# PRESENTING COUNTERPOINTS TO THE DOMINANT TERRESTRIAL NARRATIVE OF EUROPEAN PREHISTORY

MARITIME ENCOUNTERS I

# PRESENTING COUNTERPOINTS TO THE DOMINANT TERRESTRIAL NARRATIVE OF EUROPEAN PREHISTORY

*Edited by*

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Cecilia Lindhé holds a PhD in Comparative Literature and is director of GRIDH: Gothenburg Research Infrastructure in Digital Humanities at the University of Gothenburg, Sweden. Lindhé has extensive experience of developing and maintaining research infrastructures. Her current research spans ancient rhetorical and aesthetic theory in relation to Bronze Age rock art, artificial intelligence and image analysis, and visualizations of cultural heritage.

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# Introduction

*John T. Koch, Mikael Fauvelle, Barry Cunliffe & Johan Ling*

## Background to this volume

This book is the first in the multi-author series Maritime Encounters, outputs of the major six-year (2022–28) international research initiative, funded by Riksbankens Jubileumsfond.[1] This major new series examines the contribution and significance of maritime transport, movement, and trade in the shaping of Bronze Age communities and social complexity in north-west Europe. Our research programme is based on a maritime perspective, as a counterpoint to prevailing land-based vantages on Europe's prehistory. It includes a far-ranging, research-led reconsideration of the role of mining and source areas of metals and metal exchange networks in the Bronze Age along the seaboard between Iberia, Ireland, Britain, and Scandinavia, and models a maritime mode of production.

In the Maritime Encounters project a highly international cross-disciplinary team embarks on a diverse range of research goals to provide a more detailed and nuanced story of how prehistoric societies realised major and minor sea crossings, organized long-distance exchange, and adapted to ways of life by the sea in prehistory. The programme includes reviews of evidence for the genomes of Bronze Age Scandinavia and the Atlantic façade, its implications for population movements and long-distance contacts, and the formation of the Indo-European languages in these regions, together with the relationship of word meanings to socio-cultural developments.

The current volume in this series serves to introduce both the project and its theoretical and methodological underpinnings. The chapters collected here all challenge aspects of the dominant terrestrial narrative that has shaped our understanding of European Archaeology for much of the past century. We present a range of case studies, new data, fieldwork, and theoretical arguments that comprise the first results of our project and provide inspiration for future research. Together, the chapters highlight the importance of maritime movement, exchange, and travel for shaping the ancient history of Atlantic Europe.

In the following introductory chapter, we lay out the motivations and organization of the Maritime Encounters project. We hope that understanding the overarching research programme that produced the chapters collected here will help the reader understand the rationale behind the research presented in this volume. We first present the structure of the project, followed by a description of its theoretical basis and research goals. Following this summary of the Maritime Encounters research agenda, we provide summaries of each of the chapters collected in this book.

## Introduction to the research programme

For many years now, the main thrust of European prehistory has followed a fundamentally terrestrial plot line. This terrestrial paradigm has undervalued the story of Europe as a peninsula between the Baltic, Mediterranean, and Atlantic, and likewise downplayed that of many navigable rivers that reach deeply inland and the large lakes important for travel and subsistence. In vast areas of Europe, the survival of incoming groups depended on coping and interacting with a seascape as much as a landscape. From the late Mesolithic onwards, in regions such as Scandinavia, the British Isles, and the Mediterranean, most occupation was coastal; seas or rivers provided the most important infrastructure for transport, exchange, and communication (Cunliffe 2001; 2017; van de Noort 2011). Know-how about seascapes, boatbuilding, navigation, and maritime networks had a profound impact on social organization, ritual monuments, and iconography, and the spread of materials and ideas, enabled by the adaptation of languages to these new environments (Cunliffe 2010; 2011).

Recent advances with ancient DNA and isotopes have brought migration back into archaeological explanation

(Allentoft et al. 2015; Anthony & Ringe 2015; Haak et al. 2015; Anthony & Brown 2017), but little attention has been paid to maritime aspects of these movements or the maritime legacies inherited from indigenous cultures. The great prehistoric migrations or phases of mobility have often been represented as large arrows spanning vast seas or rivers – just the same as they are drawn across open grasslands – with no further explanation about how these groups negotiated formidable bodies of water. There is also a tendency to view Eurasia's maritime edges as the 'ends of the line', passive targets of migrations and movements emanating from homelands in the interior.

The formation of the populations, cultures, and languages of Europe are now seen largely as consequences of three great prehistoric migrations: hunter-gatherers repopulating the post-glacial landscape, followed by farmers spreading from Anatolia, and then Indo-European-speaking pastoralists from the steppe. We do not dispute the main thrust of this 'terrestrial' narrative and its three milestones. In fact, this programme builds on these conclusions reached by aDNA-driven projects, but now focuses on the major gaps that remain, gaps that we sense most acutely in Scandinavia and the British Isles.

Unanswered questions include:

- How did groups from innermost Eurasia reach the archipelagos and peninsulas of Scandinavia and Atlantic Europe?
- Did they, in effect, 'reinvent the wheel' of sea crossing *de novo*?
- To what extent did the hunter-gatherers and farmers who had reached these coastal environments before them contribute traditions and knowledge of boats, boat building, seaways, navigation, and subsistence?
- What are the direct or indirect evidences of boat building?
- What types of boats were used?
- How many people and animals could they carry?
- How was the long-distance trade in metals organized during the European Bronze Age?
- What was the impact of this sea-crossing network on the cultures, languages, and populations of the producers and consumers of bronze?
- In which places in the landscape/seascape did maritime crossing organized during prehistory take place?
- How did these maritime encounters spread and transform languages and ideas?

There is a fear that simplistic terrestrial migrationist models of cultural change without proper archaeological contextualisation may lead back to Kossinna's discarded culture historical archaeology and its far worse political misuse (Heyd 2017; Klejn et al. 2018; Frieman & Hoffmann 2019; Furholt 2019; Hakenbeck 2019). Adopting maritime and riverine perspectives empowers our nuanced approach to focus on the transformative contributions of indigenous coast dwellers to incoming groups and the interaction between groups in networks driven by water-borne mobility, which resonates with up-to-date post-colonial insights on the modern world (Klejn et al. 2018). There is also a feminist/gender-studies dimension in the recognition that indigenous survivals were sometimes biased towards female ancestry (Goldberg et al. 2017; Silva et al. 2017; Reich 2018; Olalde et al. 2019b).

## Purpose and project framework

The project focuses on four major maritime encounters, as turning points in prehistory, as reflected in the organization of the research team and work plan into four subprojects. Our ultimate objective – a synthetic transdisciplinary overview of European prehistory from a maritime perspective – is ambitious (Koch & Ling 2023). Therefore, our work plan focuses tightly on four specialized Subprojects in research areas in which the participants and participating institutions have relevant world-recognized expertise and track records. Each Subproject will yield new high-quality datasets to fill lingering gaps in the understanding of Europe's maritime and riverine prehistory. The Subprojects interact closely and regularly to consider new scientific data and their implication for the emerging bigger picture.

- SUBPROJECT 1: Encounters between the Pitted Ware Culture in Scandinavia and Corded Ware groups (3400–2300 BC), led by Mikael Fauvelle. In the archaeogenetic-based narrative of prehistoric Eurasian migrations, the 3rd millennium BC is crucial. However, most narratives neglect the maritime realities that brought the steppe migrations to Northern Europe. How did groups descended from pastoralists from inner Eurasia reach new lands by crossing major bodies of water? This question applies to the maritime migration of Corded Ware Cultures (CWC) over the Baltic to Scandinavia where they encountered Pitted Ware groups (PWC) (Malmström et al. 2009; 2015; 2019) and farmers of the Funnel Beaker Culture (FBC). The research field of Subproject 1 can potentially throw light on early stages of the evolution of Proto-Indo-European towards Pre-Germanic (Kristiansen et al. 2017; Koch 2019; 2020; 2024).
- SUBPROJECT 2: Dispersal of the Bell Beaker/Beaker complex (BBC) along the Atlantic façade ~2800–1900 BC, led by Marc Vander Linden. The BBC is characterized by multiple items (e.g., Beakers, daggers, stone wrist-guards) and practices (e.g., individual burials) with a widespread distribution across western and central Europe. Some of its earliest material traits are found ~2800 BC on the Lower Tagus near Lisbon. From ~2600 BC these appear rapidly along the Atlantic to Brittany and along the Mediterranean to southern France, reaching Central Europe by 2550 BC (Harrison & Heyd 2007;

Vander Linden 2007; Olalde et al. 2019a) and Britain and Ireland by ~2450 BC (Fitzpatrick 2013), in the latter in association with early copper metallurgy at the Ross Island mine (O'Brien 2004). From ~2300 BC a local Beaker variant can be observed in North Jutland, linked to a strong metalwork tradition (including specialized weaponry), iconic pressure-flaked flint daggers (Horn 2014; Artursson 2015), and, possibly, more complex plank-built boats. The BBC impact beyond Jutland was slight; however, some scholars argue that depictions of plank-built boats in rock art in Norway and Sweden was due to BBC influence (Melheim & Ling 2017). The BBC groups possibly focused on Jutland for its flint and amber resources, not available in equal quantity or quality elsewhere in Scandinavia (Vandkilde 2016).

- SUBPROJECT 3: The rise of the Atlantic North: tin bronze, warriors, and advanced seafaring ~2100–1400 BC, led by Johan Ling. Increased social and political complexity appears in the archaeological record ~2000 BC, often reflecting demand for a new metal, tin bronze (cf. Koch 2013). This demand effectively transformed Europe, creating new and varied social institutions (Earle et al. 2015). The aim is to model how Atlantic societies organized long-distance trade of metals, looking closely into evidence for boatbuilding, seafaring capacity, and how much metal was transferred along the Atlantic façade. We also aim to map organizational variation between coastal and inland societies, identifying the causes of coercive and cooperative formations, integrative and disruptive factors, connected to the maritime expansion of plank-built boats. Plank-built boats occurred in the British Isles in the early 2nd millennium BC, and their development is strongly connected with the use of tin-bronze tools. The boats demanded a huge investment of labour, materials, and technology (van de Noort 2006). Rock art and metal axes indicate a rapid spread of this technology to Scandinavia (Vander Linden et al. 2009). These larger and more seaworthy vessels facilitated the maritime trade of metals. Recent research suggests the amount of metal arriving in Scandinavia increased rapidly between ~1600 BC and ~1500 BC to a yearly consumption of ~1–2 tonnes of copper (Radivojević et al. 2019). These boats also spurred the rise of new maritime institutions, a new class of mobile warriors able to raid, trade, and intimidate (Earle et al. 2015).
- SUBPROJECT 4: The Atlantic North and the Iberian Peninsula: Contacts ~1400–600 BC, led by Marta Díaz-Guardamino. A notable side effect of the predominant terrestrial viewpoint has been to downplay or virtually overlook the role of Iberia in synthetic overviews of European prehistory. Focusing on movements over land, the Peninsula appears marginal, a subcontinental *cul-de-sac*, cut off by the lofty Pyrenees. But from the maritime perspective, Iberia is literally pivotal, as Europe's unique fulcrum around which continuous sea voyages could link the Mediterranean and Atlantic systems. Add to this Iberia's mineral wealth – its abundance of copper, tin, silver, gold, and lead – and this makes plain why Maritime Encounters finds it essential to consider Iberian evidence deeply in a re-assessment of the European Bronze Age. Iberian copper found in Scandinavian and British bronze artefacts of 1400–800 BC (Ling et al. 2014) has been a startlingly unexpected discovery challenging earlier thinking about Bronze Age maritime networks and Iberia as a metal-producing region. Advancing knowledge of Bronze Age Europe now reveals a growing and increasingly integrated system by the mid-2nd millennium BC (Pare 2000; Ling & Uhnér 2014; Earle et al. 2015, 132). In Ireland and Britain, rising demand for copper coincided with the decline of insular mining, notably the Great Orme mine, which had been the major source of copper ~1700–1400 cal. BC (Williams & Le Carlier de Veslud 2019; Williams 2023). After 1400 BC there was an influx of continental copper derived from sulphide ores with lower levels of impurities (Radivojević et al. 2019). Recent work points to Iberia among the sources replacing British copper at this stage (Ling et al. 2014; 2019). Also at this time, Baltic amber appears near copper extraction sites in Iberia (Murillo-Barroso & Martinón-Torres 2012; Odriozola et al. 2019). Recent research points to the mineral-rich La Serena region in Extremadura as a major source area for copper: Late Bronze Age copper alloys from across Iberia, as well as British, Irish, and Scandinavia of this date, match La Serena ores. Of special interest are the mines Las Minillas and Lomo del Perro and others in the Belalcázar and Garlitos area. Both have evidence of prehistoric mining and Pb isotopes matching Scandinavian artefacts (Ling et al. 2014; Hunt Ortiz et al. this volume). Project members have already begun primary investigations of the mine in Las Minillas. Over 900 stone hammers with hafting grooves have been registered; an extraordinary number of mining tools if compared with any other prehistoric Iberian mines (Hunt Ortiz 2003).

## Theoretical and methodological approaches

We adopt a trans-disciplinary approach building on data, methods, and theories from six discourses:

- Archaeology: high-resolution analytical data, methods, and theory to reveal utilization of marine resources, evolution of boatbuilding, evidence of ancient maritime technologies (i.e., navigation), and the spread and exchange of metals and other raw materials, artefacts, and monument types.
- Oceanography and digital humanities: modelling of ancient waterways and navigation.

- Anthropology: comparative, multi-scalar maritime approaches, updated post-colonial theory, material culture studies, and interviews about maritime technologies (i.e., boat building and navigation).
- Archaeogenetics: an up-to-date overview and re-analysis of extant data for migratory expansions and indigenous survivals from a maritime perspective.
- Historical linguistics: critical review of the expansion and transformation of languages spread by sea.
- The project is built on four dedicated Subprojects that will use high-quality datasets and produce new data where gaps are identified to reconstruct the maritime prehistory at four major turning points. The project is profoundly international, synthesizing data from across Europe and comparative ethnological and anthropological data worldwide. The team comprises highly experienced researchers, prominent in their fields, most of whom have previously collaborated or are presently collaborating.
- Combined with the outcome of recent aDNA projects, this project will re-theorize prevailing societal models of forces and institutions driving maritime expansion, water-borne mobility, migrations, warfare, and exchange.

The archaeogenetic revolution allows us, for the first time, to infer how populations of historical times with known languages were related to communities pre-dating written records. The difficulties of bringing archaeological evidence, aDNA, and findings from other fields together has been intensely debated (Kristiansen 2005; van Reybrouck 2012; Melheim et al. 2016; Ling et al. 2018a). The pitfalls of equating prehistoric archaeological cultures with languages are also well known. However, it is commonly acknowledged that languages are as an important feature of human societies as economy, ideologies, and social organization. Thus, it is important to theorize about language in line with the other features for prehistoric societies. We agree that a reflective approach to analogies, aDNA, and historical linguistics is more illuminating in a comparative evaluation of differing archaeological models (Ling et al. 2018a; 2024a; Koch 2020; 2024). Cross-cultural patterns reveal specific spatial, social, economic, technological and environmental conditions that may shape humanity's ability to live and thrive by the sea. Thus, life in a maritime environment gives rise to recurring social and settlement patterns. Similarly, the adoption of watercraft innovations will require a new or changed vocabulary.

Recent research stresses the expansive dynamism of Bell Beaker and Nordic Bronze Age groups as a result of their ability to organize, and capitalize on, a complex 'Maritime Mode of Production' (MMP; Hayden 2018; Ling et al. 2018b; Ling 2019; this volume; Fauvelle & Ling this volume). The MMP included political strategies to control trading and raiding through owning boats and financing expeditions. Such institutions are often formed at the edges of world systems, feeding on large structures using their maritime comparative advantages, their ability to deploy boats and crews including warriors capable of both long-distance exchange and warfare. In such systems, surpluses raised from farmsteads gave the upper strata of society the wherewithal to invest in maritime social organizations and institutions, i.e., boats and crews (Hayden 2018; Ling 2019). However, this institution must have had roots in earlier forms of maritime social organization, on hunter-gatherers' long experience of organizing offshore fishing, hunting, maritime exchange, and warfare. The 'Maritory' (Needham 2009) is another important theoretical concept we plan to explore, which connects seascapes with maritime social organizations and long-distance exchange.

Maritime exchange, however, is often studied only in patterns of utilization or transfer of material culture, whereas social control of maritime exchange can be viewed as fundamental to the development of social complexity, such as anthropological analogies of 'secret societies' for prehistoric mariners. Secret societies are associated with 'the first institutional manifestation of ritual organization linked to political power' (Hayden 2018; Ling et al. 2018b; cf. Chacon et al. this volume). These sodalities generally transcended kinship, forming 'fictive' supra-kinship organizations along with extensive networks and regional organizations to conduct long-distance exchange. Following Hayden and others (Hayden 2018; Ling et al. 2018b), secret societies can be associated with trading, raiding, and slaving, also boat guilds for transmission of knowledge of navigation, boat construction and maintenance, and cultic activities connected to power, death, long-distance voyaging, and warfare, manifested for example in rock art (Ling et al. 2018b; Ling et al. 2024a; Ling 2019).

We will apply oceanographic methods to model ancient sea crossings and navigation with an innovative simulation tool that we have developed in collaboration with the Centre for Digital Humanities at the University of Gothenburg and Ohio State University (Montenegro et al. 2006). These simulations will use data on prehistoric boats with different capacities (logboats, plank-built boats, bark boats, skin boats) and various modes of propulsion (paddling, rowing, sailing) as affected by wind and oceanographic patterns to simulate routes useable during various weather conditions with ancient seafaring capabilities. These patterns are based on open-source present-day data on sea currents and wind collected by Copernicus (European Union's Earth Observation Programme) and ECMWF (European Centre for Medium-Range Weather Forecasts) collected since the 1970s. The simulations will first establish success rates under the most predictable weather conditions in reaching potential stepping stones within maritories, and to assess seasonality and duration of journeys. By comparing simulations based on a) present-day values, b) altered according palaeomodels, and c) palaeomodel output only, we seek to improve the application of seafaring simulations for prehistory. This method will set a baseline for prehistoric simulations of coastal North Atlantic seafaring, to infer navigational abilities and routes at earlier times.

We are developing a new model for maritime enterprises of the Late Bronze Age, using fine-tuned chronology of archaeological evidence, a re-assessment of the distribution of key bronze artefacts exchanged between the western Mediterranean and Scandinavia via the Atlantic façade, large-scale lead isotope and metallographic analyses (Stos-Gale & Ling this volume), Baltic amber, and comparing rock art imagery (Ling et al. 2024a).

## Direct and indirect evidence of boats and boatbuilding

The evolutions of maritime technologies are essential for explaining the four transformative turns that are this project's subject. We focus on both direct and indirect prehistoric evidence of boats and boatbuilding as well as archaeological proxies like boats depicted on rock art, inherited maritime vocabulary, and anthropological/ethnological comparative data for boats and boatbuilding. From the Mesolithic to the Early Iron Age there is evidence for logboats along the Atlantic façade and Baltic region (McGrail 2014). There is evidence of skilled woodworking with planks from the Early Neolithic and onwards, but there is no direct evidence that this knowledge was applied to boat building (Cunliffe 2011). Although logboats appear to have been the earliest primary type of boat, other types, such as skin boats and bark boats, are also considered (McGrail 2014; Fauvelle et al. 2024). These issues will be investigated in Subprojects 1–2, for example with a re-evaluation of Neolithic boat carvings of the so-called Nag-type (from ~2500 BC) in southern Scandinavia (Bengtsson 2013; Melheim & Ling 2017). The technological revolution of plank-built boats occurred in the British Isles in the early 2nd millennium BC. Their development has been linked to tin-bronze tools (van de Noort 2006; 2011). Bronze axes and rock art images reveal the rapid spread of this technology to Scandinavia (Austvoll 2020). The introduction of larger and more seaworthy vessels facilitated long-distance exchange as well as social complexity and inequality (cf. Fauvelle & Ling this volume), issues to be investigated in Subprojects 2–4. The earliest known example of a boat from Scandinavia is a fragment of a bark boat from Byslätt, West Sweden, of 800–700 BC (von Arbin & Lindberg 2017). This find pre-dates technologically more advanced plank-built boats, such as the famous Hjortspring boat of the Pre-Roman Iron Age (Crumblin-Pedersen & Trakadas 2003; Kaul 2003) and fragments from Haugvik and Troms in Norway.

