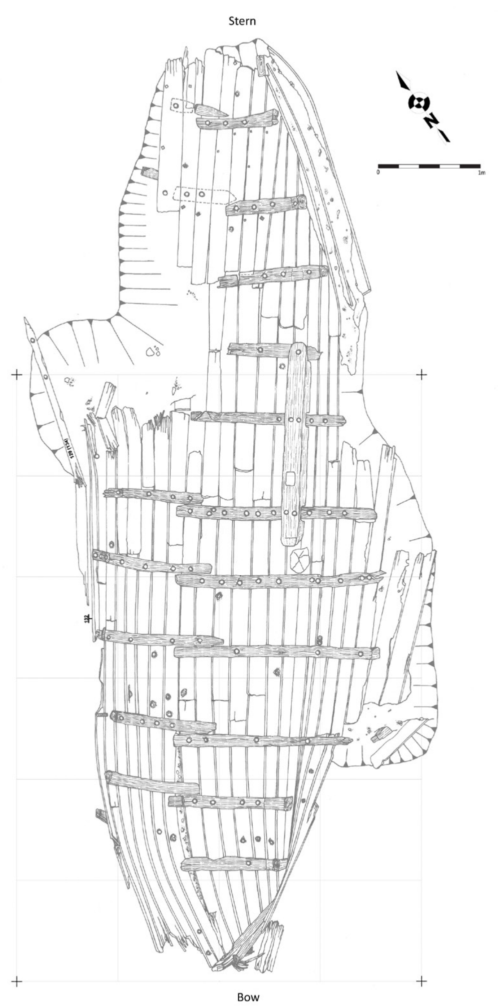

Figure 3-3: Site plan of the Drogheda boat (after Bangerter 2007)

Since the wreck was recovered from the riverbed on a timber-by-timber basis, recording and labelling of the in-situ remains was carried out to the highest standard possible prior to the removal of any elements. This included the compilation of scale site plans and strake diagrams. A detailed and comprehensive project plan was devised for the recording and analysis of all recovered material. For the wreck itself this was guided by the high level of preservation of structural components, including crucial components such as stem, stern and up to 15 strakes of planking on the starboard side, which were believed to be almost at original gunwale level. Therefore one of the aims of the project was to record with a view to build a scale model and attempt reconstruction of original hull shape. The then relatively new method of recording ship timbers three dimensionally using a FaroArm in combination with Rhinoceros 3D software was seen to be the best option to achieve the desired result (Fig. 3-4). A second aspect for choosing this method of recording was that many of the hull planks, particularly near bow and stern still held significant shape. This would have made accurate two-dimensional recording of the plank surfaces very difficult, but it was also deemed that the preserved shape (albeit altered over the centuries by weight of overlying sediments, etc.) were of equal archaeological importance to features preserved on the plank surfaces. The three dimensional record was supplemented by a photographic and written documentation of all hull elements. Similarly all casks and finds were photographed and described.

In order to do justice to the wealth of information contained within the overall assemblage, a comprehensive programme of scientific analysis interdisciplinary research was integrated into the project design. As with excavation and post-processing it was the author's responsibility to devise and project manage this programme in close cooperation with the relevant specialists. In brief this comprised dendrochronological analysis, undertaken by Aoife Daly, on the one hand and environmental analysis on the other (Daly, 2009b; Davis et al., 2009). The environmental analysis was to investigate the waterproofing of the boat as well as the organic residues recovered from some of the casks. It comprised a number of different strands analysis from insect analysis over micro/ macro plant and pollen analysis to chemical analysis as well as analysis of the fish bone assemblage from the casks. This was undertaken by a number of specialists from the UK and Ireland under the direction of Steve Davis of University College Dublin. Archaeological analysis of the casks was undertaken by Sarah Fawsitt as part of a MA thesis at the University of Southern Denmark (Fawsitt, 2010) and the structural remains of the wreck were analysed by the author. Three-dimensional reconstruction and naval architectural analysis was carried out by Pat Tanner (Tanner, 2012). Historical research with a view to shed more light on 16th century trade, shipbuilding and general socio-economic context for the wreck was done by Chiara Buldorini (Buldorini, 2010). A publication presenting the results of Drogheda boat project is currently in preparation for the monograph series of the National Monuments Service.

3.2 Date and provenance

Dendrochronological analysis of the wooden elements belonging the boat and its cargo was deemed to be of crucial importance to the analysis of the wreck with a view to establish potential dates and chronologies for the construction and maintenance of the boat but also its wooden casks. In addition to the dating aspect, it was hoped that the geographic origin for the various elements could be identified.

The wealth of material recovered from the bed of the River Boyne allowed compiling a programme of extensive sampling and analysis. This was undertaken shortly after the recovery and recording of the hull and cargo elements. A total of 23 samples from the boat and 36 samples from the casks were taken and processed (Daly, 2009b).

3.2.1 The boat

Overall 18 planks and five frame timbers were sampled and with the exception of two frame timbers, all could be dated. The reason for the relatively small number of analysed frames was that it proofed to be very difficult to extract usable data from them.

All boat timbers selected for dendrochronological analysis are of oak, Quercus sp.. Although all

Figure 3-4: FaroArm recording (Brogan 2009)

planks and frame timbers, as well as other main structural timbers are oak, the small bow mast step as well as wooden fasteners and rigging elements required further wood species identification to obtain a better picture of the choice of wood for the various structural elements. With the exception of one treenail, which mas made of oak, all analysed treenails were made from willow. No exceptions were observed for the treenail wedges, all of which were made of oak (Daly, 2009b).

Dendrochronological dating shows that all of the sampled frame timbers and nearly all of the planks belong to the construction of the vessel. It has to be noted that none of the dated samples have bark edge preserved, but sapwood was present on the majority of timbers. An approximate felling date between c. 1525 and 1535 was established. The high number of samples taken from hull planking also allowed correlating the tree-ring curves between individual samples. This was possible for two pairs of planks belonging to the original construction of the boat. The correlation from samples of these planks was so high that it is likely that they may have been sourced from the same tree. Three planks, which could be identified as being part of repairs to the hull, gave results showing that their trees may have been felled at a later date. All of those planks had sapwood preserved but no bark edge. Daly estimates an approximate felling date for the trees used for the repairs between c. 1532 and 1560 (Daly, 2009b).

The tree ring curves for the boat timbers reached the best match using Irish and English master chronologies as well as Northern European site

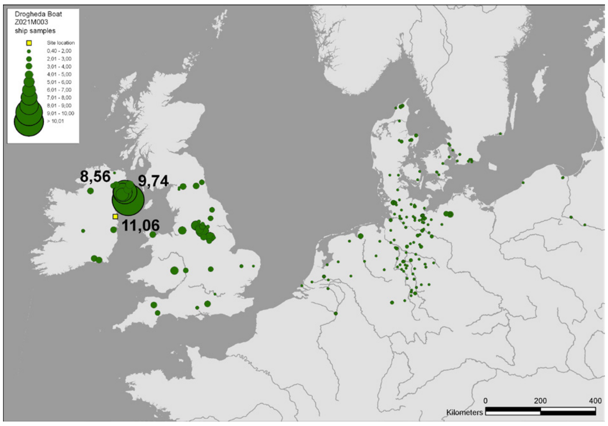

Figure 3-5: Drogheda Boat boat timber t-values matched against northern European site chronologies (Daly 2009)

chronologies. The highest t-values were achieved with a master chronology from Northern Ireland (Fig. 3-5). Daly was hence able to determine that Irish oak was used to build the Drogheda boat. Further correlation against site chronologies made it possible to narrow down the provenance of the timbers, both for construction and repair, to the coastal regions of north-east Ireland (Daly, 2009b).

Based on the data gathered from the dendrochronological analysis Daly attempted to give an impression of tree age and growth rate of the timbers used. Since all planks were converted by radially splitting the parent trees, the innermost centre of the trees as well as the barkwood edge were not present. Therefore the presented age of the trees has to be taken as a minimum. In by far the majority of measurements the pith is greater than ten years from the innermost measured ring. The dendrochronological data shows that the trees used to build the boat were from a relatively young forest. However, it seems that the planks were taken from older trees than the frames. In this respect it has to be kept in mind that not all framing timbers could be included in the analysis since not all had sufficient rings for dendrochronological analysis (Daly, 2009b).

3.2.2 Cargo and finds

Of the 13 casks found with the Drogheda boat, eight were sampled. The decision not to sample each cask was taken on the basis on the uniformity of the assemblage, to minimise the destructive nature of dendrochronological sampling. All 36 sampled timbers were of oak, Quercus sp. and 32 could be successfully dated. Sapwood was preserved on a number of the sampled cask elements. Further to sampling staves and head pieces of casks wood species identification was carried out for a number of hoops and bungs. Despite a presence of a variety of species it was apparent that in most cases the hoops of each cask show uniformity in species used. Overall the majority of the hoops are made of half spilt willow or hazel rods. An exception to this was cask 8 where the majority of analysed hoops are of willow. Two pieces, however, are of pomaceous fruit, such as apple, pear, or similar. The withy bindings used to fasten the hoops are consistently willow (Daly, 2009b).

The internal correlation of the dated tree-ring curves from the sampled timbers shows that the timbers belong to three groups differing form each other by provenance. Group 1 is represented by five samples, all from Cask 3. Group 2 consists of just a single stave (F310), which did does belong to any of the articulated casks and Group 3 is comprised of the majority of the casks. In short the main cargo carrying casks belong to group 3, while the single smaller cask is of different nature and provenance. The single stave seems to have been in secondary use on board and again did not match with the timbers used for the casks of Groups 2 and 3 (Daly, 2007).

The felling date for the trees used for making the cask belonging to Group 3 was between c. 1525

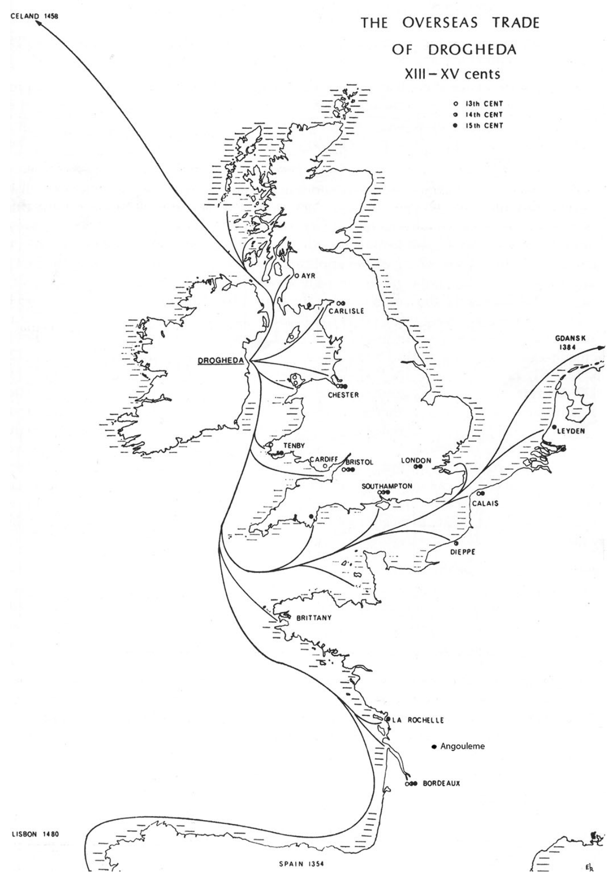

Figure 3-6: Trade connections of Drogheda between the 13th and 15th century (Bradley, 1996 p. 23)

and 1545. The felling date for the single cask of Group 2 may be pinpointed to the winter of 1527/28. The presence of sapwood on all five sampled staves and even bark edge on one example allow such precise dating. It has to be kept in mind that this date is based on the assumption that the sampled staves are representative for the entire cask (Daly, 2009b). As mentioned above the broken stave (F310) was found loose among the cargo of casks in the boat. It is significantly larger than any other staves found on the wreck and its appearance and features show clearly that it was re-used (Fawsitt, 2010). Since only heartwood was preserved on this stave, the dating was less precise with a felling date after c. 1518 (Daly, 2009b).

The three groups were correlated against each other and a selection of available master chronologies from Northern Europe. This shows that all groups achieve the highest correlation with French chronologies. Groups 1 and 2 match best with east and northeast France, while Group 3 matches best with chronologies from western France. The highest t-values for group 1 are with chronologies from the Bourgogne region (t = 8.39) and from East France (t = 8.82) as well as with areas along the River Seine. The timbers therefore appear to have been transported either raw or as assembled casks by river transport following the River Seine from Eastern France towards the French Atlantic coast (Fig. 3-6). The fact that Group 2 is represented by a single sample did not allow for precise provenancing. Nonetheless a relatively good match against eastern and northern French chronologies was achieved (Fig. 3-7). Conversely Group 3 was very well represented and south-western France could be identified as the most likely area of origin for the timbers of this group. Particularly the regions of the Aquitaine with a t-value of t = 7.70 and around Angoulème (t = 8.62) match well despite a relatively wide spread of high t-values with south-western French chronologies. Notwithstanding a certain level of uncertainty the two highest t-values belong to areas, which have navigable rivers towards Bordeaux, indicating a potential route of transport for the timbers (Daly, 2009b).

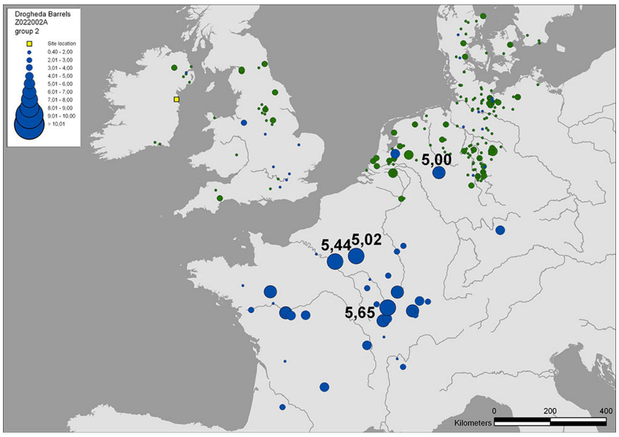

Figure 3-7: Drogheda Boat cask timber t-value correlation (Daly 2009)

3.3 Construction

3.3.1 Introduction

The technical description and presentation of the individual hull elements largely follows the formats established by McGrail for the medieval boat and ship timbers from Dublin (McGrail, 1993) and Nayling for the Magor Pill medieval wreck (Nayling, 1998). This also entails the format of presentation, which is structured roughly in sequence of original construction starting with the keel, stem and sternpost, followed by hull planking, frames, etc. The individual timbers are presented by context number as assigned during the excavation. The descriptions comprise basic measurements and a brief description of form, wood working details, fasteners and other observations, such as surface coverings, intentional marks and possible evidence for repair. For ease of description the level of information on dimensions and measurements is kept to a minimum.

3.3.2 Keel, stem and sternpost

The Keel

The 6.02m long keel is preserved to its full length and in good preservation condition (Figs. 3-8 and 3-9). It is shaped from the whole log of an oak tree of slow to moderate growth rate with c. 90 tree rings visible and a significant number of branch knots present mainly along the inboard and starboard facing surfaces. The pith is slightly off centre towards the port side. The complete absence of sapwood especially around the starboard facing edges indicates that the boat builder was able to choose a tree of ideal dimensions for the keel without restrictions in size. The absence of sapwood and other diagnostic grain features, such as knots, neither allows for an estimation of the parent tree's girth nor for an interpretation which end of the keel belongs to the top of the parent tree and which to the bottom.

The keel is converted from the parent tree by boxing the timber from a whole log of a trunk section of an oak tree. The trunk was first roughly hewn to shape by removing bark and sapwood with axes. Finishing the surfaces was done using adzes and possibly planes. The use of adzes is particularly well visible for the keel rabbets. These are largely worked to smoothly finished surfaces. However, several deep adze stop marks can be seen along the vertical rabbet surfaces.

The keel falls into the category of rabbeted keels with a roughly U-shaped cross section and a consistent high deadrise angle along its full length (Fig. 3-9). Rabbets are cut into the upper longitudinal edges to accommodate the garboard planks. The keel measures 15cm sided (width) and 16cm moulded (depth), giving it a moulded/sided ratio of 1.07, which characterises the Drogheda boat keel as a "beam-type" keel as defined by McKee and McGrail. This means that the keel is deeper that wide, giving the vessel it improved anti-leeway properties (McKee, 1983; McGrail, 1998).

The positive anti-leeway properties of the keel are further improved by the depth of the keel below the garboard rebate and the sharp deadrise of the garboard strakes along the full length of the keel with 83° both forward and aft and 63° midships. The garboard rebates are finely cut into the port and starboard side of the keel to a depth of c. 5.5cm at the forward end, tapering to c. 4cm at the aft end of the keel, thus allowing for a good garboard/keel overlap. The depth of the rebates at the bottom edge varies between 1.5cm and 1.9cm, leaving the bottom outboard edge of the garboard planks slightly protruding.

Both garboard strakes were fastened to the keel with square shanked iron nails. The shanks of the iron nails are of identical dimensions to the clench nails used for the planking and measure on average c. 6mm by 6mm. Nail spacings vary between 17cm and 33cm but mostly range between 25cm and 27cm and can be described as relatively regular.

The keel shows evidence of hogging (Fig. 3-8). Hogging occurs with many vessels over time, especially with more negative buoyancy at stem and stern compared to midships, thus slowly "flexing" the keel upwards (McGrail, 1998). However, it is extremely difficult to determine the length of usage of a vessel in relation to the level of hogging as this is a very unique process for every ship or boat depending on hull characteristics as well as usage.

Vertical flat scarfs with butt ends joined the keel to the stem and stern hooks. Their lengths are 23cm and 21cm respectively. The same type of joint was also observed for stem and sternposts. Although only fully preserved on the stern hook, the visible remains on the stem hook are sufficient to suggest the presence of a vertical flat scarf. Four countersunk iron nails were used per keel scarf as fasteners (Fig. 3-10) with two nails each driven from either side, which were placed in pairs vertically above each other. Although no protective coating or waterproofing was preserved, the purpose of using countersunk nails appears to have been to allow for covering the nail heads with waterproof material to prevent corrosion.

Stem and stern hooks

Curved compass timbers were used to connect keel to stem and stern (Figs. 3-11 and 3-13). The term "hook" is used to describe both pieces. This terminology is based on Bill's PhD dissertation where it is used for vessels of similar construction, size and date range (Bill, 1997a). Their shape and nature as naturally grown timbers have a

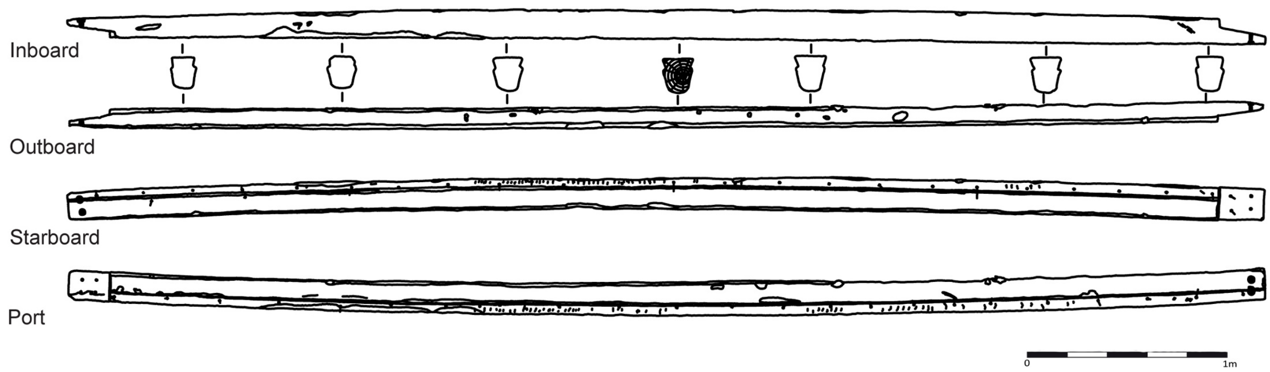

Figure 3-8: Drawing of the keel (Schweitzer 2012 based on the Rhino drawing by McCarthy and Gallagher 2009)

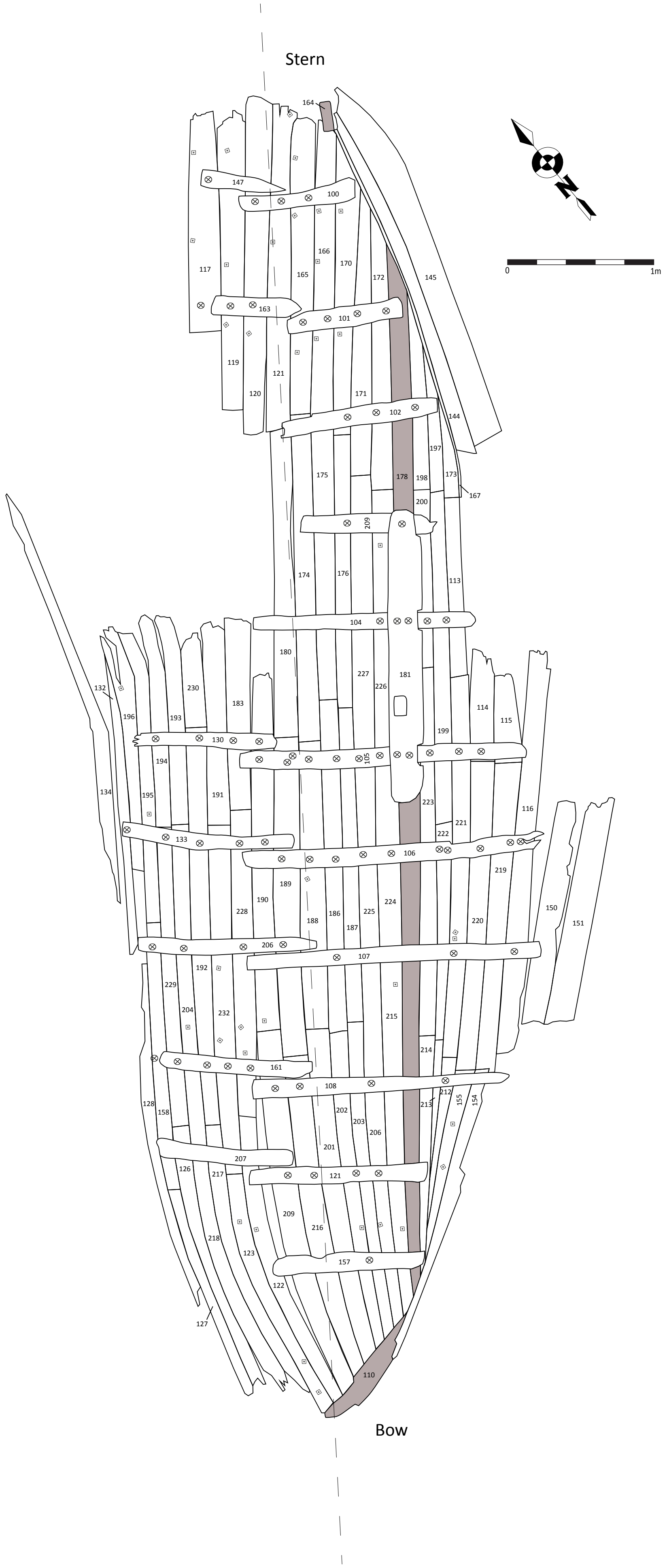

Figure 3-9: Overview plan of the wreck. Keel, stem and sternpost are highlighted in grey (Schweitzer 2013 based on the site plan by Bangerter 2007)

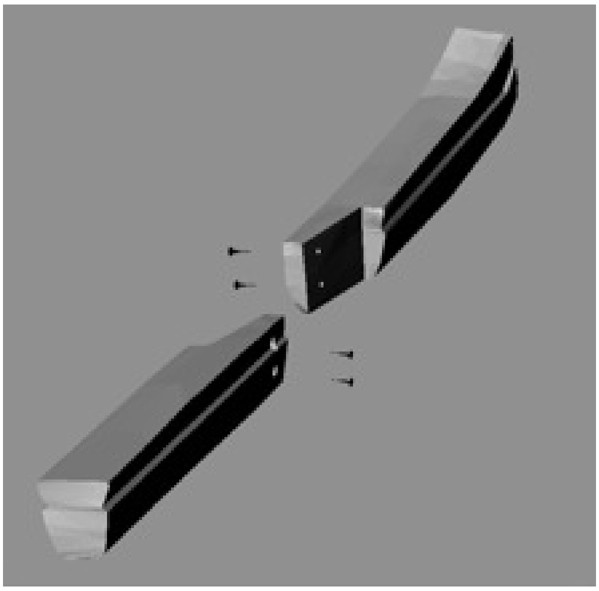

Figure 3-10: Sketch showing vertical main scarf and fastening arrangement (Schweitzer 2013)

dual effect. On the one hand their horizontal sections extend the overall keel length. In case of the Drogheda boat this equates to c. 1m fore and aft respectively. The second aspect is that using compass timbers utilized the strength of the natural run of the grain for lateral and longitudinal support.

Both, stem and stern hook are generally well preserved. While the stern hook is almost in pristine condition the stem hook shows some damage at its upper forward end. Having been exposed over prolonged periods of time the timber has eroded substantially with its upper end missing and the surface details degraded and overgrown by marine borers.

The stem hook is boxed from a half log of the trunk and first major branch section of a large oak tree of moderate growth rate. The timber is of relatively good quality with only few knots present and some sapwood visible roughly along the starboard and port side rebates. The location in the parent tree is based on diameter of the timber and the estimated girth. The stern hook on the other hand is made from a whole log of a main trunk/ branch section of a moderately fast grown oak tree. Sapwood is present along all surfaces except outboard. While the grain on the upper arm is straight, it slightly veered towards the upper edge along the horizontal arm. A small number of knots are visible on its port and starboard surfaces. It shows approximately 60 tree rings with approximately ten sapwood rings visible meaning that the original bark edge was not too far off the preserved edges. A diameter of 20cm can be estimated for the parent timber based on the cross-section measurements of 16cm by c. 10cm. Original diameter and estimated girth indicate that the parent log was relatively limited in size and can probably be placed in the lower part of the parent tree, probably one of the first major branches. The straight-grained upper arm can be placed in the trunk of the tree and the slightly curving grain on the horizontal arm reflects the shape of the parent branch.

The preserved length of the stem hook measures c. 2.50m. The remains of a vertical flat scarf on the badly eroded top end indicate that the timber formed the bottom section of a composite stem post. This scarf sits on the level of the eighth and ninth strake (Fig. 3-11). The horizontal arm of the stem hook is straight and similar to the keel it is rabbeted with a deadrise angle of c. 80°. The upper arm is slightly curved reflecting the original curvature of the parent branch. Triangular shaped rebates are cut into the length of each side of the timber along either side to accommodate the hood ends of the hull planking. The plank hood ends were fastened to the stem post with two rectangular shanked iron nails each. Strakes S4 and S5 are the exception where an additional third nail was placed near the lower edge. Dimensions of all plank fasteners and average distances between the garboard strake nail fasteners are identical to the fasteners on the keel.

Further iron nail fasteners are evident on the inboard facing surface of the stem post. One nail

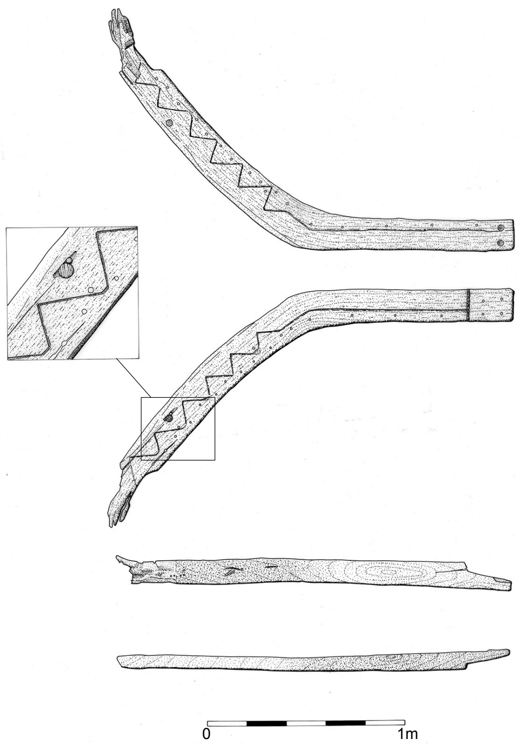

Figure 3-11: Illustration of the stem hole with detail of plugged hole (Ryan 2010)

position relates to the fore mast step while a cluster of four nail positions located towards the upper end may belong to fastenings associated with a bowsprit.

Setting out marks indicating the location of the hood end rebates, are evident in form of shallow scribed lines adjacent to the hood end rebates between the second and fourth starboard strake (Fig. 3-12).

A circular wooden plug (diameter 3.2cm) is situated between the hood end rebates of strakes five and six (Fig. 3-11). The plug was cut flush against both surfaces and two smaller blind rectangular wooden plugs were placed directly next to either side of the plug on the port side. No signs of wear or other possible indications for its usage were identified.

The two straight arms of the 1.29m long stern hook have an enclosed angle of 70° (Fig. 3-13). In contrast to keel and stem hook it is not rabbeted. Faint wear marks, waterproofing residue and holes of the spike nail fasteners were the only evidence for the original positioning of the garboard strakes. Similarly, no rebates for the plank hood ends are cut into the upright arm of the stern hook. The plank hood ends are fastened to the stern hook with an average of two iron nails each. Again size and dimensions are identical to the fasteners observed on keel and stem hook.

Figure 3-12: Detail of hood end rebates with setting out marks (Brogan 2009)

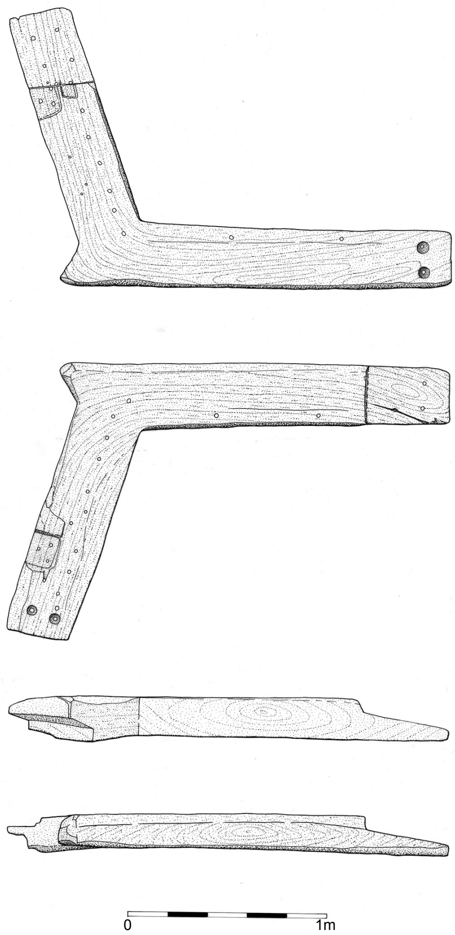

Figure 3-13: Illustration of stern post (Ryan 2010)

Several features and diagnostic elements of the stern's construction show that the boat was originally fitted with a stern rudder. Rectangular shaped rebates are cut into the aft edges of the starboard and port surfaces just below the upper scarf. This originally accommodated iron gudgeons supporting the stern rudder, one of which was preserved in-situ (F413). The gudgeon was fastened to the sternpost with three iron nails. Two of the gudgeon rebates are almost identical in size while a third, smaller rectangular rebate on the starboard side is only partially preserved as it originally extended across the scarf joint into the missing stern post. The small rebate has two iron nail fasteners. The presence of a triangular shaped skeg at the base aft end of the stern knee and a 20cm long concave notch cut into the outboard aft facing surface can also be associated with the stern rudder mounting (Fig. 3-13). The skeg protected the forward edge of the rudder whereas the notch was cut to allow the rudder to swivel without rubbing against the stern hook.

With the exception of a shallow "Y"-shaped notch, cut perpendicular into the inboard surface of the horizontal arm, no further features were observed. The purpose of the shallow notch could not be determined.

3.3.3 Hull planking

Introduction

With a total of 125 planks and plank fragments, hull planking elements account for the vast majority of the structural boat timbers. 83 of these were found articulated or their original location could be re-established (Figs. 3-14 and 3-15). Another 42 planks, many heavily damaged and only partially preserved, were recovered dislodged and disarticulate from the wreck itself. The impact and damage by the backhoe dredger, which led to the discovery of the wreck in the first place, can be seen as the main factor for the physical damage to structural elements of the wreck. In addition to this, erosion and fluctuating sedimentation over time had caused damage to the preserved hull and its individual components, particularly the upper preserved sections.

The articulated planks and plank fragments belong to eight partially preserved port side strakes and 15 partially preserved starboard side strakes (Fig. 3-15). Seven port side strakes and five starboard side strakes are further preserved in their full original length, whereas the remaining strakes are preserved to varying degrees due to afore mentioned erosion and dredger impact damage. Of strakes six to nine of the starboard side all original planks are preserved although not to their full original length and represent the midships section of the wreck.

Wood Science, conversion and toolmarks

All hull planking is made from trunk sections of oak trees with the logs radially split and hewn to their final shape. Its specific properties made oak the preferred material for building clinker vessels during the medieval period. As a hardwood species it is very tough and strong while still being comparatively light and can be easily bent (McGrail, 1976). Due to its high density it is important to work it relatively fresh and avoid prolonged seasoning. Another reason why oak was a preferred choice for shipbuilding is its good rot resistance with the exception for its outer sapwood layer, which is prone to rot more easily (Goodburn, 2009). Despite the significant advantages of oak it also has a number of weak points. These include a tendency to split during seasoning and weathering as a result of corroding iron fasteners. In terms of choice of material when constructing a vessel using ok it can be concluded that Sapwood should be avoided where possible. However, in case of the Drogheda boat 65 percent of the articulated planks have sapwood preserved along one of their edges. In an attempt to reduce the exposure with seawater, the sapwood edges of the vast majority of those planks are placed along their bottom edge. The arrangement of plank overlaps on clinker vessels mean that bottom edges are on the outboard facing side of the plank overlaps and therefore more likely to come in direct contact with seawater than if placed on the top edges where they would be better protected from rot. The high percentage of planks with the weaker and rot-susceptible sapwood edges used for the Drogheda boat shows that no logs of sufficient girth were available to produce planks solely consisting of the higher quality heartwood.

The average length of the planks indicates that the logs used for splitting the planks a between 2m and 2.50m long. Based on preserved treerings, the parent trees appear to have had diameters between 60cm and 75cm. Dendrochronological analysis further showed that the parent trees had a slow to moderate growth rate. The vast majority of planks also have straight grain with very few to no knots indicating that the parent logs were taken beneath the first major branches and that they were carefully selected. Only three planks show grain which veers sharply to one side near one of their ends. In these cases it is possible to say that the ends with curving grain belong to stems of the trunks where the grain fans out towards the roots. Combining all information it can be concluded that the parent trees for the hull were probably sourced from a relatively dense woodland environment where the trees grew in competition to each other thus growing relatively straight and without lower branches because of the surrounding underwood cover (O'Sullivan, 2000). Their age can be estimated to on average 109 at least years old taking into account that not all rings near pith and bark edge were preserved (Daly, 2009b).

As mentioned above all planks were converted from their parent trees by radially splitting logs. This conversion method follows the natural grain of the timber, which is why cleft planks are superior in strength over sawn or tangentially split planks. They are also less prone to warp or split as their shrinkage from green wood is only half that from tangentially converted planks. The preferred choice for the production of high quality planks are therefore parent logs with straight grain and as few knots as possible. Due to the moisture contained within the cell structures of oak, green wood is easier to split than seasoned wood (McGrail, 1976). To avoid drying out of the readily cut parent logs it is believed that storage in water was widely practised before they were converted to planks and curved hull timbers. The advantages of watering were two-fold. On the one hand it ensured that the wood retained its moisture contents for easier dressing and shaping. It also removed certain substances from the sapwood, thus reducing the risk of warping and cracking later on but also reducing the wood's tendency to rot (Crumlin-Pedersen, 1986; McGrail, 1976).

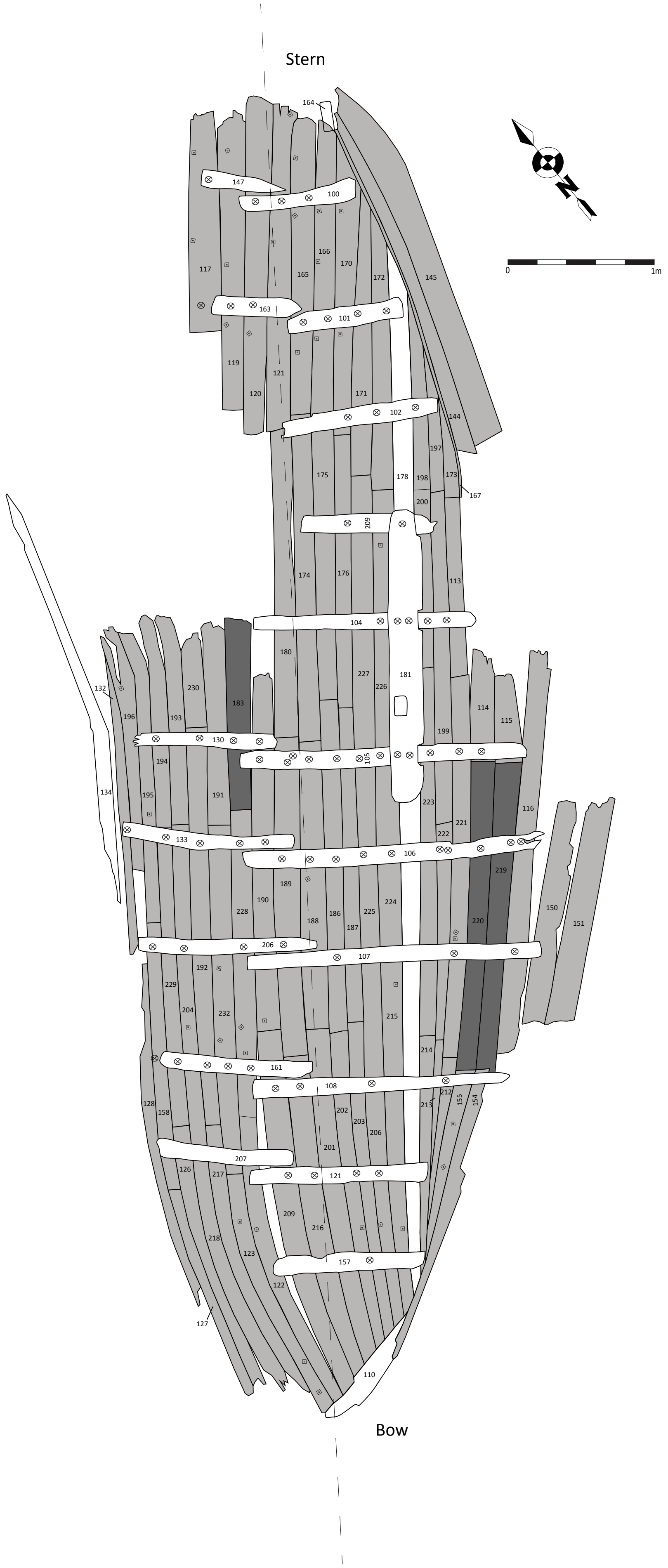

Figure 3-14: Overview plan of the wreck. Keel, hull planks are highlighted in light grey, later repair planks are shown in dark grey (Schweitzer 2013 based on the site plan by Bangerter 2007)

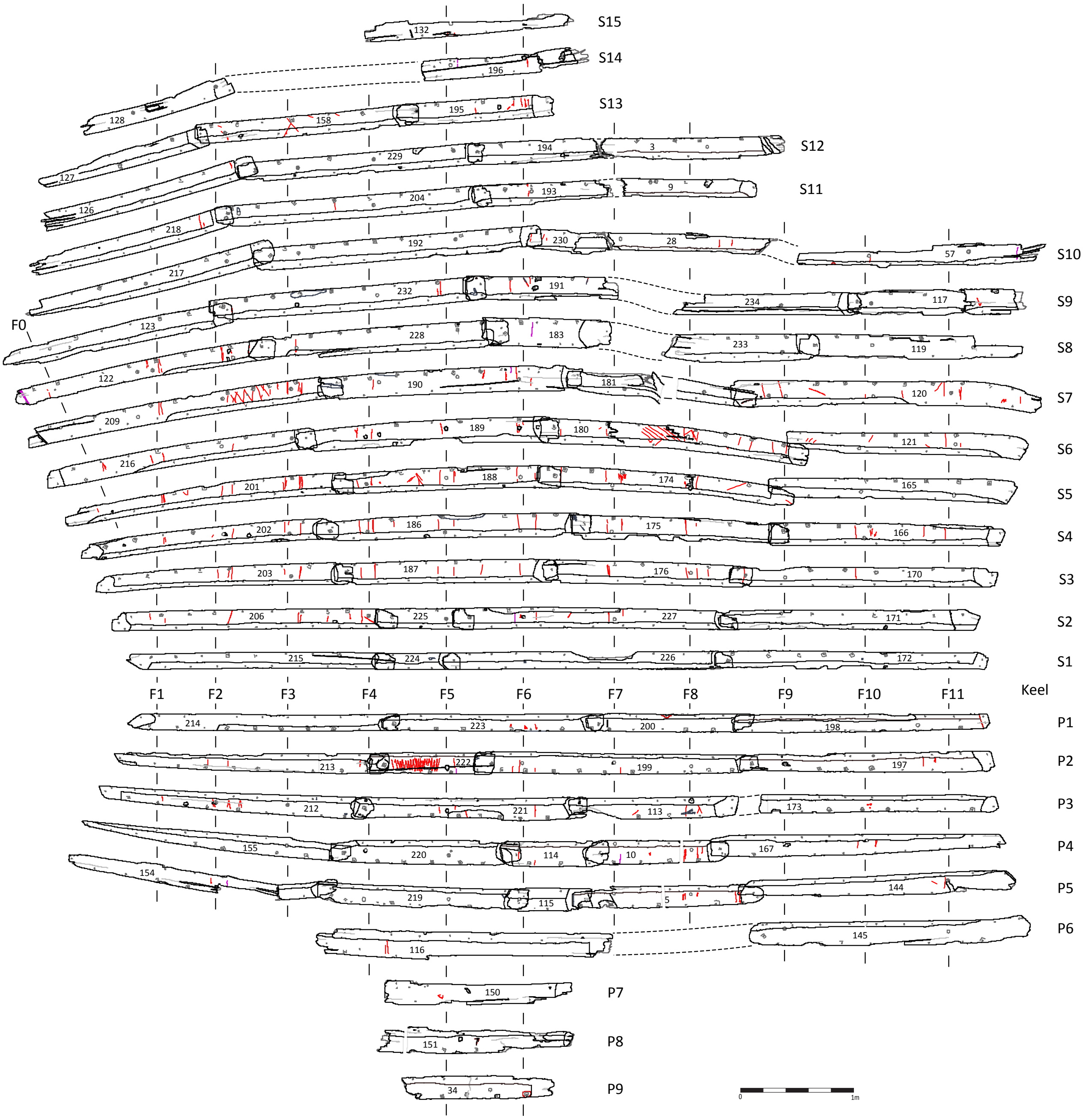

Figure 3-15: Strake diagram showing the wreck as found based on the Rhino drawing of the hull planks (Schweitzer 2013)

The actual conversion process is undertaken by first splitting the full logs in half using wedges, which is then repeated until the desired width for the raw boards is achieved (Fig. 3-16). Consequently the freshly split boards are essentially slightly wedge shaped slices narrowing towards the pith of the log and with the weaker sap- and barkwood edge on the opposite side. Both are usually removed as much as possible depending on the required width of the plank and the diameter of the log. In order to produce roughly parallel sided planks, the sides of the wedge shaped boards are trimmed and hewn with axes often giving planks a roughly "D"-shaped cross-section. For assembly on clinker hulls the planks have to be bent into shape and therefore require the flexibility of fresh and green wood. This is particularly important as it becomes very hard to work oak with hand tools when dried out (Daly, 2007). Larger logs may have been split directly after felling and cutting the logs into desired lengths, a procedure seemingly mostly done during the winter months (Crumlin-Pedersen, 1986; McGrail, 1976).

The process of converting planks from whole logs can often be traced by marks made by the tools used. Typically these are represented by axe and adze marks for ships and boats built from radially split planks during the medieval period. The

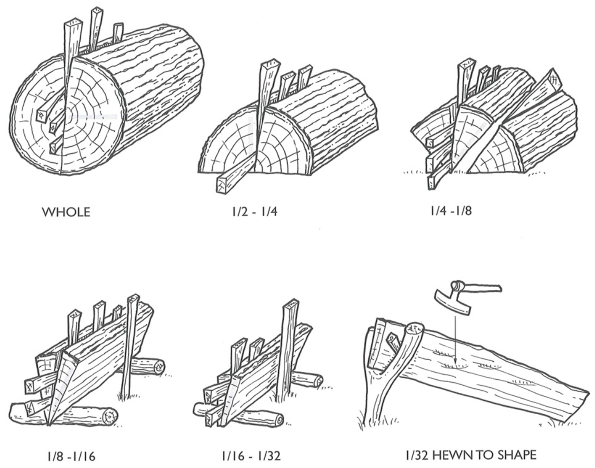

Figure 3-16: Conversion method for radially split planks (after Goodburn, 2009 p. 72)

planks of the Drogheda boat plank similarly show solely use of axes and adzes. Continuing from the production process described above the split planks are first roughly hewn into shape using axes and further trimmed with adzes and possibly planes. Unfortunately the heavy charring on most inboard faces of planks largely obscured and destroyed potential axe, adze or plane marks. The protective coating on the outboard faces, however, meant that original plank surfaces were often quite well preserved. Despite this excellent level of preservation no diagnostic plane marks are visible on any of the planks. Nonetheless, the smooth nature and finish of most planks suggests that planes were possibly used in addition to adzes to provide a finer trim after the planks had been dressed with axes. The use of adzes is frequently evident by adze stop marks and facets, particularly on the surfaces of scarf tables and land bevels. One of the few occasions where distinct axe stop marks are preserved is on stringer C37. The reason for this lies in the generally lesser degree of finish on stringers, which is also evident by the consistent occurrence of adze marks along the longitudinal edges.

Strake arrangement

The preserved hull planking indicates originally that the boat was constructed with four planks per strake (Table 3-1, Fig. 3-15). Only three exceptions to this rule were observed where strakes were comprised of five planks. These were port side strakes 4 and 5 as well as strake 8 on the starboard side. Construction details as well as dendrochronological analysis (see chapter 3.2.1) show that this was the result of partial replacement of original planking with repair planking during the lifespan of the boat. An arrangement of four planks per strake can thus be postulated for the original construction.

Comparing strake arrangement on port and starboard side it can be concluded that it is by and large non-symmetrical and unsystematic (Fig. 3-15). For example the scarf positions on adjoining strakes are barely staggered. In many cases scarfs were more or less located directly above/below each other leading to potential weak points in the hull structure. The most significant staggering is apparent near bow and stern where the strake lengths continuously increase resulting in a roughly symmetrical scarf positioning. With varying plank lengths near the midship sections this regular joining pattern becomes less defined leading to frequent overlapping plank joints. However, the consistency of this joining pattern across the hull planking means that it was not deemed problematic.

The lengths of the individual planks varies significantly from 76cm to 2.84m but if fully preserved and repair planks are not taken into account, the average plank length is c. 2m. The plank width ranges between 17cm and 25cm with an obvious concentration of wider planks apparent around the turn of the bilge. The overall average plank thickness is c. 2.2cm. Although a number of longer planks are present, the frequent use of short planks strongly suggests restrictions in the length of planks available for the construction. This is particularly visible at the first two strakes on either side. The potential limitations in planks of appropriate or desired length in turn may explain the asymmetrical scarf positioning and strake arrangement.

Starboard	No. Planks	Portside	No. Planks
SS 1	4	PS1	4
SS2	4	PS2	4
SS3	4	PS3	4
SS4	5	PS4	4
SS5	5	PS5	4
SS6	4	PS6 *	2
SS7 *	4	PS7 *	1
SS8 *	5	PS8 *	1
SS9 *	5		
SS10 *	4		
SS11 *	3		
SS12 *	3		
SS13 *	3		
SS14 *	2		
SS15 *	1		

Table 3-1: Number of planks per strake (* marks fragmentary and intermittent preservation)

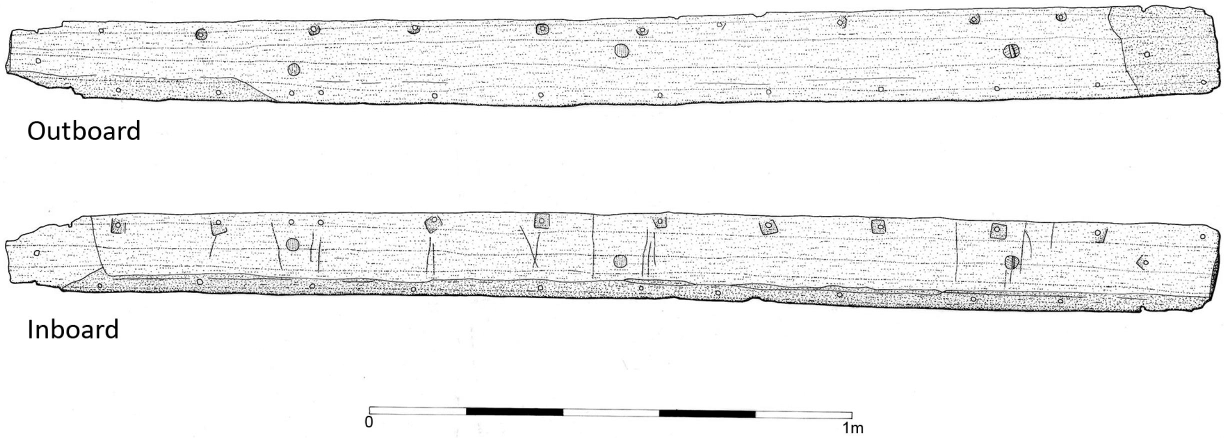

Figure 3-17: Illustration of in- and outboard faces of plank C199 (Ryan 2010)

Adjoining planks on the same strakes were joined with "opening aft" vertical scarfs, meaning that the forward scarf tables were bevelled inboard and the aft scarf tables bevelled outboard, thus avoiding water being pressed into the joints (Figs. 3-17 and 3-25). All scarf tables are worked to near feathered edges. Many scarfs further show an additional short chamfer on the opposite face to the worked scarf table further reducing the thickness of the scarf lips (Fig. 3-18). Most scarfs were fastened with two or three iron clench nails. The majority of the scarf tables, i.e. 76 percent, are between 17cm and 21cm in length. However, the overall average length is 16.25cm.

Scarfs of adjoining planks along the same strakes were fastened with nails and roves identical to the ones used for fastening the plank seams (see below). A number of different nail patterns were observed (Fig. 3-19). However, all are more or less variations of a main method whereby the scarfs were fastened with nails placed on upper and lower land seams as well as roughly at the centre of scarf tables. Of the 52 in-situ preserved scarfs, the vast majority of scarfs (32 in total) have three nails with two nails placed along both plank seams and a third nail situated centrally on the scarf table. It is noticeable that no coherent pattern in relation to exact location of nails on scarf tables is present. The placement of nails appeared to be more following the individual requirements of each scarf and the nail spacing along the relevant plank seams. Exceptions to the main theme did occur but can often be attributed to repair measures or are the results of the scarfs being damaged, thus not allowing a definitive interpretation.

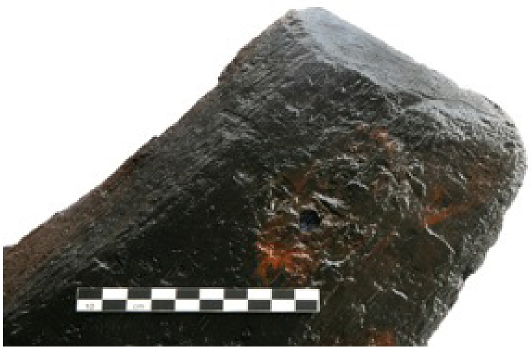

Figure 3-18: Detail of a lank end with chamfer outboard (Brogan 2011)

Lands

Lands are one of the diagnostic features to be found on clinker planks as they are direct results of the clinker construction where the bottom edges of strakes are lapped over the top edges of the strakes below (Figs. 3-17 and 3-25). Lands are defined as the space of this overlap. They are frequently worked to accommodate the waterproofing material between the plank seams and to allow for changes in hull shape. Although no grooves for waterproofing were encountered, the latter could be well established for the lands on the Drogheda boat planks. These are bevelled to various degrees depending on the specific hull location. The hull shape with sharper turns around the turn of the bilge or near bow and stern for example required sharper bevels compared to other sections of the hull.

The vast majority of planks of the Drogheda boat have bevelled lands. Of the 89 articulated planks lands are not bevelled inboard on ten planks and of the outboard lands 38 are not bevelled. Another ten planks are either eroded or damaged and therefore do not allowing a clear identification of the land features. The bevelled lands on outboard faces show mostly only very slight angles between 1° and 5°. The width of the outboard lands ranges significantly between 2.8cm and 7cm but is by in large between 4cm and 5cm.

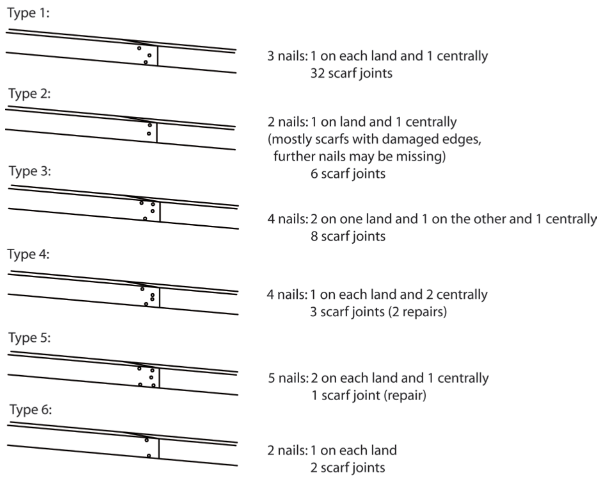

Figure 3-19: Diagram of plank scarf nail patterns (Schweitzer 2013)

In contrast to the lands along the outboard edges, the inboard lands are carefully and consistently bevelled. Land widths range between 4cm and 9cm but are on average 6cm. The degree of bevel angles on the inboard lands varies substantially from not or only barely bevelled up to angles of 30°. The average bevel angle was 11.4°. It has to be said, however, that certain variations of land angles occur along individual planks, most noticeable near bow and stern.

Iron fasteners

The plank overlaps were fastened with iron clench nails with round domed or faceted heads, which were driven from outboard to inboard through partly pre-bored holes and clenched over rectangular roves on the inboard face. Exceptions to the "outboard to inboard" rule were encountered at hood end planks near aft and stern between strakes one and four where nails were placed from inboard to outboard. The practice of clenching in the opposite direction can best be explained by space restrictions on the interior hull at both ends. As the opposing hull sides were only c. 15cm apart from each other, reversing the fastening method avoided the difficulties of clenching in these narrow and confined spaces. Spacing between nail positions can be described as fairly standard with 86 percent of nail intervals ranging between 17cm and 30cm. The average distance between clench nails is 23.5cm. Deviations in spacings only occurs near and at scarf overlaps or were nails were added or replaced.

In addition to clench nails spike nails of similar size and dimensions were used for fastening garboard planks and plank hood ends against the keel, stem and stern hook. These were driven blind through the planks into the underlying timbers. One of the few apparent differences between spike and clench nails is that the holes for keel, stem and stern hook nails appear to have been drilled with an auger to avoid splitting of the timber. Spike nails were also occasionally used as additional fasteners between hull planking and frames. 20 such examples were observed. These seem to have been employed were strengthening of the main wooden treenails fasteners between hull planking and frames was deemed necessary.

All iron components were in poor condition and had largely disintegrated with very little to no hard iron surviving in many cases (Wallace, 2011). Hence no fully preserved nail heads were recovered. However, circular impressions on the outboard surfaces of planks and concreted examples indicate that they were originally domed. Shafts were square to rectangular with average sided length of 7.5mm and head diameters varied between 2cm and 3.5cm but the overall average was 2.57cm. Taking into account that the nails had to span the thickness of two planks with luting material placed in between, the nails must have had a minimum length of c. 5.5cm to allow for their tips to be clenched over the roves. No intact roves were found intact with the exception of a single heavily concreted example in poor condition (Fig. 3-20). However, in general their size and shape are only evident by impressions on the inboard surfaces of the planks (Figs. 3-17 and 3-21). Their shape only varied slightly and was rectangular to diamond shaped measuring on average 3cm sided. A single fragmented nail

Figure 3-20: Concreted rove with outline highlighted in red (after Brogan 2009)

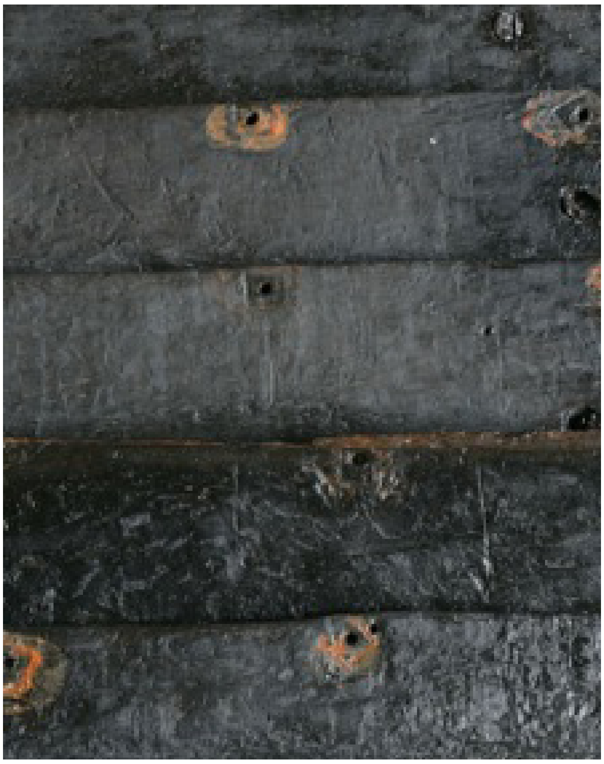

Figure 3-21: Detail of hull planking showing rove impressions and intentional lines (Brogan 2009)

tip indicates that the nails were turned over the roves thus clenching the planks together.

While size and dimensions of clench nails and spike nails for frames are quite similar, the original length of spike nails is difficult to determine. However, holes visible in frames, keel, stem and stern hooks give approximate estimations. Although the nails were removed from holes as much as possible, it was not possible to remove the iron fully. Consequently it was difficult to estimate the exact depth of each nail hole and draw conclusions on the length of the original nail. The recordable depth of spike holes varies significantly between 7mm and 4.8cm but the overall average was 2.2cm. It was noticeable that the holes at keel, stem and stern hooks were slightly deeper compared to the ones observed on frames. Assuming that the deepest nail holes only fall short of the original shaft length driven into the compass timbers, an approximate shaft length of c. 7.5cm appears likely taking the thickness of the hull planking also into consideration. The archaeological evidence, however, does not allow an interpretation whether standardised lengths were used for the entire boat or if dedicated spike and clench nails of differing lengths were employed.

Spike nails were also employed to fasten the bilge stringers and bow mast step to the frames. The only significant difference in nail dimensions to the clench nails was apparent for the bilge stringer spike nails with shaft dimensions of 9mm by 9mm.

Treenails

All frames were fastened to the hull with treenails driven from outboard to inboard through holes, which were augered through the hull planking and frames. The average diameter the treenails is 2.6cm and all of the sampled examples are made from willow with only one example being oak (see chapter 3.2.1). In total 145 treenail positions were found on the preserved hull planks with 90 treenails preserved in-situ on hull planks and 100 on frames. All treenails were broken at the joints between hull planking and frames. As no treenails were removed during recording and post-processing the following description is largely based on the externally visible treenail components. The manufacture of the treenails appears to be as described for the treenails of Dublin ship timbers (McGrail, 1993). The end grain indicates that the treenails were converted from radially split boards and then worked to a circular cross-section. The heads of treenails on the outboard can be divided into two groups, characterised by expanded or dome shaped heads on the one hand and a second group where the heads were cut flush with the outboard surface (Fig. 3-22). With 67 percent of the recognisable examples, protruding heads of expanded and dome shape represent the larger group albeit of varying levels of preservation. On the well-preserved examples the diameter is on average 3.2cm and knife facets from their manufacturing and shaping can be seen. No evidence of waterproofing was found under the preserved in-situ treenail heads. Another 24 percent of the preserved treenails were cut flush with the outboard surface. Whether this was done as part of the original construction or was a later maintenance measure could not be ascertained.

The vast majority of treenails (83 percent) are wedged on the inboard facing ends, a method known as end-wedging leading to swelling at the treenail ends and providing a more secure grip on the frames (McCarthy, 2005). In addition to the "end-wedges" a large number of wedges, which had been inserted from outboard to inboard were encountered. These were observed on 57 percent of all preserved treenails and indicate that it was felt that additional tightening on the outboard facing ends of treenails was required to some degree. Considering the absence of waterproofing beneath treenail heads, the insertion of outboard wedges indicates that they served a similar purpose. However, outboard wedges are not solely confined to treenails with expanded heads and also occurred on flush-cut examples. All wedges were inserted perpendicular to the grain of the planks and frames, thus reducing the risk of radially cracking the timbers (Fig. 3-17). The positioning of the frames perpendicular to the hull planking consequently means that the inboard and outboard wedges were placed at 90° angle to each other.

Treenails were further employed to fasten rubbing strake and sheer clamp to the hull. These were identical in diameter to the treenails used for fastening hull planking to frames. However, no such treenails were preserved in-situ, which could have provided further information on fastening details and material used. Similarly the main mast step was fastened to the underlying frames with oak treenails of identical dimensions.

Plugs

While treenails were predominantly used for fastening hull planking and frames together, wooden fasteners and plugs were also employed for other uses. Smaller wooden plugs made of oak and cut to rectangular cross-section were for example used to fill unused clench nail holes when damaged nails had to be replaced or repaired. On occasion wooden plugs were also employed for other purposes on the boat, including the plugs of the bilge drain holes. Repair and other wooden plugs are described in more detail below chapter 3.3.4.

Waterproofing

A vital aspect of any wooden ship or boat is the prevention of water penetrating into the vessel through the plank seams. In the case of medieval clinker vessels this is normally achieved by placing organic waterproofing material, usually plant matter or animal hair mixed with tar or pitch, between the plank overlaps before the planks are put together and fastened (Friel, 1995). The waterproofing of the Drogheda boat was only partially preserved, a result of disassembly of the wreck on the riverbed together with poor levels of preservation. The preserved waterproofing remains were fully sampled and subjected to exhaustive environmental analysis.

Micro- and macro plant, pollen, insect and lipid analysis has provided comprehensive information on the makeup of the waterproofing material, which was matted between the lands. It proved to be mostly Sphagnum moss (“bog” or “peat” moss) mixed with wood pitch. This composition was relatively coherent across the entire wreck and can be seen as the main waterproofing material

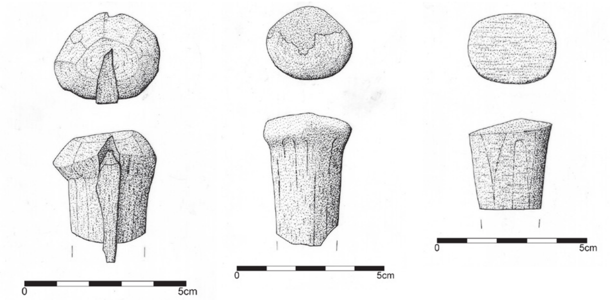

Figure 3-22: Illustrations of treenail heads (Ryan 2010)

applied during the original construction of the boat. A single sample did not conform to the otherwise coherent composition of the waterproofing material. It was almost entirely composed of woodland mosses instead of the Sphagnum mosses, which prefer wetter environments, such as bogs and heathland (Cappers et al., 2000; Davis et al., 2009). This deviation is part of a repair during the lifespan of the boat where a repair plank was fitted to starboard strake 8 (Fig. 3-14).

The environmental analysis further showed a consistent presence of animal dung among the waterproofing material. This was confirmed by insect as well as chemical analysis (Davis et al., 2009). In particular the presence of dung beetle species indicates that most likely horse or sheep dung was either mixed among or found its way into the waterproofing material. Due to the consistent occurrence across most samples it was originally interpreted as a deliberate addition. However, a second interpretation to the presence of animal dung cannot be ruled out. Since none of the hull fasteners were intact it was not possible to identify how tightly the original plank seams were fastened. Should the boat have transported livestock, such as sheep at some stage, it is possible that dung was trampled in between the seams. This may have been even more the case where plank overlaps were slightly open allowing for surrounding material to get in. Therefore presence of herbivore dung in the seams of the Drogheda boat hull may well be an indicator for former cargo rather than a deliberate addition to the waterproofing.

Should, on the other hand, dung have been added deliberately to the waterproofing, it would appear to be the first observed evidence for such practice in late Medieval and early Modern clinker boat building. If this was indeed the case, it could be argued that it may reflect a tradition specific to Ireland or even North-eastern Ireland, thus explaining why it has not been identified in other clinker boats and ships in north-west Europe. Notwithstanding this possibility the extensive

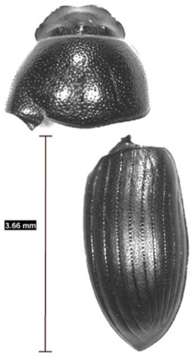

Figure 3-23: Head and thorax of Aphodius ater beetle (Davis 2009)

Figure 3-24: Detail of stempost with protective coating (Brogan 2009)

environmental and scientific analysis applied for the waterproofing of the Drogheda boat is so far unprecedented. Similar occurrences on other ships and boats may therefore have stayed so far undetected.

The environmental analysis further gave evidence for storage conditions of the Sphagnum moss prior to it being used. Earwig remains found in several waterproofing samples indicated that the moss was dry when applied and thus kept in dry storage in the boat yard. Seasonality could also established by the relative short active season of the dung beetle Aphodius ater around August/ September (Fig. 3-23), thus either showing the season for waterproofing of the vessel or when the boat had at some point carried livestock (Davis et al., 2009). A depiction of a small open boat of roughly contemporary date from a Danish context shows the vessel carrying cattle, thus highlighting the versatility of small coasters (Fig. 3-45).

Protective coating

A whitish soft creamy material covered the outboard surfaces of most planks, keel, stem and stern hooks (Fig. 3-24). Although its extent varied significantly with some planks even showing almost no coating remnants, this can most likely be attributed to loss as result of erosion or handling during excavation and recovery. Considering the overall consistent and extensive presence of the coating, it appears likely that it originally covered the entire outboard hull. Analysis of the material by the State Laboratory in 2007 showed that its main component was a pine resin pitch. Unfortunately it was not possible to determine the exact pine species used to source the resin (The State Laboratory, 2007). Further chemical analysis identified terrestrial sulphur in several luting samples suggesting that it was deliberately used rather than a coincidental occurrence (Davis et al., 2009).

Texture, colour and composition of the Drogheda boat coating appear to identify it as a mixed soft pitch or resin mixed with sulphur. The outboard surface of the hull shows no evidence of scorching thus indicating that the pitch was applied without previously burning the hull surface.

In addition to the application of the pitch coating to the outside hull, it appears that protective measures against weathering and rot on the inboard hull were also taken. Since the inner hull was constantly subjected to wear and tear a different approach was taken by slightly burning the surfaces of the hull planks. This was done after the shell of the hull was assembled and before frames were inserted as none of the lands, scarfs or frames show evidence for charring in contrast to the often heavily charred plank surfaces. The absence of charring on the plank lands also excludes the possibility that it was done during the bending of the planks for the assembly of the hull.

Intentional Marks

A range of different scored linear and compass drawn lines were observed on plank surfaces. The different tools used and the varying positions on planks make it possible to draw certain conclusions regarding their purpose. Some of these belong to the original construction of the boat and were scribed by the boat builder. Others, however, seem to have been added during the lifespan of the vessel and could have been cut by the crew or another boat builder. A total of 76 planks have intentionally scribed lines, ranging from a single example to several of varying nature.

Most of the deeply incised lines mark positions of floor and side timbers. They can be found either to one or both sides of the relevant frame position as single or multiple lines. The lines usually span across several strakes and are confined to the inboard surfaces of the planks, indicating that the boat builder marked these after the shell had been assembled (Figs. 3-15, 3-17 and 3-21). In some cases these score marks are accompanied by angular cut lines, which may have marked positions for treenail. Other deep scribed lines cannot be associated with frame stations but appear to be marking the extent of scarf tables or land bevels. A number of intentional lines were also applied to outboard plank surfaces and covered by the pitch coat. Vertical dotted scribed are solely found on outboard surfaces and are represented by only two examples. They appear to mark frame positions but their isolated occurrence and execution as dotted lines are striking.

Twelve planks show lightly scribed lines either above or below treenails. In contrast to the above described scribed marks they are only lightly cut into the surface of the planks. Mostly occurring on plank outboard surfaces they are scored out below or above treenails on the inboard faces. The predominant occurrence on outboard surfaces may be a result of better preservation conditions underneath the protective pitch coat compared to the frequently degraded inboard surfaces resulting from charring. Shallow scribed lines appear as single linear lines but mostly two or three are found grouped together. Their immediate association with treenail locations indicates that they represent score lines marking the position of treenails prior to drilling the holes. More or less confined to the outboard surfaces of planks are also wide compass drawn lines and line clusters, both lightly scribed. Their purpose, however, is unclear as no relationship to damaged areas or constructional details are apparent.

Other lines were scribed to mark cracks or damaged areas on inboard surfaces of planks. These are scored as widely converging lines indicating the extent of cracks. In six cases zigzagging lines of varying size and extent were inscribed and also appear to mark more substantial damage to planks. This is for example the case with plank C222 where a large crack had split the entire plank and was marked with heavy zigzag lines highlighting that this plank required repair or replacement (Fig. 3-15 and 3-25). A small number of other intentional marks, which do not fit into any of the above-described categories, were also observed. A number of other scribed lines represented by only few examples each were also observed but their purpose could not be established. These include lightly scribed crisscrossing lines, others scribed to a triangular shape and clusters of shallow polygonal dimples.

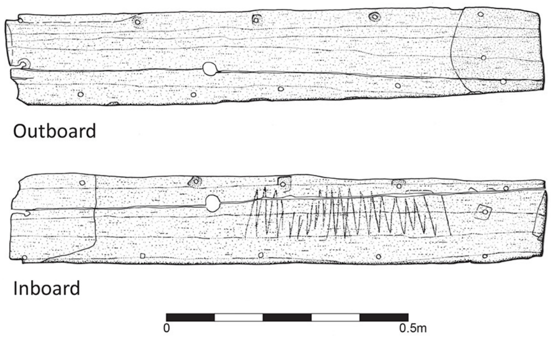

Figure 3-25: Illustration of plank C222 with inscribed zigzag lines (Ryan 2010)

Bilge drain holes

Both garboard aft hooded planks are fitted with a hole near the stern of the vessel. The holes were drilled just above keel level and plugged with wooden dowels, which slightly protruded inboard. The starboard bilge drain hole is located on the garboard plank 25cm from the aft end and has a diameter of 1.5cm. The hole on the port side garboard plank is 3.2cm in diameter and located 63cm from the aft hood end. A third potential bilge drain hole was observed on the hood end plank on starboard strake 2. It is c. 55cm aft of the forward end of the plank. The softwood plug of this 1.4cm wide bilge drain hole was preserved in-situ. The plug was initially believed to be associated with frame station 9 but it was later established that it was located forward of the frame station and must have served a different purpose.

All three plugged holes are interpreted as being used for draining the bilge of the boat's hull despite their differing appearance and dimensions. None of the plugs are in line with any of the frame stations and their dimensions also differ from the standard treenails. Their positioning at garboard planks near the aft end on both sides of the hull suggests that water could be drained through these holes while the boat was on the dry and at a slight angle tilting aft wards. In this way the bilge could be cleaned, dried and ventilated. The difference in their dimensions may indicate that they were drilled at different times to accelerate and improve the draining of the bilge.

3.3.4 Repair and maintenance

Two types of repair and maintenance work to the hull of Drogheda boat are evident. The clench nails holding the seams of the plank overlaps tight appear to have been replaced or reinforced over time in several positions. More serious damage to hull could either be fixed by fitting short repair patches over the damaged area as e.g. evident in the late medieval material from London (Marsden, 1996) or by replacing entire planks if the damage was deemed to severe for patching the damaged areas. Although no repair patches were found on the preserved remains of the Drogheda boat, two areas where hull planks were fully or partially removed were encountered (Figs. 3-14 and 3-15).

Replacement of broken clench nails or retightening of the plank seams was mostly done by removing the original nails and replacing them with oak plugs shaped to the size and dimensions of the original nail and cut flush against both surfaces. A new iron nail was then often placed directly next to the original nail position. Wooden plugs were found on 17 planks and eleven planks have additional nails placed next to the original nail positions with the original nail having been left in place. Some of the wooden plugs were inserted when repair planks were incorporated in the existing hull structure.

On one occasion wooden plugs appear to have been inserted in an attempt to prevent a crack from extending further. Two rectangular shafted wooden plugs presumably inserted successively into the then furthest extent of a crack on the upper land on plank C219, seem to have served this purpose.

Actual repair to planks was evident at portside strakes 4 and 5 where the two adjoining planks were partially replaced with new planks near the forward end of the wreck. The two original planks were shortened, retaining the intact aft ends of the planks. The then "new" forward ends were cut rather roughly as the jagged ends show. New scarf tables were then worked into the shortened planks and the new planks inserted and fastened to the surrounding hull. As the original planks were shortened just forward of frame station F6 the treenail holes on the original planks were still visible on the "new" scarf joint to the repair planks. These in turn had no treenail holes showing that the original fasteners were not replaced. The location of the repair just beneath the turn of the bilge could indicate that the boat had damaged its lower hull in shallow water, possibly by running aground. The fact that parts of the original planks were retained as part of the repair hint that either no planks of sufficient length were available for the repair or that it was simply a way of retaining as much as possible of the original hull structure. Exchanging planks on a clinker built hull without damaging the structural integrity of the surrounding hull elements is a complex task requiring skill and care. Leaving intact "old" plank elements in the hull may therefore have helped in the repair.

The second plank repair is located on starboard strake 8 where again a plank was inserted to replace a damaged plank. As it was positioned in a heavily damaged area of the hull only partial information regarding the nature of this repair is available. Although the actual repair plank is fully intact, the adjoining original plank is only partially preserved. Therefore it cannot be determined if the original was shortened in a similar fashion to the damage on the port side described above. The repair manifests itself in a new arrangement of clench nail positions along plank overlaps showing that new nail distances were required to accommodate the new plank. The environmental analysis also proved that the plank overlap to the above plank was waterproofed with a different material compared to the waterproofing used for the rest of the boat (see above).

All repair planks were subjected to dendrochronological analysis. Interestingly the provenance of all repair planks was established to be identical to the original hull planking. Dating, however, proved to be more difficult due to the lack of sapwood edges from the repair planks. The felling date for these could only be estimated between 1530 and 1562 (see chapter 3.2.1). This strongly suggests that both repairs were undertaken in the same region, possibly even by the same boat builder. Should this have been the case the difference in waterproofing used for the second repair could indicate that the boat builder may not have had a particular preference for a specific material but used what was either cheap or readily available. Conversely, a slightly different locality for the repair(s) is possible, albeit in the same wider geographic region.

3.3.5 Framing

Introduction

The framing comprises twelve preserved frame stations, which have been numbered consecutively from bow to stern (Figs. 3-15 and 3-26). Each of the preserved frame stations (F1 to F11) consists of a floor timber and abutting side timber placed aft of the floor timber with an overlap of two strakes. Of the eleven frame stations all floor timbers were at least partially preserved. Of the side timbers ten were preserved on the starboard side either in-situ or found dislodged from their

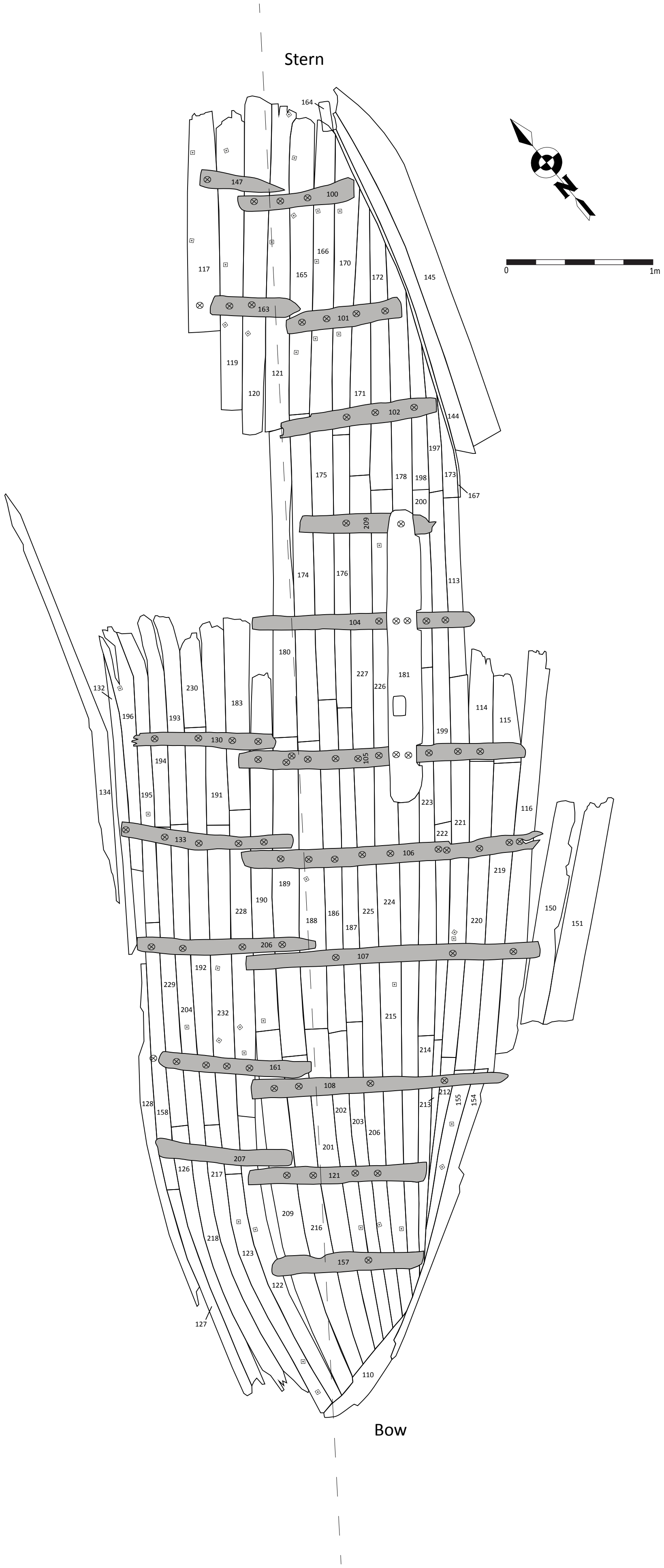

Figure 3-26: Overview plan of the wreck. frame timbers are highlighted in light grey (Schweitzer 2013 based on the site plan by Bangerter 2007)

original positions, three of which were almost fully intact. No side timbers were preserved on the port side. However, several side timbers were preserved on the starboard side, three of which were almost fully intact, giving a good indication to their former structural nature and layout. The floor timbers span seven strakes up to the turn of the bilge. The only exceptions to this rule are the stem and stern floor timbers, which span eight strakes. The side timbers span between nine and ten strakes, reaching up to strake 15 of the hull planking.