Wickler (2019) reviews the evolution of boats in Scandinavia and interprets Early Iron Age 'paddles' from Arctic Norway to be in fact rowing oars, a conclusion with drastic technological and hence socio-political implications. Such studies show the need to examine previously overlooked evidence.

There exists much unexplored secondary evidence suggestive of shipbuilding that we are examining in this Programme to compare further with relevant anthropological/ethnological data.

Of special interest are sites with fire-cracked stones at ancient seaside locations, from Neolithic times onwards in Scandinavia (Ling et al. 2024b). They usually include abundant burnt wood of types similar to those used in the construction of prehistoric boats. Ethnographic studies document similar features at similar locations used to steam, bend, and expand timber and planks for both dugout canoes and plank-built boats (Clausen 1993; Ling et al. 2020). To expand dugout boats, or the bottom plank of a plank-built boat, stones are heated up by setting intense fires then placed at the bottom of the water-filled log. This action bends the log and the heat can be better controlled than by bringing the wood and fire together directly (Prøsch-Danielsen & Simonsen 2000). Some 20,000 Bronze Age boat images are known from the rock art of southern Scandinavia dated from the Late Neolithic to Early Iron Age (Ling 2012).

## Contribution to the international research front

There is no comparable project of this scale and scope focusing on prehistoric maritime encounters in a long-term perspective along the Atlantic façade. In contrast to previous projects and Programs, what we propose will generate something novel, foregrounding human interaction with the sea and seascape at major turning points of prehistory to create a more detailed and nuanced narrative of prehistoric societies' realization of sea crossings, long-distance exchange, and ways of life by the Atlantic façade. However, earlier specialized studies have anticipated our approach (Clark 2009; Broodbank 2013; Cunliffe 2017). More general aspects of migration, exchange, and mobility based on ancient DNA and isotopic analysis have been studied in several projects based in Scandinavia, Europe, and the USA (Kristiansen 2014; Reich 2018).

## The chapters

The chapters deal with key facets of the integrated multi-disciplinary foundation of the Maritime Encounters programme. Each concerns an area of ongoing research being carried forward by the team. New findings are anticipated throughout, and each can be fairly characterized as a 'watch-this-space' state of affairs.

Situated at the chronological beginning of the work plan within the scope of Subproject 1 is the first chapter**:** 'A millennium of war – violent encounters during the 4th and 3rd millennia BC in the Western Baltic' by Christian Horn and Sebastian Schultrich. The extensive evidence assembled and interpreted provide a strong basis for reconsidering the widespread concept – sometimes stated explicitly, more often assumed – that the European Neolithic contrasted with following Bronze Age with an essentially more peaceful social order. This study arrives at an opportune moment, as it has lately become clear that this transition – as well as marking the advent of metallurgy – was all the stage new genetic ancestry entered, and probably with it the prehistoric Indo-European ancestral to the attested Germanic languages.

Chapter 2, 'Chalcolithic and Bronze Age Atlantic connections *c*. 2500–800 BC' by Aurélien Burlot provides a synthetic overview of these two millennia across the Atlantic façade. It tracks over this span the ebb and flow of long-distance connections among Atlantic Europe's subregions.

The third chapter, 'Using direct and indirect evidence of boats and boatbuilding for understanding the nature of seafaring in Atlantic Europe *c.* 5000–500 BC' by Boel Bengtsson covers the entire chronological span of Maritime Encounters. This substantial contribution draws together diverse evidence that is essential to all aspects of the programme and its four Subprojects going forward.

Chapters 4–7 bring us to anthropological analogy, seeking deeper understanding of the Nordic Bronze Age through comparisons with fully documented societies. In Chapter 4, 'Larger boats, longer voyages, and powerful leaders: Comparing Maritime Modes of Production in Scandinavia and California', by Mikael Fauvelle and Johan Ling, seafaring indigenous groups of North America's Pacific coast provide new comparative insights into the heyday of boat building and long-distance connectivity characterizing Bronze Age Scandinavia.

Chapter 5, 'The Maritime Mode of Production in relation to self-sufficiency, reciprocity, comparative advantages', by Johan Ling, presents a further theoretical development of this anthropological model for the social structure and political economy, relevant especially to the periods canvassed in Subprojects 3 and 4.

Chapter 6, 'The origins of secret societies and their contribution to the rise of social complexity', by Richard Chacon, David Dye, Brian Hayden, Johan Ling, and Yamilette Chacon, explores the cross-cultural phenomena of shamanism and secret societies. There is potential in these investigations for new insights in the longstanding enigmas of the secret knowledge conveyed by Scandinavia's Bronze Age rock art and the coeval rise of sodalities of seafaring trader-raiders.

Chapter 7, 'Maritime memoria: navigating through Bronze Age rock art', by Cecilia Lindhé, brings to bear another field of study, namely classical rhetoric, to advance our understanding of the meanings encoded in the rock carvings. Information that appears merely bewildering when a linear narrative is sought may be more fruitfully approached as a *ductus* or 'leading in' into its own multi-dimensional world or as aiding an *ekphrasis*, a description transmitted by words. Such new perspectives will vitally inform Maritime Encounters' reconsideration of Bronze Age Scandinavian rock art and the thought patterns of the societies that produced it.

Chapter 8, 'Archaeology and science: impact of lead isotope analyses on the archaeological discourse of metal trade for the Scandinavian and British communities in the 3rd–1st millennia BC', by Zofia Anna Stos-Gale and Johan Ling, introduces a key research pillar of Maritime Encounters. Together with chemical analysis, isotopic sourcing of Bronze Age metal objects can fairly be said to be revolutionizing our understanding of long-distance exchange in later prehistory with many unexpected findings, contributing to the emerging picture of Iberia as a major contributor of copper to the Nordic Bronze Age. The isotopic data reviewed is consistent with other evidence, favouring a model in which a watershed occurs around 1400/1300 BC, after which copper came to Scandinavia from more distant sources, including the Italian Alps, Sardinia (possibly), and most notably the south-western Iberian Peninsula, from which it reached the Atlantic seaways via the Guadalquivir and Guadiana.

An important strand running through the Maritime Encounters research programme, especially Subproject 4, is the rising recognition of the connectivity between the metal-rich Iberian Peninsula and the Atlantic North in the later Bronze Age. Chapter 9, 'Late Bronze Age copper mining in southern Iberia: preliminary results of fieldwork at Las Minillas (Granja de Torrehermosa, Badajoz, Spain)' by Mark A. Hunt-Ortiz, Juan Latorre-Ruiz, Miguel Ángel de Dios-Pérez, Jacobo Vázquez-Paz, Magnus Artursson, Manuel Grueso-Montero, Marta Díaz-Guardamino, Zofia Stos-Gale, and Johan Ling presents preliminary findings of surveys and excavations at this key site. The impressive scale of the Bronze Age mining activity there is now evident. We look forward to future upcoming seasons that will clarify such issues as the time-line, the destinations of the copper extracted from Las Minillas and the place of this site alongside that of other prehistoric mines in southern Iberia that we are investigating.

In Chapter 10, 'What genetics can say about Iron Age and Bronze Age Britain', Nick Patterson returns to the question of the linguistic implications first explored in the seminal 2022 study, 'Large-scale migration into Britain during the Middle to Late Bronze Age', for which he was the lead author (Patterson et al. 2022). As in that earlier publication, he reasons that Celtic probably arrived in southern Britain with the recognized genetic flow of the Middle Bronze Age to the beginning of the Iron Age, but that the Beaker period, roughly 1,000 years before, cannot yet be decisively ruled out as the horizon of this language shift.

In Chapters 11 and 12, John Koch offers further linguistic perspectives on the archaeogenetic evidence of Patterson et al. (2022) and other milestone publications of 'archaeogenetic revolution'. In both chapters, Koch returns to long-standing issues in historical-linguistic theory, exploring how archaeogenetic findings have now favoured one disputed approach over another. Chapter 11, 'Cross-disciplinary considerations', sees in the apparent genetic confirmation for the steppe hypothesis of Indo-European origins support for the method known as 'linguistic palaeontology', which had led to the same conclusion before the genetic evidence was known. Chapter 12 argues that the 'Convergence in situ' theory of the formation of the Indo-European branches better harmonizes with the archaeogenetic evidence than the ubiquitous family-tree model and its underpinning assumptions.

### *Note*

1 Maritime Encounters: A Counterpoint to the Dominant Terrestrial Narrative of European Prehistory, Riksbankens Jublieumsfond reference number M21-0018.

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1

# A millennium of war – violent encounters during the 4th and 3rd millennia BC in the western Baltic Sea

*Christian Horn & Sebastian Schultrich*

*This study aims to shed light on Neolithic warfare and violence by examining specialized weapons and their depositional contexts. By incorporating other evidence for violence, we demonstrate that conflict and warfare were important in shaping the social fabric of the Nordic Neolithic. Additionally, we explore the significance of cross-sea relationships, which became prominent by the onset of the Middle Neolithic at the latest. Our findings suggest that there was at least a millennium of warfare before the Nordic Bronze Age. We demonstrate that understanding the social, economic, and political impacts of warfare, rather than viewing it in isolation, is essential, as it may have been a key driver of change.*

## Introduction

Following in the wake of Keeley's (1996) now almost three decades old seminal critique that archaeologists and anthropologists had pacified the past, it has long been accepted that the Nordic Bronze Age was a time of warriors forming elites and shaping a warrior ideology (Harding 1999; Kristiansen 2001; Vandkilde 2003). Indeed, even before reaching this general consensus, earlier studies of weaponry in Denmark had concluded that many of these artefacts had been heavily used (Kristiansen 1984). Building on this body of research, it was recognized that future Bronze Age studies needed to consider the social, economic, and political impact of warfare rather than treating it in isolation (see for example contributions in Horn and Kristiansen 2018).

Although the evidence is less conspicuous, it is also now accepted that warfare, involving actual fighting and victims, was an important factor during the Late Neolithic that influenced later developments (Fibiger et al. 2013; Schulting 2013). While the idea that the migrations of the Corded Ware Culture (CWC) in the 3rd millennium BC involved genocidal events (Barras 2019) has been challenged by some scholars (Furholt 2019a), the true impact of the migrations remains unclear and requires more paleo-demographic modelling. Nevertheless, in the light of the evidence for skeletal trauma, it is hard to deny that the Corded Ware groups engaged in violence and were not merely peaceful herders (Meyer et al. 2009; Lidke 2012).

For the 4th and 3rd millennium BC, recent research has brought to attention the use of thick flint points as specialized weapons by the Funnelbeaker Culture (TRB) communities. Other evidence, for victims of violence, together with a significant and sudden decline in population numbers at the end of the period has also challenged the perception of these farming communities as peaceful societies (Iverson 2016; summary in Horn 2023). Some of these phenomena may have been associated with the arrival of hunter-gatherer groups from the eastern Baltic Sea – the so-called Pitted Ware Culture (PWC) (Malmström et al. 2009). However, this view is perhaps too simplistic. It needs to be considered that neither TRB nor PWC groups were in any sense internally unified, with both cultures expressing a high degree of heterogeneity at the micro-scale, as evidenced by, for example, differing burial customs, such as the cattle burials in north and west Jutland (Johannsen et al. 2016). In the absence of political unity among these groups, they probably fought each other much in the same way as groups perceived as culturally different fight each other today. This can be seen within other groups present in the region, such as the Globular Amphora Culture whose communities occupied an area spreading from the southern Baltic shore in East Germany through Poland to the Dnjeper river. A mass-grave discovered in Koszyce (southern Poland) containing 15 killed individuals demonstrates that brutal violence during the Neolithic was independent of cultural context (Konopka et al. 2016; Schroeder et al. 2019). Overall, the Nordic Neolithic was a rich tapestry of different, contemporaneous, spatially overlapping, and internally diverse cultures with a high mobility (Fig. 1.1).

In this contribution, we seek to elaborate on research concerning Neolithic warfare and violence, with our primary focus being the identification and discussion of specialized weaponry, such as battle-axes, thick flint points, etc. Our objective is to demonstrate that conflict, violence, and warfare were significant factors tied into the social fabric of the Nordic Neolithic, and that cross-sea relationships held importance, starting at the latest with the onset of the Middle Neolithic. This research highlights a millennium of warfare prior to the emergence of the Nordic Bronze Age and its prominent maritime warrior ideology (Ling & Toreld 2018; Horn 2023).

## Weapons

### *Battle-axes*

#### *Dating and context*

With the beginning of the Early Neolithic (*c.* 4100/4000–3300 BC), the battle-axe emerged as a distinct type of object in northern Central Europe (Fig. 1.2) (Zápotocký 1992, 40–3). It is probable that this type of artefact may never have been intended to serve as a multi-functional tool (cf. Horn 2014, 222). Instead, battle-axes were perhaps designed purely to be weapons that derived their symbolic significance from that purpose (Ebbesen 1975, 208; Zápotocký 1992, 195). Mundane shaft-hole axes differ from battle-axes in terms of their general shape (simple vs complex), cutting edge shape (sharp vs. blunt), and use-life (often reworked when broken vs. almost never reworked) (Hoof 1970, 80; Schultrich 2018, 189; 2022, 341–2; cf. Lekberg 2004).

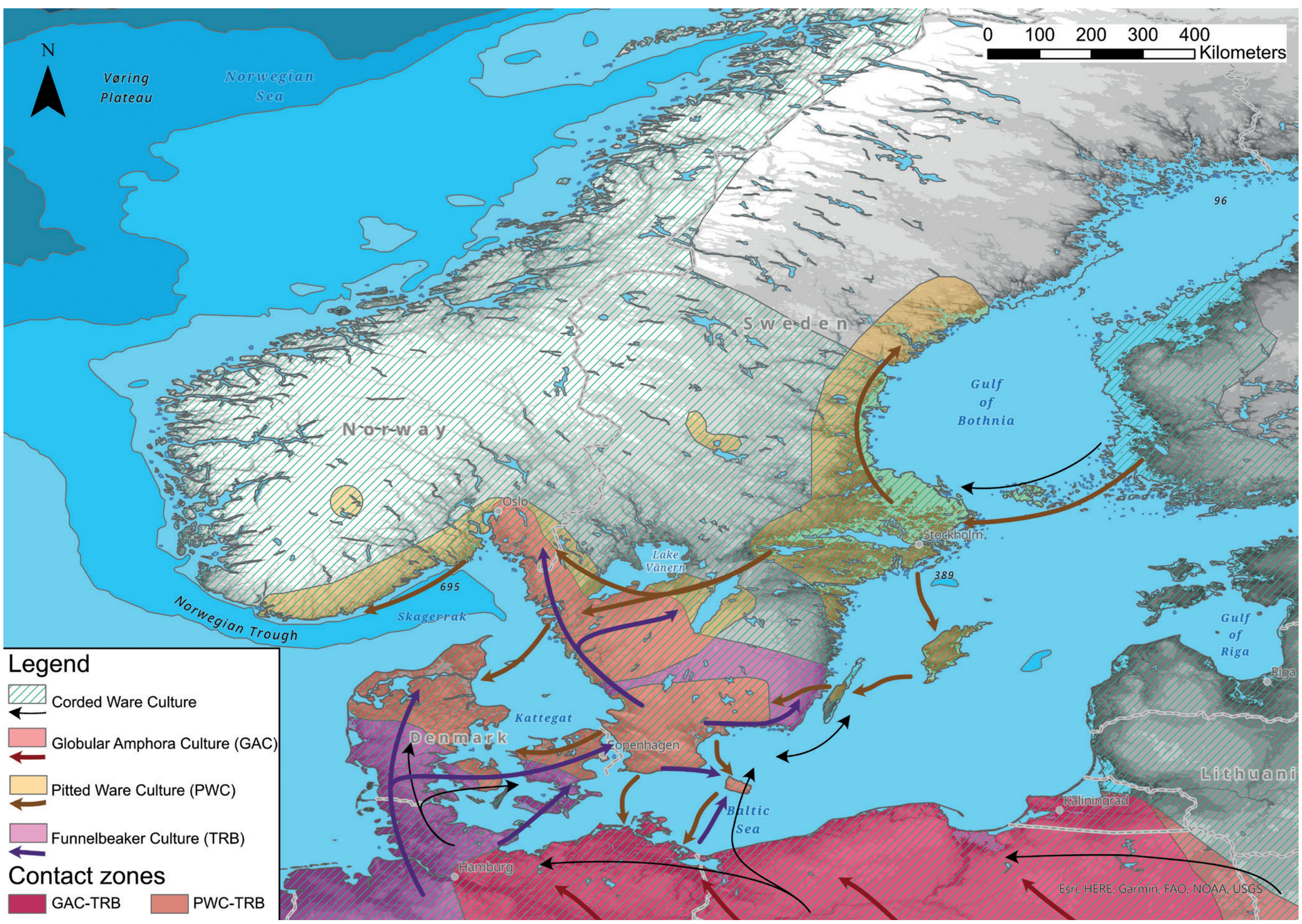


*Figure 1.1. Archaeological cultures present with arrows indicating an interpretation of their potential spread. Sea levels around 3300 BC indicated, current shoreline in grey. Map by CH and Ashely Green.*

Most Neolithic battle-axes have been discovered as individual deposits, burial finds being the second most common. The absolute numbers of battle-axes and the relative numbers of buried specimens changes significantly throughout the periods (Fig. 1.2e). Hammer-axes dating to the Early Neolithic were only sporadically put into burials. This changed during the Middle Neolithic when the relative number found in burials increased significantly, whereas the absolute number was only marginally higher. A significant rise in absolute numbers has been recorded during the Younger Neolithic, but the relative number in burial contexts slightly decreased. In both phases, depending on the respective sub-region, *c*. 10–20% of the battle-axes are burial finds while the other 80–90% are single finds. From this perspective, an important change in burial customs happened during the Middle Neolithic with continuity during the Younger Neolithic.