Although most of the top sections of side timbers are either heavily eroded or had been damaged by dredger impact, three side timbers show rebates, which were worked into their top inboard ends. Initially it was thought that these represented scarfs to which top timbers or stanchions were fastened to span the remaining distance to the gunwale over approximately one or two more strakes. Reconstruction of original hull shape, however, showed that strake 15 marks the original gunwale position, thus making it more likely that these rebates held a sheer clamp to provide additional strength to the gunwale (see chapter 3.5).

A line of treenail holes with associated scribed marks near the starboard hooded planks indicates an additional frame (F0) located c. 50cm forward of frame F1 and crossing the bow section of the hull from strake 5 upwards. The original frame crossed the stem hook and extended up to the gunwale on both sides. Due to the lack of preserved hull structure near the stern section of the boat it could not be firmly established whether a further frame or cant frame was placed between frame F11 and the sternpost. However, the presence of such a cant frame is postulated on the basis of the hull reconstruction of the vessel, which indicates a heavily curving stern section of the boat (see chapter 3.5).

Wood Science

All framing timbers were made of compass timbers, i.e. from naturally grown branches or tree sections. The parent timbers for all compass timbers were carefully chosen so that the run of the grain of each timber matched the required shape of the end piece. The Drogheda boat has a broad variety of curved hull timbers from large stem and stern hooks to floor timbers with angles ranging from almost flat to very sharp. The parent material for the slightly curving side timbers appears to have been largely taken from curved branches, very often barely sufficient in girth to be fully boxed and squared to the final shape (Figs. 3-27 and 3-28). Compared to the hull planks the proportion of sapwood was even higher where sapwood and occasionally even bark was retained on many floor and side timbers.

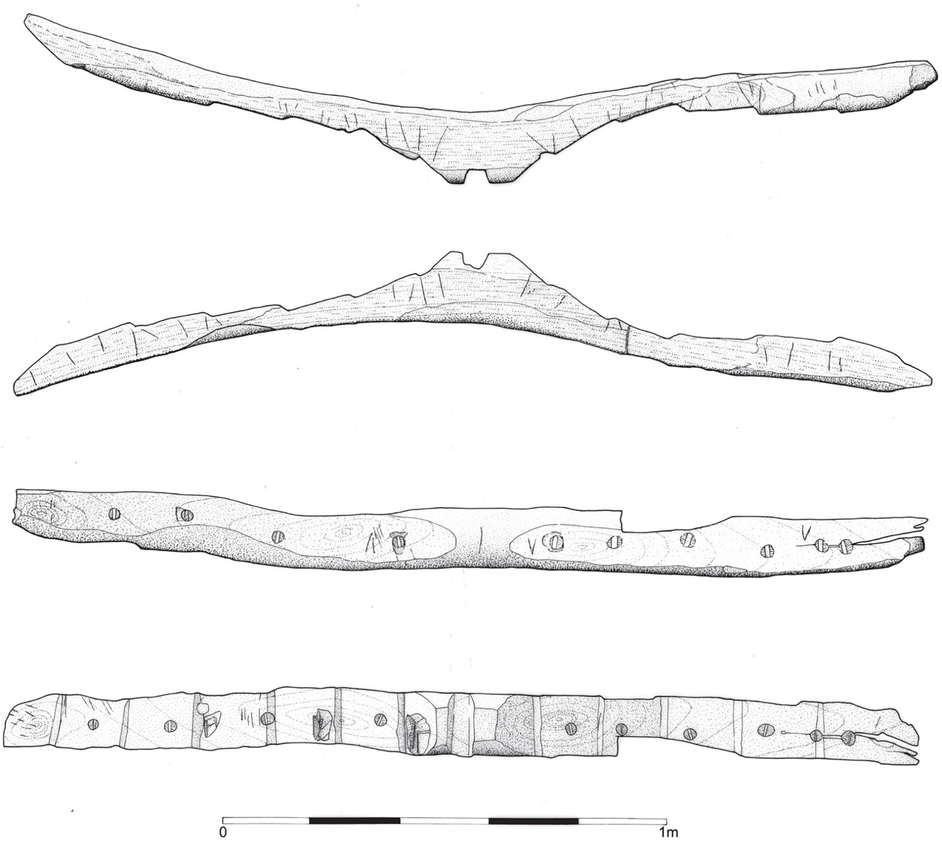

Figure 3-27: Illustration of floor timber C106 showing wood quality, structural details and inscribed lines (Ryan 2010)

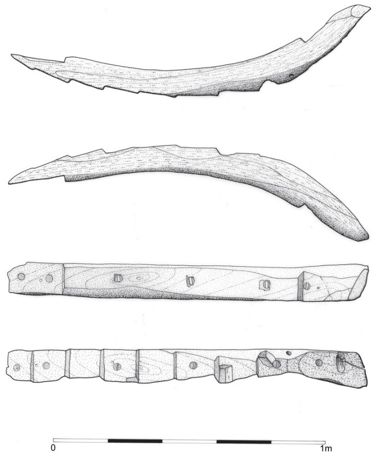

Figure 3-28: Illustration of floor timber C133 showing timber quality and structural details (Ryan 2010)

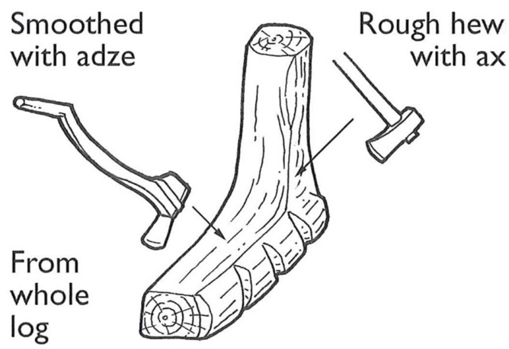

Figure 3-29: Conversion method of frames (after Goodburn, 2009 p. 71)

Floor timbers from the midships section of the boat were mainly taken from stem-branch junctions whereas the sharp enclosed angles near bow and stern indicate that forks and stem-branch sections higher up in trees were used as raw material. Ten of the 21 in-situ frame timbers were made from branches or crooks of very slow grown oak trees. These were most likely taken from hedgerow trees, which grow relatively slowly and produce heavy side branches (O'Sullivan, 2000). Another eight are from trees of more moderate growth rate, which indicates an origin in a more dense woodland area. Based on the small number of frames sampled for dendrochronological analysis an average age of c. 83 years for the parent trees can be assumed (see chapter 3.2).

The first step towards converting frame timbers from the parent trees is to select crooks or branches where the naturally grown shape is close to the required shape for the individual pieces (Fig. 3-29). The felled trees are cross-cut ("bucked") to the rough shapes and lengths, i.e. straight or curved logs (Goodburn, 1991; Goodburn, 1992). Evidence for this early stage of processing timbers is extremely scarce on the Drogheda boat timbers but axe marks on the ends of some of the frames show that cross-cutting and trimming was done using axes rather than saws. The timbers are largely full bodied in many cases with waney edges and irregular crooks. Some are in parts barely worked thus retaining much of the original branch structure and shape. However, the vast majority of curved timbers were converted from full logs where it was sufficient to square them off by removing most of the bark- and sapwood by hewing and chipping (Fig. 3-27). In few cases the parent logs were too big for direct usage and had to be reduced in size by splitting in half or quartering before shaping. The usage of such half and quarter logs was not confined to specific types of structural timbers but was rather dictated by the size of the parent logs, which can be seen with a number of floor and side timbers as well as the stem hook.

Finally the rough outs were trimmed and smoothened with adzes (Goodburn, 2009). Frequently visible adze marks in combination with the complete absence of saw marks bear witness to this conversion method. Despite stop marks of adzes often still visible on the surfaces, it can be said that they were mostly well trimmed with relatively smooth surfaces. Axe marks occurred regularly on the underside of frames, where the joggles were mostly cut using solely axes while the plank faying surfaces again were smoothened with adzes. Adzes were also used to cut rebates into the outboard surfaces to accommodate rove plates of the underlying hull planking.

As mentioned above the level of finish varies significantly. Some frames are fully boxed and distinct joggles are worked into the shell-facing surface. Others in turn retain much of their original rounded shape with little to no dressing to the surfaces leading to the relatively high percentage of sapwood on the frames (Fig. 3-27). The surfaces of three frames further retain small traces of the bark edge. The overwhelming use of raw material with branch diameters close to the required measurements of the frames bears witness to limitations or restrictions in obtaining good quality timbers. The timbers were often of insufficient girth to reduce the parent timbers down to the heartwood cores. Two major negative side effects were the result. Firstly the frames were more susceptible to damage and wear and secondly it was not possible to work the timbers to the degree of finish to achieve a shape giving

Figure 3-30: Detail of floor timber showing limberhole and worked saddle for the mast step (Brogan 2009)

a snug fit against the hull. Overall a use of lesser quality raw material for the internal framing compared with the hull planking, stem, stern and keel can be attested.

Positioning and treenails

The preserved eleven frame stations (F1 to F11) were placed at irregular intervals ranging between 52cm to 83cm with an overall average of 70cm. Keel and floor timbers were not fastened together. Furthermore none of the floor timbers sat flush against the keel with gaps between keel surface and floor timbers reaching up to 10cm. Regarding distribution and frequency of treenails no fully consistent pattern is apparent for fastening frame timbers to the hull. However, the placement of treenails was not done entirely random as certain patterns could be observed. Firstly no treenails were inserted through the garboard strakes. A distinct regularity was further apparent amidships where apart from one exception all frames between F4 and F9 have treenails passing through strake 2. In the same area the frequency of treenails is the highest with the frames fastened to almost all strakes with only few exceptions where every second strake was fastened to the frames.

Other patterns, albeit not as consistent were also observed for other parts of the wreck. Among these are similarities between stern frame (F11) and stem frame (F1), which show no treenails in the lower strakes. In case of F11 treenails are evident for all preserved strakes from strake 5 upwards while F1 has treenails passing through every second strake from strake 8 upwards. Treenails for frames F2 and F3 commence from strakes 3 upwards with the exception of the starboard side of F2 where the first treenail is inserted through strake 4. Frequency and pattern for these two frame stations can be described as fairly regular with treenails present on most strakes with only few exceptions. The foremost frame F0 has treenails passing through every second strake from strake 7 upwards (Fig. 3-15).

Nearly all treenails pass more or less through the centreline of the planks, although several treenails were inserted near or at land edge lines. Only two treenails were inserted through strake overlaps penetrating through two planks and one treenail passes through a scarf joint between two adjoining planks. The insertion of spike nails for additional fastening was observed in fourteen examples and no distinct pattern or frequency for their use was apparent. They supplemented existing treenail but were also inserted on their own without accompanying treenail. It could not be established whether spike nails were part of the original construction or added at a later stage.

Dimensions and Form

A number of measurements and dimensions have been recorded following McGrail's methodology for the Dublin Viking Ship timbers (McGrail, 1993), a method often used as a standard template for recording medieval ship timbers. A discussion of the validity and significance of this recording method can be found in chapter 1.3.3. As many of McGrail's documentation aspects are not deemed suitable for the purpose of a comparative analysis. Therefore the measurements presented are confined to enclosed angles and average moulded/sided dimensions. The enclosed angles of the Drogheda boat floor timbers vary significantly from 69° to 158°. As can be expected, the enclosed angles are sharper near bow and stern with angles continuously increasing towards midships. The average moulded/sided dimensions of the framing timbers were 12cm by 9cm.

Both, floor and side timbers share a number of diagnostic characteristics. These include joggles along the hull facing surfaces of all frame timbers, which allowed for a snug fit against the stepped hull planking. The slightly protruding nail ends and roves on the plank inboard surfaces also required that small rebates had to be cut into the hull facing surfaces of frames so that the frames could rest flush against the planks (Figs. 2-27 and 3-28). Varying levels of finish is evident for the execution of joggles. Some frames are fully boxed with distinct joggles worked into the hull facing surfaces along the full length of the underside. Yet others retain much of their original curved shape and joggles are only partially present.

It further appears that not all frames rested snugly against the strakes. This is not only indicated by the reoccurring absence of carefully worked joggles in the underside on many frames. Two floor timbers, although being almost fully boxed and joggled, have well-preserved treenails protruding by up to 6cm from the hull facing surfaces. Assuming that treenails mostly broke near the entry points into the hull planking, an approximate gap of 4cm to 6cm between the strakes and the underside of these frames can be estimated. One floor timber (C106) shows an asymmetrical shape with port and starboard arms taking different angles. Compared to the starboard arm the port side arm, which was damaged and partially cracked, appears slightly sagged compared to its starboard counterpart. This may indicate a certain degree of sagging of the portside hull resulting in the frame to crack. It is also possible that the asymmetrical shape of this floor timber is more or less original, which could suggest that one arm did not fit snugly against the hull. This interpretation, however, is based on the assumption that both sides of the vessel were fully symmetrical, which in practice did not have to be the case. The asymmetrical shape may therefore well be indicative for the original shape of the vessel's hull in this location.

Some frame timbers were further dressed and worked to accommodate for bilge stringers, the sheer clamp and mast steps. The insertion of bilge stringers at the overlap between floor and side timbers necessitated that the ends of two frames had to be notched to allow for a snug fit of the stringer against the run of the frames. Two timbers (C107 and C133) have particularly well pronounced and preserved stop scarfs serving this purpose (Fig. 3-28). Similar stop scarfs were cut into the upper ends of the side timbers to accommodate for a sheer clamp. These were preserved on three of the side timbers.

The saddles of the three floor timbers over which the main mast step was scarfed, were worked to varying degrees providing a snug fit for the mast step. The most pronounced finish can be seen on floor timber C104 where a distinct notch was cut into the saddle to accommodate the overlying mast step (Fig. 3-20).

Limber holes were cut into the keel-facing surface of all but the stern frame allowing for water to pass more easily along the bottom of the boat (Figs. 3-27 and 3-30). All limber holes are of roughly rectangular shape with the exception of floor timber of F1 where it shows a more triangular shape. Overall it can be said that relatively little care went into the manufacturing process.

Figure 3-31: Detail of roughly cut treenail rebate (Brogan 2009)

The limber holes are often roughly worked to shape with deep and heavy axe marks being a characteristic feature. Circular holes at the bases of the limber holes of two floor timbers show that at least these two limber holes had been initially prepared with an auger prior to being hewn to their final shape with axes.

Shallow rebates defining the location of auger holes for treenails were found on 55 percent of the preserved treenail positions. These were cut into the inboard facing surfaces of the frame timbers with an adze creating shallow rebates of roughly rectangular to triangular shape (Fig. 3-31). Three of these rebates were left void with no auger hole drilled and treenail inserted. A second way of marking auger hole positions is indicated by shallow linear scribed lines at or near treenail positions, which was observed at six frames (see below).

Intentional Marks

Most frames show intentionally scribed lines, which can be divided into different types according to their nature, arrangement and location. The first and by far the highest number of intentional marks are comprised of scribed lines on forward and aft faces of floor and side timbers. As frame timbers were inserted into the preassembled hull, the desired positions for joggles and limber holes were marked to ensure a good fit against the planking (Fig. 3-27). Other intentional marks include widely converging scribed lines, shallow scribed lines at treenail positions and deep scribed zigzag designs as well as parallel line clusters. All of the latter marks can be

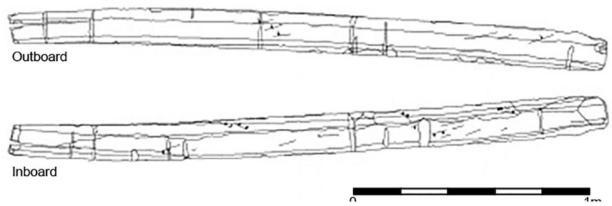

Figure 3-32: Drawing of stringer C37 (Schweitzer 2012 based on the Rhino drawing by McCarthy and Gallagher 2009)

found on the inboard facing surfaces of frames. While the linear scribed lines at or near treenail positions can be interpreted as setting out marks for defining auger hole locations, it was not possible to identify the purpose of the converging scribed lines and line clusters.

3.3.6 Stringers

It was evident that the boat was originally fitted with bilge plank stringers. These provide longitudinal internal support to prevent the vessel from sagging and hogging (Bill, 1997a). Three stringer fragments and one intact stringer plank were recovered from the wreck site. The stringer fragments were found quite heavily damaged and disarticulated from their original positions as a result of the dredger impact. One intact stringer plank was found beneath the cargo of casks (Figs. 3-32 and 3-40). Its exact position on the wreck, however, could not be established. Since all nail fastenings had disintegrated the timber only rested loosely in position coming afloat and disarticulated during excavation.

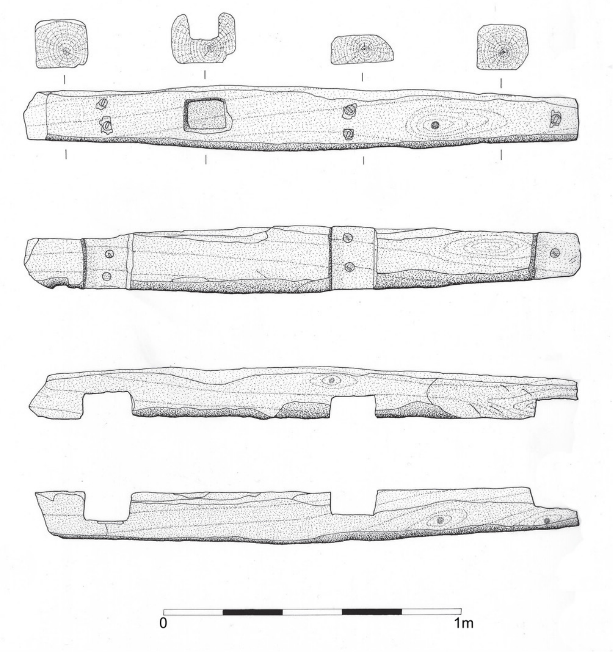

Figure 3-33: Illustration of main mast step (Ryan 2010)

The stringer plank and fragments are on average 16cm in width. With a thickness of on average c. 2.5cm the stringer planks are thicker compared to the hull planks. The intact stringer plank is 2.3m in length. It slightly curves towards one end indicating that its shape follows the bilge line of the boat. One edge of the hull-facing surface was worked to a rough chamfer where the stringer rested against the underlying frames.

The stringer planks were made of radially split logs in the same process as described for the hull planking. Frequent and deep axe marks and signatures are present along both surfaces of the timbers showing that the final dressing of the stringer planks was done with less care compared to the smooth surfaces of the hull planks. Distinct adze marks and on the longitudinal edges of the stringer timbers are further testimony to this observation as is the lower quality of wood compared to the hull planking. The latter manifests itself in high numbers of knots, wavey grain and thick sapwood edges on the timbers. Not only does this show that parent logs was most likely taken from a trunk section above the first branches but also that logs for stringers did not have to be of the same quality and strength as for planking.

Each stringer was made up of two to three planks, which were fitted to the floor and side timbers along the turn of the bilge of the vessel (Fig. 3-43). The use of nails can be described as sparse with only one nail per underlying frame. Furthermore the shallow depth of the spike nails evident in the underlying frames indicates that the stringers were fastened relatively superficially. None of the recovered stringer planks and fragments have scarfs, indicating that the planks of each stringer were laid end to end rather than joined with scarfs.

3.3.7 Mast steps

Two mast steps were found, a main mast step midships and a small bow mast step partially fastened to the stem hook. The latter came detached and afloat during excavation and is thus not represented on the wreck plan (Fig. 3-34).

The main mast step is 1.86m long with moulded/sided dimensions of 18cm/22cm (Fig. 33). Like the keel it is made from a straight oak trunk of moderate growth rate with relatively straight grain. Several knots are visible on its aft half. Its rounded edges reflect the original roundwood

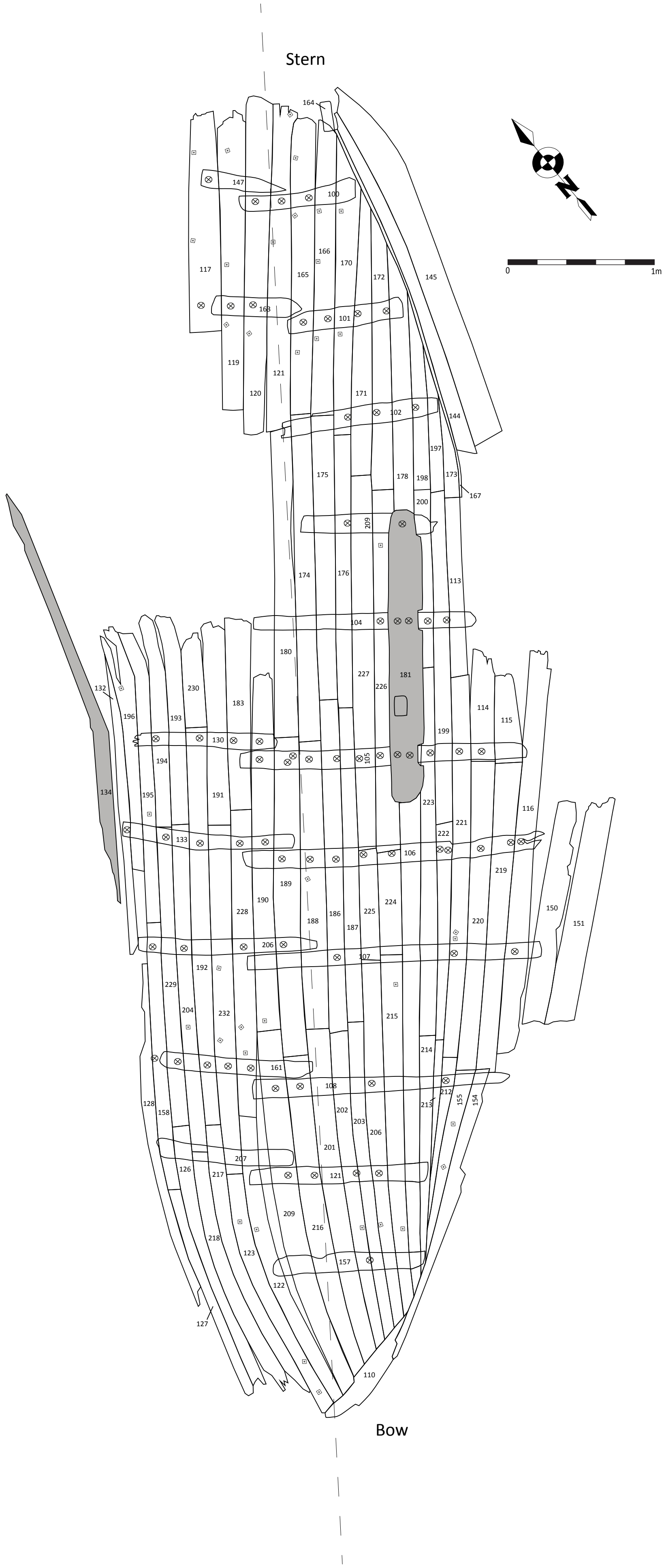

Figure 3-34: Overview plan of the wreck. main mast step and rubbing strake are highlighted in light grey (Schweitzer 2013 based on the site plan by Bangerter 2007)

shape of the parent log indicating that only its sides were trimmed and hewn to shape. Judging by the preserved sapwood edges preserved on the port side surface, the original diameter of the parent log was c. 35cm. These observations show that the timber was taken from the main trunk of the parent tree just below or around the first line of major branches. The occurrence of knots towards the aft end of the timber indicates that the forward end was placed near the base of the tree and the aft end close to the first line of branches. The conversion method was largely the same as for other compass timbers, i.e. the piece was first roughly hewn to shape by removing bark and sapwood with axes and surfaces were then finished using adzes and possibly planes.

As described above the main mast step was scarfed over three floor timbers of frame stations 6, 7 and 8. For this purpose notches were cut into the underside of the mast step to ensure a secure fit (Fig. 3-33). The boat builder cut lines above the forward notch to ensure that the timbers would be worked to perfectly fit over the underlying floor timbers. The middle section is slightly wider and the timber tapered to both ends. Oak treenails were used to fasten it to the underlying floor timbers. While the forward and middle floor timbers were fastened with two treenails each, the fastening at the aft frame consisted of a single treenail. A rectangular socket for the mast measuring 14cm by 11cm and 8.5cm depth was cut between F6 and F7. No significant signs of wear and tear were visible along its edges.

A small bow mast step was fastened to the stem hook and scarfed over floor timber of frame F1. It measured 13cm in width, 9cm in depth and had a preserved overall length of 51cm (Figs. 3-35 and 3-43). As mentioned above the mast step was made from alder, the only structural element of the wreck not made from oak.

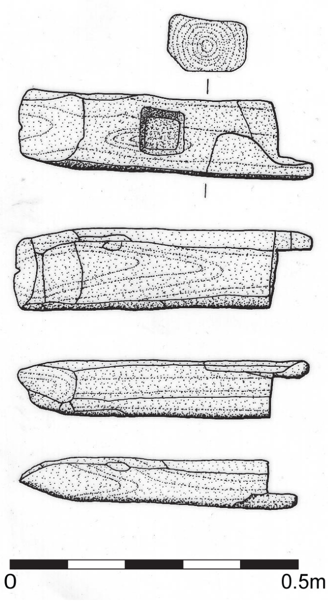

Figure 3-35: Illustration of bow mast step (Ryan 2010)

Portside and starboard edges along the underside are chamfered in contrast to the sharp edges along the upper edges. The mast step came loose during excavation resulting in the only 3cm thick scarf joint breaking into small fragments. To allow for a tight fit against the upper arm of the stem hook the bottom surface was cut to an angle. Fastening to stem hook and floor timber was achieved with a single iron spike nail each. These had disintegrated entirely with only the nail holes preserved. Their shallow depth of c. 6mm suggests that the mast step was only superficially fastened to both timbers. The positioning of the forward spike nail is striking as the nail was placed directly on the timbers forward edge only providing limited fastening strength. Overall, both scarf and fastenings can be described as superficial and were not designed to take much pressure. Similar to the main mast step, it has a rectangular mast socket for the mast measuring 8cm by 8cm and 4cm depth. No signs of wear and usage were apparent along its edges. The usage of alder as well as its superficial fastening raises the question as to whether the mast step was fitted at the time of the original construction. It is therefore conceivable that it was added at a later stage, changing the rig layout.

3.3.8 Rubbing strake

The fragment of a rubbing strake timber was found resting loosely against the outboard side of starboard strake 15 to which it was originally fastened. It was hit by the bucket of the backhoe dredger and sustained substantial damage as a result, partially breaking the timber and twisting its aft section by 90° (Fig. 3-34). Furthermore long-term exposure meant that surfaces of the timber were in parts heavily degraded. Both ends had also eroded away leaving the timber at a preserved length of 2.84m. The timber was originally cut to a roughly rectangular cross section measuring 10.4cm by 7.5cm.

The timber, although in poor condition, still provides valuable information in relation to wood science. The centrally running pith shows that the piece was converted from a whole log, which is further indicated by remaining sapwood along all four edges. The grain is slightly wavey and several knots are evident along its full length. With an estimated diameter of c. 15cm to 20cm the parent log appears to have derived from a young woodland tree.

Six treenail positions are evident on the timber, five of which go horizontally through the timber and served as fasteners to the external hull of the vessel. These were at least to some degree the same treenails used for fastening frames to the hull, extending through the hull planking, side timbers, sheer clamp and of course the rubbing strake. The remaining two treenails are 14cm apart from each other and were fastened directly to hull planks.

Two partial or half-treenails, 2.3cm in diameter, were drilled blind into the top edge of the outboard surface immediately next to each other. Their original purpose is not clear but it cannot be ruled out that this timber was in secondary use and originally was originally meant to have or had a different function before being used as a rubbing strake element. Serving as buffers against other vessels or quay walls during mooring, rubbing strakes are prone to damage during the lifetime of a vessel, often requiring repair or replacement.

Two observations indicate that this timber was originally fitted snug against the external hull. Firstly a shallow rebate, cut into the hull-facing surface approximately 1m from its aft end, has to be mentioned. Similar to the rebates on the undersides of floor and side timbers it is believed to have received a clench nail head. The second observation was made during digital reconstruction of the timber. Despite its heavily damaged and distorted condition it became evident that the rubbing strake fragment curved slightly towards the outboard facing side reflecting the original shape of the hull.

3.3.9 Sheer clamp

As described above three side timbers had rebates cut into the inboard surfaces at their top ends similar to the ones at the bottom ends to receive the bilge stringer planks (Fig. 3-28). No structural timbers associated with these rebates are preserved ore were identified during excavation. Initially it was believed that they might have served as scarfs for fastening short stanchions, which would have spanned one or two more strakes up to gunwale level. The reconstruction process, however, has shown that the gunwale level can most likely be placed at strake 15 (see chapter 3.5).

The current interpretation for these rebates is that they served a similar purpose to the ones cut for the bilge stringer planks for receiving longitudinally placed timbers. Providing additional longitudinal strength and protection to the inner and also often to the upper edge of vessels, these elements are known as sheer clamps. Treenail holes in the floor timber rebates may also relate to sheer clamp fasteners, although a single spike nail hole on the rebate of one side timber indicates that the sheer clamp was at least partially fastened to the underlying frames with spike nails similar to the bilge stringer planks.

3.3.10 Crossbeams and decking

Considering the high level of preservation, particularly on the starboard side, the absence of evidence for beams or thwarts providing transverse support is striking. As the starboard side of the Drogheda boat was reasonably well preserved, particularly around the midships section, it can be assumed with some certainty that protruding crossbeams were not part of the Drogheda boat's constructional characteristics. However, lateral strengthening in shape of crossbeams was most certainly required, particularly around amidships to support for the main mast. Three crossbeams were seen as a minimum requirement assuming that the original vessel had no decking (see chapter 3.5).

No evidence for decking was found on the preserved hull remains. In light of the overall size of the boat and the presence of a cargo of wooden casks, a full deck can most likely be excluded. Although fore and/or aft decking cannot be entirely excluded, an open arrangement without any form of decking can be seen as likely. It was therefore decided to refrain from including any decking in the reconstruction.

Figure 3-36: Small block (Brogan 2008)

3.3.11 Rigging

Block

A fragmented but almost complete pulley block (F289) was found broken underneath the intact stringer plank between frames F3 and F4. It measures 13cm in length and 5.5cm in width (Fig. 3-36). The shell is made of ash and was turned to a roughly cylindrical shape with a pronounced circular collar on its top end. The oak wheel (sheave) was originally held in place between the shell cheeks by a partially preserved dowel most likely made of holly (see chapter 3.2.1). The dimensions of the sheave show that the block could have taken a rope of 5.4cm circumference. During turning the shell of the block, three shallow linear grooves were cut across the centre of the shell where the hole for the sheave fastening dowel was drilled.

A block similar of similar fashion, material and size was found in the rigging store area of the Mary Rose where the characteristic circular collar is attributed to prevent chaffing against nearby objects, such as sails or yards. It was identified as possible being a spritsail sheet block or a clew garnet block (Goodburn, 2009). The term clew is used to describe the lower corner of square sails. Tackles or lines, which are fastened to clews are known as clew garnets. They allow for the clews to be hauled up to the yard when raising, lowering or furling of the sail was needed. Clew garnets appear to have been only used on square rigged ships and boats (Falconer, 1815; Kemp, 1976).

Figure 3-37: Possible parrel truck (Brogan 2008)

Possible parrel truck

The possible parrel truck (F250) from the Drogheda boat was found immediately next to the starboard side of the mast step. It is spherical in shape with a central hole. The piece is made from beech and measures 34mm in diameter and 35mm in length with a diameter of 1.5cm for the perforated hole (Fig. 3-37).

Given its shape, material and find location in the immediate vicinity of the mast an interpretation as parrel truck seems likely. Despite ash having been the preferred wood species for trucks, other hard woods such as beech were also deemed suitable (Goodburn, 2009; Falconer, 1815).

Parrels were devices attached to the yard and wrapped around the mast allowing for the yard to be moved up and down the mast. Elaborate parrels comprised a rope collar with a number of vertical wooden ribs and so-called trucks in an alternating pattern and threaded onto a series of ropes. The trucks were usually spherical shaped wooden objects with a hole through their centre to allow for the ropes to pass through (McGrail, 1993). Although ribs were often used to separate the trucks of parrels it was also possible to fasten the yard to the mast with a single rope and a number of trucks without using ribs (Falconer, 1815). The exact construction of the Drogheda boat parrel remains unknown but the absence of ribs could indicate a relatively plain parrel where a number of trucks were threaded on a single rope.

3.3.12 Ballast, ceiling and anchors

No ballast was found in the bilge of the Drogheda boat, which is not surprising as the casks rested immediately on the frames and hull planking, thus leaving no room for ballast. Ballast stones would further have potentially damaged the casks during the transport. Nonetheless a single coarse limestone was found immediately fore of the mast step. It is limestone of possible Irish origin, but no further geographical classification was possible (S. Mandel, pers. comm.). A potential explanation for the presence of this isolated stone is that all ballast stones with the one exception were removed to make place for the casks to be loaded and stowed.

Seeing that the Drogheda boat was at least partially used as a cargo carrier, the absence of any form of ceiling planking is striking. Although it cannot be ruled out that the vessel was on occasion fitted with a temporary ceiling, it can be stated with certainty that it had no ceiling planking at the time of wrecking. This would have been preserved at least partially underneath the cargo of wooden casks. Similarly no dunnage for cushioning the casks against the hull was evident. It can be assumed that due the otherwise high level of organic preservation on the site at least remnants of organic or non-organic dunnage beneath the casks would have been detected.

Judging by historical evidence most ships were equipped with at least two anchors, yet smaller ships and boats may have had one anchor (Friel, 1995). No anchor or hawse-elements were found with the Drogheda boat. This may mean that the anchor was either dropped in an attempt to hold position and/or was lost somewhere along the events leading up to the sinking of the vessel. Similarly it cannot be ruled out that it was salvaged after the boat had run aground.

3.3.13 Summary

The exceptional level of preservation on the Drogheda boat means that many structural elements of the original vessel were either fully or partially preserved. Nevertheless some information on the bow and stern section was missing alongside most of the portside and upper works of the boat. A number of non-preserved elements could be reconstructed based on remains of fasteners, fittings or joints. In this way frame 0, sheer clamp and stern rudder can be considered secure reconstructive elements. In turn the lack of evidence for transverse cross-beams or thwarts shows that these were not fitted as low placed biti or as upper transverse beams projecting through the hull. However, beams providing lateral strength were certainly required and it appears likely that at least one thwart at amidships also supporting the mast was fitted near gunwale level (Friel, 1995; see chapter 3.5 for more detail). A similar conclusion was reached for the absence of transverse beams on the Magor Pill wreck (Steffy, 1994; Redknap, 1998).

The choice of material for the boat was almost entirely oak, sourced from the north-west coast of Ireland. All hull planks were made of radially split timbers of mostly good quality with the exception of relatively high frequency of sapwood. This is contrasted by much lesser quality timber used for the internal framing, where fast grown, curved and often poorly dressed and finished compass timbers were chosen.

Generally the construction of the Drogheda boat follows the clinker boat building tradition known from medieval contexts with radially split hull planks fastened to each other using iron clench nails. Nails were rectangular in cross-section and clenched by bending the nail tip over rectangular rove plates. Distances between clench nail positions varied between but were on average c. 25cm. The average plank length was c. 2m but the re-occurring presence of short filler planks indicates restrictions in the length of available planks. Scarf lengths were fairly uniform and averaged c. 20cm. Most intentional marks found on plank surfaces were applied as part or during the construction by the boat builder and appear to be largely associated in marking out frame positions and to a much lesser degree lands and scarf tables. Other marks seem to have been scribed during the life of the vessel, often marking out cracks on planks. The crew to monitor the extent of such cracks may have done this in an attempt monitor the extent of such cracks. There is no evidence that other measures to stop cracks from worsening were attempted.

Frames were fastened to the hull with treenails, often end-wedged and spaced at an average distance of c. 70cm. A more unusual observation was the frame arrangement with side timbers abutting the floor timbers, rather than being scarfed over the latter. With average moulded/sided dimensions of 12cm by 9cm the framing timbers can be described as relatively light. No ceiling planking was apparent and stringers appear to have been confined to bilge stringers, more or less superficially fastened to the underlying frames.

Stem and stern were made in form of stem and stern hooks vertically scarfed into the rabbeted beam keel and in return with scarfs for the actual posts. A curved stem defines the bow whereas the straight sternpost is indicative for a stern rudder. Two mast steps showed that the boat was fitted with two masts at the time of wrecking, a main mast roughly amidships and a smaller mast far forward in the bow. Whether the bow mast was a later addition can currently not be said with certainty.

Generally it was apparent that the constructional details point towards a construction guided by economic necessities rather than aesthetic or representative objectives. The quality of timber used as well as the rather rough degree of finish on certain elements bears witness to this. This is further reflected in other constructional aspects, such as the barely staggered scarf pattern, which does not provide the same level of strength as more staggered arrangements.

The waterproofing between the plank seems to be largely Sphagnum moss mixed with wood pitch Only one sample consists mostly of woodland mosses and differed from the otherwise coherent material used for waterproofing. This sample belonged to a repair on the starboard side. Yet the dendrochronological analysis indicates an identical provenance for timbers of original construction and repair. This raises the questions for the reason behind this difference of waterproofing material. If repair was carried out at the same boat yard, the boat builder may have either deliberately chosen the woodland moss for economic reasons or not have had no Sphagnum in storage at the time. The second possibility is that the repair was done by a different boat builder using different luting material.

A number of repairs to the hull planking and the slight hogging of the keel show that the Drogheda boat was had been in use for some time before sinking in the River Boyne. Two of the repairs involved removal of plank damaged plank sections and inserting repair planks into the intact hull, a procedure requiring skill and experience due to the structural integrity of clinker hulls.

3.4 Construction Sequence

The relevance of construction and building method for comparatively analysing small clinker built watercraft on a trans-national level will be discussed in more depth in chapters 5 and 6. Nevertheless, a brief introduction to the basic methodological and conceptual aspects of clinker construction will be presented in this chapter. This is done to illustrate how certain features and constructional elements cannot be seen isolation as the concept and sequence of construction of any vessel is directly reflected in assembly nature and the physical traces left behind. As constructional elements and other diagnostic features indicate that the Drogheda boat was built in the shell-first method, the conceptual and practical concepts are presented in relation to their archaeological manifestation.

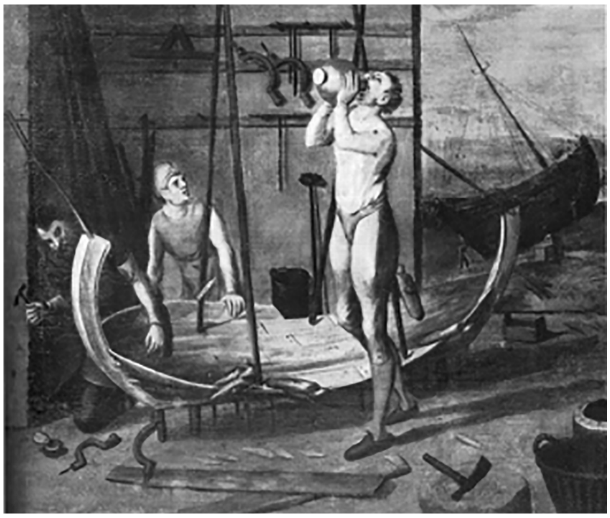

Figure 3-38: Dutch shipwrights building a clinker boat. Detail of a painting by a Master of Gouda 1565 (Friel, 1995 p.45)

Boats and ships built in this manner first have keel, stem and stern assembled followed by erecting the hull planking (the shell) prior to fitting internal framing elements (Steffy, 1994). The planking thus defines shape with the frames serving as internal support. This way of building boats and ships is well documented and known to be used for clinker boats and ships throughout the medieval period and is still used for traditional wooden boats for example in parts of West Norway and on the Faeroe Islands. The principle of the shell-first method is that the construction process is guided by the hull planking where the boat builder uses the planking as a visual reference during the construction. Seeing the boat coming to shape he can control and amend the overall shape of the vessel by directly changing the shape of the individual planks during construction (Fig.3-38). Size and shape of the vessel are therefore not predetermined by line drawings as needed for example for skeleton-first ships and boats and ships where the hull planking is fitted to a pre-erected framing system. With the shell-first method the boat builder rather uses the experience from previously built vessels, small carved models or principal measurements engraved on wood pieces or stick with marked proportions. It further has to be kept in mind that using scale drawings requires a certain degree of literacy and mathematical knowledge, which in turn requires some form of formal education. This, however, was certainly only available to a relatively small percentage of the overall population up until the 19th or even 20th century.

Nevertheless clinker boats were built by people often belonging to what could be described Transfer of knowledge, training and methods of converting complex geometry into a physical structure, such as boats and ships, was therefore passed on from generation to generation. It was taught by practical demonstrating the individual tasks and proficiency was achieved repetitive exercise (Christensen, 1972).

This is not to say that clinker boats are built without the use of any aids and tools although experienced boat builders may be able to do exactly that. Nevertheless, generally the tools used for defining rough size and shape for construction can be described as basic and self-made. These include boat levels, plumb–bobs hanging off a wooden board to ensure vessels do not become lopsided and measuring sticks known as "boat ells". In case of the Norwegian tools the marks on the tools were only of relevance to the boat builder himself and kept as a secret, only to be passed down to his successor (Christensen, 1972).

As mentioned above for vessels built in the shell-first method, the construction begins by laying the keel. Joining the stem and stern elements gives the vessel a "spine" thus defining length and even roughly the shape on both ends. Once these key elements are in place the hull planking is added strake by strake, usually by concurrently fitting the same strakes on starboard and portside. This enables the boat builder to retain control over overall shape and to maintain symmetrical shapes on both sides as much as possible. The use of relatively basic tools and the construction being mostly based on experience results in vessels often not being fully symmetrical.

In order to give the hull its desired shape it is necessary to bend the planks into shape prior to fitting them to the hull. Various heating methods are known both archaeologically and ethnologically and mainly achieved by charring the planks on one side while keeping the opposite side wet. The heated planks are then clamped to the boat and left until cooled (McGrail, 1998). The lands on the Drogheda boat show that when planks were fastened to the existing structure, the inboard bottom edge was often bevelled to the correct angle for the desired hull shape. The areas of the outboard upper edge were mostly left unworked showing that hull curvature and shape were largely established by bevelling the inboard lands while the planks were not yet fastened to the hull.

Once the strakes are assembled at least up to the turn of the bilge, i.e. for the Drogheda boat the first seven strakes, the floor timbers are inserted. A good indicator that the floor timbers were placed and fastened after the hull planking was assembled are the score lines marking their locations (see chapter 3.3.3). As the strake diagram shows these marks were not cut into planks individually but rather cut across several strakes at the same time, both for floor timbers and the abutting side timbers (Fig. 3-15). A further diagnostic feature for shell-first construction, which also applies to the Drogheda boat, is that keel and floor timbers are not fastened together. Since the floor timbers are fastened directly to the completed hull sections, there is no necessity for these two elements to be physically joined. The evenly occurring charring of the inboard plank surfaces is another sign that the hull planking was fully assembled prior to the insertion of frames (see chapter 3.2). The complete absence of any charring on frames, lands and scarfs demonstrates that this was done after assembling the planks, yet prior to fitting the frames.

3.5 Reconstruction: From scale model to hydrostatic data

The high level of preservation of the hull remains from the Drogheda boat soon raised the question to which degree original hull form, shape and overall design should or cold be reconstructed. It was felt the relatively large amount of relevant information preserved would allow for almost full reconstruction of the original vessel. Starting by using the "as-found" information of the wreck a 1:10 scale model of the wreck as preserved was made. Allowing for a certain level of distortion, displacement and shrinkage, the objective was to incorporate or add hull elements, which were not preserved but could be deduced through traces in the hull remains, comparative archaeological wreck sites and contemporary depictions. The result achieved in this manner is known as "minimum reconstruction" (Crumlin-Pedersen & McGrail, 2006; Tanner, 2012).

Another important aspect for reconstructing the hull shape was to generate a floating hypothesis for the vessel in order to establish lines plans and hydrostatic data. This combined with the information from the preserved remains was to provide information on approximate displacement, sailing characteristics, rigging, sail plan and cargo carrying capabilities of the original vessel (Tanner, 2012). The reconstructive and naval architectural work was undertaken by Pat Tanner under archaeological guidance and in close cooperation with the author.

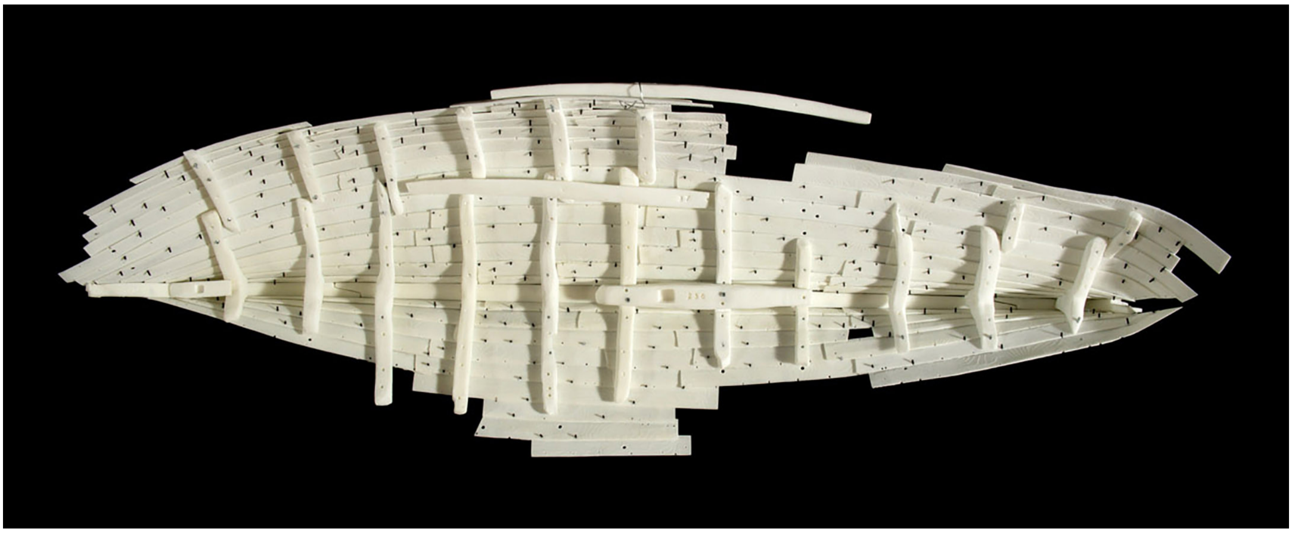

Figure 3-39: 1:10 scale model of the wreck made by using three-dimensional documentation data. The model is comprised of all timbers for which the original location in the wreck could be established (Brogan 2011)

It has to be kept in mind that despite attempting to achieve a result, which would give an accurate as possible representation of the original sixteenth century vessel, the end product still reflects our contemporary interpretation and does not claim to be 100 percent valid. Therefore any hull elements added as part of the reconstructive process have been highlighted to avoid confusion between archaeologically known fact and reconstructive interpretation.

The initial step of producing a 1:10 model was done using the 3D data of the original timbers as recorded with the FaroArm and Rhinoceros 3D software (Fig. 3-39). Since many of the planks retain some shape this method allowed to utilize this advantage with a view to achieve a more accurate result for the shape of the overall hull. Practically this meant that the three-dimensional records were converted to digital solids while retaining exact shape and fastener positions. The digital solids were then used to manufacture model pieces using the selective laser sintering (SLSR) method again retaining exact shape and fastener positions. As the name suggests SLS uses a high power laser to melt and fuse fine powdered nylon into solid objects. The model pieces manufactured in this way are of high accuracy regarding shape, fastener details, flexibility and durability for assembling the scale model (Nayling & Jones, 2012; Schweitzer, 2012).

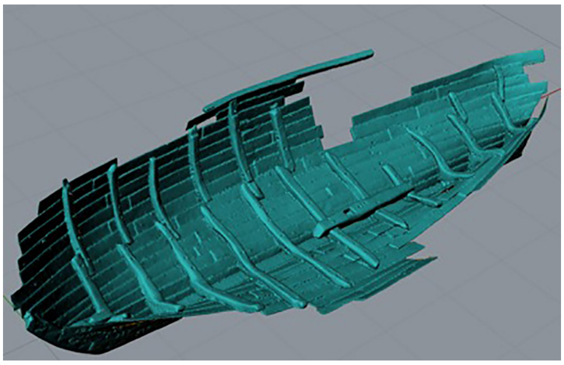

Figure 3-40: Screenshot of 3D Point Cloud Data of scanned scale model prior to processing (Tanner 2010)

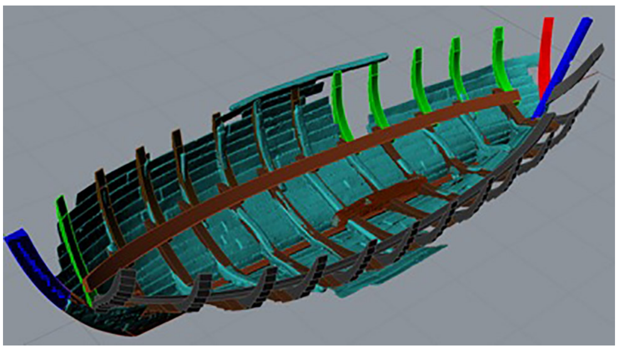

Figure 3-41: Screenshot during data processing and remodelling (Tanner 2010)

Next the 1:10 model was laser scanned (Fig. 3-40). The three-dimensional point cloud captured in this way was subsequently processed, interpreted and naval architectural data extracted. The end product was the production of lines plans, calculation of hydrostatic data and form coefficients as well as interpretation regarding the vessel's sailing characteristics (Tanner, 2012). Prior to commencing the actual remodelling process the scale model was examined for any twists or hogging and the missing portions "repaired" and the hull faired in order to produce a reconstructed hull shape from which modern naval architectural information could be extracted. As mentioned above only elements preserved in the archaeological record or components deemed to be obviously necessary were remodelled (Fig. 3-41). The latter included main and fore mast with yards and thwarts, upper stem and stern sections, rudder, cockpit sole with beams (required for a suitable helmsman position) and sheer clamp. After

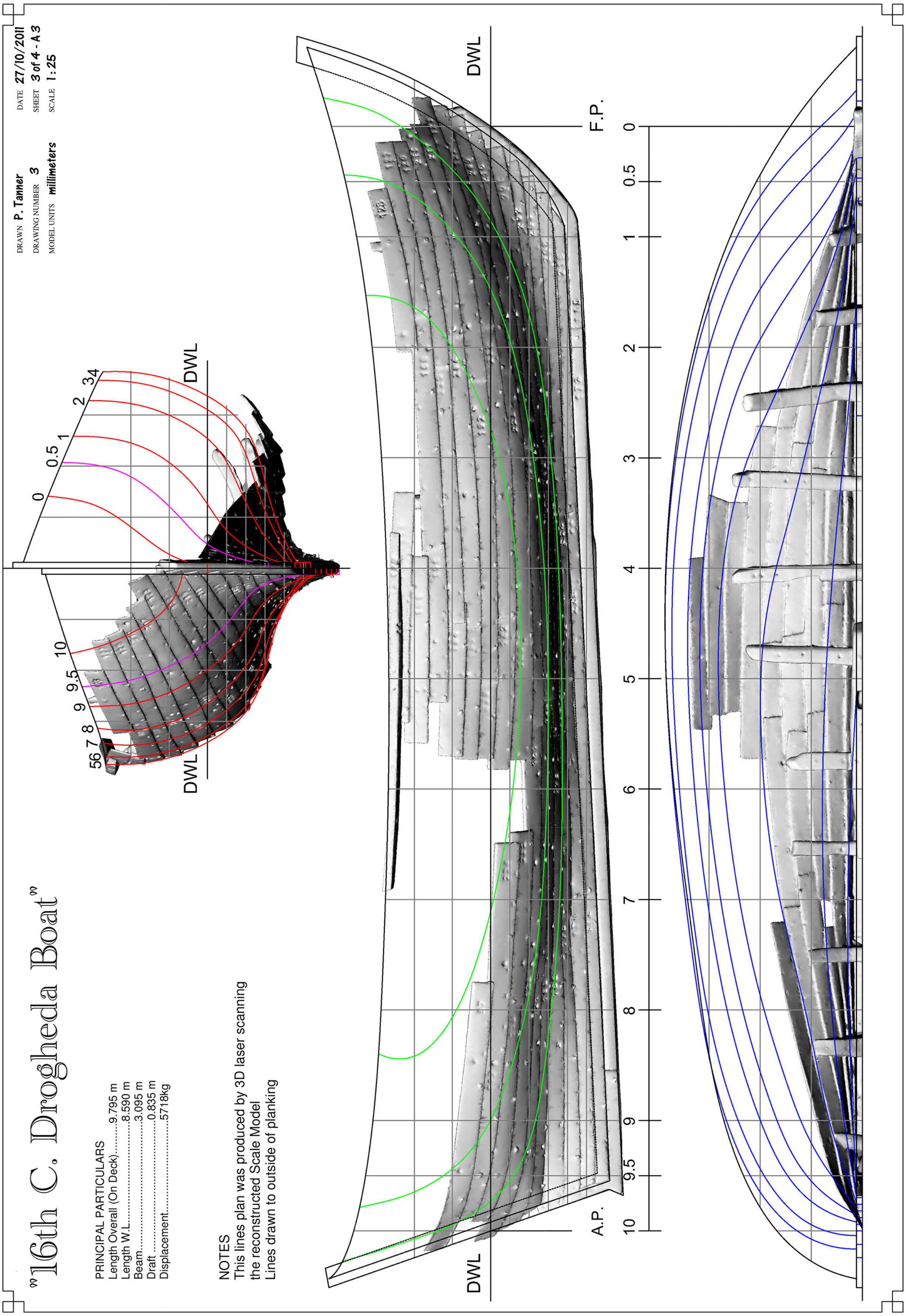

Figure 3-42: Lines plan of the Drogheda boat based on the processed laser scanned 1:10 scale model overlaid with laser scan image of the scale model (Tanner 2011)

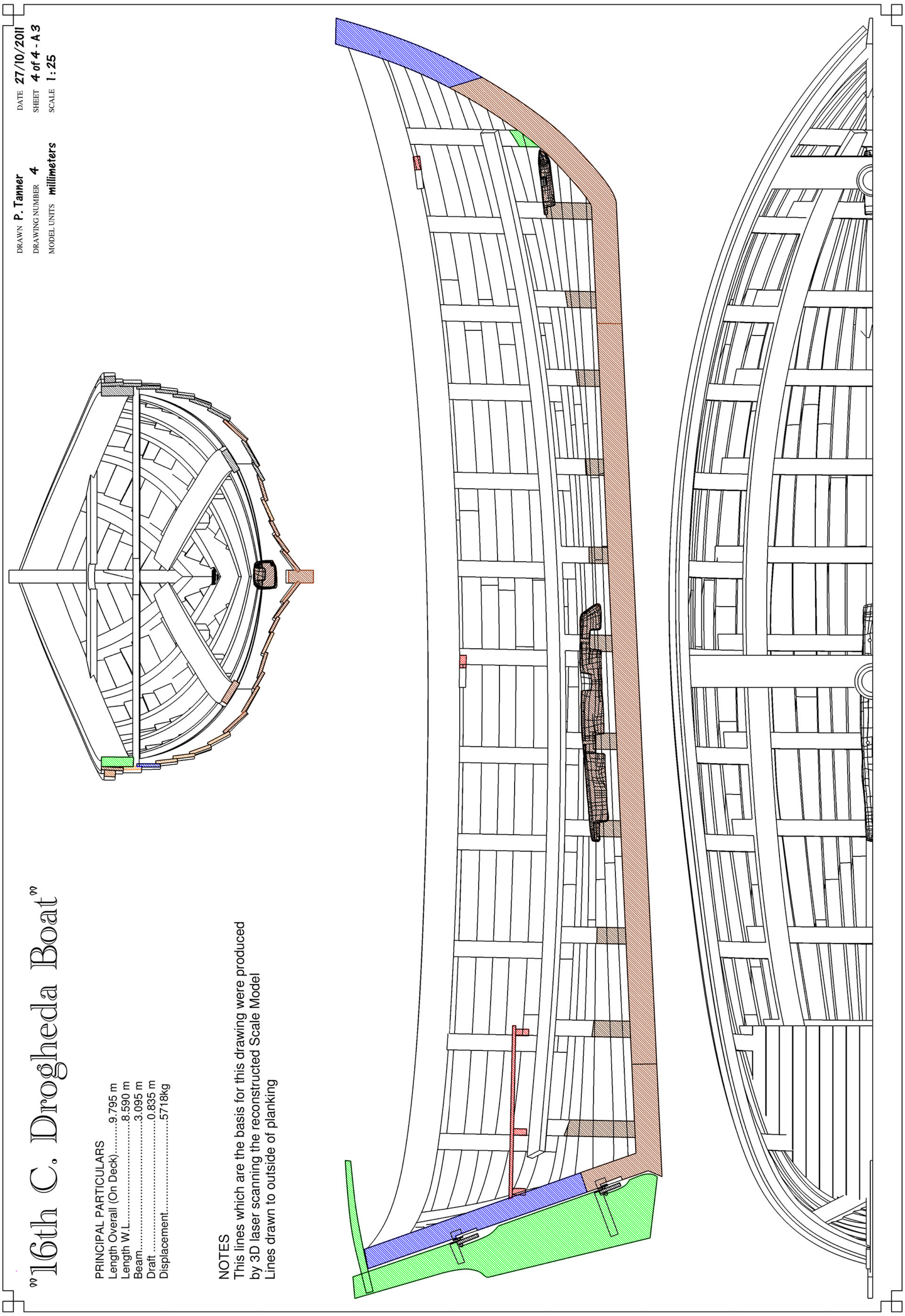

Figure 3-43: Construction plan of the Drogheda boat showing reconstruted and remodelled elements in red, lilac and green (Tanner 2011)

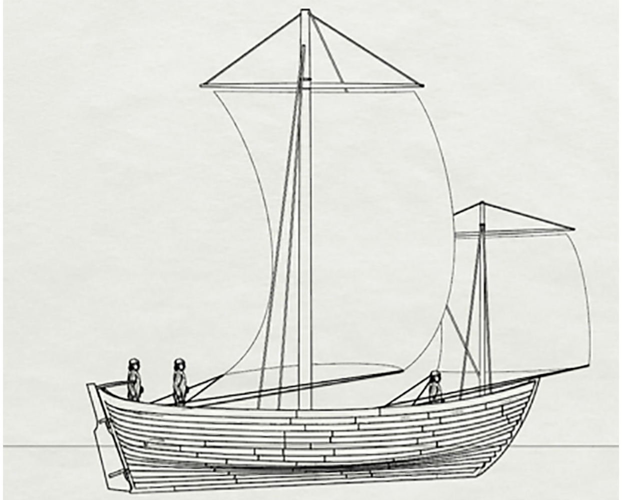

Figure 3-44: Fully reconstructed boat with proposed sail arrangement and three crew (Tanner 2011)

Description	Dimension
Length overall (LOA)	9,795m
Beam overall (BOA)	3.095m
Draft (T)	0.839m
Freeboard (F)	0.922m
Waterline length (LWL)	8.587m
Waterline beam (BWL)	2.627m
Displacement	5718kg
Prismatic co-efficient	0.678
Waterplane area	19.02m^2
Wetted surface area	24.68m^2
Downflooding angle	38 degree
Righting moment 38 degree	1953kg-m
cargo (discplacement lightship)	2818kg

Table 3-2: Principal dimensions of the Drogheda boat when floating in its as found condition (after Tanner 2011).

the remodelled boat was orientated on its correct floatation plane the final lines plan was generated using Orca Marine software (Fig. 3-42). This was supplemented by a construction plan (Fig. 3-43). Hydrostatic data for the boat was calculated for the following different conditions (Tanner, 2012):

As built without ballast, cargo or crew

Empty boat without cargo and ballast but with two crew and one days store

As found with cargo of 12 casks and four crew

Fully laden with 32 casks and four crew

A provisional and basic hull shape for the reconstructed vessel was created using the preserved 15th strake as the gunwale level for the reconstruction process. This allowed further examination of the vessel with a view to proceed towards a full reconstruction. For this purpose it was crucial to establish how the boat floated. Three key factors had to be established for creating a floatation condition for the boat. These were hull shape, centre of gravity and weight in order to establish displacement. For the production of naval architectural lines plans, the datum waterline (DWL) had to be established on the three dimensional model. In case of the Drogheda boat the DWL was unknown and the floatation plane had to be established based on the assessed model. Using Rhinoceros 3D in combination with Orca Marine software overall weight, centre of floatation and centre of buoyancy for the entire vessel were calculated. Once the floatation plane was established in this way lines plans were produced and hydrostatic data for the reconstructed boat calculated (Tanner, 2012).

Based on the obtained data a digital solid model was generated allowing calculating total weight and centre of floatation of the reconstructed vessel. Excluding any cargo or ballast the vessel as reconstructed had a weight of 2909kg. As discussing the different scenarios in detail would go beyond the scope of this study, the principal dimensions and hydrostatic characteristics are presented in summarised format according to the as found condition (Table 3-2). Rigging and sail plan was reconstructed based on contemporary illustrations and naval architectural calculations. Taking tidal currents in the Irish Sea into account, the boat had to achieve a target speed between four and five knots. By incorporating historically known sail plans for similarly sized vessels and archaeological data a balanced sail plan could be calculated (Tanner, 2012). Although two masts allow for numerous possibilities regarding rig, it was decided to adopt a sail plan comprising two lateen sails (Fig. 3-44) as depicted for certain small 16th century vessels (Fig. 3-45) and as reconstructed e.g. for the Bredfjed ship (Bill, 1999). The boat depicted on H.C. Vroom's painting also shows an aft deck or platform for the helmsman. A platform providing the helmsman with a good view forward was seen as essential for the Drogheda boat reconstruction.

As part of the assessment of the vessel's seaworthiness Tanner calculated the hydrostatic data on the four above described conditions. For illustrative purposes only the fully laden condition shall be presented here. This comprises the vessel as reconstructed with rigging, a cargo of 32 casks, three crew with stores for two days plus anchors and warps. Leaving aside the detailed hydrostatic

Figure 3-45: Detail of a painting by H.C Vroom showing an open boat carrying livestock sailing into the Øresund before Kronborg castle (Lemée, 2000)

data, it would appear that in this condition the boat would be considered stable in protected waters not taking wind into consideration However, its low freeboard of 66.2cm would seem to have made the vessel unsuitable for sailing in open waters and only marginally suited for use in partially protected waters (Tanner, 2012)

As mentioned above describing the processes and results of the hydrostatic analysis in detail would go beyond the scope of this study. Reconstruction methodologies and hydrostatic calculations are therefore presented in summarised form. Overall the Drogheda boat can be characterised as a "vessel with a reasonable fine entry forward, full length keel, long smooth run aft below the waterline, and changing to fuller sections above the waterline. This would indicate a vessel designed for sailing, intended to be reasonably fast and still have a load carrying capacity." The hydrostatic analysis further indicates "a vessel with a good speed potential and an easily driven form shape not requiring excessive sail areas, while still capable of carrying cargo." (Tanner, 2012)

In summary the naval architectural analysis of the reconstructed Drogheda boat indicates that it could have been used for fishing as well as a lighter with a comfortable loading capacity of 32 casks (c. 7300kg) or maximum 42 casks (8400kg) in sheltered operational waters. It may well have undertaken coastal journeys within reach of sheltered anchorage but it seems unlikely that it was used to cover longer voyages in unsheltered offshore conditions (Tanner, 2012).

3.6 Cargo

A number of wooden casks were found partially preserved inside the wreck. All rested on their sides along the longitudinal axis of the wreck and appeared to be more or less spread along much of the length of the vessel (Fig. 3-47). Although the casks had collapsed into themselves and had suffered a certain degree of degradation, the overall level preservation was exceptional including remains of the original wooden hoops, which were fastened with delicate willow withy-type bindings. The casks were recovered on a timber-by-timber basis and fully recorded as part of the post-processing stage of the project (see chapter 3.1.2). This included a comprehensive programme of scientific analysis of the casks and their contents, as well as archaeological and historical research and analysis of the Drogheda boat cargo and the wider context of maritime trade in late medieval to early modern times. Scientific analysis of the casks included dendrochronological dating, lipid analysis with a view to identify remnants of potential previous liquid contents, such as e.g. wine. Initial assessment of the contents proofed this to be fish, which upon further specialist analysis was identified as Atlantic Herring. Further analysis comprised insect, pollen, micro and macro plant analysis as well as chemical analysis. As described in chapter 3.3.2 a comprehensive and interdisciplinary programme of scientific analysis and research spanning from dendrochronological analysis to the already mention environmental analysis and archaeological as well as historical research aimed to address all potential aspects of the Drogheda boat cargo.

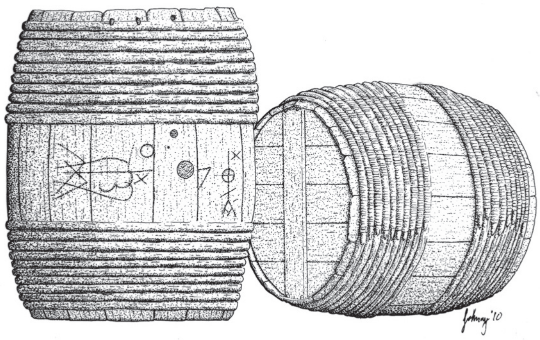

Figure 3-46: Reconstruction of a Drogheda Boat cask with wooden hoops and incised symbols (Ryan 2010)

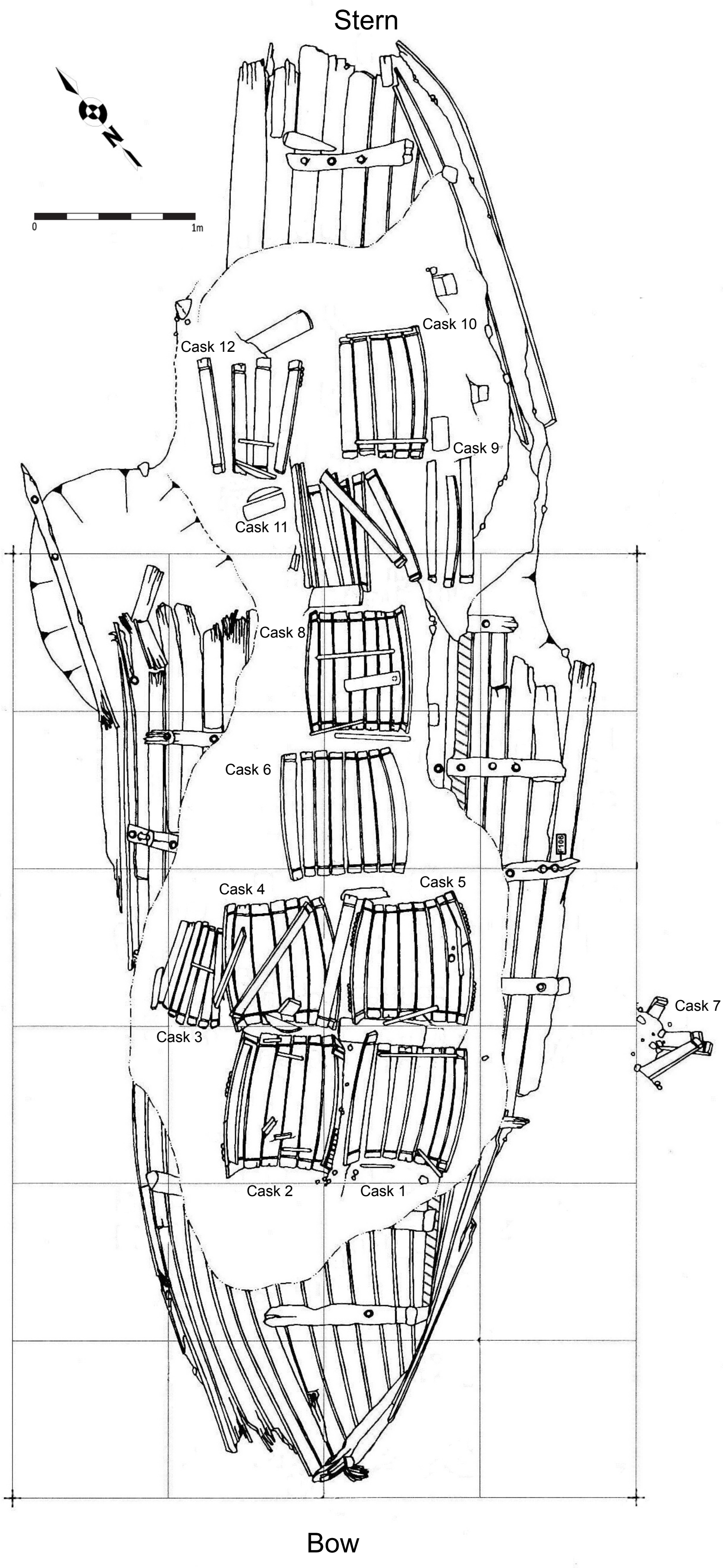

Figure 3-47: Site plan overlaid with recorded find locations of the casks in reference to the excavation grid (after Bangerter 2009)

Figure 3-48: Staves of cask 4 with examples of bung and dowels (Brogan 2009)

3.6.1 The casks

Casks as containers served countless functions, yet their function was often linked to their construction and design. As described in chapter 3.2.2, dendrochronologically and archaeologically 3 distinct groups of casks could be identified. The bulk of the cask material (12 of 13 casks) served as containers for the herring cargo, all of which were of identical size and nature (Figs. 3-46 and 3-48). A second group was represented by a single cask, which was smaller in size and made of lesser quality oak. A single stave, clearly re-used and not belonging to an articulate cask marked the third group. In the following the results of the analysis of the group 1 casks will be presented on their own, as they are immediately relevant to usage of the vessel and implications on contemporary trade and practices.

The uniformity in size and dimensions of the casks alongside the re-occurring presence of bungs and dowels appeared to point to the cask originally having been made to carry liquid goods, such as wine. Particularly tap holes, staves with bungs, non-constructional dowels and head pieces, which were not doweled together, are further indicators for this interpretation (Fig. 3-47). The presence of bungs and air vent bungs in both the staves and the head pieces suggests that the cask contents were capable of being sampled horizontally and vertically (Fawsitt, 2010). Their content of herring is therefore evidence that the Drogheda boat casks were in at least their second phase of use. Although chemical analysis did not detect remnants of wine in the casks, the presence of lanosterol was found in two casks. Amongst other potential sources of origin lanosterol is a chemical component of wool and may thus indicate that the casks had been used for more different purposes than immediately evident. However, lanosterol is also a component in fish and may thus represent a degradation product of the herring cargo (Davis et al., 2009).

Physical evidence that the casks had been reused at least once before being used to carry the cargo of herring was present in form of scratches and heading vice holes on the heads. These as well as damaged and widened crozes can be attributed to the removal and replacing of head components (Fig. 3-46). The construction of the head components does not suggest that they were made to be opened and closed regularly, which would be more suitable for casks used for the herring trade (Fawsitt, 2010).

The casks further showed a wealth of symbols carved into the casks. Fawsitt believes that the majority of marks on staves are merchant marks. Their location on the cask bilges and relatively large size and complexity would have provided easy recognition for customs officials and merchants recognising their property (Fig. 3-46). The complexity in turn indicates that the marks belong to well established merchant families. A number of other marks present mostly on head pieces were identified as cooper's, content or assembly marks (Fawsitt, 2010).

Figure 3-49: Possible butchered cleithrum next to modern inact example (Harland 2009)

The results from the archaeological analysis of the casks further points to a non-organised timber supply. The evidence from the timber conversion of the staves for example suggests that there was no centralised area of production. The hoops on the other hand were more consistent with two distinct groups, either hazel rods bound with willow or willow rods bound with willow. Fawsitt deduces from this distinct pattern that two separate supplies for hoops are visible in the archaeological material. This in return could be the result of at least two different coopers in two geographically separate locations assembling the casks. It has to be noted, however, that a mix of materials was also observed on cask were one hoop was a made of a mixture of pomaceous fruit and willow (Fawsitt, 2010).

The volume of these casks lay between 224 and 247 litres and is almost identical with the casks from the San Juan in Red Bay. Historically casks of this size are known as Hogsheads and Barricas (Fawsitt, 2010), cask types typically used for the wine trade. Returning to the question of original use of the question this identification is of some relevance particularly in light of the results of the dendrochronological analysis (chapter 3.2.2), which points to the casks originating from south-west France. Combining all information it seems probable that the Drogheda boat casks originally found their way to Ireland containing wine from south-west France before being re-used for the herring trade.

3.6.2 Fish bone analysis

Fifteen samples containing fish bone taken from seven casks were analysed by Harland. These were found represent the remains of at least several hundred herring. The analysis showed that the herring were cured to preserve the fish over several months up to one year. This was achieved with a distinctive butchery technique known historically, but which has rarely been found archaeologically. The fish were butchered to remove the gills and part of the guts, which also removed most of the cleithra, scapulae, urohyals and supracleithra (Fig. 3-49). The herring were then most likely packed with salt and/or brine in layers in the casks (Harland, 2009).

Potential origins for the Drogheda boat herring can be traced based on modern and historically known shoal and spawning seasons and grounds for Irish Sea herring. The fish caught from Drogheda were likely a mixture of autumn-spawning herring from the Isle of Man and Mourne and spring-spawning herring from the Clyde. The former seems more probable, given that it would take time to process the fish before export. Herring fished in late September and October could be ready for export in the autumn and winter. The variety and range of sizes represented in the preserved herring from the Drogheda boat suggest that more than one source was being exploited. Taking the wide availability of herring between autumn and spring into consideration, this is appears a likely explanation (Harland, 2009).

3.6.3 Environmental analysis

Environmental analysis provided further vital insights into the activities surrounding the preparation and packaging of the herring casks. Insect analysis for example showed several typical taxa of stored grain products and warehouse environments. It could not be determined, however, whether these found their way into the casks prior, during or after being filled filling with herring. Micro and macro plant analysis further proofed presence of small amounts of charcoal, coal, clinker and hammerscale, in addition to occasional charred food remains, such as wheat grains, grape pips and hazel nutshell fragments, which are of general waste and may reflect poor storage conditions. Food waste is further represented by waterlogged hazel nutshell fragments, and fruitstones of elder, bramble and raspberry. The results from the environmental analysis therefore indciate that the casks were kept fully assembled in a storage or warehouse environment before being sealed and laden on to the Drogheda boat (Davis et al., 2009).

3.6.4 Summary

Bringing the information from the individual strands of research on the casks of the Drogheda boat together paints a more vivid picture of its wider economic context. Given its size and nature, the presence of a cargo of processed herring concurs beautifully with known export goods and expected usage of such a watercraft. The obtained knowledge on primary use and origin of the casks, fish processing and storage conditions of the cargo prior to shipping enriches our understanding of locally organised trade against an international economic background.

3.7 Naval historical context, usage and operational waters

3.7.1 Introduction

Following on from presenting the research results on the Drogheda boat, this chapter discusses in brief aspects regarding its naval historical context. This includes considerations on typology and naval history focusing on the immediate geographic context as identified through the various research strands. Notably the Irish Sea and apparent socio-economic contacts with England and France are of relevance in this regard. This will be discussed in more detail and in regard to the comparative reference sites in chapters 5 and 6. Rather than pre-empting argumentation aspects and results, this chapter aims to illustrate potential possibilities and limitations in placing a boat find in its historical context.

3.7.2 Small-scale watercraft sailing the Irish Sea in the 16th century

The difficulties of matching archaeological wreck finds with historically known ship types as discussed in chapter 6.4 certainly also apply for the Drogheda boat. Despite a relatively large amount of types present in historical records, details on construction, rigging, shape and design of these vessels are either only partially described or remain fully enigmatic. It appears that most names for ships and boats of the late Middle Ages and Renaissance seem to have referred to distinct characteristics or purpose shared by some vessels, such as *fisherboat* or *piscator* (Burwash, 1947). It may well be that the Drogheda boat fell into such a general category by contemporary sixteenth century understanding.

Occasionally, however, descriptions of vessels include their average capacity, general usage, operational waters and travel routes (Burwash, 1947). For this reason two historically known types, which may be of relevance for the interpretation of the Drogheda boat have been selected, namely *balingers* and *picards*. Both appear to have been relatively representative for small to medium sized sailing vessels of the Irish Sea during the later Middle Ages and Renaissance and may have had certain similarities with the Drogheda boat. As with other known ship types caution has to be taken when accepting historical descriptions as definitive fact to define and distinguish types. It has to be kept in mind that function, size, construction and rigging or a variety of these attributes may have change over time or indeed have varied in different geographical regions.

Notwithstanding these uncertainties it appears that *balingers* were very common in Irish waters between the 14th and 16th century. Although frequently mentioned in historic records, little is known regarding their shape, size and constructional features. The term *balinger* appears to have originated from baleine (whale). One possible interpretation may be that the name refers to its origin as a whale fishing vessel in the Bay of Biscay. A second possibility is that the overall shape of the *balinger* was reminiscent of a whale. A French manuscript from c. 1540 certainly indicates close relationships between Irish and French vessels by stating that Irish *nefez* were just like French ones and built in Ireland or “Bisquaye” (De Courcy, 1989). Although this reference does not specifically refer to *balingers*, contemporary 16th century knowledge and perception observed certain similarities, which may be indicative of an at least partially shared boat and ship building traditions. Historic records and custom accounts indicate that *balingers* had an average capacity between 20 and 50 tons and that at least some were rowed. On one occasion a two masted rig with potentially two lateen sails and a bowsprit are mentioned. Geographically they appeared to have been common in Atlantic waters between Britain and France and seem to have been used both for fishing and cargo transport (Burwash, 1947). Although the capacity of these vessels rules the Drogheda boat out to being a *balinger*, the reasoning for describing this vessel type in such detail lies in its potential relationship to the smaller and more relevant *picards*.

Picards are believed to have been slightly smaller versions of the *balingers*, yet even less is known about these watercraft, such as tonnage or constructional details. One early 16th century source describes them as having foremasts with a capacity between 15 and 36 tons (Burwash, 1947). Unfortunately it is not clear whether this refers to the vessel being single masted with the mast placed towards the bow or if it carried a two masted rig. Yet historical sources give good indication towards the type of work *picards* carried out. They seem to have been used frequently as lighters or cargo vessels for delivering small cargos of fish to the markets or even across the Irish Sea. The evidence suggests that their main cargo was fish, which they are known to have carried from Ireland to England in the 16th century (Burwash, 1947). They are believed to have been the most common sailing vessels in Irish waters (O'Neill, 1987) in the period of question and not confined to a particular region with *picards* known in Scotland, Wales the east coast of England and Ireland (Burwash, 1947). Overall the *picards* appear to be representative for the average size of vessels engaged in trade across the Irish Sea during the later Middle Ages with average capacities estimated to be between 15 and 30 tons. For the late 15th to early 16th century the Welsh port books even indicate that Irish vessels had an average tonnage of under 8 tons in contrast to 15 tons for the Welsh vessels. An extremely rare mentioning of such a small vessel is the *Margaret of Hollywood* with a capacity of 9 tons sailing from Lecale to Workington in 1615 with 60 barrels of oat (Woodward, 1989).

3.7.3 Implications on usage and operational waters

Leaving aside the comparison with historically known ships and boats, good indications towards the purpose and operational waters of the Drogheda boat are provided by the archaeological evidence and the results of hull reconstruction and naval architectural analysis (see above). The physical presence of the cargo of wooden casks containing herring, most likely dedicated for export, clearly shows that it was involved in carrying cargo to some degree. This is further underlined by the overall hull design with swiftly widening beam to increase the boat's holding capacity. Whilst the boat was clearly designed to carry cargo, its deep keel and sharp cutwater also show that it was built as a fully seagoing vessel, capable of travelling swiftly through the frequently rough conditions of the Irish Sea. Yet the absence of certain structural features, such as ceiling planking, deck planking, and its relatively light overall construction suggests that it was most likely operating as an inshore vessel or coaster but certainly also capable of travelling across the Irish Sea (see above). The limitations for sailing in offshore conditions are further highlighted by certain constructional features, such as the barely staggered strake overlaps and relatively poor framing quality. This gives the impression that the boat builder was quite satisfied that the built quality was sufficient for the purpose of the vessel. A possible sinker with line for long-line fishing also found on the wreck (Heckett, 2010) indicates that the Drogheda boat may also have been used at least to some degree for fishing. Overall its nature points to a relatively wide functional range from fishing to working as a lighter or coaster, thus matching well with the scarce descriptions for smaller vessels of this time, such as the picards.

Long distance travel and cargo carrying as far as France on the other hand can more than likely ruled out. Although the trade vessels travelling between Ireland and Gascony from the 15th century onwards appear to have been smaller compared to the medieval period, it seems evident that they were still relatively large ships reaching a capacity of up to 100 tons (Bernard, 1980). These were most certainly significantly larger than the Drogheda boat and better suited for long distance off-shore crossings.

Regardless whether the crew sailing the Drogheda boat or her owner knew her as a *picard* or by another name, the archaeological evidence on its own enables us to draw conclusions on construction, origin, usage, lifespan and its role in 16th century Irish craftsmanship, trade and shipping.

3.8 Political, economic and social context in 15th/ 16th century Ireland

3.8.1 Introduction

From the 16th century onwards England pushed for full control over all of Ireland, which by then was still partially under the control of Gaelic lords. This process saw the slow establishment of a centralised government alongside increasing colonisation of the island with protestant settlers. Protestant dominance was achieved in 1691 after the surrender of the Catholic Jacobites thus finalising the radical change of the Irish socio-political landscape.

Considering that the dendrochronological analysis of the wreck quite firmly established a north-eastern Irish origin for the vessel, the following chapters aim to shed light on the historical background of the regions of origin and usage of the Drogheda Boat. As described in chapter 3.1 Drogheda lies to both sides of the River Boyne, which also forms the natural border between the Counties of Louth to the North and Meath to the South. Following the coastline northwards the border between Louth and Down is situated immediately North of Carlingford Lough. Antrim is the north-easternmost County beginning not far North of the northern extent of Strangford Lough. Since the political events and context are closely linked to the different Counties this brief introduction to the coastal geography of north-east Ireland aims to provide a better understanding of the geographical context.

The north-east of Ireland was the scene of turbulent events through the entire sixteenth century. Drogheda was located at the frontier of English controlled territories with Gaelic lords being still very influential and well established to the North. Particularly Co. Down was an area where English and Gaelic interests for control clashed continuously. This struggle for power weakened the entire area and left it open to invasion from Scotland and Spain and was further under suspicion of treasonable correspondence with France. As a consequence Louth suffered considerably from Irish raids and invasions during this period (Buldorini, 2010).

The status of Drogheda as a royal town therefore has to be seen against this background and its location on the border to areas under Gaelic control. After the two Drogheda's to either side of the river were incorporated into one town in 1412, it was also granted county status. This formally recognised that the town could exercise territorial unity. It further acted as the main depot for the transport of supplies and provisions for military operations in the northern areas. Although being a royal town of quite some importance the town held somewhat illegitimate economic and political contacts with their Gaelic neighbours (Buldorini, 2010).

The importance of Drogheda can be seen in its economic importance throughout the Middle Ages when it was Dublin's strongest rival for international trade. Drogheda traded with cities on the East coast of England, such as Chester, Liverpool and Bristol as well as with several places on the continent, including Spain and the Bay of Biscay. However, by the 16th century the situation gradually changed and trade was affected by a number of factors. In addition to the already mentioned political instability, increased silting of the Irish harbours and the start of the Dutch Golden Age were crucial factors for the slow decline of Drogheda (Buldorini, 2010).

3.8.2 Drogheda's medieval quays and port access

The presence of a quay in Drogheda is known from as early as c. 1200 and is confirmed by both archaeological and documentary sources (Conway, 2001; Murphy, 1998). Interesting insights into the layout and logistics of Drogheda's medieval port are described in a charter granted to Drogheda in 1358. It states that size of the port and its dangerous access made it impossible for large ships to berth and unload their cargoes at the quays. The deepwater out-ports of Dalkey, Lambay and Howth were used alternatively until merchants and other buyers had received the price for their merchandise, or until they had found a lodeman to bring the ships to the port at their own risk (Buldorini, 2010). Lodemen, or pilots as they would be known nowadays, are for example mentioned in Gascon sources as an essential requirement to help Breton ships entering into Irish harbours during the fifteenth and sixteenth centuries (Bernard, 1980).

D'Alton provides a good description for the layout of Drogheda's port. It dates to 1624 and was made by an anonymous traveller. It describes Drogheda as "most commodiously seated upon a good navigable river called Boyne, whereinto flows the sea in so deep a channel (although it be very narrow), as their ships can come to their doors. This river is built in both sides, and there is on either side a convenient quay and stone wall built all along the river, so as a ship may lie close into this quay, and may unload upon her." (D'Alton, 1844) Although probably post-dating the life span of the Drogheda boat by a few decades, the account describes Drogheda as a town certainly accessible for bigger ships, although most likely dependent on the services of lodemen.

3.9 National and international trade around Drogheda in the 16th century

As the previous chapter alluded Drogheda disposed of a wide and well-established national and international trade networks. In the following the two focal points of the herring and wine trade shall be highlighted in some more detail to provide a better understanding of the Drogheda boat in this context.

The difficulties in accessing Drogheda's port was described above but there may also have been other reasons for the herring fishing fleets not bringing the catches directly into the town. Instead the fish was brought to the islands of Dalkey, Lambay and Howth to the south of Drogheda. Sailing from Drogheda, fishing vessels were able to reach the herring grounds off the coast of Lecale and Strangford within less than one day (Buldorini, 2010). As part of the curing process the herring were partially gutted, salted and packed into casks. In order to compensate for shrinkage the herring was later repacked. In case of herring gutted and cured on board of the fishing vessels, the repacking was done on shore (Childs, 2000). Little is know for the exact procedures in the Irish herring industry but although some processing and curing of the fish may have taken place on board of the fishing vessels it cannot be ruled out that the mentioned landing places also served as fish palaces where curing took place before local merchants bought the catches. It appears that curing was also done to at least some degree within the town walls of Drogheda. Although referring to Dublin, this is indicated by an ordinance dating to 1576 prohibiting the processing of herring within the town limits and suburbs (Buldorini, 2010). The fact that such practice was prohibited clearly shows that it took place to some degree. Despite the absence of preserved references for prohibited herring processing in Drogheda, it is quite conceivable that the situation was not too dissimilar from the one in Dublin.

There is also evidence that, fishing boats not engaging in fishing also served as lighters bringing the fish to Drogheda. After its arrival in the town some of the catch was sold for local use in the town market and was transported to inland villages. However, the vast majority of the herring was destined for export (Buldorini, 2010).

After 1450 increased numbers of herring, following migration from the Baltic, appeared in the North Sea, the Atlantic but also the Irish Sea resulting the Irish fishing industry to flourish and leading to increased prosperity (O'Neill, 1987). The drawback of this development was that the increased fishing activities and export of herring and other fish from Ireland was so lucrative that fish numbers declined. To counteract this development the king imposed restrictions on fish exports in 1515 (Buldorini, 2010). The booming Irish herring industry during the 16th century also served as a catalyst for direct trade and exchange of fish for wine between France, England and Ireland (O'Neill, 1987; O'Brien, 1995).

The wine trade was based on a well established trade relationship with the towns of Bordeaux, Dordon, La Rochelle and Bayonne in Gascony, from Nantes and St. Malo in Brittany, from Calais, Dieppe and Rouen in Normandy and from Spain and Portugal (Fig. 3-6). Part of the trade was carried out via direct trade links between Drogheda and these towns while other trade connections were done on a triangular basis. This involved e.g. Chester merchants travelling to Bordeaux and returning with wine to Drogheda before sailing back to Chester. A part of the imported wine was sold on local and regional markets. However, it also served the purpose to fund warfare against the Gaelic lords and was distributed among the troops. Of the merchants and ships engaged in the trade it can be stated that Breton, Norman and English ships played major roles in trading wine with Drogheda during the 16th century. Nonetheless, Irish or indeed ships registered in Drogheda are also known to have carried French wine to Chester (O'Neill, 1987; O'Brien, 1995).

3.10 Wreckage and site formation

Neither archaeological nor historical investigations provide sufficient results to definitely identify date and circumstances of the demise of the Drogheda boat. However, a number of observations from the archaeological material give clues towards approximate time and potential events surrounding its wreckage. Firstly the dendrochronological analysis provides good reference points for the construction time and place of the vessel. With a construction date around 1530 and assuming a potential life span of c. 20 to 30 years as often assumed realistic for historic wooden watercraft (Verweij et al., 2012), its sinking could have occurred more or less any time between the 1530s and 1560s. Despite not knowing the precise year, the environmental and fish bone analysis were able to narrow the season to autumn of the year of the wrecking (see chapter 3.6). Unfortunately the surviving remains of the vessel itself did not yield any clues as to why it sank. No obvious damage or leakage was observed, which could have helped in reconstructing the events surrounding the wreckage.

The cargo of herring on board of the vessel, however, suggests that it sank as the result of an accident as it would appear unlikely to decommission and abandon a vessel with its cargo still on board. Considering that the cargo comprised cured herring, an export good well-known to have been traded from Drogheda, it is tempting to assume that the boat was about to leave Drogheda with its cargo when unknown events caused its sinking relatively near to the town. The discovery of wheat grain and a grape pip from the wooden casks also indicates that the casks were kept in a warehouse environment during or prior to assembly, which would be expected in an urban port engaged in a variety of trade activity like Drogheda (see chapter 3.9).

Historical research on the other, which has been very carried out very comprehensively for the Drogheda boat project by Buldorini, did not provide any direct or otherwise indicative results on the loss of the Drogheda boat. The only potential historical hint, which may be in connection with the demise of the boat, is a suit made by the mayor of Drogheda to Queen Elizabeth in November 1567 where it states, “the haven of the town is decayed by adverse weather.” The source describes the damage to buildings and structures in the town and could well relate to a severe flood on the River Boyne causing damage to port structures and vessels (Buldorini, 2010).

The presence of the wooden casks in the wreck raises the question on how the wreck was left after it sank in the relatively shallow waters of the River Boyne. It certainly did not seem to have posed an immediate risk to shipping as it was not fully salvaged and recovered. Partial salvage of any structural elements or cargo within easy reach must have taken place in the aftermath of the sinking. That at least some of the cargo was left in the wreck could mean that the cost-benefit factor of investing money for the recovery of a number of herring casks was financially not viable. It also has to be assumed that the submerged part of the cargo would have been seen as spoilt and could not have been sold on to regular market price value. Should the sinking of the vessel be in connection with a larger event, such as the above described flood, the infrastructure of salvaging the boat shortly after its occurrence would probably also have been limited.

Overall the evidence from the wreck indicates that it was covered relatively quickly with silts and other sediments after it came to rest on the riverbed. Most of the timbers, both structural and cargo related were in pristine condition with little to no erosion or marine borer damage. Solely the upper elements, which had been exposed regularly, were at least in parts heavily degraded. The sediment cover over the lowermost hull elements was up to 60cm and comprised relatively fine but compact silt. The layers above the preserved cargo were clearly exposed to phases of erosion and siltation, which was indicated by the mix of encountered objects ranging from remote operated toy cars to 19th century steamship slag. Considering the high currents and relatively heavy navigation traffic on the River Boyne, the level of preservation can be described as unusual. As the wreck lay slightly to the south of the main shipping channel, it was never impacted by dredging works and remained largely intact embedded in the compact river silts.

3.11 Conclusions

The wealth of information contained within and extracted from the Drogheda boat is the result of an equally fortunate as well as deliberate interaction between excellent preservation conditions and exhaustive analysis and research. The application of comprehensive documentation methods in conjunction with a multifaceted and interdisciplinary research programme yielded a number of unprecedented results. Firstly, the utilisation of innovative three-dimensional tools and methods for documentation proofed crucial towards providing as accurate as possible reconstructions for hull shape and construction. Secondly the implementation of comprehensive interdisciplinary research enabled providing insight into the socio-economic context and background of the Drogheda boat.

In summary the research results show that the Drogheda boat was a small coastal workboat, which was built, maintained and operated around the north-eastern coast of Ireland during the middle of the 16th century. Its construction and design made it a swift vessel with good cargo capacity for its size and it was capable of sailing fully laden in sheltered waters of the North-eastern Irish coastline. Although found with a cargo of wooden casks containing cured Atlantic Herring, probably destined for export, it may well have served as a multiple purposes, such as a fishing boat, a lighter or coastal trader.

Original use and provenance of the casks as containers for French wine beautifully places the Drogheda boat into the wider socio-economic background of 16th century Ireland and Europe (see chapter 5.3). Although mostly not finding entry into the historical records small coasters watercraft very much formed the backbone of Europe's Renaissance maritime economic landscape where the majority of waterborne trade was via short distance coastal routes. The example of the Drogheda boat thus stresses the importance of these inconspicuous but numerous workboats for the European economy during a time of political, social, economic and scientific upheaval. The following compilation of comparative boat finds aims to deepen our understanding of the role of small clinker built watercraft in Renaissance society and economy.

4. Reference sites

4.1 Introduction

Structure and sequence in which the reference sites are presented follows the format and sequence employed for the source review in chapter 2. Consequently the wreck finds are presented by country of discovery. Starting with reference sites from Ireland and the United Kingdom, the descriptions are then roughly structured in a south to north sequence beginning with Portugal and finishing with Norway. Overall twenty reference sites have been chosen for the comparative analysis although several sites are comprised of two or more wreck finds (Fig. 4-1). The Barcode site in Oslo stands out as it is represented with fourteen recorded wrecks. Furthermore three wrecks plus a significant number of disarticulate boat and ship timbers are included from London as well as the boat timber assemblage from the presumed boatyard site in Poole in Dorset. The three Dokøen wrecks and the two wrecks from Lundeborg further increase the actual number of represented comparative wrecks to at least 40 (see Appendix I and II).

As outlined above, a conscious decision was taken not to present the archaeological data in catalogue format due to the marked discrepancies both in quality and quantity of available comparative data. Whilst the empiric and statistical value of the available data for the study at hand is limited, certain conclusions regarding trends in shipbuilding techniques can certainly be observed and assessed. Presenting the comparative material as integral part of the thesis rather than in Appendix format allows conveying nature and quality of the archaeological datasets in a more immediate manner.

Figure 4-1: Map showing the distribution of sites used for the comparative analysis (Schweitzer 2013)

4.2 Ireland and United Kingdom

4.2.1 Introduction

In absence of wreck finds of medieval to early modern clinker built vessels in Ireland, comparative data to date is restricted to boat and ship timbers or disarticulated or small articulated sections of vessels, which were re-used for example in quay revetments. The vast majority of these finds date to the Viking Age and are therefore of limited value for the purpose of this study (McGrail, 1993; McGrail, 1997b). Albeit dating to the later Middle Ages, the ship timbers found next to the River Boyne in Drogheda, Ireland (Conway, 2001; O'Rourke, 2006), are equally of too fragmented nature to provide meaningful information on the construction or development of small clinker built watercraft. The situation in the United Kingdom is quite similar, although more data regarding early to high medieval clinker built watercraft is present, including for example the Graveney Boat, the Magor Pill boat, the Newport medieval ship and the Sandwich ship (Fenwick, 1978; Nayling, 1998; Trett, 2010; Milne, 2004). As these lie outside the parameters set for the study, either due to their date or size, they are not included as comparative sites as such. Nevertheless occasional references to certain structural features may be made as part of the wider comparative background and context. The sites chosen for the comparative analysis and presented in this chapter include the Kingsteignton boat and the potential boatyard in Poole. Furthermore the Blackfriars ships 3 and 4, the Morgan's Lane boat and collection of 15th to 17th century boat and ship timbers from London are presented (Fig. 4-2).

Figure 4-2: Map of reference sites in Britain and Ireland (Schweitzer 2013)

4.2.2 Kingsteignton boat, Devon

Introduction

The well-preserved remains of a clinker-built vessel were discovered near the River Teign in Kingsteignton in 1898 during clay cutting works. The discovery was made c. 150m away from the current course of the river, indicating that the river has changed its course. The find spot is c. 9km inland from the estuary of the River Teign into the English Channel (Fig. 4-2). Following its discovery, the wreck was excavated shortly afterwards and observations noted in a report. Although most of the wreck was subsequently discarded, five planks were kept for display in a local Natural History Museum. These were conserved in 1977 and research including C14 and dendrochronological dating was undertaken in the following two decades, which eventually showed the boat to be built of timber felled after 1305 with the material originating from south-west England (Hillam, 1993). As a result the available information regarding constructional elements and detail is relatively scarce and largely limited to the five partially preserved planks as the following paragraph shows.

Structural Remains

The original record shows that the preserved remains measured 6.4m in length while a number of disarticulated timbers are visible on a photograph showing the wreck during the excavation (see Fig. 4-3). The bow is described to having faced towards the camera and the wreck therefore seems to have been tilted and resting on its starboard side. Although both ends appear to have been missing, a possible sternpost or sternpost knee appears to have been preserved. The only information regarding the keel is that it was comprised of a single piece, square in cross section. Furthermore a possible mast step, which is described to have been "just before midships" and starboard stringer were documented. Although seemingly not described in detail in the contemporary report a total of nine floor timbers are visible in the photograph. Dudley et. al refer to the frames as closely spaced and substantial in dimensions. Measurements taken from the scale plank drawings, which were made in the 1990's as part of re-visiting the Kingsteignton boat, show that the frames were placed at intervals between 38cm and 45cm with average of c. 40cm (Dudley et al., 2001).

Figure 4-3: Contemporary photograph of the Kingsteignton boat during excavation (Dudley et. al, 2001 p. 268)

The preserved planks are in relatively poor condition with significant damage to all edges. They are made of oak and appear to have been radially split from their parent logs. Scarcity of knots as well as plank lengths of up to 2.4m indicates that the used raw material was of good quality. Despite the significant damage, the original plank width is estimated to be c. 23cm while the thickness varies between 1.4cm and 2cm. The planks were fastened to each other with square shafted clench nails measuring 7mm sided. Based on the location of clench nail holes an average land width of c. 5cm is suggested and the original excavation report describes the waterproofing material to be made of hair and tar. The spacing between clench nails varies. Relatively regular spacings were observed on three planks. One plank has nail spacings of on average 13.5cm and two more planks have spacings between nails of 7cm to 8cm. However the remaining two planks are defined by even more densely spaced intervals, which may be indicative for repair. The interpretation that this may be the result of repair is supported by the presence of round-shanked nails in addition to the square-shanked examples (Dudley et al., 2001).

Conclusions and discussion

Besides the archaeological value of the structural remains of the Kingsteignton boat for the comparative analysis at hand, the history of the archaeological discovery as well as its “rediscovery” and renewed documentation and analysis make it an important case study for assessing the validity of archaeological research and interpretation. Upon its discovery in the late 19th century the boat was immediately interpreted as being Viking in date in absence of associated diagnostic finds and modern scientific dating methods. The conclusion was reached based on the dominant research preference at the time and by comparing the boat with finds of similar nature (Dudley et al., 2001).

Equally interesting and of importance when utilising C14 dates for dating medieval material is the dating process for the Kingsteignton boat until a satisfactory date could be established. Two attempts for C14 dating the wreck were undertaken at AERE Harwell in the late 1980s. Initial radiocarbon dating carried out in 1986 gave a date of 140BC +/- 120 (HAR 6738, and NMM/ASA 2247). As the excavated remains did not seem to match a (pre-) Roman date a second test was undertaken in 1988 (NMM ASA 7789), giving a calibrated date of AD 730 +/- 100, albeit with a large spread in the confidence limit. Going hand in hand with the C14 testing dendrochronological analysis of the preserved timbers was carried out where eventually a satisfactory match was achieved against medieval chronologies from south-west England. In absence of sapwood on the sampled timbers the felling date was determined to be after AD 1305. The numerous efforts of dating the Kingsteignton boat show the shortcomings and dangers in applying C14 dating for medieval material. The initial date of 140 BC was rejected, as the find did not show any diagnostic features of what one would expect from a vessel of this period. This goes to show how quickly one can be led to believe a date should diagnostic features and suggested date range is an apparent match. It begs the question if in such a scenario would be subjected to similar re-testing. The inaccuracies and wide potential date ranges provided by radiocarbon dating for medieval and post-medieval material are simply inadequate as changes in building tradition and technologies occur in narrower time frames as captured by C14 dating (Dudley et al., 2001).

The wreck is interpreted as having been double ended with an overall estimated length of c. 7m and 2.5m in width. With frames spaced at c. 40cm intervals it is believed to have been a robust undecked working boat suitable for riverine as well as coastal use (Dudley et al., 2001). Although a double-ended construction is certainly feasible, such interpretation appears uncertain in absence of the bow section and no knowledge on shape of the originally preserved sternpost or sternpost knee. Similarly estimations on the vessels’ original length and width should be seen with caution. The relatively dense framing pattern in combination with the former presence of a mast step certainly appears to indicate that the vessel was designed as a workboat with sailing capacity.

4.2.3 Late medieval and Renaissance boat timbers from London

Introduction

Over the last few decades many intact and fragmented boat and ship finds from the various (pre-) historic periods were made in London as part of building and construction works (Fig. 4-2). Utilising this resource Marsden comprehensively analysed and researched the archaeological evidence of Roman to early modern shipwrecks and boat and ship timbers (Marsden, 1994; Marsden, 1996). Through such detailed analysis spanning over several centuries Marsden was able to identify a multitude of changes during the 16th century, evident in usage of raw material and general deterioration of building quality for smaller watercraft. A more detailed discussion of these changes can be found at the end of this chapter following the presentation and descriptions of the archaeological material. The archaeological material assessed and analysed by Marsden comprises the remains of three articulated vessels, two of 15th century date (Blackfriars Ships 3 and 4) and one boat of 17th century date (Blackfriars 2). In addition to these wreck finds numerous fragments of boats and ships as well as articulated sections of hull planking re-used in river revetments dating from the 12th to the 17th centuries, including articulated remains of a 16th century clinker built boat at Morgan's Lane (Marsden, 1996).

In the following chapter the structural characteristics of the three mentioned wrecks will be described while relevant information regarding the boat fragments will be presented in summarised form. Although the results and conclusions on the London finds are discussed at the end of the chapter, it has to be kept in mind that none of the wreck finds are of seagoing watercraft. They represent river barges serving the economic infrastructure of London during the later Middle Ages and the Renaissance. Notwithstanding the difficulties of including river craft in a comparative analysis of seagoing vessels, the aspect of place of construction is of crucial importance. Due to the limited reach and specific area of use, river barges, such as the ones formerly operating in the Thames estuary, it is likely such boats and ships were built more or less locally (Marsden, 1996), a characteristic shared with coastal watercraft. Overlaps in certain aspects of construction and choice of raw material are therefore likely. Keeping in mind the inherent differences in shape and construction between riverine and coastal watercraft, incorporating the London ships and ship fragments serves to potentially identify similarities in building tradition and organisation of clinker boat building.

Blackfriars Ship 3

Introduction

The almost complete remains of a medieval clinker built river barge were found in 1970 during construction works in the River Thames (Marsden, 1996). Dendrochronological analysis showed that the ship was most likely built between 1380 and 1415 using locally sourced oak (Tyers, 1996). Pottery and building materials found underneath and within the wreck indicate that the ship sank sometime in the second half of the 15th century (Tyers, 1996). Although the wreck was almost fully intact, the associated development resulted in damage to the vessel at the bow as well as to starboard and port side sections aft of amidships. As detailed in-situ recording was not feasible as much as possible of the wreck was recovered with a view to undertake detailed documentation of the material at a later stage (Marsden, 1996).

Keel

The 10.77m long keel consisted of two pieces joined together with a horizontal scarf. It measured 43cm sided amidships tapering to 34cm at both ends and 14cm moulded characterising it as a plank keel. Rabbets to accommodate the garboard strakes were cut into the underside of the keel, which showed an elaborate shape in cross-section (Fig. 4-4). Between the rabbets the underside of the keel was rounded with a slightly protruding ridge running along its lowest part, which is believed to give the vessel slightly improved anti-leeway properties. The horizontal scarf joining the two keel timbers was located near the stern and was cut diagonally across the keel with the outboard end facing the stern to avoid water being pushed into the scarf. The scarf was fas-

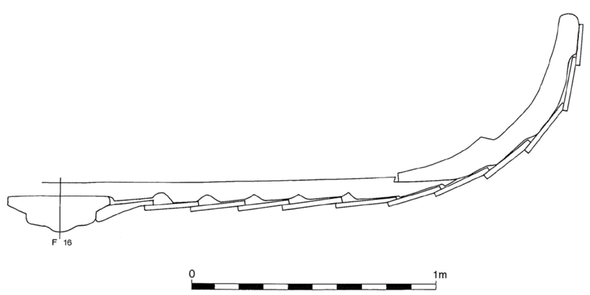

Figure 4-4: Schematic cross-section of keel and hull planking of the Blackfriars 3 ship (Marsden, 1996 p. 82)

tened with six iron nails and secured with roves. Three wooden patches were found applied to the keel, one of which had been inserted into the keel scarf. These were secured with iron nails and are believed to be repair measures to damaged roves (Marsden, 1996).

<u>Stern assembly</u>
The stern assembly consisted of two structural elements, a stern hook connecting the keel with the stem post and the actual sternpost, which was joined to the stern hook with a vertical lap scarf. The stern described a gentle curve upwards. A thin iron band, 4cm wide and 3mm thick was fastened to the outboard surface of the stern assembly, extending from c. 20cm aft of the keel/stern hook scarf along the full length of the preserved assembly. Iron nails and three thin iron brackets (6cm wide) served as fasteners for the iron band.

The stern hook was joined to the keel with a horizontal scarf with a diagonal lap, which was fastened with five iron nails driven from inboard. The keel rabbet continued into the horizontal arm of the stern hook and rebates were cut into the upward curving arm to receive the plank hood ends. A small board was nailed against a recess on the timbers' inboard side, thus roughly filling the transition across the scarf to the sternpost (Fig.4-5). The recess is interpreted as a lip of a horizontal scarf, which seems to have formed the original joint to the sternpost, thus implying that the original sternpost with horizontal scarf was replaced by the preserved stempost with a vertical scarf.

<u>Stem hook</u>
In contrast to the stern, only the lower part of the stem assembly was preserved in the archaeological record. Nevertheless, construction, shape and joining with the keel appear to have been identical to the stern assembly, i.e. the parts of the stem hook fastened to the keel with a horizontal scarf. The stem hook also shared the presence of a rabbet to receive the garboard strakes and rebates to accommodate the planking hood ends.

Figure 4-5: Upper part of the sternpost of the Blackfriars 3 ship during excavation (Marsden, 1996 p. 65)

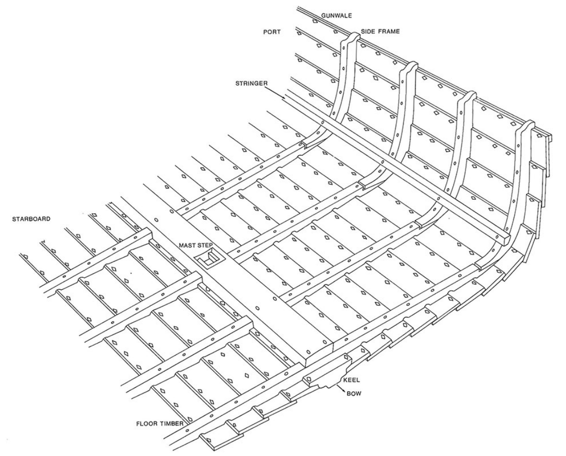

Figure 4-6: Reconstruction sketch drawing of construction details of Blackfriars 3 (Marsden, 1996 p. 84)

<u>Planking</u>
Twelve strakes of planking were preserved on either side, half of which formed the flat bottom of the hull (Fig. 4-6). Three strakes covered the turn of the bilge and the remaining three strakes were from the sides. As mentioned above all planks were made of oak and converted by radially splitting the planks from the parent logs. The planks by and large appear to have been shaped from heartwood with only a small number of planks showing sapwood edges.

The plank measurements were on average 25cm in width and an average thickness of 3.5cm. Plank overlaps between strakes were on average 7.5cm wide and lands were bevelled consistently on both sides. Waterproofing between the plank seams consisted of matted goat hair mixed with tar. Planks were fastened with square shafted iron nails measuring 7mm sided, riveted over diamond shaped roves. The nails were spaced at relatively regular intervals of 16cm. Planks were fastened lengthwise with long scarfs averaging in length between 30cm and 34cm. Most scarfs were worked to feathered ends, while a small number were lipped. Marsden sees the presence of the two variations indicative for at least two shipwrights having worked on the construction and/or repair. Contrary to the general orientation whereby scarfs open towards aft to avoid water being pushed into the seams, a small number of scarfs opened forward. In absence of other apparent reasons explaining this peculiar observation, Marsden interprets these scarfs as being a result of repair whereby damaged planks were removed and replaced with repair planks. As part of the repair the scarf joints would then have been rearranged. The arrangement of scarfs between adjacent strakes was observed to have occasionally been barely staggered, despite this posing potential weak spots in the hull structure (Marsden, 1996).

Numerous repairs to the hull planking are testimony to the vessel having been in use for some time prior to its wrecking. The presence of potential repair planks has already been mentioned above, apparent in shape of forward opening plank scarfs. More numerous and more clearly identifiable as repair measures were repair patches applied inboard as well as outboard to planks. Some patches were removed to identify the reason why a patch was deemed necessary. None of the removed patches covered split planks. However, as the patches covered scarf joints, iron and wooden nail fastener positions it is believed that fasteners and scarfs may have worked loose resulting in leakage, which in return required patching the relevant areas (Marsden, 1996).

Framing timbers and stringers

Frames consisted at floor timbers and sided timbers joined with scarfs and fastened with single treenails (Fig. 4-6). The frames were spaced at relatively regular intervals of c. 47cm (Fig. 4-8). Since the vessel was built flat-bottomed the floor timbers were converted from straight-grained logs, whereas the side timbers spanning across the turn of the bilge to the sides were made of compass timbers.

The dimensions for floor timbers varied slightly but were on average 12cm moulded by 12cm sided while the side timbers were slightly smaller dimensioned, measuring on average 9cm moulded by 12cm sided. All framing timbers were joggled and had rebates cut into the outboard facing surfaces to accommodate roves in the underlying planking. Long-rectangular limber holes were cut into the floor timbers, which spanned over the keel and the first five strakes of planking to either side of the keel. Shallow rebates were cut into the inboard facing surfaces of the side timbers at the turn of the bilge accommodating bilge stringers. A number of side timbers were preserved to their full length and all showed chamfered off heads curving towards outboard and covering the uppermost strake. In absence of any fasteners or other diagnostic features it has been concluded that no wash strakes or other extending elements were fastened. It seems therefore likely that the vessel was preserved up to gunwale level. Framing timbers were fastened to the hull with softwood treenails of c. 1.3cm in diameter, some of which were secured with oak wedges driven from the inboard end.

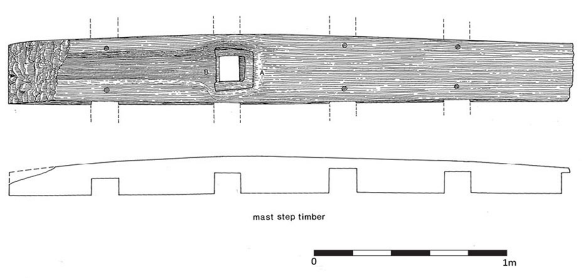

Figure 4-7: Mast step of the Blackfriars 3 ship (after Marsden, 1996 p. 80)

Stringers were fastened to the above-mentioned rebates in the side timbers. These were triangular in cross-section measuring 12cm sided and fastened to the underlying side timbers with treenails.

Mast step

The mast step was made from a straight log measuring 2.93m long, 20cm moulded and 37cm sided and was scarfed over four floor timbers to which it was fastened with two treenails each (Figs. 4-6 and 4-7). The rectangular mast step socket positioned near amidships consisted of a shallow ledge and the actual smaller socket, suggesting that the ledge reflects the dimensions of the mast foot, while the socket held the actual base of the mast. The edges of the socket showed further signs of wear indicative of raising and lowering the mast.

Reconstruction

Due to the excellent levels of preservation shape and size of the vessel was reconstructed including full hydrostatic analysis (see Fig. 4-8). The reconstruction gives an overall length of c. 14.6m and a beam of c. 4.3m with a height of c. 90cm. In plan view the ship was of elongated pear-shape continuously widening towards what Marsden interprets as being the stern based on orientation of plank scarfs and location of mast. His reasoning is that masts in single-masted vessels are generally placed slightly forward of amidships which can also be observed for Blackfriars 3. While the latter argument may not necessarily have been the case and the general shape in plan view appears to suggest a reverse orientation, the orientation of plank scarfs opening towards aft is indeed commonly accepted. Overall the flat-bottomed construction with a plank keel clearly characterises the vessel as a river craft designed to carry cargo without any constructional elements required for a seagoing vessel. Notwithstanding the large cargo capacity of the vessel, the absence of ceiling planking indicates that no heavy goods, such as large coarse stones, which could have damaged hull and fastenings, were carried (Marsden, 1996). Nevertheless it has to be pointed out that the below described Blackfriars 4 ship proves that cargoes of stone were transported in vessels without ceiling planking in at least in some instances.

In absence of rudder mountings on the stern assembly, it can be ruled out that a stern rudder was fitted. Equally no rudder fastenings for a side rudder were found on the preserved port side. As the starboard side was outside the limits of excavation it remains unknown if this was originally the case. Based on absence of side rudders from wrecks and historical depictions in Northwest Europe after 1300, Marsden deems it unlikely that the vessel was fitted with a side rudder. He rather believes that a steering oar or sweep was used to steer the ship (Marsden, 1996).

Conclusions and discussion

By comparing the archaeological evidence with historical sources it is believed that the Blackfriars ship 3 most closely resembles the shout, a common 14th and 15th century river transporter, although other vessel types are also known and possible. Construction and choice of raw material show that the Blackfriars ship 3, which was built as a river barge operating in the Thames estuary during the 15th century, was built very much in a building tradition commonly referred to as "Nordic", i.e. hull made of radially split oak planks with plank overlaps fastened with iron nails riveted over roves and frames fastened to the hull with treenails. Other characteristics such as keel and stem-stern solutions should be seen as adaptations to purpose and operational environment (Marsden, 1996).

Blackfriars ship 4

Introduction

The wreck was found as part of the same construction works leading to the discovery of the Blackfriars ship 3. Dating of the vessel to the 15h century is entirely based on the stratigraphic relationship with the Blackfriars ship 3 and 15th century pottery in the vicinity of the wreck. Due to time constraints and limited access to the wreck, it was not recorded to the same degree as the neighbouring Blackfriars ship 3. By far not as much of the original vessel was exposed and only basic documentation could be carried out. Consequently the following descriptions provide a much more restricted insight into the ships' construction and shape. As with Blackfriars ship 3, ship 4 was a flat-bottomed clinker built vessel with all assessed elements made of oak. A layer of ragstone overlying the wreck is believed to be cargo (Marsden, 1996).

Keel

As only a short section of the keel was exposed, its original length could not be determined. It measured 42cm sided by 10cm moulded, thus identifying it clearly as a plank keel (see Fig. 4-9). Rabbets to receive the garboard strakes were cut into the outboard facing edges of the keel, thus giving it a flat T-shaped cross-section (Marsden, 1996).

Planking

Six strakes of the flat-bottomed hull were recorded to both sides of the keel. Dimensions were documented as between 24cm and 30cm in width, 1cm thickness for the garboard strake and land widths ranging between 3cm and 4cm (Marsden, 1996).

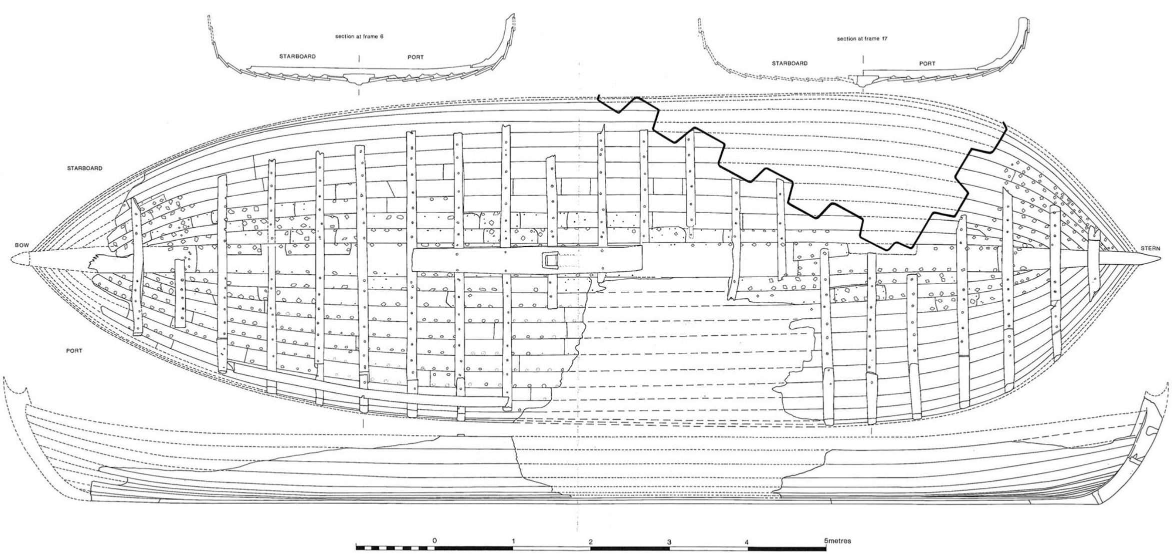

Figure 4-8: Wreck plan with overlaid reconstructed lines plan of the Blackfriars 3 ship (after Marsden, 1996 Fig. 65b)

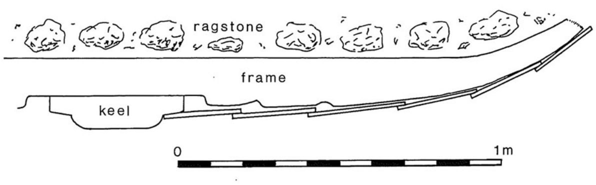

Figure 4-9: Schematic cross-section of the Blackfriars 4 ship (after Marsden, 1996 p. 106)

Framing
A single floor timber was encountered in the exposed section of the wreck and was recorded with dimensions of 12cm sided and 13cm moulded. Interestingly the timber did not seem to be joggled to fit over the underlying planking. A long rectangular notch slightly wider than the keel was cut into the underside of the keel-facing surface. Consequently the floor timber rested directly on top of the keel thus turning the two ends of the notch into limberholes. Two further sub-triangular limber holes were cut into both arms of the floor timber at the overlap of strakes one and two and again at the overlap between strakes three and four (Fig. 4-9). No fasteners were encountered but treenail fastenings between hull planking and framing timbers are assumed, as no iron fastenings were evident (Marsden, 1996).

Cargo
A cluster of Kentish ragstone was found lying on top of the exposed floor timber. As it was spread regularly over the frame it is believed to have been remains of the vessels' cargo, which was placed in the hold of the vessel. Seemingly no ceiling planking was present protecting the hull from the stones, which measured up to 50cm in diameter (Marsden, 1996).

Conclusions and discussion
Although the archaeological evidence obtained from Blackfriars ship 4 is extremely scarce, particularly in comparison with ship 3, a number of interesting observations can be made. Stratigraphic relationship indicates a roughly contemporary date for both vessels in the 15th century. Both vessels were flat-bottomed clinker built barges most likely built using oak, although no species or dendrochronological analysis of ship 4 was carried out. Consequently the shape in cross section of both ships is quite similar. The main apparent difference lies in the floor timbers. The floor timbers of ship 3 are fully joggled and have long-rectangular limberholes directly on top of the keel, thus allowing bilge water to pass through the central axis of the ship. The single recorded floor timber of ship 4, however, does not appear to be joggled and placed in such a way over the keel that three limber holes to either side allowed bilge water to pass.

Clinker boat, Morgan's Lane

Introduction
An articulated section of six planks belonging to a clinker boat, were found reused in a revetment of a moated house dating to the late 16th/ early 17th century (Fig. 4-10). The remains appear to have been from the starboard side and stern of a boat based on shape and plank scarf orientation. The section of hull planking was cut from the vessel using a saw and broken off the sternpost. Dendrochronological analysis gave an approximate felling date after 1577 in absence of sapwood on the sampled planks thus giving a more or less contemporary date for moated house and boat (Marsden, 1996; Tyers, 1996).

Sternpost
Although the preserved remains were comprised solely of hull planking, the plank hood ends contained important clues towards reconstructing the shape of the vessels' sternpost, which is reconstructed to relatively sharply at the transition to the keel and then continuing with a gentle curve, giving the post an almost vertical orientation against the keel (Marsden, 1996) (Fig. 4-8).

Planking
All planks were made of oak and radially split from the parent logs. It seems that the boat builder had access to good quality timber as indicated by the absence of sapwood edges, as well as the straight grained and largely knot free composition of the planks (Marsden, 1996).

The planks measured between 8.7cm and 15cm in width and c. 2.5cm in thickness, generally becoming thinner towards the hood ends. Lands measured between 3.7cm and 5cm in width. The

Figure 4-10: Find context of the Morgan's Lane boat, re-used in a wooden revetment (Marsden, 1996 p. 136)

bottom outboard edges of planks were bevelled giving the outer hull a smoother surface. Although two scarfs between planks were preserved, one was too damage to determine its original length. The fully preserved scarf measured 18.5cm in length. Both scarfs were fastened with a single iron nail. Square shanked iron clench nails measuring 5mm sided were used to fasten adjoining stakes. The nail tips were secured over diamond shaped roves. It could not be established with certainty how the nail tips were clenched over the nails but both riveting as well as bending the nail over the rove appeared to have been present. The spacing between nail positions varied but was on average between 10cm and 15cm. Waterproofing of the plank seams was achieved with animal hair and tar, however no further details on species are available. Protective coating was preserved at least in parts on the outboard surfaces of all planks and consisted of an up to 4mm thick layer of tar. Scorching was observed on the outboard surfaces of two planks (Marsden, 1996).

Framing

As with the sternpost no physical evidence of framing timbers was preserved. Treenail holes fastening framing timbers to the hull, however can give at least some information regarding the vessels' framing. No impressions of the framing timbers as such were evident on the inboard surfaces of the planks, which could have given at least clues to the sided dimensions. The spacing between the different frame positions preserved on the preserved section of planking was on average 82cm (Marsden, 1996).

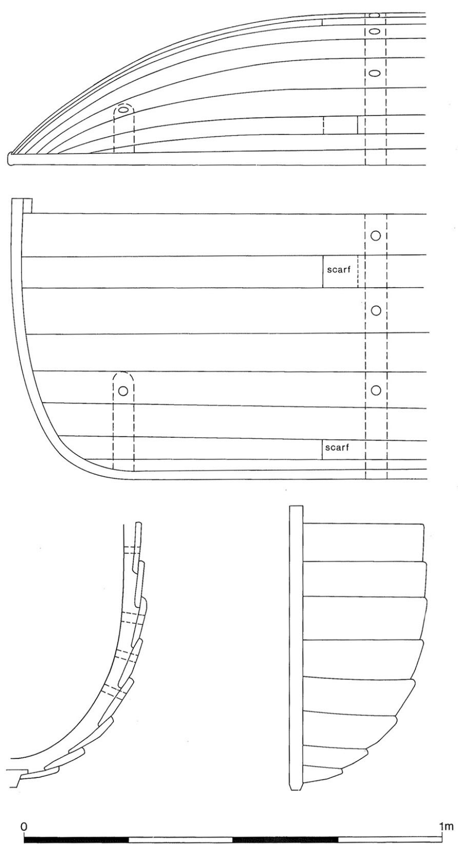

Figure 4-11: Proposed reconstruction for the stern of the Morgan's Lane boat (after Marsden, 1996 p. 134)

Reconstruction

Despite the scarce information contained in the archaeological material, a tentative reconstruction of the stern of the reverse clinker boat was attempted (Fig. 4-11). In absence of the keel and actual stern assemble components it has to be kept in mind that the stern could have taken a number various shapes depending on shape and construction of hull, keel and sternpost (Marsden, 1996).

Conclusions and discussion

As the original clinker vessel was dismantled and a section cut out to be reused in a revetment, the preserved section can only provide insights into certain aspects of construction and shape of the boat. Marsden interprets the structural remains as belonging to a boat built in reverse clinker, although it has to be pointed out that the supportive evidence remains scarce. Leaving aside discussing the concept of reverse clinker construction, the Morgan's Lane boat nevertheless provides important information, primarily regarding the usage of raw material. As the dendrochronological analysis showed the boat was most likely built during the second half of the 16th century, a time where shortage of timber supply as well as more industrialised production processes can be observed for across north-western European boat and ship building (see chapters 1.2.2 and 6.4). The preserved planks are made of radially split good quality oak, which is indicated by the absence of sapwood and scarcity of knots. The combination of good quality raw material and radially split planks can be seen as remarkable for a boat built in the late 16th century. Unfortunately information on provenance of the used oak is not provided, which would have helped in deepening our understanding of Renaissance boat building in south-west England.

Miscellaneous ship and boat fragments

Introduction

As part of his comprehensive analysis of ship and boat timbers from London, Marsden included boat and ship timbers fragments as well as small and articulated hull sections, often reused in revetments. He was able to draw from a broad range of source material, mostly dated by stratigraphy and related deposits. As a result general patterns regarding construction details and usage of raw materials became apparent. For the medieval and post-medieval period Marsden divided the material into two groups, the first describing ship and boat timbers dating from the 12th to the 15th century and the second the material dating to the 16th and 17th century. In the following the results will be presented in summarised form with a view to present the core results of Marsden's comprehensive analysis.

Boat timbers from the 14th and 15th century

Dendrochronological analysis of the assessed material shows that the majority of boat timbers were made of locally grown oak and planks radially split from the parent logs. A small percentage of Baltic oak was noted for the 14th century and appears confined to larger vessels. However, the fragmented nature of the material prohibits identifying the place of construction of the original vessels. Conversion of boat and ship timbers appears to have been done solely using axes and adzes as no saw marks were noted. As hinted above the majority of vessels built from locally grown oak appear to have been small watercraft, largely built for riverine use. Occasional presence of Teredo Navalis damage to timbers, suggest that some of the vessels were used in estuarine and coastal environments (Marsden, 1996).

Boat timbers from the 16th and 17th century

Significant changes regarding wood technology and usage of raw material are apparent in the material, particularly during the second half of the 16th century. While oak continues used, some timbers are now made from elm. The co-occurrence of locally sourced oak alongside elm in the same vessels indicates that availability of good quality building material becomes more difficult for the production of small watercraft. This trend is further evident in the appearance of tangentially sawn planks in addition to radially split planks (Marsden, 1996; Tyers, 1996).

Conclusions and discussion

Based on the above-described archaeological material, Peter Marsden detected significant changes in the construction of smaller watercraft during the 16th century both in building material used and differences in construction. Changes in wood usage include the introduction of elm as raw material for planking and a shift to tangentially sawn planks rather than radially splitting. Although radial splitting of planks continued to exist, the oak used was of lesser quality, i.e. knottier, grain less straight and taken from faster grown parent trees. Based on these observations Marsden attests a decline in building quality for smaller watercraft. An interesting example for this development is change in how the nails are clenched over the rivets. Instead of the nail tips being riveted, i.e. hammered flat over the rove, the tips were often simply hooked over the roves (Marsden, 1996). The Blackfriars ship 2 dating to the second half of the 17th century incorporated said changes in raw material and clenching technique (Marsden, 1996). Marsden further observed evidence of a more conceptual change manifesting itself in the frame positioning within vessels. While the frame spacing for medieval vessels ranged between 31cm and 48cm the distances widened during the 16th century to 50cm to 61cm (Marsden, 1996).

Overall the London ship and boat timber analysis provides a very useful basis for assessing nature and development of local clinker boat building from the Middle Ages into the early modern period. The impact of changes in availability in raw material alongside more "industrialised" and "economic" production processes appear to manifest themselves during the second half of the 16th century, although good quality oak converted by radially splitting planks from logs does continue to exist into the late 16th century as the clinker boat from Morgan's Lane indicates.

4.2.4 Poole boatyard timber store, Dorset

Introduction

The remains of a late 14th-/early 15th century estuarine beach with a boatyard timber store were discovered in Poole, Dorset in 1985/86 (Fig. 4-2). 61 boat timbers were discovered immediately on top of the beach deposits without associated floor surfaces, suggesting that the material belonged to boat building activity carried in the vicinity of the beach. The timbers were partly rough-outs to be finished while others appeared to have been removed from vessels and destined for re-use. Most timbers of the assemblage were neatly stacked and arranged into six groups according to their type and purpose (Fig. 4-12). Dendrochronological analysis of the boat timbers was carried out. However, the material proved to be either unsuitable or no satisfactory results could be obtained (Hillam, 1994; Watkins, 1994). The stratigraphic makeup of the site suggests that the timbers were laid down during a short time period in the early 15th century, which also indicates radical changes in the estuarine environment in the latter half of the 15th century. Interestingly the timbers are located in an area, which would have been within the mean tidal zone at the time the boatyard was in existence, thus exposing the material to at least regular flooding. Applying modern tidal cycles to the find location would even result in the timbers having been submerged for 88 percent of the time. Consequently the site could equally represent a wet timber store used for wet seasoning timbers, accessible only at low water during spring tides. However, as no arrangements for securing the timbers in place were encountered, an interpretation as wet timber store is seen as unlikely. The context rather appears to suggest that sudden and severe flooding caused the loss of the valuable raw material (Watkins, 1994).

Keel rough-outs

Five timbers were found laid next to each other (Group 6). Four were straight and long pieces made of elm while one was of oak and was also shorter and of more irregular shape. The elm timbers were of almost equal length ranging between 4.73m and 4.96m and showed moulded/sided dimensions of c.14cm/23cm by 30cm. The oak timber was marginally shorter, measuring 4.56m in length, 18cm moulded and 26cm sided. In support of her interpretation that the five logs are roughed-out keels, Hutchinson mentions that elm was favoured for keels in clinker vessels due to its resistance to splitting (Hutchinson, 1994).

Stempost assembly and rough-out timbers

As with the framing timbers salvaged timbers for re-use were found alongside rough-out pieces, again all made of oak. The used stempost assembly was comprised of two elements, an upper stempost and a lower stem hook connecting the post with the keel, which were found still fastened together (Fig. 4-13). Stacked next to the assembly were six rough-outs for stems (Hutchinson, 1994).

As mentioned above the two timbers of the stem assembly were found still fastened together with a 32cm long vertical stop-splayed scarf. An almost identical scarf, measuring 34cm in length, formerly joined the stem hook with the keel. Both scarfs were fastened with numerous and irregularly arranged square shanked iron nails, which appear to have been driven from both sides as indicated by nail head impressions. The presence of three rove impressions on the upper scarf of the stem hook scarf indicates that nail fasteners were at least partially secured by clenching the nails over roves (Hutchinson, 1994).

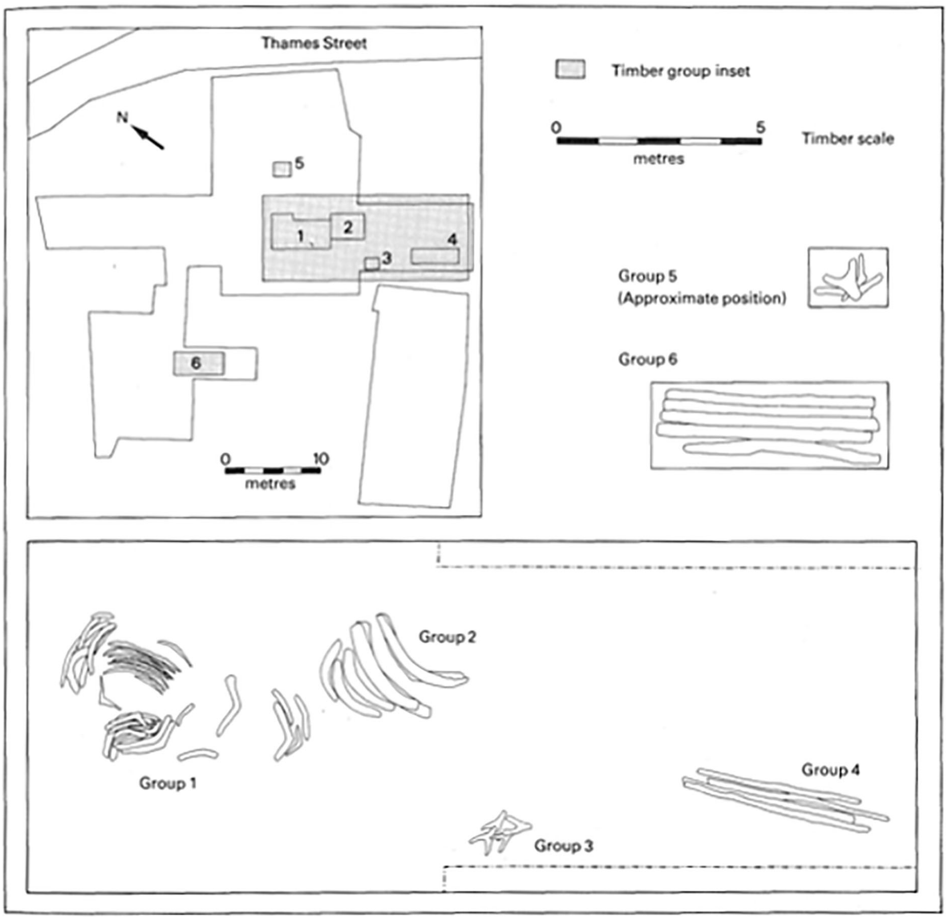

Figure 4-12: Distribution of the ship timber groups in the excavation area (Hutchinson, 199 p. 24)

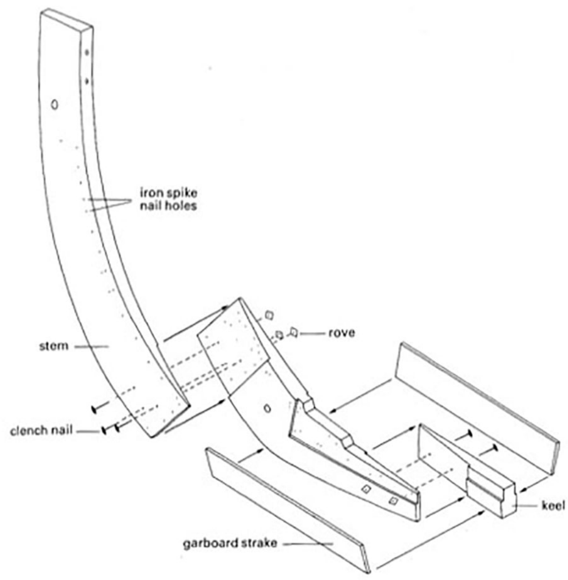

Figure 4-13: Sketch of the stem assembly from the Poole boat timbers (after Hutchinson, 1994 p. 25)

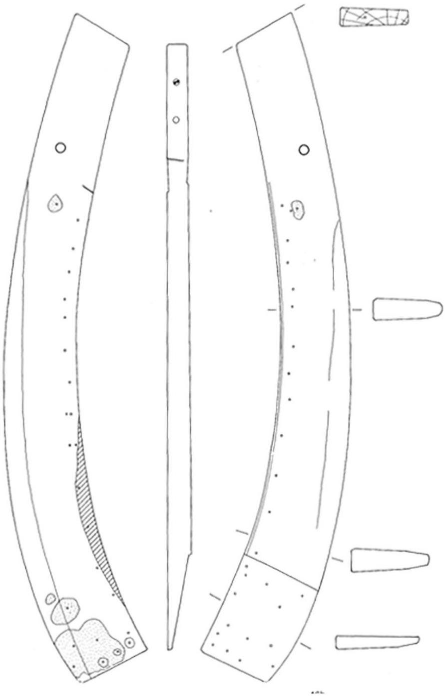

Figure 4-14: Upper stem element from the Poole boat timbers (Hutchinson, 1994 p. 31)

The upper stem element, or post, is relatively narrow (6.5cm sided) and has a roughly blunt wedge-shaped cross section, which was achieved by chamfering the forward outboard edges (Fig. 4-14). It measures 25cm moulded at the keel-facing end tapering to 19cm towards the top end and describes a distinct and gentle curve. The planking hood ends were simply nailed against the sides of the stempost with no rebates cut to provide a smoother transition between plank ends and stempost surface. The gunwale level, i.e. upper extent of planking is evident by the termination of nail holes as well as by an intentionally incised line on the port side surface. A circular hole (3.5cm in diameter) near the top end of the timber is presumed to have served for fastening rigging, such as a forestay. The lower stem element, or stem hook, forms the transition between the straight run of the keel towards the curving stem. A rabbet accommodating the garboard strake runs along the horizontal arm of the stem hook terminating in a rebate for the garboard hood end. Similar to the circular hole in the upper stem timber, a circular hole of 2.5cm diameter is located at the transition between horizontal lower arm and curving upper arm of the stem hook. It is interpreted as a fastening point for rope for pulling the vessel ashore (Hutchinson, 1994).

As hinted above fastening between the two elements and the missing keel and planking was provided by square shanked iron nails of 4mm to 6mm in cross section. The only evidence for potential wooden fasteners was found on the stem hook were a number of square shanked wooden plugs of similar size to the iron nails. Their exact purpose is unknown but it is suggested that they plugged holes of iron nails used during construction and removed after the vessel was completed (Hutchinson, 1994).

Waterproofing material consisting of two moss types (Sphagnum palustre and Sphagnum recurvum) was found preserved between the scarfs as well as on the surfaces originally in contact with planking hood ends. Furthermore, remnants of a yellow matter of soft and pliable composition was partially observed on areas not covered by planking and is believed to be remnants of outer coating (Hutchinson, 1994).

The stem rough-out pieces appear to represent elements of stem assemblies similar to the used example described above. As three timbers resemble the upper stem post timber and three are of similar shape to the stem hook, the assemblage would provide the raw material for three complete stem assemblies (Hutchinson, 1994).

Framing Elements

All of the framing timbers were made of oak and were comprised of salvaged as well as roughly prepared timbers. The rough-out frame elements did not show any diagnostic elements, such as joggles, scarfs or limber holes and were only roughly dressed towards their final shape. The timbers were stacked in three different groups, one of which contained the used framing timbers

(Group 1). While one of the remaining two groups of timbers clearly consisted of roughed-out framing elements (Group 5), the other has been interpreted as a group of potential rough-outs for mast crutches (Group 3). It seems, however, that the distinct Y-shape of the timbers would also allow these timbers to be interpreted as rough-outs for frame timbers. The assembly of used timbers consisted of six floor timbers, three side timbers and one unidentified piece. Hutchinson observed that all floor timbers are distinctly asymmetrically shape with the arms of either side rising at different angles. As frames in clinker built vessels are commonly inserted after the shell or parts thereof are assembled, it is feasible that not all chosen frames fit perfectly against the underlying hull planking. Such a case may be evident in one of the salvaged timbers were one joggle appears to stretch over two strakes (Hutchinson, 1994).

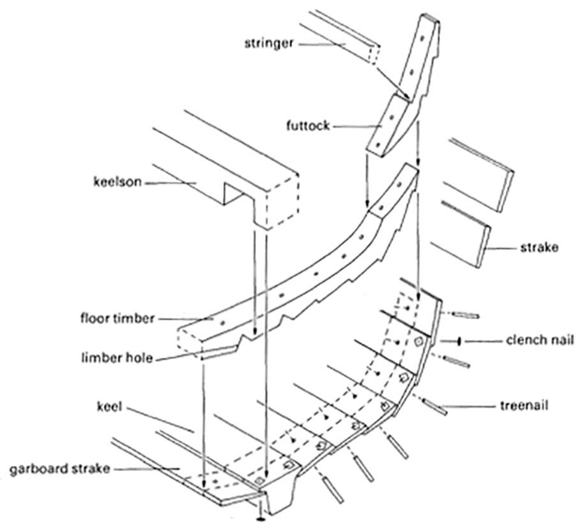

Figure 4-15: Reconstruction sketch drawing of construction details from Poole boat timbers (after Hutchinson, 1994 p. 25)

Dimensions for the frames varied but floor timbers had average moulded/sided dimensions of c. 8cm by 10cm while the side timbers measured c. 8cm by 9cm. As mentioned above, all floor and side timbers have joggles cut into the outboard facing surfaces (Fig. 4-15). Most floor timbers were made to fit against at least seven strakes per arm, while the side timbers spanned over three to four strakes. Further to the joggles, rebates to accommodate clench nail roves ensuring a snug fit against the underlying planking. Triangular shaped limber holes were cut to either side of the keel facing surfaces. With the exception of one floor timber, all limber holes where chamfered at the aft facing surfaces. These chamfers are interpreted as aiding to funnel water through the limber holes. Floor and side timbers were fastened with scarfs varying in length between 23cm to

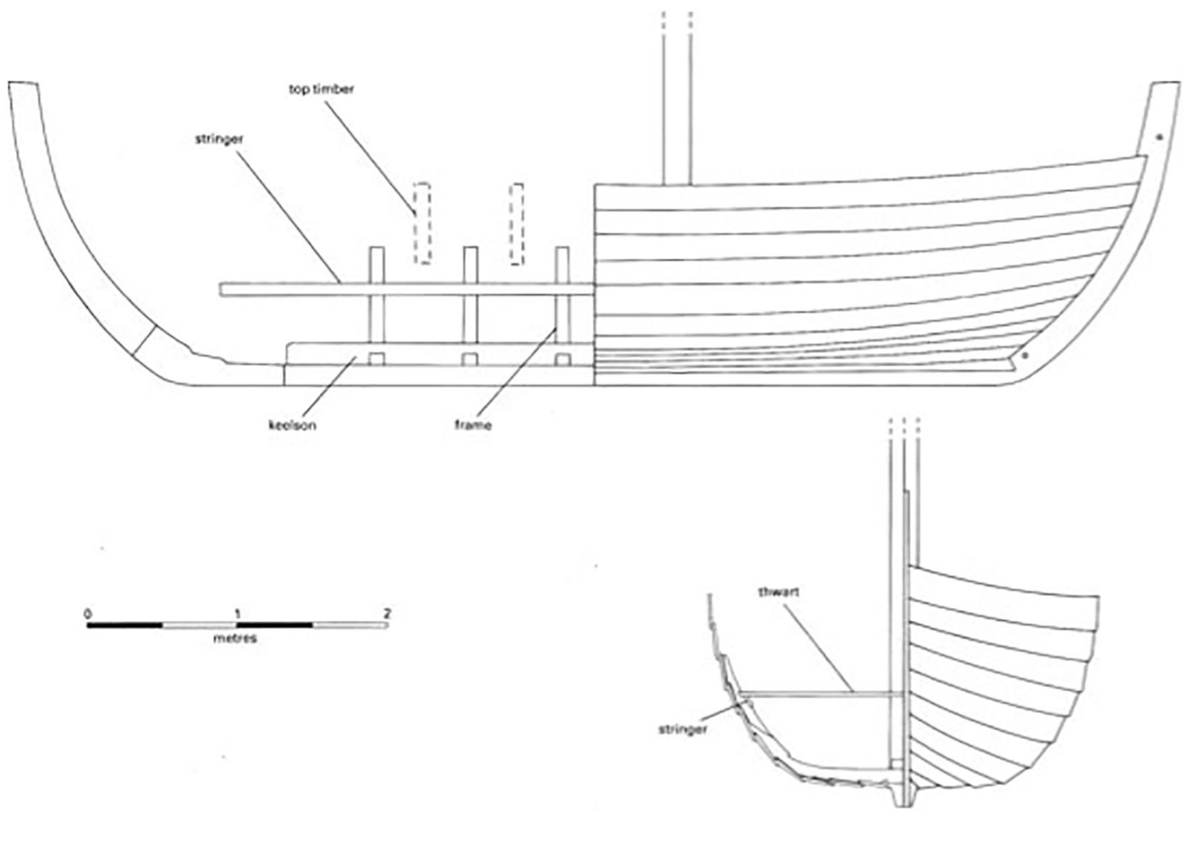

Figure 4-16: Reconstruction of a hypothetical boat based on the assemblage of boat timbers in found at the boatyard site in Poole (Hutchinson, 1994 p. 36)

34cm and were by and large cut to a gentle curve tapering towards the upper/lower end of the frame. Fastening was achieved using treenails identical to the ones used to fasten the frames and hull planking. Side timbers showed scarfs cut square into the top ends of the inboard surfaces of c. 25mm depth and maximum 38cm in length. Although interpreted by Hutchinson as possible scarfs to receive stringers, their substantial dimensions may also indicate that they served as joints to stanchions (Hutchinson, 1994).

Although no treenails were in found in-situ, some information regarding size and fastening method could be obtained from the preserved treenail holes, all of which appear to have been augered and show a more or less identical diameter of 18mm on the outboard surfaces. Most of the treenail holes on the inboard surface are asymmetrical and slightly larger in diameter, suggesting that the treenails were secured with wedges from the inboard side (Hutchinson, 1994).

A number of toolmarks bear witness to the conversion methods, dressing of the timber and construction process. These include axe marks and possible knife facets on joggles. Potential saw marks were observed on one timber and auger spirals in treenail holes were visible in another example. Furthermore a number of chisel marks were encountered around treenail positions on the outboard surfaces of frames and are seen as evidence of the dismantling process of the original vessel. The timber drawings presented by Hutchinson show that a number of framing timbers have toolmarks on their aft/fore faces, resembling axe marks. These may be the result of bucking, which is part of boxing the raw log into its desired four sided shape. While this is an unintentional by-product of the shaping of the timber, some marks are located at the steps of joggles and may thus be intentional marks incised by the boat builder as part of fitting the frame into the preassembled hull (Hutchinson, 1994).

Potential Keelson rough-outs

Similar to the group of keel rough-outs, four long timbers, all made of elm, were found grouped together (Group 4). Their lengths range between 4.05m and 4.31m with widths between 15cm and 20cm and depths ranging from 15cm to 20cm. Due to the consistency in length Hutchinson assumes that the timbers were intended to be used in combination with the keel rough-outs and were intended to be keelsons (Hutchinson, 1994).

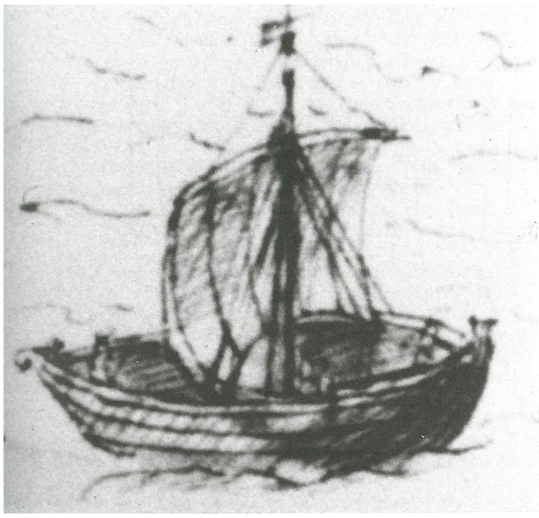

Figure 4-17: Single masted oben boat from a map of Poole Harbour c. 1597 (Hutchinson, 1994 p. 37; Marquess of Salisbury)

Reconstruction

Taking into consideration the resemblance in dimension and form both between the used timbers and the rough-outs, it was seen as likely that the material served to construct vessels of more or less identical shape and dimensions. This in turn served to reconstruct a hypothetical boat based on the excavated material (Fig. 4-16). Assuming a 4.15m long keel, a curved stem assembly as found and a hypothetical sternpost an overall length of 7.81m with a beam of 2.45m was reconstructed. Although the reconstruction drawing shows the hypothetical vessel to be double ended, a straight stern accommodating a stern rudder is also seen as feasible. The used stempost assembly shows that the original vessel had ten or eleven strakes of planking. Assuming that the recovered floor and side timbers belong to a vessel of the same size, it is believed that the floor and side timbers span over c. 8 strakes of planking while top timbers would have reached the uppermost two strakes towards the gunwale. Hutchinson suggests that these top timbers or stanchions were not physically connected to the top timbers. Notches and scarfs encountered on the side timbers are reconstructed to have accommodated bilge stringers and thwarts (Hutchinson, 1994).

The vessel is reconstructed single masted with the mast stepped directly into the keelson immediately fore of amidships. Depictions of small single masted vessels, one being engaged in fishing, from a map of Poole Harbour dating to c. 1597 appear to be similar to the reconstructed hypothetical Poole boat (Fig. 4-17) (Hutchinson, 1994).

Figure 4-18: Map of reference sites in Spain and Portugal (Schwetizer 2013)

Conclusions and interpretation

Based on the above reconstruction, a boat built using the timbers from the Poole timber yard is believed to have been as work and/or fishing boats for coastal waters. Overall the assemblage served as storage of timbers for a nearby boatyard where boats of similar size and shape were constructed. The used boat timbers are believed to derive from at least three different vessels and served as guides towards the desired size and shape of the vessels to be built. As Hutchinson points out, the nature of clinker boat building in the shell-first method involves constructing boats by using simple tools and is largely guided by rule of thumb and the experience of the boat builder. Consequently utilising finished and used frames as templates is equally unlikely as attempting to fit them into a newly built vessel (Hutchinson, 1994). Nevertheless, the presence of such construction guides and the layout and location of the Poole boatyard provides a unique glimpse into nature and organisation of clinker boat building in the later Middle Ages.

The archaeological evidence speaks strongly for a site engaged in constructing small coastal watercraft for the local community. As no remains of planking were found as part of the excavations, no information regarding the shell construction and potential local building traditions can be made. However, the preserved archaeological material does provide good comparative data. Two aspects of the archaeological interpretation may be questioned and appear not fully convincing. Firstly the interpretation of the group of Y-shaped rough-outs as mast crutches appears not fully conclusive. Shape and size would equally allow an interpretation as floor timber rough outs for frames placed far forward or aft in a vessel. Furthermore the interpretation of the group of c. 4m long rough-out timbers as keelsons can also be seen differently. Small watercraft, such as the Poole boats, would not necessarily require substantial, almost keel length keelsons. Shorter mast steps or keelsons, scarfed over the frames in the desired location, would suffice and have been documented in other contemporary boats, such as the Drogheda boat and the Skanör wreck (see chapters 3.3.7 and 4.8.2). Hutchinson interprets the Poole examples as potential rough-outs for shorter keels or even masts (Hutchinson, 1994). The frequent straight growth of elm in conjunction with its tough properties due to the interlocking grain made it well suitable for keels (Goodburn, 2009). As masts are rarely found with wreck sites, the proportion of elm masts in comparison to oak masts remains unknown.

4.3 Portugal and Spain

4.3.1 Introduction

As discussed in chapter 2, the comparative data regarding clinker built vessels from the south-western coastal regions of the Atlantic are extremely scarce. So far the Ria Aveiro G wreck in Portugal and the Urbieata boat in Spain are the only two examples of clinker built vessels from the Iberian peninsula (Fig. 4-18). However, good archaeological background data exists for carvel built vessels for the period in question, providing an insight into potential overlaps and/or impacts into clinker ship and boatbuilding of the later Middle Ages and Renaissance. This is of particular interest, as Spain and Portugal are believed to have played a crucial role in the spread of carvel ship construction from the 15th century onwards. Comparison to contemporary ship finds of carvel construction is therefore discussed chapter 6.

4.3.2 Ria de Aveiro G , Portugal

The lagoon of Ria de Aveiro is located on the Atlantic coast c. 60km south of Porto (Fig. 4-19). During dredging and construction works over the last two decades a number of shipwrecks were discovered (Alves, Rieth, Rodrigues, et al., 2001; Alves & Ventura, 2005) Most are of early modern date and carvel built. However, one wreck named Ria de Aveiro G, proved to be of clinker construction and 16th century in date. Understanding the lagoon and its formation history over the last several hundred years is important when it comes to understanding the maritime and naval environment in which Ria de Aveiro G was discovered. The lagoon is formed and shaped from alluvial deposits as well as river and wind action. Stretching over an area of 50km length, it is separated from the Atlantic by dunes. The formation process appears to have been on-going since the beginning of the previous millennium when it became a complex system of canals, which are continuously subject to silting up. This continuous change of an already complex naval environment meant that the number of navigable canals progressively diminished and make regular maintenance dredging necessary (Alves & Ventura, 2005).

In 2003 during monitoring of capital dredging works for the construction of a new bulk terminal, a number of timbers belonging to a clinker built vessel were discovered. The vast majority of timbers was recovered during the actual dredging phase and are thus largely heavily damaged and fragmented. The wreck was located at a depth of c. 11m and under 5m of sediment. This substantial sediment cover meant that only a small section of the wreck over a length of c. 2.2m was exposed on the steep slope of the dredging area, thus allowing only a small insight into its construction. Low visibility and continuously shifting sediments overlying the wreck site further hampered investigations.

Figure 4-20: frame timber recovered from Ria Aveiro G (Alves & Ventura, 2005 p. 15)

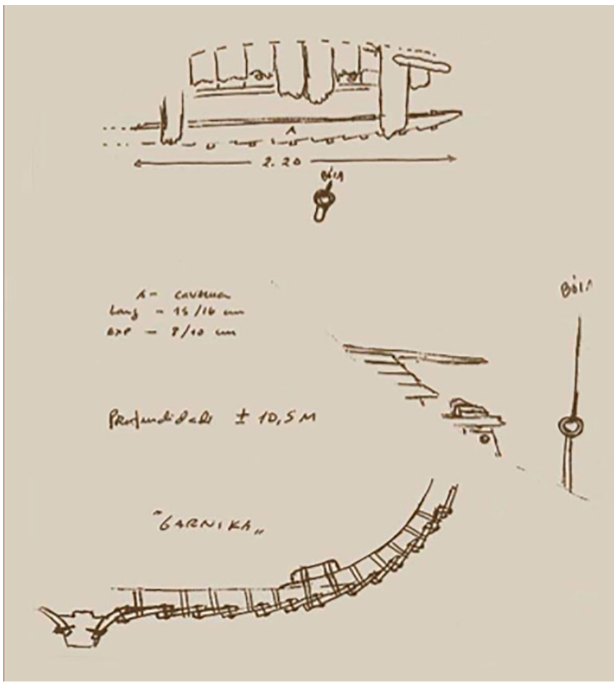

Figure 4-19: Field sketches of construction details of Ria de Aveiro G (Alves & Ventura, 2005 p. 10)

Notwithstanding the adverse conditions some construction details were recorded and documented during the dive investigations. Several strakes of planking fastened to internal frames with pronounced joggling on the outboard facing surface were recorded in-situ. An interpretive section drawing shows a beam keel, side timbers scarfed over floor timbers and a bilge stringer fastened against frames and hull planking (Fig. 4-19). The keel is shown as being rabbeted with a distinct central ridge along the top surface. Detailed documentation was done for the small assemblage of recovered timbers, yet no detailed measurements for the in-situ components and construction are available. However, a small number of timbers were recovered and later documented (Fig. 4-20).

4.3.3 Urbieta, Spain

Introduction

The Urbieta wreck was found in 1998 during river works of the Gernika estuary in the province of Biscay in the Basque country. The discovery was made near the historic town of Gernika (also: Guernica), which is located c. 6km inland from the estuary of the river Oka and as such just outside the tidal range of the Atlantic sea (Fig. 4-18). Consequently the context of the Urbieta wreck can be described as riverine, particularly as it was found at the confluence of two former rivers in c. 4m depth. The wreck of which approximately half of its originally c. 11m long hull was preserved and C14 dated to c. 1450-1460 (Izaguirre et al., 2001). Although dendrochronological analysis was attempted, the number of treerings in the sampled timbers was insufficient for successfully dating the wreck. The preserved remains are comprised largely of a portside section of the hull between amidships and sternpost as well as fragments of the bow section (Rieth, 2006). All hull elements were of oak with the exception of the keel, which was made of beech (E. Rieth, pers. comm.).

The keel

As mentioned above two sections of the keel were preserved in-situ, comprised of a c. 5m long section in the aft half of the vessel and a short fragment at the bow (Fig. 4-21). Although the keel was not preserved to its full original length remaining in-situ sections at bow and stern of the vessel allowed to estimate an overall original length of c. 8.5m. The keel is rabbeted and has a trapezoidal cross section measuring sided maximum 17cm amidships tapering to 10cm towards the stern end and an average moulded dimension of 14cm. The 2cm deep rabbet is placed strikingly low at c. 4cm from the bottom face, providing a wide rest for the garboard planks against the keel and giving a sharp deadrise of almost 90° (Rieth, 2006).

Stem and sternpost

The sternpost was preserved over a length of 99cm and is fastened to the keel with a vertical scarf joint. It was made from a curved compass timber and as the keel it is rabbeted to receive the garboard strakes. Two holes 2cm in diameter placed at a distance of 15cm to each other are located near the bottom of the stern and clearly below the waterline. No further features potentially indicative for rudder fastenings are evident. Although no detailed descriptions of the preserved stempost sections are published, the reconstruction of the vessel indicates that it took a curved shape, thus giving the boat a double ended appearance (Rieth, 2006).