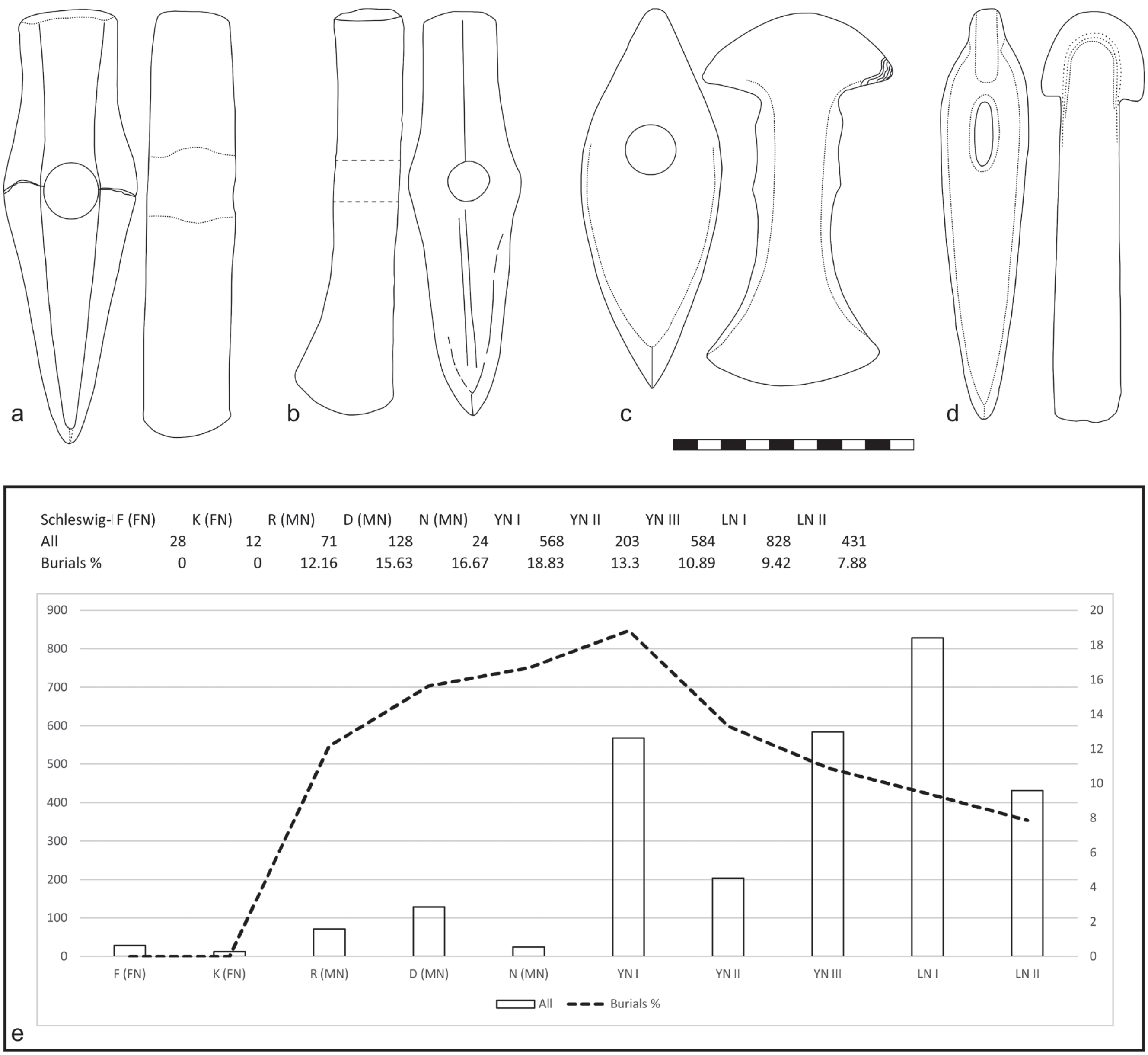


*Figure 1.2. Neolithic battle-axes: a. Early Neolithic F-axe from Heringsdorf, Schleswig-Holstein (Zápotocký 1992, cat. 14); b. Younger Neolithic A-axe from Zarnekau, Schleswig-Holstein (Schultrich 2018, cat. 726); c. Middle Neolithic DII-axe from Schleswig-Holstein (Zápotocký 1992, cat. 244); d. Middle Neolithic N-axe from Oldenburg, Schleswig-Holstein (Zápotocký 1992, cat. 107); e. left axis = absolute number and right axis = percentage of buried specimens of Early Neolithic (F, K), Middle Neolithic (R, D, N), and Younger Neolithic battle-axes and Late Neolithic flint daggers of Schleswig-Holstein (data accordng to Schultrich 2022).*

### *Were battle-axes used as weapons?*

It is possible to argue that the labour investment required to produce sophisticated forms and the small shaft-holes contradict the interpretation that these objects were practical weapons. In addition, flint axes may have been much better suited to cause tremendous injuries (Malmer 1962, 662; Konopka et al. 2016). However, there is evidence to assume that battle-axes were functional and, in fact, were better to handle than flint axes (Ebbesen 1975, 208) in that one targeted blow with a blunt cutting-edge or butt from a battle-axe would be sufficient to incapacitate an enemy (Löhr 1982, 5; Klimscha 2016b, 206). Blunt and sharp traumata like those discovered in Koszyce (Schroeder et al. 2019) may have been caused by battle-axes; although it should be pointed out that the impacting parts of flint axes and battle-axes are morphologically similar. The use of battle-axes as weapons is attested for the Younger Neolithic (CWC) of Central Europe (Meller et al. 2015). Even if some battle-axes were never used in combat, they displayed readiness for violence within societies accustomed to objects being used in violent encounters (Horn 2014, 221; cf. Knappett 2005, 89–90). Accordingly, battle-axes were symbolically similar to Bronze Age swords that were understood as implements of power in the societies that used them. Furthermore, the morphology of battle-axes was quite similar in large parts of central Europe especially compared to flint axes (Zápotocký 1992). This indicates that different societies had the same basic understanding of the battle-axe concept possibly grounded in the functionality of the form (Klimscha 2016a, 86; Schultrich 2022, 347–49).

Neolithic battle-axes were produced from both mundane (hard stone, antler) and exotic materials (copper, soft stones). In addition, their symbolic value is highlighted by their occurrence in depositions and burials as miniaturized, symbolic objects crafted from wood, clay, and amber, or depicted on stones in graves or on free-standing stelae (Schultrich 2022, 555–6, 602–3; cf. Zápotocký 1992, 158–66).[1] The specific meaning of this symbol may have differed in the various regions, periods, and contexts.

At the turn from the 4th to the 3rd millennium BC, an important morphological shift in battle-axe construction took hold when oval shaft-holes became dominant over round ones (Fig. 1.2a-d). This trend can be observed on lithic (L-axes) and copper double axes in the western Alps (Schultrich 2022, 283–86; cf. Winiger 1999), the L-axes and 'Bohemian axes' in central Europe (Schultrich 2022, 264–5), and the so-called *Nackenkammäxte* (N-axes) which evolved from lithic double axes in north-eastern Germany (Zápotocký 1992, 143; Woidich 2014, 75; Schultrich 2022, 282–3).

In could be argued that the oval shaft-holes were introduced simply to copy the symbolism of heavy copper double axes which were so small that the axes were probably not usable in combat (cf. Kibbert 1980). However, symbolic and practical value do not need to be separated: oval shafts fitted in oval shaft-holes were superior to round forms because they avoid twisting the axe during a blow (Matuschik et al. 2009, 43). This means that the innovation of oval handles improved the combat capabilities of battle-axes.

### ***Thick flint points***

Battle-axes were not the only specialized weapons known to the communities of the late 4th and 3rd millennium BC. In German archaeological research, a specific type of core implement has been referred to as thick flint points (*dicke Flintspitzen*) (Langenheim 1936; Lübke 1997–98; Klassen 2000). The Danish technical term is more interpretative and equivalent to the English term 'halberd' (*dolkstaver*), which is used for the Chalcolithic and Early Bronze Age specialized metal weapon (Ebbesen 1992; 2011; Vang Petersen 1993). These objects have been retouched on all sides, with some examples showing dulling up to, but often not including, the butt end (Fig. 1.3a–b). This indicates that these implements were attached to a handle that ran perpendicular to the object's axis, i.e., like a halberd (Horn 2014).

The identification of the *dolkstaver* as a specialized weapon was contested by Lutz Klassen (2000), who argues that flint, being a brittle material, is unsuitable for producing thrusting weapons. However, numerous observations about flint weapons and tools counter this argument. Flint arrowheads, for instance, were weapons that likely endured high impact forces and were used repeatedly to cause harm and injury to individuals (Iversen 2016). Flint daggers are typically seen as thrusting weapons (Christensen 2004), but even tool-weapons like flint axes had to endure significant impact stresses. Flint is a highly versatile and resilient material (Norton 2021) and, despite regular breakage of axes, daggers, and arrowheads, people continued to utilize them because it was the best material available at the time. Macroscopic use-wear analysis and initial experiments on hafting and utilization of flint halberds have also shown their effectiveness as high-impact weapons (Horn & Schenck 2016). It is hoped that future study will extend and refine these observations.

The presence of flint halberds in Spilamberto (Italy), contemporary depictions of such blades in alpine rock art, and the later blades from Surendorf (Germany) provide compelling evidence for the feasibility of constructing flint high-impact weapons (Ebbesen 1992; Horn 2014). Furthermore, a type of curved flint blade found in Poland and Western Ukraine dating to the 4th and 3rd millennium BC exhibits typical halberd characteristics, with one example even preserving its perpendicular handle (Libera 2001, fig. 30–1) additionally supporting the hypothesis that thick flint points could have functioned as halberds.

A review of the evidence, focusing primarily on Denmark, Schleswig-Holstein, and adjacent regions produced a number of interesting observations. Though by

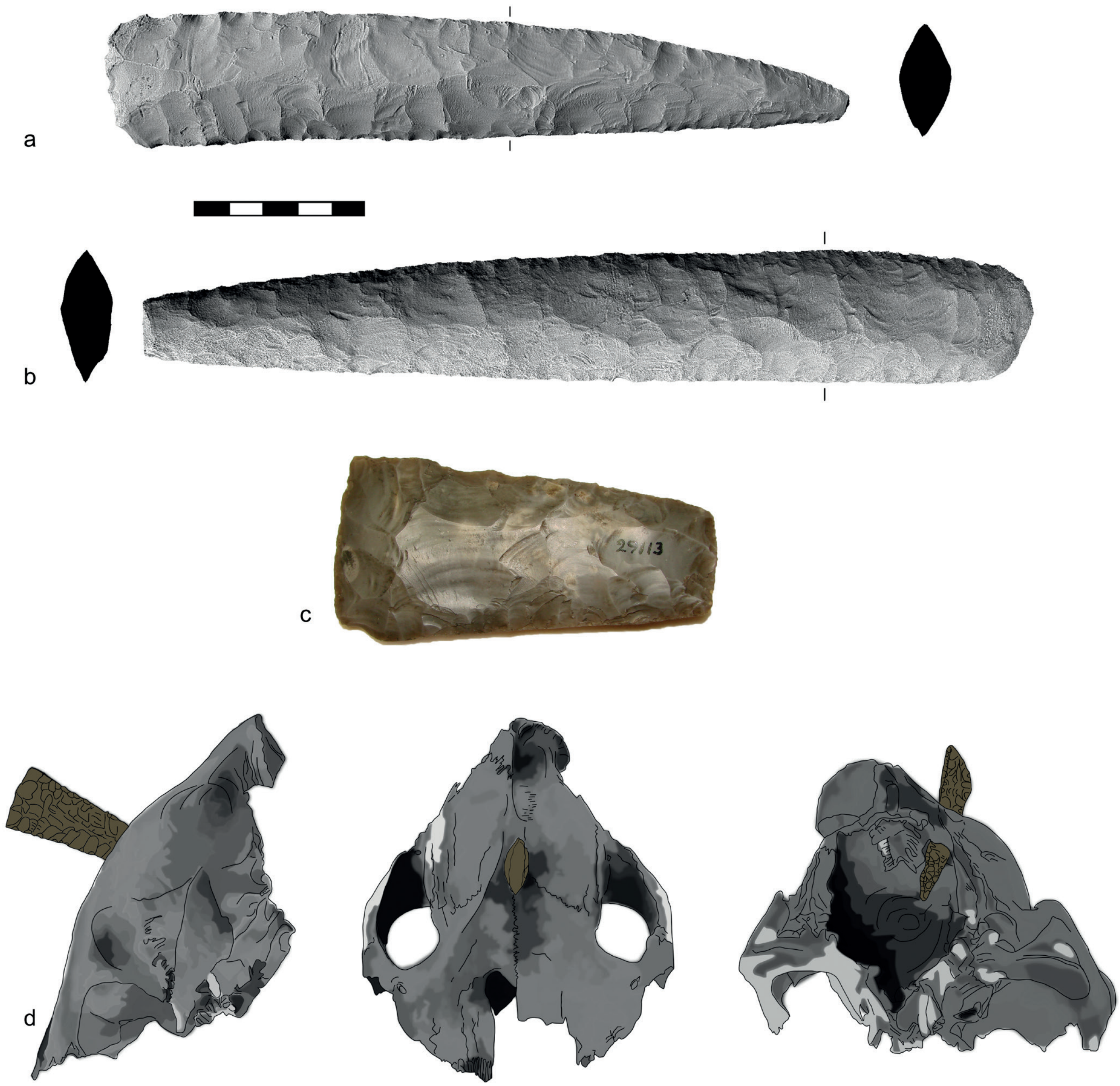


*Figure 1.3. Thick flint points with broken tips from a. Geestrup (LMSH KS12449) and b. Gelting (LMSH KS12542); c. fragmented thick flint point reworked into an axe from Oppstad (Museum Oslo C29113); d. a fragmented piece stuck at the centre of a horse skull found close to Tomelilla (redrawn by CH from Andersson 1901 with the blade emphasized in colour).*

no means exhaustive, to date the survey has recorded the presence of at least 248 thick points, a number of which show surprising variations in material and manufacture across the different regions. Some points found in the central to northern regions of Sweden were made from quartz, while, as Klaus Ebbesen (1992) noted, approximately 90% of the contemporary two-sided flint chisels found in Denmark were crafted using fractured thick flint points. In Norway, Einar Østmo (1988, 50) made similar observations, noting that broken flint points were repurposed into axes. This highlights how limited our archaeological knowledge is regarding the actual number of weapons in use during this time including even potential metal weapons (Horn 2021). The settlement at Barkær (Randers, Denmark) further underscores this notion, as it yielded 21 fragmented thick flint points (Ebbesen 1992). It is plausible to assume that the unusually high number of finds in one locale resulted from exceptional

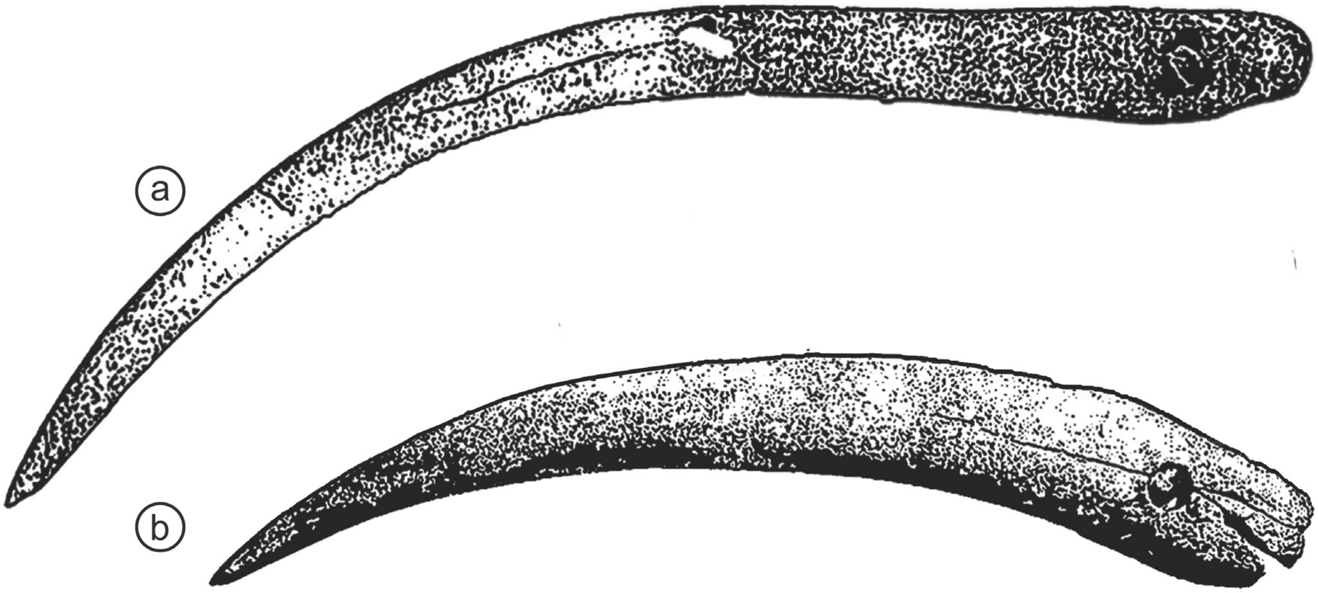


*Figure 1.4. Pick from a. burial 36 and b. burial 65 in Västerbjers, Gotland (redrawn by CH from Stenberger 1938).*

circumstances, rather than indicating the possession of a large quantity of weapons solely at this site.

### Antler picks

In the Scandinavian Neolithic, additional implements with a hafting to thick flint points and halberds can be identified. These implements, made from antler or bone, lacked cutting edges but featured sharp points. They were hafted perpendicular to their handles. Hafting was achieved by drilling a hole into the central or terminal portion of the object and securing it to the handle with organic pegs, nails, or lashings made from raw hide or plant materials (Fig. 1.4). A well-preserved antler pick, affixed to a wooden handle was discovered at Sutz-Rütte, Switzerland (Winiger 1999).

The antler picks in burials on Gotland, e.g., Västerbjers, were produced by PWC communities (3400–2300 BC) (Stenberger et al. 1943). However, the quantitative analysis of this material is hindered by the lack of comprehensive catalogues, unlike those available for Bronze Age metalwork. Furthermore, with the exception of Gotland, bone and antler do not preserve well in the soils of most southern Scandinavian regions. Radiocarbon dating of two of antler picks from Västerbjers indicates a dating to 2840–2580 cal. BC (Eriksson 2004), while a find in Tygelsjö was dated slightly later to 2465–2200 cal. BC (Ahlström & Molnar 2012; Tornberg & Jacobsson 2018). The Tygelsjö pick's tip was found embedded in a skull, providing clear evidence of its use as a weapon. Ethnographic evidence also supports this interpretation (Tudor 1969; de Laguna 1972).

The Tygelsjö pick belongs to several finds from flat burials, but of the five to six finds from Scania only Åraslöv, Nosaby is better documented. Forssander (1936) connects the group to the Boat-axe Culture, a local variant of the CWC. He assumed a strict chronological separation of the PWC from the CWC, and thus, pointed to links to what he assumed to be a previous stage. However, today it is known that while TRB, PWC, and later CWC groups had different genetic profiles, they were partially contemporary communities in contact with each other (Malmström et al. 2009; 2019). In addition to the antler picks and other burial goods, the deceased in Scania were laid out on their backs like those on Gotland, suggesting a connection between the communities (Janzon 1974). The migration aspect of this connection is still unclear. However, discoveries in in Djursland, the Danish Isles, and north-eastern Germany seem to indicate some degree of population movement (see below).

### Pick/battle-axe hybrids?

There are similar implements that have received even less scholarly attention due to their scarcity. In the absence of a find like the antler pick from Tygelsjö, there is no conclusive evidence supporting their use as weapons. However, their formal characteristics suggest that they could have served in such a capacity. These bone implements, known as double picks with central shaft-holes (Fig. 1.5a), have been found at sites such as Ostendorf-Tannenwerder (burial III/35) and Zirzow 2-Krappmühle in Mecklenburg-Vorpommern, Germany (Nilius 1971; Lübke et al. 2007). The necropolis in Ostendorf-Tannenwerder contains flat graves associated with hunter-fisher groups living near TRB communities. Furthermore, material connections, including boar tusks, amber beads, bone points, and chisels, link this site to the PWC necropolis in Västerbjers (Stenberger et al. 1943). Some early AMS dates suggest that the burials at

Ostendorf-Tannenwerder may date as far back as 3800 cal. BC. However, the shaft-hole picks under discussion appear to be later: ranging from approximately 3400–3000 cal. BC, falling within the expected timeframe for the early PWC (Lübke et al. 2007).

In Sweden, there are several stone shaft-hole implements with similar pointed ends (Fig. 1.5b), examples of which have been found at two sites in Västergötland (Sweden): Gårda, Timmele, and Bärby, Svarteborgs. These have been dated quite early to the Mesolithic Lihult Culture (Cederschiöld 1950). Shaft-hole picks and axes made from lithics, antler, and bone have a long tradition, including the Ertebølle T-axes found in the eastern Baltic, Poland, Scandinavia, and the Netherlands (Andersen 1981; Grygiel & Bogucki 1990; Louwe Kooijmans et al. 2001; Rimkus 2023) to the Neolithic stone double axes discovered throughout Scandinavia. However, the Gårda finds share more similarities with finds from the Schönfelder group of the Central German Final Neolithic, dating from 2800–2200 BC (Brandt 1976). Another fragmented discovery from the Tanum area is dated to the end of the 'Younger Neolithic', aligning with the middle or early second half of the 4th millennium BC (Montelius 1917). These finds were mostly concentrated in western Sweden. Some of the artefacts discussed in this section were richly decorated suggesting that they, like contemporary and later weapons, held high cultural and perhaps ritual significance (Montelius 1917, Andersen 1981. For later weapons see Molloy & Horn 2020).

### *Brief outline of other weaponry*

Close combat weapons associated with the northern Neolithic are subject to a very fragmented publication record which hinders their wider study. Clubs with stone heads were already widespread during the Mesolithic, continuing through the 5th millennium BC Neolithic cultures of Central Europe into the Scandinavian Late Neolithic period (Biermann 2001; Hübner 2005; Schultrich 2018). A round stone club with a richly decorated wooden handle was discovered in Oldenburg-Dannau (Germany). The handle was radiocarbon dated to 2470–2341 cal. BC (Brozio 2016). Similar round-headed, but also disc-shaped mace heads are known from Sweden, Denmark, and northern Germany (Fig. 1.6) (Montelius 1917; Ebbesen 1978). The wooden club from Wiesmoor (Germany) demonstrates that wooden weapons were probably also pervasive but are difficult to assess due to preservation issues (Strambowski 2015).

Neolithic warfare encompassed not only close-combat weapons but also archery, which cannot be overlooked. Southern Scandinavia has yielded numerous arrowheads from PWC contexts, categorized into four types (A–D) by Carl Johan Becker (1951). Rune Iversen (2016) further interpreted these forms based on archaeological evidence and ethnographic comparisons, suggesting that some arrowheads were specifically designed for conflict rather than hunting.