Planking

With ten preserved strakes the portside constitutes for the vast majority of the preserved hull planking whereas only three strakes are preserved on the starboard side. As mentioned above all hull planks are made of oak and were probably by and large tangentially sawn (E. Rieth, pers. comm.). Planks are on average 2cm

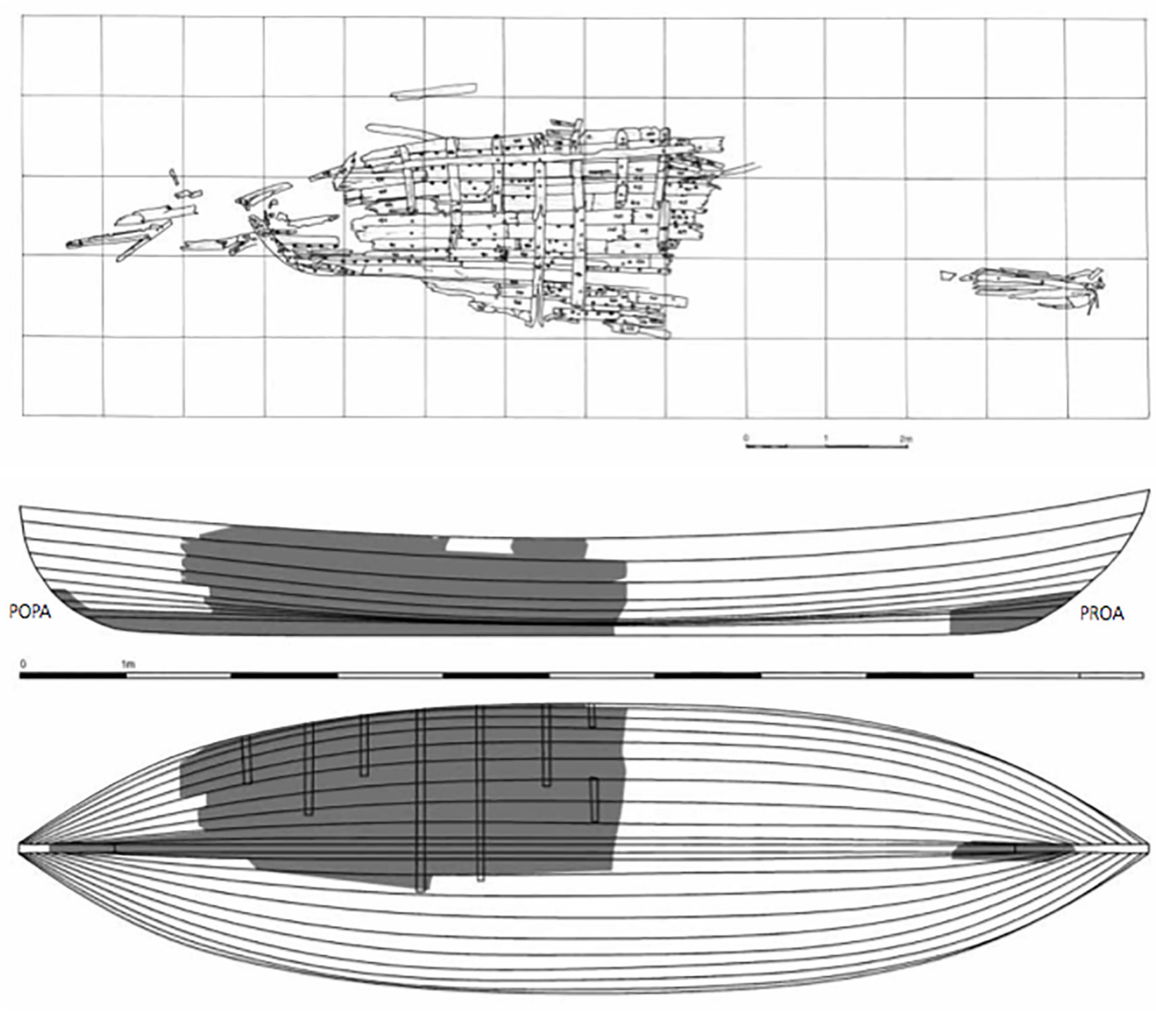

Figure 4-21: Site plan by Izaguirre and reconstructed lines plan by Rieth and Ginisty of the Urbieta wreck with preserved hull remains highlighted in grey (Rieth, 2006 p. 604)

Figure 4-22: Hull planking after conservation with "reinforced" strakes visible in the foreground (Rieth, 2006 p. 608)

thick, vary in width between 17.5cm and 21cm and have an average length of between 1.10m and 1.46m. However, two planks reach up to 3m in length. The short average plank length is seen potentially as a result of economic factors, which only allowed the provision of short planks either deliberately chosen by the boat builder or in response to availability of raw material. Rieth further observed that the small number of longer planks seem to be located in the upper part of the hull close to the gunwale where strake lengths are the highest. He further notes that the short plank lengths may be in relation to the multiple repairs evident on the hull. However, no detailed information regarding nature and frequency of repairs is provided. In addition, some planks are "reinforced" or doubled with a second plank on the outboard, a feature that is not further interpreted (Fig. 4-22).

Plank overlaps between strakes are strikingly narrow, measuring between 2cm and 3 cm in width. Fastening of plank seams was achieved using square shafted iron nails, measuring c. 6mm sided, with round heads and driven from outboard to inboard. The nails were fastened on the inboard side using rectangular rove plates, over which the nail heads were hammered at right angles. Garboard planks were fastened to the keel with the nails driven blind into the keel. The spacing between the clench nails can be described as relatively irregular ranging between 10cm and 19cm. Planks on the same strakes are joined to with vertical scarfs varying in length between 12cm and 25cm and fastened with two clench nails each. No remains of waterproofing material were preserved (Rieth, 2006).

Framing

All frame timbers are made of oak and of naturally curved compass timbers. Each frame consists of two elements comprising a floor timber and a side timber joined and fastened with scarfs. The distance between frames is irregular and ranges between 35cm and 48cm (Rieth, 2006).

Of the 18 floor timbers recovered, eight were found more or less structurally articulated in the wreck while the others were found loose in the surrounding area. Their moulded dimensions varied between 6cm and 14.5cm and the sided dimensions ranged between c. 12cm and 13.5cm. While the sided dimensions of 10cm to 14cm for the side timbers, of which seven were preserved in-situ, were similar to the floor timbers, the moulded dimensions are somewhat smaller with 5.6cm to 8cm. Rectangular limber holes, measuring on average 5cm sided, are cut into the keel facing surfaces of the floor timbers. The outboard surfaces of all frame timbers are joggled to provide snug fit against the underlying planking. However, the joggles on side timbers seemingly appeared less pronounced compared to the ones on floor timbers. Furthermore rebates were cut into a number of framing timbers to accommodate for rove plates from the plank fasteners (Rieth, 2006).

Each side timber was joined to the adjoining floor timber with two treenails on the scarf overlap. Occasional traces of iron nails on side timbers are seen as an indication that these may have been temporarily fastened prior to final assembly. All frame timbers were attached to the hull with treenails measuring 2.5 to 3cm in diameter. Floor timbers were not fastened to the underlying keel (Rieth, 2006).

Stringer

The stringer is broken into two pieces and preserved to a total length of 3.62m. It is rectangular in cross section and measures c. 4.5cm in thickness and is c. 10cm wide. The stringer is additionally fastened to four side timbers by one round-shanked nail each, driven from the inside of the vessel. In addition, the upper stringer has, at the crank of the side timber, an indentation c. 40cm long, which might be consistent with the location of a thwart. A similar but shorter impression was found on another side timber where it is interpreted as possibly marking the position of a bench (Rieth, 2006).

Gunwale and other structural elements

An isolated fragment with an "L"-shaped cross section is assumed to be part of the gunwale. It measures 4.5cm by 7.5cm. One preserved nail position is believed to have served as a fastener to the hull planking (Rieth, 2006).

No archaeological evidence of floor or ceiling planking, mast steps, thwarts or rowlocks was observed. Although the absence of these elements may be a result of erosion and preservation conditions, it cannot be ruled out that structural elements within reach were salvaged after the wrecking or abandonment of the vessel (Rieth, 2006).

Reconstruction

As the above descriptions show the Urbieta wreck is a clinker built vessel of c. 11m original length with curved bow and stern giving the vessel a double ended shape. For both sheer and body plans a well-balanced and symmetrical shape was reconstructed (Fig. 4-21). The boat takes a full and wide shape amidships speaking for the vessel having been made to take cargo. The low freeboard is seen as an indication that the vessel was designed for beaching whereby reduced freeboard would have allowed for easier loading and unloading (Rieth, 2006).

The boat shows a length/width ratio of 3.91, which Rieth places in context with other medieval clinker vessels where L/W ratios for overall length and width between 3.9 and 4.1 are seen as belonging to vessels of mixed propulsion, i.e. rowing and sailing. Furthermore the displacement coefficient for the L/W ratio at the waterline of the boat ranges between 3.92 and 4.62 and indicates a good lateral stability of the hull (Rieth, 2006). Albeit somewhat unusual in comparison with northern European examples the low rabbeted keel of the Urbieta wreck, giving the boat a sharp deadrise would speak for a vessel well suited for sailing coastal waters.

Conclusions and discussion

In his interpretation Rieth attempts to place the constructional details as well as the shape of the Urbieta wreck in context with northern European medieval lapstrake traditions, i.e. the so-called Nordic tradition, the Slavic and Anglo-Saxon traditions. In this he highlights the observation that the tips of clench nails were hammered over the rove plates at right angles, which he identifies as differing from vessels belonging to the "Nordic" tradition where nail tips are hammered flat over the tip. Due to this difference Rieth suggests that this may represent a potential diagnostic feature of Basque or South-west Atlantic building traditions. Furthermore the low placed rabbet for the garboard strakes on the keel are pointed out as atypical for ships from northern European contexts. In his interpretation Rieth pursues the idea that the Urbieta wreck may belong to a regional variation of the Nordic tradition, similar to the Magor Pill and Graveney boats, which are seen as representative for the Anglo-Saxon tradition based on similarities in shape and construction. In support of such an interpretation he refers to 19th century ethnographic evidence of vernacular vessels in the Basque country whereby local variations of boats and rigging were commonplace and reflected local or regional adaptations to the needs and operational waters involved. Rieth thus recognises the importance of marine environment, cultural and socio-economic background when assessing and interpreting ships and boats from archaeological contexts (Rieth, 2006).

Although sharing most similarities with high medieval wrecks from northern Europe, Rieth does not assess the dating of the Urbieta wreck to the mid-15th century critically. As the accuracy of C14 dating, particularly for medieval to modern dates has to be viewed critically, the chronological context within the 15th century should not be seen as secure. An open mind towards a potential earlier or even later date for the Urbieta wreck should be kept. The usage of sawn planks and the hooked clench nails play an important role in this assessment, particularly in comparison with the boats and boat timbers from London (see chapter 4.2.3). Nevertheless, the value of the Urbieta wreck cannot be underestimated as it does provide a first glimpse into local Basque boat building techniques, of which we know so little to date.

A further question addressed and investigated was a comparison between the main dimensions of the Urbieta wreck and the *codo de ribera*, the main unit of measurement used in late Medieval/Early Modern Basque shipyards. One codo equals 57.46cm and it is known that units of 1/2 to 1/8 were in use. Applying these to the dimensions and measurements of the Urbieta wreck deviations of up to 4cm, which Rieth overall considers sufficient to suggest that the boat builder used the *codo de ribera* measurements for constructing the Urbieta boat (Rieth, 2006).

4.4 France

The review of archaeological reference material from France as outlined in chapter 2 shows that medieval to early modern ship and boat wrecks from the French Atlantic coastline are currently near to non-existent. The sole representative of clinker built vessels from archaeological context to date is the wreck of Aber Wrac'h (L'Hour & Veyrat, 1989; L'Hour & Veyrat, 1994). With an overall length of over 20m and heavy construction, it classifies more of a long distance trade ship than small coaster. Consequently the Aber Wrac'h is not included in the core of reference sites presented in this chapter. Nevertheless the wreck is not fully omitted and will be considered for the discussion of the core reference material against the wider archaeological context.

Figure 4-23: Map of reference sites in the Netherlands and Germany (Schweitzer 2013)

4.5 The Benelux countries – Belgium and the Netherlands

4.5.1 Introduction

Belgium and the Netherlands are in some ways of similarly scarce data as France, particularly when looking at Belgium (see chapter 2 for more information). This may sound strange for the Dutch material, especially considering the wealth of wrecks known and researched. Although a good number of wrecks of small watercraft dating between 1400 and 1600 are known, the vast majority is either carvel built or constructed bottom-based with the first strakes built in carvel followed by clinker strakes up to gunwale level. Nevertheless a number of clinker built vessels have been found and documented. However, most exceed the size limits set for this comparative study and are thus not represented in this chapter. Three clinker built ships of reconstructed lengths of c. 20m, OM11, NO28 and NB36 have been considered (Holk, 2003; Overmeer, 2008). However, due to their heavy construction they are more characteristic of long-distance ships and are of relevance for the wider archaeological context of the comparative analysis (chapter 6).

Smaller clinker built watercraft from archaeological context are largely represented by waterships, a ship type first appearing in historical sources in the 14th century, which became a prominent and important vessel in the Zuiderzee for the centuries to follow. Hull shape and its strong construction made the *watership* ideal for heavy-duty work, such as trawl fishing, transport and by the late 17th century tugging large ocean-going ships through the Zuiderzee. Therefore the general shape of the *watership* remained more or less unchanged during its existence while structural changes, such as the transition to carvel construction allowed increased dimensions and improved manoeuvrability.

Although most likely geographically confined to North-Holland operating in creeks, lakes and inlets around the Zuiderzee, historical sources indicate that *waterships* were at least to some degree also engaged in coastal and possibly North Sea and Baltic trade. Archaeological evidence to date suggests that *waterships* during the medieval period up until approximately the mid-16th century were largely clinker built and were largely replaced by carvel constructed vessels, which appear during the first half of the 16th century (Verweij et al., 2012). Structural features of clinker built waterships are intriguing and indicate a close relationship to local bottom based building traditions as well as displaying features of seemingly "Nordic" influence (Reinders, 1985; Verweij et al., 2012). Verweij et al. identified a number of diagnostic design and structural features based on a comparative analysis of archaeologically documented waterships. In particular the S-shaped cross-section, which the waterships share with clinker built vessels of medieval "Nordic" construction in contrast to the otherwise predominating flat-bottomed design of Zuiderzee vessels, is a design feature clinker and carvel hulls have in common. It is believed that the sharp entry and resulting sailing characteristics played an important role in the success of the vessel type. The transition from keel planks to beam type keels towards the 17th century are believed to be owed to changes in functional demands, especially the increased use of waterships for tugging and towing tall ships (Verweij et al., 2012).

All archaeologically recorded waterships date to the first half of the 16th century and are of strikingly similar construction, such as an overall length of c. 10m, presence of keel planks, curved stemposts and frames placed at c. 45cm distance (Verweij et al., 2012). Consequently one well-preserved and documented example has been chosen to represent the group of *waterships* for the purpose of this study. Wreck ZN 42 from Flevoland was comprehensively analysed and provides valuable data for the research questions at hand (Fig. 4-23).

4.5.2 ZN42

Introduction

The well-preserved remains of wreck ZN 42 were found in 1975 and after initial investigations it was reburied until full excavation took place 1979 (Fig.4-24). Pedersen reassessed the excavation archive and documentation in 1987 and produced a detailed account of the wreck, including suggested reconstruction. An almost unique aspect to wreck of this study is that it was possible to identify ZN42 as a watership, a historically and archaeologically well documented and represented ship type (Pedersen, 1997). Consequently Pedersen was able to place the wreck in its naval historical context as well as compare its construction with other wrecks of waterships. The outcome is a remarkable study of small watercraft, built to suit the task and sailing requirements in the local operational waters.

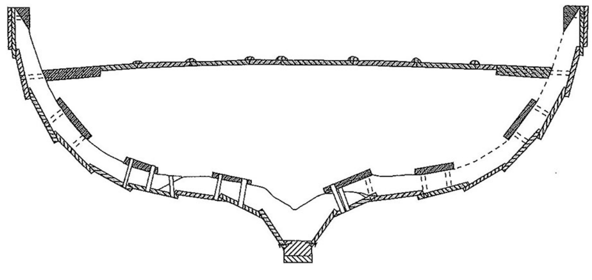

Figure 4-25: Reconstructed cross-section of ZN42 (after Pedersen, 1997 Encl. 3.3)

One central theme and research question of the present study is whether structural details on small clinker built watercraft allow drawing conclusions on how demands on usage and operational waters impact on the vessels' construction. In case of the *watership* ZN42, the presence of a fishwell amidships, which was filled with fresh seawater by way of perforated hull planks to both sides of the fishwell. This in turn demanded internal waterproofing to contain the water within the fishwell. Dendrochronological dating of the timbers, which were made of oak showed a felling date of c. 1527 – 1531 for the boat's construction. Pottery found within the wreck indicates that the end of the vessel's life was in the latter part of the same century. ZN 42 was found resting upright, slightly heeled to the port side and largely structurally intact with only the stem post having come apart and upper parts of the stern missing. Furthermore parts of the former three decks (forward, amidships, and aft) had collapsed into the wreck. Not represented among the archaeological remains were rudder, mast and rigging components as well as most of the sheer strake and gunwale (Pedersen, 1997).

Keelplank

As the keel of ZN42 differs in cross-section significantly to all other examples presented here, the term keelplank as used by Pedersen, is adopted

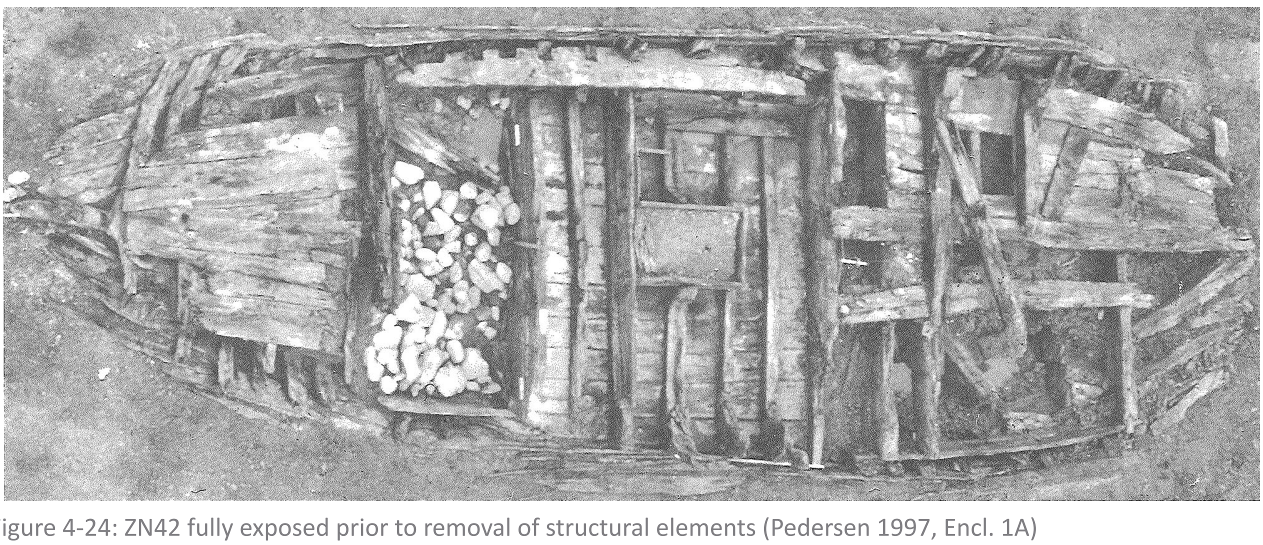

Figure 4-24: ZN42 fully exposed prior to removal of structural elements (Pedersen 1997, Encl. 1A)

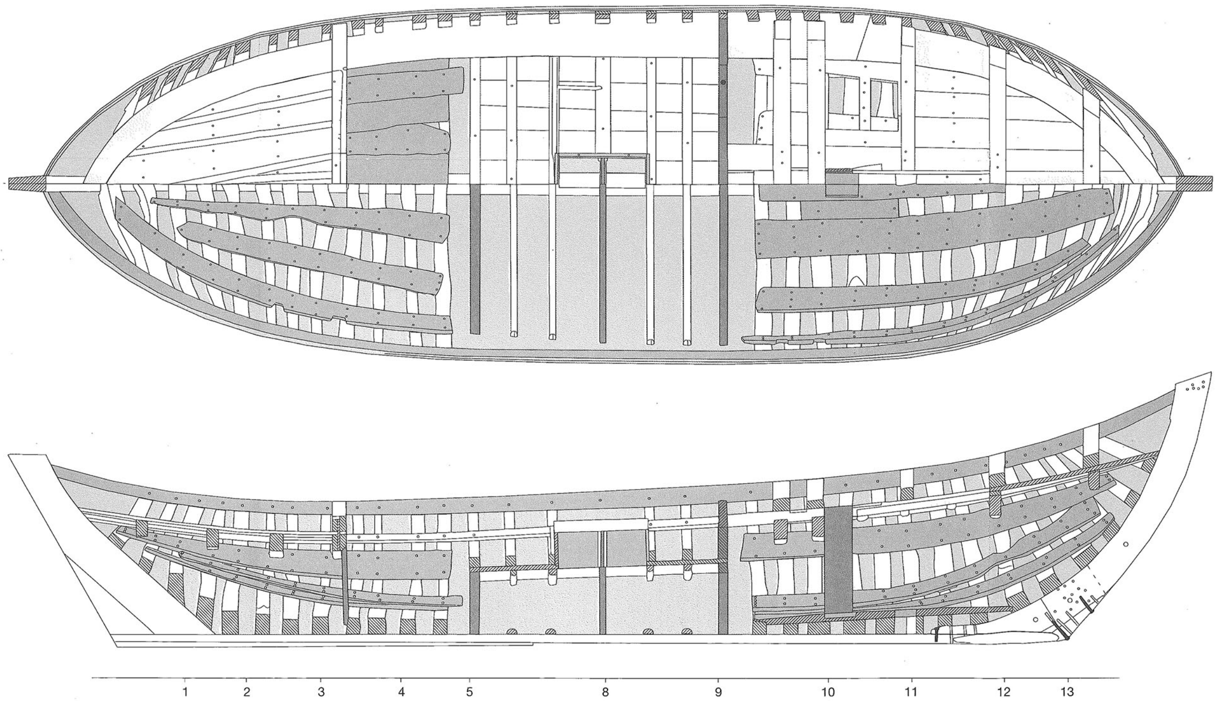

Figure 4-26: Construction plan of ZN42 (after Pedersen 1997, Encl. 6 A & B)

for this purpose (Figs. 4-25 and 4-26). The keelplank is preserved to its full length of c. 12.5m, with moulded dimensions varying between 11cm (stern) and 13cm (bow). The width of the keel plank or sided dimensions show that it was widest roughly amidships (c. 17cm) tapering to c. 14cm at the bow and to 10cm at aft end. Rabbets were cut into both sides of the keel, which did not extend along the full length of the keel, stopping c. 1.3m forward of the sternpost. The underside of the stern was protected with a partial shoe, attached to the keel with iron nails (Pedersen, 1997).

Stem assembly

The gently curved stem assembly was almost fully intact measuring 3.9m in height, between c. 44cm and 55cm moulded and c. 22cm sided. The assembly was comprised of a lower and upper piece, joined with a vertical scarf and secured with seven iron nails on the lower scarf end and with eleven treenails in the centre (see Fig. 4-26). The lower timber is quite short, acting as a transition piece between keel and stempost. Further to the two main timbers, a filler piece and a cutwater were present. The cutwater was placed on the forward face and fitted between lower and upper stem piece to a smooth transition to the curved rise of the stem. A small filler piece was placed between lower stem piece and cutwater. Three treenails and two iron nails secured the cutwater arrangement. Finally a pair of horizontally placed timbers, measuring c. 1.5m in length and 15cm in height were fastened to the bottom of the stem and are interpreted as stabilisers, improving the vessel's beaching behaviour (see Fig. 4-27). The stem assembly was joined to the keelplank with a horizontal stop scarf and secured with three treenails and one iron spike nail (Pedersen, 1997).

Sternpost

The sternpost consisted of the actual sternpost standing on the keel plank at an angle of c. 41° and a second triangular shaped timber, which was also fitted on top of the keelplank and snugly against the aft surface of the sternpost, serving as an additional support to the sternpost. The main post appears to have been shaped from a curved compass timber thus requiring the placement of the triangular support member (see Fig. 4-26).

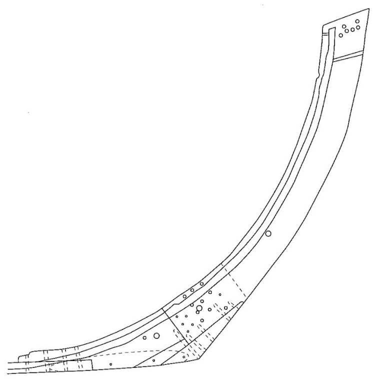

Figure 4-27: Reconstructed stem assembly of ZN42 (after Pedersen, 1997 Encl. 6 F)

This further gives the post a perfectly straight appearance aft, required for a mounting a stern rudder, which was evident by preserved remains of a gudgeon. The overall preserved height of the sternpost was c. 1.5m with sided dimensions of 20cm on the forward face, tapering to 8cm aft. Rebates to receive the plank hood ends were cut into both sides along the full height of the sternpost (Pedersen, 1997). As the wreck was not dismantled the exact fastening method between keel and sternpost could not be established. However, considering the sternpost timbers position, a mortise-and-tenon variation appears likely.

Hull Planking

The preserved hull planking was in good condition up the eighth strake on the port side and up the sixth on the starboard side. Although all planks appear to have been made of oak, the conversion method is unknown. The strake pattern recorded for ZN42 shows that scarfs on adjoining planks were often barely staggered, thus posing a potential weak spot in the hull structure (see Fig. 4-28). This observation is even more remarkable considering that the strake arrangement and placement of scarfs on port and starboard side are mirrored (Pedersen, 1997). While symmetrical arrangement of strakes was clearly deemed either important or part of the overall conceptual approach, avoiding closely neighbouring scarfs was obviously not.

Planks varied in length between c. 1.40m and c. 7.90m but mostly ranged between 4.30m and 6m. Plank widths are unknown but the average thickness was c. 3cm. Lands were between 6cm and 10cm wide and fastened to each other with iron nails secured by double clenching the nail tips. The spacing between nails ranged between 10cm and 14cm. Waterproofing of the hull was not done by placing the moss based waterproofing material between the lands, instead the waterproofing material comprised of was placed over the inboard edges of plank overlaps and held in place with laths and secured with iron sintels. Size and shape of sintels as well as spacing was not recorded. Planks were joined lengthwise with long scarfs with an average length of c. 45cm. As mentioned above planks up to the sixth strake adjoining the fishwell were perforated with many small holes, c. 1cm in diameter. The holes were drilled systematically at 4cm spacings and arranged to a diamond pattern. The plank seams for the perforated plank sections were not waterproofed and no waterproofing material between hull planking and bulkheads on both sides of the fishwell were preserved (Pedersen, 1997).

Overall sixteen repairs to the hull planking were identified and are believed to have been carried out during the construction rather than during the lifespan of the vessel (Fig. 4-28). The vast majority of repairs consisted of short planks placed over cracked or otherwise damaged plank sections (Pedersen, 1997).

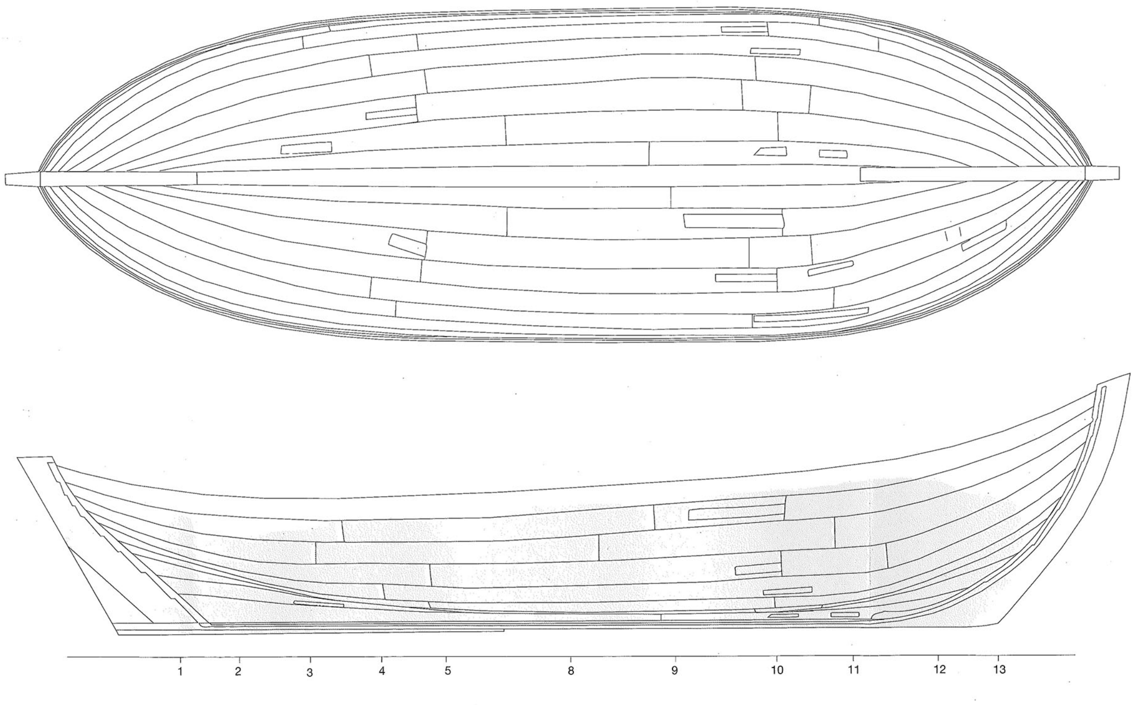

Figure 4-28: Plan of ZN42 showing strake arrangement an drepairs (after Pedersen 1997, Encl. 5 A & B)

Framing and Stringers

The particular design of ZN42 with a fishwell amidships required that the framing system was adapted accordingly. This is reflected by the frame arrangement within the fishwell differing from the framing fore and aft. Furthermore the three fishwell bulkheads have to be taken into consideration as lateral strengthening elements. All frames consisted of floor timbers and abutting side timbers joined with horizontal through scarfs (Pedersen, 1997).

A particular frame pattern, albeit not fully consistent, was noted for the frames aft of the fishwell. Floor timbers with one short and one long arm were placed alternating between starboard and portside (Fig. 4-29). Although not specifically mentioned by Pedersen, the images showing the vessel's frames indicate that numerous frames were not perfectly four-sided and straight. Waney edges and rounded shapes reflecting the original shape of the planks are frequently visible. This usage of lesser quality timber for the frames is also reflected in joggled surfaces. Although all frames were joggled, it was inconsistent and often with a poor finish not allowing for a snug fit against the hull planking. Frames were spaced quite regularly at distances between 40cm and 45cm. The frames are relatively consistent in their dimensions, measuring on average 25cm moulded and 15cm sided. All frames were fastened to the hull planking with two treenails per strake, 3cm in diameter, which were wedged outboard. The floor timbers were not fastened to the keel and had no limber holes (Pedersen, 1997).

Framing in the fishwell consisted of bulkheads and light framing timbers. The three bulkheads were placed fore and aft and a in the centre of the fishwell. Two light framing timbers with average moulded/ sided dimensions of c. 10cm by 15cm were placed between the central and fore and aft bulkheads respectively. Similarly to the timbers used for the fore and aft frames, much of the original roundwood shape of the parent timber was retained. The two fully preserved fore and aft bulkheads were made of two pieces placed on edge horizontally and all three bulkheads were fastened to the hull with treenails as well as spike nails (Pedersen, 1997).

Bottom, bilge and upper stringers/ port shelves provided longitudinal strengthening of the hull fore and aft with the exception of the fishwell where no stringers were fitted. All stringers were fastened to the frames with treenails, and secured with wedges from the inside (Pedersen, 1997).

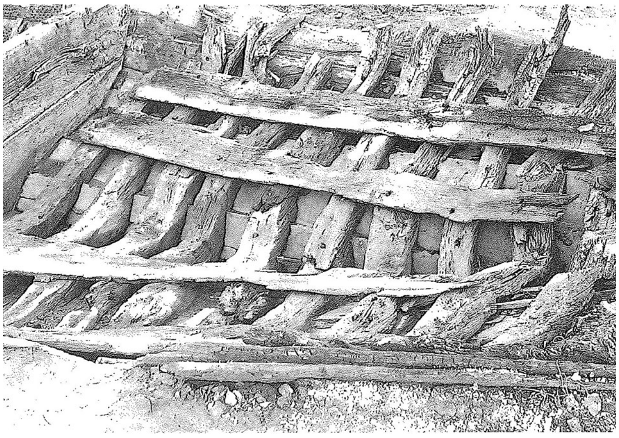

Figure 4-29: stern section of ZN42 showing stringers and alternating frames (Pedersen 1997, p. 35)

Mast step

The mast step was placed in the forward part of the vessel and consisted of a c. 3.5m long plank, measuring 49cm sided at the centre, tapering slightly to both ends and 11cm moulded (Fig. 4-26). A rectangular notch interpreted to have held the pump was located forward of the rectangular mast socket. Two rectangular chocks were placed at either side of the mast step, filling the gap between mast step and bottom stringers (Pedersen, 1997).

Decks

The presence of the fishwell required to accommodating decking accordingly. Consequently the wreck showed three decks, a forward deck, a fishwell deck and an aft deck (Figs. 4-24 and 4-26). As all decks had collapsed into the vessel, most structural components were preserved and reconstruction possible. As no other reference wreck has decking preserved, the structural elements are described in summarised form. Decks were made of planks longitudinally laid over the deck beams. The latter were using rider beams and waterways (Pedersen, 1997).

Conclusions and discussion

The extremely well preserved condition of ZN42 provided a unique insight into the vessels makeup, design and construction. The original vessel had an overall length of c. 17.2m, a beam of c. 5m and a depth of c. 2m. It was fitted with a single mast placed forward of amidships where the fishwell was located. Reconstruction of shape and displayed features made it possible to match the wreck with the historical ship type *watership* (Pedersen, 1997).

Structurally ZN42 is in many ways similar to bottom-based boats and ships from the Low Countries. This includes the use of a keel plank instead of a beam keel as well as the characteristic solution for waterproofing the hull using laths and sintels rather than placing the material between the plank seams. (Pedersen, 1997).

Despite the wealth of structural information from ZN42, two major aspects that have currently not been addressed would aid in deepening our understanding of this important wreck. Both aspects relate to the raw material used. Where was the oak for the construction sourced and secondly how were the planks converted. Nevertheless, ZN42 shows how clinker construction was used and adapted to build a specialised boat type, of which also bottom-based and carvel built examples are known. Without pursuing the reasoning in building a watership in clinker, ZN42 serves as an excellent comparative find.

4.6 Germany

4.6.1 Introduction

Continuing the trend observed for the majority of the Atlantic coastline covered in this chapter so far, the archaeological data for small coastal clinker built watercraft can be described as meagre. In total two reference sites are presented for the German North Sea coastline, matching the required criteria, the so-called Teerhof wreck and the Beluga ship (Fig. 4-23). Neither of those wrecks was discovered through diving surveys or offshore developments. Instead both were not only found in the same city, Bremen, but also during construction works near the River Weser. As intriguing as the similarities between both wrecks in find location, date and construction are, the absence of other reference sites from the remaining coastline and urban contexts is striking. The treacherous coastline of the Wadden Sea most certainly took its toll on ships and boats throughout history and remains an archaeological resource of tremendous value.

4.6.2 The Teerhof wreck, Bremen

Introduction

The remains of a clinker built vessels were discovered during riverfront construction works the River Weser in Bremen at the so-called Teerhof in 1978. Preliminary recording of the structural remains in-situ prior to recovery was undertaken with a view to carry out full documentation afterwards. Dating is entirely based on associated pottery, giving a terminus ante quem

Figure 4-30: Disarticulate mast step in stern section of the Bremen Teerhof wreck (Brandt, 1979 p. 325)

for the deposition of the wreck before or during the 16th century. Neither C14 dating nor dendrochronological analysis of timbers was carried out (Brandt, 1979). Equally no information regarding wood species or conversion methods is available. Photographs taken during the excavation of the wreck show the vessel lying on its portside and a number of timbers lying lose in the aft part of the wreck. These include the mast step, a potential stringer, a number of other unknown timbers (Fig. 4-30) and a capstan (Rech, 2004). Several of the portside frames seem broken and pushed down. While it appears that this is partly the result of the wreck having been distorted and flattened over the centuries by the weight of the overlying sediments, modern damage as part of the associated construction works may also have been responsible for some of the apparent damage. The absence of the stern rudder and presence of disarticulated structural timbers in the wreck may indicate that attempts to salvage the wreck were made in antiquity after the vessel had come to rest on the riverfront of the River Weser.

The wreck was not conserved and the vast majority of timbers appear to have been discarded over the years, thus not allowing revisiting this important find for more detailed documentation.

Keel

The keel was preserved to an overall length of 11m. As the bow and forward section of the vessel were not preserved the original overall length is unknown. However, as the vessel was believed to be two masted with the forward mast not represented in the archaeological record, the overall length of the vessel has been interpreted as being originally over 15m (Brandt, 1979).

Notwithstanding the absence of detailed documentation of shape and dimensions of the keel, a photograph taken during the cleaning of the wreck shows the keel and a section of hull planking fully exposed around the midships section of the vessel (Fig. 4-31). The port side garboard plank seems to be more or less in line the keels' inboard surface and fastened underneath it. A wing-shaped cross-section for the keel at least for the amidships part of the vessel thus appears likely. This indicates a very flat deadrise for the garboard strakes midships, which in turn may be of relevance for interpreting purpose and sailing characteristics of the former vessel. The above interpretation of the keel, however, will have to remain tentative in absence of detailed dimensions.

Figure 4-31: The Bremen Teerhof wreck under excavation (Brandt, 1979 p. 325)

The stern assembly

No detailed description of the construction of the stern assembly is published. Equally none of the available photographs give insight into shape and dimensions of the stern assembly. However, the mentioning of rudder gudgeons for a stern rudder clearly indicates that the vessel had a straight sternpost (Brandt, 1979; Brandt, 1994).

Planking

No descriptions or measurements regarding the hull planking are published. The following observations are solely based on the few published photographs showing the in-situ wreck. Ellmers' initial interpretation of the wreck to be of the cog building tradition in conjunction with reported finds of sintels from the wreck appear to speak for a mix of flush laid and clinker planking in the hull of the Bremen Teerhof wreck (Rech, 2004; Förster, 2009). However, nothing is known on the find circumstances or context of the sintels.

The two photographs taken during the excavation of the wreck show at least four strakes of preserved planking on both sides of the vessel (Figs. 4-30 and 4-31). The photograph showing a section in the aft part of the wreck gives good insight into the structural makeup from garboard to the fourth strake. Similarly the photograph showing the wreck during cleaning clearly shows the run of the keel and an exposed section of the port side hull planking. All planks appear to be clearly overlapping the ones below, while the visible section does not seem to depict evidence for flush laid planking. No further structural information such as plank dimensions, scarf or fastenings details exist and cannot be deduced from the available material with sufficient accuracy.

Framing

Similar to the planking no descriptions or measurements on the framing system or framing timbers have been published. Consequently the following observations and roughly estimated dimensions are solely based on the few published photographs of the in-situ wreck. Photographs taken during the excavation show a series of up to eight in-situ floor timbers in the aft part of the wreck. Several more frames, potentially side timbers are partially exposed in the sediment in the foreground in one of the photographs. As mentioned above, damaged ends of framing timbers protruding from the surrounding silts may be the result of the vessel having been flattened and distorted by the weight of overlying sediments.

The spacing between frames seems relatively irregular ranging between c. 10cm and 30cm. The visible floor timbers appear well finished to rectangular cross sections and sided dimensions of c. 10cm to 15cm. The foremost floor timbers seem to span over four strakes of planking on each side, while the adjacent floor timber seems to have spanned over at least five strakes. As the portside arm of this floor timber is damaged, this has to remain speculative. No joggles or other features associated with accommodating the frames to the underlying hull planking are apparent. The upper ends of the foremost floor timber are chamfered and most likely represent scarf joints to accommodate adjoining side timbers. Although not well visible on the floor timbers, circular holes in the surrounding hull planking indicate that wooden treenails were used to fasten the frames to the underlying hull.

Mast step

Although the exact original location of the mast step is not known, the disarticulated piece was found relatively far aft, thus leading to the interpretation that the vessel was originally fitted with two masts (Brandt, 1979; Brandt, 1994).

No documentation of the mast step survives. Information on size and characteristics consequently has to be deduced from the excavation photographs showing the timber in-situ (Fig. 4-30). In absence of reference scales the following dimensions are rough estimations and aim to provide a better understanding of the mast step in relation to the wreck. It appears to be c. 50cm to 60cm in length with a rectangular rebate cut into the centre to receive the mast. As the underside is not visible it is impossible to say whether scarfs for fastening the mast step over frames were present. Judging by the in-situ floor timbers underneath the mast step, it could have been fitted over no more than two floor timbers. The dimensions of the mast step would therefore most likely exclude a function to support a main mast. Assuming an original length between 15m and 20m for the original vessel, a positioning near the bow of the vessel to support a smaller forward mast appears more likely. As the mast step was found loose on top of the structurally intact hull, it should not be ruled out that it was salvaged from another vessel and ended up in this location by coincidence.

Seemingly a piece of the original mast was also among the recovered material. However, no further information, including dimensions are known (Rech, 2004).

Possible stringer or ceiling plank

A potential stringer or ceiling plank was found lying underneath the mast step and in line with the longitudinal axis of the vessel (Rech, 2004) (Fig. 4-30). Although possible that the plank rested in its original position, no documentary evidence exists to support this. Three relatively large circular holes are visible on the plank section forward of the mast step. These may represent treenail holes as used to fasten hull planking against the framing timbers. However, the holes are not aligned with the underlying frames, which may be an indication that the plank was either not in its original position or that a salvaged hull plank found its way into the hull of the vessel after its abandonment.

Conclusions and discussion

A preliminary assessment of the wreck compiled by Ellmers shortly after its discovery identified the remains as the aft section of a two masted vessel belonging to the cog building tradition. He furthermore suggested a date after 1500 due to the suggested two masts (Brandt, 1979).

Closer analysis of the few published and available photographs showing the wreck in-situ give a slightly different perspective to the conclusions drawn after the vessels' discovery in 1978. As the discussion on utilising typological terms, such as cog, for the interpretation and identification of shipwreck, is subject of chapter 6.3, it shall suffice to say that the interpretation as the Teerhof wreck belonging to the cog tradition without detailed explanatory discussions, can lead to misinterpretation of the actual archaeological data. The surviving photographs clearly show that the preserved and visible remains were solely clinker built without any evidence for a bottom based construction. Furthermore the interpretation that the vessel sailed with two masts cannot be seen as conclusive. The find circumstances of the mast step, which has been used to support such interpretation, neither allow deducing number and location of masts, nor can it be said with certainty that it originally belonged to the vessel. Similarly the estimation on original overall length of the vessel, which was based on the boat having been two masted has to be re-evaluated. The preserved photographs appear to show more or less the full extent of the preserved wreck up to roughly amidships. The exposed planking section does not appear to show a rise in the garboard angles, which would roughly indicate the remaining length towards the stem. As this is not the case it appears reasonable to assume an overall length between 15m and 20m for the original vessel.

As mentioned at the outset the Teerhof wreck was included in the study due to the ambiguous nature of the published information, which indicated potential relevance for the comparative analysis. Closer investigations and assessment of the wreck, however, show that both date range and size may not necessarily be in compliance with the reference parameters. Considering the scarcity of similar wreck finds not only from Germany but also from the wider North Sea region, the Teerhof wreck would have posed an excellent opportunity to investigate the nature and origin of watercraft operating in and out of Bremen.

4.6.3 The Beluga Ship, Bremen

Introduction

The Beluga ship, named after its place of discovery on the grounds of the Beluga Shipping GmbH, was found in 2007 during construction works on the Teerhof peninsula in the River Weser in Bremen (Fig. 4.23). The find location was thus relatively close to the above-described Teerhof wreck.

The wreck was preserved to an overall length of c. 7m and was found in relatively good preservation condition resting upside down and seemingly fastened in place with wooden stakes driven through the hull. These are, however, believed to be of later date and part of fishing activities. The preserved remains comprised eight strakes of the hull's portside as well as parts of keel and stempost (Fig. 4-32). The level of preservation continuously deteriorated from keel level to the upper strakes (Zwick, 2010). As the wreck was recovered structurally intact, certain constructional details could not be addressed in the documentation of the remains.

Dendrochronological analysis provided a date for the construction or repair of the vessel after 1447. As none of the sampled planks held sapwood the date gives an earliest possible felling date, taking an average value of sapwood rings into account. An interesting result of the dendrochronological analysis is that two clearly distinguishable groups of timbers became evident. The first is comprised of oak, which could be provenanced to the Baltic with high T-values for Polish chronologies. This first group further appears older with dates for earliest felling dates ranging between 1313 and 1402 and potentially concentrated to the lower hull of the vessel. The second group gave consistent dates for earliest felling dates around the middle of the 15th century with the oak originating from the area around Bremen. Of the three planks belonging to the second group one plank belonged to the articulated wreck and was part of strake eight (Zwick, 2010; Heußner, 2009).

Keel and stempost

The keel was partially damaged by the construction works leaving a c. 3m long section preserved (Fig. 4-31). It measured 11.3 cm sided at the broken end and tapered to 6.5cm at its forward end. No rabbets to receive the garboard strakes were cut into the keel, meaning that the garboard planks were simply nailed against the flush side surfaces of the keel, which showed a V-shaped cross-section at its broken end turning more to a U-shape at the forward end.

The stempost was joined with the keel just below the transition from keel line to the gentle upward curve of the keel. A vertical scarf, 25cm in length, joined keel and stempost. A c. 18cm long iron nail driven at an angle of c. 45° secured the joint.

Planking

All planks were radially split and made of oak measuring on average 20cm in width and 2.1cm in thickness. The width of overlaps between planks on adjoining strakes varied but had a min. width of 2.5cm. Scarfs joining planks on the same strakes were between 15cm and 20cm long. Outboard facing lips of the scarf tables were worked to feathered ends, almost giving a flush surface texture. Plank seams and scarfs were waterproofed with a material comprised of sheep wool and tar.

Plank overlaps were fastened with square shafted iron nails measuring on average c. 55mm sided. The nails were secured by riveting the nails over rectangular roves. A number of nails with bent nail tips were found disarticulate from the wreck and their original purpose or location could not be determined. The spacings between nail fasteners are quite irregular. In comparison the garboard strakes appear to have been fastened with an unusual high number of nails to the keel.

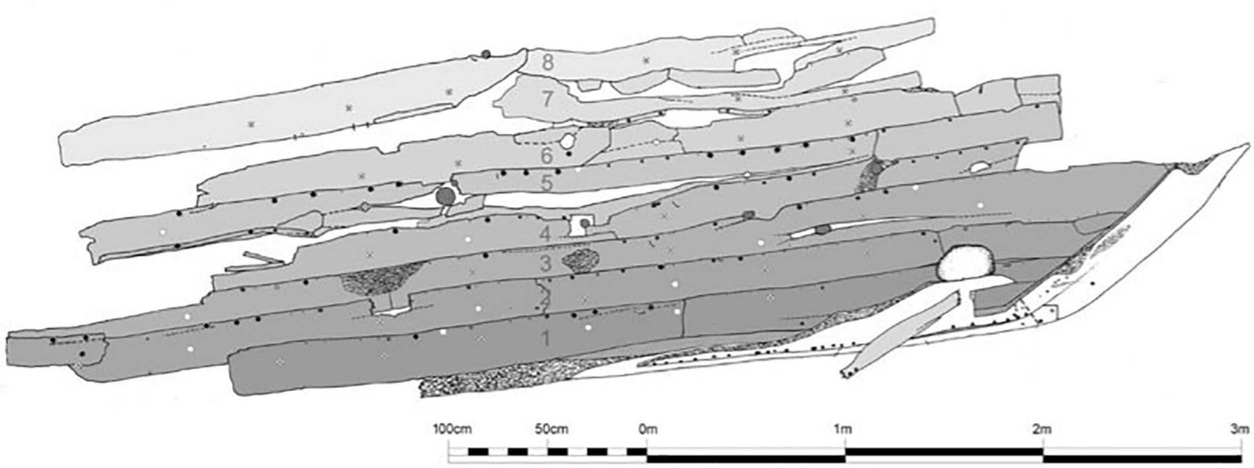

Figure 4-32: Site plan of the Beluga ship (after Zwick 2010, p.64)

Framing

All frames appear to have been removed prior to the deposition of the vessel. Therefore clues to framing of the original vessel have to be deduced from the fastening positions with the underlying hull. By measuring the distances between treenail holes it became apparent that the distance between frames was quite regular and measured c. 50cm. Most treenails were broken as a result of the frames having been removed (Zwick, 2010).

Conclusions and discussion

As the wreck was positioned upside down and without internal framing attempting to reconstruct shape of the original vessel was deemed not feasible. Considering the weight of overlying sediments the structural components most certainly changed shape significantly over time. Furthermore the preserved remains constitute the lower section of the bow section of the vessel, thus not providing any insight into the upper hull, amidships or aft half of the original boat. The seemingly deliberate removal of framing timbers from the wreck, indicates that the boat was decommissioned and either abandoned or deliberately placed in its find position and location. Since the find location is on a known medieval shipbuilding site, the latter scenario is certainly possible.

Zwick believes that the hull section found at the Beluga site may have served as a basic working platform or riverbank revetment (Zwick, 2008). He further states that constructional details, such as the use of radially split oak planks, the usage of animal hair as waterproofing material and clinker construction would speak for a southern Scandinavian origin. Furthermore based on the preserved dimensions he believes that the vessel was operated regionally in coastal waters of the western North Sea rather than long distance trade. The overall interpretation therefore identifies the Beluga ship as a vessel built in the southern Scandinavian tradition and finding its final resting place in Bremen (Zwick, 2010).

The results of the dendrochronological analysis shed an interesting light on the Beluga ship. Nevertheless the results should be viewed with due care as the absence of sapwood prohibits placing the wreck into a narrow date range. Furthermore the limited number of samples overall and small number of samples from known positions within the wreck, place restrictions regarding drawing conclusions on construction and repair of the original vessel. Notwithstanding these limitations the consistency within the samples does point to the lower hull potentially being built from Baltic oak, while the upper part may have been built using locally sourced timber or represent repair measures (Zwick, 2010). The use of raw material from mixed sources is also e.g. evident in the Dokøen wrecks found in Copenhagen (see chapter. 4.7.4) and raises the question why potentially imported wood was used in addition to locally sourced material. While the planks made from local materials in the Dokøen wrecks were sawn, the Beluga ship planks appear to have been radially split. The important aspect of choice and wood quality for the construction of small seagoing watercraft during the later Middle Ages and Renaissance are discussed in more depth in chapter 6.2.

As one of the extremely scarce examples of small clinker built ships found on the German North Sea coastline the Beluga ship plays an important role in gaining a deeper understanding of small-scale watercraft and seafaring in the North Sea during in the outgoing medieval period.

4.7 Denmark

4.7.1 Introduction

As outlined in chapter 2 Denmark plays a significant role due to a well-established maritime archaeological research tradition and a wealth of ship and boat wrecks from the Middle Ages into the early modern period. Nevertheless, it has to be kept in mind that reference sites used for this study were exclusively found in the Baltic Sea (Fig. 4-33). Although the focus of this thesis lies on wrecks found on the European Atlantic coastline, a number of wrecks matching the perimeters

Figure 4-33: Map of reference sites in Denmark (Schweitzer 2013)

of the study have been included for two reasons. Firstly the Danish islands in the Baltic Sea can be seen as a transition or contact zone between the Atlantic and the Baltic Sea. Although ships and boats may well have been built to suit the sailing environments between the Danish Islands with strong currents and inherent wind conditions, certain overlaps in structural solutions, building traditions or innovations cannot be ruled out.

Consequently it is endeavoured to provide a good descriptive account of boats from Danish waters in the period in question whilst restricting the level of detail to ensure that the balance to the Atlantic reference material is kept. As such potential reference sites where size and date are doubtful are not included in this chapter. This includes e.g. the articulated segments from a late 16th century clinker vessel found in Copenhagen Havnegade where certain construction elements, such as relatively dense framing and presence of futtock riders indicate that the remains may have belonged to a larger vessel (Gøthche, 1996; Bill, 1997a). Furthermore the wreck discovered in 1968 during construction works at the Danish National Bank has not been added as only a small number of timbers were retained following the excavation (Bill, 1997a) and in the overall value for comparative analysis is outweighed by the high number of wrecks from Denmark fulfilling the set criteria.

4.7.2 Amager Strandpark

Introduction

The remains of a small clinker-built vessel were discovered during construction works on the beach park on the Island of Amager near Copenhagen (Fig. 4-33) in 2004 and subsequently excavated, recovered and recorded by the Viking Ship Museum, Roskilde. The preserved remains were spread out over an area c. 9m length and c. 3m width. However, only a section of c. 4.5m length by 2.5m width comprised the stern section of the partially structurally intact vessel (Fig. 4-34). Positioned upside-down, the intact remains consisted of several strakes of port and starboard side planking as well as floor timbers, which by and large had come detached from the boat structure. Although, the keel was not preserved, the fragmented timbers belonging to stem and stern were among the excavated material (Ravn, 2011). Dendrochronological analysis gave a felling date for the timbers between 1560 and 1570 using locally sourced oak (Daly, 2008a).

Keel

As mentioned above the keel was not preserved. Nevertheless the preserved stem and stern sections as well as garboard strakes allow reconstructing certain aspects of the keel. While the arrangement of garboard strakes leads Ravn to the conclusion that the keel most likely had a T-shaped cross, section, the dimensions of stem and stern timbers indicate moulded/ sided dimensions of c. 9cm by c. 10cm. Wear on the underside of the stem hook is further seen as evidence that the vessel was frequently beached, which may have damaged the keel. A number of iron nails on the underside of the stem hook are seen as evidence for a secondary attached false keel (Ravn, 2011).

Stem assembly

As mentioned above the stem section of the keel was not preserved. The only indicators of the former construction are the fragmented stem-hook and a gently curved compass timber interpreted as a stem-gripe or stem hook. The stem hook was preserved over a length of c. 1.5m and was fastened to the keel with an oblique stepped scarf. The upwards-rising arm of the stem hook describes a gentle curve and rebates are cut into both sides to receive the plank hood ends similar to the sternpost (Fig. 4-35). Traces of a vertical stop scarf connecting the piece with the stempost are visible near the upper edge. Nail holes indicate that the scarf was secured with spike and riveted nails. A circular hole with wear marks is located roughly in line with the second strake on the forward part of the timber and is interpreted as a dragging hole (Ravn, 2011).

Sternpost

The fragmented piece of the sternpost measures c. 95cm in length. As both ends are broken, original fastening and angle to the keel cannot be determined. Equally the connection of the sternpost to the keel remains tentative. Based on comparative contemporary finds the sternpost is believed to have been mortised into the keel. Rebates to receive plank hood ends are cut into both sides of the timber. A four-sided compass timber with iron nail and treenail holes is interpreted as a stern knee, which would have been internally fastened against keel and sternpost. A number of nail holes aft of the hood end rebates are interpreted as gudgeon fasteners and therefore indicators that the vessel was fitted with a stern rudder (Ravn, 2011; Gøthche, 2004).

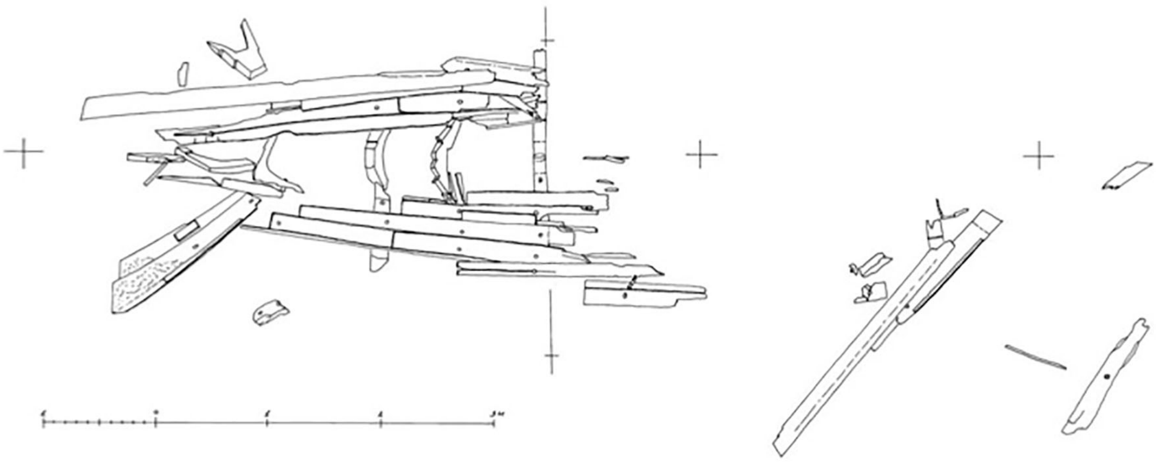

Figure 4-34: Site plan of the Amager Strandpark wreck (by Gøthche; Ravn, 2011 Fig. 3)

Planking

All planks are radially split and measure on average 24cm in width and 2.5cm in thickness. The planks were fastened with square shanked iron nails riveted over roves, which were spaced at c. 16cm intervals. Lands measure on average c. 4.5cm in width and grooves have been planed into the plank overlaps to receive the waterproofing material, which consisted of twined wool. Scarfs between planks on the same strakes open towards the aft end and are on average c. 25cm long and show distinct lips at their ends (Ravn, 2011).

Repairs are evident by numerous former iron nail holes filled with wooden plugs. Repair patches were furthermore applied to the outboard surfaces of several planks (Ravn, 2011). Specific arrangements of iron nails paired with plugged nail holes are seen as evidence that entire planks were replaced (Gøthche, 2004).

Framing

Of the framing timbers eleven floor timbers are preserved, while none of the side timbers survived. Spacing between frames was relatively regular with an average distance between 60cm and 65cm. The outboard facing surfaces of the floor timbers appear consistently joggled to provide a snug fit against the underlying hull planking.

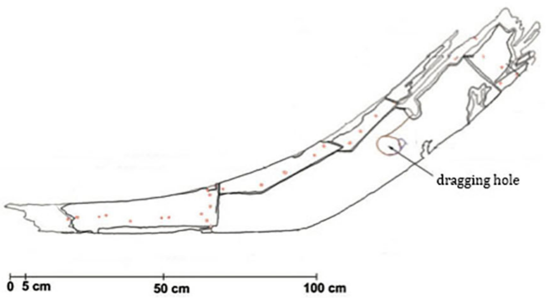

Figure 4-35: Stem hook of the Amager Strandpark wreck (after Ravn, 2011 Fig. 6)

The frame timbers were fastened to the hull with treenails mainly made of conifer and measuring c. 2cm in diameter. Heads with a diameter of c. 2.8cm were observed on the external hull surface, thus indicating that the treenails were driven from outboard to inboard. Nail holes belonging to iron spike nails were observed on the inboard surfaces of a number of floor timbers and may have belonged to spike nails fastening stringers or ceiling planking to the frames (Ravn, 2011).

Rebates measuring c. 21cm in width and 2.8cm in depth were cut into the saddles of four floor timbers. The rebates are believed to have accommodated the keelson or mast step, fastened to the underlying frames with iron spike nails (Ravn, 2011).

Conclusions and discussion

Based on the archaeological evidence the Amager Strandpark ship is reconstructed with an overall length of 11.5m with eleven frame stations, a transom and two breast-hooks in the bow as well as three to five crossbeams. In his reconstruction Ravn concludes that the beam of the vessel was widest just aft of amidships, which would be in contrast to other contemporary vessels, such as the Bredfjed ship where the widest point appears to have been forward of amidships. Ravn sees this as a potential deliberate choice whereby the ship would have been built to suit the sailing environment on the Sound. He bolsters this hypothesis with local watercraft from the early 20th century, the *sundbåde*, which show a similar design of widest beam aft of amidships and sharp bow (Nielsen, 2005). The cargo capacity of the Amager beach park ship is calculated to c. 9.5 tons and thus interpreted as a small cargo vessel used for local trade but equally capable of being used for fishing. Heavy wear marks on the underside of the stem lot with associated secondary fitting of a false keel in conjunction with the equally worn dragging hole are seen as evidence that the Amager Strandpark vessel was frequently beached (Ravn, 2011).

Although levels of preservation prohibited a more detailed understanding of the vessels' construction, including masts and keel-stem-stern assembly. Much of the reconstruction of the boat is based on comparative ship finds in Danish waters and may not fully represent the actual original structure of the Amager Strandpark ship, including the hypothetical mortise-and-tenon joint with stem-knee fastening between keel and stempost. Nevertheless the apparent co-existence of clinker vessels with radially split oak planks alongside sawn planks during the second half of the 16th century is an important observation regarding the nature and organisation of boat building in Renaissance Denmark. Equally reconstructed shape and potential rigging arrangement are placed in the local context, taking into account that such a small locally made vessel was made with the requirements for usage and operational waters in mind.

4.7.3 The Bredfjed ship

Introduction

The Bredfjed ship was originally found in 1967 during construction works with basic recording and documentation carried out the process. It was not until 1993, however, that the site was re-visited and full excavation, documentation and post-processing were undertaken as part of a comprehensive research project. The wreck was located on the southern coast of the island of Lolland and Bredfjed formerly formed one of many small islets flanking the shallow mouth of Rødby Fjord prior to extensive land reclamation works in the 1860s (Bill, 1997a) (Fig 4-33).

The wreck comprised the relatively intact lower part of the hull but had been damaged by the construction works in the 1970s when a sewer trench was cut through the aft half of the wreck. It was found more or less upright, slightly heeled to the portside and both sides were found well preserved amidships up the eighth strake (Fig. 4-36). In addition parts of the ninth strake were preserved on the starboard side while the lower portside was relatively intact up to the twelfth strake. The archaeological investigations showed that significant parts of the upper structures had been removed in antiquity, possibly salvaged shortly after the vessels' demise (Bill, 1997a). Dendrochronological analysis was carried out following the excavation, including samples from planks as well as frames. All elements are made of oak. Three of the sampled timbers contained sapwood, thus allowing to narrow their felling date to c. 1593-1600. Initial analysis suggested a potential origin of timbers in the Schleswig-Holstein area of Germany (Bartholin, 1997), an interpetation which has been relativised (see below).

Keel

The keel is preserved to its full length of 9m with moulded/sided dimensions of c. 20cm by 20cm. It is U-shaped in cross-section and rabbets have been cut into the sides to receive the garboard strakes. The outboard facing surface of the keel shows evidence for wear (Bill, 1997a).

Stem assembly

Although the actual stempost was missing the large stem hook was found well preserved (Fig. 4-37). It measures c. 3.6m in length and is of a somewhat intricate shape. The horizontal arm,

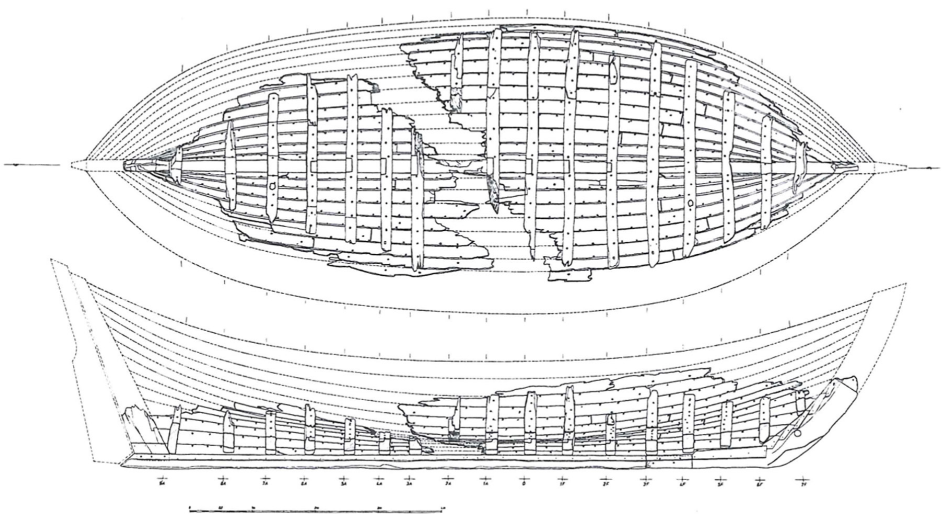

Figure 4-36: Site plan of the Bredfjed ship with reconstructed lines (Lemée, 2000 p. 27)

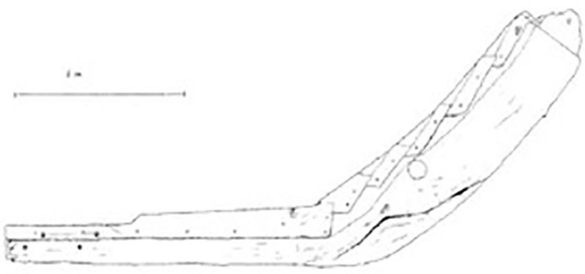

Figure 4-37: Stem hook of the Bredfjed ship (after Bill, 1998 Fig. 7)

which measures c. 1.1m in length and 20cm sided, increases slightly in height to 31cm from the keel scarf to the upwards-curving arm. This increase is continued on the rising arm to max. 49cm. The enclosed angle between the gently curved upper and horizontal arm is roughly 45°. The horizontal arm continues the garboard rabbet and rebates accommodating the plank hood ends are carefully cut into both sides of the upper arm. A circular hole of 10cm diameter, with worn edges fore- and downwards, is placed between strakes three and four. Stem hook and keel were joined with a vertical, butt-ended scarf, 72cm in length, which was fastened with four treenails and several spike nails (Bill, 1997a).

Sternpost

The sternpost was composed of a single piece of timber preserved to a length of c. 1m. A tenon was worked into the lower end connecting it with the keel while the original top end is missing. Fitted into the matching mortise in the aft end of the keel the sternpost stands at an enclosed angle of 75° to the keel. The sided dimensions taper from 21cm inboard to 10cm outboard. Remains of iron concretions on both sides of the sternpost may have belonged to stern rudder fastenings. Similar to the stem hook, rebates to receive the plank hood ends are cut into both sides of the timber. Further to the rebates lands to accommodate the garboard strakes were worked into both sides and across the full width of the sternpost, indicating that the garboard planks extended to aft end of the post (Fig. 4-38). This is seen as an additional fastening arrangement to secure the mortise-and-tenon-joint between keel and sternpost (Bill, 1997a).

Planking

All planks were made of oak and sawn from the parent logs. The strake arrangement, i.e. the distribution of scarfs to both sides of the hull was distinctly symmetrical. The deviation between the mirrored scarf positions was remarkably small with an average deviation of 4.2cm (Bill, 1997a).

Width varied significantly between 18cm and 33cm with an average of 28.6cm. Plank thickness also varied but was on average 3.6cm. Lands were bevelled to ensure a correct fit in the hull and to receive the waterproofing material. Planks were fastened to each other using square or rectangular shanked iron nails, measuring c. 7mm sided, with round heads and riveted over rectangular roves. Nail spacings varied between 17cm and 32cm with no apparent systematic pattern. Adjoining planks on the same strakes were joined with long scarfs, lipped inboard and outboard, measuring on average 25cm in length. Plank seams and scarfs were mostly waterproofed with a material made of cattle hair, while one sample indicates the use of wool as raw material, and vegetable matter is associated with secondary waterproofing (Bill, 1997a).

Repairs to hull planking are evident in shape of additional clench nails, which served to seal leaks in plank seams. By assessing the distribution of additional nails in the wreck, a concentration became apparent on the port side midship section (Bill, 1997a).

Framing

Sixteen frame positions were recorded in the wreck, each one comprised of a floor timber joined with scarf joints to side timbers. The frames were spaced relatively even with most distances between frames lying between 60 and 66cm. All preserved floor and side timbers were joggled to a snug fit over the hull planking (Bill, 1997a).

Floor and side timbers were made of naturally curved compass timbers of good quality oak,

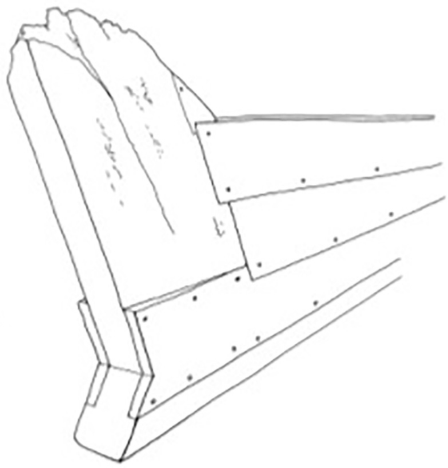

Figure 4-38: Schematic reconstruction of the Bredfjed stern assembly (by Bischoff; Bill & Gøthche, 2006 p. 64)

indicated by the full-bodied nature and absence of waney edges, irregular shapes and bad knots. Sided dimensions are relatively regular and vary between 15cm and 20cm. The floor timbers show more variations in the moulded dimensions but are generally similar to the sided measurements. Nevertheless floor timbers near the bow are heavier, coinciding with a slightly denser spacing of the frames, indicating that stronger lateral support was required in the forward part of the vessel. All floor timbers have limber holes cut into the keel-facing surface, mostly cut to a rectangular shape. As mentioned above floor and side timbers were joined with long flat scarfs and fastened with treenails and iron spike nails. None of the small number of fragmented side timbers is preserved to the top end (Bill, 1997a).

Fastening between hull planking and frames shows a consistent pattern. Treenails of 3cm in diameter and made of juniper with domed heads were driven from outboard to inboard and secured from inboard with wedges made of oak. Furthermore frames were consistently fastened to all strakes with the exception of the garboard strake (Bill, 1997a).

Keelson or mast step
No keelson or mast step was found among the archaeological material. Its original position in the vessel was evident by notches cut into the saddles of eight floor timbers. Although the width of the notches varies, it clearly is at its widest towards the middle and tapering towards the ends. No fasteners, such as treenails or spike nails, to secure the keelson/ mast step are evident (Bill, 1997a).

Stringer and floor planking
No clear evidence for the potential former presence of stringers or ceiling planking was found. A small number of spike nails over a number of frames suggest that a short plank was fastened in this position. Two loose boards found within the wreck are interpreted as part of original floor planking. Their find location appears to indicate that they were formerly placed in the stern and the foreship (Bill, 1997a).

Reconstruction
The Bredfjed ship was subjected to full-scale reconstruction including masts and rigging (Fig. 4-39). Basis for the reconstruction formed the archaeological evidence from the wreck with good indications towards size and shape up to the eighth strake. The remaining structure was reconstructed using profile drawings, knowledge on inner and upper structural elements as well as comparative ship finds and pictorial sources (Lemée, 2000a). However, as bow and stern were not as well preserved as the midships section, their reconstruction has to be seen with greater caution. Nevertheless the preserved parts of stem and sternpost give an indication towards general shape. The final reconstruction describes the Bredfjed ship with an overall length of c. 13.4m, a beam of c. 4.9m and a height amidships of c. 2m (Bill, 1997a).

In terms of shape, the Bredfjed ship and interpretative reconstruction show a vessel with a sharp keel and relatively flat bottom with a slightly rounded chine. The bow appears full and the stern quite slender with sharp underwater hull fore and aft. These characteristics would have given the vessel good stability even when not fully loaded. Displacement was calculated on the basis of a 60 percent load line to 16.5 tons giving a draught of c. 1m (Bill, 1997a).

The only clear evidence to the Bredfjed ships' rigging are the notches cut into the floor timbers to receive the keelson or mast step. Using this in combination with contemporary written and pictorial evidence, a hypothetical rigging arrangement was reconstructed. As the position of the mast step indicates a relatively far aft position for the mast, a two masted rig was reconstructed. Based on current knowledge of contemporary boats of this size the main mast is believed to most likely have carried a square sail, while a sprit sail or square sail are possible for the fore mast (Bill, 1997a; Lemée, 2001).

Conclusions and discussion
The high level of preservation supplemented with detailed archaeological analysis and research enabled the identification of a number of striking structural characteristics of the Bredfjed ship. These are most notably the structural makeup of the stern, the symmetrical strake arrangement and the homogenous use of sawn oak planks for the construction. Further to these prominent structural features, Lemée investigated whether it was possible to identify if the vessel was built utilising a specific measurement system. He based his approach on the dendrochronological analysis, placing the origin of the timbers potentially to the Schleswig-Holstein area of Germany. Since the Lübeck inch/foot system, which was used in Schleswig-Holstein between 1584 and 1768/9 is well known a meaningful comparison with the Bredfjed ship timbers. The results of this exercise showed that the measurements of the Bredfjed timbers match extremely well with the

Lübeck inch/foot system with only small deviations. Lemée thus sees it as highly likely that the Bredfjed ship was built according to the regionally used measurement system (Lemée, 2000a).

All of the above-described factors are therefore important for placing the wreck into the wider comparative context as they are of substantial significance in terms of building tradition, socio-economic background and conceptualisation of building a clinker boat in such an "unconventional" manner. Symmetrical strake alignment and adherence to a measurement system strongly indicate variations to the commonly accepted conceptual basis of medieval clinker boat building. Bill believes that the Bredfjed ship is strongly influenced by Dutch carvel or bottom-based boat and ship building traditions. He further sees it as likely that it originally served as a ferry between Fehmarn and Rødby harbour due to its find location and the historically attested existence of ferry services between both places (Bill, 1997a; Bill & Gøthche, 2006).

As Daly has stated in her re-assessment of the dendrochronological data, the homogenous nature of the treering data from the Bredfjed ship suggests that the oak used to build the vessel was sourced from a confined local area. Although pinpointing the exact geographic origin is currently not feasible due to an insufficient density of local treering data, Daly believes that the Bredfjed ship timbers most likely originated from the German side of the Fehmarn- Rødby ferry route (Daly, 2007).

Given the combination of local character in combination with potentially externally influenced structural features, the Bredfjed ship plays an important role in gaining a deeper understanding of change and continuity in nature and organisation of small scale clinker boat building during the Renaissance.

4.7.4 Copenhagen opera house – The Dokøen wrecks

Introduction

Five wrecks dating from the 15th to the early 19th century were found in 2001 during construction works on the grounds of the Copenhagen opera house (Fig. 4-33). As the area is known as Dokøen, the wrecks have been named accordingly. Three

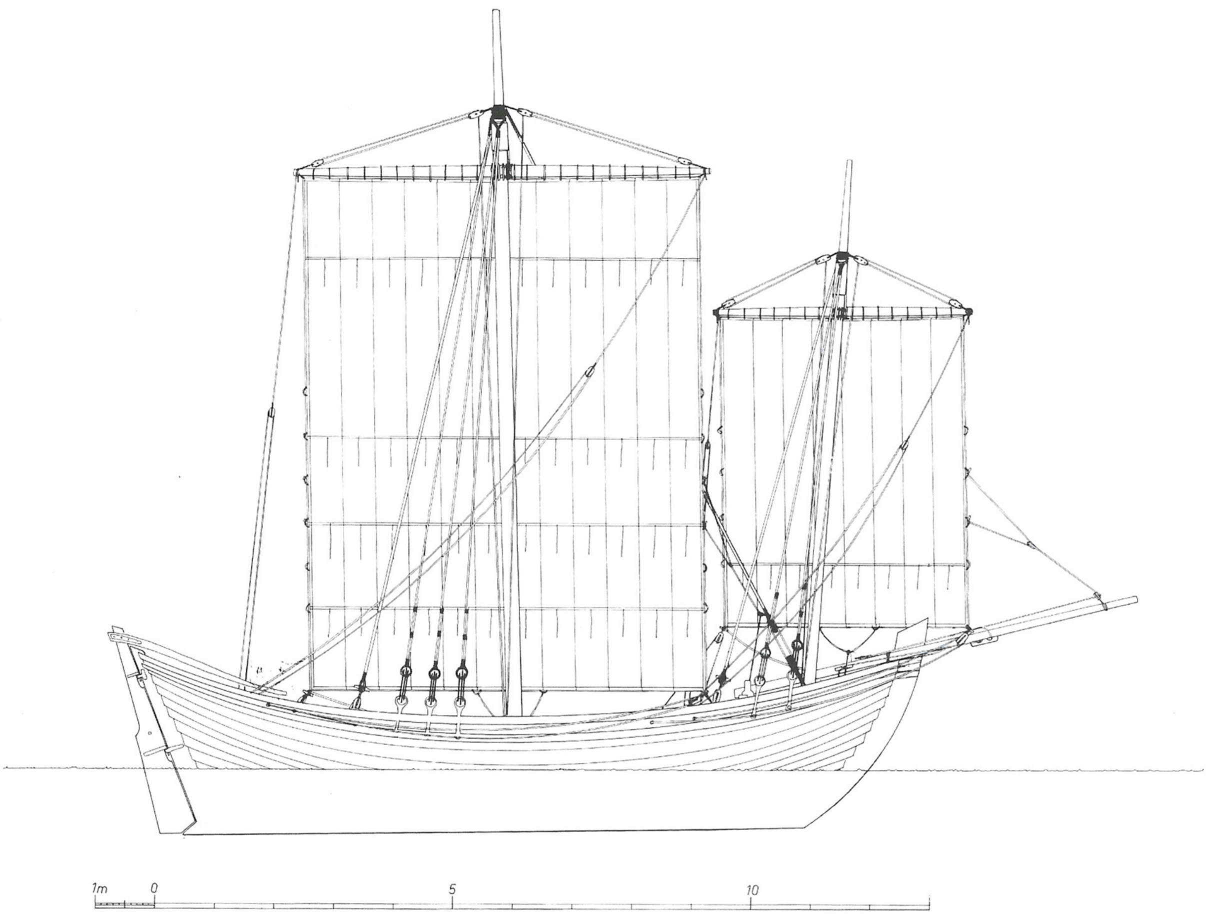

Figure 4-39: Reconstruction of the Bredfjed ship (Lemée, 2001 p. 19)

of these, wrecks 2, 3 and 4, date to the early 15th century. Wreck 3 was the best preserved, while very little survived of wrecks 2 and 4. All wrecks were covered by scattered rocks (Gøthche & Høst-Madsen, 2001; Høst-Madsen, 2007). Consequently the focus is placed on the best preserved and best analysed wreck 3, whereas wrecks 2 and 4 are presented in summarised form. As the wrecks are of roughly contemporary date and share significant structural features, concluding remarks and discussion is undertaken for the assemblage as a whole rather than on an individual basis at the end of the paragraph.

Dokøen 2

Structural remains

The preserved remains of wreck 2 were approximately 10m long and comprised the fragmented keel and hull planking while framing timbers were missing entirely (Fig. 4-40). The keel was made of oak and was preserved over a length of c. 10m, which is believed to be close to its original length. The exact shape in cross-section is not known, but rabbets for garboard strakes are reported on both sides. A scarf joint of unknown design was preserved on the forward end of the piece. Hull planking was made of radially split oak planks in the lower and sawn planks in the upper strakes and comprised two portside strakes as well as eight starboard strakes. The lands on plank overlaps show no decorative moulding and planks were fastened with iron clench nails of square cross section, fastened with rectangular roves. The waterproofing material sealing the plank seams consisted of animal hair. Repairs to the planking were evident in several places but are not specified. Despite the absence of framing timbers, an average distance between frames of c. 60cm and approximate sided dimension of c. 20cm could be established through treenail holes and impressions on the hull planking (Gøthche & Høst-Madsen, 2001). Dendrochronological analysis of the timbers provided an approximate felling date for the timbers of 1405 with evidence for repair c. 1425. The origin of the timbers was established to be from the southern Baltic, most likely Poland and relatively weak internal correlation indicates that the timbers came from a wider geographic area rather than a single source (Eriksen, 2001; Daly, 2007).