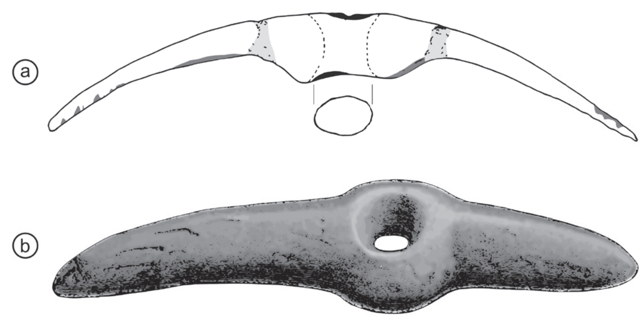


*Figure 1.5. Double picks from a. Ostendorf-Tannenwerder, burial III/35 and b. Gullbringa (redrawn by CH after Lübke et al. 2007 and Montelius 1917).*

Bone arrowheads were also utilized in combat (Lindman 1985; Iversen 2016). In the Danish Bell Beaker-inspired burials of the latter half of the 3rd millennium BC, the presence of archery gear alongside flint daggers served as indicators of warrior status for the deceased (Christensen 2004; Sarauw 2007).

### Collective burials, collective identities?

TRB communities during the Middle Neolithic buried their dead predominantly in collective graves which is often interpreted as indicative of the social collectivity of peaceful, egalitarian farmers (Müller 2010) who were eventually conquered by migrating CWC warrior pastoralists (Glob 1944; Kristiansen et al. 2017). However, this connection is often left unexplained. In many passage graves, a huge amount of often high-quality artefacts was directly associated with individuals in the chambers (Brozio 2016, 54–5, 144–5; cf. Lorenz 2018, catalogue). It is, of course, difficult to know how the individuals were made visible, but, in a few contexts, detailed observations indicate that the integrity of individual identities was kept during sorting when clearing space for new interments (Jensen 2001, 379; Furholt & Mischka 2019, 926). This is further supported by findings from central German chamber tombs (Müller 2001, 338). In other megalithic tombs, this is more difficult to assess. For example, in gallery graves the decomposed bones were displaced when new dead arrived while often broken objects of poorer quality were placed in the entrances and antechambers (Schierhold 2010, 182; Cottiaux et al. 2014, 472; Pape 2019, 222–4). This is in contrast to the situation in the north where battle-axes appear more frequently in passage graves and are found mostly intact (Schultrich 2022, 459–61, 470–2; cf. Ebbesen 2011, 316–7). Despite some difficulties, it is possible to view the battle-axes left in passage graves as being given to specific individuals, anticipating the practices in Younger Neolithic single graves. Whereas in other regions, like the western German gallery graves, battle-axes possibly lost their relationship to individuals (cf. Cottiaux et al. 2014, 515).


*Figure 1.6. Round club from a. Oldenburg-Dannau (redrawn by CH from Brozio 2016) and b. a discoid club from Sieverstedt (LMSH KS18717).*

This is broadly in line with those interpretations that argue that, while collective burials contained many bodies, they were still receptacles for deceased individuals who were seen and treated as such (Brown 1995, 4–5; Weiss-Krejci 2011, 164). Jan-Piet Brozio (2016) and others (Raemaeker & Velde 2022) share this interpretation by regarding each vessel in a tomb as grave gift for one individual. This is supported by burials in Mander (Netherlands), where many of the single graves attached to a collective burial contained only one vessel (Lanting & Brindley 2004). In other necropolises with single burials, such as Dalfsen (Netherlands) or Heek-Nienborg (north-west Germany), we see the same pattern (Pak & Pfeffer 2019; Raemaeker & Velde 2022). In both these examples, only one burial out of 138 and one in 24 burials respectively contained a battle-axe. In Dalfsen this burial was richly furnished with another axe and several ceramic vessels. This demonstrates the connection of battle-axes to specific individuals and the exclusive status that these deceased persons enjoyed.

Based on this it can be argued that the deceased in the passage graves of northern Europe may have been buried as individuals with equipment demarcating or constructing specific personal identities. For a few individuals, such burial items comprised battle-axes or thick flint points, i.e., specialized weapons. Both items could be seen as specific symbols for a warrior-related identity (cf. Jeunesse 2017). Thus, even though the picture is blurred by the Middle Neolithic burial customs, and less clear than for the Bronze Age, collective burials could contain deceased individuals buried in accordance with a warrior ideal, similar to that found in later warrior burials. This indicates that a warrior ideology already existed in TRB societies and was not an innovation introduced by migrating CWC groups.

## The victims

Skeletal remains provide crucial evidence for warfare and inter-personal violence, complementing our focus on weaponry. Gundula Lindman (1985) conducted a pioneering study comparing the quantity of projectile points embedded in animal bones with those found in humans from the Palaeolithic to the Bronze Age. Excluding three projectiles discovered in the USA, it is noteworthy that the Neolithic period yielded the highest number of projectiles embedded in any type of bone, with a significantly greater number in human than in animal bones. While we will not delve into detailed discussion here, this finding supports the concerns raised by Lawrence Keeley (1996) that archaeologists often overlooked evidence of Stone Age warfare and violence.

Recent analyses and revaluations of earlier studies have revealed an increasing number of Neolithic individuals who fell victim to violence. It is important to note that survivable injuries should not be misconstrued as indicating less conflict or even peaceful times. Blows that left cranial injuries result in severe brain trauma, often leaving victims impaired and reliant on the care of their contemporaries (Tornberg & Jacobsson 2018). The interpretation of trepanations as ritual practices has been challenged by archaeological and ethnographic research, suggesting that these procedures were likely performed to relieve pressure or remove skull fragments following serious injuries. In addition, some skull traumata have been wrongly interpreted as trepanations (Bennike 2004; Ullrich 2011; Dosedla 2013).

Evidence of warfare-related cranial trauma has been found at approximately 35 sites in Sweden, Denmark, and northern Germany (Fibiger et al. 2023). However, post-cranial injuries have received less attention. In Denmark, an astonishing 16.9% of analysed skulls displayed cranial trauma, both healed (12.6%) and lethal (4.6%). In Sweden, the percentage is lower at 9.4%, including healed (6.8%) and lethal (2.6%) trauma (Fibiger et al. 2023). To provide context, on the Bronze Age battlefield in Tollense, where all individuals died due to violent conflict, the presence of both healed and lethal cranial trauma amounts to 7%. Only 14% of all injuries in Tollense affected the skull (Brinker et al. 2014; 2016). This comparison highlights the intense violence and warfare that likely occurred during the Nordic Neolithic period.

Palaeo-demographic estimates provide another indication of the scale of violence. A multi-proxy model for population dynamics in northern Germany and southern Denmark revealed a significant population decline in the second half of the 4th millennium BC, likely influenced by factors such as the transition from individual farms to village-like structures and movements from east to west (Hinz et al. 2012; Feeser & Dörfler 2015; Feeser et al. 2019). This decline aligns with similar population busts in wider Europe, coinciding with an intensification of metallurgy, specialized copper weapons (e.g., halberds) and, in Scandinavia, the immigration of PWC groups. It suggests that in addition to other factors the endemic warfare inferred from cranial trauma and weaponry may have contributed to this population decrease, as argued by Stephen Shennan (2013) for other population busts.

In the early 3rd millennium BC, there appears to be a short-lived population recovery. The subsequent decline in population is less severe with some calculations suggesting stagnation (Feeser et al. 2019; Müller & Diachenko 2019). However, ancient DNA (aDNA) analysis presents a different narrative of relatively sudden decline of Neolithic ancestry and the introduction of a steppe genetic component from the east (Brandt et al. 2013; Kristiansen et al. 2017; Kristiansen 2022). The scale and timeframe of this transition are subjects of intense debate (Frieman & Hofmann 2019; Furholt 2019b). However, perhaps it is possible to say that the initial strong impact had a long tail-end caused by the continuous migration of people which may be easier to recognize in the archaeological record. While it is not possible to prove whether this arrival led to genocide (Furholt 2019a), it can be suggested that any population decline may be obscured by the long-term influx of new groups. Ultimately, it was likely that the earlier population bust in the second half of the 4th millennium BC made the region and its local groups susceptible to the influence of Corded Ware groups, marking the end of TRB communities.

### The spatial dimension of violence

The focus of the spatial analysis of Nordic Neolithic weaponry will be on battle-axes and thick flint points, as they have been extensively documented compared to other weapons. Their common occurrence makes them suitable for quantitative analysis. By examining their distribution, we can gain insights into the spatial patterns and mobility of the groups involved. To achieve this, we employ a straightforward method called the kernel density estimate (KDE), which aids exploratory analysis and can provide predictive models for regions where future discoveries are more likely.

The thick flint points are concentrated primarily in Jutland, the Danish Isles, and the south-eastern Baltic Sea coast (Fig. 1.7a). The KDE reveals the highest density between the fjords of the Anglia peninsula, and a second concentration in eastern Holstein around Eutiner Lake. This distribution extends from Kiel Bay to Langeland in the north. Other notable clusters are found in north-west Zealand and a larger area spanning from the inner parts of Aarhus Bay to south-east of Silkeborg, following a line of prominent inland lakes. The most prominent distribution, considering the number of finds, is at the innermost point of Aarhus Bay, although this is influenced by a unique discovery in the settlement of Barkær (Fig. 1.7b). Additional isolated clusters are observed in northern Jylland (Denmark), at the convergence of three prehistoric fjords close to Dingle (Bohuslän, Sweden), and along the western shore of Gotland.

The early battle-axes of type F form clusters in an arc around the south-western Baltic Sea, with significant concentrations in Scania, Östersund, northern Zealand, eastern south Jutland, and central Mecklenburg-Pomerania (Fig. 1.8). Additional clusters are observed in the narrowest part of Kalmarsund, the western end of Bråviken extending to the eastern shore of Lake Vättern, and the wider region from the western shore of Gothenburg to the famous Fallbygden area between Lakes Vänern and Vättern. Beyond this, these axes are even more prevalent throughout central Europe (Zápotocký 1992).

The late Early Neolithic axes of the type K were more prevalent in the northern regions, with a particularly dense cluster extending from western Scania across Øresund into eastern Zealand (Fig. 1.9). A strong cluster was detected in eastern Mecklenburg-Pomerania and northern Brandenburg south of the Pomeranian Bay. Another dense cluster can be seen in eastern Sweden between lake Hjälmaren to the north, the Bråviken fjord to the east, Lake Roxen in the south, and Lake Vättern to the west. Additionally, the south-east Limfjord region and the Aarhus area exhibited notable concentrations. Overall, these battle-axes extend further northwards and eastwards, with a more balanced and denser distribution than the type F. Inner southern Swedish regions do not show considerable find agglomerations so that it is possible to observe that these axes follow waterways and important water passages.

The Middle Neolithic axes exhibited a contrasting pattern, with a notable concentration in the southern region on the island of Rügen (Fig. 1.10). This cluster was strongly connected to the extreme south-east of Sweden and the south-western Baltic coast in Germany, extending from the Eckernförder fjord to the Lübeck bay and south to Hamburg. Additionally, there are still scattered clusters on Gotland, the Kalmar passage, Fallbygden, and Bohuslän where they were also discovered in PWC burials. When excluding the Swedish finds, the prominence of the cluster on the island of Rügen becomes even more evident. Overall, the axes repeat the water-related pattern of the late Early Neolithic axes.

If we separate the Middle Neolithic battle-axes into early and late forms, it shows that in the early phase the cluster on Rügen was pronounced, but did not yet have the densest distribution (Fig. 1.11a). The areas around the Flensburg fjord and on Zealand the areas in the south of the Lammefjord and Isefjord stand out. The inner Limfjord region seems to match Rügen. There are still several concentrations visible on the Scandinavian Peninsula around the Oslofjord, Lake Vättern, and Scania as well as the archipelagos north of Gothenburg, the Uppsala region, and east of Lake Hjälmaren. In the late phase, the KDE does not show any area on the Scandinavian mainland (Fig. 1.11b). This means that, while battle-axes do not completely disappear, the tradition of depositing them retreated and became concentrated in the southern Baltic coastal regions.

### Discussion

If we consider violence and warfare during the 4th and 3rd millennium BC in the light of the archaeological evidence, the sheer mass of specialised weapons in terms of numbers and variability is striking. While none of these weapons may be seen as a pinnacle of specialized weapon design in the way that the later sword came to represent, they anticipate many of the attributes of later weapons. The battle-axe may have been a readily available and accepted concept prior to its appearance as the dominant weapon during the CWC incursions of the 3rd millennium BC. The thick flint points were perhaps inspired by the development of copper alloy halberds in the south which in turn may have inspired PWC groups to pick up the concept in the form of bone and antler picks. This in combination with ideas about battle-axe construction and older weapon forms may have given rise

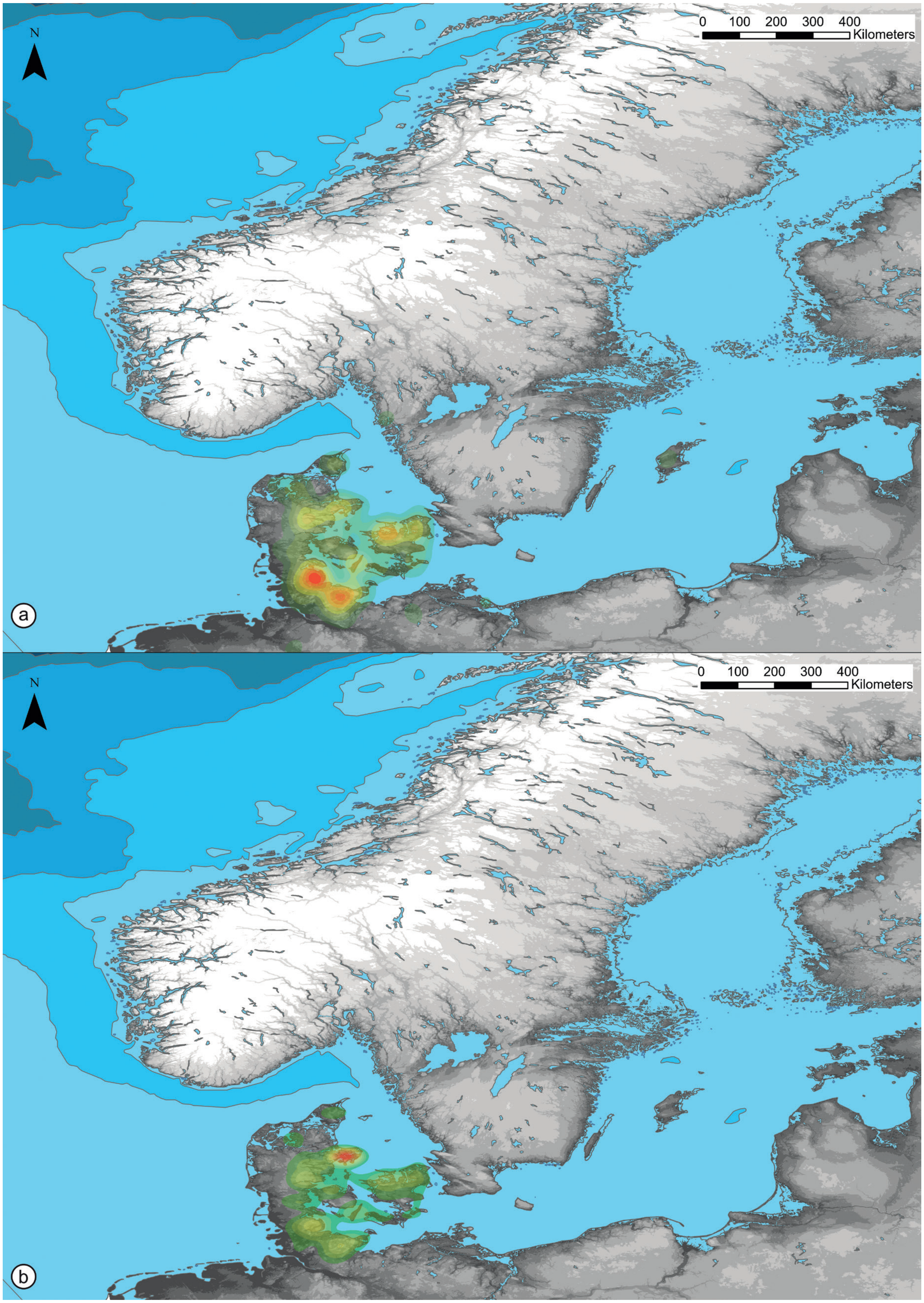


*Figure 1.7. Kernel Density Estimate of thick flint points a. sites and b. absolute number of finds. Map by CH and Ashely Green.*

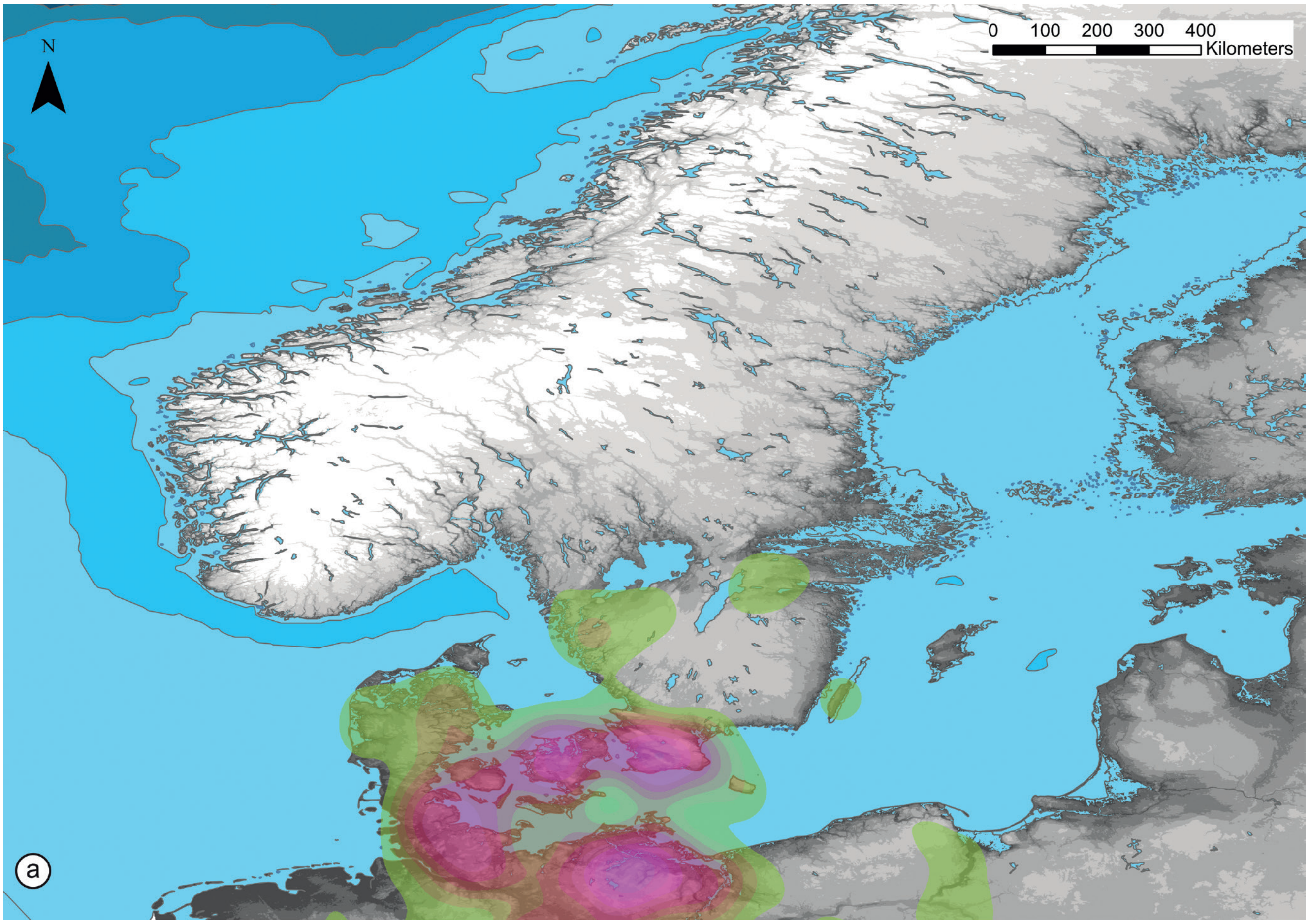


*Figure 1.8. Kernel Density Estimate of Type F axes. Map by CH and Ashely Green.*

to the double picks. However, this requires more research as it has the potential to unveil an even older stratum of violence and warfare in the north.

Like later weapons, battle-axes and flint points were involved in rituals. What had once appeared to be an especially apt illustration of this must now be discounted as a falsification (see endnote 2). It was published very early and at that time mistaken for an arrow or spear point (Andersson 1901). However, the dimensions and curved shape clearly identify it as a thick flint point (Fig. 1.3d). It was apparently discovered in a horse cranium that was retrieved from a river (Ullstorpsån) close to the modern town of Tomelilla, c. 12 km directly north of the south Scanian coast. The point sits right at the centre of the cranium which would be an apparent testament to the penetration capabilities of these points (for halberds see O'Flaherty 2007). That position would therefore suggest that the weapon bearer stood right in front of the animal which must then have been held still or already dead when the blow was carried out, thus seeming to suggest a ritual act.[2] Battle-axes have been subject to symbolic treatment. For example, complete and fragmented battle-axes were deposited as single finds. Additionally, cup-marks were applied to a few fragments, which links them to wider cup-mark phenomenon (Schultrich 2024). Together with their presence in burials and in rock art, this find underlines the high symbolic value attached to all the weapons under discussion. Their link to specific, deceased individuals can be interpreted as evidence that these individuals were marked out as warriors similar to later deceased (Sarauw 2007; Molloy & Horn 2020). This suggests that the warrior identity was present at least 1500 years prior to the beginning of the Bronze Age.

The victims of violence demonstrate that this identity was based on actual bloodshed, and given this observation, combined with the high number of weapons, it is likely that endemic warfare contributed to the busts in the palaeo-demographic models. Here the impact of the spreading PWC communities could have been stronger than the later arrival of CWC groups in the region. This could have been exacerbated by a decline in social cohesion through a loss of linking TRB traditions and an intrusion of GAC (Globular Amphora Culture) elements. However, while warfare may have been a common occurrence, the interpretation of a genocide during either period seems unjustified. Instead,

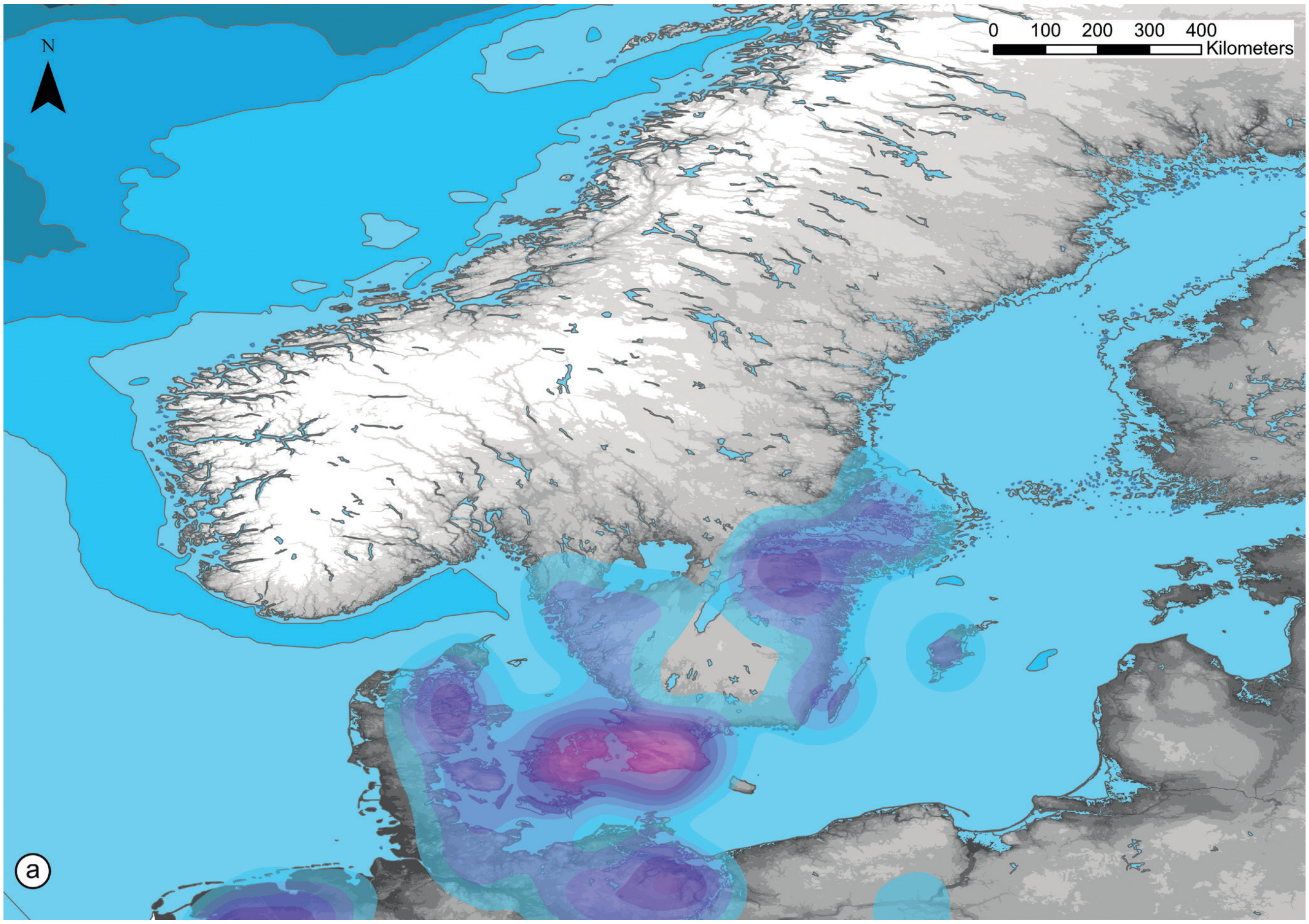


*Figure 1.9. Kernel Density Estimate of Type K axes. Map by CH and Ashely Green.*

it may have been a scenario similar to that described by Herfried Münkler (2005) as the 'new wars'. This violence rarely erupts in large battles, but instead is like a low burning but constant fire of raids, skirmishes, and clashes, which can cause very high numbers of victims over a long duration of time (see also, Kristiansen & Earle 2022). Of course, not all groups were fighting each other all the time as the evidence for cultural contact and hybridization, for example in Alvastra (Sweden), Djursland, and in Mecklenburg-Pomerania, suggests.

Again, similar to the Bronze Age, a high density of finds including ritual depositions occur at important nodes of mobility for boats, such as the strait at Öresund, fjords, e.g., Oslofjord, the Flensburger fjord, etc., islands, and peninsulas. The sites of these depositions were often less that a day's march away from the coast. Such weapon depositions along crucial passages for sea journeys have been interpreted as indicative of the high importance for boats in the conduct of violence (Horn 2016). This is emphasized, for example, by the settlement close to the find location of the mace from Oldenburg-Dannau. The shore area of the site was fortified by a palisade and disarticulated skeletal remains of two individuals have been discovered (Brozio 2012; Müller 2012). Other palisaded enclosures were located right by the water's edge (Brink et al. 2009). Overall, enclosures associated with TRB communities were highly defensible with multi-tiered layers of ditches and presumably palisades located on promontories or other locations higher up in the landscape (Lindman 1985; Christensen 2004). In addition, there is evidence that some of these fortified sites ended in conflagrations (Svensson 2002; Nielsen 2004; Brink 2009). As has been discussed before (Horn 2021), these were likely multi-purpose sites and as such neither ritual nor mundane use preclude a defensive function of these sites (Parkinson & Duffy 2007). Fortified sites may have even helped to pacify their surrounding areas, enabling cultural and other forms of exchange as well as ritual functions. The Alvastra pile-settlement may serve as an example: an easily defensible site with evidence for cultural interaction between PWC and TRB (Frödin 1910; Malmer 2002).

The interpretation of enclosures as defensive structures is probably in line with the second wave of enclosures at the end of the TRB culture which is linked to the transition to the

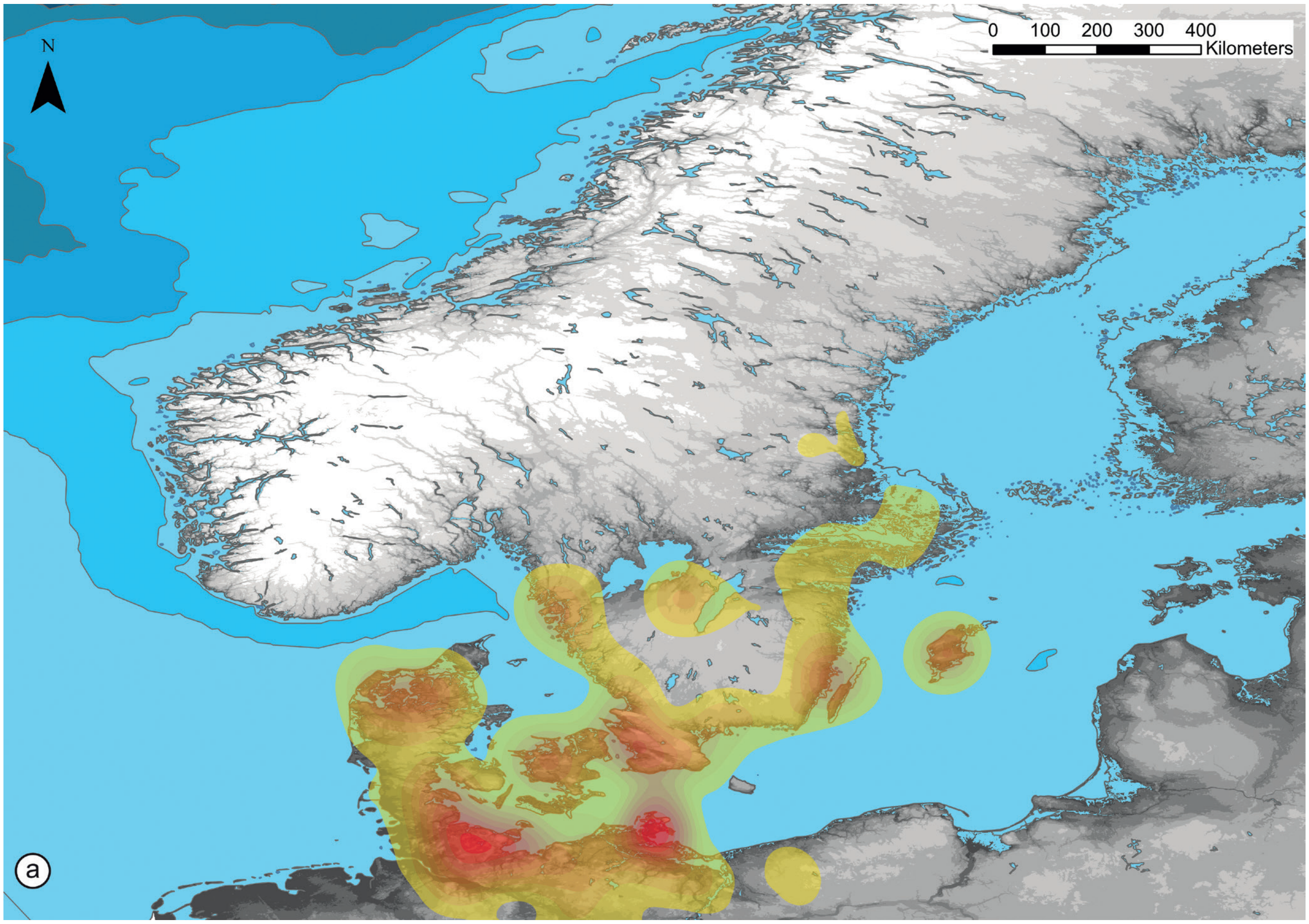


*Figure 1.10. Kernel Density Estimate of all Middle Neolithic battle-axes. Map by CH and Ashely Green.*

Battle-axe Culture (Nielsen 2004; Iversen 2015) which then continued the tradition (Brink 2004). This may indicate the retreat of TRB communities during the second half of the 4th millennium BC corresponding with the expansion of the PWC groups overseas and the expansion of the GAC to the east. Even though PWC communities evidently knew about late battle-axes (see Zápotocký 1992), the significant temporary decrease in the use and deposition of battle-axes on the Scandinavian mainland supports the idea of retreating TRB groups. This long-term process may have exacerbated the crisis that led to the drawn-out decline of the TRB.

The attrition reeked by warfare, in combination with other factors such as disease (Rascovan et al. 2019) and climatic changes (Smith et al. 2016), may have spelled the eventual demise of the TRB culture in the north. However, weakened local communities may also coalesce into new multi-ethnic groups with newly emerging shared cultural institutions as observed anthropologically by Stephen Kowalewski (2006). With the continued evidence for violence in the second half of the 3rd millennium BC, for example in Tygelsjö, the continuing importance of battle-axes, CWC related evidence of violence including arrow wounds, such a process may have contributed perhaps together with a Bell Beaker influence (Sarauw 2007) to the disappearance of the CWC and PWC communities and the emergence of the unique Nordic Late Neolithic. However, further research into this topic is necessary.

## Conclusion

Based on our interpretation of the evidence, it seems that there is little that separates the Neolithic from the Bronze Age in terms of warrior ideology, the scale of violence, the ritual importance of weapons, and the pathways taken to conduct raids and other modes of warfare (Fig. 1.1). The only thing that might be said to distinguish Bronze Age warriors from their Neolithic forebears is that they seem to have been extraordinarily successful in transforming their involvement in bloodshed into political clout. Specialized weapons such as those discussed here indicate a readiness to conduct violence, even if not every weapon was actually used in combat. Weapon technology was developed, and combat may have influenced innovations in non-specialized hybrid items, as suggested in the case of the antler picks.

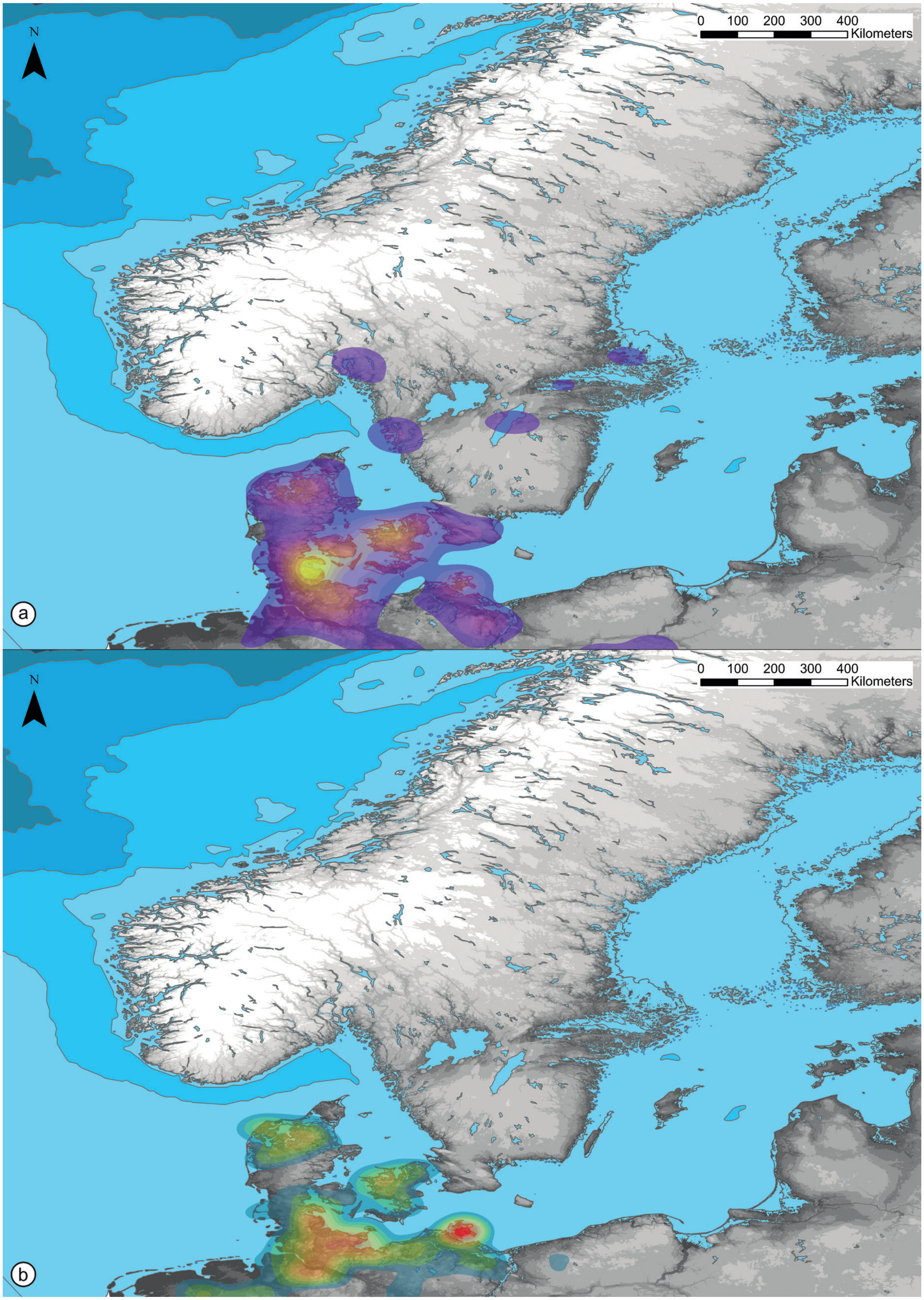


*Figure 1.11. Kernel Density Estimate of MN battle-axes: a. early Middle Neolithic; b. late Middle Neolithic. Maps by CH and Ashely Green.*

However, as the continuity of round shaft-holes indicates that innovations in weapon technology were probably accepted by some groups and rejected by others in equal measure.

As discussed previously, endemic warfare, evidenced by weapons, victims, and fortifications, clearly left an impact on the cultural mosaic of the Nordic Neolithic. Of course, not all interactions were necessarily violent. The development of boat technology and waterborne travel also facilitated peaceful encounters between groups. As the presence of GAC elements on the Danish Isles shows, the overall picture is far more complicated than we might assume (Iversen 2015). The appearance of new features such as palisade enclosures, the rise of individualized burial practices, and the cessation of others, such as collective burials and causewayed enclosures, were doubtless the products of complex processes. However, along with epidemics and other crises, violence driven by waterborne mobility may well have been a significant contributing factor in propelling change, accelerating the end of the TRB and the coalescence of different groups in the Nordic Late Neolithic.

### *Notes*

1 While Early and Younger Neolithic copper axes are well-known (Kibbert 1980, Maran 2008), the dating of copper double axes – the Zabitz type – to the Middle Neolithic is a rather recent discovery (Schultrich 2022).

2 While the flint blade is Neolithic, the skull returned a radiocarbon analysis indicating a Viking Age date for the cranium. Unfortunately, this means that the find as it is today is a falsification (Liljegren & Lagerås 1993). Since this has not been widely published in English, we decided together with the editors to leave the discussion above in the text together with this clarification note, in order to alert readers about the known evidence for the find and potential hazards of drawing conclusions from it.

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# 2

# Chalcolithic and Bronze Age Atlantic connections, *c.* 2500–800 BC

*Aurélien Burlot*

*Exchanges of exotic and precious materials along the Atlantic façade of Europe have occurred since at least the mid-5th millennium BC, evidenced in Atlantic France by the presence of beads of Iberian variscite in Early Neolithic tombs around the Gulf of Morbihan. Such exchange routes across the Bay of Biscay appear to have continued during the 3rd and 2nd millennia BC, with further evidence of Iberian influence on metal objects (copper, gold, and silver) in the Chalcolithic Beaker period from* c. *2500 BC onwards.*

*These maritime networks of metal exchange are not confined to Iberia and France, with strong evidence of connections not only to Ireland and Britain but also as far afield as Scandinavia. The appearance of Beaker goldwork, such as 'sun discs' and basket-shaped ornaments in Iberia, Ireland, and Britain, for example, clearly demonstrates Atlantic connections between these regions. These networks appear to shift and alter over time. This is particularly evident during the early Middle Bronze Age (mid-2nd millennium BC) with the widespread distribution of shield-pattern palstaves made of Great Orme copper across southern Britain, but also in Brittany, the Low Countries, and western Sweden. At the end of the Bronze Age (*c. *1000–800 BC), further shifts in metal-exchanging networks can be detected, notably in the distribution of Carp's Tongue swords in Iberia, Atlantic France, and south-east Britain.*

*Regarding the involvement of Scandinavia in the metal trade, it is suggested that Baltic amber may have played a significant role. While there are problems interpreting the origins of this material in certain contexts, the presence of Baltic amber as early as the mid-4th millennium BC in north-eastern Spain, provides strong evidence of early connections between northern Europe and Iberia.*

## Introduction

One of the key aims of the Maritime Encounters project is to determine and assess the flow of metal along the Atlantic façade from Iberia to Scandinavia. This objective represents the continuation of several decades of scientific study (see Stos-Gale & Ling this volume). However, for certain regions of Atlantic Europe, such as western France and Ireland, modern analyses of Bronze Age metalwork have not been as thorough or extensive as those in other countries; hence the need, at this stage, to review typological developments in the material record in order to determine the impact of long-distance exchange in these areas.