Dokøen 3

Introduction

As mentioned above, wreck 3 was the best preserved of the three wrecks. Its overall preserved length was with c. 11m almost identical to wreck 2 (Fig. 4-41). The articulated structure comprised, keel, hull planking, framing timbers, ceiling or floor planks as well as fragments of cross-beams. Neither stem, nor sternpost was presented in the archaeological material. Although in some aspects quite similar to wreck 2, the dendrochronological analysis of wreck 3 showed an additional significant aspect. The vessel was constructed using radially split oak planks in the lower hull while sawn planks were used for the upper parts. The radially split planks match wreck 2 quite well regarding date (c. 1420 – 1425) and provenance. The sawn planks, including the keel, matched best with southern Scandinavian tree ring curves (Bonde & Eriksen, 2002; Daly, 2007). The implications of these results are presented following the description of the individual hull elements.

Keel

The keel of wreck 3 is made of oak and its length of c. 9.80m constitutes the full original length. The cross-section changes from T-shaped forward to a U-shape with rabbets aft (Fig. 4-42). It measures 18cm sided amidships tapering to c. 12.5cm at both ends. The moulded dimensions vary from 23.5cm aft to 18cm at the bow. Deadrise angles are recorded with c. 87° at both ends decreasing substantially with the change to the T-shaped

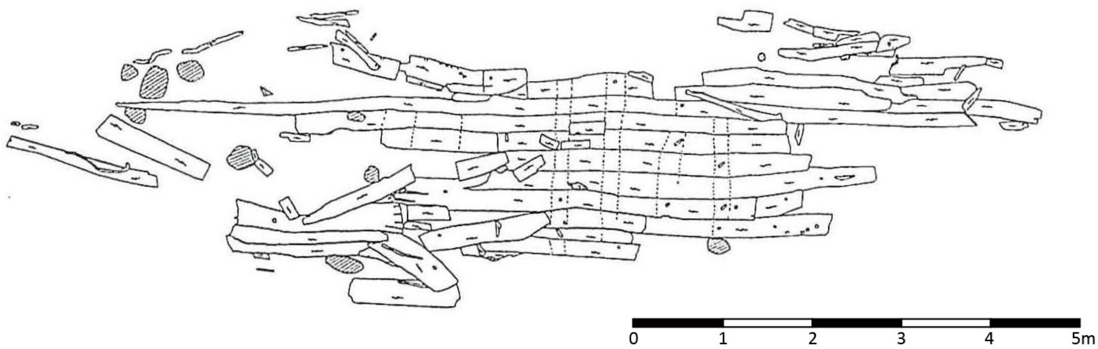

Figure 4-39: Site plan of Dokøen 2 (after Gøthche & Høst-Madsen, 2001 p. 30)

profile amidships where it decreases up to 17°. Stem and keel were joined with a vertical diagonal scarf and fastened with several iron nails. The keel-stern transition was evident in shape of a mortise, cut into the top aft end of the keel. The missing sternpost was placed in position with a matching tenon and the joint secured with two treenails penetrating through the joint horizontally. A shallow rectangular rebate extends forward of the mortise. The aft end of the keel tapers to a skeg, indicating that the vessel was originally fitted with a stern rudder (Fig. 4-43). Wear on the underside is interpreted as evidence of occasional beaching (Nielsen, 2012).

<u>Hull Planking</u>

As mentioned above all hull planking was made of oak. Most planks were radially split planks with a small number of sawn which appear to have been exclusively used for the uppermost strakes. As the wreck was found resting on the starboard side up to thirteen strakes of planking were preserved starboard while only the garboard and second strakes were partially preserved on the port side (Gøthche & Høst-Madsen, 2001). Three to five planks formed the individual strakes. Plank lengths varied significantly between 73cm and 6.87m but main groups regarding lengths were identified; the first with length ranging between 1.20m and 2.36m and the second with longer planks of lengths between 4.3m and 5.37m. Width ranges between 22cm and 25cm and the average thickness is recorded as c. 2.5cm. Lands vary in width but are on average 5cm wide, show decorative mouldings but are bevelled to accommodate the waterproofing material. Scarfs joining the planks lengthwise were relatively long, measuring on average 21cm in length and worked to feathered edges. Planks were fastened

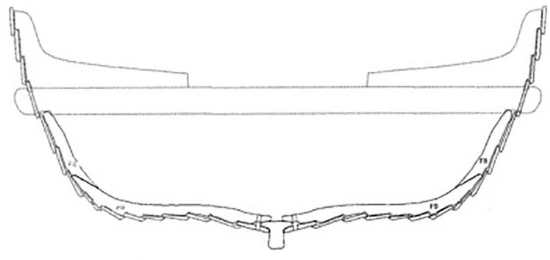

Figure 4-42: Reconstructed cross-section of Dokøen 3 Gøthche & Høst-Madsen, 2001 p. 32)

to each other with square shanked iron clench nails measuring 7mm sided and secured with rectangular roves. Whether the nails were bent or riveted cannot be said with certainty. Wool was used as waterproofing material between plank seams and scarfs (Nielsen, 2012).

A variety of intentional marks were observed on the plank surfaces, which are by and large interpreted as score marks made by the boat builder as an aid during the construction process. Repair to the hull structure was evident in shape of replaced planks, which had been sealed with waterproofing material consisting of wool and occasionally moss (Gøthche & Høst-Madsen, 2001; Nielsen, 2012).

<u>Framing and stringers/ ceiling planking</u>

All frame timbers were naturally curved compass timbers largely sourced from oak branches. Most frames parallel sided and only where the girth of the parent timber was of insufficient girth to fully box the frames into shape the timbers show waney edges, rounded shapes and on occasion even bark edge. Overall eleven fragmented framing timbers survived showing that frames consisted of floor timbers, side timbers and top timbers joined with horizontal through scarfs

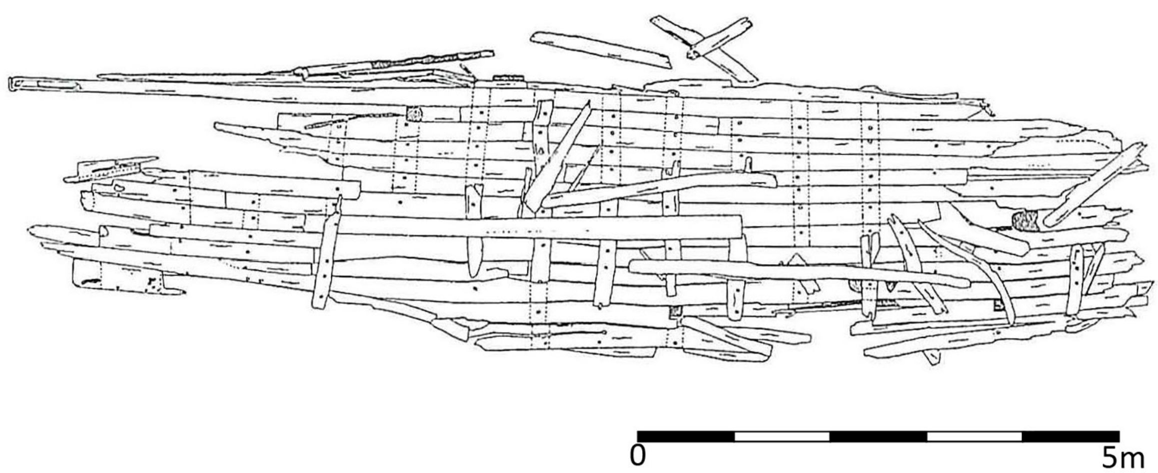

Figure 4-41: Site plan of Dokøen 3 wreck (afer Gøthche & Høst-Madsen, 2001 p.30)

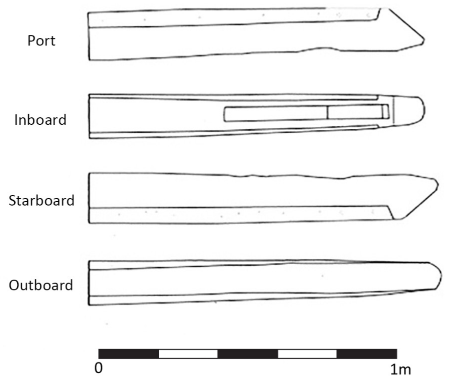

Figure 4-43: Stern end of keel of Dokøen 3 with skeg (after Nielsen 2012, p. 31)

(Fig. 4-42). Originally 14 frames were placed in the vessel, spaced relatively regular at distances between 65cm and 70cm. The moulded dimensions had an average value of 9.62cm and the sided dimensions were on average c. 16cm. All framing timbers were joggled to provide a tight fit against the hull and limber holes appear to have been cut to either side of the keel into the joggled surfaces. Frames were fastened to the hull planking with treenails and secured with wedges from inboard (Nielsen, 2012).

Three stringer or ceiling planks were found in-situ amidships, which had been placed at regular intervals around the turn of the bilge and fastened to the frames with iron spike nails (Gøthche & Høst-Madsen, 2001; Nielsen, 2012).

Crossbeams

The uppermost strake showed evidence of three crossbeams protruding through the hull, measuring c. 15cm by 18cm in cross-section (Fig. 4-42). Two openings, however, had been closed and sealed during the lifespan of the vessel with externally applied plank patches and water-proofed with a linen cloth. The closed cross-beam cut-outs are interpreted as a possible measure to increase the vessels' freeboard and cargo capacity by adding strakes and moving cross-beam positions (Gøthche & Høst-Madsen, 2001; Høst-Madsen, 2007).

Reconstruction

Based on the preserved remains an overall former length of the vessel of c. 13m is reconstructed with a height amidships of c. 2m and a beam of c. 3.8m. Although both stem and sternposts are missing, the vessel can be reconstructed with a straight stern and curved stem (Fig. 4-44). The mortise-and-tenon joint evident in the aft end of the keel is a clear indicator to a straight stern, fastened with two treenails and a stern knee fitted into the shallow rectangular rebate next to the mortise. The position of the forward keel scarf set back in the preserved hull structure indicates that a stem hook was originally placed in this position Nielsen further concludes that the flat bottomed shape extending over much of the vessel's length indicates that it was built to meet the demands of a cargo carrier. The stones covering the wreck site may indeed have been the last load of cargo carried (Nielsen, 2012).

Dokøen 4

Structural remains

Only a small section of intact hull planking alongside a spread of disarticulate planks were preserved of wreck 4 (Fig. 4-45). No framing or other structural elements had survived. The articulate hull section is comprised of five strakes of radially split oak planks. Scarfs joining the planks lengthwise are long, measuring between 22cm and

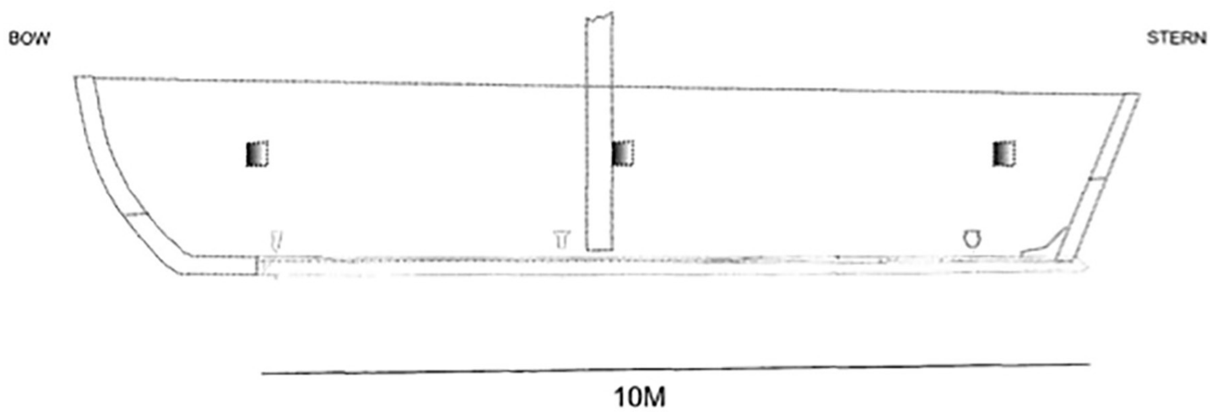

Figure 4-44: Reconsruction of Dokøen 3 wreck (Nielsen, 2012 p. 68)

25cm in length. In contrast to wrecks 2 and 3 the plank seams were consistently sealed with moss based waterproofing material. Although no framing timbers were preserved, an average distance between frames could be established to c. 60cm based on the treenail positions in the hull planks (Gøthche & Høst-Madsen, 2001; Høst-Madsen, 2007). The wreck was dendrochronologically dated to c. 1415 with two main origins of the timbers. While three samples point to a southern Baltic origin spanning over a wider area similar to wreck 2, one sample matched best with lower Saxony. Although it could not be established if any of the sampled timbers belonged to repair, the wide range of timber sources is apparent (Eriksen, 2001; Daly, 2007).

Conclusions and discussion

The similarities in date, origin of timbers and coverage of stones is intriguing leading to the interpretation that the deposition of the wrecks in this location was not coincidental. Due to the significant size of the stones, it is believed that they were cargo rather than ballast, destined to supply construction sites in Copenhagen. Archival study may even connect the wreck to a specific historical event. Stone filled ships were sunk in Copenhagen harbour in 1428, 1523 and 1536 to block entrance to the harbour. A Hanseatic fleet blocked the harbour twice in 1428 by sinking up to 48 stone filled ships and boats (Gøthche & Høst-Madsen, 2001; Høst-Madsen, 2007).

A reassessment of the dendrochronological data from the Dokøen wrecks by Daly produced interesting results regarding trade of construction materials and potential identification of the place of construction for the vessels. Although a general southern Baltic origin was evident for the radially split oak timbers, the material appears to have come from a wide geographic reach rather than a single forest. This, in combination with the presence of southern Scandinavian sawn planks in wreck 3 and northern German timber in wreck 4 completes the picture that the boat builders collected the building material from a variety of sources. Assuming that certain structural timbers for clinker vessels, such as keel, stem, stern and frames are ideally sourced locally due to cost factors as well as ensuring the compass timbers of the right shape and size are chosen, strategic dendrochronological samples could provide vital clues regarding the place of construction. In the case of Dokøen 3, the tree ring curves of the keel correlated well with curves from Northern Jutland and western Sweden, coinciding with the provenance for the lesser quality sawn planks used in the upper strakes. Daly therefore deems it likely that this reflects the origin of the vessel, while imported planks were used to a large degree for the hull (Daly, 2007).

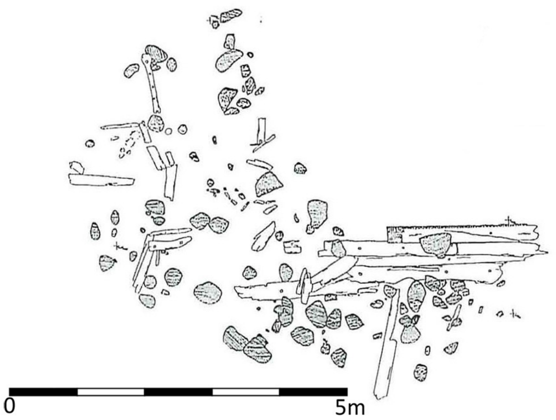

Figure 4-45: Site plan of Dokøen 4 (after Gøthche & Høst-Madsen, 2001 p. 30)

Similar to the Drogheda boat, the research results from the Dokøen wrecks clearly show how intensive and strategic scientific analysis aids to complete more than just our understanding of the actual naval architecture of small, locally built watercraft. The results further illustrate vividly how socio-economic factors impacted on boat and shipbuilding practices and organisation in past societies. As this aspect forms a crucial component of the wider comparative analysis it is discussed in more detail in chapter 6.

4.7.5 Grønsund

Introduction

The wreck of a clinker built vessel was found by sports divers near the Gåsesand lighthouse on the northwest coast of the Island of Falster (Fig. 4-32). Non-intrusive archaeological investigations were carried out in 1995 and 1996 (Dencker, 1995). The wreck presented itself in a more or less upright position and with a total exposed length of almost 16m and a width of c. 4.9m. The lower hull is believed preserved to almost the full original length of the vessel. As no full excavation was carried out it is deemed likely that more structural components remained buried in the surrounding sediments, including most of stem and sternposts (Bill, 1997). Dendrochronological dating of three samples showed the timber to be oak of Baltic, possibly Polish origin. In absence of sapwood an approximate felling date for the timbers to after 1520 could be established (Bill, 1997a).

Keel, Stem and Sternpost

No measurements or detailed information on the keel is currently available. However, a stern knee is reported to be still fastened near the stern end of the keel, thus indicating that the sternpost was joined to the keel via a mortise-and-tenon joint. Seemingly, no joints between keel, stem and stern were uncovered. The exposed part of the stem was curved and rabbeted (Bill, 1997a).

Planking

All planks appear to have been made of radially split oak. Width varied between 17.5cm and 28cm with a maximum thickness of 2.5cm. Up to twelve strakes of planking are preserved on the starboard side, which is believed to be the gunwale level. Plank fastenings consisted of iron clench nails and scarfs between planks are long and lipped, measuring c. 25cm in length. Spacing between clench nails varies between 16cm and 35cm and waterproofing was found to be animal hair, most likely wool (Dencker, 1996).

Framing

A total of 24 framing timbers were recorded during the investigations, comprising floor and side timbers. Information on average distance between frames varies. Dencker reports a varying spacing, but it mostly appears to have been between 30cm and 35cm (Dencker, 1996). Bill, however, describes an average value of c. 46cm (Bill, 1997a). Sided dimensions are between 15cm and 19cm while moulded measurements of 8cm to 10cm are noted for the upper ends of framing timbers. Most floor and side timbers appear to have been joined with through scarf, although at the upper strakes more advanced joinery seems to have been present. This, however, is not further specified (Dencker, 1996; Bill, 1997a).

Conclusions and discussion

Based on the exposed remains and investigation results the vessel is thought to have been c. 17m in length with a beam of c. 5m. Despite the uncertainty in the vessels' exact date, a mid- to late 16th century date is certainly feasible based on the structural evidence. The combination of radially split oak planks originating from the eastern Baltic with a seemingly mortised sternpost raises interesting questions in relation to provenance of the vessel as well as questions regarding usage of raw material. While other small clinker built vessels often appear to have been built using local material, the possibility that imported timber was used is intriguing and further discussed in chapter 6.2.

4.7.6 Knudsgrund

Introduction

Located in shallow water between Åbenrå Fjord and the Genner Bugt, this wreck was discovered by sport divers in 1996 at a depth of 2.5m (Fig. 4-33). It was then subjected to excavation and documentation by the Viking Ship Museum Roskilde. Following the investigation the wreck was covered with sandbags for future preservation. The preserved remains of the wreck are c. 10m long by 4m wide and since keel and parts of bow and stern assemblies were encountered, the recorded dimensions roughly reflect the original size of the vessel (Fig. 4-46). Furthermore hull planking on the starboard side was preserved up to gunwale level and up to the ninth strake on the portside. Framing timbers, a crossbeam and rowlocks were also present. All assessed boat timbers were made of oak and planks appear to have been sawn (Dencker, 1998b; Bill, 1997a). The wreck rests roughly upright on the keel and both sides have folded open. As a result the vessel presents itself more or less flattened out (Dencker, 1998a). The wreck was dendrochronologically dated to c. 1537 (Bill & Gøthche, 2006)

Keel

The 7.75m long keel had a U-shaped cross-section and was fully preserved although not fully uncovered as a section was left buried under sediment amidships. A moulded measurement of 18cm was recorded in the aft section of the wreck while sided dimensions are not known (Dencker, 1998a).

Sternpost

The lower part of the sternpost was preserved over a length of c. 1m. The straight sternpost was connected with the keel via a mortise-and-tenon joint. It was found resting in its original position at an enclosed angle of c. 60° to the keel. Fastening was achieved with two treenails and a stern knee, which was found near its original position (Fig. 4-45). Rabbets are cut into the post to receive the plank hood ends. An Iron gudgeon was found preserved on the lower part of the preserved sternpost, indicating that the vessel was originally fitted with a stern rudder. The rudder itself was not preserved (Dencker, 1998a).

Stem

In contrast to the stern no rising parts of the stem were preserved. The preserved remains comprised an element fastened with the keel and continuing the longitudinal run of the keel. It measured c. 1.20m in length and had a sided width of 30cm. A slight curve upwards was apparent towards the forward end indicating the originally curved shape of the stem (Fig. 4-47). The horizontal section continues the rabbet for the garboard strakes while rebates to receive the plank hood ends are cut into the upwards-curving arm. Despite the upper part of the stempost not being preserved, the fully preserved and assembled lower strakes of starboard planking, including plank hood ends, indicates the stems' curvature. It could not be established whether the stem component was a stem hook connecting forming the connection between keel and stempost, or whether the stem was made from a single piece of curved compass timber. Stem and keel were joined with a 38cm long horizontal scarf and fastened with two iron nails (Dencker, 1998a).

Planking

As far as the investigations were able to identify scarfs between planks on same strakes, no symmetrical alignment of planks on port and starboard side was evident. Consequently the exact number of planks per strake and average plank lengths could not be established. Nevertheless, planks appear to show lengths between 2m and 3m. Plank width was on average 24.4cm becoming wider towards the gunwale and the average width was c. 2cm (Dencker, 1998a). Scarfs between planks on the same strakes are described as long and lipped, while no details on the lands are known. Fastenings between planks were comprised of iron clench nails of unknown cross section (Bill, 1997a).

Framing

Nine frame stations were evident with eight floor timbers preserved in-situ. The frames were relatively evenly placed at an average distance of 63.5cm. The average sided dimension recorded is 10cm while a moulded dimension of 16.5cm is reported for one of the floor timbers. Side timbers were scarfed over the floor timbers with long flat scarfs. All frame timbers were fastened to the hull planking with treenails (Dencker, 1998a).

Gunwale

Parts of the gunwale were found preserved on the starboard side near the stern. It was comprised of two elements of square cross-section notched over the top ends of the side timbers. Paired sets of holes at three frame stations are interpreted as fastening points for rigging, indicating that the vessel was sailed. A 2m long straight branch with a Y-shaped end made of beech is seen as a potentially related to the use of the yard or the sails (Dencker, 1998a).

Crossbeams

One transverse crossbeam was found loose within the wreck near the stem where it was originally placed. It measures 69cm in length and has a centrally placed bollard to fasten ropes or rigging (Dencker, 1998a). Despite the absence of further crossbeams in the archaeological record, further crossbeams can be assumed. The fully preserved starboard side shows no further evidence for through-beams that could provide indirect evidence for transverse strengthening of the hull (Bill, 1997a).

Conclusions and interpretation

No cargo or other evidence, which may have given clues towards the original use of the vessel were found. Given the shallow water depth it cannot be ruled out that any cargo on board was salvaged after the boats' demise (Dencker, 1998a).

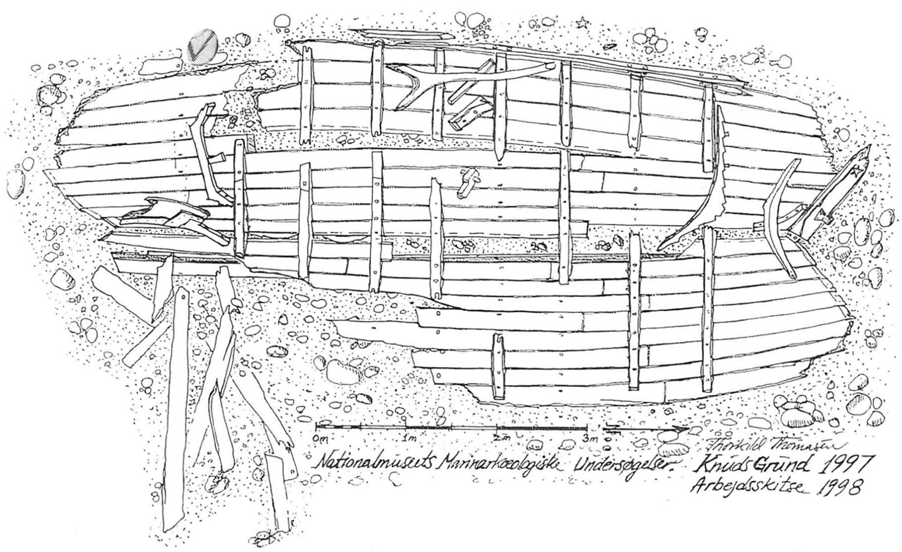

Figure 4-46: Site plan of Knudsgrund the Knudsgrund wreck (Dencker, 1998, p.27)

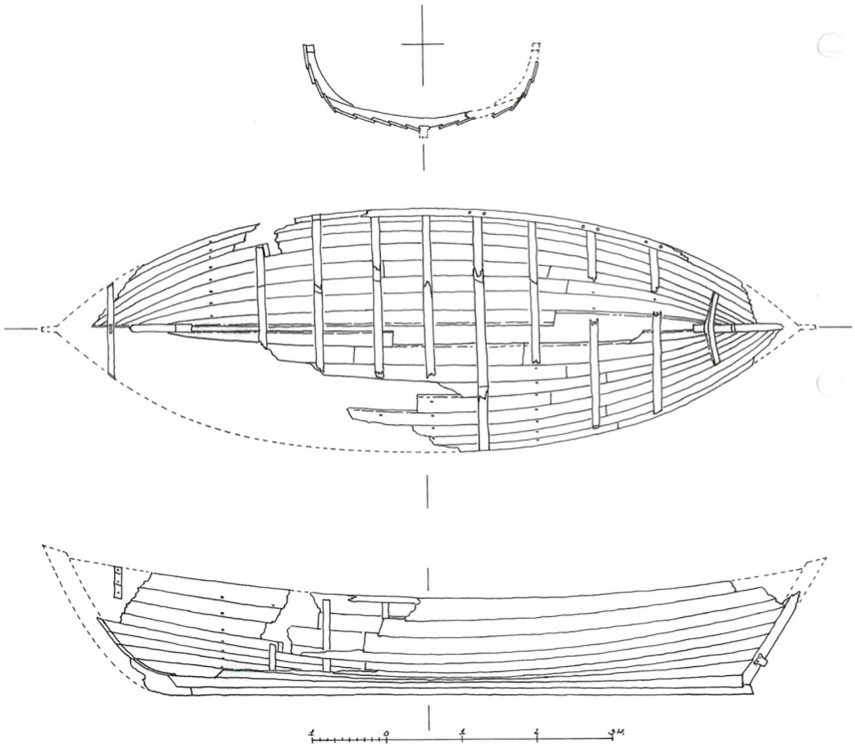

Figure 4-47: Reconstruction of the Knudsgrund wreck (Gøthche 1998)

The well-preserved condition of the Knudsgrund wreck provides an excellent opportunity to analyse a small 16th century clinker built watercraft in detail. Investigations so far, however, have focused on obtaining basic information regarding dimension, construction and date, leaving many questions on detailed structural solutions unanswered. Nevertheless the currently available data formed the basis for a reconstruction drawing providing a good indication towards original size and shape (see Fig. 4-47) Chronological analysis indicates a mid-16th century date. This in conjunction with the presence of sawn planks make Knudsgrund one of the earliest known boats in Southern Scandinavian context of clinker construction where sawn planks were used (Bill & Gøthche, 2006). Unfortunately question regarding timber provenance and potential mixed planking comprising sawn as well as radially split planks, can currently not be answered. Similarly number of masts, keel construction and information on shape remain unknown.

4.7.7 Køge

Introduction

The wreck was discovered in 1895 during construction works in the harbour of Køge, a town of medieval origin located on the east coast of the island of Zealand (Fig. 4-33). Following discovery parts of the wreck were excavated and recorded. The uncovered remains comprised a 7.5m long section from the forward part of the hull (Fig. 4-48). Although the vessel rested upright with the lower parts of the hull preserved, keel, stem and sternpost as well as garboard strakes were not present. As no timbers were kept and available for scientific dating, the find was dated via a selection of artefacts, seemingly from a cask found within the wreck, to c. 1450. This indicates that the vessel was probably built not too long before this date as no significant repair measures were observed (Liebgott, 1995; Bill, 1997a). As the various structural elements are only documented relatively scarcely these are presented in summarised format below.

Structural elements

Five to six strakes of planking were preserved on either side of the hull. Bill believes it likely that the planks were made of radially split oak planks rather than sawn planks based to the absence of central cracking. This in turn is evident for the boats' stringer, which are reported to have been pine. Further information regarding planking is absent with the exception of the waterproofing material, which is noted to be cattle hair.

Floor timbers were wide-angled to almost flat, indicating that the boat was relatively flat-bottomed (Fig. 4-49). Average spacing between frames was c. 61cm. Floor and side timbers were joined with horizontal through scarfs and all frames were fastened to the hull with treenails. The keelson was made of oak, measured c. 4.8m

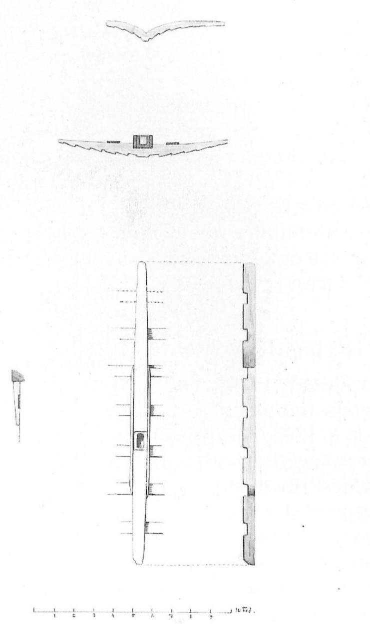

Figure 4-48: Structural timbers of the Køge wreck (after Liebgott, 1995 p.177)

and was joggled over floor timbers to which it was fastened with treenails (Fig. 4-49). It was widest at the central part where it measured 20.5cm sided and tapered to both ends and measured 18cm moulded. One keelson knee was found aft of the keelson, indicating that it was secured with three more knees in respective positions fore and aft (Liebgott, 1995; Bill, 1997a).

Conclusion and discussion

Due to the scarce documentation record and impossibility of reassessing the material first hand, the Køge wreck is of limited value for meaningful comparative analysis. Although an original length of c. 14m is assumed, the substantial dimensions of the keelson alongside additional support could indicate that this estimation could fall short of the original length by several meters. Estimation of size and shape of the vessel should be seen with care as neither stem nor sternpost were preserved or documented.

4.7.8 Lundeborg

Introduction (Heading 4)

Wrecks of two clinker built vessels, also known as ”Brick wrecks” were discovered in 1973 by sport divers near Lundeborg on the East coast of the Island of Fynen only 100m apart from each other (Fig. 4-33). Several campaigns of archaeological investigations were carried out on the wrecks during the following decade by Langeland Museum in cooperation with the local sport diving community. Both wrecks are of similar construction, size and date. Both carried cargoes of brick roof tiles and were found near known tileworks dating to the Middle Ages and Renaissance. It is known that this formed the setting for a fairly substantial export of tiles and bricks through historical sources but is also evident in the archaeological record. The now submerged remains of a stone jetty or quay as well as large numbers of scattered bricks and tiles on the surrounding seafloor show that export by sea was well established for the local industry. Ballast stone mounds in the vicinity of the wrecks may have belonged to both vessels and may indicate that ballast was thrown overboard before the cargo taken on. The brickworks appear to have been destroyed during the Swedish wars 1658-60. However, production never really recovered and ceased after 1663. Neither of the wrecks was scientifically dated and dating is solely based on associated artefacts, particularly the pottery assemblages (Skaarup, 1979; Skaarup, 2010).

Lundeborg wreck 1

<u>Constructional details</u>

Of wreck 1 only a small section measuring c. 4m in length was preserved. Erosion, wave action and shipworm had severely taken their toll on the wreck with only small sections near the stern as

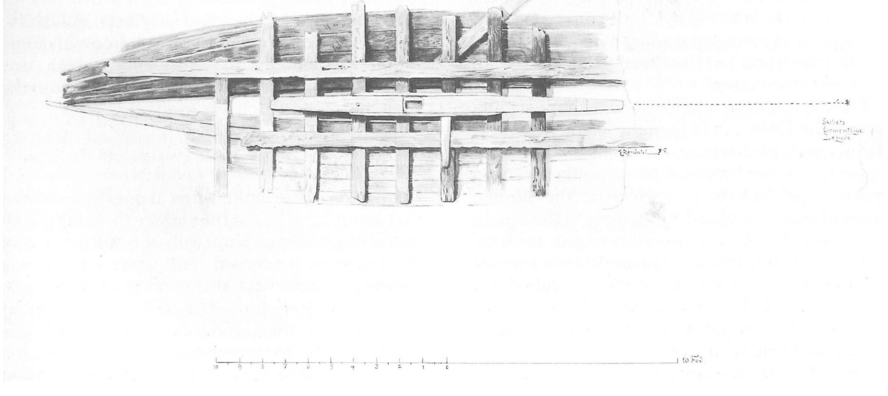

Figure 4-49: Site plan of the Køge wreck (after Liebgott, 1995 p. 176)

well as starboard planking intact. It was clinker built with and reconstructed to a length of 15m to 20m and 4m to 6m width. The oak hull planks were fastened to the frames with wooden tree-nails. It carried a cargo of monk tiles and a small number of wing tiles. These were also found spread around the vicinity of the wreck site. Not much is known regarding structural details, except that strakes on port and starboard side were arranged symmetrically at least to some degree. (Thomsen, 1982; Skaarup, 2010).

Lundeborg wreck 2

Introduction

The most prominent feature of wreck 2 is the boat's cargo of wing tiles. The articulated remains of the largely flattened hull underneath the cargo mound include the keel, several strakes of planking on both sides and a number of framing timbers (Fig. 4-50). Yet, most hull timbers were found more or less loosely scattered surrounding the cargo mound as result of continuous disintegration, erosion and exposure to wave action and Teredo Navalis. Despite the relatively scattered and deteriorated nature of its remains, the wreck provided a wealth of information in relation to structural composition, rigging, design and usage. In close proximity to the bow of the wreck, the remains of another small boat were found. Skaarup believes it to be associated with the wreck and to have been used for rowing to land but also for loading and unloading (Skaarup, 2010). Unfortunately no further information regarding this boat is available.

Keel

The rabbeted keel was made of oak, measured 15cm sided by 20cm moulded and was preserved to an overall length of c. 11m. An iron band was fastened to the underside of the preserved forward end. Skaarup interprets it as a repair measure to the keel rather than an additional fastener to the adjoining stem. This is based on the observation that in-situ preserved hull planking extended over 2m forward of the keel end. Skaarup thus estimates that up to 5m of the original keel length is missing forward of the preserved end (Skaarup, 1979; Skaarup, 2010).

Stem and stern knee

The stern knee measured 18cm moulded and c. 10cm sided near the top end tapering slightly to the bottom. A narrow long-rectangular notch, 9cm deep, was cut into the inboard surface near its aft end (Fig. 4-51). It is believed to be part of a mortise-and-tenon joint for the upright sternpost (Skaarup, 1979).

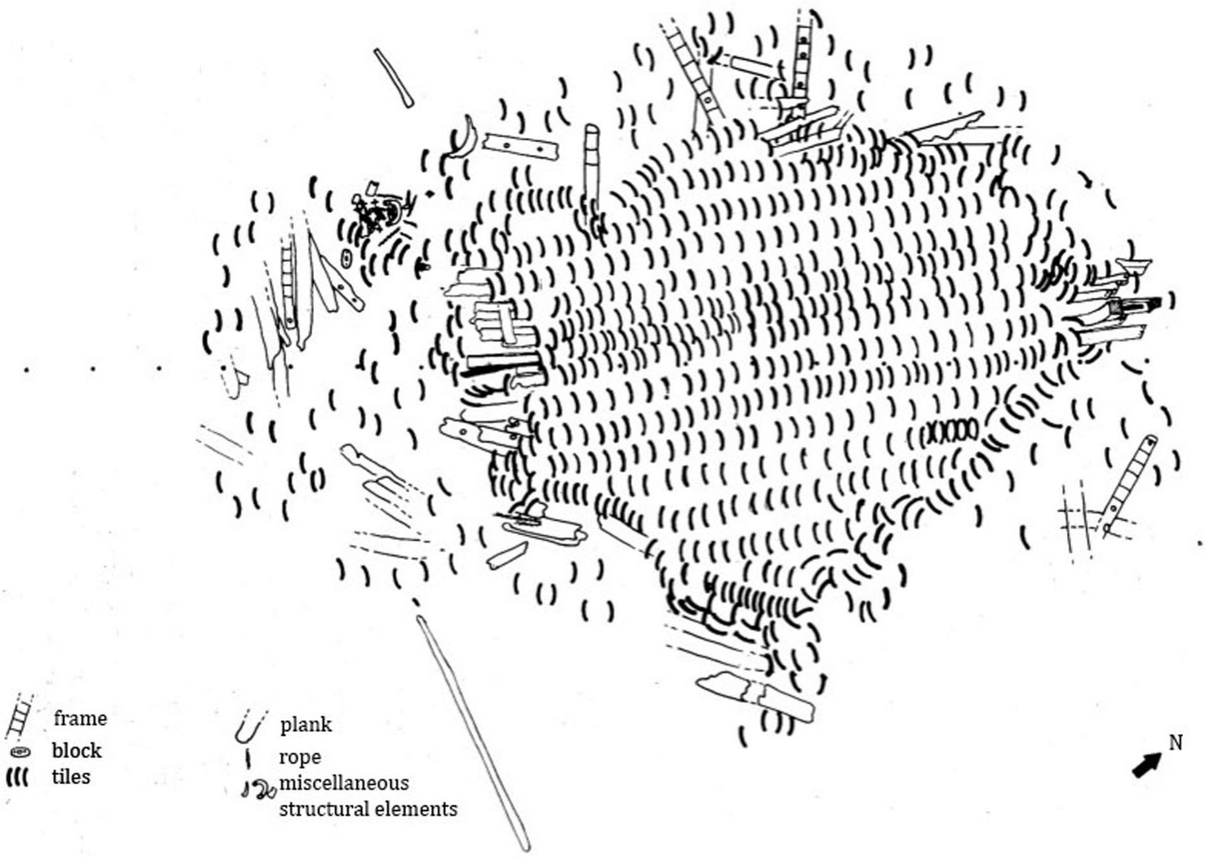

Figure 4-50: Site plan of the Lundeborg 2 wreck (after Skaarup, 1979 p. 66)

Figure 4-51: Stern end of keel with mortise for sternpost of Lundeborg 2 wreck (Skaarup, 1979 p. 70)

The stem was found loose and in poor condition c. 20m forward of the bow section of the wreck. The curved timber was made of oak. It measured 1.75m in length, 25cm moulded and 10cm sided. Three transverse holes on the upper section of the stem post are interpreted as fasteners of a bowsprit (Skaarup, 2010). A 4.2m long and c. 9cm thick timber with straight cut ends was found loose with the wreck and may have been the associated bowsprit (Skaarup, 1979).

Planking

Hull planking was preserved to both sides of the keel under the cargo mound and to a certain degree beyond the cargo load. The starboard side had seven strakes preserved while five strakes were preserved on port side. All planks were made of oak and measured on average 21.5cm in width and 2.5cm in thickness. Plank overlaps were fastened with square shanked iron nails and square rove plates. The average distance between the nails was c. 17cm. The waterproofing material appears to have been hemp or sheep wool mixed with tar (Skaarup, 1979; Skaarup, 2010).

Framing timbers and ceiling planking

Frames appear to have been placed relatively regular at an average distance of 30cm to 40cm. Frames had moulded/-sided dimensions of c. 12.5cm by c. 17cm. All exposed frames had distinct joggles cut into the hull facing surfaces and were fastened to the hull with treenails of c. 3cm diameter. A sharply angled floor timber found at the bow end of the wreck indicates a sharp deadrise in the forward part of the vessel (Skaarup, 2010).

Ceiling planking made of 2.5cm thick pine planks was fastened over the frames providing a solid platform for the overlying cargo (Skaarup, 2010).

Internal division and cargo

The preserved cargo mound indicates size and extent of the cargo hold. It covers an area of up to 9m by 4m in with a height above the seabed of c. 1m. The load largely comprised wing tiles, supplemented by a small number of monk and beavertail tiles. The wing tiles were stacked in three to four layers on top of each other in c. 15 parallel long, closely set rows. This allowed estimating the full number of tiles to c. 12,200 with a total weight of c. 36 tons (Skaarup, 1979). A concentration of artefacts relating to cooking and personal use were found concentrated in the area forward of the cargo mound, indicating that this served as living compartment and galley for the crew. The artefact assemblage comprised amongst others clay pipes, shoes, the remains of an oak barrel, ceramic pots, bowls and dishes, as well as animal bone fragments and firewood (Skaarup, 1979; Skaarup, 2010).

Rigging

A number of rigging elements were also found with the wreck, particularly around its starboard bow section. This includes a possible parrel in the form of a U-shaped worked piece of beech alongside associated rope fragments and two well-preserved wooden blocks. A small teardrop shaped wooden “virgin” with traces of a circular iron frame, as well as the remains of a coil of three-stranded hemp rope, were attributed to the vessel’s standing and running rigging (Skaarup, 1979).

Further a mastlock was found loose near the wreck site. It was a 1.9m long oak board tapering to one end with a 40cm by 20cm wide square inset with rounded edges at the other end for the mast (Fig. 4-52). It is thought to have been originally scarfed longitudinally over three cross beams. Wear marks along the edges of mastlock indicate that the mast was lowered numerous times (Skaarup, 2010). Unfortunately its original position within the wreck could not be determined.

Reconstruction

Based on the preserved hull remains and composition of the wreck site a total length of 15m to 16m with a beam of c. 4m to 5m is assumed for the vessel. The mortise-and-tenon joint arrangement for the sternpost indicates that the vessel was fitted with a stern rudder. Although no mast step or keelson was found during the investigations, a bowsprit and at least one mast can be attested. Evidence for upper works is scarce but the mastlock may point to an open cargo hold and potentially stern section, whereas the density of material culture from the bow section could indicate a partial decking at the bow (Skaarup, 1979).

Conclusions and discussion

While very little can be said about size, shape and construction of wreck 1, the excellent preservation conditions of wreck 2 provide a wealth of information not only on construction but also on rigging and division of space on board a small Renaissance coastal trader. Unfortunately the high levels of preservation and rich archaeological assemblage lacks comprehensive analysis of the structural remains as well as dendrochronological analysis. Secure dating in conjunction with provenance determination and wood scientific analysis could deepen our understanding on organisation and nature of organisation and nature of contemporary small-scale boatbuilding and maritime trade.

As stated above wreck 2 was dated solely on the basis of the associated finds and its cargo. The wing tiles point to a date in the 16th century as they started coming into use from c. 1500 onwards. Beavertail tiles, on the other hand are more characteristic for the Middle Ages. Monk tiles in return were used throughout the Middle Ages and Renaissance but were gradually replaced by other tile types in the course of the 1600s. A dating of the wreck to around 1600 based on the cargo thus seems reasonable. The pottery assemblage, however, was used to provide a more refined dating as it appears to be diagnostic for the first half of the 17th century. Considering that the nearby brickyard was destroyed around 1659 with little to no further production happening after this date, the wrecking of the little cargo carrier can be assumed to have occurred in the early 1600's (Thomsen, 1982; Skaarup, 1979).

4.7.9 Vedby Hage

Introduction

The Vedby Hage wreck was discovered in 1995 during cable laying works across Storstrømmen, off the north coast of Falster (Fig. 4-33). The wreck was subsequently excavated in 1996 and presented itself almost entirely disassembled with many timbers lying loose and spread out over a larger area (Fig. 4-53). Only small intact sections of articulated planking with in-situ frame timbers were found. The bottom part of the hull was missing entirely with the exception of a small number of floor timbers and parts of the stem (Gøthche & Myrhøj, 1996; Myrhøj, 2000). As

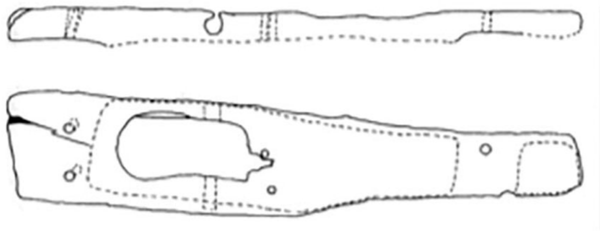

Figure 4-52: Sketch drawing of mastlock of Lundeborg 2 wreck (Skaarup, 1979 p. 41)

sapwood was preserved on a number of samples, including two samples with bark edge, the felling date for the oak timbers used for the construction could be pin-pointed to 1435/36, while one sample showed that the vessel was repaired at least once c. 1444/45. Provenance determination showed a local origin of the timbers with best matching correlations for tree ring curves from eastern Denmark (Daly & Eriksen, 1996).

Keel, stem and stern

As the bottom section of the vessel was missing entirely, no information on the keel is available. Similarly information regarding stem and stern assembly timbers is diffuse. Gøthche & Myrhøj describe a preserved timber measuring c. 3m in length without further dimensions or descriptions regarding shape, except for the existence of two vertical through scarfs marking both ends of the timber (Gøthche & Myrhøj, 1996). In a later discussion of the wreck, Myrhøj does not refer to this piece, but instead describes a c. 1.4m long curved timber with a T-shaped cross-section, which she believes to belong to the upper part of the stem post (Myrhøj, 2000).

Contrary to earlier descriptions of the wreck (Gøthche & Myrhøj, 1996; Bill, 1997a) Myrhøj describes a stern-knee with remains of iron fastenings, which are interpreted as remnants of the original rudder fastenings. The original position of the timber, which describes an enclosed angle of 158°, in the vessel is not illustrated in more detail. However, according to Myrhøj's description the timber appears to have been a sternhook joined directly to the keel and accommodating the stern rudder on the upper arm (Myrhøj, 2000).

Hull Planking

Although not preserved in structural cohesion, c. 19 strakes per side are reconstructed. Most assessed planks were radially split with lengths mostly less than 2.5m and below 20cm in width and an average thickness of c. 2.5cm. The planks fastened to each other with square shanked clench nails, which had been hammered flat over roves. The lands did not show decorative mouldings and the scarfs joining the planks lengthwise can be categorised as long, measuring between 20cm and 30cm with lips inboard as well as outboard. Seams between planks were waterproofed using animal hair, probably sheep. As mentioned above at least two repair measures to the hull planking were evident in shape of patches to planks as well as replacement of clench nails evident by former nail holes plugged with wooden dowels. In contrast to clench nails of the original construction, nail tips of repairs appear to have been simply turned over roves. A rubbing strake was found attached to the outboard side of the third-uppermost strake. Five pairs of double-holes penetrate vertically through this timber and are believed to have been used to fasten standing rigging (Gøthche & Myrhøj, 1996; Bill, 1997a; Myrhøj, 2000).

Framing timbers and crossbeams

Frames consisted of floor timbers with adjoining side timbers, placed at distances of between 35cm and 54cm. Floor and side timbers are described as irregular in shape with waney edges, often barely worked to parallel sided timbers and frequently showing sapwood edges. The preserved floor timbers were flat angled and joined to the side timbers with long, horizontal through scarfs.

Lateral strengthening elements were evident in shape of partially preserved crossbeams with heads protruding through the hull planking and a large beam knee. A c. 40cm long, wedge shaped timber is interpreted as a beam-fender placed in front of the protruding beam head to protect the beam head from damage and to divert passing water when under sail. Two stringer planks were found in-situ and fastened to the frames with the beam knees. In contrast to the hull planks, these appear to have been sawn (Gøthche & Myrhøj, 1996; Myrhøj, 2000).

Keelson and miscellaneous pieces

The keelson was largely preserved to a length of c. 6m but is believed to have had an original length of c. 10m. No dimensions and measurements are known but it is described as “slender”, with a pronounced wide central part and tapering towards the ends. It was fastened to the floor timbers with treenails. Two mast steps were cut into the central section of the keelson, of which one is interpreted as a secondary addition to improve the vessels’ trimming. Further to the structural hull elements, two Y-shaped timbers were found, which are believed to be hawse pieces (Fig. 4-54), as well as a windlass drum (Bill, 1997a; Gøthche & Myrhøj, 1996; Myrhøj, 2000).

Conclusions and discussion

Based on the evidence obtained from the preserved remains the original vessel is reconstructed to a flat-bottomed shape with an estimated overall length of c. 15.5m and beam of c. 5.6m with a height at the centre of c. 2.15m (Myrhøj, 2000). Should this interpretation be correct, the presence of the substantial keelson is remarkable. Furthermore the presence of cross-

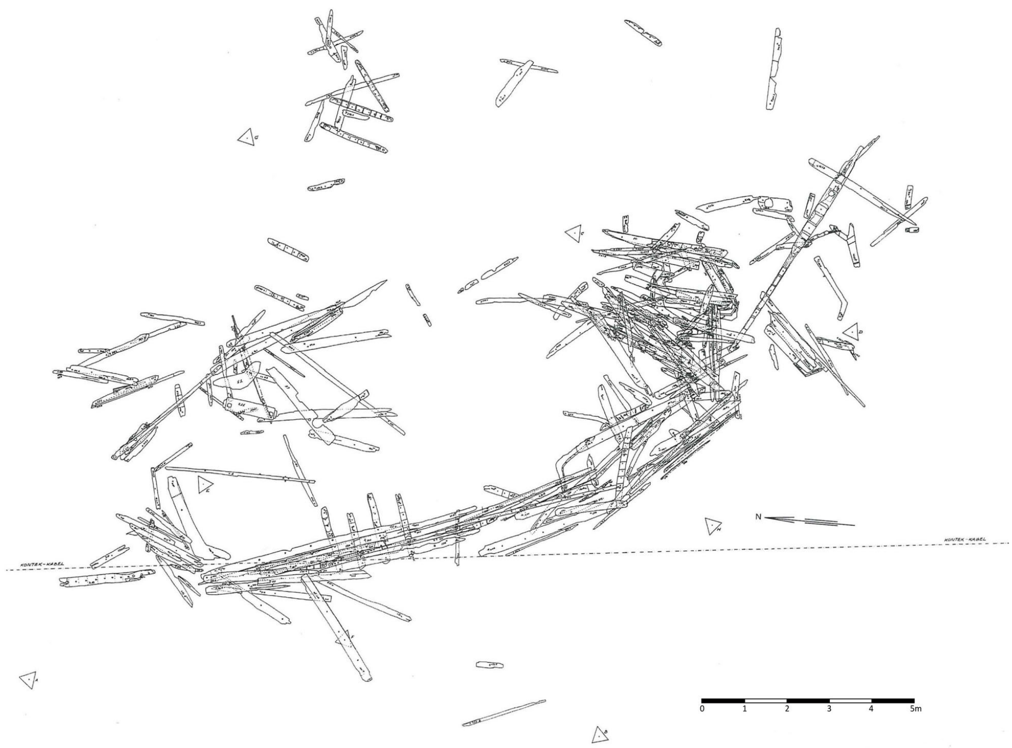

Figure 4-53: Site plan of the Vedby Hage wreck (Gøthche & Myrhøj, 1996 p. 13)

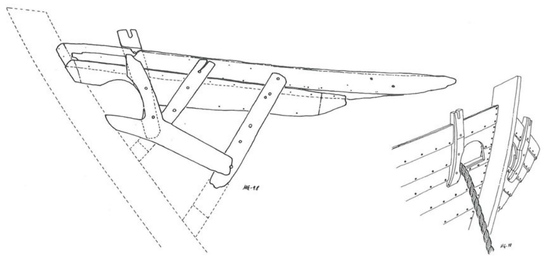

Figure 4-54:Potential hawse assembly of Vedby Hage with proposed reconstruction o (Gøthche & Myrhøj, 1996 p. 231)

beams with protruding beam heads is a remarkable feature, as many comparative vessels do not show evidence for such a crossbeam solution.

Overall the level of detail obtained from the recording allows for an excellent insight into the vessel's construction. For example the frequent use of planks containing sapwood shows that the boat builder did not have access to or deliberately chose not to use planks converted from logs of sufficient girth to avoid potential vulnerable sapwood in the planking. Potential restrictions in access to high quality timber are further reflected in the relatively low quality timber used for frames and the choice of sawn planks for stringers. Furthermore the countersunk roves of inboard surfaces on planks have to date seldom been observed. One comparative example is the 15th century Mönchgut 92 wreck found off the coast of Mecklenburg-Vorpommern, Germany (J. Auer, pers. comm.). What is interpreted as being original to the vessels' construction by Myrhøj to provide a smooth surface between hull planking and frames (Myrhøj, 2000), may equally have been part of repair, whereby the rove rebates served to remove original roves (J. Auer, pers. comm.).

Considering the probable local construction and usage of the Vedby Hage wreck, the wealth of information obtained from a quite damaged wreck site provides excellent comparative data for the study at hand.

4.7.10 Vejdyb

Introduction

The fragmented section of a clinker vessel was found and excavated in 1985 at the eastern entrance to the Limfjord, south of the islet of Korsholm (Fig. 4-33). The 4.5m long and 3.8m wide fragment comprised of the amidships and forward part of the vessels' lower hull. The preserved remains consisted of up to seven strakes on port and starboard side from the second strake upwards as garboard strake and keel were missing. Internal framing was evident in shape of ten floor timbers. Evidence of repair to the planking shows that the vessel was in use for some time prior to its demise (Rieck, 1986; Bill, 1997a). A felling date for the radially split oak planks of c. 1475 could be established through comprehensive dendrochronological analysis, which included a number of samples with sapwood. All sampled timbers were furthermore identified to have originated from the Baltic with a high likelihood that the wood was sourced in Poland (Daly, 1997).

Planking

Port and starboard side strakes were arranged relatively symmetrical, i.e. scarf positions were mirrored to both sides with the exception of one short additional plank on the seventh port side strake, which is believed to be part of the original construction. No dimensions and measurements for the hull planking are known. Plank overlaps did not show decorative mouldings and fastening consisted of square shanked iron clench nails and willow pegs. As both fastener types are evenly distributed throughout the wreck, both are believed part of the original construction of the vessel. On occasion wooden pegs were supplemented with iron clench nails. Planks were joined lengthwise with long scarfs measuring on average 35cm. Scarfs tables were worked to feathered edges outboard, but left lipped inboard. Plank overlaps and scarfs were waterproofed using moss.

Framing

The frame timbers are made of oak and not entirely parallel sided, some only roughly hewn and not fully straight. Distance between frames varies but was on average c. 40cm. Floor and side timbers were joined with horizontal through scarfs. No moulded/sided measurements for floor and side timbers are known. All frames were fastened to the hull planks with treenails, mostly oak and to a lesser degree willow. Fastening appears to have been consistent with one treenail per strake, except for the garboards. Noticeably flat saddles on the two foremost floor timbers may indicate the position of a keelson, which is otherwise evident by treenail fasteners in two other floor timbers.

Conclusions and discussion

The original size of the vessel has been estimated based on the shape of the floor timbers to an overall length of c. 15m and a beam of up to 5.5m. The flat shape of the floor timbers is seen as an indicator that the vessel was designed to take cargo. Despite the limited level of preservation, the appearance of mixed hull fasteners and timber of Polish origin are significant observations. The use of non-native raw materials and the potentially non-native mixed fastening method is of importance for the further discussion (see chapter 6.2).

4.7.11 Århus Å

Introduction

The Århus Å wreck was found in 1938 during construction works in the river basin in Århus (Fig. 4-33). Unfortunately the contemporary archaeological report does not provide much detail. However, the wreck was recovered and kept in storage until it was subjected to renewed archaeological investigations in 1973 and 1993. As all timbers had been stored dry, dimensions and shape captured in the re-recording only reflect the state after shrinkage and distortion. The wreck was dendrochronologically dated to after 1411. As the sampled contained no sapwood, the exact felling date for the timbers could not be determined. Furthermore the sampled planks may be part of repairs, thus indicating that construction or repair took place during the course of the 15th century (Bill, 1995; Bill, 1997a). As documentation of the wreck is quite limited its structural elements are described in summarised format below.

Figure 4-55:Map of reference sites from Sweden and Norway (Schweitzer 2013)

Structural elements

The c. 11.7m long keel was T-shaped in cross-section amidships. A vertical through scarf at one end was fastened to stem- or stern assembly with iron spike nails. The hull planking consisted of radially split oak planks, which were fastened to each other with square shanked iron nails. Scarfs between planks measured between 23cm and 28cm in length and had lipped ends. The distances between frames were relatively wide at c. 75cm to 80cm. No measurements for the squared framing timbers are known. Floor and side timbers were joined with horizontal through scarfs and fastened to the hull planking with one treenail per strake. No keelson or mast step was found but a blind treenail hole in one of the floor timbers, which also showed a notch of 25cm width, indicates its former presence (Bill, 1995; Bill, 1997a).

Conclusion and discussion

The original length of the vessel is estimated to c. 13m to 15m based on the length of the fully preserved keel. Although found in the first half of the 20th century when it was recorded quite scarcely, the fact that the wreck was kept, albeit left to dry out, allowed for its reassessment including dendrochronological analysis. In absence of more detailed structural information and provenance determination of the planks, a more detailed interpretation regarding the vessels origin, usage and operational waters is not possible.

4.8 Sweden

4.8.1 Introduction

As outlined before Sweden hardly any wrecks of relevant size, construction and date have been found and published within the geographic reach of this study (see chapter 2). Although only one wreck for the western Swedish coastline is represented in this chapter (Fig. 4-55), recent developments in Swedish maritime archaeology are a promising prospect that new discoveries change the current lack of small Medieval and Renaissance clinker built watercraft. Given the wealth of wreck sites from the neighbouring Danish islands, it would appear likely that a similar situation can be expected for the western Swedish seaboard.

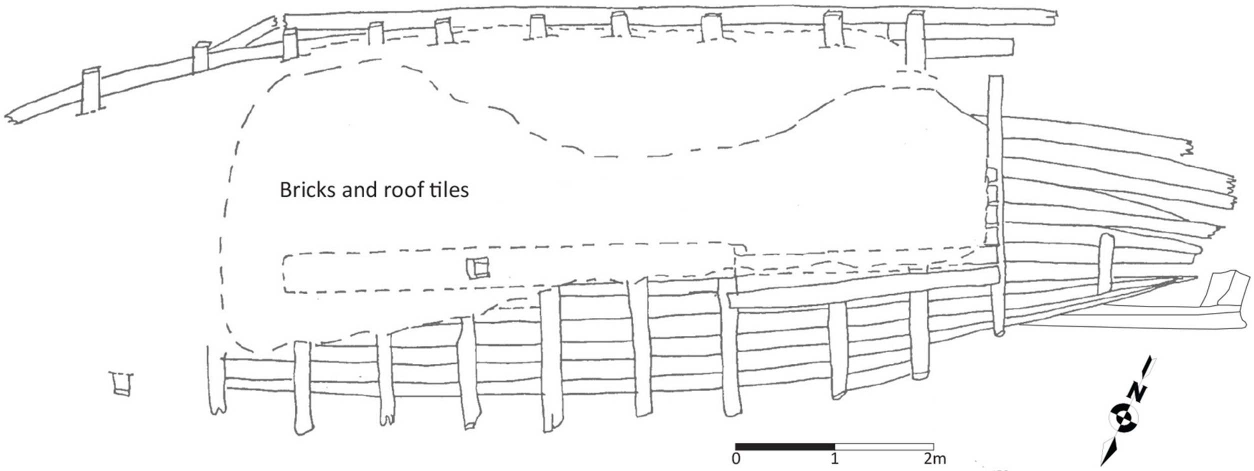

Figure 4-56: Sketch site plan of the "Brick wreck", Skanör (Schweitzer 2013 after Alopaeus, 1993)

4.8.2 The "Brick wreck", Skanör

Introduction

The so-called "Brick-wreck", named after the cargo found on board the wreck, was discovered in 1991/92 during a dive survey in the harbour of Skanör, located on the south-western tip of Scania (Fig. 4-55). All available information regarding the wreck derives from the brief survey and provides a basic account of the preserved remains. Found in shallow waters, the wreck presented itself at a length of c. 12m and a width of c. 5m containing a cargo of bricks and roof tiles (Fig. 4-56). The wreck appears to be well preserved with the starboard side intact up to gunwale level at the time of the survey, while six strakes of hull planking are reported preserved for the port side. Dendrochronological analysis provided a felling date for the timbers to c. 1540. As the various structural elements are only documented relatively scarcely these are presented in summarised format below (Hörberg, 1995; Bill, 1997a).

Structural elements

The keel of the wreck is reported to be rabbeted with a U-shaped cross-section and of substantial dimensions, although exact dimensions are unknown (Fig. 4-57). A mortise-and-tenon joint was used to connect sternpost and keel and was secured with an additional treenail. The stern garboard hood ends were placed regularly and not continued to the aft edge of the post as evident with the Bredfjed ship. There is no information whether a stempost was preserved and no detailed description of nature and dimensions of the hull planking exist. Solely the uppermost strake of the starboard side is reported to be thicker and seems to have served as gunwale (Alopaeus, 1993; Hörberg, 1995; Bill, 1997a).

The spacing between frames appears quite wide with c. 90cm amidships and even widening further towards bow and stern. Again no further descriptions or measurements are known. A mast step and keelson are mentioned with the mast step documented well forward of amidships and the keelson to have spanned over six floor timbers. The physical relationship between keelson and mast step is not further described. Floor planking was evident in shape of six planks fastened to the inboard side of the frame timbers (Fig. 4-57) (Alopaeus, 1993; Hörberg, 1995; Bill, 1997a).

Conclusions and discussion

Based on the preserved remains the original length of the wreck is believed to be c. 20m (Bill, 1997a). Considering the size of the preserved remains, the reportedly substantial keel and the presence of a large keelson alongside mast step, such interpretation appears likely. Although an overall length of c. 20m places the "Brick wreck" slightly outside the perimeters set for this study, the structural elements do show significant overlaps with vessels of smaller size. Reassessing the wreck with a view to identify quality and origin of planks and framing timbers would provide valu-

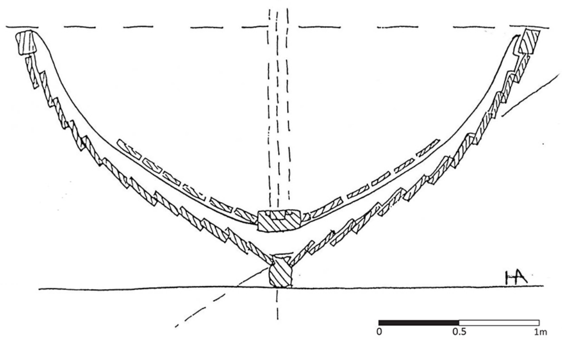

Figure 4-57: Sketch cross-section of the "Brick wreck", Skanör (after Alopaeus, 1993)

able insight into potential origin and operational waters.

4.9 Norway

4.9.1 Introduction

Norway poses a curious a two-fold predicament. On the one hand a wealth of medieval clinker built wrecks have been excavated and researched in the past. However, the vast majority of these either pre- or post-date the chronological perimeters of this study or are almost exclusively too large to be incorporated in the immediate comparative assemblage, leaving only three sites matching the criteria set for this comparative study (Fig. 4-55). On the other hand during a single archaeological project, 15 wreck were found during the excavations on the so-called Barcode site, most of which would be of immediate relevance. However, all wrecks are still in the process of being recorded and analysed in depth, and thus no detailed results are available for this study. Consequently the presented data can only provide a keyhole insight into the immense potential of the material. Nevertheless, the fragmented remains of a clinker built boat found at Portør and the recently excavated Vaterland 1 wreck, also included in this chapter, are testimony to increasing awareness and value in documenting small scale watercraft of late or post-medieval date in Norway.

4.9.2 The Barcode wrecks

Introduction

During construction works for the so-called Barcode project in Oslo (Fig. 4-55) in 2008 15 wrecks, all clinker built and dating to the late 16th and early 17th century were found and excavated. Several of the wreck are further within the size perimeters for this study and would provide valuable source material. However, due to the scale of the project, post-processing and recording of the wrecks is still on going and very little regarding structural details and scientific analysis is currently published. Therefore the wrecks are presented in summarised format, reflecting the currently available information. The wrecks were discovered in an area that formed part of the medieval harbour and harbour front of Oslo prior to the fire of 1624 in which most of the medieval town of Oslo was destroyed and the town then rebuild from new on the other side of the bay (Gundersen, 2012). Although no comprehensive dendrochronological analysis on the wrecks has been done to date, the wooden foundations associated with the wrecks have been dated to between 1571 and 1623 (Daly, 2008b; Daly, 2009a).

The levels of preservation were excellent with ten boats considered almost entirely preserved. Although all boats are clinker built varying in size between c. 8m and 20m, they display great variety in detail and structural makeup as well as intended use (Fig. 4-58). All vessels share oak as raw material for their construction, although some boats contain certain structural elements made of pine or spruce. This includes boat 2 where every second floor timber as well as a

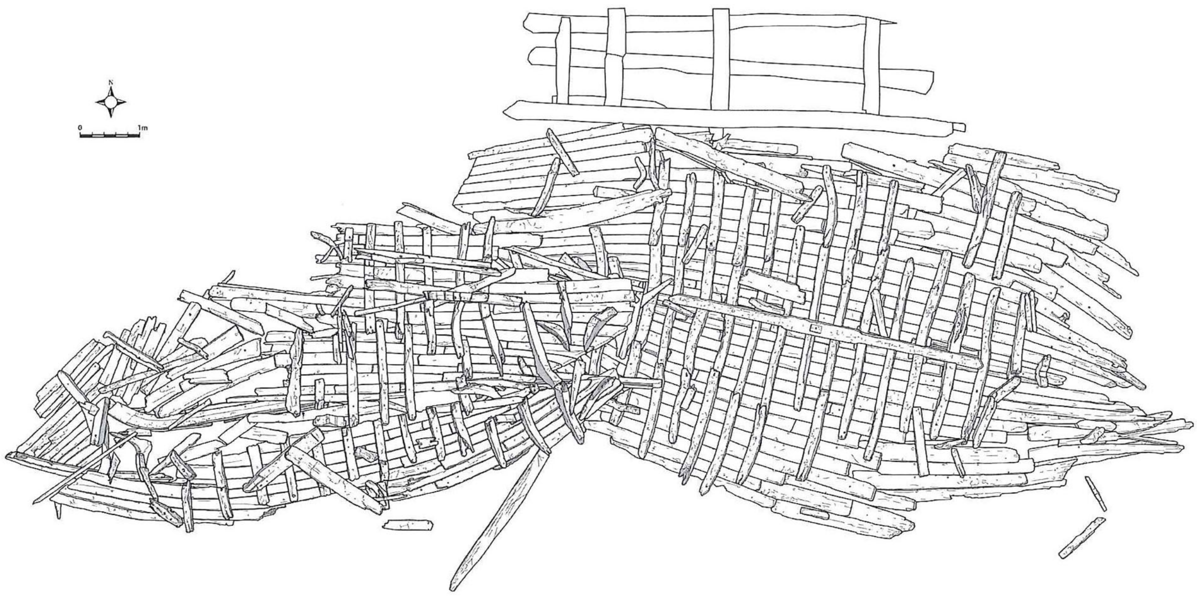

Figure 4-58: Site plan of wreck 8 to the left and 14 on the right (by Ahrens; Gundersen, 2012 p. 79)

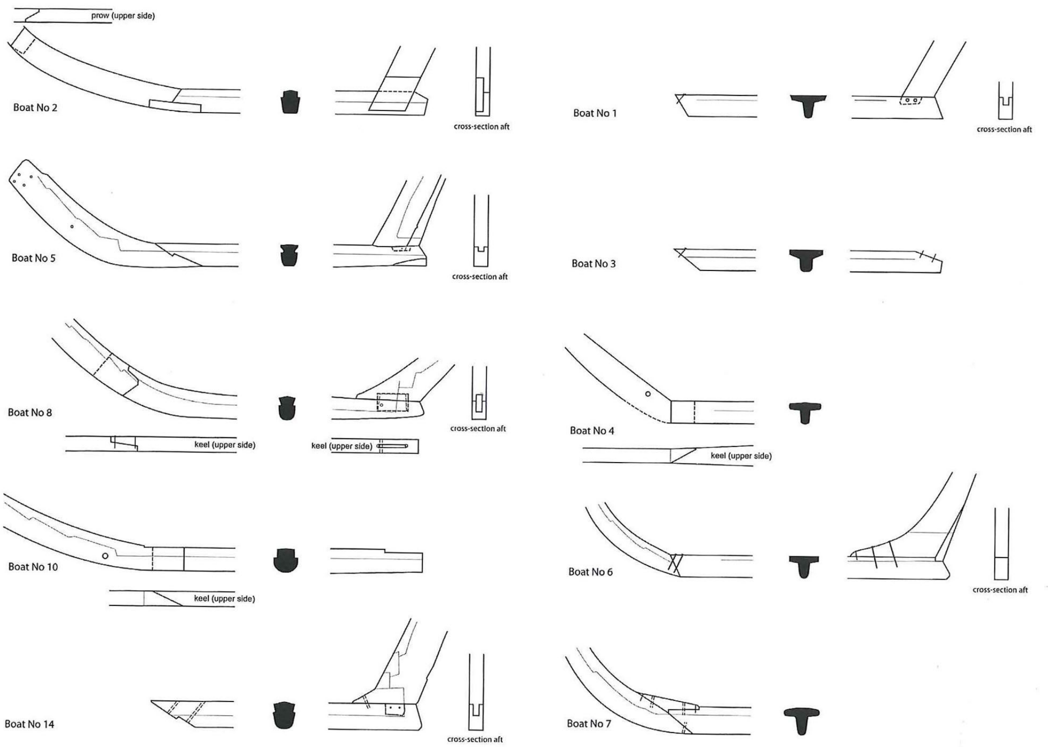

Figure 4-59: Sketch drawings showing stem and stern construction details of the Barcode wrecks as well as keel cross-sections (by Ahrens; Gundersen, 2012 p. 78)

number of planks in the lower strakes are made of pine (Gundersen, 2012).

The smallest vessel had an overall length of c. 8m while the largest was close to 20m long, indicating that some were made for use within the Fjord, while others are considered coastal and some even capable of long distance travel. This is e.g. reflected in the presence of decking in the bigger boats while the small vessel were open without any decking (Gundersen, 2012). In the following the key structural features are presented as currently known, which displays a focus on keels, stem and sternposts, while to date no detailed information on hull planking and framing exist.

Keels, stem and sternposts

Ten of the boats had keels preserved, five with U-shaped cross-sections and five with T-shaped cross sections (Fig. 4-59). Interestingly T-shaped keels appear to be predominantly used for the smaller boats while the larger vessels show U-shaped keels (Gundersen, 2012).

All of the preserved stems share a curved rake, albeit with varying enclosed angles and degree of curvature. Stems further display great variety in construction as well as in how transition and fastening with the keel is achieved (Fig. 4-59). While all are joined with the keel with scarfs, the orientation and joinery techniques differ significantly, even including a horizontal hook scarf in boat 5. Boats 5 and 10 have the scarf set back quite far, thus identifying the stem timbers as stem hooks. Most other stems, however, are joined with the keel more ore less at the transition from the keel to the rising stem, in two cases (boats 2 and 7) reinforced with under- and overlying blocks (Gundersen, 2012).

Similar to the variety in stem solutions, the sternposts display an equally remarkable diversity in shape, technology and angle to keel (Fig. 4-59). Although all solutions share mortise-and-tenon joints to connect sternpost and keel, the actual execution of the joint as well as additional fastening methods vary. Notwithstanding apparent differences the fastening techniques, two main groups are identifiable. The first comprises fastening the tenon with horizontally placed nails while the other involves securing the joint with nails driven from inboard into the keel. The joint of boat 14 combines both methods. A remarkable discovery was the fully preserved transom on one of the small boats, a feature so far not encountered on other small watercraft of clinker construction (Fig. 4-60). Two more boats do not have transoms preserved but shape and ending of their upper aft strakes indicates potential transoms (Gundersen, 2012).

Hull planking

Little information regarding the hull planking is currently published. However, as mentioned the

Figure 4-60: Transom of wreck 6 (by Ahrens; Gundersen, 2012 p. 78)

boats appear to have been made using mostly oak with occasional usage of pine and possibly spruce. Interestingly the planks used to build all vessels seem to have been consistently sawn with no apparent usage of radially split planks (T. Falck, pers. comm.). Fastenings for planks appear in great variety. Iron nails either riveted or bent over roves as well as double bent iron nails and wooden pegs are recorded. Not all three variations were present at all wrecks simultaneously. Some wrecks only displayed one method, while others show combinations of plank fastenings. In some cases the mixed use was identified being the result of repair. However, in other instances, such as wreck 6, the combination of both types of fasteners is believed to be part of the original construction. Barcode 6, the smallest boat in the assemblage appears to be the only vessel where wooden nails were used in combination with iron fasteners. Conversely the larger boats seem to have been fastened using clench nails in combination with double hooked nails (T. Falck; pers. comm.). Coherent and homogenous across all wrecks was the use of treenails to fasten frames to the hull planking (Gundersen, 2012).

Conclusions and discussion

As all boats were found empty and missing crossbeams or thwarts, it is believed possible that the vessels may have been deposited in this location deliberately and more or less contemporaneously in course of land reclamation or served as foundations for warehouses built near the shoreline (Gundersen, 2012). Should this be the case, it would appear likely that the boats were relatively old and considered at the end of their lifespan, thus pointing to a mid to late 16th century date for their construction and time under sail.

The meticulous recording and analysis effort put into the documentation of the Barcode wrecks should provide a wealth of information to help deepening our understanding of small watercraft operating in and around the Oslo Fjord during the 16th/ early 17th century. Particularly the variety in structural details evident in keels, stems and stern alone shows the diversity in local boat building during the later Renaissance. The seeming divide in usage of keel types for smaller and bigger vessels further indicates that certain structural decisions were taken based on practical grounds rather being dictated by specific building traditions. No doubt will detailed documentation, research and analysis, including dendrochronology, provide a deeper insight into boat building practices, traditions and socio-economic impacts.

4.9.3 The Portør boat

Introduction

The fragmented section belonging to a clinker built boat were found during small-scale dredging works at Portørenga in Southern Norway (Fig. 4-55) and excavated in 1981. The recovered remains comprised five strakes of planking, the keel, stem and sternpost as well as framing timbers (Figs. 4-61 and 4-62). Most timbers are described to be of oak, although some framing timbers appear to have been made of spruce. C14 analysis undertaken shortly after the wreck's discovery by NTH in Trondheim gave two differing dates. The initial date was AD 1575 +/- 65, which was later revised to AD 1465 +/-45 (Christensen, 1985). The vast majority of timbers appear to have been made of oak with only few exceptions. These include the mast thwart and some side timbers (Molaug, 1981).

Keel, stem and stern

The overall preserved length of the poorly preserved keel is unknown as both ends were missing. The keel had a T-shaped cross-section with sided dimensions of 18cm and measured 11.5cm moulded (Molaug, 1981).

The stempost was preserved to a length of 1.44m and is described as gently curving. It measured c. 10cm moulded in the middle tapering to both ends to c. 7cm. The stem measured c. 4.5cm moulded inboard tapering to c. 2.4cm outboard, giving in a slight wedge shaped cross-section. Neither stem nor sternpost had rabbets for garboard strakes or rebates to accommodate plank hood ends. The nature of joints and fastenings between keel stem and stern are unknown. The preserved sternpost consisted of two pieces scarfed together with a vertical stop scarf. Similar to the stem the sternpost describes a gentle curve (Figs. 4-62 and 4-63). Impressions of a rudder bracket indicate the former presence of a stern rudder (Molaug, 1981).

Hull planking

The hull planking was comprised of five strakes on either side. It appears that all hull planks were made of oak and sawn. Molaug notes that the inboard surfaces of several planks were not as smoothly finished compared to the outboard counterparts. Planks on the same strakes were joined with relatively short scarfs measuring on average c. 13cm in length. Plank overlaps were fastened with wooden nails made of juniper, rather than iron nails. The wooden nails measured 1.2cm in diameter and were secured with wedges from the inboard side. Distances between nails varied between 8cm and 23cm but were on average c. 16cm. Occasionally additional nails were observed interpreted as supplementing original nails. Actual repair to the hull was evident in at least one instance where a short plank was placed over a leak on the starboard side. The plank seams and scarfs were waterproofed with a material made of tar and vegetable matter (Molaug, 1981).

Framing timbers

All of the seven original frames were preserved. These were place at regular intervals of c. 60m with all floor timbers spanning all strakes of planking to gunwale level (Fig. 4-62). Nevertheless some stanchions made of pine were also present. The framing timbers were fastened to the hull with treenails of 1.6cm diameter (Molaug, 1981). Excavation photographs show that the framing timbers were well finished to four-sided cross-sections, and all showing distinct joggles on the outboard faces. At least one floor timber had a limberhole cut into the keel-facing surface.

Figure 4-61: Assembled stern section of the Portør boat after excavation (Molaug, 1981 p. 371)

Mast step, mast thwart and rowlocks

A plank thwart with a central hole for a mast was found resting loos on a framing timber in the forward half of the wreck, which is believed to reflect more or less its original position in the vessel (Christensen, 1985). The thwart was made of pine and measured 47cm in by 6cm in thickness. The mast hole was 11cm in diameter. The mast step is described as relatively flat with the rebate for the mast measuring 4.6cm in diameter. The boat was further fitted with four rowlocks on each side of the gunwale (Fig. 4-62). Additional wooden gunwale timbers were fitted to reinforce the rowlock positions. Each rowlock consisted of a pair of rowlock pins, which were set at a distance of 11.8cm (Molaug, 1981).

Conclusions and discussion

In spite of detailed information on date, size, dimensions and structural detail missing, the Portør wreck still provides valuable clues for increasing our understanding of small-scale seafaring in the outgoing Middle Ages. It would appear that the Portør boat was smaller than most of the other presented wrecks, with an overall length probably below 10m. As stem and sternposts were partially preserved it can be reconstructed as a double ended vessel. Both, Molaug and Christensen believe the find location of the mast thwart reflects its original position slightly forward of amidships in the vessel. However, while this leads Christensen to reconstruct a two masted rigging arrangement (Christensen, 1985), Molaug deems the boat to have been rigged with a single spritsail. He further argues that the mast was a secondary addition to the vessel. Considering the presence of four rowlock pairs, indicating that the boat was propelled by rowing Molaugs interpretation cannot be ruled out (Molaug, 1981).