The present chapter discusses some of these developments based on past work and recent reviews. It can be asserted that across the Bay of Biscay, exchanges of minerals from Iberia to Brittany were already established by the middle of the 5th millennium BC, likely associated with the spread of megalithic traditions along the Atlantic coast. Further connections can be observed from *c.* 2500 BC with the appearance of metalwork in Atlantic France, which is considered to be directly associated with the spread of the Beaker material culture across Europe. A similar pattern can also be observed for the introduction of metallurgy to Ireland, with north-west France acting as a springboard for the expansion of the Beaker network (see Burlot 2019).

Following the Chalcolithic Beaker period, from *c.* 2200 BC onwards, some parts of Early Bronze Age Atlantic Europe saw the emergence of recognisable groups (e.g., Armorican Tumulus and Wessex), accompanied in some cases by the development of regional styles of metalwork. Some metal objects, however, remain typologically static, suggesting that exchanges of finished items still occurred. This reflects the uneven distribution of copper mines across the Continent, and the dominance of certain metal-producing centres overtime (see O'Brien 2014). In some regions, such as north-west France and Scandinavia, where evidence of prehistoric copper mining is not attested (Gandois et al. 2019; Stos-Gale & Ling this volume), various metal-trading networks were established during the Bronze Age. While reviewing typological developments within this regional metalwork is essential, a substantial programme of metal analysis is required in order to determine the production and consumption of exchange items at various points along the Atlantic façade trade network.

## Chalcolithic and Bronze Age contacts between Atlantic France and Iberia

While copper metallurgy was already practised in some parts of France (e.g., the Languedoc) since the late 4th millennium BC, its appearance along much of the French Atlantic façade, especially in the north-west, is generally attributed to the spread of the Beaker material culture, possibly originating from Iberia, *c.* 2500 BC (Table 2.1; Burlot 2019). This theory is reinforced by the similarities between arsenic rich copper metalwork (e.g., flat axe-heads, daggers, halberds, and Palmela points), pottery styles (Maritime type Beakers), and other elements of the Beaker package such as lithics (barbed-and-tanged arrowheads, archer's wristguards) found in both regions (Labaune 2016; Nicolas 2016; Burlot 2019). Although much of the copper metalwork from Atlantic France is often devoid of context (i.e., stray finds), or has limited direct associations with Beaker material culture (e.g., disturbed, secondary deposits in megalithic tombs; Labaune 2016), the region's early connection to the Iberian Peninsula is strongly suggested by the presence of variscite beads in Neolithic burials around the Gulf of Morbihan in Brittany from the mid-5th to the late 4th millennium BC. The sources of this stone include Palazuelo de las Cueva (Zamora) in north-west Spain and Ensinasola in the south-western province of Huelva (Querré et al. 2019), a mineral rich region identified by the Maritime Encounters project as a potentially significant source of copper ore production in the later Bronze Age period (see Hunt-Ortiz et al. this volume). These manifestations of regional exchange may also be related to Schultz Paulsson's (contested) proposal favouring the diffusion of megalithic tomb building from north-west France to parts of Iberia (Schultz-Paulsson 2017).

Copper flat axe-head, dagger, and halberd traditions pre-date the Beaker period, but one object which is definitively Beaker-related is the Palmela point (Briard & Roussot-Larroque 2002). Thought to originate from western Iberia, its presence in France, particularly along the Atlantic façade appears to suggest extended contact with the Iberian Peninsula. Determining whether these objects may have been influenced by metalwork from Spain and Portugal or represent actual imports is another matter (Labaune 2016; Burlot 2019). A few French Palmela points have been subjected to elemental analysis (see Gandois 2009, appx 1; Labaune 2016); however, lead isotope analyses of samples from north-western France are extremely scarce. Of the four Palmela points isotopically analysed by Labaune for his doctoral thesis (2016, table 31) only one (Tumulus des Sables, Saint-Laurent-de-Médoc, Gironde) came from the Atlantic façade (see Fig. 2.1 for map of the study area of France). Despite the poverty of the data, his results are nonetheless interesting, indicating a possible Iberian source of copper mineralisation (from Catalonia, or Peñalosa in Andalusia; Labaune 2016, table 46). The suggested presence of Iberian copper metalwork along the French Atlantic façade, or alternative European deposits, is not surprising since prehistoric exploitation of copper minerals is not attested in this vast area of France (Gandois et al. 2019).

Identifying potential Iberian (and from elsewhere) Chalcolithic metalwork in Atlantic France is problematic due to the likely remelting of copper for local productions (Burlot 2019). However, one flat axe-head, recovered in 1927 within a small box-like structure on the island of Les Moutons (part of the Glénan archipelago off the coast of Finistère in Brittany), may have an Iberian origin. The artefact is teardrop-shaped which makes it unique amongst the Armorican Chalcolithic material, and contains high levels of arsenic (6%) with other impurities including Pb (0.001%), Sb (0.05%), Ag (0.01%), Ni (0.2%), and Bi (0.04%) (Fig. 2.2, top left; Briard et al. 1989; Large & Gilbert 1989). Another teardrop-shaped axe-head was found further south at Salebœuf (Gironde), but this example appears rougher and has not been analyzed (see Roussot-Larroque 1987, fig. 1.3). Generally speaking, the teardrop shape is more commonly associated with certain Iberian flat axe-heads rather than those from Atlantic France and this feature, combined with the high As levels of the Breton axe-head, suggests that this artefact is a potential Iberian import to Armorica (Briard et al. 1989, 51). A few other axe-heads also exhibit similarities between Iberia and Atlantic France (e.g., Burlot 2019, figs 91–6), but these types remain common across both regions (and elsewhere in western Europe) and are less diagnostic of their origin than the teardrop-shaped examples.

Continued links with Iberia at the beginning of the Bronze Age (*c.* 2300–1600 BC), are evidenced by some of the finds from the chambered barrow at Lothéa, Quimperlé in Finistère, excavated in 1843. The barrow is located above the Laïta, a coastal river, near the southern coast of Brittany. The material comprised three large daggers, another dagger of Armorican type, a flanged axe-head, a copper alloy rod,

*Table 2.1. Simplified chronological divisions, from the metal-using Neolithic/Chalcolithic to the end of the Bronze Age in Iberia, Atlantic France, Ireland, Britain, and Scandinavia.*

| BC DATE | IBERIA | ATLANTIC FRANCE | IRELAND | BRITAIN | SCANDINAVIA | BC DATE |
|---|---|---|---|---|---|---|
| 2500 | | | | | | 2450 |
| 2400 | Calcolítico/ Eneolithico | Néolithique final/ Chalcolithique | | | | 2350 |
| 2300 | | | Chalcolithic | Metal-using Neolithic/ Chalcolithic | | 2250 |
| 2200 | | | | | Late Neolithic I | 2150 |
| 2100 | | BA 1 (Keranou/ Kervrazet) | | Bithdir | | 2050 |
| 2000 | Bronce Inicial | | Killaha | | | 1950 |
| 1900 | | | | Mile Cross | | 1850 |
| 1800 | | | Ballyvalley | Willerby | Late Neolithic II | 1750 |
| 1700 | Bronce Medio | BA 2 (Muids) | | | | 1650 |
| 1600 | | | Derryniggin | Arreton | | 1550 |
| 1500 | | BM 1 (Tréboul, Escalles) | Killymaddy | Acton | | 1450 |
| 1400 | Bronce Tardío | BM 2 (Bignan) | | Taunton | Early Bronze Age | 1350 |
| 1300 | | BF 1 (Rosnoën) | Bishopsland | | | 1250 |
| 1200 | | | | Penard | | 1150 |
| 1100 | | BF 2 (St-Brieuc-des-Iffs, St-Denis-de-Pile) | Roscommon | Wilburton | | 1050 |
| 1000 | Bronce Final | | | | | 950 |
| 900 | | BF 3 (Carp's Tongue, Vénat/Plainseau, Créon/St-Loub.) | Dowris | Ewart, Blackmoor | | 850 |
| 800 | | | | Llyn Fawr | Late Bronze Age | 750 |
| 700 | | | | | | 650 |
| 600 | Hierro Antiguo | 1er âge du Fer (Günlinden) | Early Iron Age | Early Iron Age | | 550 |
| 500 | | | | | | |

Late Neolithic
Metal-using Neolithic/Chalcolithic
Early Bronze Age
Middle Bronze Age
Late/Final Bronze Age
Early Iron Age


*Figure 2.1. Départements of France (plus the Channel Islands) included in metalwork studies for the present project (map by Ashely Green and Aurélien Burlot).*

a gold chain, a silver chain, barbed-and-tanged arrowheads, an archer's wristguard, a jadeitite pendant, and a quartzite pebble (Nicolas et al. 2013; Nicolas 2016). The grave goods belong to the late Beaker tradition from the Early Bronze Age, and the tomb can be broadly dated to the 22nd century BC (Nicolas et al. 2013; Nicholas 2016). Iberian connections are suggested by the three large daggers and the two chains (Fig. 2.2). Based on shape and decoration, these rivetted daggers (known as the Quimperlé type) are similar to examples of the larger Quinta de Romeira type found in Galicia in north-west Spain (Nicolas et al. 2013). Although this Iberian type rarely matches the size of the

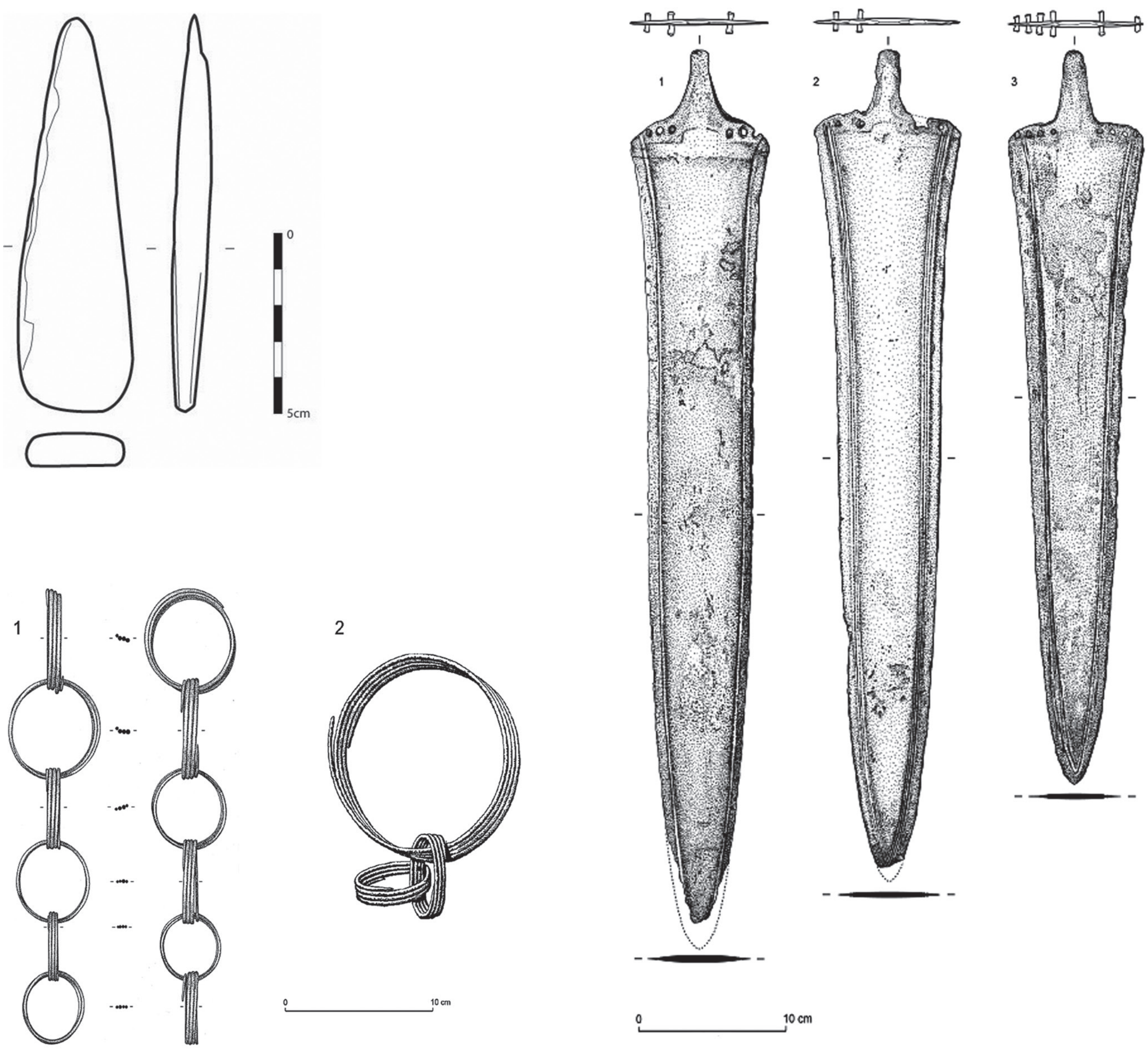


*Figure 2.2. Top left: teardrop-shaped copper axe-head from Île aux Moutons, Glénan archipelago (Finistère) (outlines redrawn after Briard et al. 1989, fig. 4.1); bottom left: 1. gold chain and 2. silver chain from the barrow at Lothéa, Quimperlé (Finistère) (after Nicolas et al. 2013, fig. 12); right: the three arsenic-rich, large daggers from the barrow at Lothéa, Quimperlé (Finistère) (after Nicolas et al. 2013, fig. 14) (Nicolas et al. (2013) illustrations courtesy of Gallia Préhistoire, CNRS Editions).*

Lothéa daggers, and does not have rivets, the overall form is very close. Another shared similarity are the high levels of arsenic (up to 7.1%), which is still apparent on the Armorican blades. It is unclear how such levels of arsenic came to be on the surface of the objects, with various theories suggested (e.g., deliberate addition on the surface, or natural electrolysis in the ground, or the result of segregation during the cooling process, such as repeated quenching) (Briard & Mohen 1974; Mohen 1990; Papillon 1997; Nicolas et al. 2013). Such high As levels are comparable to levels found in some Iberian type Quinta de Romeira daggers (e.g., Pinhal dos Melos and Quinta da Agua Branca, both in Portugal) (Nicolas et al. 2013).

Further connections between Lothéa and Iberia may be suggested by the presence of gold and silver chains. Gold chains are not represented in Atlantic France during the previous Chalcolithic Beaker period (Labaune 2016; Burlot 2019). There is also no evidence in Armorica of extracting silver from silver-bearing lead ores (cupellation technique) before the Iron Age, although there are Early Bronze Age precedents from Iberia (Briard 1984; 2003). This implies that the chains from Lothéa, and silver grave goods recovered from contemporaneous Armorican barrows, may be Iberian productions. Briard (1984, 137) suggested that there may have been a northward inland silver diffusion route, from the southern Armorican coastline using river systems.

Finally, regarding Early Bronze Age goldwork, it is worth noting three gargantilla-type objects from Brittany. Gargantillas are closed-up bands of sheet gold with incised lines in the middle of the object, commonly found in Iberia. The Armorican examples include one from a megalithic tomb at Port-Saint-Père, Saint-Père-en-Retz (Loire-Atlantique), and two from a megalithic tomb at Rondossec, Plouharnel (Morbihan) (Labaune 2016). These two locations are coastal, reinforcing the suggestion of maritime contacts between Armorica and Iberia.

Later during the Early Bronze Age, the Iberian connections to Atlantic France seem to have waned somewhat and, in Armorica especially, there are stronger links with Wessex and Ireland instead (Burlot 2019). During the Middle Bronze Age (*c.* 1600–1350 BC), cross-Channel links remained strong, potentially associated with the widespread trade of tin from Cornwall and Devon (see Penhallurick 2008; Williams and Le Carlier de Veslud 2019; O'Brien 2023; Williams 2023). These links are demonstrated by the recovery, in France, of bronze shield-pattern palstaves of the British Acton Park phase, made of copper from the Great Orme mine in north Wales (Williams and Le Carlier de Veslud 2019; Williams 2023). Two of these palstaves come from the Breton Tréboul hoard (Finistère), which gave its name to the most prevalent metalwork group in Armorica during the Middle Bronze Age (Briard 1965; Williams and Le Carlier de Veslud 2019; Williams 2023). The discovery of some Armorican (including from the early Tréboul group) material, but also Normand type palstaves, as far south as the Gironde during the Middle Bronze Age (see Lagarde 2008; Couderc 2017), suggests that the Iberian connections were more limited there than during the previous periods. Nonetheless, the recovery of a gold chain alongside many axeheads, scrap metal, and pots of the later part of the Middle Bronze Age (*c.* 1450–1350 BC) on a beach at L'Amélie, Soulac-sur-Mer (Gironde), may reflect enduring Iberian connections based on its resemblance to contemporaneous examples from Mérida (Extremadura) in Spain, and Torres Vedras (Oeste) in Portugal (Coffyn et al. 1995).

During the Late Bronze Age (*c.* 1350–800 BC), the early metalwork phases represented by the Rosnoën (*c.* 1350–1250 BC) and the Saint-Brieuc-des-Iffs (*c.* 1250–1000 BC) groups in Armorica, do not seem to present many connections with the Iberian Peninsula. Instead, these appear more closely related to metalwork groups from eastern and northern France (Briard 1965). A similar situation is noticeable further south in Aquitaine where some material shows affinity with Armorican assemblages (e.g., Rosnoën group). This state of affairs appears to change, however, during the last phase of the Late Bronze Age (1000–800 BC), with evidence of some renewed connections between Atlantic France and Iberia. One notable instance of this is the appearance of Iberian palstaves. These heavy bronze axes are typically elongated (exceeding 200 mm in length), with a small midrib, and with one or two side loops to receive the haft (Lagarde 2005). Within the study area, there is one example from Brittany (Pen-ar-Prat, Folgoët, Finistère), another recovered from the Loire river (Angers, Maine-et-Loire), and a few from the Gironde (Briard 1965; Lagarde 2005). From the latter area, some were associated with material of the local Saint-Denis-de-Pile metalwork group, which corresponds to the later phase of the Saint-Brieuc-des-Iffs group, and the rest belong to the local Créon/Saint-Loubès group (*c.* 1000–800 BC) (Lagarde 2005). This suggests a gradual restoration of Iberian connections sometime around 1000 BC, most prevalent around the Gironde estuary, and moving northwards to reach Brittany.

The last century of the French Bronze Age (*c.* 900–800 BC) in Atlantic France, is characterized by the production of Carp's Tongue swords, often deposited fragmented in hoard of mixed material comprising plano-convex ingots and casting waste. Although found in some inland contexts; in Brittany for example, the Carp's Tongue sword hoards tend to have a strong coastal distribution (Briard 1965; Boulud & Fily 2009). The origins of the Carp's Tongue sword are unclear, but it may have developed in southern Iberia as a cross between early Urnfield-inspired leaf-shaped swords and late rapiers, or in northern France (Branderm & Moskal-del Hoya 2014). Based on typological differences, mainly hilt and *ricassi* styles, Branderm & Moskal-del Hoya (2014) have proposed Carp's Tongue developments, including a Huelva type (from Iberia), a Nantes type (from north-west France), a Monte Sa Idda type (from Sardinia), as well as several variant, miscellaneous and undetermined types. The Huelva type may be considered the earliest form (Branderm & Moskal-del Hoya 2014). The various Iberian and French styles display an unequal pattern of distribution. Whereas the Huelva type (and variants) sword in France is well-represented, particularly along the Loire river (Branderm & Moskal-del Hoya 2014, fig. 5), the Nantes type (and variants) sword is widely distributed along the French Atlantic façade from the Gironde to northern France, and even south-east Britain. By comparison, only four examples are recorded in Iberia (Branderm & Moskal-del Hoya 2014, fig. 3). Conversely, the Monte Sa Idda type and its variant, is distributed mainly in Sardinia, with eight examples from Iberia, and only two from France including a single example from the Atlantic façade (Branderm & Moskal-del Hoya 2014, fig. 7). Finally, Carp's Tongue swords of miscellaneous and undetermined types are widespread in north-west France, south-east Britain, northern and western Iberia, and central Italy (Branderm & Moskal-del Hoya 2014, fig. 8). Overall, the distribution of Carps' Tongue swords of Huelva and Nantes types demonstrate very strong links between

Iberia and Atlantic France at the end of the Bronze Age, something which does not appear to have occurred for a few centuries.