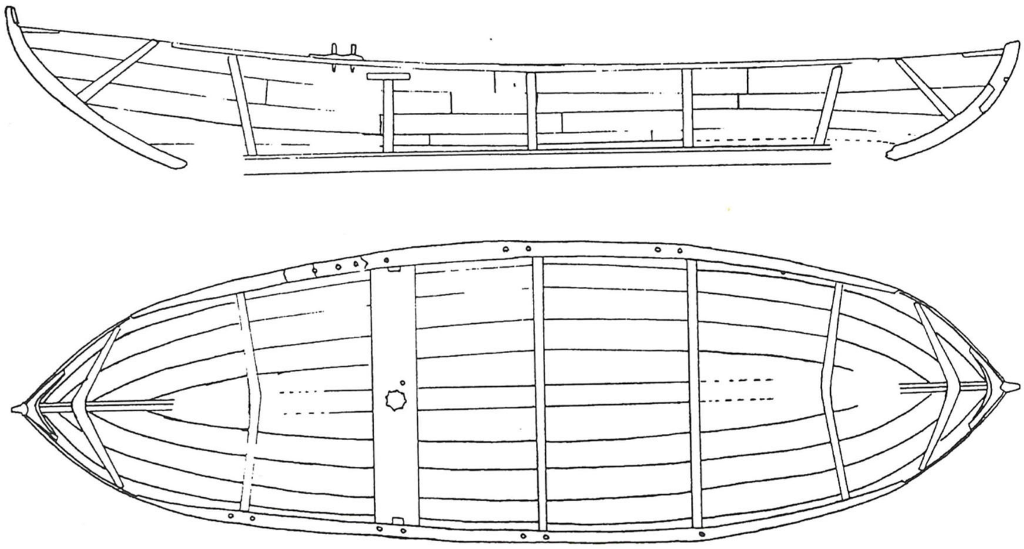

Figure 4-62: Reconstruction drawing of the Portør boat (Molaug, 1981 p. 92)

The above-mentioned C14 date for the vessel indicates a 15th century date for the wreck. Christensen, however, believes a 16th century more likely based on the presence of sawn planks (Christensen, 1985). This interpretation is supported by Molaug and Hobberstad who link the appearance of sawn planks with the introduction of sawmills in Norway during the beginning of the 16th century (Hobberstad, 2012; Molaug, 1981). Christensen further states that "…*the wreck is east-Norwegian in character, but shows features that resemble West- and North-Norwegian practice*…" (Christenen, 1985 p. 369). In support of this interpretation he mentions the seemingly eastern Norwegian shape as well as the combined wood usage, whereas the thwart loosely fastened to the framing timbers is seen as indicative for western Norwegian boats. Christensen therefore sees the Portør boat as an evolutionary link between the western Norwegian built boats built in more medieval or Viking fashion and the later medieval southern Scandinavian vessels (Christensen, 1985). The use of wooden nail fasteners instead of iron clench nails is forms an important aspect in this line of thought.

Figure 4-63: Stem- and sternpost as well as keel fragment after excavation (Molaug, 1981 p. 371)

Although much credit is owed to the documentation and interpretation of the Portør boat, the lack of more precise dating and knowledge on timber provenance, means that its interpretation as a chronological or evolutionary link between building tradition should not be taken as fully secured.

4.9.4 Vaterland 1 wreck

Introduction

During road construction works in 2011 on Schweigaardsgate in Oslo the remains of the so-called Vaterland 1 wreck were discovered (Fig. 4-55). The well-preserved remains of the small boat measured c. 5.5m in length by c. 2m in width (Fig. 4-64). Among the structural elements were the fully intact keel, three strakes on either side as well as a number of framing timbers (Stanek, 2012). Dendrochronological analysis provided an approximate felling date of c. 1505 for the hull planks, which were made of oak most likely originating from southern Norway (Daly, 2011).

Keel and stem fragments

The keel has a total length of 3.8m, measuring maximum 27cm sided by 8cm moulded with a distinct T-shaped cross-section (Stanek, 2012). Both ends have diagonal vertical scarfs and were secured with an iron nail each (A. Stanek, pers. comm.). Garboard strakes were fastened to the keel with iron clench nails. A protective tar coating covered all surfaces with the exception of the position of the nine frames (Stanek, 2012).

Two small timber fragments are believed to be part of the original stem. The wedge-shaped appearance with a penetrating nail holes are interpreted as scarf fragment. The second timber shows no diagnostic features (Stanek, 2012).

Hull Planking

As mentioned above the hull planking was comprised of the lowermost three strakes either side of the keel and at least three planks were sawn. Plank widths varied between c. 12cm and c. 33cm and thickness ranged from 1.3cm to c. 3cm. Planks are fastened with iron clench nails of unknown cross section with nail tips hammered flat as well as turned twice back into the wood. The hull planking was covered with a protective coat of tar inboard and outboard (Stanek, 2012). Analysis of the waterproofing material showed that a variety of materials were used, including hemp, moss and flax (Walton Rogers & Hall, 2011).

Repair was evident in one instance where a patch with a piece of cloth underneath was applied over the inboard surface of a plank where a crack had caused leakage. The patch was found to be a reused piece of a cask stave. Two further repairs cover outboard seams of planks (Stanek, 2012).

Framing timbers and possible stringer

A total of nine framing timbers were preserved mostly comprised of floor timbers and one side timber. The latter has a preserved scarf table, showing that floor and side timbers were joined with horizontal through scarfs. While the vast majority of framing timbers were made of oak, two floor timbers were made of pine. The average values for sided dimensions are c. 11.5cm and c. 8.5cm moulded. Frames were fastened to the hull planking with one treenail supplemented with one or two iron spike nails per strake. The possible stringer presented itself as a roughly worked branch, split in two halves. It is believed to have been fastened against the frames with an iron nail at each end (Stanek, 2012). No evidence that a keelson or mast step was originally fastened to the floor timbers was encountered.

Conclusions and discussion

Based on the preserved remains the original vessel is reconstructed to an overall length of 7.8m and a beam of c. 3m by Hobberstad as part of a MA thesis. The vessel is furthermore reconstructed to a double ended shape, i.e. curved stem and sternpost (Hobberstad, 2012).

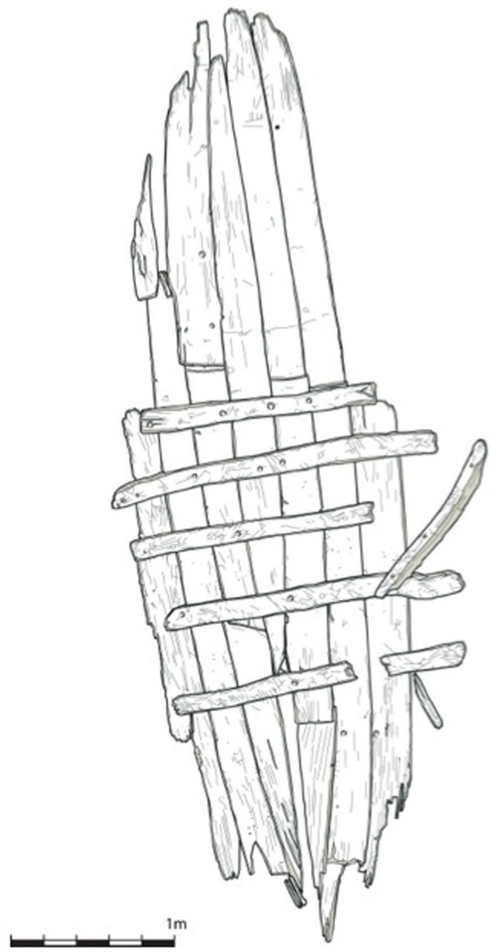

Figure 4-64: Site plan of the Vaterland 1 wreck (Stanek, 2012 p. 3)

4.10 Conclusions

The collection of the material as listed and described above forms the core material for the comparative analysis. Prior to engaging in detailed discussions on specific aspects of construction, building tradition, etc., two major aspects immediately become apparent. Firstly the relatively limited overall comparative material considering the vast geographic reach of this study becomes tangible. Secondly, and leading on from the first point, the immense imbalance between northern Europe and the southern and western European coastline transpires. Nevertheless, the density of find material from extremely localised contexts, such as London and Oslo to nationwide representations as evident in Denmark, show the enormous potential to gain insights into nature and agents impacting on change and continuity in local and regional boat building.

5. Comparative parameters

5.1 Introduction

The presentation of reference sites in the previous chapters gives a detailed understanding of the nature, quantity and quality of the data available for the study. However, before commencing with the comparative analysis the framework parameters have to be defined and described. Using such a diverse base of data for comparative purposes in terms of spatial distribution, date of recovery or investigation, find location and circumstances as well as level and detail of archaeological investigations, means that no site is 100 percent comparable to the next. Although such variations bear no immediate relevance for the actual archaeological comparative research, their potential influence on absence or limited knowledge on certain features has to be taken into consideration and are outlined at the outset of this chapter.

The core section of this chapter, however, is dedicated to a discussion of the main comparative parameters of direct relevance and importance for the subject at hand. These can be divided into three main categories:

Operational waters/ Environmental factors (Geography, climate, etc.)

Contemporary political and socio-economic context

Technological and other relevant hull features

As stated previously, the vast geographical reach of this study imposes limitations on depth and detail in regarding certain subjects. This includes for example detailed discussion on nature of operational waters and environmental conditions as well as an in depth analysis of the respective regional/ national socio-economic and political contexts.

5.2 Archaeological context

5.2.1 Introduction

Assessing a wreck detached from its archaeological context, i.e. circumstances of discovery, find location etc. bears the danger that limited or poor archaeological information can lead to false or skewed interpretation of the find. Circumstances of discovery, accessibility to the site, means for documentation and excavation and levels of preservation are vital factors to be taken into consideration for all of the presented wrecks. Some wrecks may have been discovered relatively well intact with little immediate threat to their preservation, allowing thorough archaeological investigations with a view to carry out research based investigations. On the other hand wrecks discovered during development led projects are frequently subject to project-bound restrictions in terms of access as well as time and financial constraints. Documentation and recording is therefore less research oriented and post-excavation processing analysis rarely financed. However, both examples are by no means exclusively representative as development led projects can also facilitate research and publication, which is not self-evident in non-commercial settings.

5.2.2 Discovery and documentation background

The picture emerging from the assessed data shows that 83 percent, the vast majority, of wrecks were discovered as part of development led projects, such as dredging or other types of construction works (Chart 5-1). In turn only a small number of wrecks were found and reported either by interested members of the public or found through targeted archaeological surveys. The potential impacts of development led discoveries on quality of archaeological research and dissemination are manifold. Although pre-construction surveys and assessments aim to reduce the risk of physical damage and impact on wrecks in the footprint of developments, it is often only through the actual groundworks and the impact going with it that wrecks are found. Similarly size and nature of the developments can dictate how much a wreck is exposed or accessible, particularly for construction works in urban

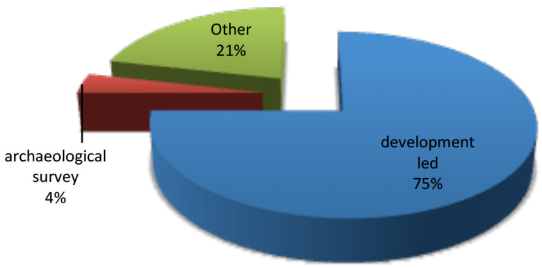

Chart 5-1: Percentage composition of discovery contetxt (Schweitzer 2013)

or river front settings. The wrecks of Blackfriars 4 in London (Marsden, 1996) and Ria de Aveiro G in Portugal (Alves & Ventura, 2005) are good examples for scenarios where the footprint of the development only provides a certain glimpse into the overall picture.

Considering potential time and financial constraints of investigating wrecks discovered during development works shortcomings in documentation, analysis and research could be feared. However, the material assessed as part of this study by and large shows that this is not necessarily the case. As the examples of the Barcode and Dokøen wrecks (Gøthche & Høst-Madsen, 2001) as well as the Drogheda boat and Bredfjed ship (Bill, 1997a) show, large and small scale projects often result in comprehensive investigations from excavation to analysis and publication. The aforementioned Bredfjed Ship is a good example for a wreck found during groundworks and later revisited to be fully excavated on a research basis. Conversely wrecks found outside commercial settings are frequently investigated relatively superficially, such as the wrecks of Knudsgrund (Dencker, 1998b), Grønsund (Dencker, 1996) and Skanör (Bill, 1997a). Lacking the immediate threat of being destroyed by development works, this is not surprising and may reflect a lack of available resources or prioritization by the relevant authorities. In the case of the Lundeborg wrecks, the close co-operation between local sports divers and authorities led to comprehensive investigations spanning over several seasons of fieldwork (Skaarup, 2010). Unfortunately no scientific dating was undertaken and the level of published detail does not seem to reflect the excellent preservation conditions and intensity of fieldwork.

It is noticeable that discoveries of wrecks as part of developments are equally spread across the entire geographical study area. However, to assume that the lack of wreck finds from certain regions and countries reflects actual presence of absence of certain vessel types would be too simplified. Preservation conditions may equally vary, as do heritage legislation and practices (see chapter 2). Assessing and evaluating the heritage management policies of the various countries would go beyond the scope of this study. Nevertheless it is important to understand and appreciate that the reasons for absence of certain material in the archaeological record in individual geographical regions may be manifold and complex.

While the circumstances for discoveries may not necessarily immediately have an impact on the outcome of archaeological research and dissemination, a clear link between the date discoveries and level of investigations can be observed at least for the north-western European areas. The two earliest finds of assembled material, the Kingsteignton boat, discovered in 1898 (Dudley et al., 2001) and Århus Å, found in 1938 (Bill, 1997a), were discovered during construction works and archaeological documentation carried out. In both cases some of the timbers were kept and short reports on the discovery compiled. As scientific dating methods unavailable in the late 19th and early 20th century and maritime archaeological recording methods in their infancy, the limited value of the contemporary documentation is by no means to be criticized. On the contrary, the retention of at least some timbers from the wrecks enabled reassessing at least certain aspects of those wrecks.

5.2.3 Find location

As mentioned above the high number of wrecks discovered in course of construction works or similar, have a significant bearing on the locations of discoveries. Consequently current and former riverbanks and foreshore environments in urban contexts are frequent locations. While this certainly allows drawing certain conclusion between the discovered wrecks and their operational environment, it also highlights a certain bias towards wrecks from urban contexts compared to e.g. rural contexts through discoveries made in course of development works. Nevertheless the *watership* ZN42 (Pedersen, 1997), the Bredfjed ship (Bill, 1997a) and the Lundeborg wrecks are good examples for wrecks found in non-urban contexts. The find location of the Lundeborg wrecks near known medieval tileworks is an example where the economic context of the vessels is probably best tangible. Wreck 2 sank with its cargo of tiles on board just a few hundred meters away from where the tiles were produced and loaded onto the small coastal watercraft (Skaarup, 2010), thus beautifully illustrating late medieval tile production and trade.

5.3 Operational waters and environmental factors

5.3.1 Introduction

The importance of environmental and geographical factors on seagoing watercraft and seamanship has been observed by a number of scholars. McGrail for example dedicates introductory descriptions of regional environmental conditions and implications on seafaring in his comprehensive volume "Boats of the World" (McGrail, 2004). The immediate relationship between sailing environment and design and construction was highlighted by McKee by noting that any boat is built in response and to suit its surroundings and purpose: "B*efore a boat can operate, she must have come to terms with the limitations imposed by the climate, land and seascape.*" (McKee, 1983 p. 19).

As stated at the outset of this chapter detailed analysis of operational waters, including assessment of geographical makeup currents, prevailing winds, climate and seasonal changes would go beyond the scope of this study due to the enormous geographical reach. Nevertheless a brief introduction into the various geographical and environmental surroundings aims to highlight the differences that boats, their builders and crew were confronted with in the different geographical regions of the study area.

In keeping with the previous chapters, the geographical regions are presented more or less according to state borders. Nevertheless, in presenting data such as hydrography and climate, it has to be kept in mind that the various regions are more defined by their overall environment in which they are embedded. In the case of Britain, for example, the western and southern coast belong to the North Sea and English channel whereas the eastern coastline are largely part of the Irish and Celtic Sea with strongly differing hydrographical and climatic conditions. A similar scenario can be attested for Denmark where the west coast of Jutland is part of the North Sea while much of the western part of the country lies in the Baltic Sea.

It further has to be pointed out that the environmental factors outlined below by and large represent modern day scenarios. Historic fluctuations, particularly of hydrographical and wind patterns are extremely difficult to assess. However, as main influential factors, such as main Atlantic currents and climatic tendencies affected and regulated the environmental conditions during the Renaissance as well as today, it is believed that current environmental and climatic factors are valid comparative measures. Nevertheless the known climatic event of the so-called "Little Ice Age" will be taken into consideration.

5.3.2 Climate

Introduction

Returning to McKee's comment on the limitations imposed on boats and crews by climate, it is aimed to give a general introduction into the diversity of climatic and other environmental conditions of the European Atlantic coastline. One difficulty in assessing climate as an influential factor for a specific historic period lies in the variability in climatic patterns, a phenomenon we are currently experiencing through the effects of the so-called "Global Warming". Consequently current climatic conditions can only be seen as guidelines for past weather patterns. Thus the modern contrast between southern and northern European climate with their approximate seasonal temperature fluctuations can be assumed to have also existed in the past with certain variations in average temperatures and weather patterns. Since the period under investigation falls into the so-called "Little Ice Age", the main aim is to illuminate the general climatic background for the European Atlantic coast.

While climate is a rather variable factor, geographical and hydrographical morphologies of the coastal regions can be seen as more stable and thus relatively close to modern day conditions. Portraying and discussing the variations in coastal geography and hydrography thus increases our understanding of environmentally dictated limitations and possibilities for small-scale coastal seafaring.

The "Little Ice Age"

Climatically the 15th and 16th century fall into the so-called "Little Ice Age", a period of colder, wetter and rougher weather following the Medieval Warm Period. Even though the term Ice Age is not factually correct as it exaggerates the climatic conditions. It is believed that temperatures fell by approximately one degree Celsius and growing seasons shortened by c. three weeks. Although colder, rougher and wetter climate were noticeable phenomena, it is the extreme variability in weather swinging between climatic extremes that characterizes the period making the term “Ice Age” is misleading. The unreliability of weather and seasons thus was an important aspect in societies attempting to adapt and cope with the climatic change (Aberth, 2012).

Exact beginning and end point of the cooling period are difficult to determine due to significant local variations and disagreeing scientific viewpoints. It would appear, however, that mean temperatures slowly but gradually fell from the early 14th century until the late 16th century when a significant drop in temperatures affected the climate. It was not until the mid-19th century that temperatures rose again. The effects of a cooling climate for seafaring were certainly noticeable during the time in question with harsher winters and heavier storms affecting seaborne trade as well as fishing (Fagan, 2000). Assessing the impact of said climate change on design and construction of coastal watercraft is extremely difficult without detailed knowledge on changes in climates and development of boat design and architecture in the various coastal regions. Nevertheless a general trend towards rougher climatic conditions may well have resulted in small adjustments to improve durability and seaworthiness.

As most small coastal boats were either fully open or partially decked, keeping the vessel watertight and reducing exposure to the elements to a minimum certainly was an important factor, particularly considering the relatively low average Atlantic water temperatures for most of the study area (McKee, 1983). Further to this sailing was often seasonally restricted due to the low temperatures and higher risk of storms and gales during the winter months. With an increased frequency of gale force winds and risks of storms combined with overall lower average temperatures during the 15th and 16th century, a certain climatic impact on small scale seafaring during the “Little Ice Age” can be assumed. Furthermore the severe winters restricted seafaring activities due to waterways more frequently freezing over (Fig. 5-1).

A good example for variations in local weather patterns and the climatic impact on shipping during this period is the succession of at least seven extremely hard winters in the 1430s. In this phase extensive periods of severe frost dominated the weather alongside rougher weather conditions with a number of heavy storms causing the loss of many ships and boats in the Bay of Biscay alone. This phase of severe and rough weather was followed by a phase of milder climatic conditions from c. 1450 to the early 16th century allowing for economic recovery. Deteriorating weather patterns with average annual temperatures dropping and stronger winds combined with more frequent storms again dominated the

Figure 5-1: Detail of a painting by H. Avercamp showing ships frozen in on a beach, dating to c. 1610 - 1620 (Museum Boijmans Van Beuningen)

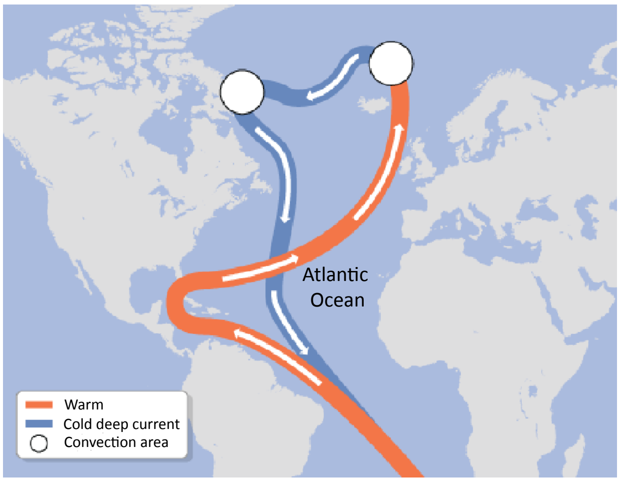

Figure 5-2: Flow direction of the North Atlantic Drift (map by GCSE Bitesize 2013)

second half of the 16th century with the coldest conditions recorded in the 1590s. Winds during this period are believed to have been significantly stronger with storms frequency increasing by c. 85 percent, especially during the winter months. The number of recorded severe storms even rose by 400 percent. Probably the most prominent incidence associated with this period is the loss of the Spanish Armada, struggling with severe storm force winds in August/September of 1588. Based on the contemporary logs of weather records from Armada ships, the wind conditions are estimated to have reached between 40 and 60 knots, close to hurricane strength. Further to the impact on shipping, failing crops and sequences of famines took their toll on European society and economy during this period (Fagan, 2000).

General climatic observations

While the long-term effects of general climatic trends are usually slow and of limited scale, annual variations in temperature, i.e. between winter and summer can be substantial, and are thus an important factor for seafaring. These annual fluctuations naturally vary drastically from Portugal at the southern periphery of Europe's Atlantic coastline to the extensive Norwegian coast in the North. An important factor in the severity of annual fluctuations, are the main Atlantic currents. As currents are discussed in more detail below only the two main currents affecting climate are briefly described. The North Atlantic Drift on the one hand slowly carries relatively warm water from the Gulf Stream in a northwards direction into the Bay of Biscay and past Brittany, the British Isles and the Scandinavian Atlantic coast (Fig. 5-2). The climatic effect of the North Atlantic drift is a combination of relatively mild winters and cool summers.

Conversely the Portugal and Canary Currents are broad and slow currents comprised of relatively cool water flowing in a southwards direction affecting the Atlantic coasts of Portugal, Spain and the Bay of Biscay. Due to the prevailing moderate and warm Mediterranean climate on the Iberian Peninsula, the Portugal Current results in slightly lower average temperatures on the Atlantic coast combined with wet and mild winters. The Bay of Biscay, however, shows more extreme weather patterns due to its wide crescent shape and parts of the continental shelf reaching far into the bay. Particularly the winter months depressions enter the bay with severe thunderstorms developing and causing prolonged periods of rain along the coast. In addition fog is a characteristic feature of the Atlantic coast from Portugal up to Brittany, particularly in late spring and early summer (Saundry & Bransford, 2011). Wind conditions in the North Sea are characterized by large variations in wind direction and speed, a high level of cloud cover, and relatively high precipitation. Annual temperature fluctuations vary significantly from the northern parts of the North Sea where prolonged periods of temperatures below zero are frequent to more moderate and mild conditions towards the English Channel. Relatively mild and moderate climatic conditions are equally present at the western fringe of the study area, particularly along the west coast of Ireland where the inflow of relatively warm water from the Gulf Stream generally counteracts extreme climatic fluctuations (OSPAR, 2000b; Hogan, 2011a).

5.3.3 Coastal geography

Britain and Ireland

The north-eastern coastline of Ireland is comprised of low rocky relief alongside large sandy beaches. The embayment of Lough Foyle equally consists of large areas of sandy beaches. Further to the south the coastline is divided by three major fjordic inlets or sea loughs, including Strangford and Carlingford Lough, which are comprised of sandy beaches, extensive areas of intertidal mud and salt marsh as well as intertidal rock in the southern areas sections (Fig. 5-3).

The middle section of the eastern Irish coastline is comprised of a low and relatively soft relief with extensive sandy beaches and very few major bays and inlets, Dublin Bay and Wexford Harbour mark exceptions to the otherwise uniform nature of the coastline. A number of small islands are dotted along the eastern coast. With the transition to the southern coastline the relief again becomes more jagged and rocky alternating with sandy beaches. The relief becomes increasingly rocky towards the western section of the southern coastline, which is also characterised by frequent small bays and estuaries and large estuaries, such as Cork and Waterford Harbour. The absence of barrier islands means that the south coast is barely sheltered from the prevailing west to south-west winds. The rocky character with steep cliffs and a series of large bays and inlets continues in the southern half of the western Irish coastline with some fjord like long and narrow providing shelter from the prevailing south-westerly winds and large Atlantic fetch. Overall the topography remains rocky with frequent steep cliffs, except for the middle section of the western coastline where linear sandy beaches become more frequent. Further to the north the north-west and north coasts remain rocky but numerous large bays with fine sandy beaches characterize its appearance. Several small islands lie off the west coast of County Donegal (OSPAR, 2000c).

The north-westernmost section of the British coast is comprised of a series of fjordic sea lochs, mountainous stretches with steep cliffs mixed with areas of sand dunes. Low rocky reliefs and small dunes define the coastlines of the Western Isles. The western coasts of the Hebrides where up to 50 days per year with gale-force winds are known highlight the exposure and force of the Atlantic. Following the western Scottish coastline southwards the geography is dominated by rocky reliefs with fjordic inlets providing shelter from the Atlantic. Further to the south a number of offshore islands follow, including e.g. Islay and Mull. From the Clyde Estuary southwards the coastline is softer and less jagged.

The northern section of the coastlines between the south-western Scottish coasts and the north-east coast of Wales the coastline is mountainous and jagged giving way to frequent sand and shingle beaches further south. A prominent feature of this coastline is the high number of estuaries. The fourteen estuaries make for nearly a quarter of the total estuarine area in Britain with Morecambe Bay even representing the second largest area of intertidal mud and sand in Britain. The southernmost coastline is dominated by rocky geography with steep cliffs, such as Land's End and Cape Cornwall. The east and south-west coasts of the Isle of Man are rocky alternating with sandy beaches on the exposed north-west coast (OSPAR, 2000c).

Figure 5-3: Northern Ireland relief map showing Carlingford and Strangford Lough (Schweitzer 2013 based on a map prepared by Nilfanion, Wikimedia Commons)

The northernmost Scottish coastline is quite mountainous with many rocky islands, and characterized by numerous deep fjords similar to the opposing Norwegian coast. The southern Scottish and northern English coasts fronting onto the North Sea are characterized by rocky reliefs mixed with pebble beaches and occasional river inlets. Further to the south the English coastline becomes softer with more frequent sand beaches, mud flats such as the Wash as well as large estuaries, such as the Humber and Thames Estuaries. Along the English Channel low cliffs become more frequent alternating with river inlets (OSPAR, 2000b).

Bay of Biscay and Iberian Coast

The topography and appearance of the coastline along the Iberian Peninsula varies significantly. The Iberian Atlantic coast is by and large without islands protecting the coast from wide fetch from the Atlantic. It is mostly defined by alternating rough cliffs and fine sand beaches. Starting from the Bay of Cadiz where a rocky, jagged coastal relief alternates with sandy beaches, dunes and marshes, the coastline gives way to a number of barrier islands flanking the Ria Formosa lagoon near Faro. This is followed by a coastal stretch between Faro and Sagres at the south-westernmost tip of the Iberian Peninsula where sandy beaches at the base of steep cliffs are predominant. Continuing north, the vast majority of the south-western coast as far as Galicia is largely defined by a rocky relief with steep cliffs, alternating with occasional beaches, which are mostly small in size and around mouths of rivers and coastal inlets.

Specific features of the Iberian coast are rias, coastal inlets located at the northern Iberian

Figure 5-4: Aerial photo of Ria de Aveiro (Ferrand, 2002)

Peninsula. They can be described as Fjord-like, although they usually become quite narrow and shallow inwards (Fig. 5-4). While some rias are known for their productive ecosystems allowing for example mussel production, others have been used for salt production. In addition most rias provide shelter from the open Atlantic leading to the establishment of important trade settlements and towns in some rias. The Ria de Aveiro coast deserves special mentioning as is defined by a large delta of c. 45km in length and up 11km wide. Four main channels flow through several islands and islets of the delta, resulting in the formation of a lagoon since the 16th century.

To the north of Galicia, the coastline first becomes sandy mostly rocky before giving way to a sandy coast. From the Galician coast a largely mountainous, jagged coastline stretches over c. 1400km to the entrance of the Bay of Biscay and along the east-west oriented Basque coastline of the Bay of Biscay. With the transition to the Aquitaine coastline, the geography changes drastically to long sandy beaches, which are directly exposed to the fetch of the Bay of Biscay. This is followed by areas of marshland between the Gironde estuary and the Vendée coast, which again is defined by coastal dunes. Further north coastal geography gives way to large mud banks and shoals with a series of small islands flanking the mainland coast. Finally the north-western part of the coastline in the Bay of Biscay has a jagged, rocky relief with steep cliffs (OSPAR, 2000d). The diversity of the coastal makeup of the Iberian coastline from long sandy beaches to rough, steep mountainous cliff and marshy estuaries highlights the varying demands on boats sailing and operating in the Bay of Biscay and along the southern Iberian Peninsula.

North Sea coastal area from France to Denmark

The French coastline along the English Channel extends across Brittany and consists of a largely rocky relief mixed with maritime plains and estuaries (OSPAR, 2000b). Important geographical features are the Bay of Seine, located between Cherbourg and the Seine estuary near Le Havre in France as well as the Channel islands, including Guernsey and Jersey (Hogan, 2011a).

The North-eastern part of the study area is comprised of the North Sea, a relatively shallow part of the Atlantic, enclosed by Britain, Norway, Germany, Denmark, Netherlands and Belgium. Much of the continental mainland coastal areas in the North Sea are characterised by an intertidal zone with sandy beaches, dunes extensive mudflats or coastal marshes, which occur particularly around the main river estuaries (Hogan, 2011b; OSPAR, 2000b). This intertidal zone, known as the Wadden Sea, is the largest freshwater tidal area in

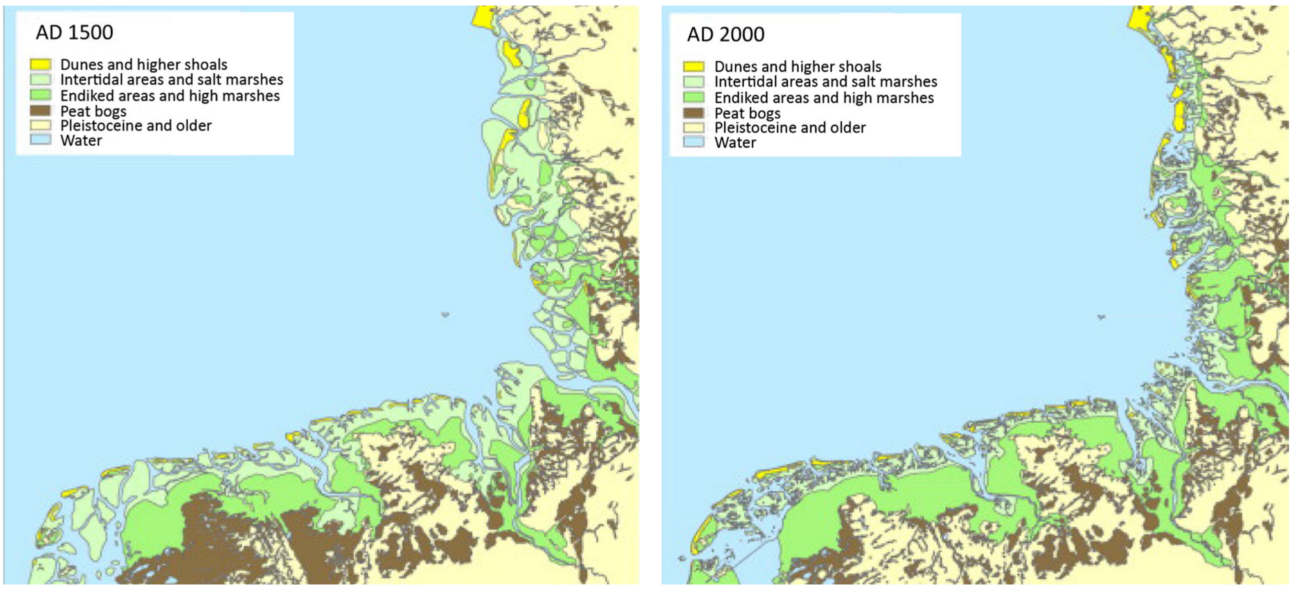

Figure 5-5: Morphological development of the Wadden Sea illustrated for c. 1500 and 2000 (after Wiersma et al., 2009)

Europe is between 3km and 25km wide and spans over the north-eastern part of the Dutch coastline, across the entire German North Sea coast up to the Jutland peninsula. Its outer margin is defined by roughly 50 small to moderately sized barrier islands. The land- and seascape of the Wadden Sea as it presents itself today has been substantially shaped and altered by coastal communities over the last three millennia with much of the coastal landscape diked (Fig. 5-5) (Hogan, 2011c).

The English and south-eastern coastline of the North Sea is largely defined by jagged cliffs and skerries whereas wide beaches and coastal dunes in the vicinity of estuaries are diagnostic for the North Sea coasts of eastern Scotland and north-eastern England (Hogan, 2011b). The western coast of the North Sea is rocky and with mountains, islands, steep cliffs and fjords defining the Norwegian coastline becoming less rough towards the southern parts of the Norwegian coast.

Sweden and Norway

A chain of islands flanks and protects most of the Swedish and Norwegian along the Kattegat and Skagerrak coastline. The Norwegian North Sea coastline, similar to the opposing northern Scottish coast, is mountainous with frequent deep fjords and numerous rocky barrier islands, a relief continuing northwards along the Arctic Sea coastline (OSPAR, 2000b). The coastal makeup to north of the North Sea is comprised of two main components, the strandflat on the one hand, an undulating and partly submerged rocky platform extending seawards from the steep mountainous coast, and steep and deep fjords on the other. The gently sloping relief of the strandflat, which can be up to 60km wide, forms an uneven coastline with numerous bays, coves, inlets and islands of varying sizes. It offers protection from the Atlantic and provides good sailing conditions as well as sheltered harbours. In contrast to the Scottish fjords, the Norwegian fjords are usually long and narrow, frequently curving or with side arms branching off (Fig. 5-6) (OSPAR, 2000a).

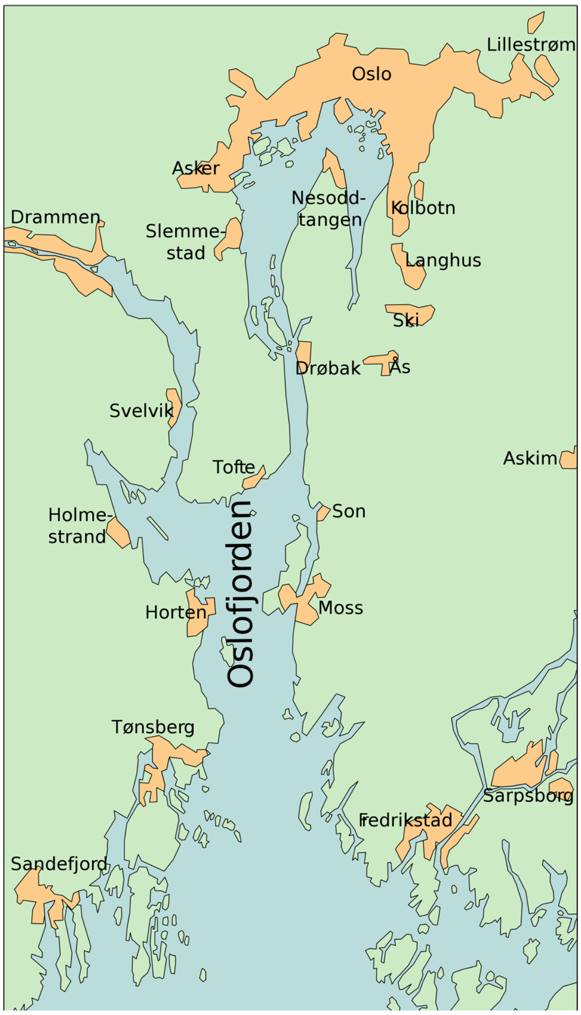

Figure 5-6: Schematic map of Oslo fjord (map by Finnrind, Wikimedia Commons)

5.3.4 Winds, tides and currents

Introduction

Major aspects of any seafaring are prevailing winds, currents and tides in the respective operational waters. Although general observations regarding certain geographical regions can be made, the individual composition between the three aforementioned factors can vary significantly within small geographical regions. This in turn means that sailing environments and demands on boats can differ hugely in relatively small geographical areas. McKee was able to show the diversity of environmental factors influencing coastal seafaring for Britain. Notwithstanding Britain being an Island, thus multiplying the nature and surroundings of a countries coastline, the sheer number of unique interactions between the various factors for different coastal areas shows the complexity of comparing boat designs and their construction (McKee, 1983).

Ireland and Eastern Britain

As mentioned above Ireland and Britain spread over of two separate geographical regions in terms of hydrography and climate. The western region belonging to the Celtic and Irish Sea is described first, followed by the Britain's east coast, which is part of the North Sea.

Generally the water flow along to around Ireland and the Irish Sea is in a northerly direction with water from the North Atlantic being carried from

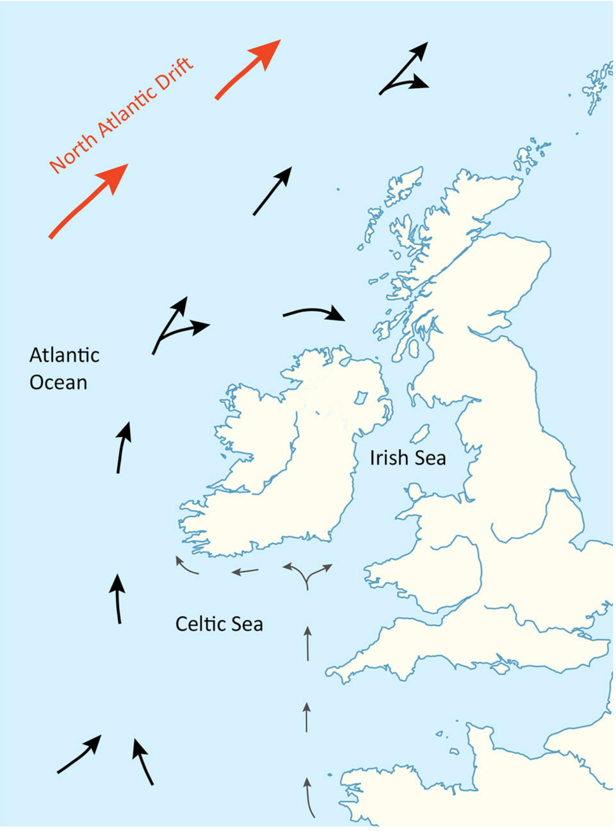

Figure 5-7: Circulation around the Irish Shelf (Schweitzer 2013 after OSPAR Commission, 2000c p. 10)

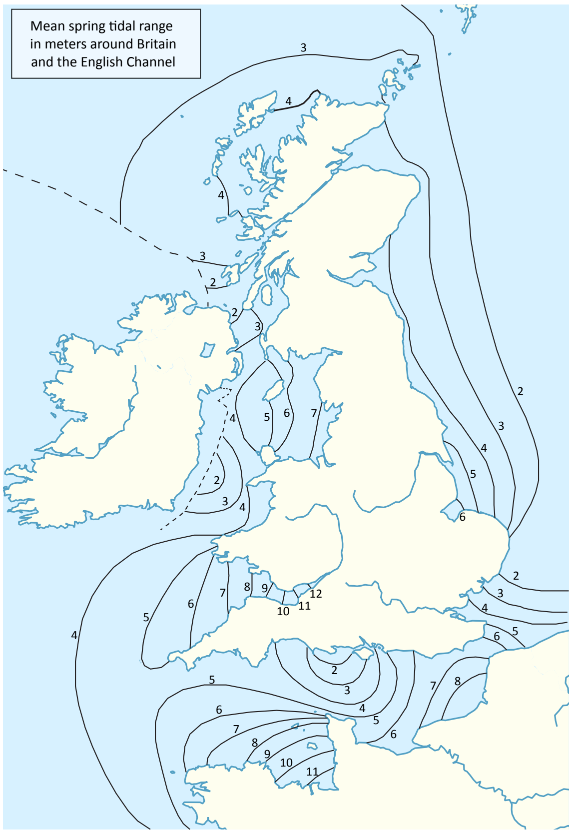

Figure 5-8: Mean spring tidal range around Britain and the English Channel (Schweitzer 2013 after Uncles, 2010 Fig. 1 and Scott et al., 2011 Fig. 1)

the south and west northwards either into the Arctic Sea or into the North Sea after circulating around the north of Scotland. The main current encircling Britain and Ireland to the west is a persistent north-westerly current following the Atlantic shelf slope edge from the Bay of Biscay to the south-west of Ireland (Fig. 5-7). In addition a weaker and more variable current flows from the coast of Brittany across the western entrance of the English Channel. Roughly at the height of the Isles of Scilly the current forks into a stronger flow in a westerly direction along the south coast of Ireland on the one hand and a weaker flow northwards into and through the Irish Sea being strongest on the eastern side.

On a smaller scale, however, the tidal and current systems are far more complex, particularly within the Irish Sea. Particularly the tidal systems represent a far more important factor in water movement within the Irish Sea with tidal varying significantly regionally and in amplitude. In turn the high frequency of strong winds in combination with the large fetch of the Atlantic create not only strong wind driven currents but also some of the largest waves particularly along the south- and north-western Irish coast. In fact wind-induced currents can play a significant factor across the entire Celtic and Irish Sea region, particularly during periods of prolonged heavy and persistent winds.

Looking at the southern-eastern part of the Celtic Sea, again the prevailing south-westerly winds mean that the coasts of Devon and Cornwall to the south are far more exposed than those of the Severn estuary and Bristol Channel. The Orkney Islands and Outer Hebrides off the north-western Scottish coast shelf provide some protection from the strong and frequently extreme prevailing westerly airflow. They further act as a dividing barrier between water flowing northwards from the Irish Sea and the North Atlantic Drift to the west. While the overall water movement along the eastern Scottish coast is northerly, climatic factors, such as wind can lead to strong short-term variations in the flow pattern. Waves in the Irish Sea in contrast are usually generated locally and thus not as extreme as on the western periphery. Nevertheless they can be quite steep particularly during storms within the shallower eastern Irish Sea, and inner Bristol Channel. Finally the tidal ranges vary significantly across the different areas of the Celtic and Irish Sea. While tidal waves in the open Atlantic tidal waves are usually quite small they increase as they move eastwards towards the landmasses and are further enhanced by bays and estuaries where water is funnelled, such as the Severn estuary with the spring tidal range exceeding 10m (Fig. 5-8) (OSPAR, 2000c).

Iberian Coast and Bay of Biscay

Currents along the Iberian Atlantic coastline are affected by a number of factors but the mean surface current is broad, slow and generally flows in a southward direction. However seasonal winds in the region can change flow directions. Its surface waters are relatively cool because as it travels south it entrains upwelled water from the coast (Mittelstaedt, 1991). Coastal upwelling is the most important hydrodynamic process along the Iberian coast during the summer months and develops as a result of consistent occurrence of northerly winds. In line with the main current flow direction the prevailing winds during summer are northerly changing to westerly during winter combined with higher frequency of gale force winds. Due to the exposed nature of the Portuguese coast combined with westerly onshore winds result in a large fetch and a particularly treacherous sailing environment, especially for vessels attempting to seek shelter in treacherous harbours only accessible through shallow estuaries, blocked with sandbanks.

The tidal range along the Atlantic coast of the Iberian Peninsula varies slightly but is on average c. 3m. Environmental conditions change drastically from the Iberian Atlantic coast to the Bay of Biscay, which is known as a treacherous sailing environment due to its rough seas and frequency of storms. Due to the presence of the continental shelf in the bay, waters are relatively shallow in some areas allowing for seas to build up treacherously. Both severity and frequency of storms in the Bay are much higher, particularly during the winter months, compared to the all other stretches of coast covered in this study. The main current in the bay is dictated by the North Atlantic Drift, which enters the bay in the south and circles through the bay in an anti-clockwise direction (Fig. 5-9). Freshwater discharged from a number of estuaries further creates generally northward currents along the coast with seasonal variations depending on freshwater volumes and prevailing winds (OSPAR, 2000d).

North Sea coastal area from France to Denmark

Moving further North into the English Channel and North Sea the water consists to varying degrees of a mixture of induced North Atlantic water and freshwater run-off (OSPAR, 2000b). The main current is comprised of a current branching off the North Atlantic Drift entering the North Sea between the Orkney Islands and Norway and along the slope of the Norwegian Trench parallel to the Norwegian Coastline (Fig. 5-10). It circulates through the North Sea in an anti-clockwise direction combined with the main current through the English Channel in a northward direction. Coming to the Norwegian coast, the northwards flow along the coastline is quite strong and encircled by a relatively strong southward branch of the Main Atlantic current towards the Baltic. The narrows of the Skagerrak Strait between Southern Norway and northern Jutland are particularly affected as strong and complex stratified counter-currents control the marginal water exchange between the Baltic and the North Sea (Hogan, 2011b; OSPAR, 2000b).

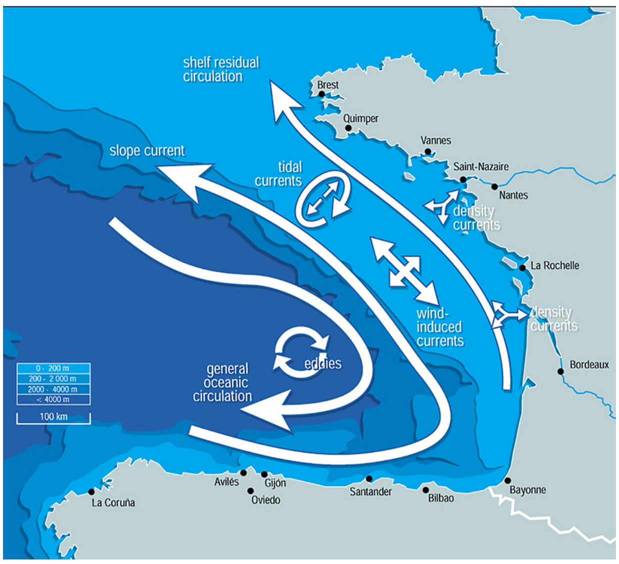

Figure 5-9 Bay of Biscay circulation: Schematic illustration of circulation in the Bay of Biscay. (OSPAR Commission, 2000d Fig. 2.8)

Figure 5-10: North Sea circulation: Schematic diagram of general circulation in the North Sea. (after OSPAR Commission, 2000a Fig. 2.3)

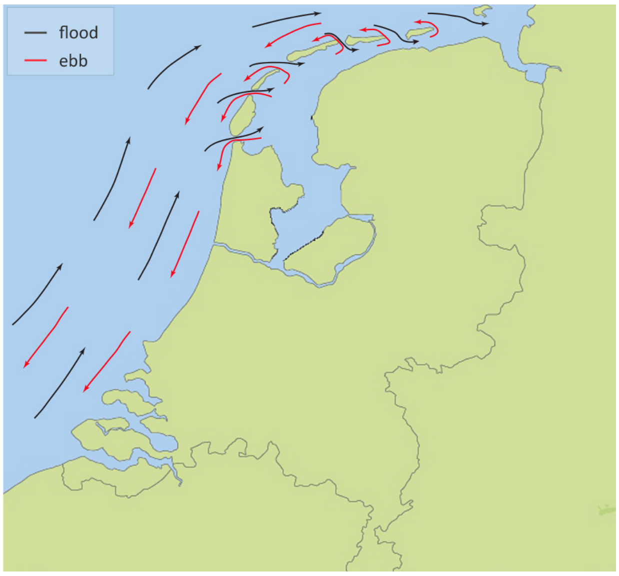

Figure 5-11: Tidal currents in the western Wadden Sea (Schweitzer 2013 after a map by Ecomare 2013)

In addition to the main currents the circulation pattern in the North and Wadden Sea are dependent on tidal ranges. For the western Wadden Sea for example, ebb and flood currents have opposite flow directions with the flood current generally being stronger (Fig. 5-11) (Hogan, 2011c). However, the particular geographical makeup of the Wadden Sea with its extensive tidal mudflats and barrier islands means that currents between individual islands, tidal inlets and estuaries can vary significantly and be quite complex. This in combination with shallow waters and shifting sandbanks makes the Wadden Sea a demanding sailing environment, requiring particular types of watercraft and seamanship skills. Notwithstanding the importance of understanding the specific hazards and other environmental factors that compose the Wadden Sea as a Sailing environment, it is not feasible to discuss the individual aspects and regions of the Wadden Sea in detail.

Further to the main currents, the tidal streams are of significant environmental factors to be taken into consideration for the assessment of operational waters for boats and ships. The tidal system in the English Channel can be divided into two main streams. The tidal flow in the eastern English Channel, including the Channel Islands is generally in an anti-clockwise direction. In contrast the tidal streams of the western half of the channel have a clockwise circulation, which is owed to the proximity of the Celtic Sea. (Hogan, 2011a). Fig. 5-8 shows how tidal ranges even with a geographically confined area like the English Channel can be far from uniform and display drastic variations of up to eleven meters in the Gulf of Saint Malo. The tidal range in these estuaries leads to highly mobile zones of mud and sand, thus tending to block their entrances. (OSPAR, 2000b) It has to be kept in mind that further to the actual tidal range itself, significant velocities in tidal flows are associated with the tides of such high amplitude. With currents reaching up to four knots, McKee has rightly pointed out that such currents could frequently not be overcome by smaller watercraft. He further describes that although the prevailing winds for most of Britain are south-westerly, there is frequently a period around Easter usually "*lasting a few weeks when easterly winds persist in the English Channel, and sometimes re-occur later in the year. While these winds are dangerous to havens sited primarily to give shelter from the prevailing wind, these periods once assisted westward-bound shipping and fishing fleets*" (McKee, 1983 p. 21). This short account highlights how coastal communities and trade networks were aware of reoccurring environmental patterns and knew how to utilize them to their advantage.

Overall the prevailing winds can be described to be westerly as the climate is generally influenced by the inflow of water through the North Atlantic Drift bringing prevailing westerly winds and frequent low pressure systems. However, as mentioned above, due to the high variability in short term current and thus weather patterns, wind directions and strength are equally variable. Nevertheless relatively high levels of cloud cover and rain are characteristic features (OSPAR, 2000b).

Sweden and Norway

As already mentioned above the currents for Norwegian and Swedish North Sea coastline are influenced by the main inflow of Atlantic water north of the Shetland Islands into the Norwegian trench, which turns back off the south-western tip of Norway in an anti-clockwise direction (Fig. 5-10). However parts of the inflowing water crosses the trench prior to reaching the saddle point while some water continues into the Skagerrak before turning back northwards in an equally anti-clockwise direction. The hydrographical circulation from the North Sea does not reach the Kattegat, which generally shows a slow northward current of water leaving the Baltic Sea through the belts between the Danish islands and the Kattegat (OSPAR, 2000b).

The water movement and current system on the Norwegian coastline north of the North Sea is unique compared to all other areas covered in this study. The specific feature of the hydrographical makeup of the waters north of the Outer Hebrides is that the circulation system has to be seen as three-dimensional. Complicated horizontal currents not only dominates upper as well as deeper water layers, but the particular geological deep water formation of the region results in the induction of vertical water exchanges. Consequently the main flow direction in the upper layers follows the North Atlantic Drift in a northerly direction in the upper layers in combination with a southerly outflow towards the south in the deeper layers.

As a comprehensive discussion of the complex circulation patterns of the Arctic Sea would lead too far for the scope of this study the main current drifts along the western Norwegian Atlantic coastline shall be outlined. The main current moves along the Continental shelf in a northerly direction, supplemented with a weaker parallel running current closer to the mainland. In terms of waves, average wave heights decrease the northwards along the Norwegian coast as the influence of the North Atlantic diminishes towards the ice covered Arctic Ocean. As for all oceanic areas, the longest waves in this area are the tidal waves, although the tidal amplitude for the Arctic Sea relatively negligible reaching up to 1m along the northern Norwegian coast (OSPAR, 2000a).

5.3.5 Conclusions

As stated at the outset of this chapter, the above descriptions served to provide a better understanding of the variability in environmental factors surrounding sailing and seafaring in the various coastal waters. Notwithstanding potential similarities and discrepancies in building traditions and respective socio-economic factors, a closer look at the operational waters shows how drastically different the receiving environments can be. For example Iberian Atlantic boat builders and crews had to ensure their vessels endured the open and unsheltered waters along the often mountainous and rocky coastline with shallow rias. Conversely the relatively sheltered coastline of the Norwegian North and Atlantic Sea required adapting to the extreme seasonal climatic fluctuations and often quite complex local currents within the archipelagos and fjords. Similarly boats in sailing the relatively sheltered Irish Sea had to be able to sail against the frequently strong tidal waves in the various river inlets and estuaries. Although strong fluctuations in tidal amplitudes are less drastic in the North Sea, variability in wind strengths and directions combined with treacherous navigation within the continuously changing and shallow Wadden Sea are the challenges for past and present coastal seafaring. This complex and diverse array of coastal environments shows that boats built and designed to sail in coastal waters cannot be seen detached from their surrounding environmental context.

5.4 Late medieval and Renaissance political and socio-economic context

5.4.1 Introduction

The 15th and 16th century are part of an important period in Europe's history, markedly the transition from the Middle Ages to the Renaissance. The period was characterised by a multitude of changes covering all aspects of life from politics to social and economical aspects as well as religion. However, the transition was far from uniform in speed and nature. The climatic effects of the above describe "Little Ice Age" further strongly influenced changes in society and economics. However, given the vast geographical reach of the study area, portraying and discussing these in depth would lead too far for the objective of this study.

5.4.2 General political and economic background

Although the field of interest for this study are small inshore watercraft for more or less local use and low social significance it is important to review their development and place in the wider political, economic and social background of the Renaissance and the preceding 14th century. Although political consolidation of existing kingdoms was apparent during the 14th century it also led to increased conflicts as monarchs strived to increase their power and expand their territorial claims. One of the major conflicts, the Hundred Years' War (1337-1453) had a lasting impact on trade and economy across Western Europe. A physical dimension of the war was certainly the increase of piracy during this period (Unger, 1980). Evidence for decline in trade certainly seems evident for the wine trade between England and Gascony, which only recovered in the 1480's albeit slowly and with less intensity whereas trade with Normandy, northern France, Spain and Portugal appears to have improved much faster (Scammell, 1961).

Furthermore the impacts of war on economical productivity and technological innovation have to be taken into account for the discussion of tradition and innovation in boat and ship building during times of political unrest. Duran, for example, sees peace as a crucial agent for the stimulation of shipping productivity and development of merchant naval activity. Peace allowed for the development and diversification of multilateral trade. This in turn enabled increased technological diffusion through transfer of knowledge facilitated by an increase in migration of workforce, such as seamen, merchants as well as boat and shipbuilders (Duran, 2011). Notwithstanding a certain restrictive impact of armed conflicts on technological development and diffusion, trade and exchange of knowledge did not come to a standstill with boat and shipbuilding developing and advancing nonetheless (Unger, 1980).

The Black Death caused a lasting and drastic impact on Europe's economy and population structure in the mid-14th century, killing approximately one third of Europe's population. Although the demographic blow by the Black Death had enormous consequences, it appears that population had already stagnated significantly by the late 14th and early 15th century as a result of climatic changes leading to famines and shortcomings in food production. Contemporary methods in food production barely sustained existing population levels, not only preventing further growth but also leaving the system fatally vulnerable. Due to recurring outbreaks of the plague in the second half of the 14th century population continuously dropped, until the first half of the 15th century. The economic knock-on effect of the plague was significant with trade volumes seemingly falling exponentially lower than the population. The drastic change in the socio-economic landscape in 14th century Europe meant that trade had to adapt to the shifting market requirement and with changing demands on ships and boats used in the trade networks. Unger believes that the increase in tonnage of cogs is a manifestation of the changing requirements (Unger, 1980).

The 15th century marked a changing point in a number of ways. The discovery of the New World, partly enabled by innovations in ship building techniques, opened up new markets and stimulated the European economies and political developments. Monarchs sought to consolidate and expand power and land, both in Europe and the newly established colonies, thus laying the foundations for the building of Nation States. Colonial endeavours and the establishment overseas trade networks in turn led to the establishment of naval fleet to protect and expand political interests but also as means to display power and sovereignty. In Northern Europe the influence of the Hanseatic League slowly diminished from the early 15th century onwards, while the foundations for the Dutch Golden Age were laid with the counties of Holland and Zeeland united with the lands of the Dukes of Burgundy and Flanders. The role and influence of the Reformation on socio-economic and political developments as described above it difficult to assess and qualify. Nevertheless the Protestant Reformation certainly quickly gained ground in society and politics during the 16th century although its influence on maritime trade and shipbuilding practices are probably best described as subtle and indirect (Unger, 1980).

The demise of the Byzantine Empire in 1453 had impacts across Europe not only on a political level but also on European economy and trade. Particularly raw materials formerly sourced from the East could no longer be obtained and alternative production in Spain and Portugal commenced to meet demands (Davis, 1973). Overall, however, economic growth remained relatively stable with only little economic growth between c. 1500 up to the early 18th century. As a consequence and with total population not significantly increasing during this period, the necessity to develop diversification and technical change was relatively small (Lucassen & Unger, 2011).

Nevertheless it is evident that long distance and European trade expanded quite rapidly from the 15th century onwards. Western European trade for example involved shipping of corn from the Baltic to Holland, Spain and Portugal. French salt from Biscay was traded to the Atlantic and North Sea coasts. Further French products included wine from Bordeaux, La Rochelle and Nantes which was a sought after commodity in Holland, Britain and the Baltic. Herring and timber were also in high demand with Atlantic Herring fished and traded from Ireland and Britain before the Dutch Herring fisheries became predominant from the later Renaissance onwards (Davis, 1973).

However, the medieval herring trade was not solely resting on Atlantic resources. The rich herring grounds off the Scanian cost led to the establishment of the Scania market, originally a market for the distribution of the locally caught herring. However, over time it developed into the most important trading venue in the Baltic Sea attracting western European merchants and the Hanseatic League alike with herring and salt accounting for the most important trade goods. The Scania market maintained its predominant role until the early 15th century when collapsing fish stocks, which is believed to be linked to climatic changes of the "Little Ice Age" (see chapter 5.2.2), led to the decline of the market (Mortensøn, 1995; Bill et al., 1997; Hoffmann, 2005).

The increased economic demand meant higher trade volumes in turn requiring bigger ships. However, many ports were either not big enough to accommodate these ships or as in the case with many Irish ports along the east coast, siltation prohibited access to vessels with deeper draught. This in return meant that the ships either had to anchor in the vicinity of the ports with lighters taking on the business of loading and unloading and that the trade goods had to be redistributed to smaller ports along the Atlantic coast (Davis, 1973).

The beginning of the 16th century largely saw a continuation of developments spawned in the previous century with solidification of dynastic states, growing economic and political interest in overseas colonies. In line with increased long-distance sea travel and growing national political self-confidence, European governments increasingly engaged in establishing military naval fleets to secure their national interests. The second half of the 16th century was marked by political unrest in Western Europe affecting the Netherlands, Spain and France further fuelled by the religious struggle of the Reformation also impacting the political and economic landscapes in Europe. It was not until the end of the 16th century, however, that the overall situation stabilised. Due to increased demands on ship builders to provide highly specialised merchant ships as well as warships ship builder developed into a recognised occupation of high social standing (Unger, 1980). To what degree master ship builders and large-scale shipyards were engaged in the construction and production of small seagoing watercraft is an important aspect and of significant relevance in relation to conceptualisation and construction of vessels, which are otherwise associated with non-specialised, tradition-bound boat builders.

5.4.3 Role and development of coastal watercraft in the socio-economic context

The solidification and continuous expansion of trade networks with similar or comparable socio-economic pressures across Europe led to greater uniformity in design and construction, a development already tangible in the 14th century. With the arrival and spread of carvel ships and shipbuilding, ship builders across Europe responded to the innovations in design and construction, albeit with certain differences in types and building methods (Unger, 1980).

The progression in design and construction of large vessels, including the introduction of full rigging enabling safer and more efficient long distance can also be observed for small watercraft. The continuous expansion of long distance trade networks and increase in productivity demanded higher quantities of small ships of boats. The need for economically viable and technologically improved small vessels manifested itself in significant changes. In addition to changes in shape and construction new rigs, such as spritsails and two masted rigs, were introduced improving handling and performance (Unger, 2011a). In this respect design and construction of Dutch vessels, which were able to cope and operate in a variety of operational waters, appears to have assisted in the increasing superiority of Dutch merchants (Unger, 1980).

The financial values and volumes of traded goods during the Renaissance give a good insight to the importance of small watercraft and the external economic pressures to improve their efficiency whilst reducing construction costs. The majority of the total financial value of the European trade was made up of goods of high unit value, such as textile, dye stuffs, and spices. However, in terms of volume, the greatest part was made up by goods of low unit value, such as corn, salt and timber, meaning that these also required much larger means and facilities for transport (Davis, 1973). However, as Scammell has pointed out, attempting to deduce types and sizes of vessels used for transporting individual goods is not only extremely difficult due to the generally poorly known custom accounts and trade figures but also problematic as contemporary statements on ship sizes were far from accurate and strongly depended on individual observations. Recorded cargo carrying capacity for ships, daily trade patterns and operations could vary heavily depending on changes in types in ships and boats used or even the availability of vessels to merchants at the time. Returning to unit value of goods, luxury goods of high value could be transported in smaller volumes to achieve profitable results, whereas the incentive to utilise large bulk carrying vessels was higher at least for long-distance trade (Scammell, 1961).

Not only were small coastal vessels capable of delivering goods from less accessible local markets to towns, they were also a favoured mode of transport by merchants for the wider coastal trade networks. Although more expensive compared to larger vessels in terms of higher manning ratios, the advantages of smaller vessels were faster turnaround times and their flexibility in usage (Unger, 1980) as well as the above-mentioned easier and more direct access to harbours inaccessible for ships with deeper draughts. Consequently coasters found increased usage for port-to-port trade, which up until the 11th century was largely done by large cargo ships. Unger states that as a result the overall number of small coaster rose significantly from the second half of the 15th century onwards to a degree that they by far outnumbered ships over 100 tons (Unger, 1980). A much higher proportion of small vessels engaged in overall trade compared to large bulk carriers during the period in question is certainly evident for England and Denmark, a distribution that appears to have been predominant until the 19th century (Scammell, 1961; Bill, 2009b).

The high number of small vessels sailing European Atlantic waters in turn seems to have stimulated increased specialisation and differentiation in their design going hand in hand with the wider trend of specialisation of workforce. Specialisation allowed for an increase in efficiency and thus in output and economic growth, in case of small scale shipping this meant growing numbers of for example specialised fishermen, pilots or skippers of cargo boats. Probably the highest degree of specialisation in boat and ship design occurred in the Netherlands where construction, rig and design were adopted and adjusted to a produce high variety of low-cost vessels (see chapter 6.4.2) (Unger, 1980).

The interaction between generally growing economy, rise in short distance trade and numbers of coastal vessels available stimulated spread of settlements and towns as population grew. It further facilitated the development of specialised ports and harbours engaging either in short- or long-distance trade. Using small vessels with improved designs and rigs certainly widened trade possibilities due to their low construction costs, ability to access a wide range of ports, improved sailing characteristics and frequency of voyages, the productivity of smaller vessels made them a competitive alternative to large seagoing vessels for certain trade routes and activities (Unger, 1980; Scammell, 1961). The high productivity and relatively cheap initial construction costs compared to the large fully rigged ships further attracted new merchants and shippers into the market, a trend particularly evident for Northern Europe where shared ownership appears to have increased from the 15th century onwards (Unger, 1980).

Another aspect of importance is that the two centuries between 1400 and 1600 mark the start of the triumph of the fully flush or carvel built ship spreading from Portugal and Spain northwards and reaching the Scandinavian countries towards the end of the period. The introduction of carvel ship building in the hitherto clinker dominated northern countries is believed to have reached the Scandinavian countries relatively late and replaced the strong clinker dominated ship building traditions of the north. Although carvel shipbuilding became the favoured building method, especially for bulk carriers destined for long-distance trade, shape, design and construction methods were far from uniform.

Two main strands of building methods appear to have dominated this early phase of carvel shipbuilding in Europe; the Ibero-Atlantic tradition predominant in Portugal, Spain and Britain on the one hand and the Dutch tradition, seemingly derived from earlier bottom-based shipbuilding methods. The beginnings and introduction of carvel ship building in Scandinavia are currently attributed to utilising either English or Dutch shipbuilders. Again, political changes during the 16th century with monarchs developing an interest to establish Navies are an important catalyst for the actively pursued introduction of the new ship building method in the Scandinavian countries (Bill & Gøthche, 2006; Lemée, 2006).

But how do the large-scale developments in the building of large oceangoing vessels designed to facilitate not only expanding European trade but also the desire to transfer political self-confidence and claim to power into the realm of small scale, frequently rural boat and shipbuilding? As Bill and Gøthche have pointed out, historical sources for Denmark give a good indication how transfer of knowledge in conjunction with socio-economic pressures can facilitate changes and adaptations in boat building techniques. The example of the year 1565 when King Frederik II (1563-1588) drafted 167 shipbuilders from across the country to help in building the ships for the newly created Navy, highlights how local shipbuilders came in touch with new methods and ideas. After returning home it would appear plausible that skills and ideas acquired on the royal shipyards were implemented to some degree for the construction of vernacular vessels. Although the circumstances of this Danish example are quite specific, it can be assumed that similar transfers of knowledge and ideas took place in other European countries (Bill & Gøthche, 2006).

Notwithstanding the relatively good historical and archaeological knowledge for Northern Europe, indicating an originally exclusively clinker ship building tradition later influenced and partly replaced by non-native carvel ship building traditions, the situation for southern Europe remains elusive. The potential existence of small coastal watercraft built in carvel fashion for the Iberian Atlantic coast during the medieval period has been suggested by Hasslöff based on the example of the Privilegium of Alfonso III of the year 1255. In this the term caravela is used to describe small fishing boats used along the Portuguese coast (Hasslöf, 1972a). However, inferring from this historical source that these 13th century fishing vessels were of the same construction as caravels of 15th and 16th centuries can by no means seen as secure. So far the origin of the term caravel is unclear.

Neither historical sources nor pictorial evidence provide sufficient evidence to trace the origins of the carvel ship building tradition back to historically known ship types One possible interpretation links the roots of the caravel in small lateen rigged watercraft, known as *qâribs* of Muslim Algarvian and Maghrebine origin dating back to the 13th century. *Qâribs* appear to have been coastal watercraft operating in Atlantic waters used for fishing, lighting and even as small warships (Elbl, 1985). Another interpretation equally goes back to small watercraft, although even less is known on their construction, design or rig. This second approach sees etymological origin of the caravel in the Italian vessel type *cara bella,* potentially in reference to its beauty. As historical sources provide no indication towards the construction of these vessels, only referring to good sailing capabilities and that they operated in the Mediterranean as well as the Atlantic, their identification as ancestors of the caravel remains tentative (Edwards, 1992; Schwarz, 2008). Since no small medieval watercrafts from southern European Atlantic context have so far been discovered, their nature and construction remains enigmatic. Furthermore the potential existence of contemporary clinker built vessels cannot and should not be ruled out.

5.4.4 Conclusion

The above outlined historical context highlights the importance of small coastal vessels as agents of an effective short distance trade network supplying and supplementing the national and international trade and shipping during the 15th and 16th century. The importance of regional, national and international socio-economic pressures on small coastal watercraft is significant, particularly in light of increased specialisation and diversity of demands. Further to socio-economic factors, the development of nation states with monarchs seeking to solidify power internally as well as externally, fostered the spread of carvel ship building across Europe, particularly during the second half of this period. Growing competiveness and pressure to reduce production costs while improving efficiency and productivity certainly affected the daily practice of boat and ship builders in all European countries. Furthermore the increase in trade network, migration of work force and knowledge transfer appears to have led to a continuous generalisation in boat and shipbuilding practices. Transfer of knowledge certainly also seems to have taken place with boat builders adopting certain conceptual and structural elements of the increasingly dominating carvel shipbuilding. Nevertheless availability in raw materials, adaptation to operational waters and boat and ship building traditions remained diverse thus resulting in a certain differentiations in design, construction and rig between vessels in the various geographical regions of the study area.

Assessing and identifying the physical expression and dimension of these differences based on historical sources and context is currently extremely difficult. The analysis of the direction of knowledge transfer is rarely clear-cut. In absence of a broad basis of historical and archaeological comparative material from local to regional or even trans-national levels, a meaningful comparative analysis is severely restricted.

5.5 Framework of technological and other relevant features

5.5.1 Introduction

Following on environmental, historical and other external factors of relevance for comparing small coastal watercraft of clinker construction from a vast geographical reach and relatively confined time span, the actual physical archaeological dimension of the comparative analysis has to be addressed. The archaeological data presented in chapters 3 and 4 contains a variety of information spanning from a range of measurements to descriptions of materials used and structural solutions observed and recorded. Traditionally boats and ships sharing certain characteristic elements are categorised and associated with building traditions. For the Nordic clinker tradition Crumlin-Pedersen describes the cluster of defining features as consisting of the four main aspects, shape (double ended with slightly curved continuous keel-stem and sheer line), the shell of the hull (central keel with curved stems fore and aft and clinker planking), interior timbers (e.g. evenly spaced floor timbers and diagnostic thwarts at all frames, known as biti) and structural characteristics (relatively light, yet strong structure utilising high-quality materials).

These four key points formulating the main defining framework for boats and ships belonging to this building tradition are supplemented by detailed aspects, such as materials used for waterproofing, execution of plank fastenings and attention to visual detail. Even combinations of selected features, such as waterproofing and fastenings of plank overlaps are seen as diagnostic for various traditions. The attribute combination of iron clench nails riveted over roves in conjunction with animal hair waterproofing is seen as diagnostic for the Scandinavian tradition. Conversely wooden fasteners in combination with moss-based waterproofing are commonly believed to be of Slavic origin while double bent iron nails together with moss as waterproofing material are presumed to be typical for the cog tradition (Crumlin-Pedersen, 1997).

The approach of using attribute clusters to categorise wreck finds according to building tradition or historically known ship types is well established as can be seen in the definitions for vessels built in the so-called Ibero-Atlantic tradition (Oertling, 2001), the cog or bottom-based tradition (Hocker, 2004a) or early modern Dutch carvel shipbuilding (Maarleveld, 1994). Notwithstanding the principal validity of using attribute clusters for archaeological classification and typological purposes, the practice of applying this method to ships and boats is not unproblematic and is discussed in more detail in chapter 6.3. Nevertheless, individual structural elements and diagnostic features are the physical expression of contemporary boat and shipbuilding practices. For this reason the broad variety of attributes contained within boat and shipwrecks provide the key to understanding similarities and differences as well as potential developments and changes in building practices. Through his assessment of a wide body of archaeological material, Jan Bill was able to identify chronological trends in the development of the aforementioned Nordic shipbuilding tradition. These include e.g. the transition from round to square shanked clench nails, plank scarfs becoming longer and the disappearance of decorative elements towards the late medieval period. He further noted a progression from strong regional difference to more trans-national uniformity in building practise towards the end of the Middle Ages (Bill, 1997a). In his interpretation of these conclusions he seeks explanations in the wider socio-economic and political context of the late and post-medieval period (Bill, 2009b; Bill & Gøthche, 2006), an approach to a certain degree detached from conventional classification and typology formats.

While the four categories established by Crumlin-Pedersen are valid for the differentiating wrecks with a view to identify whether newly found wrecks match the selected criteria, they are a less suitable tool for undertaking a comparative analysis where an as much as possible unbiased and objective approach is required. For example one inherent difficulty in Crumlin-Pedersen's categories lies in potential overlaps between categories, whereby certain features can be placed in two or more categories, thus complicating interpretation and analysis. Nevertheless it is aimed to keep the analysis transparent and comparable with previous research and interpretational models. For this purpose it was felt that Steffy's main research objectives for the documentation of shipwrecks provide a superior template for the task at hand as it is deliberately kept quite general. As the objectives are further meant as a guide for recording ships and boats, it is envisaged that by employing them in this context improved recording methods and approaches for small coastal watercraft can be devised. Ordered by importance and relevance starting with Construction, the list of research objectives is only slightly amended in sequence compared to Steffy. The list comprises the following categories (Steffy, 1994):

Construction

Technology

Shape and Design

Cargo and Artefacts

People and Economics

In the following the meaning of the individual categories in relation to the body of archaeological material encompassed by the comparative analysis is presented.

5.5.2 Construction

As Steffy has put it so aptly and concisely - "*the construction category encompasses every detail of the hull structure*" (Steffy, 1994 p.194). In terms of this study the category, the main defining and commonly shared feature is the clinker construction method. Further to this the category covers wider aspects, such as nature and arrangement of the vessels backbone, in case of the wrecks covered by this study frequently keels joined to curved stems and straight sterns. Further features defining hull structure are the arrangement of internal framing, number and location of masts as well as strake patterns for the hull planking. As hull structure is intrinsically linked with more practical aspects, such as joinery and craftsmanship, it is closely linked with the elements covered under the category technology below.

5.5.3 Technology

Again quoting Steffy this category "*encompasses the practical sciences and mechanics as seen in the metals, timber usage, structural arrangements, measurements, tool marks, surface coverings, repairs, and other applications found in the hull*" (Steffy, 1994 p. 194). As this list of features shows, this category covers most aspects usually captured during detailed recording of wrecks and their individual structural components. Although detailed discussion of the technological features follows in chapter 6.2, it has to be pointed out that knowledge of individual technological features between the studied wrecks varies significantly. Notwithstanding the fact that lack or absence of information may be a result of preservation conditions, restrictions in documentation possibilities and other external factors, in some instances investigations appear to have placed less focus on capturing the breadth of technological detail. Therefore one aim of this study is certainly to highlight the importance of thorough and comprehensive recording and analysis of wreck finds.

As mentioned previously the technology aspect cannot be seen in isolation. It is closely linked and frequently dependent on all other categories. Construction, shape and purpose place certain demands on the technology to achieve the required results. Equally people and socio-economic factors strongly influence availability and purposely chosen technological means. The selection of raw material for hull planking can serve as an example to illustrate this. Although tangentially split oak planks appear to have been the preferred choice by medieval boat builders for building clinker boats, external pressures seem to have forced a change towards utilising sawn planks during the outgoing medieval period and Renaissance (Bill, 1997).

5.5.4 Shape and Design

The shape of any vessel is obviously of crucial importance. It determines sailing characteristics depending on usage and operational waters and is thus a key point, decided upon in the design stage. Consequently riverine barges look different to coastal fishing vessels and war ships differ from long distance bulk carriers. As the above chapters have shown, socio-economic developments influence design and shape, as do surrounding environmental factors. Therefore including the shape of wreck finds into the comparative analysis is not only sensible, it has significant potential to identify how local factors influenced variations in shape and design. Unfortunately preservation conditions in many cases do not allow reconstructing the former shape of wrecks. For numerous wrecks where much of the original hull is preserved, crucial information particularly at aft and forward ends of the vessels, has not survived. The shape of the bow for example is hugely important for the overall sailing characteristics as it defines a vessel's entry and thus speed and handling. On the other hand, if not preserved in the archaeological record, a multitude of shapes are possible, all impacting the overall behaviour of the vessel in the water.

Although many wrecks do not allow reconstructive interpretations above the turn of the bilge, the lower part of hulls still contains valuable information regarding approximate hull design and shape. This includes for example the deadrise of the garboard strakes as well as overall shape of the bottom hull, which can be indicative whether a vessel was designed to carry cargo.

Furthermore the execution of stem and stern holds important clues. In contrast to the above-mentioned ships of Nordic tradition, the vast majority of wrecks included in this study are not double ended. Rather an arrangement with curved stem and straight sternpost is predominant. Not only is the straight sternpost a strong indicator to the presence of a stern rudder, it is also a decisive factor for the overall shape of a vessel. It further allows for the insertion of transoms, which is evident for at least one of the wrecks in this analysis. Even in cases were little to no articulate hull sections are preserved, individual structural components can inform on certain aspects of the vessel's shape. Again the deadrise of garboard strakes can be deduced from angles of keel rabbets, and further information on shape in cross-section or body plan views is contained in the shape of framing timbers, which due to their rigidity largely maintain their original shape. Shape contained in hull planks in contrast has to be seen with more caution as degradation and site formation processes can lead to significant distortion.

Overall this highlights the important role of recording shape retained in ship and boat wrecks in spite of the difficulties in accurately reconstructing former hull shape. However, the dilemma of limited available information on shape remains for many of the reference wrecks incorporated in this study. A meaningful comparative analysis of hull shapes between the various operational waters is thus not feasible. It is hoped that such investigations will be possible with more wrecks of sufficient preservation levels found in the future.

5.5.5 Cargo and artefacts

Cargo and artefacts are closely related with the above-discussed aspect of shape and design. Demands on cargo capacity whilst facilitating social space on board were crucial considerations for the design of any trade vessel. It can be assumed, however, that providing for suitable and sufficient private and personal space on board small coastal vessels designed to cover relatively short distances played a lesser role compared to large bulk-carriers where prolonged periods at sea were normal. If preserved, the cargo and artefacts can help to increase our understanding of the types of activities a boat was involved in as well as the nature of trade and trade routes it was engaged with. Artefacts can further deepen our knowledge on social structures and life on board.

5.5.6 People and Economics

This last category, presented by Steffy as two separate categories (Steffy, 1994), covers the aspects of People and Economics in conjunction. Since basic contemporary socio-economic background is discussed in more detail in chapter 5.3.3, the focus is placed on the physical expression of economic factors and pressures manifested in the structural remains of wrecks (Steffy, 1994). Again availability of resources for hull elements and fasteners often determined quality and nature of materials used. While some boat builders may have resorted to using lesser quality local material, others may have used imported material by choice or necessity. Then again choice of raw materials or construction methods may equally reflect attempts to reduce production costs, either by the boat builder or imposed by the commissioning merchant. By any rate the role of economic factors and their physical expression in hull features must not be underestimated. This is particularly true for small-scale coastal watercraft where display of status and wealth was rather insignificant compared to long-distance bulk carriers or warships. For the latter visual expression of played a much more important role through, evident e.g. by decorative ornamentation, size or design.

The aspect of builders and owners leads to the people behind the boats and ships. Investigating, analysing and researching wrecks involves trying to understand the human dimension, the reasons behind people's decisions, inspirations, methods and goals. It covers no only what Hocker termed the philosophy of shipbuilding, i.e. the conceptual reasoning behind different ways of building boats and ships (Hocker & Ward, 2004). Any boat also carries the signature of the owner commissioning its building, of the crew sailing it, of the merchants having their cargo transported as well as other people getting in touch with it, be it through repairs, harbour activities or even salvage after the boats demise.

5.6 Conclusions

The above section serves to provide a better understanding of the complexity of parameters affecting archaeological research and analysis of boat and shipwrecks. The most tangible dimension represented by structural hull features is supplemented by more abstract dimensions of the wider economic, political contexts as well surrounding factors imposed by the environmental conditions of the operational waters. Finally, processes incurring after wrecking and context of discovery determine comparability. Recognising the above outlined aspects and parameters is of crucial importance prior to embarking on the following comparative analysis and interpretation of the archaeological material at hand.

6. Comparative analysis

6.1 Introduction

This chapter is structured in three main sections. The first section is focused on a direct comparison of the technical and structural features of the wrecks in the dataset and aims to highlight the similarities and differences for further discussion. This is followed by a review of past and current classification schemes used to interpret the data. Since typology and classification are one of the main interpretational tools, the outcome of comparative analyses is heavily influenced by the nature and suitability of the typological framework. Discussing suitability, shortcomings and strengths of established classification tools is therefore a crucial aspect of the wider comparative context. A presentation and discussion of the core results concludes the chapter.

6.2 Review of structural features

6.2.1 Introduction

The presentation of data from the Drogheda boat, the main case study, and the collection of reference sites show the broad variety of different structural and technical features contained within the wrecks. The wealth of detail documented and presented from the Drogheda boat may appear disproportional when compared to the, frequently, basic documentation from other wreck sites, particularly in regard to extracting expressive comparative data. The weakness of the dataset is further evident in their geographical bias. Since wrecks from northern Europe by far outnumber wrecks from other regions, a balanced interpretation of the data is not feasible.

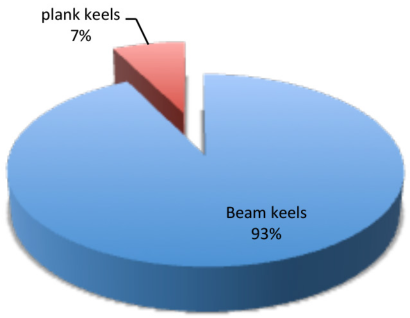

Chart 6-1: Percentage composition of Keel types (Schweitzer 2013)

Nevertheless, considering the complexity of boats and ships, only the provision of exhaustive data can enable a holistic approach towards increasing our understanding of their development and diversity. The presentation of the complete dataset thus serves to provide a comprehensive basis for current and future research.

In response to the imbalanced nature of the data, the comparative analysis focuses on a number of key structural components known from most wrecks (see Appendix I and II). Although this more or less automatically results in utilising datasets previously and traditionally used for comparison and interpretation it also provides the opportunity to review and discuss conventional research methodologies. In recognition of the shortcomings in the dataset this study aims to progress the archaeology of small watercraft not only for the formulation of research questions for fieldwork but also for expanding our understanding and knowledge of this rich archaeological resource.

6.2.2 Size

As discussed in chapter 5.4.2 a relatively small number of wrecks assessed as part of this project have yielded sufficient data and have been recorded to a sufficient degree to allow for reconstruction, including load capacity. A number of methods to estimate approximate cargo capacities for medieval ship finds have been devised over the years, many of which use the maximum load line of three fifths to the height of amidships as basis for calculation (Crumlin-Pedersen, 1991; Lahn, 1992; Jensen, 1994). However, in recognition of inconsistencies in the application of calculating cargo capacity as a tool to compare ship sizes, Bill (1997a) utilised an estimation between length and deadweight as a rough indicator for vessel size. Given the rough imprecise nature of such comparative estimations a conscious decision was taken to refrain from such an undertaking as part of this study, particularly in light of the relatively narrow defined size range of this study.

The archaeological and historical outcome of such a comprehensive analysis should address among others, two main aspects. Firstly, the establishment of cargo capacities may allow for the crossreferencing of the results with historically known load capacities and in turn enable the identification of potential vessel types. The small coastal watercraft addressed by this project, however, did not find their way into the historical sources to a degree, which would provide a solid and reliable basis for comparison (see chapter 3.3.3). Secondly, the estimated cargo capacities obtained through such tentative methodologies are less suitable for the smaller vessels in this study (Bill, 1997a). While some boats, such as waterships, were highly specialised, others are likely to have been built as multi-purpose workboats. Accounting for such a diversity through a tentative estimation based on a by and large scant dataset therefore goes beyond the scope of this project.

6.2.3 Keel, stem and stern

Keels

Forming the backbone of clinker vessels built in the shell first method, keels form a crucial part of design and construction of all vessels included in this study. Two main types of keels can be discerned and have been defined by McKee (1983)

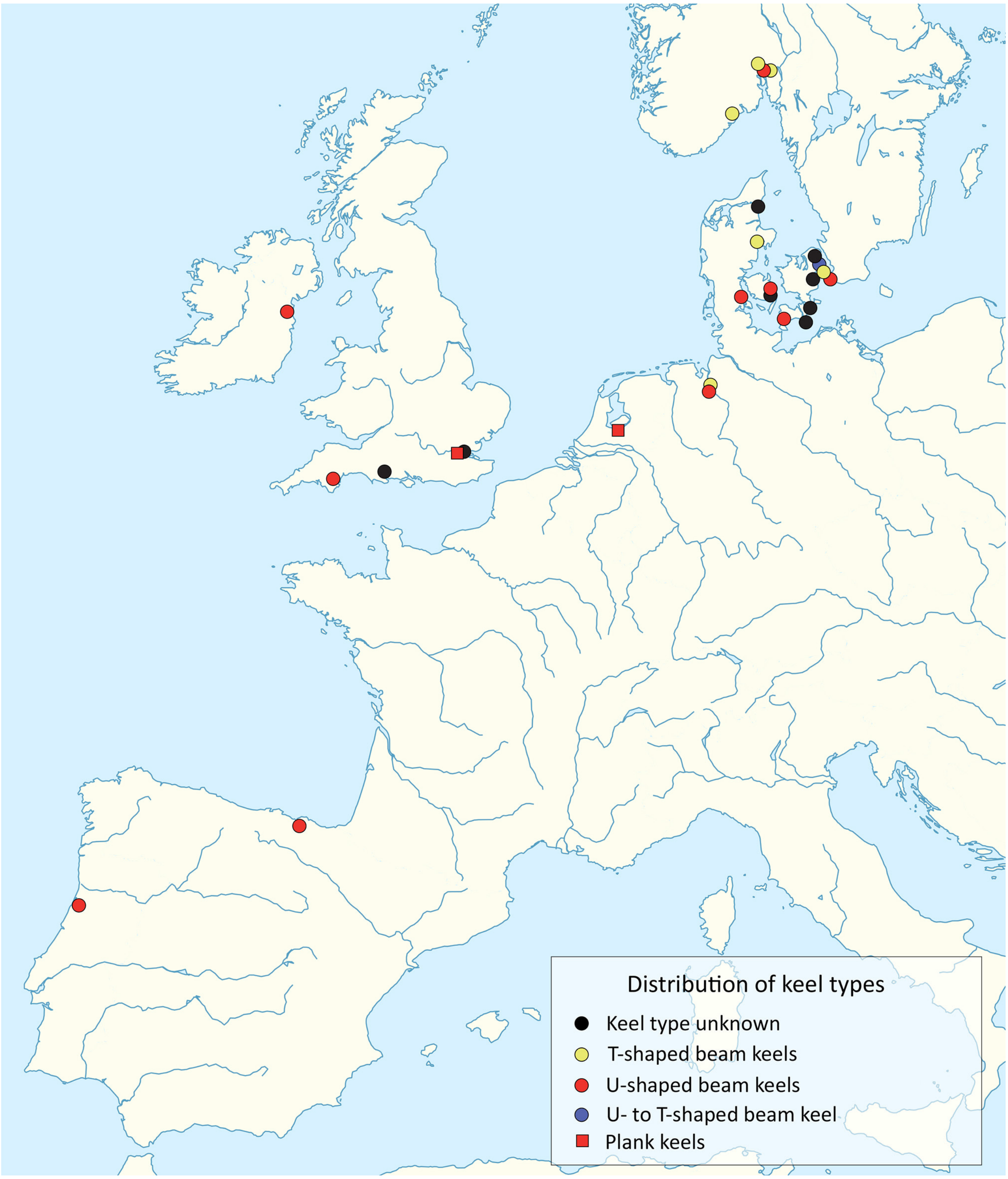

Figure 6-1: Map showing the distribution of the different keel types (Schweitzer 2013)

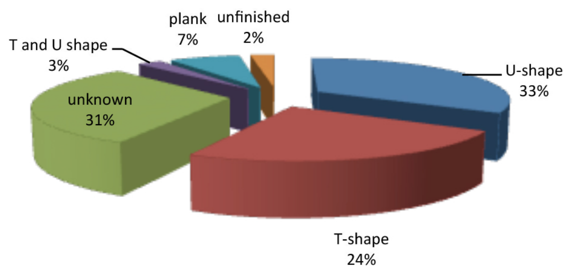

Chart 6-2: Percentage composition of keel shapes (Schweitzer 2013)

and McGrail (1998) as beam and plank type keels. The definition is based on beam type keels being deeper than they are wide, thus giving the vessel improved anti-leeway properties for sailing. Plank type keels on the other hand are wider than they are deep and are more diagnostic for vessels operating in shallow waters, such as the Zuiderzee (Verweij et al., 2012). The keels of the vessels assessed as part of this study almost exclusively have beam type keels (Chart 6-1). Considering their usage as coastal watercraft in frequently rough Atlantic waters this appears a logical selection.

Beam keels can be sub-divided into variations of U-shaped keels with or without rabbets for garboard strakes and T-shaped keels. Again, the latter are seen as a characteristic feature of the "Nordic" clinker tradition (McGrail, 2004). However, in comparison T-shaped and U-shaped keels are almost at a par for the dataset of this study with thirteen U-shaped keels and ten T-shaped keels (Chart 6-2). Nevertheless the nature of 14 examples is unknown for a variety of reasons, including keels not being preserved or not recorded. The relative balance in numbers per category is also reflected in the geographical distribution (Fig. 6-1). Where evident, no distinct preference for one or the other type can be attested, The absence of plank keels from the relatively well reprsented Scandinavian material, however, appears to suggest that plank keels remained a predominant feature of the Low Countries and riverine watercraft. Conversely a tentative predominance of T-shaped keels in Scandinavia may be suggested based on the comparative sites used for this study.

However, the potential division of T-shaped and U-shaped keels in relation to vessel size observed for the Barcode material may be of significant importance for future research. Should T-shaped keels have been used mostly for smaller boats while U-shaped keels appear predominantly in the larger vessels (Gundersen, 2012), the decision for a specific keel type may have been chosen on practical grounds. However, the Barcode observation could not be verified using the dataset of this study. Currently detailed information on size-keel ratios from the Oslo wrecks is not yet available, making a direct comparison to other wrecks and areas difficult. Furthermore the restricted nature of the dataset of this study does not allow for such detailed interpretation of the material. Nevertheless, a closer look at the best represented Danish material shows that U-shaped as well as T-shaped keels appear on wrecks of roughly similar size and date with the Bredfjed ship and the Amager Strandpark wreck as prominent examples. Charts 6-3 and 6-4 show the distribution of keel shapes by vessel date and size.

The high number of T-shaped keels evident for vessels below 10m in length as well as the bias towards U-shaped keels for larger vessels can be attributed to the above discussed nature of the Barcode material, thus leaving no significant quantifiable distributions for the remaining material. Similarly, no chronological division or trend between both keel shapes can be identified as both appear throughout the two centuries from 1400 to 1600. Two anomalies within the studied dataset have to be pointed out. Firstly the keel of Dokøen 3 changes shape from T-shaped to U-shaped along its length and cannot be included into either group (Nielsen, 2012). Furthermore the keel of the Beluga ship, although of distinct U-shaped cross section, was the only example in this assemblage with no rabbets to accommodate the garboard strakes. Instead the strakes were nailed flush onto the plain side surfaces (Zwick, 2010).

The three examples of plank type keels represented here, not surprisingly, belong to the two London river barges Blackfriars 3 and 4 as well as the Dutch *watership* ZN42. While the keels of the two London barges are roughly T-shaped in cross section, the keel of ZN42 is rabbeted, a feature

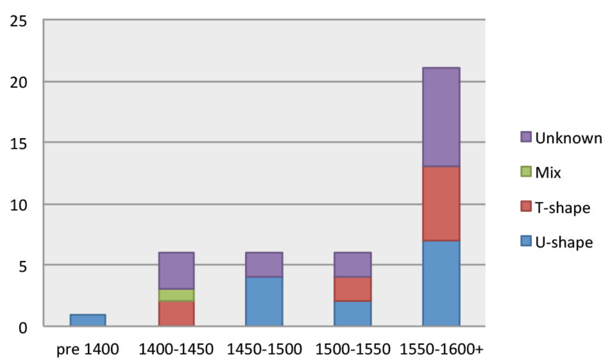

Chart 6-3: Distribution of keel shapes by vessel date (Schweitzer 2013)

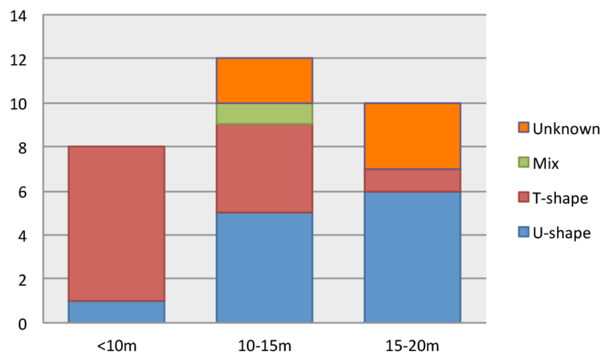

Chart 6-4: Distribution of keel shapes by vessel size (Schweitzer 2013)

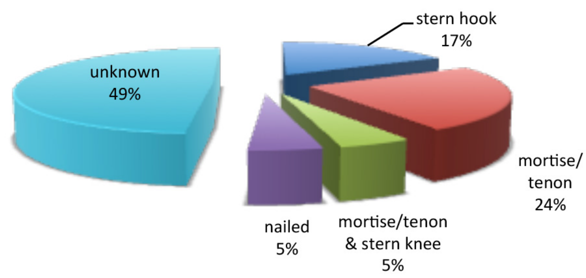

Chart 6-5: Percentage composition of main scarfs (Schweitzer 2013)

it shares with most known clinker built waterships. ZN42 provides an interesting insight into the utilisation and change of structural design of a particular vessel type over time. Although historically known from the 14th century, the oldest archaeologically known example of a *watership* dates to c. 1500. Judging from current knowledge *waterships* appear to have been built in clinker fashion with a keel plank in response to the primary operating environment of the vessels in the Zuiderzee, as well as creeks and rivers of North Holland. Although waterships are known to have been involved in short to long distance trade, the vessels structurally remained tailored towards their original sailing environment. This combination does not seem to change during the latter part of the 16th century, first with the change to carvel construction followed by the introduction of beam keels. Verweij et al. attribute this change in keel type to higher demands in manoeuvrability and adaptation to increasing towing and tugging activities of *waterships* (Verweij et al., 2012). The watership is thus a good example of the "form follows function" principle whereby practical demands dictate adaptation in construction and design.

Main joints

A variety of connections between keel, stem and sternpost are present in the assembled dataset. As discussed above, the vast majority of the wrecks included in this study have a curved bow and straight stern. Only a few examples of double ended vessels, i.e. curved bow and stern, are among the discussed wrecks. In order to achieve a smooth and structurally solid transition from keel to curved stem or sterns and straight sternposts, two main technical solutions can be identified. The first and most frequent solution is using hooks made of compass timbers with desired shape and curvature extending a certain length of the keel and curving upwards to connect with the stem or sternpost. Hooks are a common feature throughout the medieval period for clinker built vessels but are also common in early modern carvel built ships, an aspect further discussed below. While all wrecks with preserved stem sections share the use of stem hooks, their function as joining elements between keel and stern was only evident in seven cases. Almost at par with the number of stern hooks, ten of the assessed wrecks show mortise-and-tenon solutions for joining and fastening the sternpost to the keel (Chart 6-5).

Bill (1997a) sees a chronological development in the use of specific types of main joints in the southern Scandinavian material. While technically more advanced scarf solutions, such as stop and hooked scarfs occur during the high medieval period, he identifies plain diagonal through scarfs as predominating joint solutions from the 11th century onwards through medieval period (Fig. 6-2). According to Bill more advanced joinery, including stop and hooked scarfs alongside mortise-and-tenon solutions are introduced or at least increase significantly during the 16th century. He excludes the hooked scarf connecting stem and keel from the Copenhagen Nationalbanken wreck due to technical execution of the

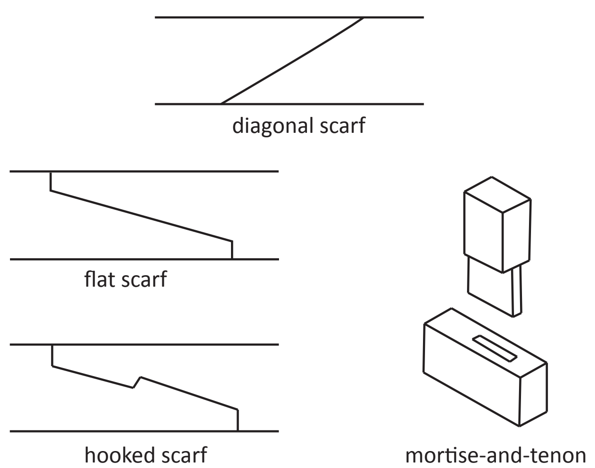

Figure 6-2: Schematic drawings of main scarf and joint types (after Steffy, 1194 Fig. G 11b)

scarf. As the hook was created by horizontally inserting a treenail halfway into scarf rather than being cut, he classifies the scarf as a horizontal stop scarf turned into a type of hooked scarf (Bill, 1997a). Despite the high number of unknown scarf details, the trend towards more advanced joint solutions is mirrored in the present study (Chart 6-6).

Further to Bill's results it appears that through scarfs continue to be used into the late 16th century alongside more elaborate joinery methods. This is for example reflected in some of the Barcode wrecks where through scarfs connecting keel and stem occur alongside mortise-and-tenon joined sternposts. The Drogheda boat, ZN42 and Barcode 8 wreck are the only example where stop scarfs are present. The number of more elaborate hooked scarfs is not much higher. True through hooked scarfs are evident from 2 of the assessed wrecks, comprising the Amager Strandpark wreck and Barcode 5. Two of the Barcode boats, wrecks 2 and 7, display an interesting variation of through scarfs. In each case the scarf has been cut out to receive a rectangular wooden block as additional reinforcing element. For wreck 2 the block was placed on the outboard face while wreck 7 has it on the opposing inboard face. Although these scarfs do not classify as hooked scarfs the technical execution certainly display high levels of craftsmanship.

Although the present study can confirm the development towards more elaborate main joint solutions during the second half of the 16th century as suggested by Bill, the limited number of available overall data is in contrast to an overwhelming number of wrecks where no information on main joint solutions has to be taken into consideration. It is important to note that the nature of the main joints from the two Iberian wrecks, Urbieta and Ria de Aveiro G, is unknown. The above-described observations are thus only valid for the northern

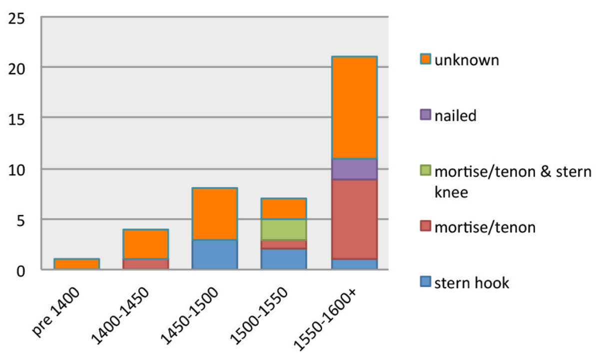

Figure 6-6: Distribution of advanced main joints by date (Schweitzer 2013)

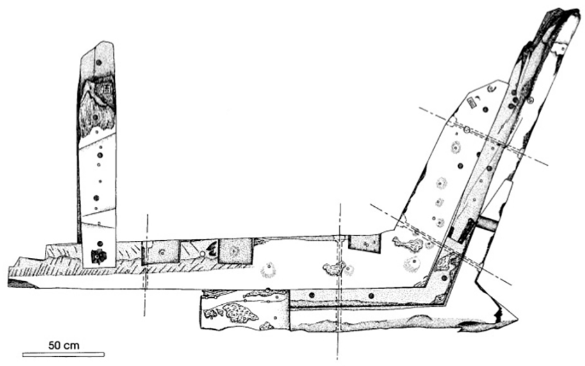

Figure 6-3: Stern assembly of the M24 Red Bay wreck (after Rieth & Rodrigues, 2001 Fig.4)

Atlantic region. Interestingly Bill attributes the development to more advanced joinery, including the appearance of mortise-and-tenon sternpost solution partly to increased specialisation and professionalization in the organisation of boat and shipbuilding in Southern Scandinavia during the 16th century as a result of the arrival of carvel shipbuilding technologies and more specifically a strong Dutch impact on changes in boat and shipbuilding practices in Denmark (Bill, 2009b; Bill & Gøthche, 2006).

Stems and sternposts

A total of seven stern hooks from across the entire geographical reach are evident. Conversely the twelve sternposts with mortise-and-tenon joinery as well as two cases with sternposts simply nailed to the keel are confined to Norway, Sweden and Denmark. However, considering the significantly higher number of wreck finds from Norway and Denmark compared to the other countries within the study area this result should be treated with caution. Nevertheless the high proportion of mortise-and-tenon sterns from Norway appears to bolster Bill's line of argumentation, particularly as Norway was then politically part of Denmark through the Kalmar Union.

In spite of the lack of information from the Iberian Atlantic coastline, a view at sternpost solutions from contemporary 16th century carvel shipbuilding may shed some light on regional boat and shipbuilding practices. Assuming technological diffusion between clinker and carvel shipbuilding as suggested e.g. by Bill, similarities in technical solutions may be deduced. In this respect the stern posts from a number of Iberian wrecks, including the 16th century M24 Red Bay wreck (Fig. 6-3) (Loewen, 2007) and the 15th century Ria de Aveiro A wreck (Alves, Rieth, Rodrigues, et al., 2001) as well as the Corpo Santo wreck dating to the 14th century (Fig. 6-4) (Alves, Rieth & Rodrigues, 2001). The connection in all three cases is achieved using stern hooks joined with the keel via stop scarfs.

The use of hooks in Iberian Atlantic carvel built ships is also historically documented (Alves, Rieth & Rodrigues, 2001) and may thus indeed reflect a well-established structural solution that could equally have found implementation in regional clinker boat and shipbuilding. Although economic pressures and shortage in raw materials must have impacted on Portuguese, Spanish and Basque carvel shipbuilding, it is striking that Iberian shipwrights appear to have continued using stern hooks instead of mortise-and-tenon joined sternposts. Surmising a purely northern European provenance and context of stern hooks for clinker and bottom-based boat and ship building as evident in the current scientific consensus (Hocker, 2004a; Bill & Gøthche, 2006; Bill, 1998), thus seems premature and unjustified. Although no clinker vessels of south-western European origin are currently known, it appears prudent to admit the thought of the potential influence of Ibero-Atlantic carvel ship building methods or even the existence of hitherto undetected (Ibero)-Atlantic clinker building traditions.

Stem hooks with rebates accommodating hood ends are present on a number of wrecks, such as the Drogheda boat, the Bredfjed ship (Bill, 1997a) and Amager Beachpark wreck (Ravn, 2011). It has to be pointed out, however, that this is a feature not unique to the wrecks included in this study but can be observed on numerous other clinker built wreck of Medieval and Renaissance date, such as the Kungör (Fredberg, 1983) and Kalmar IV wrecks (Åkerlund, 1951). The two-piece stem from the Poole Waterfront excavations is an interesting example for comparison with the Drogheda boat stem. It shares similar features in principle but significant differences in detail. The Poole stem belonged to a smaller vessel dating to the 15th century. Although significantly shorter, its lower piece corresponds roughly to the stem hook of the Drogheda boat. Serving as a connecting piece between stempost and keel, it extends over two strakes of planking but retaining the rabbet for the full length of the garboard strake. However, the fully preserved stem shows no rebates for hood ends, which were simply nailed flush against its sides (Hutchinson, 1994).

Horizontal holes through stems, such as the plugged example from the Drogheda boat, are well known from medieval Scandinavian clinker boats. However, they vary significantly in size,

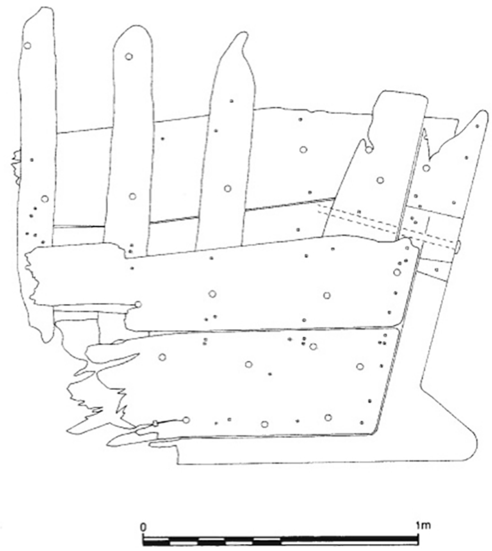

Figure 6-4: Stern section with stern hook of the Corpo Santo wreck (after Alves, Rieth & Rodrigues, 2001 Fig.4)

shape and positioning. The holes are currently often interpreted as fastening points for pulling vessels ashore depending on their positioning on the stems, as well as stem dimension and vessel size. For example smaller vessels with less overall weight can be pulled more easily compared to bigger boats. Accordingly holes higher up on the stem, such as the Drogheda boat example, would be restricted to vessels less than eight meters long. Conversely pulling holes on larger vessels, such as the Bredfjed ship and the Amager Strandpark wreck, have the holes placed quite low and display more massive stems to provide the required longitudinal strength (Bill, 1998). The relevance of pulling holes for the interpretation of vessel use is further discussed in chapter 6.2.7. Further to stem design and pulling holes, wear on the underside of stem and keel can be seen as an indicator for beaching. The Bredfjed ship and the Dokøen 3 wreck display such wear but no stem post was preserved for the Dokøen 3 (Nielsen, 2012; Bill, 1997a). Wear was also observed for the keel of the Amager Strandpark wreck for which a secondary false keel or keel shoe is reconstructed (Ravn, 2011). Repair to the keel or adding a false keel may be another indication that the boat was frequently beached causing damage or at least stress to the keel.

Nevertheless it appears unlikely that the plugged hole in the Drogheda boat stem served a fastening point for pulling the boat ashore. Considering that the Drogheda boat was c. 10m long the hole in the stem does not match the criteria set out by Bill to render the hole suitable for pulling. This is substantiated by the lack of wear, both on the edges of the plugged hole and the underside of stem hook and keel. The latter indicates that the Drogheda boat was not exposed to frequent pulling. The two piece stem from Poole shows two holes. One was located relatively high up on the upper piece and a second on the lower piece was situated almost level with the keel. While the upper hole is interpreted as serving as an attachment for rigging, the lower hole is thought to have been used for pulling the vessel ashore (Hutchinson, 1994). A more likely interpretation for the Drogheda boat hole thus appears that it served as a fastening position for bow sprit rigging, which can still observed in some contemporary boats of similar size, such as the Danish clinker built *Fejøkrivkvase* (Nielsen, 2005) or the Irish *Drontheim yawl* (MacPolin, 1999).

6.2.4 Hull planking

Introduction

Hull planking plays a crucial role in understanding and interpreting clinker built ships. Since the vast majority of clinker built vessels are constructed in the shell first method where the hull is erected prior to the insertion of framing, the shell not only determines shape but is also the primary carrier of lateral and longitudinal strength. Choice of materials used and structural execution thus hold vital information on conceptualization and socio-economic background (Crumlin-Pedersen, 2004). The following aspects form the key aspects for the assessment and comparative analysis:

Plank details

Strake symmetry

Plank joints and fastenings

Waterproofing

Protective coating

Plank details

The overwhelming majority of planks from the studied dataset are made of oak. The only instances were no information on building material is available are the wrecks Ria de Aveiro G and Bremen Teerhof. Further exceptions to the rule are present among the fourteen Barcode wrecks were in addition to oak, pine and possibly spruce have occasionally been observed (T. Falck, pers. comm.). However, no further information on frequency and structural integration is currently available.

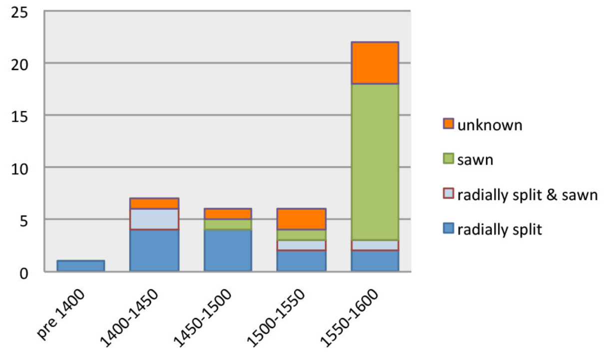

Chart 6-7: Distribution of plank conversion method by vessel date (Schweitzer 2013)

The consistent use of oak is not surprising considering the advantages of oak as building material due its properties as a strong and durable hardwood, yet providing good flexibility (see chapter 3.3.3). In order to fully utilize the advantageous properties of oak, plank were predominantly converted by radially splitting from the parent logs. For further reducing the risk of rot and splitting, it was favourable to use planks converted from straight grown logs with a minimum of knots and of sufficient girth to avoid sapwood edges. The aspect of wood quality, however, is discussed in more detail below.

Returning to the usage of radially split planks, an increased usage of sawn planks can be observed in clinker built vessels in Scandinavia during the 16th century (Bill, 1997a). As Chart 6-7 shows, an increase in sawn planks from the 15th century onwards can be attested for the dataset of this study. The Dokøen wrecks 2 and 3 appear to represent the earliest examples exhibiting the usage of sawn wood, albeit not for the entire hull. While radially split planks were used for the underwater hull, sawn planks were used higher up in the hull. The decision to mix sawn and radially split planks and the respective placing in the hull clearly indicate that the utilization of conceived high quality wood was deemed important for the lower part of the hull, whereas the lesser quality sawn planks were used above the turn of the bilge (Nielsen, 2012).

The reason for this is largely twofold. Firstly the shape of boats built in the shell-first method is determined and guided by shaping and fitting the planks to the hull. In order to create and achieve the desired hull shape the assembly of the bottom part of the hull plays a crucial role. Therefore the superior bending and shaping properties of radially split oak made it a preferred choice for the initial stage of building clinker boats. The second aspect relates to the lower part being the underwater part of any boat and ship, leaving it exposed to higher degrees of wear, rot and weathering. Again the properties of radially split oak, particularly for planks shaped from knot free heartwood logs would be a preferred choice to increase durability. As discussed in chapter 7.2.4 the provenance determination for the timbers used to build Dokøen 2 and 3 showed that the vessels were most likely built in Northern Jutland or western Sweden with main compass timbers, keel and the lesser quality sawn planks most likely locally sourced whereas the higher quality radially split timbers were imported from a variety of places in the southern Baltic (Daly, 2007).

Judging from the relatively scant evidence of the available dataset it seems that sawn planking as the sole building material for hulls does not become widespread before the second half of the 16th century (Chart 6-7). This observation matches with the observations made by Bill (1997a). However, the drastic increase of sawn planked boats during the 16th century apparent in the assembled data, can be largely attributed to the collection of vessels from the Barcode site in Oslo where the vessels were made exclusively with sawn planks. The two examples of sawn planking, the Urbieta wreck dating to the 15th century (Rieth, 2006) and the Portør boat dating between 1450 and 1550 (Molaug, 1981) should be treated with caution as the dating is C14 based and cannot be regarded as accurate.

For southern Scandinavia Bill believes that sawn planks were introduced in shipbuilding around 1400 with the Gedesby ship wreck and Roskilde Havn 1 wreck as indicative examples (Bill, 1997a). The combination of radially split and sawn planks within the material of this study during the first half of the 16th century on the other hand is documented for the Vaterland 1 wreck in Norway (Stanek, 2012) as well as through miscellaneous ship timber finds from London (Marsden, 1996). Notwithstanding the introduction, and in case of the Barcode material, seemingly complete change to sawn planking, the use of radially split planks remains evident throughout the 15th and 16th century. The two latest examples where radially split planks were used are the wrecks Amager Strandpark near Copenhagen (Ravn, 2011) and Morgan's Lane in London (Marsden, 1996).

As the above paragraphs show, wood quality plays an essential role when it comes to analysing boat and shipwrecks. Further to assessing planks on presence of sapwood edges, grain direction and frequency of knots, the average lengths of planks can provide vital information on the quality of raw material available to the boat builder. However, no information on plank lenghts is available for 31 of the wrecks in the studied assemblage, no information on the length of planks. For the six wrecks where plank lengths were recorded, the average lengths are by and large less than 3m. With measured lengths between 4.3m and 6m, the ZN42 planks are exceptionally long compared to the other reference sites. Notably the Bredfjed Ship and Dokøen where sawn planks were used, display a variety of lengths of up to and over 4m. Nielsen was able to discern the planks two main groups of plank lengths. While one group is defined by relatively short planks measuring between 1.20m and 2.36m, the second group is significantly longer with lengths between 4.3m and 5.37m (Nielsen, 2012). Unfortunately it is unknown whether the two distinct groups coincide with the division between sawn and radially split planks.

The Bredfjed ship could indicate such a relationship between plank length and conversion method where a variety of lengths was employed, including a limited number of planks of up to 6m lengths (Bill, 1997a). A mixture of lengths is also evident in the Drogheda boat with lengths ranging from less than 1m up to almost 3m. However, on average planks measured c. 2m (see chapter 3.3.3), a value mirrored in the Kingsteignton boat (Dudley et al., 2001). The shortest known plank lengths are recorded for the Urbieta wreck with lengths between 1.10m and 1.46m (Rieth, 2006). While the Drogheda boat and the Kingsteignton boat were made with radially split planks, the Urbieta boat planks were sawn, thus seemingly speaking against the use of sawn planks allowing for using longer planks during the later Middle Ages and the Renaissance. Nevertheless the usage of relatively short planks with the associated disadvantages in hull strength is a common observation for ships and boats of the later Middle Ages (J. Bill, pers. comm.) and can also be observed on other wrecks lying outside the parameters of

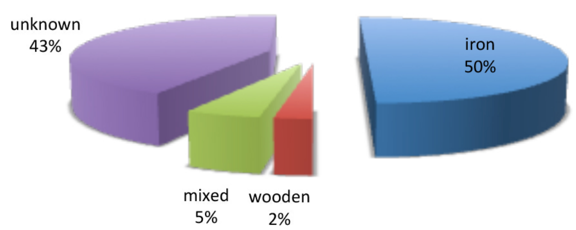

Chart 6-8: Percentage composition of plank joint fastening methods (Schweitzer 2013)

this study, including e.g. the Vedby Hage wreck (Myrhøj, 2000).

Plank joints and fastenings

Characteristic to the clinker method, planks are joined by overlapping lengthwise as well as end-to-end. The longitudinal overlap does not vary significantly between the various wrecks. As common for boats and ships of the later medieval period none of the longitudinal plank overlaps for the wrecks included in this study display decorative elements or mouldings (Bill, 1997a). While the nature of plank overlaps do not display sufficiently diverse features to allow comparative analysis, the types of fasteners used to secure plank overlaps are frequently used to identify chronological developments and distinguish building traditions (Fig. 6-5). While the vast majority of medieval clinker built vessels in Northern Europe appear to have been fastened with iron nails, wooden nails also found use, albeit to a lesser degree (Chart 6-8). Traditionally wooden nails have been brought into connection with medieval Slavonic boat building traditions, but recent discoveries in Britain, including the 10th century Hungate Ship, indicate a more complex distribution pattern (Marsden, 1994; York Archaeological Trust, 2010; S. Allen, pers. comm.).

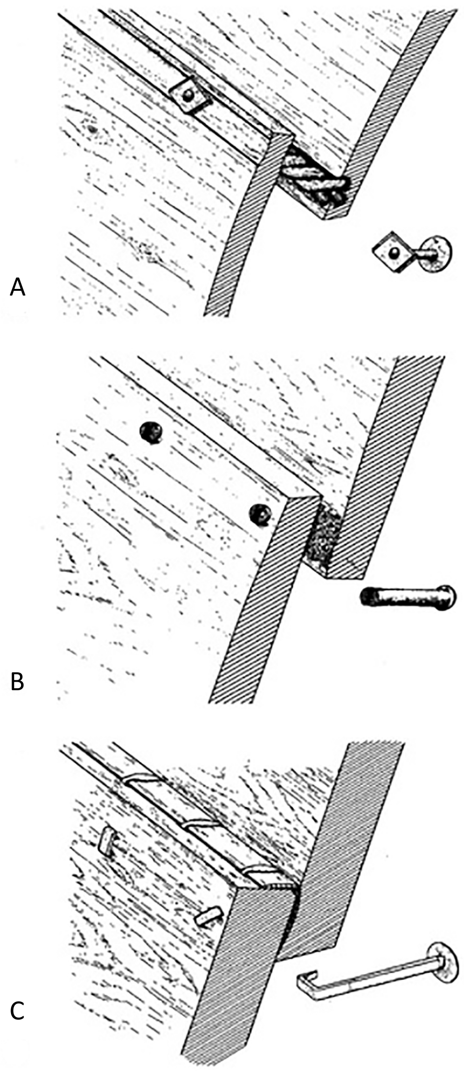

Figure 6-5: Clinker plank joint fastening methods: A- Iron nails with nails clenched over roves, B- Treenails wedged inboard, C- Double bent iron nails (after Crumlin-Pedersen, 1997 p. 29)

As far as nail fasteners are concerned, the dataset presented here displays a broad variety in materials and fastening methods. Firstly the nails were almost exclusively made of iron. Wooden nails are documented in three instances, two from small boats less than 10m in length from Norway and the originally c. 15m long Vejdyb wreck. The Portør boat was exclusively fastened with wooden nails made of Juniper (Molaug, 1981), while a mixture of iron nails and wooden fasteners is noted for the Barcode 6 wreck (T. Falck, pers. comm.). The usage of wooden nails in both wrecks of roughly contemporary date may thus indicate a potential regional building tradition for such small watercraft. A link between the Portør boat and contemporary vernacular wooden boats in northern Norway based on the usage of wooden nails has indeed been proposed by Molaug and Christensen (Molaug, 1981; Christensen, 1985).

Similar to Vaterland 1, the Vejdyb wreck displays a combined use of iron clench nails and willow nail fasteners. Provenance determination of sampled hull planks showed that the timbers originated most likely from Poland. While the origin of the timbers used for the hull planking does not necessarily mean that the vessel was built in Poland, the mixed use of iron clench nails and willow pegs may indeed be an indication for this. As Bill observed, the 15th century clinker wreck U34 found in Holland also shares the feature of mixed plank fasteners and planks of Polish origin (Bill, 1997a). Based on the scant evidence currently available, the combined use of clench nails and wooden pegs may point in two separate directions. Firstly a local building tradition for small clinker built boats in Norway on the one hand and a potentially Polish fastening method used in small to medium sized vessels engaged in long distance trade.

As stated above the vast majority of the vessels included in this study where details on plank fastenings are known were fastened with iron nails. Further all nails were without exception square-shafted. The appearance of iron nail fastenings can be described as quite diverse. Nevertheless nails can be divided into two main groups consisting of clench nails, which were secured over roves on the one hand and double bent nails, or as described by Steffy, nails bent over the surface they last penetrated (Steffy, 1994). Regarding clench nails, a distinction can be made between nails riveted, i.e. hammered flat over roves and nails with tips bent over roves. Riveting, the clench method traditionally seen as characteristic for the "Nordic" clinker tradition, is evident for four wrecks in the dataset: The Bredfjed ship, the wrecks Amager Strandpark, Vedby Hage and Blackfriars 3 (Bill, 1997a; Ravn, 2011; Myrhøj, 2000; Marsden, 1996). Unfortunately in many instances no information on the clench method is available. While in several cases documentation records do not refer to clench methods in other cases the iron had disintegrated to such a degree that identification could not be established.

As a result eleven wrecks of the dataset are reported to have clench fasteners without further information available. The Drogheda boat is a good example where the poor preservation conditions for iron prohibited detailed analysis of the plank fasteners. A single preserved nail tip suggests that bending over roves was carried out

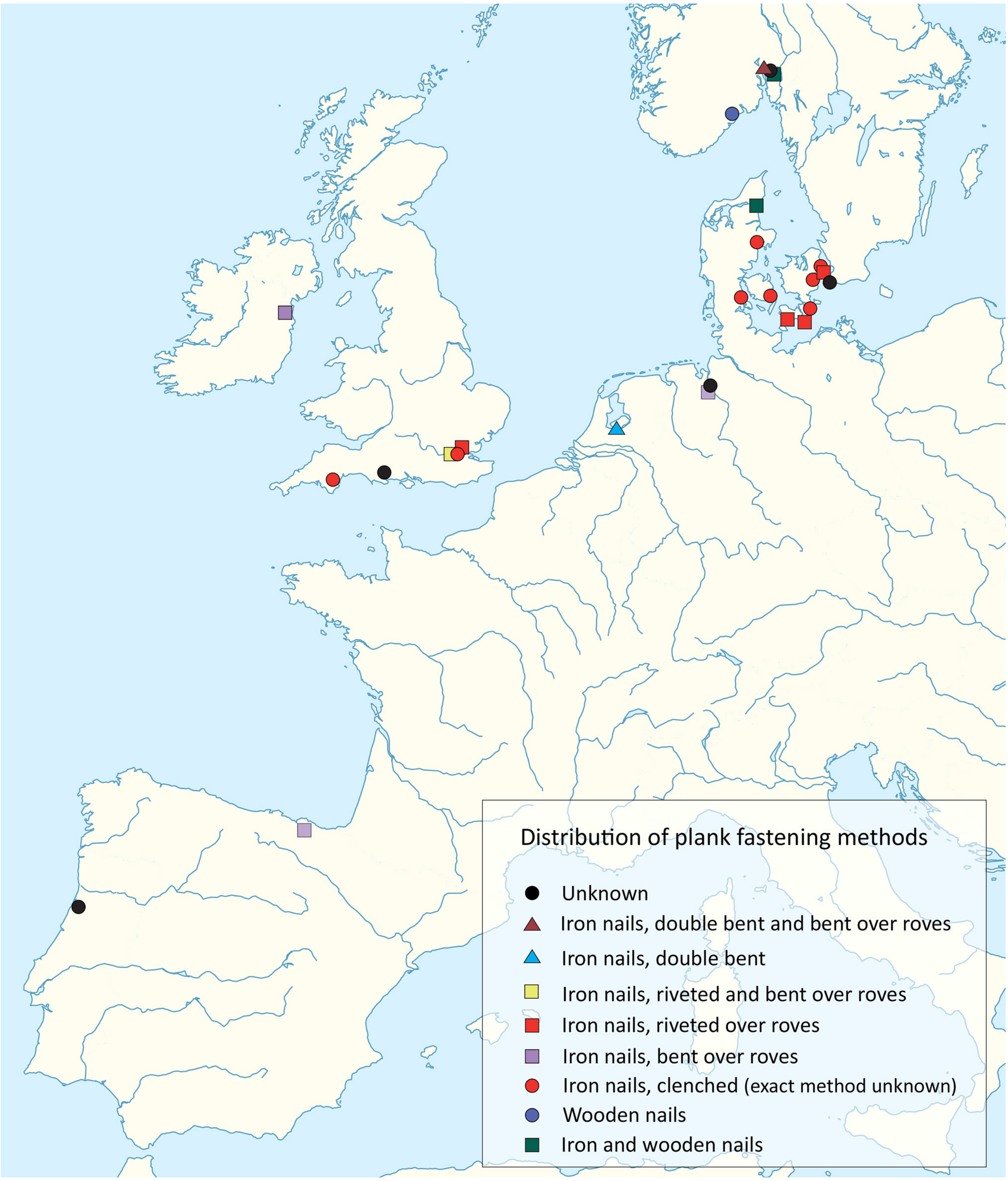

Figure 6-6: Map showing the distribution of the different plank joint fastening methods (Schweitzer 2013)

to some degree. Consistent impressions of roves on all planks of the preserved hull, however, confirmed that the entire hull was originally fastened with clench nails (see chapter 3). While the sole use of bent nails over roves is suggested for the Beluga Ship and the Urbieta wreck (Zwick, 2010; Rieth, 2006), a co-occurrence of riveted and bent nails on the same vessel is put forward for the Morgan's Lane wreck. The conjoint use of at least two different fastening methods appears particularly in the Norwegian material. In addition to the above-mentioned mix of iron and wooden fasteners, four Norwegian wrecks display fastenings where clench nails were used in conjunction with double bent nails. These are three of the larger Barcode wrecks (T. Falck, pers. comm.) and the Vaterland 1 wreck where the clench nails appear to have been bent over roves (Stanek, 2012). Finally the sole use of double bent nails to fasten hull planks together is evident in wreck ZN42 (Pedersen, 1997). Considering that double bent nails are traditionally seen as a characteristic feature of vessels built in the bottom-based tradition with a predominant distribution in the Low Countries, this may not seem surprising.

Looking at the diversity displayed by the remainder of the material, the situation is less clear-cut. As may be expected clench fastened hulls appear across the entire timespan and geographical reach of the studied material. The scarcity of comparative material in particular makes it difficult to come to conclusive interpretations. While Rieth sees the appearance of bent nails as a potential regional expression of the wider "Nordic" clinker tradition (Rieth, 2006), Marsden concludes based on the wealth of material from London that bent nail tips are part of a general decline in building quality. Thus riveting would have been replaced with the less labour intensive and thus cost cutting method of simply bending the nail tips over roves (Marsden, 1996). The appearance of clench nails alongside double bent nails in some of the Norwegian wrecks may indeed bolster Marsden's

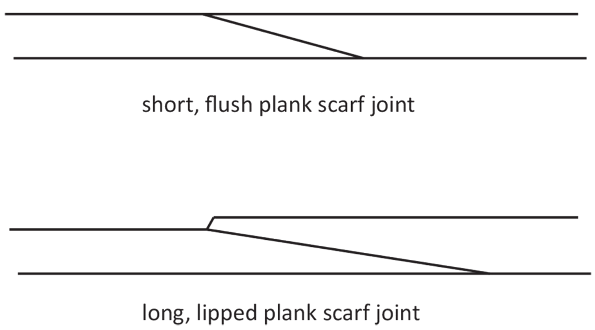

Figure 6-7: Schematic drawing of end-to-end plank joint types (Schweitzer 2013 after Bill, 1997)

interpretation. Higher demand of watercraft in conjunction with economic pressures could well lead to a dilution of previous higher quality and traditional ways of building small watercraft. Double bending nails moreover meant saving costs in building material since roves were no longer required. Technological diffusion from the "cog" or bottom-based shipbuilding may well be a factor, but should by no means form the sole basis for explaining this phenomenon.

Returning to Rieth's argumentation for the Urbieta wreck, does this mean that transnational developments towards reducing production costs go hand in hand with a loss of local or regional distinction in boat building tradition (Bill, 2009b)? As the dating of the Urbieta wreck remains tentative and in absence of comparative wrecks from the southern Atlantic coastal regions, this question can currently not be answered. Future wreck finds may well confirm that bent clench nails are an attribute of regional or local boat building traditions, just as it may turn out that Urbieta is part of a wider western European trend of amalgamating and merging building traditions.

A comprehensive analysis of end-to-end joints between planks of medieval and early modern wrecks in southern Scandinavia was carried out by Bill as part of his PhD dissertation. He identified two main groups of scarf joints, distinguished as short, flush on the one hand and long, generally lipped scarfs on the other (Fig. 6-7). According to his analysis the long, lipped scarfs become predominant during the later medieval period due to their easier and quicker production (Bill, 1997a). This observation also reflected in the dataset of this study with almost all known examples displaying scarf lengths of between 15cm to 30cm. The only significant exceptions from this general trend are the Portør boat where scarfs were on average 13cm long (Molaug, 1981) and ZN42 with up 45cm long scarfs (Pedersen, 1997). The short scarf lengths of the Portør boat can be explained by the small overall size of the vessel, measuring less than 10m in length. The long scarfs of the watership ZN42 are certainly striking in comparison to the remainder of the currently available data.

Strake Symmetry

Although the Bredfjed ship and ZN42 are the only wrecks in the dataset displaying secured symmetrical arrangement of scarfs, this feature is of significant relevance regarding the conceptual basis behind building a clinker vessel by mirroring the positioning of scarfs on the same strakes on port and starboard sides. The strake arrangement in the Vejdyb wreck is described as fairly symmetrical with the exception of one strake (Bill, 1997a). Potential plank symmetry is suggested for the Lundeborg 2 wreck (Skaarup, 2010) but in absence of accurate hull documentation this will have to remain tentative until further investigations.

Following the discovery of this feature in the Bredfjed ship, Bill undertook comprehensive research to identify parallels and reasoning behind this phenomenon. The bottom-based wreck NZ43 and watership NZ42 from Holland were the only matching comparisons at the time, thus leading Bill to the conclusion that symmetrical strake alignments are one of a series of features found in Danish wrecks of the Renaissance pointing to Dutch shipbuilding influence (Bill, 1997a; Bill & Gøthche, 2006). Bill explains the use of planks of identical shape and symmetrical scarf patterns "*…in a systematical method used somewhere in the processes shaping the planks prior to their attachment to the hull*" (Bill, 1997a p. 102). The planks would thus be manufactured to the required length and shape in pairs in advance without testing, rather than matching and shaping the planks strake-by-strake and independent from side as otherwise usual practiced in clinker shipbuilding. This predetermined way of shaping planks with a view to create a symmetrical hull in turn requires symmetrical positioning of scarfs. According to Bill the advantages of this elaborate method, for which he sees the use of sawn planks as beneficial, lie in increased accuracy and time consumption (Bill, 1997a).

In summary his explanation for the appearance of symmetrical strake arrangements in Southern Scandinavia infers an immediate relationship between the introduction of sawn planks into clinker shipbuilding and influence and adaptation of Dutch ship building methods. However, this would not necessarily explain the apparent strake symmetry in the above mentioned Vejdyb wreck. Although symmetry is not as consistent as in the Bredfjed ship, it is certainly evident to a sufficient degree. Unlike Bredfjed, the hull planks are radially split and timber provenance indicates a Polish origin for the hull planks. While origin of planks and place of construction do not necessarily have to be identical, the difference in plank conversion is notable. Nevertheless a potential Polish origin for the vessel may be indicated by the plank fastenings (see above). As the Vejdyb wreck is currently an isolated occurrence the interpretation on the symmetrical strake pattern remains speculative and uncertain.

Contrary to the presumed desire to achieve not only strake symmetry but also symmetry in shape, the evidence from at least two presented sites indicate that hull symmetry played a secondary role in the construction process. Some floor timbers from the Drogheda boat and the Poole waterfront site display a distinctly asymmetrical moulded shape (see chapter 3.3.5; Hutchinson, 1994). For the Drogheda boat this observation may be explained by damage and sagging of the floor timbers during the lifespan of the boat. However, the excellent preservation conditions make it likely that the timbers have suffered very little distortion from their original shape. The fact that most floor timbers from the Poole excavations have asymmetrical arms indicates that symmetrical lines were not always deemed crucial for small clinker built watercraft (Hutchinson, 1994).

In contrast to other aspects addressed in this study, such as utilization of raw materials and structural as well as technical solutions, the implementation of strake symmetry is of significant importance as it goes well beyond the diffusion of technology and impacts of socio-economic pressures. Due to the frequently regional character of small scale shipbuilding, the introduction of a new conceptual approach to existing boat and ships tradition requires strong and lasting impact. Consequently the appearance, albeit currently on a very limited scale, of a seemingly Dutch conceptual approach in Danish vessels is significant for current and future research.

Waterproofing

The most common luting material for clinker vessels throughout the medieval period in northwest and western Europe appears to have been mainly animal hair. Conversely and notably Moss, Sphagnum or other plant material seem to have been used only occasionally or as secondary waterproofing. Since detailed information on waterproofing materials is frequently not available for many wreck finds, it is so far difficult to establish chronological or geographical trends for usage and development during the Middle Ages. Some of the few wrecks with moss-based waterproofing are the Vejdyb and Hafnia-Vejle wrecks (Bill, 1997a) as well as the Sørenga 2 wreck in Oslo (Paasche et al., 1995). Moss was also evident for the stem piece found in Poole (Hutchinson, 1994) and the hull planking of the Aber Wrac'h wreck (L'Hour & Veyrat, 1994). The waterproofing material of the Gedesby 1 wreck was a mix between cattle hair and moss (Bill, 1997a).

A number of wrecks dating to the later Middle Ages such as the 14th century Skaftö wreck in Sweden (von Arbin, 2012) share this feature of mixed luting material. Determining whether this forms part of a certain building tradition is extremely difficult. The reasons can be manifold and may either be a deliberate and specific method but may equally reflect availability of materials or different phases of waterproofing during the lifespan of a vessel. The latter certainly appears the case for the Drogheda boat where one sample with woodland moss in the otherwise coherently used Sphagnum moss is part of a later repair measure (see paragraph 3.3.3). As the example of early modern Dutch carvel ship building shows, different waterproofing materials may have been reserved or found preferred use for certain hull parts. While moss was used e.g. for planes in stem or stern scarfs, other components were waterproofed using felt or hemp (T. Maarleveld, pers. comm.). In absence of such detailed knowledge on building practices for medieval and early modern clinker vessels, interpretations on waterproofing as indicators for boat building traditions should be treated with due care.

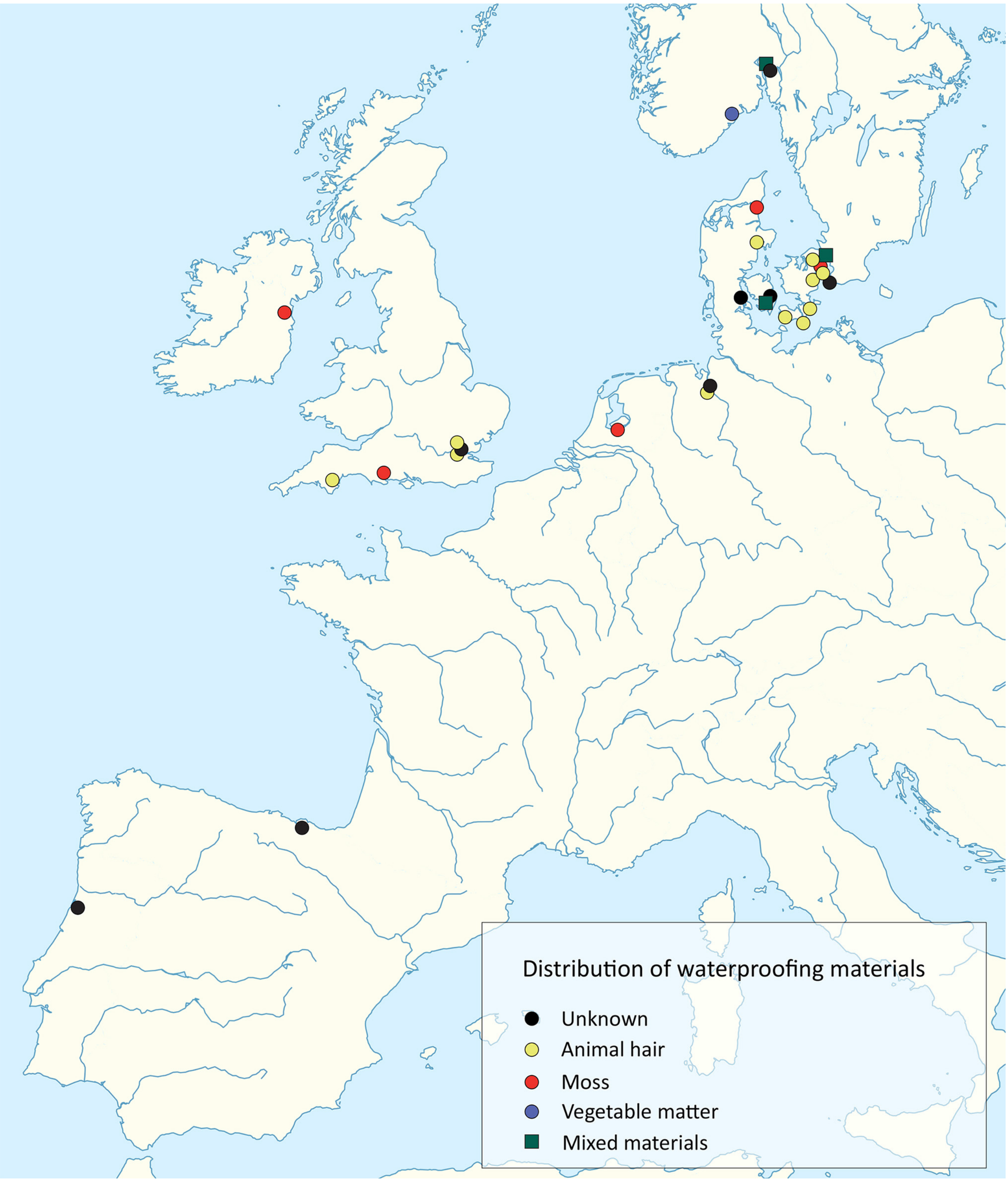

Figure 6-8: Map showing the distribution of the different waterproofing materials used (Schweitzer 2013)

Looking at the waterproofing materials of the wrecks included in this comparative study a similar picture emerges. (Chart 6-9). For most of the wrecks where waterproofing material was analysed animal hair (eleven examples), including sheep, cattle and goat hair, was the sole raw material used in combination with tar. Almost at a par are moss based waterproofing materials with five examples and waterproofing consisting of mixed raw materials represented by four examples. The cases with mixed materials include e.g. Lundeborg 2 where hemp and sheep wool was used as well as Vaterland 1 with hemp, flax and moss as components. A single case of a not further described and analysed waterproofing material made of vegetable matter from the Portør boat is also present.

Notwithstanding the relatively broad variety of waterproofing materials within the assessed assemblage, it has to be kept in mind that waterproofing materials of 21 wrecks are either unknown or have not yet been analysed. Again, this includes the 14 Barcode wrecks where detailed analysis is currently on-going. Unfortunately no information on waterproofing material is available from the two southern European wrecks Ria de Aveiro G and Urbieta is available. Consequently the currently available data does not show well-defined spatial distributions in waterproofing materials for the small regional watercraft assessed as part of this study (Fig. 6-8). A preference for animal hair seems to be apparent for the Scandinavian material, as well as a concentration of combined use of two or three different waterproofing materials seems to be apparent in Norway and Denmark. Furthermore moss and animal hair appear to have been used alongside each other in Britain and Ireland. However the small number of currently available overall data is so limited that interpretations have to be seen as tentative and preliminary.

Protective coating

In an attempt to protect hulls of boats and ships from rot and weathering, protective coating was frequently applied particularly to outboard hull surfaces. Only four wrecks of this study are described to have had protective coating applied. For seven of the remaining wrecks the otherwise detailed descriptive accounts do not mention coating while for the vast majority of wrecks this aspect remains unknown. The on-going research on the 14 wrecks from the Barcode site in Oslo may increase the number of wrecks with protective coating. On the other hand as several wrecks were investigated non-intrusively and left in-situ,

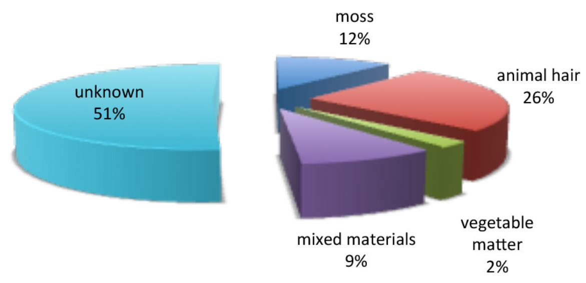

Chart 6-9: Percentage composition of waterproofing materials (Schweitzer 2013)

such as Knudsgrund and Skanör, the outboard surfaces of the hull were largely inaccessible.

The wrecks showing remains of protective coating included Vaterland 1 from Norway, the Morgan's Lane boat and timbers from Poole as well as the Drogheda boat. Notwithstanding a seemingly high representation from Britain and Ireland, this should not be seen as a diagnostic geographical indicator, as outlined in more detail below. Of the four named examples, the Drogheda boat has been subjected to the most comprehensive analysis. As described in chapter 3.3.3, the protective coating was preserved for significant parts of the outboard hull of the Drogheda boat. This proofed to be a soft resin based pitch. Conversely the delicate nature of resin based pitch coatings may explain why the material is rarely evident on wrecks. Consequently the knowledge on protective coatings is still very limited with only few reference sites available for comparison. Traces of wood-tar pitch probably mixed with linseed oil were for example evident on the Skuldelev wrecks serving not only a protective measure but probably also as a decorative element (Crumlin-Pedersen, 2002).

Residue of a potentially similar pitch to the Drogheda boat material was found on the inboard surfaces of re-used but articulated hull remains of a thirteenth century clinker vessel in London (Goodburn, 2003). Yet the application of this material to the inboard faces in contrast to the consistent outboard occurrence on the Drogheda Boat may indicate a difference in function. Intensive analysis and research was undertaken for the protective coatings of the 24M Red Bay wreck (LaRoche, 2007). Although the most extensive evidence of preserved protective coating was again found on the inboard hull surfaces remnants of pitch residue were found on the often heavily weathered and degraded outboard surfaces. The archaeological evidence did not allow to determine if the material was applied to the entire hull surface or to plank seams and countersinks of plank nails (LaRoche, 2007).

Traces of protective coating, white in colour, was also observed on the hull of the Gresham Ship (Auer & Firth, 2007) and the Mary Rose. Unfortunately the Mary Rose material was not sampled and hence no information on its composition is available (McElvogue, 2009). During the Poole excavations an unidentified yellow substance of soft and slightly pliable texture was found in the scarf joining a used stem as well partially covering its outer surface (Hutchinson, 1994). Although no scientific analysis of the substance was carried out its description appears similar to the protective coating used for the Drogheda boat. The protective coating taken from an early 17th century lnschot/Zuidoostrak wreck in the Netherlands was whitish in colour with a viscous and friable texture. It was applied to a thick layer and diamond shapes had been incised into the surface. Forensic analysis of the material showed that it was a sulphur enriched resin (Maarleveld, 1995a).

A 16th century manuscript analysed by LaRoche for the Basque M24 wreck describes the extraction and processing of resin for the production of protective coatings. The processing varied depending on the type of pitch required with a distinction between hard and soft pitch. Seemingly superior qualities were attributed to soft pitch, which ideally had to be soft, smooth and shimmering texture. Unfortunately little is known regarding its exact composition other than that resin was a main ingredient. The manuscript also mentions that resin could be used instead of pitch despite its white colour. According to eighteenth century sources it could contain a variety of substances ranging from hard pitch, tar, tallow, resin and sulphur (McElvogue, 2009). It is further known that sulphur was added to coating for colouring to achieve a more aesthetic colour for the visible hull surface. However, in the case of Inschot/Zuidoostrak, the sulphur resin based coating was also applied on the underwater parts of the ship. Therefore it must have been used for its waterproofing and antifouling qualities due to its poisonous nature (Maarleveld, 1995a).

Returning to the Drogheda boat the above-described texture, colour and composition appear to identify its protective coating as a mixed soft pitch or resin mixed with sulphur. The close match between the Iberian descriptions of pitch compositions, Dutch comparative material and the evidence from the Drogheda boat shows that methods and techniques for protecting hull surfaces were widely used and known in European ship and boat building. The previously mentioned 16th century manuscript also describes how the pitch was applied to the hull surface. Firstly the hull was slightly burnt to soften the pitch ensuring that it remained attached to the scorched hull surface. Hulls may have been coated twice to ensure that all seams and areas were properly covered. While the outboard surface of the Drogheda boat hull shows no evidence of scorching thus indicating that the pitch was applied to the hull without previously burning the hull surface, scorching was observed on the exterior of the Morgan's Lane boat (McElvogue, 2009).

For the Drogheda boat it appears that in addition to the application of the pitch coating to the outer hull, protective measures against weathering and rot on the inboard hull were also taken. Since the inner hull was constantly subjected to wear and tear a different approach was taken by slightly burning the surfaces of the hull planks. This was done after the shell of the hull was assembled and before frames were inserted as none of the lands, scarfs or frames show evidence for charring in contrast to the often heavily charred plank surfaces. The absence of charring on the plank lands also excludes the possibility that it was done during the bending of the planks for the assembly of the hull. In case of the Vaterland 1 wreck it appears that coating was applied outboard as well as inboard to achieve a similar effect of protecting the inboard side of the boat from weathering and rot (Stanek, 2012).

6.2.5 Framing, crossbeams and stringer

Introduction

Floor and side timbers as well as crossbeams in the upper hull structure provide lateral strength and stability for most of the vessels in the dataset. Overall the vast majority of wrecks with the exception of ZN42 do not allow insight into the full transverse structural makeup. As a result the following discussions are mainly based on framing timbers, i.e. floor and side timbers and to lesser degree upper lateral components, such as crossbeams and decking.

Framing

Similar to the aspect of hull planking a number of key factors regarding framing were identified. To provide a meaningful framework for comparative analysis the parameters defined by Bill as part of his dissertation were used and amended to suit the requirements of this study (Bill, 1997a). As structural appearance together with choice and quality of materials used cannot be separated from each other, the comparative parameters are formulated accordingly comprise the following aspects:

Framing system

Frame spacing

Frame joints

Frame fastenings

Wood quality

Framing system
Where evident the framing system for the vessels within this study appears to have been consistently comprised of floor timbers spanning across both sides of the keel roughly up to the turn of the bilge. Continuing from the turn of the bilge side timbers covered either the remaining distance to the gunwale or terminated just below to accommodate top timbers or sheer clamps (see below). In case of the Drogheda boat for example, the rebates, which were cut into the top inboard ends of side timbers were initially believed to have been scarfs to which top timbers or stanchions were fastened in order to cover the remaining distance to the gunwale over approximately one or two more strakes. A similar arrangement of stanchions scarfed over side timbers and covering the topmost strakes has been found on the Gedesby 1 wreck (Bill, 1997a) and the wreck from Vedby Hage (Gøthche & Myrhøj, 1996). However, reconstruction of original hull shape for the Drogheda boat showed that the preserved height was most likely gunwale level, thus making it more likely that these rebates held a sheer clamp to provide additional strength to the gunwale (see chapter 3.3.9).

Frame spacing
The distance between frames has been included as a comparative parameter with a view to identify potential chronological or other distinctions, such as geographical distribution patterns or size and usage of the vessels. For small watercraft in Scandinavia Bill does not attribute a distinct chronological development regarding frame spacings from the early to the later Middle Ages. Instead he believes that distances between frames are chosen by boat builders predominantly depending on the individual requirements for a vessel (Bill, 1997a).

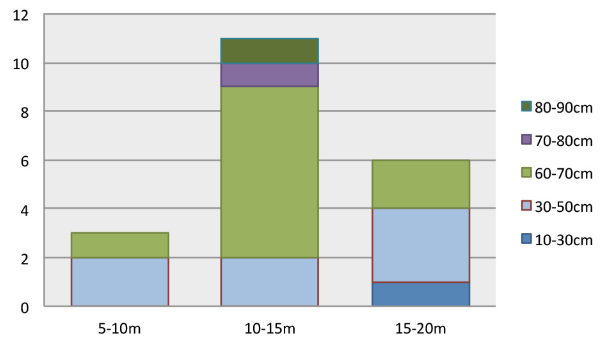

Chart 6-10: Distribution of frame spacing distances by vessel size (Schweitzer 2013)

Comparing the frame distances from wrecks included in this study appears to confirm that distances between frames do not appear to be subjected to chronological changes. Although the vast majority of vessels show distances between frames of 30cm and 70cm, it could be observed that none of the assessed wrecks had distances between 50cm and 60cm, thus dividing the material into two almost equally sized groups of distances between 30cm to 50cm and 60cm to 70cm. As the distances within the individual vessels were by and large relatively regular, the respective average values were used to identify whether distinctions on vessel size can be made.

Chart 6-10 shows the distribution of average distances by vessels size. Taking into account that boats with lengths of 10m to 15m have the highest representation, it is evident that distances are relatively evenly distributed. A slightly higher percentage of short distances between 10cm and 50cm can be attested for vessels of 15m to 20m in length. Considering that the larger boats were more likely to have carried higher volumes of cargo, increased lateral strengthening of the hull could well have necessitated shorter frames spacings. Since many of the boats in this study may have been built as multi-purpose vessels, including fishing and cargo transport, the present average distances between frames between 30cm and 70cm may represent a compromise solution to accommodate for a number of uses.

Frame joints
Another feature in clinker built boats, which has to date been rarely discussed are the joints between floor and side timbers. From the Viking period onwards almost all presently known vessels share a joining method whereby side timbers are scarfed over floor timbers with through scarfs. The discovery of a different structural solution in the Drogheda boat was the motivation to search for potential parallels in contemporary clinker boat and shipbuilding. Instead of joining and fas-

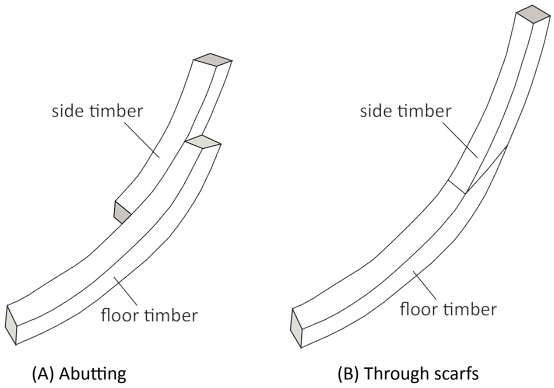

Figure 6-9: Schematic drawing of framing timber joint types (Schweitzer 2013)

tening side timbers to floor timbers via horizontal through scarfs, side timbers were placed abutting on the floor timbers. Both components were not fastened to each other but placed next to each other overlapping by approximately two strakes around the turn of the bilge.

None of the wrecks assessed in this study or any other currently known medieval or early modern clinker wreck share this feature. Identifying the reason for this currently isolated feature is extremely difficult. Attributing the abutting side timbers to a local boat building tradition or deducing influence from carvel ship building methods is not feasible in absence of suitable comparative material. Nevertheless, a potential interpretation can be proposed based on overall observations from the wreck and general developments in clinker boat building in the later Middle Ages. As characteristic for clinker boats of the period, the level of craftsmanship and materials used is of a lesser quality compared to the Viking period. As discussed in this chapter the disappearance of decorative elements in combination with other technological changes towards reducing production costs and time can be observed in a variety of construction details. Abutting side timbers may well be another manifestation of this general development. Not having to fit side timbers over floor timbers by cutting scarf joints and thus not requiring fasteners saves labour and building material.

Frame fastenings

The predominance of end-wedged treenails, i.e. treenails wedged on the inboard facing ends as observed for the Drogheda boat is a well-known and frequently recorded feature of medieval clinker built ships. The method leads to swelling at the treenail ends and provides a more secure grip on the frames (McCarthy, 2005). Prominent examples of medieval ships and boats showing this feature include the Skuldelev, Schleswig and Hedeby wrecks (Crumlin-Pedersen, 1997) as well as the Magor Pill wreck (Nayling, 1998), the Copper wreck in Gdańsk (Litwin, 1980). Several of the treenails found during the excavations at Winetavern Street in Dublin were also end-wedged (O'Sullivan, 2000). Furthermore several of the wrecks included in this study share this feature, including for example the frames from Poole (Hutchinson, 1994), the Dokøen 3 wreck (Nielsen, 2012), the Bredfjed ship (Bill, 1997a) and some of the treenails of the Blackfriars 3 wreck (Marsden, 1996). The wide geographical and chronological spread of end-wedged treenails shows that it is unsuitable as a chronological or regional indicator.

Frame shape

An aspect, which frequently appears to find limited attention in the discussion of the development of clinker built watercraft, is the level of finish and quality of raw material used. While the relevance of framing timbers for the potential place of origin of clinker vessels has been recognised through the advances in Dendrochronology and timber provenancing (Daly, 2007), framing timbers hold valuable information regarding the choice and availability of compass timbers used for framing components in clinker boat and ship building.

Framing timbers of earlier clinker ships, particularly of Viking Age date, are characteristically "wing"-shaped, which Bill describes as "a shape where the timber in question is narrow in its central portion, more or less pointed in the ends and with the widest dimensions closer to the ends than to the central portion" (Bill, 1997a p. 138). During the course of the Middle Ages this elaborate shape is continuously replaced with a more simple four sided or parallel-sided shape (Bill, 1997a). Although less sophisticated than the "wing"-shape, the production of parallel-sided frames requires parent logs of sufficient girth if a fully boxed frame consisting solely of the more durable heartwood is desired. In addition the parent log should be straight grown and with a minimum number of branches for a frame of high quality.

The evidence from the dataset of this study, however, shows significant discrepancies in shape and quality of framing timbers used (Table 6-11). Fourteen of the wrecks covered by this study have been consistently fitted with more or less straight grown and well finished parallel-sided framing timbers. However, roughly hewn framing timbers often characterized by waney edges, curved shapes, frequent presence of sapwood and occasional bark, occur in five of the assessed wrecks. In four cases parallel-sided or more or less parallel-sided frames were used alongside roughly hewn examples. These include e.g. the Drogheda boat where a number of framing timbers, particularly side timbers, consist of irregularly shaped, fast grown and barely worked branches. Although floor timbers are generally near to parallel-sided, waney edges, irregular shapes in combination with sapwood edges and occasional bark are present. Furthermore the frequent absence of joggles on the underside of frames is an indicator for the poor level of finish (see chapter 3.3.5).

Other wrecks displaying combinations of parallel-sided and roughly hewn frames are Dokøen 3 (Nielsen, 2012), ZN42 (see chapter 4.5.2) and Vejdyb (Bill, 1997a) where mostly parallel sided frames were used alongside roughly hewn examples. The only example consisting only of roughly hewn frames seems to be the Vedby Hage wreck where the frames are described as irregular in shape and often barely worked and frequently showing sapwood edges (Myrhøj, 2000).

Overall the present results appear to indicate that parallel-sided timbers were the preferred choice by boat builders during the period. Nevertheless as 22 wrecks do not provide information on frame shape this result should be seen with caution. Nevertheless, even for most wrecks where roughly hewn frames found use, it appears that parallel-sided frames were used for components of higher structural importance, such as floor timbers. The preference for parallel-sided frames over roughly hewn frames thus appears to have been functional rather than aesthetic or bound to a specific building tradition. Regarding utilisation of raw material it has to be pointed out that all known frame timbers from the dataset were made of oak. The only exception is Vaterland 1 where two of the parallel-sided frames were made of pine and are not believed to be part of the original construction (Stanek, 2012).

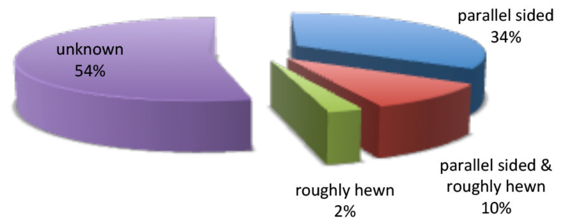

Chart 6-11: Percentage composition of framing timber finish (Schweitzer 2013)

Crossbeams

Further to framing crossbeams or thwarts served to provide additional transverse support and strengthening of the hull. Low placed crossbeams above each frame, so-called bitis are a characteristic feature of clinker built vessels up to the late 12th and occasionally the 13th century. These then gave way to hold-beams, mast-beams and thwarts where they were not necessarily placed at every frame station (Crumlin-Pedersen, 1997). In some vessels cross-beams could protrude through the hull planking and frequently occur in combination with strong vertical beam knees (Bill, 1997a). This is a well known and wide spread feature for clinker built vessels from approximately AD 1200 onwards and evident in clinker built vessels such as the A'ber Wrach wreck, OZ36 and Kalmar 1 (L'Hour & Veyrat, 1994; Overmeer, 2009; Åkerlund, 1951) as well as in vessels of the so-called cog tradition, including the Bremen and Kolding cogs (Lahn, 1992; Hocker & Dokkedal, 2001). This seemingly changes in the later Middle Ages when archaeological and iconographic sources suggest that protruding cross beams were less dominant towards the 16th century at least in southern Scandinavia (Bill, 1997a).

Although limitations in preservation conditions in many cases do not allow insight into the former nature of crossbeams for most of the wrecks included in this study, the evidence from the studied dataset appears to confirm Bills conclusion. The Døkoen 3 (Nielsen, 2012; Høst-Madsen, 2007) and Vedby Hage wrecks are indeed the only examples in the studied material displaying this feature. Even for wrecks, such as the Drogheda boat where the existence of protruding crossbeams can be ruled out, the lateral support of the upper part of the hull remains unknown. A single cross beam from the Knudsgrund wreck (Dencker, 1998a) and a mast thwart from the Portør boat (Molaug, 1981) remain the exception to the rule.

Decking

Exceptional insight not only into transverse structural components but also decking comes from the ZN42 wreck. In addition to the central fishwell, fore and aft decks were almost entirely preserved (Pedersen, 1997). In contrast to the extremely well preserved upper structural elements from ZN42, evidence for decking is near non-existent for the vast majority of the presented reference sites. Given the size parameters for the study it is likely that a high percentage of the boat finds were originally undecked. Nonetheless, at least partial decking is suggested for four wrecks. Despite the absence of the physical remains of any decking elements, potential fore and aft decking for the Lundeborg 2 wreck is reconstructed based on the presence of a galley near the bow in combination with the cargo of tiles amidships (Skaarup, 2010). Potential deck beams were found with Barcode wrecks 2, 5 and 8, indicating that at least some of the Barcode boats were fitted with decking (Gundersen, 2012).

The evidence from ZN42 and the tentative reconstructions from Lundeborg and Oslo shed light on an important aspect of the construction of coastal watercraft. The presence of decking plays an important role for usage and suitability of vessels for e.g. longer distance travel. The provision of shelter for crew and protection of cargo from water entering the hold are crucial aspects in the design and intended use. Unfortunately preservation conditions rarely allow an insight into the upper structural components of boat and ships finds. Historical depictions can help to deepen our understanding of upper works, including rigging, crew sizes and usage of boats in their contemporary setting. The depiction of a late 16th century Dutch *dog boat* shows full decking was not exclusive to large vessels (Fig. 6-10). An engraving depicting the Royal Danish shipyard in Copenhagen dating to the early 17th century, shows small open boats moored up (Fig. 6-11). These, among other contemporary depictions, including the previously mentioned small undecked vessel carrying cattle (Fig. 3-45), served as inspiration for the reconstruction of the Bredfjed ship (Lemée, 2001).

The background of the Golden Age in Holland inspired numerous artists to engage with the maritime environment leading to an unprecedented wealth in marine paintings. While sea battles and warships frequently feature in the depictions, scenes of everyday maritime life from fishing to trade have also been captured. One of these scenes, painted by Anthonisz, shows a fleet of carvel built pinks on a beach returning with their catch of fish (Fig. 6-12). Small fore and aft decks with an open cargo hold are clearly visible on the boat in the foreground. Unfortunately depictions of such incredible attention to detail are almost entirely limited to Holland.