## Chalcolithic and Bronze Age contacts between Ireland and Iberia and Scandinavia

The introduction of copper metallurgy to Ireland, *c.* 2500 BC, is also associated with the spread of the Beaker material culture along the Atlantic façade (O'Brien 2004). The exploitation of tennantite at the Chalcolithic Beaker and Early Bronze Age mine at Ross Island, Co. Kerry (*c.* 2400–1900/1800 BC), combined with the techniques of fire-setting and the use of stone hammers to extract the minerals, shows similarities to the situation in some Cantabrian mines from northern Spain (e.g., El Milagro and El Aramo) (O'Brien 2014). Based on the presence of similar Beaker material and megalithic traditions (i.e., *allées couvertes* and wedge tombs), this potential Iberian background to early Irish copper mining appears to have been launched via Armorica (Burlot 2019). However, as far as the production of copper work in Ireland is concerned, the Iberian influence is either absent (there is a significant lack, for instance, of Palmela points) or not clearly represented. This may reflect the fact that Irish copper work developed its own style at an early stage (Harbison 1969a; 1969b; O'Brien 2004; Burlot 2019).

Perhaps, the closest links between Iberian and Irish early metalwork are to be found among the goldwork. From Ireland, there is a series of basket-shaped ornaments (Benraw, Co Down, and two unprovenanced examples) which may be considered Beaker productions. Similar examples have been recovered in Iberia (e.g., Estremoz and Ermegeira both in Portugal). Additionally, there are the 26 'sun discs' found in various sites across Ireland. These artefacts are considered prime examples of Beaker goldwork and are also well-represented in Iberia (Taylor 1980; Burlot 2019). A critical point about basket-shaped ornaments and gold discs is that they are extremely rare in Atlantic France, where personal gold ornaments mostly take the form of beads of various kinds (see above). This detail may demonstrate that the French Atlantic façade was bypassed during the early period of Iberian and Irish goldwork exchange. One nuance to this picture, however, involves the appearance of gold lunulae during the Chalcolithic/Early Bronze Age transition. With some 80 recorded examples of lunulae in Ireland, an Irish origin for these artefacts is strongly argued for (Taylor 1980). The examples from north-west France (e.g., Kerivoa, Bourbriac, Côtes-d'Armor), as well as from Iberia, although varied in style, are probably Irish-inspired, rather than Irish productions. Combinations of discs and lunulae are also recorded in Iberian and Irish assemblages. A find from Cabaceiras de Basto, Braga (Portugal) comprised a lunula, two discs, and two pendants (Briard 2003) while an assemblage from Coggalbeg, Co. Roscommon shows that the two traditions of goldwork also overlapped in Ireland (Kelly & Cahill 2010).

From the later part of the Irish Early Bronze Age and into the Middle Bronze Age (*c.* 1600–1100 BC), links between Ireland and Iberia seem to decrease. Instead, relations between Ireland and Britain become more prevalent, demonstrated by the production of comparable metalwork (e.g., dirk, rapiers, and spearhead; see Waddell 2010). Possible outliers to this trend include two palstaves (and a later socketed axe-head) from Co. Cork in Ireland. These have identical lead isotope ratios to a palstave from Thisted in Denmark (Period II, *c.* 1500–1300 BC), and a socketed axe-head from Gotland in Sweden (Period III, *c.* 1300–1100 BC), that are consistent with ore from Iberia, suggesting the same origin (O'Brien 2022).

While links between Ireland and Britain remained strong from the end of the Irish Middle Bronze Age (Bishopsland phase, *c.* 1400–1100 BC) and into the Late Bronze Age (Roscommon phase, c. 1150–1000 BC, and Dowris phase, *c.* 1000–700 BC), as evidenced by the circulation of similar sword types (e.g., Ballintober and Chelsea types), there is also signs of emerging connections to central and northern Europe as well as some renewed contacts with Iberia. The main material reflecting this development comes in the form of shields. Some Irish bronze shields exhibit clear parallels with material from Britain (e.g., Yetholm type shield from Barrybeg, Co. Roscommon) and continental Europe. For example, the Yetholm type and its Irish counterpart (Athenry/Eynsham type) is reminiscent of shields depicted on Scandinavian rock art (Uckelmann 2012; Ling & Uhnér 2014). This central and northern Europe link is evidenced further by the discovery of U-notched shields of Herzprung type from Ireland (Uckelmann 2012). The Iberian connection is reflected by the V-notched leather shield from Cloobrin, Co. Longford. Whilst this type of shield is unique in Ireland, it is well-represented in Iberia as depicted on warrior stelae (e.g., Almargen, Málaga, Spain). The Cloonbrin shield is dated 1134–971 cal. BC (Gr-45808; 2880±35 BP), which falls within the range of production of the Huelva type swords (see above; Uckelmann 2012; Díaz-Guardamino et al. 2019). Nevertheless, the singularity of this find and absence of Carp's Tongue swords (excepting one possible example) in Ireland suggests that the Irish Late Bronze Age warrior's connections to Iberia was extremely limited (see Eogan 1965; Brandherm & Moskal-del Hoya 2014). In this context, it is worth noting the absence of French shields among the Irish material (see Uckelmann 2012), which suggests once again that contact between Ireland and Iberia appears to have bypassed the French Atlantic façade.

Relations between France, Britain, Ireland, and Iberia are better represented by material from the later part of the Middle through to the end of the Late Bronze Age.

This includes a number of late Middle Bronze Age gold bar torcs. Nearly 50 examples have been recovered from Britain, around 38 from Ireland, 19 from France (with a strong Atlantic distribution), and two from Spain (Waddell 2010, fig. 6.9). In addition, all four regions share similar examples of feasting equipment in the form of flesh-hooks and rotary spits. Although this type of equipment does not originate in western Europe, these assemblages constitute a highly distinctive element in the material record of the Atlantic façade from the late Middle Bronze Age until the end of the Late Bronze Age (Needham & Bowman 2005).

Like Atlantic France, Ireland was well integrated within a widespread network of contacts and exchange/trade during the Beaker Chalcolithic period until the end of the Bronze Age. However, its relations with Scandinavia are not as clear as they are with Britain, France, and Iberia, and what little evidence there is for Irish Scandinavian contacts has not always been interpreted convincingly.

The general background to Scandinavia's connections to the Atlantic and European Bronze Age is now broadly understood thanks in part to the work of the Maritime Encounters project. Throughout the Bronze Age, metal analyses and typological developments, indicate that Scandinavia produced metalwork with copper sourced from various parts of Europe, notably from central Europe (e.g., Hungary), but also, significantly, the Iberian Peninsula (see Ling et al. 2014 and Stos-Gale & Ling this volume). Post-1700 BC, Nordic forms of bronzework dominate the archaeological records, indicating that raw material and/or ingots were transformed by local metalworkers (Ling et al. 2014). A notable development during this period is the production of axe-ingots similar to the 'Ploukilla' copper axe-ingots from Armorica. In Brittany, these (deliberately) poorly cast objects have an overall shape reminiscent of the Irish Killaha axe-heads from the earliest insular phase of tin bronze production (*c.* 2150–1900 BC), most of which are made with Irish type 'A' metal, suggesting production from the Ross Island mine, Co. Kerry (Gandois et al. 2019). Gandois et al. (2019, 25) have argued that the distinctive shape of the axe-ingots was a recognisable Irish trademark, which was ultimately lost during the alloying process. A similar process may also be suggested for some Middle Bronze Age palstaves made of copper from the Great Orme mine in north Wales, including the pair from the coastal island of Hönö (Öckerö, Bohuslän) in western Sweden, which also appear to have been recycled from axe-shaped ingots (see Williams 2023). However, as noted by Gandois et al., in the absence of lead isotope analysis it is extremely difficult to determine the provenance of these remelted artefacts and assess their possible status as export items (Gandois et al. 2019, 25).

Based on typological developments, only a few copper and bronze artefacts recovered in Scandinavia have been identified as Irish productions, though some of these (see Butler 1963), are now thought to be British metalwork. A review of the material from Sweden (see Oldeberg 1974), indicates that recognisably Irish material diminishes from the later part of the Early Bronze Age onwards consistent with the dominance of Nordic metalwork in the archaeological record after 1700 BC. Butler (1963, 44), for example, notes the absence of Irish cast-flanged axe-heads in southern Scandinavia after this period. By contrast, earlier, potentially Irish material may be distinguished in southern Swedish county of Scania, an area rich in metalwork finds. Some of the material from Borrby-Gegend, Fjälkinge, and Grevie – V. Karup – Torekov (Fig. 2.3; see Oldeberg 1974, nos 81, 151, and 224) resembles the flat copper axe-heads of Irish Lough Ravel and Ballybeg types (*c.* 2500–2150 BC). A few low-flanged bronze axe-heads similar to the Irish Ballyvalley type (narrow shape with parallel sides), have also been recovered from the same region, including examples from Balkåkra and Gislöv (Fig. 2.4; Oldeberg 1974, nos 15 and 176). The Early Bronze Age Ballyvalley type axe-head dates from *c.* 1900–1700 BC, but the later Derrynniggin type with high flanges (*c.* 1700–1600 BC), does not appear to be represented in southern Scandinavia, corroborating Butler's (1963) observation that the latter type is absent from the region. Another potential Irish axe-head was found at Fredsø on the Danish island of Mors, Limfjord (Jutland). Butler (1963, 28–9) compares it to a Ballyvalley type example from Clonoe, Co. Roscommon (although on pl. IIa, he notes that the Fredsø axe-head is made of copper) and suggested that its presence in this specific area may be linked to the amber trade between Scandinavia and Ireland (see below).

The evidence of Irish goldwork in Scandinavia is not very clear though. From Scandinavia, there are no basket-shaped ornaments nor the gold discs, like the Beaker-related examples in Ireland and Iberia (and to a lesser degree, Atlantic France) (see Butler 1963). However, there are three gold lunulae from Denmark, though the examples from Grevinge and Fredensborg (both Zealand), and Skovshøjrup (Fyn), differ in style from their Irish counterparts and, in common with the find from Cabaceiras de Basto, Braga (Portugal), these are most likely to have been Irish-inspired rather than Irish-made (Fig. 2.5; Butler 1963).

Although Nordic/Scandinavian imports to Ireland in the form of amber can be traced as far back as the Neolithic (see discussion below), it is not until the late Irish Middle Bronze Age and the Late Bronze Age in particular that material of recognizably Nordic/Scandinavian influence begins to appear in the archaeological record. During the Irish Bishopsland phase, gold torcs (including bar, twisted, flange-twisted, and ribbon forms) were numerous in eastern Ireland, southern Britain, in north-west France, but also the western Baltic area (Eogan 1995; Waddell 2010, fig. 6.9). This implies the development of a creative and prosperous industry in the middle area of the Atlantic façade, which was also linked to other parts of Europe,

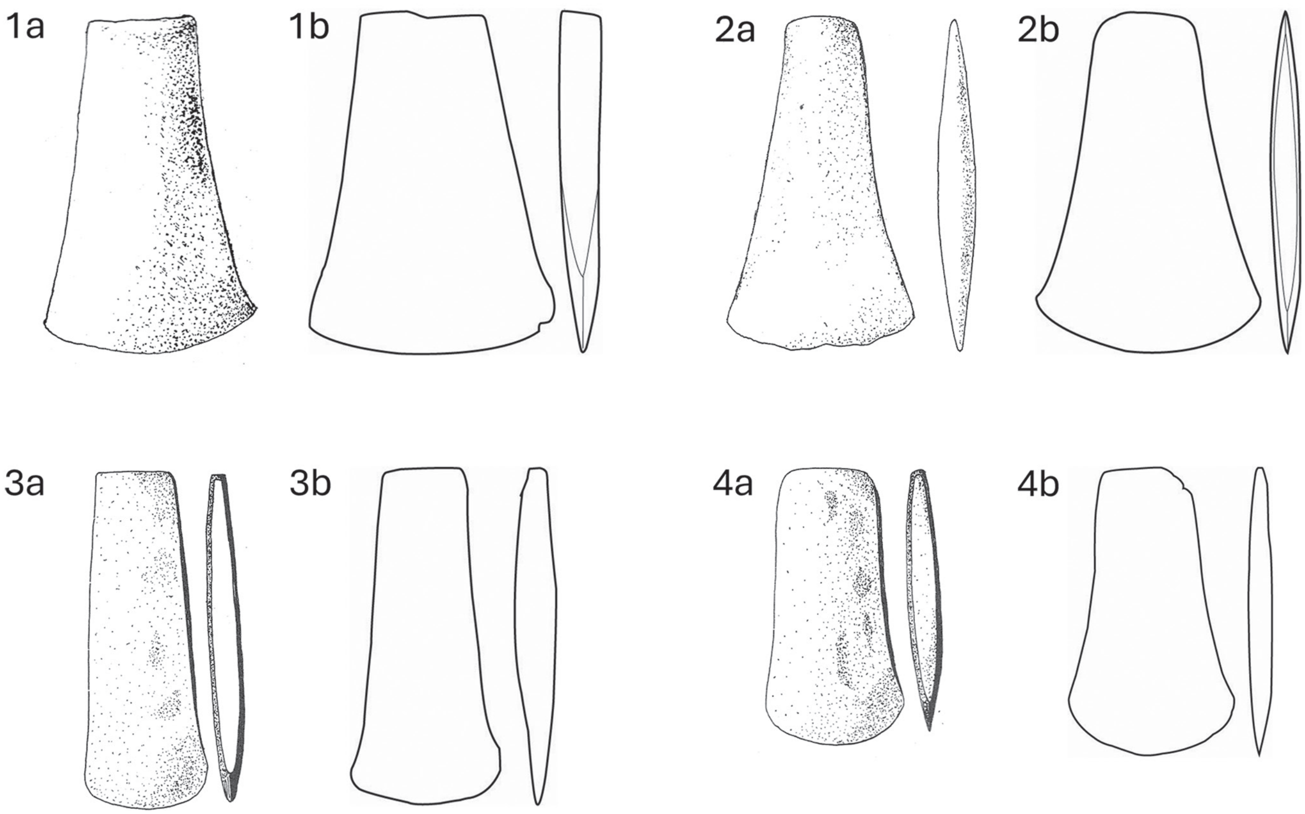


*Figure 2.3. Copper axe-heads from Scania that resemble Irish Chalcolithic material, including examples from: 1a. Borrby-Gegend, similar to an (unprovenanced) example from Ireland (1b) (after Oldeberg 1974, no. 81; outlines redrawn after Harbison 1969a, no. 249, pl. 10.12); 2a. example from Grevie – V. Karup – Torekov compared to an axe-head from Ballyfinnane, Co. Kerry (2b) (after Oldeberg 1974, no. 224; outlines redrawn after Harbison 1969a, no. 353, pl. 14.13); 3a & 4a: a pair from Fjälkinge compared to an (unprovenanced) example from Ireland (3b), and from Glenoe, Co. Antrim (4b) (after Oldeberg 1974, no. 151 for both; outlines redrawn after Harbison 1969a, no. 290, pl. 14.13, and no. 98, pl. 4.11 respectively). Illustrations not to scale (Oldeberg (1974) illustrations courtesy of Kungl. Vitterhetsakademien).*

including the appearance of a different type of gold torc (Berzocana type) from south-west Iberia. In the western Baltic, torcs were also produced but these were made of bronze (Eogan 1995). Overall, while the styles and material differed, these personal ornaments were of significance across the entire Atlantic façade and demonstrate shared materialistic values.

Further links between Ireland and Scandinavia are revealed by the presence of certain types of shield. These include two Irish U-notched shields of Hertzsprung type (Annadale, Co. Leitrim and Cloonlara, Co. Mayo), which share similarities with metal examples, dated *c.* 1100–800 BC, from Denmark and southern Sweden (e.g., Fröslunda in western Sweden). This type, alongside the previously discussed (but slightly earlier) V-notched shield, reflect a distinct Atlantic pattern linking Iberia to Scandinavia via Ireland and Britain (Waddell 2010; Uckelmann 2012; Ling & Uhnér 2014). Metal-wise, only a few bronze objects/features can be considered to be of Nordic/Scandinavian influence, including a style of conical rivets on Irish bronze cauldrons (e.g., Dowris hoard, Co. Offaly) and horns, which Waddell (2010, 241) suggests are of southern Scandinavian and/or north German inspiration. Another example is the Late Bronze Age socketed axe-head from Co. Antrim in north-east Ireland which echoes the Højby type (hexagonal cross-section, common parallel sides, looped, and with vertical grooves and ribs) from Denmark (see Butler 1963; Waddell 2010). A similar, but poorly preserved, example was also recovered at Carse Loch, Kickcubright in south-western Scotland, suggesting a possible Irish-Scandinavian exchange route via Britain (Fig. 2.6; Butler 1963).

With regard to the goldwork, the evidence for potential links between the two regions is also limited and confined to the Dowris phase of the Late Bronze Age. Possible connections include gorgets, which are large, highly decorated sheet gold collars with circular terminals. A potential Nordic origin for this design has been suggested, but this too is disputed (Fig. 2.6; see Waddell 2010, 257). Another Irish ornament with potential links to northern Europe, is the

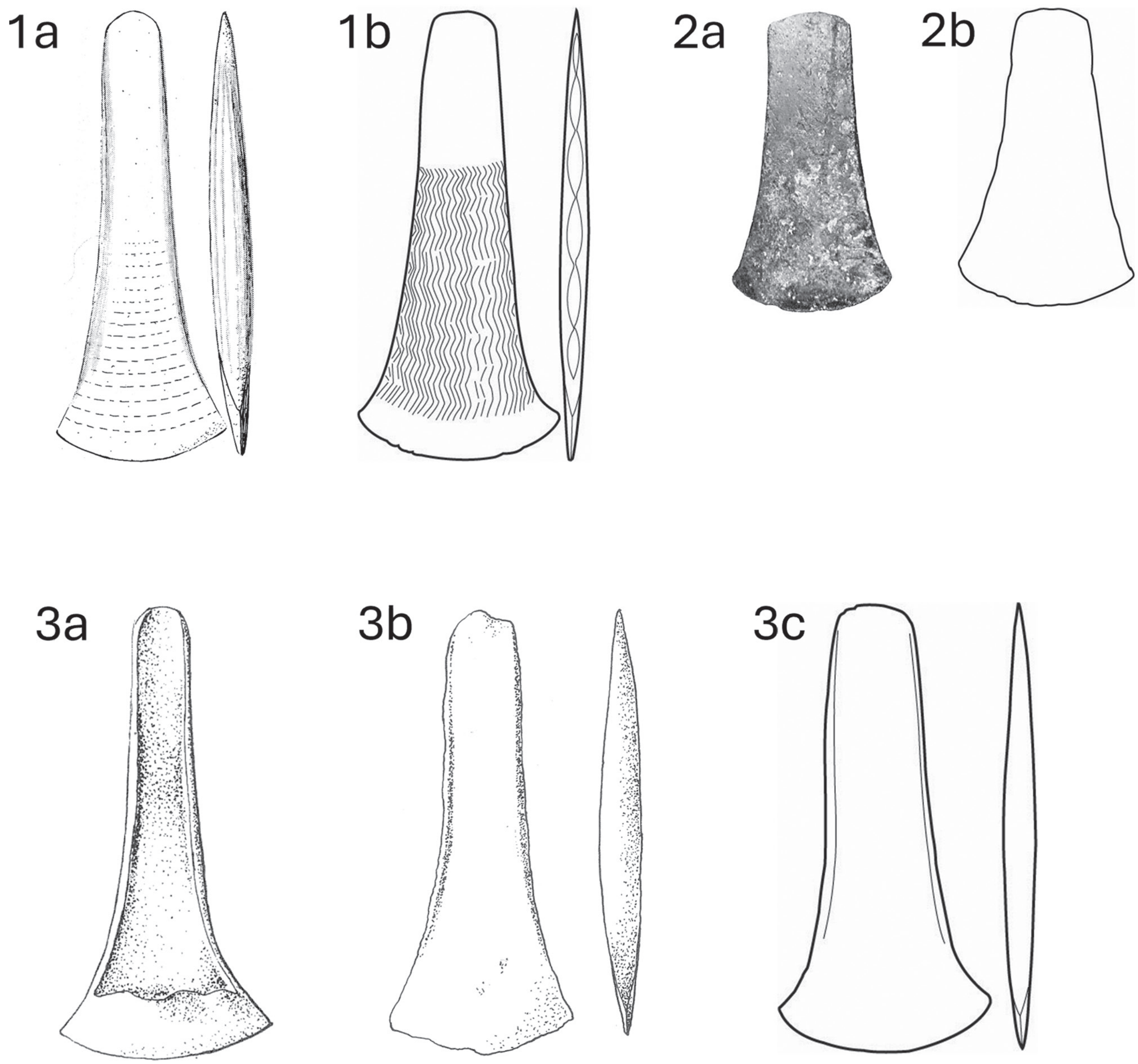


*Figure 2.4. Bronze Age axe-heads from southern Scandinavia that resemble Early Bronze Age type Ballyvalley axe-heads from Ireland, including: 1a. a decorated example from a pair from Balkåkra (Scania, Sweden) compared to an Irish example from 'near Fivemiletown', Co. Tyrone (1b), note the decoration on the lower half for both (after Oldeberg 1974, no. 15; outlines redrawn after Harbison 1969a, no. 926, pl. 41.22); 2a. the axe-head from Fredsø, Limfjord (Jutland, Denmark) compared to an axe-head from Clonoe, Co. Roscommon (2b) (after Butler 1963, pl. IIa; outline redrawn after Harbison 1969a, no. 1269, pl. 56.22); and two undecorated examples from 3a. V. Värlinge, Bodarp and 3b. Gislöv (both Scania, Sweden) compared to a stary find from Co. Galway (3c) (after Oldeberg 1974, nos 47 and 176 respectively; outlines redrawn after Harbison 1969a, no. 929, pl. 41.25). Illustrations not to scale. (Oldeberg (1974) illustrations courtesy of Kungl. Vitterhetsakademien).*

dress-fastener. These objects consist of a penannular body with bell- or cup-shaped terminals. They may have developed from similar Nordic bronze fibulae, although unlike the Irish examples these have a pin separate from the bow of the object (Fig. 2.6). The disc-headed pins from Ireland, notably those featuring a small hemispherical central boss and concentric circle, are commonly found in Denmark and northern Germany, and may even be considered imports to the island. Finally, a small gold disc, part of a hoard found at Lattoon, Co. Cavan, with its small central boss surrounded by a series of concentric circles, has been compared to the disc from the Trundholm chariot from Denmark (albeit