Stringers and ceiling planking

For eleven boat finds in the dataset stringers are evident. The number is likely to increase with the analysis and documentation of the Barcode wrecks. Stringers as additional longitudinal supporting elements are common throughout the medieval period and underwent a significant change during the 13th century when thick joggled stringers, which were fastened to the hull,

Figure 6-10: Engraving by J. Porcellis dating to 1627 showing a two masted and fully decked dog boot of 8 last with a raised aft deck (Haalmejer & Vuik, 2007 p. 27; Icones Variarum Navium Hollandicarum)

were replaced by simple plank shaped stringers laid and fastened to the frames (Bill, 1997a). This observation is mirrored in the reference sites used for this study with all stringers being plank shaped. Although the stringers are of limited value for comparative purposes, they should not be dismissed as irrelevant for the wider understanding of clinker boat and shipbuilding. As shown above the aspect of wood usage and technology provides valuable information on socio-economic context as well as continuity and change in utilisation of wood as the primary building material. In case of the stringers it is notable that in three of the eleven boat finds, the stringers were not made of oak. Instead the stringers of the Køge (Liebgott, 1995; Bill, 1997a) and Lundeborg 2 (Skaarup, 2010) wrecks were made of pine, while spruce or pine is currently assumed for the Barcode 4 boat (Gundersen, 2012). The Vedby Hage wreck shows that although oak was used for hull planking as well as stringers, the conversion method differed. Hull planking was made using higher quality radially split planks while sawn planks were used for the stringers (Myrhøj, 2000).

Only three of the boat finds in the dataset show clear evidence for permanent or temporary ceiling planking. Ceiling planking made of pine planks are fitted over the frames in the lower hull of the wrecks of Lundeborg 2 and Skanör, providing a level and solid platform for the cargos of brick tiles (Skaarup, 2010; Alopaeus, 1993). Ceiling planking of a currently unknown softwood is also suggested for the Barcode 5 wreck (T. Falck, pers. comm.) Overall, however, the almost consistent absence of ceiling planking appears to suggest that it was frequently not deemed necessary independent from intended use of the vessels. The wrecks, which were found with cargo include e.g. the Blackfriars 4 ship carrying a cargo of course stone and the Skanör wreck (Hörberg, 1995; Bill, 1997a), which sunk with a cargo of brick tiles similar to Lundeborg 2. Considering the heavy weight and potentially sharp edged nature of such loads the absence of ceiling planking is notable. The cargo of wooden casks containing herring from the Drogheda boat highlights a further aspect. As the casks seemingly rested directly on top of hull planking and frames a high risk of potential damage to ship and cargo seems likely (chapter 3.6.1). Not only does this indicate that the cargos were destined for relatively short distance coastal trade avoiding the rougher offshore conditions, it further shows that boat builders and merchants had sufficient trust that vessel and cargo would arrive safely at their destination.

Notwithstanding the absence of ceiling planking, it is therefore likely that dunnage of organic material protected hull and cargo in many cases. It can furthermore be assumed that temporarily

Figure 6-11: H. Allard's engraving of the Royal Danish naval shipyard Bremerholm, Copenhagen, showing two small watercraft moored up in the centre. The engraving dates to the 1650s but is based on a work from the 1620s (Royal Danish Library)

Figure 6-12: Detail of a painting by A. Anthonisz showing fishing pinks on a beach, c. 1600 (Het Scheepvaartmuseum, Amsterdam)

fastened ceiling planks were lost during the sinking of vessels after coming loose and afloat when hulls filled with water. Similarly ceiling planking may have been removed deliberately to gain access to the bilge for bailing (T. Maarleveld, pers. comm.). The frequent absence of ceiling planking in the archaeological record can equally be a result of the wrecking process or the events leading up to it.

6.2.6 Masts, rigging and propulsion

Keelsons or mast steps of most of the boat finds in the dataset are relatively short, measuring mostly between 2m and 6m in length and are defined by a thicker central section tapering to the ends. The keels of the Vedby Hage and Barcode 14 wrecks are exceptions (Myrhøj, 2000). Both are significantly longer and also differ in shape. Contrary to the tapering mast steps, they are parallel sided only widening around the mast socket. It is therefore better described as a keelson, which also serves as an additional longitudinal strengthening element for the hull. The Vedby Hage keelson further shows two mast sockets whereby it is believed that one added at a later stage to improve the trim of the vessel (Myrhøj, 2000).

The potential re-location of the mast position shows the importance of the placement of mast steps within the hull. The location of the mast is for example determined by type of rig and number of masts. The placement of the mast step relatively far forward in the vessel in the case of *watership* ZN42 is indicative for a single masted layout, which is mirrored in contemporary depictions (Fig. 6-13). Nevertheless the vast majority of boats in this study have the masts placed more or less amidships, a location allowing one as well as two masted rigs. In absence of mast steps from the archaeological record, the Bredfjed ship was nevertheless reconstructed with two masts based on historical depictions, including the aforementioned Koppenhagen copperplate (Fig. 6-11) (Lemée, 2001).

The difficulty in utilising selected evidence fro historical depictions can also be seen in the case of the above described Dutch *dog boats (Fig. 6-10)*. Although the shown example fits well into the size and rig deliminations of this study, the contemporay use of the term dog boat included also much bigger vessels with up three masts and 30 to 40 lasts load capacity (Fig. 6-14). In case of the *dog boats*, it thus seems that the type denomination covers a variety of vessels possibly sharing only a limited number of similar structural features. Yet, the main defining criteria appears to have been shared purpose as fishing vessels specialised in cod fishing in the Dogger Bank, which is also seen as the origin of their name (Groot & Vorstman, 1980; Hallmeijer & Vuik, 2007);

Conversely no contemporary depictions for small coastal watercraft from Ireland exist but the former presence of two masts and their exact positioning could be confirmed archaeologically for the Drogheda boat (see chapter 3.3.7). Although the exact rig of the boat remains speculative, including the question whether a bowsprit was fitted as indicated by the stem hole, a two masted rig can be reconstructed safely. A potential bowsprit was found near the Lundeborg 2 wreck although this observation should remain tentative until further assessment of the material (Skaarup, 2010).

Evidence whether the boats were designed for rowing, sailing or a combination of both can potentially be obtained from gunwale components. This includes for example the wooden fastenings between hull planking and sheer clamp of the Drogheda boat. Similar fasteners were also observed for example at the 12th/13th century Sjøvollen ship as well as the Gedesby and the Vedby Hage wrecks (Christensen, 1968; Gøthche & Myrhøj, 1996). The fasteners consist of vertically placed treenails and are interpreted as fastening points for shrouds, ropes supporting the mast (Gøthche & Myrhøj, 1996). Combined propulsion of sail and rowing is evident for the small Portør boat where a single masted layout is indicated by the centrally placed mast step with mast thwart. Four rowlocks furthermore indicate that the boat could also be rowed (Molaug, 1981).

6.2.7 Cargo and vessel use

Identifying the destined use of boat and ship finds can be extremely difficult. Particularly small watercraft as assessed within the framework of this project may have been built to serve several functions from lighting to fishing, trade as well as ferrying. Even highly specialised vessels, such as the presented Dutch *waterships* and *dog boats*, were used depending on requirements and characteristics of the vessel. Again the *waterships* are an excellent example for this, whereby the heavy, strong construction in combination with the good anti-leeway properties of design and built made the fishing vessels ideal boats for towing large ships (Verweij et al., 2012).

The exercise of identifying vessel use based on archaeological evidence is mostly limited to assessing shape, construction, present cargo and artefacts. The limitations in determining the original shape of ship finds have already been outlined in chapter 5.4.2. Nevertheless, certain conclusions on shape in relation to intended use can be drawn even for wreck finds where relatively little information is available. Sharp deadrise angles at the bow in combination with a very flat-bottomed shape amidships can be indicative for intended use as cargo carrier. This is e.g. evident for the Dokøen 3 wreck (Nielsen, 2012) but also for the Drogheda boat where cargo transport

Figure 6-13: Detail of a painting by A. Storck showing a watership sailing by, dating to the late 17th century. (Haalmeijer & Vuik, 2007 p. 148; Christie's London)

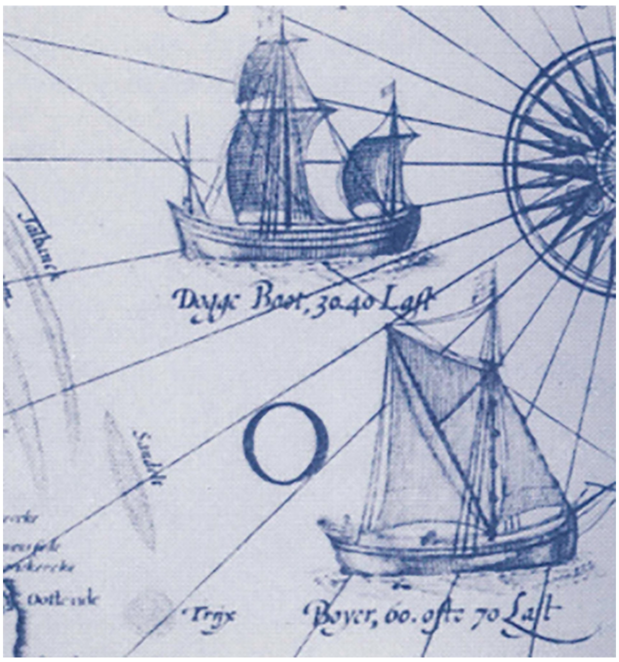

Figure 6-14: Depiction of a three masted dog boat of 30 - 40 last. Detail of the wall map of the seventeen provinces, Geo-Graphica. XVII. Inferioris Germaniae by J. Hondius the Elder dating to 1602 (Haalmeijer & Vuik, 2007 p. 55; University Library Leiden)

was further substantiated by the swiftly widening beam to increase cargo capacity (see chapter 3.5). An extreme case of adaptation for transport of goods can be seen in the hull shape of the London river barges Blackfriars 3 and 4 where the flat bottomed shape in conjunction with a continuously wide beam shows how maximised cargo carrying capacity could be implemented without having to compromise in shape in order to maintain sailing capabilities in a coastal environment (Marsden, 1996).

In addition to shape, certain characteristic structural elements can help in identifying specialised use of watercraft. For example the extremely well preserved remains of ZN42 clearly identify the wreck as a fishing vessel due to the central fishwell with perforated hull planking (Pedersen, 1997). Similarly the heavy ceiling plank of the Lundeborg 2 wreck indicates that the vessel was destined as cargo carrier, which in this case was confirmed by the presence of a cargo brick tiles (Skaarup, 1979). The vast majority of the boat finds in the dataset, however, are devoid of such characteristic structural elements. Overall only five wrecks could be clearly identified as cargo carriers due to the original cargo still being in-situ. Three vessels carried brick tiles including the aforementioned Lundeborg 2 wreck, but also Lundeborg 1 and the Skanör wreck (Skaarup, 1979; Hörberg, 1995). A cargo of coarse stone was recorded for the Blackfriars 3 (Marsden, 1996), while the Drogheda boat is the only wreck with a preserved cargo of organic material. The preservation of the cargo of wooden casks containing cured Herring provides an excellent and unique insight not only into traded goods but also into containers used and stowage arrangements in the hold of a small clinker built coaster (see chapter 3.6). The discovery of animal dung, most likely of sheep, between the plank seams indicates that the boat was also used to carry livestock and fishing activities are suggested by the discovery of a potential line with sinker for long-line fishing (see chapter 3.7.3).

Further to structural elements and material culture associated with wrecks, evidence on hull shape plays an important role for assessing potential destined use. Overall the evidence from the Drogheda boat points to a variety of uses, an interpretation shared by Hutchinson describing the timbers from the Poole boatyard belonging to “workboats” (Hutchinson, 1994). Indeed such a generic term appears best suited for small watercraft of such versatility, which frequently lack attributes indicating specialised use as e.g. evident for *waterships*. In this light the proposed use of the Bredfjed ship as a ferry between Rødby and Fehmarn based on historical depictions of similar vessels and the known existence of such a historical ferry route (Bill, 1997a), should be seen as one of a number of potential interpretations.

One aspect regarding vessel use has so far found little attention from an archaeological perspective, even though it has the potential to not only increase our general recognition of small clinker built watercraft, but also to aid in understanding the factors and agents in its development. As the example of the depiction of the Royal naval shipyard in Copenhagen shows (Fig. 6-11), small watercraft were also used for naval purposes for example as support or life boats. Built by craftsmen and shipbuilders on the naval shipyards, these boats were built using on-site technology, knowledge and materials. Unfortunately archaeological evidence for small naval watercraft is currently extremely scarce. The clinker built boat found with the *Vasa* (Cederlund, 2006) and the recently discovered wrecks of five 17th century vessels in the former Royal naval shipyard in Stockholm (Hansson, forthcoming), are so far rather exceptional.

Overall, the presence of structural features, such as pulling holes, can help in gaining a better understanding of the range of use of small watercraft. Albeit pulling holes are primarily an indicator towards the operational environment of small coasters, such structural design features indicating beaching certainly offer insights into everyday use and practice. The 17th century depiction by Anthonisz showing pinks unloading their catch on a beach is a vivid example for the interaction between adaptation to operational environment and everyday use (Fig. 6-11).

6.3 Understanding coastal watercraft

6.3.1 Introduction

As the previous chapters have shown, the material under investigation for this study offers significant potential to identify regional as well as transnational expressions of developments driven by wider European socio-economic forces. Unfortunately the uneven spatial distribution of the currently known boat finds bears the danger of biased frameworks for interpretation and analysis. Classification and typology thereby form important tools for categorising and interpreting the archaeological material. Due to the strong research tradition and wealth of archaeological data north-western European typological and interpretational models dominate research of clinker ship building in western Europe. The following chapter aims to explore whether current typological frameworks do justice to such a complex and geographically dispersed archaeological dataset.

The focus hereby lies on well-established archaeological methods for classifying medieval and early modern boat and ship finds. Ethnological comparative analysis and classification approaches as put forward by Rieth, Molaug and Christensen for the Urbieta and Portør wrecks, have been deliberately excluded (Rieth, 2006; Molaug, 1981; Christensen, 1985). Comparative analysis between existing or recent traditional working boats and wreck finds certainly has the potential to yield important results on similarities in shape, choice of materials and structural details. Identifying aspects of continuity resulting from unchanged conditions in operational waters and availability in building materials could deepen our understanding of organisation and development of small-scale coastal boat and shipbuilding. Considering the vast geographical reach of this project, such an undertaking would have breached scope and primary objectives for this study. However, it is hoped that this aspect will find more attention in future research and analysis of coastal watercraft.

6.3.2 The role of classification and typology

Classification and typology are core tools in archaeological practice, originally devised to organise, structure and understand archaeological data. Montelius who devised the typological principle in the 19th century based on Bronze Age artefacts groups, saw a comprehensive understanding and knowledge of the material in question as essential for creating and establishing meaningful and valid typologies. Although continuously challenged by other scholars the core idea of Montelius' principle could so far not be proven wrong and has found wide acceptance and utilisation in archaeological research (Sørensen, 1997). Although being a well-established approach in Maritime Archaeology, utilising classification and typology as a tool to understand and interpret shipwrecks is far from unproblematic for a number of reasons. Among the factors restricting the establishment of comprehensive understanding and knowledge for ships and boats is their structural complexity, i.e. the immense wealth of structural and material detail, which allows for a multitude of possible feature combinations. This, in combination with the relative scarcity of overall wrecks found in comparison to original numbers operating in European Atlantic waters and the inherent mobility of ships and boats creates a diffuse and inconsistent basis for grouping and organizing our data. Allowing for potential co-occurrence of similar feature combinations from separate contexts, regions or time periods is next to impossible (Schweitzer, forthcoming).

Maritime archaeological classification schemes for ship and boat finds of North-western European context was largely devised over the course of the last century. Not only have they remained relatively unchanged until the present day, they have also become institutionalized as the main typological approaches in maritime archaeological research. For the geographical region of this study two main typological schemes can be distinguished and as stated above were frequently even used in conjunction. Both typological approaches use individual as well as combinations of structural elements and design features of ship finds as defining criteria for the typological approach. However, while one strand seeks to match wrecks with historically known ship types based on written and pictorial evidence, the orientation of the other is more archaeological and anthropological in nature, such as classifying ship finds by combinations of structural details as indicators for specific boat and shipbuilding traditions (Hocker, 2004b). Although both classification schemes have valid elements, neither is currently able to accommodate for the complexity of the material and the shortcomings in our knowledge base. In response, certain classification models developed over the years combine and mix both strands in an effort to reach a more holistic understanding. However, the insufficiencies in each approach remain and can thus complicate matters further (Schweitzer, forthcoming).

For the group of boat finds under investigation as part of this project, classification schemes are mostly based on the archaeological/ anthropological approach. Size and construction method of the boat finds are equally reasons for this as the main geographical distribution of wrecks. Since the main concentration of currently known finds is in located Scandinavia, pre-industrial clinker wrecks in Atlantic and Baltic waters are traditionally classified as belonging to the so-called Nordic or Scandinavian clinker tradition (McGrail, 1997a; Crumlin-Pedersen, 2004). Considering the prevailing research tradition and the comparably high number of known wrecks throughout the historic periods, this approach has proven to be successful and valid for the Scandinavian context. Difficulties arise when the attempt is made to apply these typological parameters to a wider geographical reach and other types of shipbuilding. In certain areas archaeological datasets are far less well defined while commonly used typological parameters are not appropriate for finds from other geographical contexts (Hocker, 2004b).

Although it is accepted that a variety of clinker traditions may have developed in Europe, the Nordic tradition is currently the only tangible example. Crumlin-Pedersen pointed out that the term Nordic should not be understood in a rigid ethnic sense as he saw medieval Slavic clinker shipbuilding as part of the same building tradition. However, by referring to isolated examples of clinker vessels on the Iberian peninsula he establishes an immediate connection between Iberian clinker techniques and the otherwise strictly Scandinavian and Baltic definition of the Nordic tradition (Crumlin-Pedersen, 2004). Due to current lack of similarly strong archaeological evidence outside Scandinavia and the Baltic, tracing all clinker ship finds in Atlantic Europe to "Nordic" roots is certainly possible. Conversely imposing the Scandinavian typological approach to a wide transnational setting bears the danger of creating predetermined outcomes and suppressing the potential identification of other building traditions of similar expression. The example of a number of medieval clinker built wrecks of English origin with wooden nail fasteners highlights the difficulties in operating with such rigid typological frameworks. Both Marsden and Fenwick suggest that the use of wooden nail fasteners among other structural features that are evident in the London material and the Graveney Boat may be an indigenous feature, thus reflecting a regional boat building tradition (Fenwick, 1978; Marsden, 1994). Nevertheless wrecks displaying this feature are generally seen as a variant of the wider Nordic building tradition (Marsden, 1994; McGrail, 2004). Greenhill identified and addressed the difficulties of utilizing the typological template of Nordic clinker boat and ship building for clinker built ships of similar date but non-Scandinavian context early on (Greenhill, 1976). However, very little has happened since to amend and open classification schemes with a view to create more open and flexible typological frameworks.

Of less relevance regarding classification schemes for small clinker built watercraft are historical typological approaches. Due to the scarce historical evidence on actual existing types on the one hand and limited sources providing information on indicative structural elements on the other, the vast majority of scholars to date have refrained from applying historical typology approaches to small clinker built watercraft (see chapter 3.7.2). Although finds of small watercraft in southern Scandinavia are frequently interpreted as skudes, a watercraft well known throughout the medieval and early modern periods, this is done independently from the typological assessment of the ship finds (Gøthche & Høst-Madsen, 2001; Lemée, 2001; Bill, 1997a). As Bill points out the meaning of skude changes during the Middle Ages and is generally seen as common small clinker built work and fishing boat operating in coastal waters of late medieval and early modern Denmark (Bill, 1997a). Mortensen goes even further by saying that the Nordic ship continued to evolve with the development of the skude as the dominating vessel type of Nordic building tradition during the Renaissance. However, in his description of the skude, he states that although predominantly clinker built carvel built examples are equally known. Furthermore it is believed to have been single masted without decks, while later examples can have two or three masts with decks (Mortensøn, 1995).

This example clearly shows not only the diversity in structural attributes describing a single, well-documented historical ship type but conversely the difficulties in attempting to match structural features of wreck finds with a particular type. Further difficulties with the identification of ship types become apparent within historical documents such as inventories and lists where certain ship types, including krejers and jakts (Adams, 2003; Glete, 1977), are seemingly interchangeable and thus of limited typological value for archaeological classification purposes. The same can be attested for the above-described *dog boats* where the main shared characteristic appears to be usage rather than size, rig and possibly construction. Similarly Thier's recent linguistic research on the example of the term "cog" shows how its origins and later spread across Europe display a wide diversity in meaning thus limiting the suitability of the historic term "cog" as a fixed type of consistent shape, construction and rig (Thier, forthcoming). McKee encountered a similar situation in a more contemporary ethnological context. He notes how the wealth of names for boats and boat types along the English coastline for traditional working boats stands in the way clear typological categorization and identification for the vast variety of vernacular boats (McKee, 1983).

Notwithstanding the problematic nature of using historical ship types as typological parameters for the classification of archaeological ship finds, seeking to match ship finds with historical ship types is certainly an important component of archaeological research and should by no means be dismissed as an investigative component.

6.3.3 Historical classification

The overall role and general relevance of historical classification using historical ship types to organize small watercraft of late medieval and Renaissance date have been outlined in the previous chapter and can be summarized in two key points. Firstly, small clinker vessels such as the ones under investigation in this project are traditionally integrated into archaeological classification approaches and seen as representatives of the wider Nordic or Scandinavian ship building tradition. The second point relates to the often ambiguous and scarce representation of small watercraft in historical sources. With the exception of the Dutch context, type descriptions often barely go beyond stating rough size or rig. The same can be said for pictorial evidence where boat types are not only rather underrepresented but also rarely securely identifiable (see chapter 3.7). As alluded to above the situation for Holland is significantly better where not only Marine Art reached unparalleled wealth and detail during the Dutch Golden Age but also large amounts of historical manuscripts and sources are preserved. One of the ship types that can be clearly distinguished and structurally defined is the previously mentioned and discussed watership (see chapter 4.5.2).

Solid archaeological evidence in shape of several well-preserved ship finds allowed to securely match wrecks with the historically known Northern Dutch type of the watership.

Among the characteristic structural elements defining *waterships* are e.g. shape, design, rig and construction. A detailed analysis of the development of the watership was undertaken by Verweij et. al. based on archaeologically recorded ship finds dating to the 16th and 17th century. The results show a transition in construction from predominantly clinker built to almost exclusively carvel built by the late 17th century. The primary diagnostic feature denominating a *watership* is thus not the hull construction. Instead, shape, heavy built and presence of a fishwell seem to be more relevant indicators. The watership case study shows how archaeological and historical evidence can help to develop a better understanding on development of a particular ship type over time. Interestingly in the archaeological interpretation of clinker as well as carvel built waterships archaeological classification tools are used (Verweij et al., 2012). The methodological approach and results are discussed in more detail in the following chapter.

6.3.4 Archaeological classification

The background to archaeological classification and its role for creating typologies for the dataset investigated as part of this project has already been outlined in chapter 6.3.2. The aim of this chapter is explore how archaeological classification to date has been applied to organise and interpret medieval and Renaissance clinker boats. It is sought to identify strengths and weaknesses for the application as a typological approach with particular focus on current classification methods.

Continuing with the *watership* case study discussed above, an important aspect in the classification approach taken by Verweij et al. is the avoidance to define the historical type *watership* as an archaeological type. While similarities and variations in combinations of structural features are used to analyse the development of the watership as a historical type through time, the conceptual basis of the ships is interpreted through archaeological parameters. The structural elements are compared against the currently prevailing typological framework of Nordic clinker and the North-western European tradition, better known as bottom-based building tradition or traditionally as “cog” tradition (Verweij et al., 2012; Hocker, 2004a). Verweij et al. conclude that some clinker built *waterships*, such as ZN44 are hybrids between the two building traditions, displaying features commonly seen as characteristic for both traditions. In their conclusion they interpret the seemingly Nordic features as part of a local building tradition also shared by other clinker built wrecks found in Holland (Verweij et al., 2012; Overmeer, 2008).

As described in chapter 4.3.3 a similar conclusion was drawn for the Urbieta wreck in Spain.

In particular the method of securing clench nails by turning them over roves is seen as a potential characteristic feature of a regional variation of the Nordic clinker tradition (Rieth, 2006). In contrast to the Slavic or Anglo-Saxon traditions, which are used as comparable variations, the Urbieta wreck currently remains an isolated find without comparable wrecks of Basque or south-western Atlantic context. Notwithstanding the possibility that an "Ibero-Atlantic clinker tradition" existed and developed, a significantly higher quantity of archaeological material is required to securely identify characteristic features defining such a building tradition. Conversely the material compiled in this study shows that the method of turning nail tips over roves can be observed more or less across the entire geographical reach from Spain to Ireland, form England to as far as Norway. Of course it could be argued that the method spread as part of Basque influence in Northern shipbuilding. Alternatively it is equally possible that it is part of a wider development of rationalised and increasingly uniform boatbuilding practices commencing in the later medieval period as suggested for the Scandinavian and English material (Bill & Gøthche, 2006; Bill, 2009b; Marsden, 1996). A more detailed discussion of this aspect follows below.

The observed adherence to *codo de ribera* measurements on the Urbieta wreck, however, is so far unique for medieval and early modern clinker built watercraft. Considering that this unit of measurement is a characteristic feature for late medieval and early modern Basque shipbuilding, its occurrence in a small clinker built watercraft is all the more remarkable (Rieth, 2006). The appearance of the *codo de ribera* in the Urbieta wreck is thus is of significant relevance for the concept behind its construction. It stands in contrast to northern European clinker boat building, which was largely guided by experience and rule of thumb with limited usage of measuring tools. The adherence to a measurement unit known from carvel shipbuilding implies a very different and much more predetermined conceptual approach. A similar conclusion was reached for the occurrence of a symmetrical strake pattern and the potential adherence to the Lübeck inch/foot system in the Bredfjed ship (Bill, 1997a; Lemée, 2000a). Both features thus bear future potential to increase our understanding of the relationship and interaction between carvel ship and clinker boat building in the late medieval and early modern period (also see chapter 7.2).

The remainder of the ship finds from Germany to Scandinavia, Britain and Ireland have to date been classified according to the above described templates, i.e. either as Nordic or as variations of the Nordic clinker tradition. The recently discovered Barcode wrecks provide new and unprecedented opportunities to deepen our understanding of small-scale shipbuilding in southern Norway. The reported co-occurrence of a diversity of plank nail fasteners for example will shed new light on potential origin and reasons for the appearance of seemingly non-Nordic features.

6.4.5 A way forward

The extremely imbalanced nature of archaeological remains of clinker ships and boats on Europe's western seaboard resulted in the establishment of classification schemes reflecting a sharp north-south division in the archaeological record. Initially devised to organise and understand clinker ships from Scandinavian contexts, the criteria designating the Nordic clinker tradition are now applied to the archaeological interpretation of all clinker built ships and boats from the entire European Atlantic context. However, the framework of the typological criteria of the Nordic tradition was originally not devised as a transnational classification tool. It therefore does not allow for the recognition of other potential indigenous clinker traditions, as suggested for England, Holland and south-western Europe. Due to the overwhelming archaeological evidence from Scandinavia, clinker boat and shipbuilding from other geographical areas appears subordinated and classified as somehow deriving from the Nordic tradition.

The uncritical use of such firmly established models for interpretation further bears the danger of subtly and unconsciously influencing archaeological fieldwork, post-processing and analysis. This in turn can lead to preconditioned outcomes, which may be neither satisfactory nor appropriate.

Returning to the requirements set by Montelius for establishing meaningful classification schemes of transnational relevance it becomes clear that the essential criteria of comprehensive understanding and knowledge of the material in question are far from fulfilled. Consequently any intermediate grouping or classification of data should be seen as tentative and allow for room for alternative interpretations. This includes the acknowledgment of potential co-occurrence of independent, yet similar building traditions.

Equally, co-occurrence of specific feature combinations may not necessarily be indicative of certain regional building traditions. Similarities in operational environments and use of vessels can lead to similar structural solutions independent of prevailing building traditions. Again, the development of the watership serves as a good example. While earlier examples have plank keels, as typical for boats and ships belonging to the North-west European or bottom-based building traditions, later examples are fitted with beam keels. Rather than seeking a late adoption of a Nordic keel type, Verweij et al. explain the introduction of beam keels with the increased usage of waterships for towing tall ships. Heavier built and better anti-leeway properties made the beam keel superior to the plank keel, which is more advantageous for operating in the shallow waters of the Zuiderzee (Verweij et al., 2012).

Overall the goal of achieving of comprehensive and unbiased understanding and knowledge requires exhaustive data compilation. The immense complexity of boats and ships where a wide range of different attribute combinations is possible deserves an open-minded and comprehensive data collection process prior to typological categorisation. It is for this complexity that each wreck deserves to be recorded and analysed in its own right before attempting to apply wider classification models (Maarleveld, 1995b).

6.4 Tradition – Innovation - Adaptation?

6.4.1 Introduction

The above chapters highlight the difficulties in undertaking a comparative analysis based on geographically drastically imbalanced archaeological evidence in combination with resulting insufficiencies and shortcomings in archaeological classification and interpretation. Attempting to review late medieval to Renaissance clinker built coastal watercraft on a wide transnational scale with an unbiased approach is extremely difficult as any secondary analysis is largely dependent on the information provided by primary archaeological documentation and dissemination.

It could further be shown that understanding of the factors influencing past coastal boatbuilding and seafaring was heavily dominated by either seeking to identify regional boat and shipbuilding traditions or by matching ship finds with historically known types. However, recently an increasing awareness can be observed that neither approach can provide a holistic and comprehensive understanding. Factors such as socio-economic context and operational environments are or should be recognised to be of equal importance on development of shipbuilding methods. In light of the results of this project several of the characteristic structural features shared by many of the boats in the dataset appear to be related to socio-economic pressures on contemporary boat builders and owners.

6.4.2 Socio-economic pressure as catalyst for change and innovation

In absence of more definitive and spatially more evenly distributed evidence, the current situation appears to reflect a trend towards maximising economic efficiency in the construction of small scale watercraft during the later Middle Ages and Renaissance. The development seems chronologically and spatially not uniform as socio-economic frameworks varied between the different geographical regions of the study area. This certainly appears to be the case of wood as building material. While a general trend towards lesser quality timber is apparent the introduction of sawn planking in southern Scandinavia certainly seems as a result of economic pressure rather than conceptual changes. This is indicated by a number of wrecks, such as the Dokøen 3 wreck where locally sourced cheaper sawn planks were supplemented with higher quality imported planks.

Increasing shortages in locally available building supplies confronted boat builders with three main options, depending on the owner's demands and purpose of the vessel. Firstly the entire vessel could be built using locally sourced sawn planks of lesser quality but at potentially cheaper cost. This appears to have been e.g. the case for the majority of the Barcode boats. Alternatively higher quality imported planks could be used to achieve higher building quality in combination with locally sourced cheaper material as observed e.g. in Dokøen 3. Lastly boat builders either had access to or consciously decided to use radially split for the entire vessel. This could be imported as well as locally sourced. The Drogheda boat shows how radially split oak of local origin was used, albeit not of premium quality. Short planks, frequently with sapwood edges and other characteristic of lower quality oak found use for the construction. Overall the continuing use of radially split planks in clinker boat building into the mid to late 16th century bears witness to a desire or at least preference by boat builders to utilise the well-known radially split planks instead of sawn planks with inferior properties for boat building.

The Drogheda boat is an excellent example of a boat built very much in medieval “fashion” in the wider conceptual context but equally exhibits evidence of a decline in overall building quality and attention to detail. Wood quality for planks as well as frames can be described as far inferior compared to earlier medieval clinker built boat and ships. However, it is the low quality of the frames not only in choice of compass timbers but also in technical finish that stands out. Many frames are crooked, fast grown compass timbers, often barely fitting against the underlying hull and frequently showing sapwood or even bark. Furthermore little effort was made to convert the parent logs to parallel sided frames, frequently even sparing to cut joggles underlying hull planks. The Drogheda boat is further the only wreck in the assemblage where side timbers are not scarfed over floor timbers. Considering the overall poor quality of framing it appears likely that the decision to refrain from using scarf joints between floor and side timbers was a deliberate one to save time and labour.

Overall the picture emerging from the scarce available dataset points to a diverging development of Renaissance boat and shipbuilding into two main strands of almost opposing trends. Both share socio-economic pressures as drivers for change but the physical manifestation is quite different. Clinker boats, such as the above mentioned Drogheda boat show how medieval building methods diluted more and more in response to the pressures contemporary boat builder were confronted with. However, the pressures did not result in the implementation of new conceptual or technological elements. Instead the previously known methods and materials were maintained albeit at significantly lesser quality in material and technical attention to detail.

The second development sees the introduction of new materials, technologies and conceptual approaches in Renaissance boat building. New materials include the frequently referred to introduction of sawn planking while new technologies involves the introduction of advanced joinery, such as mortise-and-tenon joints for stem-sternpost joints and more complex scarf joints. Lastly in very few instances a change of much more depth and importance was observed. It involves a conceptual change in clinker boat building away from experience based more or less free hand boat building to a more predetermined approach as evident e.g. in the appearance of symmetrical strake arrangements. Although the Bredfjed ship remains more or less the only known example exhibiting this feature from northern European context, the more than likely local origin of this vessel clearly shows at least a willingness to experiment with new building methods (Bill, 1997a; Bill & Gøthche, 2006).

The occurrence of the *codo de ribera* measurement in the Urbieta wreck seems to indicate a similar development for south-west European clinker ships, although such interpretation has to remain much more tentative due to the lack of medieval and early modern clinker ships and boats from this region. As mentioned above a likely influence of carvel ship building methods in northern European clinker boat has been put forward for the appearance of the symmetrical strake alignment and potential usage of contemporary regional measurement systems in the Bredfjed ship (Bill, 1997a; Lemée, 2000a; Bill & Gøthche, 2006). It is tempting to assume a similar scenario for the Urbieta wreck. Further work and archaeological evidence will be required to investigate the relationship of clinker and carvel shipbuilding during the early Renaissance. Ship finds such as the Gresham and Hafnia Vejle wrecks where clinker and carvel features occur in seemingly unusual combinations, highlight that the 15th and 16th century were a time of experimentation between building traditions (Auer & Firth, 2007; Lemée, 2006).

Reluctance or willingness to accept innovations, including new materials and concepts certainly gives insight into organisation and nature of Renaissance vernacular boat building. It seems to reflect a development away from “peasant” boat builders having obtained knowledge and skill from previous generations to specialised craftsmen learning the trade through apprenticeships (Bill, 1997b). Such a tendency towards higher specialisation and professionalism is certainly evident on a wider social level in Europe during the Renaissance see chapter 5.3.3 (Unger, 1980). Speed and degree of such specialisation and professionalism can be assumed to have varied greatly between countries and regions. For example a boat builder in the north-west of Ireland may have come in contact with new methods at a later stage compared to boat builders drafted to build men-of-war for the Danish King or northern Dutch and Basque boat builders operating in a vibrant socio-economic environment.

7. Conclusions

7.1 The significance of the Drogheda boat

The Drogheda boat as the point of departure of this study has shown how a boat find from a relatively "remote" geographical location is not only an important discovery in its own right but can also stimulate re-assessing current interpretational models and research approaches. Considering the geographically and archaeologically "isolated" nature of the Drogheda boat, the excavation and analysis yielded significant results. Viewing the wreck detached from the overriding interpretational approach of associating it with particular building traditions or historical vessel types, provides vital insights into the role and usage of the small coaster in its contemporary socio-economic context.

Analysis of the structural remains of the wreck itself gives insights into the nature of Irish small-scale shipbuilding as well as the local adaptation to sailing environment and use. The latter was evident in shape of the remains of the boat's cargo at the time of its demise, comprised of processed herring packed in wooden casks. Their origin from south-western France and size classifying the casks as Barricas suggest the assumption that they originally contained wine imported from France. Although at least in secondary use after being decommissioned for the wine trade, the casks appear to have been bought or obtained in bulk for the transport of cured herring. Herring was one of the main trade goods leaving Drogheda throughout the medieval and early modern period, both for international export and regional trade.

From a construction point of view the Drogheda boat seems to match well with current observations and interpretations regarding the development of clinker boat building traditions in north-western Europe. General quality and use of materials indicates that economic viability was prioritised over aesthetic aspects and desire for quality and durability. This is most evident in the quality of wood used for the frame timbers where the chosen parent logs were mostly fast grown branches, barely of sufficient girth for the desired cross section. Similarly the moulded shape often barely fitted against the outer hull, often rendering joggling of the outboard surfaces unnecessary. Finally the so far seemingly unprecedented occurrence of side timbers placed directly next to rather than scarved over floor timbers, points to reduced labour and carpentry to a minimum.

For other structural elements of the vessel, however, the construction method and choice of raw material is very much in line with medieval clinker building methods, whereby radially split planks and naturally curved compass timbers were used for hull planking and stem and stern hooks. Overall the Drogheda boat, judging by current knowledge, can be seen as a regional expression of wider northern European developments in boat building during the outgoing Middle Ages. These are momentarily defined by a general trend of declining build quality and increased uniformity in construction (Bill & Gøthche, 2006; Bill, 2009b). Notwithstanding these observations, analysis and reconstruction showed that the Drogheda boat was well adapted to its use in the coastal environments of the Irish Sea at the north-eastern Irish coast. Further to the wider archaeological and historical context, the case study of the Drogheda boat shows that the individual and regional context of a vessel made to operate in a specific range can provide new insights into the history of national and regional boat building, seafaring and trade.

7.2 Renaissance clinker boats on the Atlantic seaboard – a comparison

The above-summarised results of the Drogheda boat analysis and research have led to the formulation of a number of research questions. In recognition of the apparent primary use as coastal vessel, the aim the study was to formulate the research questions towards a comparative analysis of finds of small clinker built coastal watercraft of the Renaissance on the European Atlantic seaboard. The results and conclusions reached in his study are summarised in the following.

The later Middle Ages and Renaissance as a time of economic expansion saw a drastic rise in seafaring and shipping, of which small coastal watercraft amounted to a significant proportion. European Atlantic coastal waters were therefore teeming with a broad variety of open decked workboats of diverse construction, rig and design. The compilation of currently known discoveries of clinker built coasters has yielded 20 sites with at least 41 represented individual vessels, including the Drogheda boat as main case study. (see Appendix I). Compared to the original number of boats operating in the two centuries between 1400 and 1600, this number is clearly minute. Viewing the distribution of the known sites a drastic north-south divide becomes clearly evident whereby the vast majority of finds is concentrated in the northern periphery of the study area and the southern areas next to void of finds.

Despite the above-described limitations in the archaeological record, the compiled assemblage of boat finds illustrates the variety of small water-craft during the Renaissance. Returning to the classification by size as defined by McGrail, the boat finds included in this study show a more or less equal distribution between the two categories Boat (7m-12m) and *Large boat/ Small ship* (12m-24m). Of the 41 presented finds thirteen are between 7m and 12m in length while another eighteen are between 12m and 20m in length (Chart 7-1). Of note is the observation that

Figure 7-1: Map showing the distribution of doubled ended boats and vessels with straigth stern and curved bow (Schweitzer 2013)

a total of five boats are below 10m, of which four are reconstructed as double-ended. Not included in this are the Blackfriars 3 ship due to its specific nature as river barge and the Morgan's Lane boat where the evidence is deemed inconclusive. Since only one further vessel of double-ended shape is represented, i.e. the 11m long Urbieta wreck, it appears to be a feature predominantly represented in smaller boats. The geographical spread of double ended craft shows a relatively even distribution across the study area (Fig. 7-1), thus highlighting the connection between size and double ended shape. Chronologically the double-ended vessels appear to be relatively closely spaced within the 15th to early 16th century. However, it has to be kept in mind that the double-ended shape reconstruction for Kingsteignton should be equally treated with care as the C14 based dating of the Urbieta wreck and the Portør boat.

For the wrecks in the 12m to 20m margin, six are below 16m in length while twelve are up to 20m long. Although overall length is in several cases tentative and based on rough estimations, particularly for the Barcode wrecks, this appears to suggest a certain preference to larger boats for the chosen timeframe. Chronologically the larger boats (12m – 20m) are well spread within the two-century delimitation with no particular observations regarding potential increase or decrease in vessel size. Lastly it is of importance to note that no information on original overall length is available for ten of the wrecks in the dataset.

As the comparative analysis has shown the extraction of widely comparable data proves to be difficult considering the imbalanced and inconsistent nature of the comparative dataset. Nevertheless a number of conclusions have transpired from the study. Providing good levels of preservation and commitment to comprehensive analysis, small coastal watercraft contain a wealth of information on boat building practices and their development over time and space. The complexities in structural detail that emerge despite seemingly increasingly standardised construction methods and decline in build quality, highlight the diversity of small watercraft as an archaeological resource. A good example for this is the diversity in plank nail fasteners, ranging from wooden to iron and various combinations of different techniques (see chapter 6.2.4; Fig. 6-6).

Although at first glance confusing and arbitrary, further research and future discoveries may be able to structure and interpret this phenomenon.

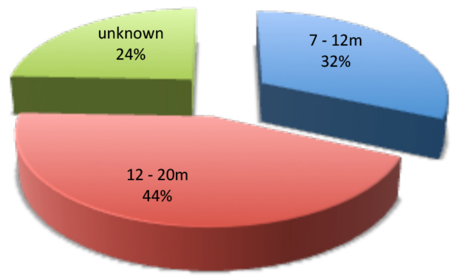

Chart 7-1: Percentage composition of comparative wrecks by size (Schweitzer 2013)

As with other areas of archaeological interpretation due care has to be taken in processing the presented information. The distribution map of nail fastening types e.g. shows the Drogheda boat as a representative for fastening using iron nails bent over roves. It is vital to keep in mind that this is based on a single poorly preserved nail tip. As other boat finds in the assembled data show, a combination of e.g. bent and riveted clench nails cannot be ruled out. Maintaining the balance between presenting tentative results and avoiding premature definitive conclusions is of crucial importance in prudent archaeological methodology. In this regard, very little can be said regarding the distribution and diversity of plank fastening methods.

Currently it would appear that the utilisation of wooden nails, also in conjunction with iron nail fasteners, is a Scandinavian feature. 17th to 19th century boat and ship finds certainly seem to bolster such a line of argumentation. This includes e.g. the Norwegian Batteristranda 1 wreck, a c. 10m long clinker built boat dating to c. 1700, and made using oak planks of southern Norwegian origin (Nymoen & Melsom, 2010). Conversely the use of double bent nails, a feature commonly associated with bottom-based building traditions from the Low Countries is unsurprisingly evident in the ZN42 wreck, but also observed in Vaterland 1 wreck. Explaining the Norwegian occurrence solely through knowledge transfer and technological diffusion originating from bottom-based shipbuilding would rule out other possible explanations for the presence of double bent nails in Scandinavian context, such as simplification of work procedures or an otherwise independent development of this feature.

Recent advances in dendrochronological analysis provide an additional angle and avenue of research into small coastal watercraft due to their frequently local or regional nature. For most wrecks where dendrochronological analysis is available the use of locally sourced timber for the construction is suggested (Fig. 7-2). This can be observed for vessels made of radially split oak, such as the Drogheda boat, the Amager Strandpark wreck, the Blackfriars 3 ship, the Kingsteignton boat and the Vedby Hage wreck. It is also evident for boats made using sawn planks represented by the Bredfjed ship and the Vaterland 1 wreck. It has to be kept in mind that above conclusions are not always based on comprehensive dendrochronological analysis and may change under closer inspection. Nevertheless the example of the Drogheda boat shows that planks for this coastally operating vessel were sourced locally both for construction and repair (Daly, 2009b).

Mixed sources of raw materials are evident for other boat finds in the assembled data set. These include the Dokøen 3 and 4 wrecks and the Beluga ship. Recent research advances in response to the inherent difficulties in matching source of building material with place of construction of ships and boats have shown that certain conclusions can be drawn dependent on type of construction element or conversion method used in case of

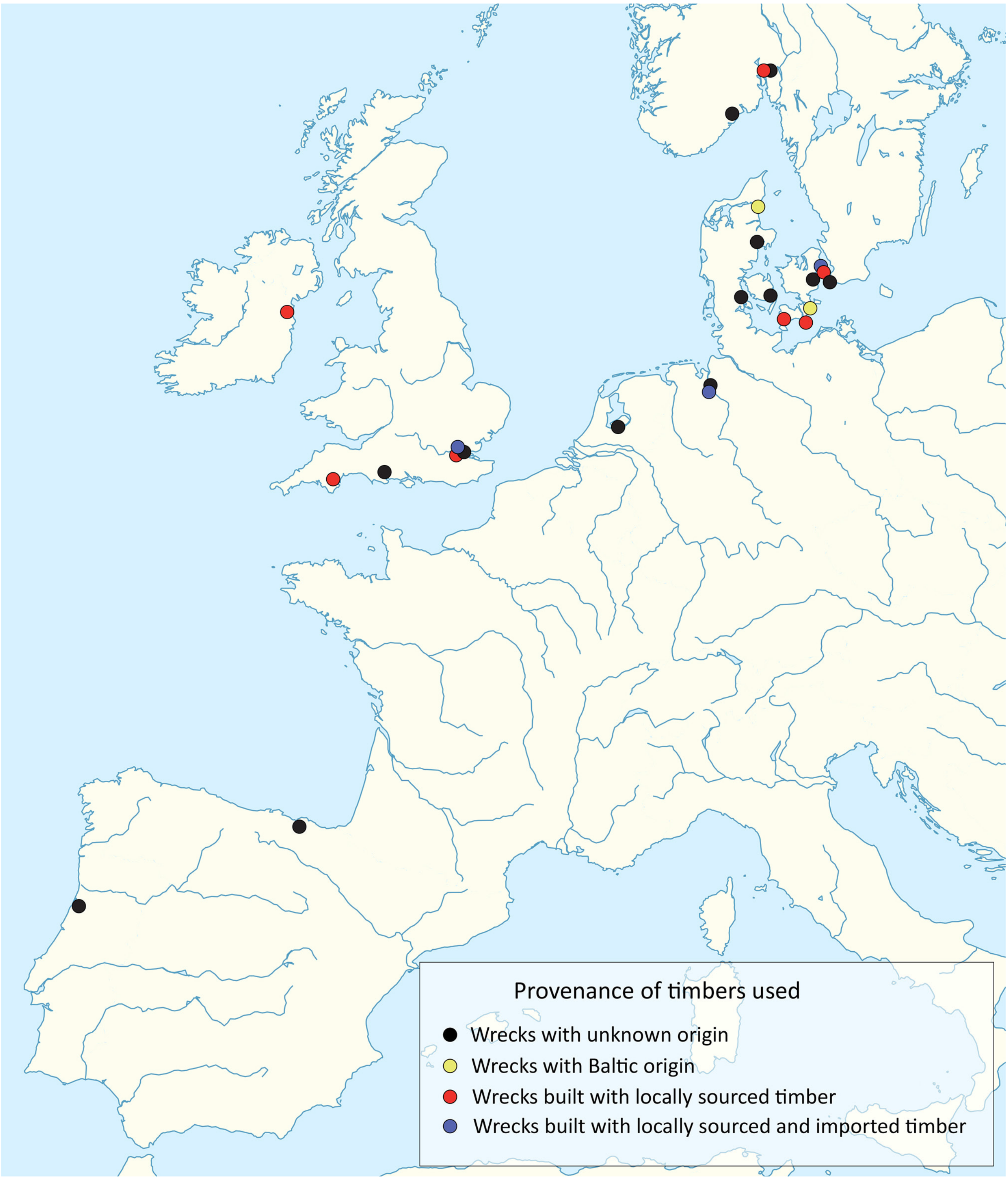

Figure 7-2: Map showing the origin of timbers used for construction and repair (Schweitzer 2013)

multiple timber sources. Therefore main longitudinal elements, such as keels, stems and stern and framing timbers made of naturally grown compass timbers are more likely to originate close to the place of construction than hull planks.

For vessels displaying the use of planks originating from two or more source it is believed that planks of inferior quality may belong to local timber supplies. The latter applies to wrecks such as Dokøen 3 and 4 where the higher quality Baltic planks are used alongside "inferior" quality sawn planks of southern Scandinavian/ northern German origin (Daly, 2007). Against this background the co-occurrence of radially split planks of Baltic and northern German origin in the Beluga ship is remarkable. The question of origin for the Beluga ship is therefore not straightforward, although a local context either through original construction or repair is certainly evident. The only two wrecks within the comparative study with potential Baltic origin are the Grønsund and Vejdyb. Both wrecks are also at the upper end of the chosen size scale with lengths of c. 17m and 15m - 24m respectively and may therefore belong to a different category of vessels, which has been recently discussed by Auer and Maarleveld as part of the research for the Skjernøysund 3 wreck excavation (Auer & Maarleveld, 2013).

Overall the aspect of timber provenance illustrates the regional character of small coastal watercraft. Nevertheless regional context and place of origin cannot be taken as a prerequisite. Particularly the larger vessels in the study show that these are likely to have operated over larger distances and may thus have come from further afield.

Further to the above-mentioned decline in build quality, the period is marked by increased professionalization in boat building methods. Particularly the second half of the 16th century sees the introduction of advanced carpentry methods such as mortise-and-tenon joints for sternpost assemblies and advanced joint solutions for main joints represented by hook and stop scarfs (see chapter 6.2.3). Yet, this observation is currently largely based on the numerous Scandinavian boat finds as none of the scarcely represented wrecks of later date from other geographic regions yield sufficient information to address this aspect. The occurrence of sawn planks in the 15th century Urbieta wreck marks the exception to this rule. Should the date for the Urbieta wreck be relatively correct, the presence of sawn planks would be quite early compared to the northern European finds where the mid-16th century dated Knudsgrund wreck is currently seen as the earliest clinker vessel built using sawn planks (Bill, 1997a). By the late 16th century the use of sawn planks in clinker building appears to be widespread as the exclusive use of sawn planks for the Barcode wrecks in Oslo shows.

A second form of increased professionalization is evident on a more conceptual level. Rather than incorporating new craftsmanship skills into existing ways of building clinker boats and ships, some wrecks show a more predetermined conceptual approach for the construction of the vessels. Namely the occurrence of symmetrical strake patterns and the adherence to historical measurement systems are of note in this regard. Building a clinker vessel with identical plank lengths and scarf positions on port and starboard side requires pre-designing shape and building sequence much in contrast to the traditional clinker building method. For the latter shape and placement of strakes are largely guided by the construction process and the experience of the boat builder (see chapter 3.4). The most prominent example for the implementation of symmetrical strake patterns is the Bredfjed ship. Current state of research suggests that the use of symmetrical strake patterns originates in the Netherlands and is e.g. also evident for the included ZN42 wreck. Thus a potential influence of Dutch ship building methods in the Bredfjed Ship as put forward by Bill and Gøthche, currently appears likely (Bill & Gøthche, 2006). To date the Bredfjed ship remains the only wreck where symmetrical strake patterns in clinker building have been observed outside a Dutch context. For many wrecks in the study detailed recording of the hull planking was or could not be carried out. The overall impact of Dutch influence in southern Scandinavian clinker boat and shipbuilding can therefore currently not be estimated but should form an essential part of any future research.

The second aspect relating to changing conceptual approaches relates, as mentioned above, to the adherence to historically known measurement systems. In contrast to the symmetrical strake patterns, the usage of measurement systems may not be fully voluntarily as certain custom regulations required boats and ships to be built according to the relevant measurement systems. This is certainly the case for the *codo de ribera*, the standard measurement system used for boats and ships as well as forestry and shipping trades along the Basque coast (Loewen, 2007a). Adherence to the *codo de ribera* in the Urbieta wreck is therefore not entirely surprising. It rather shows that boat builders were capable of merging traditional conceptual methods with the requirements of adhering to a particular metrology.

Conversely it cannot be ruled out that the utilisation of the codo de ribera was an intrinsic part of Basque clinker boat building tradition. As the nature and development of clinker boat building traditions in the Ibero-Atlantic sphere remains enigmatic it will currently have to be left unanswered. Nonetheless, usage of regional measurement units has also been identified for the Bredfjed ship where measurements appear to be in compliance with the contemporary Lübeck inch/foot system (Lemée, 2000a). Again, the motivation behind using the measurement units remains unknown. Overall the aspect of compliance with regional metrologies based on varying units in late medieval and Renaissance clinker boat and shipbuilding appears to be present over a wider geographic reach. Going beyond the scope of this study, this aspect nonetheless deserves attention and further research.

The aspect of design and construction as an indicator towards adaptation and usage within specific operational waters is not easily addressed. Although several wrecks within the compiled dataset have been subjected to intensive analysis and research towards reconstruction of hull shape, the vast majority of boat finds provides limited insights into this complex aspect. The river barges Blackfriars 3 and 4 from London and the watership ZN42 wreck from the Zuiderzee are probably the most prominent examples of vessels where design and construction are tailored towards a relatively narrow operational range and use. As mentioned earlier the particular sailing characteristics of waterships led to further fields of usage such as towing of large ships and cargo transport over longer distances despite originally being designed as a fishing vessel (Verweij et al., 2012). However, the usage of keel planks reflect their main and original operational environment in the comparatively shallow Zuiderzee while the reinforced stem assemblies are a testimony to frequent beaching along the wide beaches of the Ijsselmeer.

Although less well defined beaching is also assumed for a number of wrecks from Baltic context, including the Bredfjed ship and the Amager Strandpark wreck. This interpretation is based on the presence of holes in stem hooks that are believed to be dragging holes for attaching ropes for hauling the vessels further ashore. Wear marks on the underside of keels are seen as further evidence for beaching (Bill, 1998; Ravn, 2011). Overall most wrecks in the studied assemblage have beam keels both for Atlantic and Baltic context. This is also the case for the Drogheda boat where the absence of dragging holes and wear marks on the underside of the keel speak against intended and repeated beaching. Indeed, the high tidal ranges of the Irish Sea in the estuaries of the north-eastern coast of Ireland provide a natural way of getting boats on the dry for the duration of low tides. The sharp entry and swiftly widening lines of the Drogheda boat further indicate that it was well suited to sail in the challenging operational environment of the local coast where strong currents and frequent rough conditions require good anti-leeway properties and adapted design (see chapter 3.5).

In summary the current archaeological evidence indicates apparently contradicting developments. On the one hand the introduction of advanced carpentry solutions and novel conceptual approaches bolsters the historically suggested increase in specialisation of work force and technology. Yet the general decline in construction quality leading to a more uniform appearance in structural detail and design (Bill, 2009a) appears to stand in contrast to the rise in specialised vessel types during the Renaissance as e.g. advocated by Unger (Unger, 1998). While the restrictive nature of the assessed dataset certainly cannot rule out such developments, the versatility in range of use is striking. Although specialisation in vessel types as evident in the waterships can be deduced for Dutch boat and shipbuilding, further research and archaeological data is required before similar conclusions can be drawn on a wider European scale.

From a methodological perspective the review and assessment of archaeological classification and typology as a tool to categorise and interpret the data has yielded a number of results. As the aspect of classification and typology is covered in detail in chapter 6.3, the results are presented a summarised account of the results shall suffice for the concluding remarks. To date clinker boats covered within the geographic reach of this study have been collectively assessed and interpreted according to traditional classification approaches largely established based on north-west European boat and ship finds. In absence of boat and ship finds as well as historically identifiable clinker boats and ships from western and south-western Europe this can be seen as a logical consequence.

This leaves the question to which degree classification and interpretation models from geographically separate contexts can be transferred and imposed on a wide transnational setting. Despite pronounced similarities in construction and appearance during the outgoing medieval period, the application of conventional classification methods based on almost exclusively northern European material remains problematic. Exemplary for the methodological shortcomings is the attribution of certain attributes or attribute clusters to building traditions or variations thereof.

Currently the typological frameworks do not allow for the potential co-occurrence of structural features from chronologically or spatially separate and independent contexts. Breaking the moulds of conventional classification approaches, however, is crucial to enable unbiased and objective data compilation with a view to create meaningful classification models. Construction features and design elements of boats and ships should therefore be assessed and analysed in their own right on an individual basis prior to typological interpretation. In this way construction and design can be indicators not only of building traditions but also as expression of individual response to practical and social requirements as well as socio-economic context.

Overall the results of this study show that clinker built boats for coastal use were first and foremost built to meet local or regional demands and requirements utilising local or regional materials, knowledge and workforce. In consequence strong regional variations in building traditions should be expected. While this certainly seems to be the case for most of the early to high medieval period, it currently appears that regional diversity in clinker building traditions continuously vanished during the later Middle Ages, being replaced by more or less transnationally uniform building methods.

Nevertheless certain geographic differences can be observed as comparison between the specialised *waterships* from the Ijsselmeer, represented by the ZN42 wreck, and Scandinavian examples show. Even though *waterships* were highly specialised watercraft in contrast to the most likely frequently multi-purpose workboats from north European contexts, the comparison highlights the persistence of differing structural solutions owed to variations in building traditions, socio-economic background, sailing environment and usage. As such variations may be minimal, they may remain undetected in the frequently fragmentary remains of boat and ships. However, their identification and interpretation remains a key aspect of future research and analysis.

7.3 Outlook

Where does the knowledge obtained from this study leave us for the future? A starting point can be to view small coastal watercraft against the background of the Renaissance as a time of technological progress and change. It seems reasonable to assume that clinker boat building during this period was caught between the desire to maintain established, trusted and proven ways to build boats and a combination of increased socio-economic pressures and the introduction of new building methods. Variations in regional socio-economic and political contexts must have resulted in a diverse pattern of speed and character to which building traditions changed and developed across the western European seaboard. Recognising this complexity of small-scale shipbuilding and seafaring allows us to see the great potential of such seemingly trivial watercraft as a mirror of the developments in seafaring communities in the transition from the Middle Ages to the early modern period.

From a research perspective much work remains to be done. Firstly the persisting north-south divide in the archaeological record has to be overcome for the establishment of a more solid basis for meaningful comparison and classification. Going hand in hand with this goes the scholarly recognition of the shortcomings in our dataset and an open-minded and unbiased approach towards the expansion of the dataset. For instance the currently on-going analysis of the Newport Medieval Ship provides an excellent starting point and opportunity in this regard. The recently suggested Basque origin for the ship based on dendrochronological analysis may help to gain insight into characteristics of medieval Basque clinker shipbuilding (T. Jones and N. Nayling, pers. comm.).

However, there is no need to wait for further boat finds to be discovered and postpone further research into small-scale watercraft in European Atlantic waters. Two aspects, which could not be covered as part of this study, come to mind immediately. The limitations of the choice of geographic reach have been highlighted in chapter 1. The wealth of known wrecks from the Baltic Sea and Zuiderzee provides an excellent foundation for comparative analysis between small coastal watercraft in the drastically different sailing environments. Attempting to identify adaptations to the heavily differing sailing environments through analysis of structural details and design should be of high priority in this regard. The expansion of the geographic reach further allows the integration of other phenomena in Renaissance boat and ship construction, such as carvel ships displaying characteristic features of clinker construction and converted clinker vessels. The above outlined amalgamation of carvel and clinker construction methods as evident e.g. in the Gresham ship and Hafnia Vejle wreck (Auer & Firth, 2007; Lemée, 2006) highlights how the 15th and 16th century was a period of transition and experimentation between changing predominant building methods in northern Europe (see chapter 6.4.2).

The same can be observed in the increasing number of clinker built vessels, converted to carvel watercraft during their lifespan. This phenomenon currently appears largely confined to the Baltic Sea and seem to appear from the 16th century onwards into the 19th century (Grundvad Nielsen, 2010). The reasoning behind adding a second carvel layer to clinker built vessels can be manifold and may have changed over time. Inability and lack of knowledge to build the underwater hull of boats and ships in carvel methods may certainly play a role (Hasslöf, 1972a; Auer et al., 2012).

However, economical and practical reasons have equally been brought forward as potential explanations for the conversion from clinker to carvel. Eriksson was able to show that in the 17th and 18th Swedish ship owners were stimulated to convert their vessels in order to receive tax reductions (Eriksson, 2010). Whether such a motivation can be assumed for the earliest converted examples of the 16th century remains unknown. Practical considerations for the conversion from clinker to carvel on the other hand could have been attempts to improve protection against ice or prevent damage to fishing nets when hauled in and dragged over the sharp joggled edges of a clinker hull (Eichler, 1994). Finally the aspect of repair and extending lifespan of vessels by applying a second skin should not be forgotten (Auer et al., 2012). As the example of converted clinker vessels shows, the reasons for introducing a new design element or changing an existing one can be manifold and highlight the complexities of the development of building traditions.

The overriding results from this study are in line with the commonly accepted knowledge that the Renaissance was a period of change on social, economic as well as political levels. Manifestation of such change in the archaeological record is therefore not surprising but is to be expected. In case of small clinker built coastal watercraft the expression of transforming building traditions has been identified in shape of decline in building quality in conjunction with an amalgamation of regional building expressions (see above).

However, the comparative analysis of this study in combination with the assessment and review of the current state of wider research has shown two main aspects of importance for future research into the field. Firstly the imbalanced and skewed nature of the dataset with a strong north-south divide bears the danger of imposing interpretational models from well represented and research regions on the entire dataset. This is of particular importance as clinker boat building traditions are not only believed to have originated from the wider “Nordic” tradition, but also appear to become more uniform during the later Middle Ages into the Renaissance. This feeds directly into the second aspect, which relates to the frequently regional character of coastal watercraft. Despite shared general developments in building methods and expression, it must be kept in mind that small boats for coastal use were made to suit particular environments dependent on regional infrastructure and socio-economic context. As has been pointed out the Renaissance saw the rise of naval fleets requiring the establishment of naval shipyards. Trained master shipwrights together with skilled craftsman and drafted local boat and shipbuilders not only built men-of-war, but also smaller craft as lifeboats or support vessels for various demands. The naval shipbuilding industry as agent for knowledge transfer and technological diffusion is thus an important factor for the the development of Renaissance small-scale shipbuilding.

Given the vast geographic reach and topographical diversity of the European Atlantic seaboard, local or regional contexts may have varied drastically, both spatially as well as chronologically.

The archaeology of small coastal clinker built vessels thus confronts us with the challenge to identify the nuances in differences in construction and design over time and space. As daunting as this may sound, it is exactly the mundane character of coastal watercraft that can provide us with insights into the nature, organisation and development of small-scale shipbuilding and shipping as well as its role in past societies. Rising to this challenge should mean keeping an open mind and recognising the immense potential of such seemingly trivial watercraft.

8. References

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Appendix I

Overview of the sites used for the comparative study

Shipwreck/ Features	Country	Find context	Date	Timber provenance	Wood species	Plank conversion	Est. Length	Est. Beam
Drogheda Boat	Ireland	River estuary	c. 1530	north-east Ireland	Oak	Radially split	10m	3.1m
Kingsteignton	Britain	River	after 1305	south-west England	Oak	Radially split	7m reconstructed	2.5m reconstructed
Poole boatyard	Britain	River estuary	late 14th/ early 15th century	unknown	Oak and elm	N/A	7.81m reconstructed	2.45m reconstructed
Blackfriars 3	Britain	River estuary	1380-1415	south-west England	Oak	Radially split	c. 14.6m	4.3m
Blackfriars 4	Britain	River estuary	15th century	N/A	Oak	Unknown	N/A	N/A
Morgan's Lane	Britain	Revetment	1577	N/A	Oak	Radially split	N/A	N/A
Ria de Aveiro G	Portugal	River estuary	16th century	N/A	N/A	N/A	N/A	N/A
Urbieta	Spain	River	15th century	N/A	Oak and beech (keel)	sawn	c. 11m	c. 3m
ZN 42	Netherlands	Zuiderzee	1527-1531	N/A	Oak	N/A	17.2m	5m
Teerhof, Bremen	Germany	River	after 1500	N/A	N/A	N/A	15m - 20m	N/A
Beluga ship	Germany	River	after 1447	Baltic and Weser area	Oak	Radially split	N/A	N/A
Amager Strandpark	Denmark	Foreshore	1560-1570	Southern Scandinavia	Oak	Radially split	c. 11.5m	c. 3m
Bredfjed ship	Denmark	Foreshore	1593-1600	Northern Germany (Schleswig-Holstein)	Oak	Sawn	13.4m	4.6m
Dokøen 2	Denmark	Harbour	1405	Southern Baltic	Oak	Radially split and sawn	min. 10m	N/A
Dokøen 3	Denmark	Harbour	1420-1425	Southern Baltic and Northern Jutland-western Sweden	Oak	Radially split and sawn	c. 13m	c. 3.8m
Dokøen 4	Denmark	Harbour	1425	Southern Baltic and north-west Germany	Oak	Radially split	N/A	N/A
Grønsund	Denmark	Near shore	after 1520	possibly Poland	Oak	Radially split	c. 17m	c. 5m
Knudsgrund	Denmark	Near shore	1537	N/A	Oak	Sawn	c. 10m	c. 4m
Køge	Denmark	Harbour	1470	N/A	Oak and Pine	Radially split	12m - 14m	4.5m
Lundeborg 1	Denmark	Near shore	Early 17th century	N/A	Oak and pine	N/A	N/A	N/A
Lundeborg 2	Denmark	Near shore	Early 17th century	N/A	Oak	N/A	15m - 20m	4m - 6m
Vedby Hage	Denmark	Offshore	1435/36	Eastern Denmark	Oak	Radially split and sawn (stringers)	15.5m	5.6m
Vejdyb	Denmark	Near shore	1475	Pommerania or Poland	Oak	Radially split	15m -24m	5m - 7m
Århus Å	Denmark	River estuary	after 1411	N/A	Oak	Kattegat	13m - 15m	5m
Skanör "Brick Wreck"	Sweden	Near shore	after 1540	N/A	Oak	Baltic	c. 20m	N/A

Keel type	Keel shape	Stem	Stern	General shape	Crossbeams	Decking	Usage
Beam	U-shaped, rabbeted	stem hook	stern hook	Stern rudder fitted over stratight post	unknown, thwarts recon-structed	unknown. recon-structed open	Cargo
Beam	“square”	stem hook	N/A	Assumed double-ended	N/A	unknown, recon-structed open	workboat
Beam	unfinished	stem hook	N/A	Assumed double-ended	N/A	N/A	workboat
Plank	T-shaped	stem hook	stern hook	Double ended	N/A	N/A	N/A
Plank	T-shaped	N/A	N/A	N/A	N/A	N/A	Cargo barge
N/A	N/A	N/A	gently curved	Assumed doublee-ended	30m	15.5m	17m
Beam	U-shaped	N/A	N/A	N/A	N/A	N/A	N/A
Beam	U-shaped, rabbeted	stem hook	stern hook	Double-ended	N/A	N/A	Cargo
Plank	U-shaped, rabbeted	stem hook	Sternpost fitted on top of keel	Stern rudder fitted over stratight post	Deckbeams	Fore-, aft- and fishwell deck	Fishing
Beam	T-shaped	N/A	Straight post indicated	Stern rudder fitted over straight post assumed	N/A	N/A	N/A
Beam	U-shaped, not rabbeted	Stem hook	N/A	N/A	N/A	N/A	N/A
Beam	T-shaped	stem hook	Straight post; mortise-and-tenon joined	Stern rudder fitted over straight post assumed	N/A	N/A	Cargo
Beam	u-shaped, rabbeted	Stem hook	Straight post; mortise-and-tenon joined	Stern rudder fitted over stratight post	N/A	N/A	Cargo/ ferry
Beam	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Beam	T-shaped fore, turning to U-shaped aft	Stem hook	Straight post; mortise-and-tenon joined	Stern rudder fitted over straight post	protruding crossbeams	N/A	Cargo
Beam	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Beam	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Beam	U-shaped, rabbeted	stem hook	Straight post; mortise-and-tenon joined	Stern rudder fitted over straight post	N/A	N/A	Cargp/ fishing
Beam	N/A	N/A	N/A	N/A	N/A	N/A	Cargo
Beam	N/A	N/A	N/A	N/A	N/A	N/A	Cargo
Beam	U-shaped, rabbeted	stem hook	Straight post; mortise-and-tenon joined	Stern rudder fitted over straight pos	N/A	partial decing as-sumed	Cargo
Beam	N/A	stem hook	potential stern hook	Stern rudder fitted over stratight post	protruding crossbeams	N/A	N/A
Beam	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Beam	T-shaped	N/A	N/A	N/A	N/A	N/A	N/A
Beam	U-shaped, rabbeted	N/A	N/A	N/A	N/A	N/A	N/A

Shipwreck/ Features	Country	Find context	Date	Timber provenance	Wood species	Plank conversion	Est. Length	Est. Beam
Barcode 1	Norway	Harbour	pre 1624	N/A	Oak	Sawn	“small”	N/A
Barcode 2	Norway	Harbour	pre 1624	N/A	Oak and pine	Sawn	c. 20m	N/A
Barcode 3	Norway	Harbour	pre 1624	N/A	Oak	Sawn	“small”	N/A
Barcode 4	Norway	Harbour	pre 1624	N/A	Oak and pine or spruce	Sawn	“small”	N/A
Barcode 5	Norway	Harbour	pre 1624	N/A	Oak and unknown softwood	Sawn	“large”	N/A
Barcode 6	Norway	Harbour	1595	N/A	Oak and pine	Sawn	< 8m	N/A
Barcode 7	Norway	Harbour	pre 1624	N/A	Oak	Sawn	“small”	N/A
Barcode 8	Norway	Harbour	pre 1624	N/A	Oak	sawn	“large”	N/A
Barcode 9	Norway	Harbour	pre 1624	N/A	Oak	Sawn	N/A	N/A
Barcode 10	Norway	Harbour	pre 1624	N/A	Oak	Sawn	“large”	N/A
Barcode 11	Norway	Harbour	pre 1624	N/A	Oak	Sawn	N/A	N/A
Barcode 12	Norway	Harbour	pre 1624	N/A	Oak	Sawn	N/A	N/A
Barcode 13	Norway	Harbour	pre 1624	N/A	Oak	Sawn	N/A	N/A
Barcode 14	Norway	Harbour	pre 1624	N/A	Oak	Sawn	“large”	N/A
Portør	Norway	Near Shore	16th century	N/A	Oak and pine	Sawn	< 10m	N/A
Vaterland 1	Norway	Harbour	1505	Southern Norway	Oak and pine	Radially split and sawn	c. 8m	c. 3m

Keel type	Keel shape	Stem	Stern	General shape	Crossbeams	Decking	Usage
Beam	T-shaped	Stem hook	Straight post; mortise-and-tenon joined	Stern rudder fitted over stratight post	N/A	N/A	N/A
Beam	U-shaped, rabbeted	Stem hook	N/A	N/A	N/A	probable deck beams	N/A
Beam	T-shaped	Stem hook	N/Al	N/A	N/A	reconstructed undecked	N/A
Beam	T-shaped	Stem hookf	N/A	N/A	N/A	reconstructed undecked	N/A
Beam	U-shaped, rabbeted	Stem hook	Straight post; mortise-and-tenon joined	Stern rudder fitted over stratight post	N/A	probable deck beams	N/A
Beam	T-shaped	Stem hook	stern knee and nailed to keel with supporting aft block	Stern rudder fitted over stratight post	N/A	reconstructed undecked	N/A
Beam	T-shaped	Stem hook	N/A	N/A	N/A	reconstructed undecked	N/A
Beam	U-shaped, rabbeted	No	Straight post; mortise-and-tenon joined	Stern rudder fitted over stratight post	N/A	N/A	N/A
Beam	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Beam	U-shaped, rabbeted	Stem hook	Straight post indicated	Stern rudder fitted over straight post assumed	N/A	N/A	N/A
Beam	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Beam	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Beam	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Beam	U-shaped, rabbeted	Stem hook	Straight post; mortise-and-tenon joined	Stern rudder fitted over straight post assumed	N/A	N/A	N/A
Beam	T-shaped	Stem hook	curved	Double-ended	N/A	mast thwart	N/A
Beam	T-shaped	Stem hook	reconstructed curved	Double-ended	N/A	N/A	N/A

Appendix II

Details, Dimensions and Measurements of the sites used for the comparative study

Shipwreck/ Features	Main scarfs	Strake symmetry	Plank fasteners	Clenching	Scarf length	Plank scarf type	Waterproofing
Drogheda Boat	vertical stop	No	Iron, square shafted	bent over roves	c. 16.25cm	long, lipped	Moss
Kingsteignton	N/A	N/A	Iron, square shafted	clenched over roves	N/A	N/A	Animal hair
Poole boatyard	vertial through	N/A	N/A	N/A	N/A	N/A	Moss
Blackfriars 3	horizontal through	No	Iron. square shafted	riveted over roves	c. 32cm	long, mostly feathered	Animal hair
Blackfriars 4	N/A	N/A	N/A	riveted and bent over roves	N/A	long	N/A
Morgan's Lane	N/A	N/A	N/A	riveted and bent over roves	18.5cm	long	Animal hair
Ria de Aveiro G	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Urbieta	N/A	No	Iron, square shafted	bent over roves	12cm -25 cm	long	N/A
ZN 42	vertical through	Yes	Iron, square shaftedsdfs-dfdsfsdf	double bent	c. 45cm	very long	Moss
Teerhof, Bremen	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Beluga ship	vertical through	No	Iron, square shafted	bent over roves	15cm - 20cm	long, feath-ered	Animal hair
Amager Strand-park	vertical oblique stepped	No	Iron, square shafted	riveted over roves	c. 25cm	long, lipped	Animal hair
Bredfjed ship	vertical stop	Yes	Iron, square shafted	riveted over roves	c. 25cm	long, lipped	Animal hair, vegetable matter (secondary)
Dokøen 2	N/A	N/A	Iron, square shafted	clenched over roves	N/A	N/A	Animal hair
Dokøen 3	vertical through	N/A	Iron, square shafted	clenched over roves	c. 21cm	long, feath-ered	Animal hair, moss and textile
Dokøen 4	N/A	No	Iron, square shafted	clenched over roves	N/A	N/A	Moss
Grønsund	N/A	N/A	Iron, square shafted	clenched over roves	c. 25cm	long, lipped	Animal hair
Knudsgrund	horizontal	N/A	Iron, square shafted	clenched over roves	N/A	long, lipped	N/A
Køge	N/A	N/A	Iron, square shafted	clenched over roves	N/A	N/A	Animal hair
Lundeborg 1	N/A	N/A	Iron, square shafted	clenched over roves	N/A	N/A	N/A
Lundeborg 2	N/A	N/A	Iron, square shafted	clenched over roves	N/A	N/A	Animal hair and hemp
Vedby Hage	vertical through	N/A	Iron, square shafted	riveted over roves	20cm - 30cm	long, lipped	Animal hair
Vejdyb	N/A	Yes	Iron, square shafted	clenched over roves	c. 35cm	long, feath-ered	Moss
Århus Å	vertical through	N/A	Iron, square shafted	clenched over roves	23cm -28cm	long, lipped	Animal hair
Skanör "Brick Wreck"	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Framing quality and finish	Frame spacing	Frame joints	Keelsons/ mast steps	Stringer	Ceiling planing	Stem dragging hole
partially parallel sided, curved with waney edges	c.. 60cm	Abutting	fore and main mast step	plank shaped bilge stringer	No	No
N/A	c. 40cm	horizontal through	one mast step, not recorded	N/A	N/A	N/A
parallel sided	N/A	horizontal through	potential rough outs	N/A	N/A	N/A
parallel sided	c. 47cm	horizontal through	one mast step	triangular in cross-section	No	N/A
parallel sided	N/A	N/A	N/A	N/A	No	N/A
N/A	c. 82cm	N/A	N/A	N/A	N/A	N/A
parallel sided	N/A	horizontal through	N/A	Yes	No	N/A
parallels sided	35cm - 48cm	horizontal through	N/A	plank shaped	No	N/A
partially parallel sided, curved with waney edges	40cm - 45cm	horizontal through	one mast step in forward section of vessel	bottom, bilge and sheer stringers	No	No
parallel sided	10cm - 30cm	N/A	disarticulated mast step	possibly plank shaped	N/A	N/A
N/A	N/A	N/A	N/A	N/A	N/A	No
parallel sided	60cm - 65cm	horizontal through	mast step not preserved but evident	N/A	N/A	Yes
parallel sided	60cm	horizontal through	mast step not preserved but evident	N/A	N/A	yes
N/A	60cm	N/A	N/A	N/A	N/A	N/A
mostly parallel sided, some curved with waney edge	65cm - 70cm	horizontal through	N/A	plank stringers	N/A	N/A
N/A	N/A	N/A	N/A	N/A	N/A	N/A
parallel sided	30cm - 35cm	horizontal through	6-7m long keelson with tapering ends	N/A	N/A	N/A
parallel sided	57cm - 72cm	horizontal through	N/A	N/A	N/A	No
N/A	61cm	horizontal through	4.8m long keelson	plank shaped (pine)	N/A	N/A
N/A	N/A	N/A	N/A	N/A	N/A	N/A
N/A	30cm - 40cm	N/A	N/A	plank shaped (pine)	Yes	N/A
partially parallel sided, curved with waney edges	c. 62cm (amidships)	horizontal through	6m long keelson with two mast sockets	plank shaped (sawn)	N/A	N/A
partially parallel sided, curved with waney edges	36cm - 50cm	horizontal through	mast step not preserved but evident	N/A	N/A	N/A
N/A	75cm 80cm	horizontal through	N/A	N/A	N/A	N/A
N/A	c. 90cm	N/A	Keelson in forward section spanning over six frames	N/A	Yes	N/A

Shipwreck/ Features	Main scarfs	Strake symmetry	Nail fasteners	Clenching	Scarf length	Scarf type	Waterproofing
Barcode 1	horizontal through	N/A	N/A	N/A	N/A	N/A	N/A
Barcode 2	horizontal through with chock outboard	N/A	N/A	N/A	N/A	N/A	N/A
Barcode 3	horizontal through	N/A	N/A	N/A	N/A	N/A	N/A
Barcode 4	vertical through	N/A	N/A	N/A	N/A	N/A	N/A
Barcode 5	horizontal through hooked	N/A	N/A	N/A	N/A	N/A	N/A
Barcode 6	horizontal through	N/A	iron square shafted and wooden nails	N/A	N/A	N/A	N/A
Barcode 7	horizontal through	N/A	N/A	N/A	N/A	N/A	N/A
Barcode 8	vertical stop	N/A	N/A	N/A	N/A	N/A	N/A
Barcode 9	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Barcode 10	vertical through	N/A	N/A	N/A	N/A	N/A	N/A
Barcode 11	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Barcode 12	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Barcode 13	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Barcode 14	horizontal through hooked	N/A	N/A	N/A	N/A	N/A	N/A
Portør	N/A	N/A	wooden nails	wedged inboard	13cm	short	Vegetable matter
Vaterland 1	vertical through	N/A	iron square shafted	bent over roves and double bent	N/A	N/A	Moss, hemp and flax

Framing quality and finish	Frame spacing	Frame joints	Keelsons/ mast steps	Stringer	Ceiling planking	Stem dragging hole
N/A	N/A	N/A	N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A	plank shaped (pine/ spruce)	Yes (softwood)	Yes
N/A	N/A	N/A	N/A	N/A	N/A	Yes
N/A	N/A	N/A	N/A	N/A	N/A	No
N/A	N/A	N/A	N/A	N/A	N/A	No
parallel sided	N/A	horizontal through	N/A	N/A	N/A	No
N/A	N/A	N/A	N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A	N/A	N/A	Yes
N/A	N/A	N/A	N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A	N/A	N/A	N/A
parallel sided	N/A	horizontal through	long keelson with pronounced thicker central section	N/A	N/A	N/A
parallel sided	60cm	horizontal through	mast thwart forward	N/A	N/A	No
parallel sided, some slightly curved	N/A	horizontal through	N/A	split round-wood	N/A	N/A