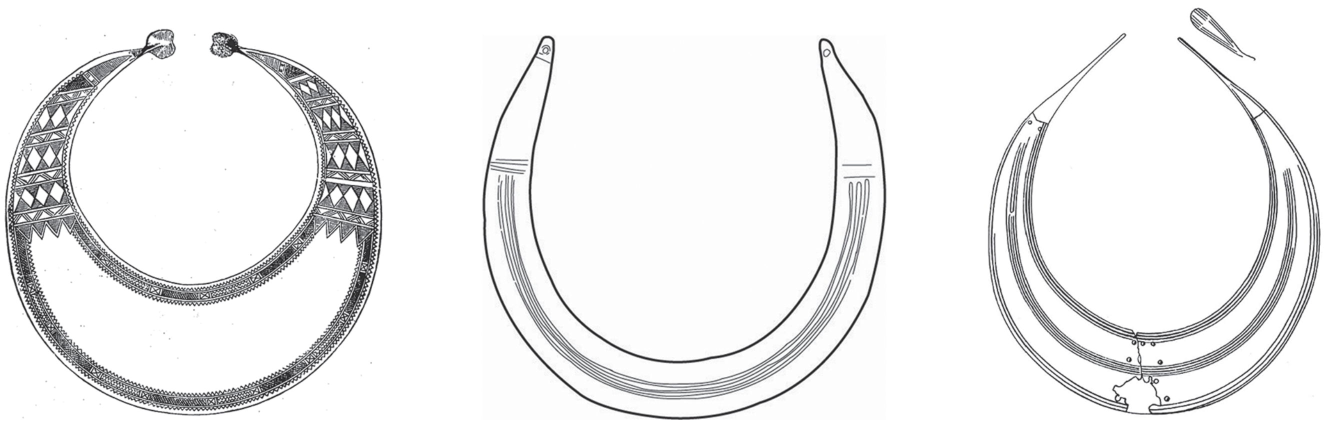

*Figure 2.5. Various types of gold lunulae from Europe, which are Irish-made or Irish-inspired: left: classical example from Killarney, Co. Kerry (Ireland); middle: lunula from the Cabaceiras de Basto, Braga (Portugal) hoard; right: lunula from Skovshøjrup, Fyn (Denmark) (after Waddell 2010, fig. 4.13.1; outlines redrawn after Briard 2003, fig. 2; Butler 1963, fig. 40). Illustrations not to scale (Waddell (2010) illustration courtesy of Wordwell Press; Butler (1963) illustration courtesy of © University of Groningen, Groningen Institute of Archaeology).*

the dates of both objects do not coincide) (Fig. 2.6; Butler 1963; Waddell 2010).

## Baltic amber and metalwork along the Atlantic façade

The presence of amber in Late Neolithic and Bronze Age contexts in Europe is widespread (du Gardin 1986; 1998; Murillo-Barroso et al. 2018). However, although many artefacts made from various types of fossilized resin have often been identified as Baltic amber, determining the precise origins of this material remains challenging even with modern technology (Briard 1984; du Gardin 1986; Briggs 1997; Murillo-Barroso et al. 2018). For instance, it is extremely difficult to distinguish amber from the Baltic and amber from the North Sea, between Denmark and eastern Britain (Du Gardin 1963; Murillo-Barroso et al. 2018). Nonetheless, a positively identified amber bead of Baltic origins was recovered within a mid-4th millennium BC funerary deposit at Cova del Fare (Matadepera, Barcelona, Spain), and clearly attests to links between northern Europe and the Iberian Peninsula at an early date (Murillo-Barroso et al. 2023). Across France, fossilized resin deposits are quite widespread with significant concentrations in the Paris Basin, the south (Languedoc and Provence especially), the central west, and in the Loire valley (du Gardin 1986, fig. 14). There are also a few references to deposits of amber-like substance from the northern half of Ireland (e.g., Rathlin Island, Co. Antrim and Craig-na-shoke, Co. Derry), as well as washed-up grains of amber on the beaches of the western Counties of Clare and Galway (Briggs 1997).

With regard to the late prehistoric amber ornaments from France, it is possible that local deposits could have been utilised for making artefacts, especially in the south where findspots occur in close proximity to amber sources (du Gardin 1986). Nevertheless, the distribution of amber objects across France appears unequal depending on the period. From her research during the 1980s and '90s, du Gardin (1986, fig. 9; 1996, 348), listed some 20 sites from the Chalcolithic period across France which produced amber material, with strong concentrations in the Paris Basin and the south. Only six of these sites are Beaker-related, and only one (La Pierre-Virante, Xanton-Chassenon, Vendée) is located along the Atlantic façade. During the Early Bronze Age, fewer sites are recorded, predominantly in the south, and just a handful of finds from Armorica. During the Middle and the Late Bronze Age the south is still strongly represented, with some noticeable concentrations in the Paris Basin and the east, while the Atlantic façade is scarcely represented (du Gardin 1986, figs 10–12).

During the Early Bronze Age, the presence of amber from a few Armorican sites is likely to reflect some link between the Baltic and north-west France, via Wessex where grave goods made of exotic material, including amber, are also numerous (Briard 1984; du Gardin 1986; see Nicolas 2016). The Armorican barrow at Kernonen, Plouvorn (Finistère) has produced a wealth of material (bronze and gold metalwork), but also a series of objects in amber, apparently of Baltic origin (du Gardin 1986). The amber material comprises personal ornaments (discoid and trapezoidal pendants) and a symbolic representation of an archer's wristguard (Fig. 2.7; Briard 1970; 1984). Based on the overall assemblage, the tomb dates from *c.* 2150–1950 BC (Nicolas 2016). A similar symbolic archer's wristguard (originally a spacer plate for a necklace) from the Armorican barrow at Kerguévarec, Plouyé (Finistère) is made from Whitby jet, confirming the existence of links

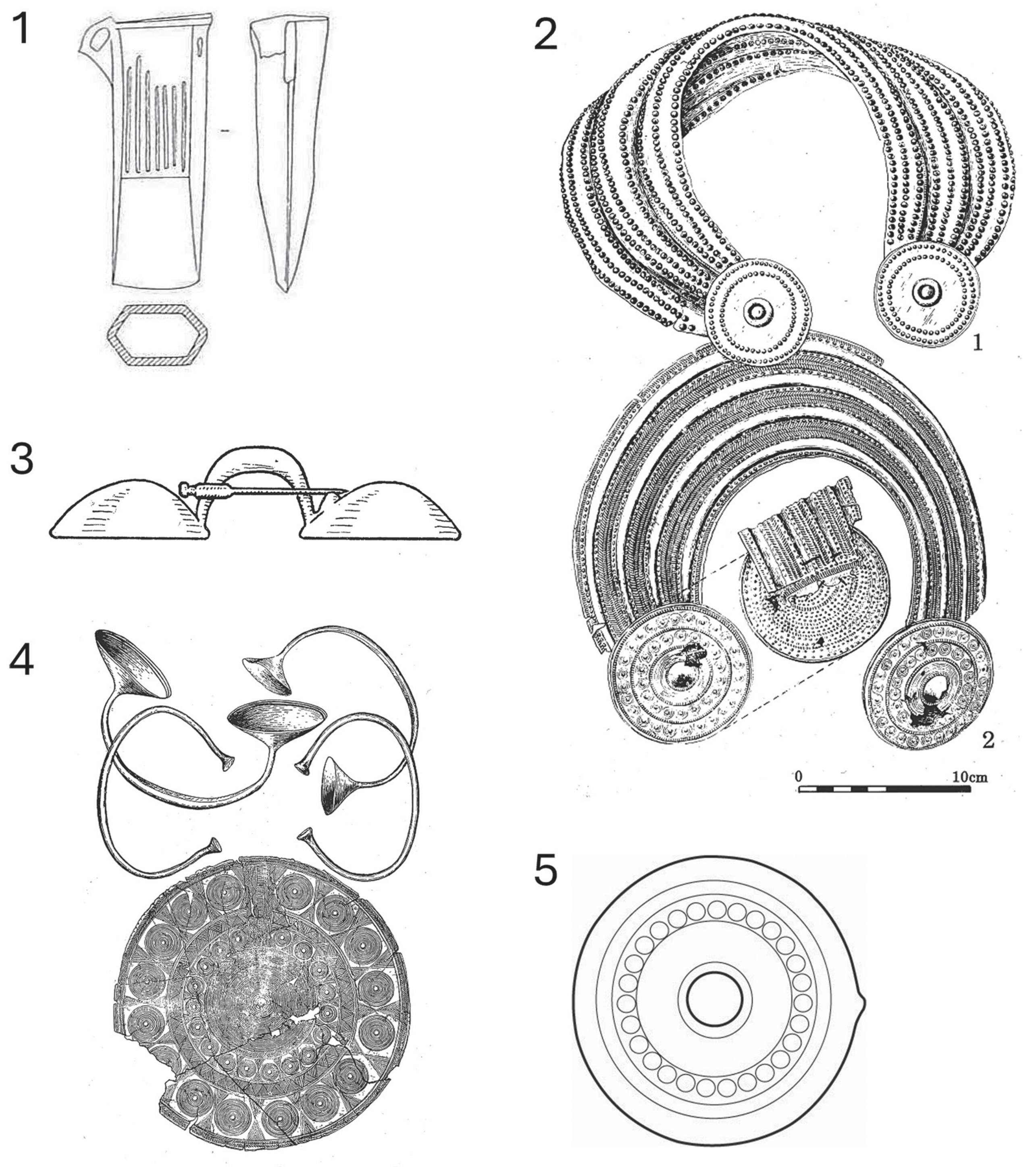


*Figure 2.6. Metalwork from Ireland potentially influenced by Nordic/Scandinavian bronze and gold metalwork: 1: type Højby socketed axe-head from Carse Loch, Kickcubright (south-western Scotland) like the example from Co. Antrim (which is not illustrated; after Butler 1963, fig. 26, not to scale). 2: gorgets from Co. Clare (1) and Borrisnoe, Co. Typperary (2) (after Waddell 2010, fig. 7.16). 3: depiction of a Nordic bronze fibula (with a pin) which may have inspired the Irish dress fasteners (after Waddell 2010, fig. 7.20.1). 4: Gold hoard from Lattoon, Co. Cavan, including the disc compared to the sun disc of the Trundholm chariot from Denmark (after Waddell 2010, fig. 7.19 based on Armstrong 1920, fig. 17); 5. representation of the disc of the Trundholm sun chariot (outlines redrawn after Bradley 2008, fig. 1; no scale provided) (Butler (1963) illustration courtesy of © University of Groningen, Groningen Institute of Archaeology; Waddell (2010) illustrations courtesy of Wordwell Press).*

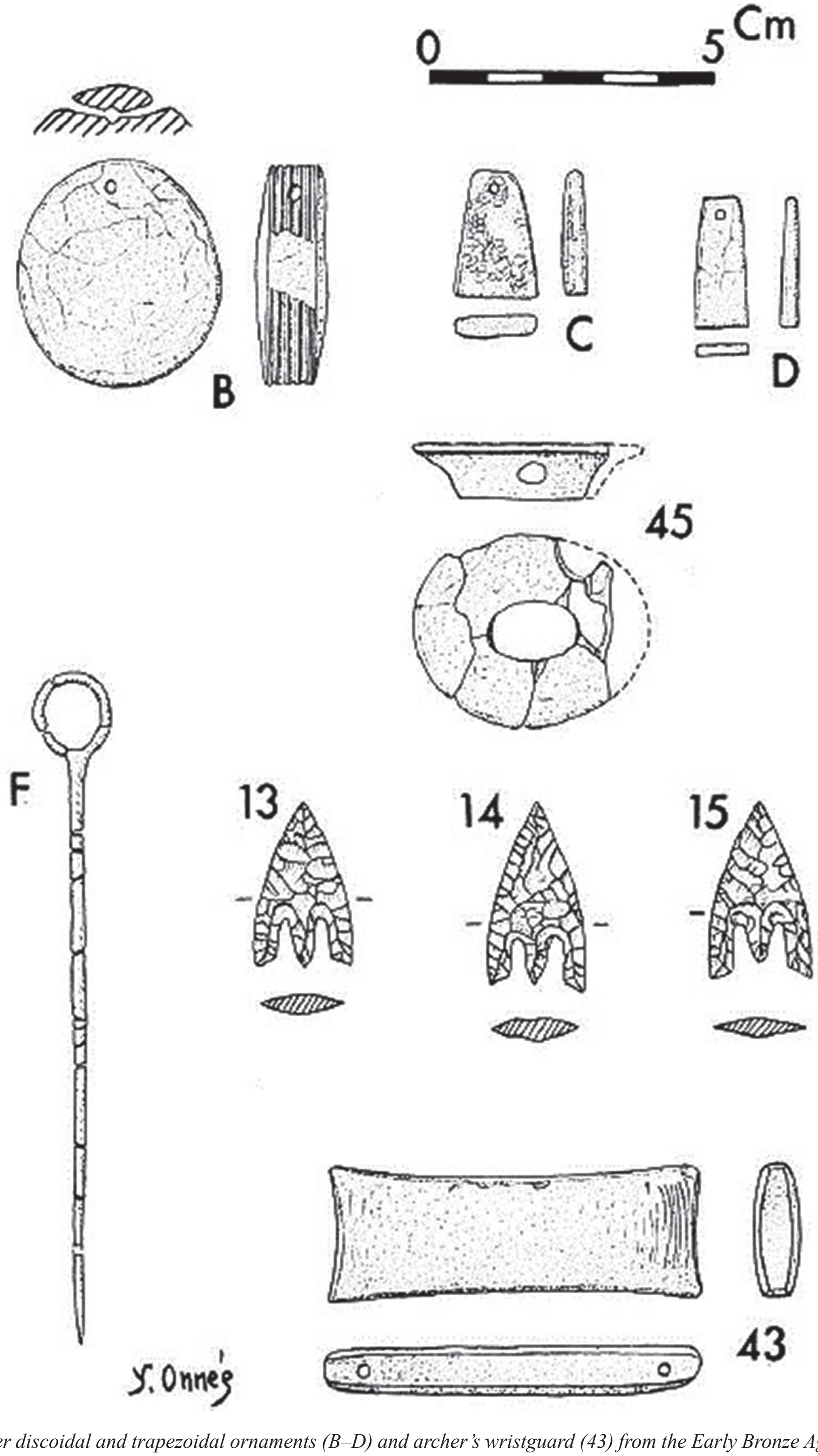


*Figure 2.7. Amber discoidal and trapezoidal ornaments (B–D) and archer's wristguard (43) from the Early Bronze Age Armorican barrow at Kernonen, Plouvorn (Finistère) (after Briard 1970, fig. 2) (illustration courtesy of the Société Préhistorique Française).*

with Britain at the time (c. 2150–1950 BC; Nicolas 2016). Another amber (of unknown origin) archer's wristguard was found in a barrow at Saint-Fiacre, Melrand (Morbihan). This tomb, which is slightly later (*c.* 1850–1750 BC) than the other two mentioned previously, also contained a silver Iberian Beaker and a damaged dagger of potential Rhodanian or even Únětice origin (Briard 1984; Nicolas 2016). The exotic character of these objects together with the amber material from Armorica in general provides further evidence of trade links to northern/central Europe and Iberia, emphasizing yet again the importance of the region as a centre of long-distance maritime contacts during the Early Bronze Age.

During the Middle Bronze Age, there appears to have been a decline in the use of amber in Atlantic France. Nevertheless, there is some potentially significant material from a re-used megalithic necropolis at Lesconnil, Plobannalec-Lesconil (Finistère). Here a series of small, perforated spacer plates was recovered during a 19th century excavation which were apparently associated with flanged axe-heads of Tréboul type (Briard 1984; du Gardin 1986). Unfortunately, the material is lost, but this potential association with the Tréboul hoard (Finistère) is important considering the presence there of two shield-pattern palstaves made of Great Orme copper similar to the pair of Scandinavian palstaves from Hönö (see above). Though tentative, this may evidence further proof of Armorica's connections to Scandinavia, possibly involving trade in Baltic amber. In turn, the absence of amber material in Atlantic France during the Late Bronze Age may suggest that these relations somehow ceased.

Metalwork exchanges between Atlantic France and Scandinavia do not appear to have been substantial, with no recognizable bronze artefacts of potential Nordic/Scandinavian origin along the French Atlantic façade. One possible exception is the copper battle-axe from Kersoufflet, Le Faouët (Morbihan) which resembles the form of Nordic stone battle-axes, metal examples of which are commonly found in central Europe (Briard 1965). On the other hand, there a few bronze artefacts from Scania in southern Sweden that echo material from Atlantic France. These include a Tréboul type spearhead from Bunkeflo, Malmö; a type Normand palstave from Välluv, Bårslöv; a Marcillac type flanged axe-head (from the Gironde area) from Örum, Hörup; a Rosnoën type spearhead from Arrie; a Rosnoën type palstave (albeit unlooped) from Malhög, Flädie; and a Rosnoën type median-winged axe-head from Katslösa, Kvistofta (Fig. 2.8; see Oldeberg 1974, nos 515, 103, 341, 10, 165, and 415 respectively). If this material was indeed from Atlantic France, it could be broadly dated 1600–1250 BC, or the Middle Bronze Age/beginning of the Late Bronze Age. This is entirely plausible given the evidence for contacts between Armorica and the North Sea from the early Middle Bronze Age. This is illustrated by the presence of Tréboul material in the Netherlands and further north in Jutland (Denmark) where a rapier fragment from Østerhoved Mose appears to belong to the same metalworking group (Butler 1963; Briard 1984).

In Ireland, amber material is most abundant during the Late Bronze Age (particularly the Dowris phase). This material, mostly beads, has been recovered mainly from hoards often associated with gold objects (e.g., Meenwaun, Co. Offaly; Derrybrien, Co. Galway) which tend to eclipse the amber finds (Waddell 2010). Amber, potentially of Baltic origin, was used as early as the 3rd millennium BC, demonstrated by the recovery of four beads from a cremation pit below a deposit containing Carrowkeel Ware pottery (Middle Neolithic) within a destroyed stone circle at Kiltierney, Co. Fermanagh (Waddell 2010). Other finds include a set of amber beads from a cave burial at Knockane, Co. Cork. The skeleton, which was discovered in 1805, was covered with a suit of small, trapezoidal gold plaques joined by gold wires. Except for one of the gold plaques, all the finds including the amber beads have disappeared, but based on the metalwork's decoration, an Early Bronze Age date has been suggested (Taylor 1980; Burlot 2019). Amber, as well as faience, jet, and bronze beads were also recovered from the re-used passage tomb in the Mound of the Hostages on the Hill of Tara, Co. Meath, along with a bronze knife associated with a later Early Bronze age unburnt burial (Sheridan et al. 2013). While amber does not appear to be represented during the Middle Bronze Age, it is attested in the Late Bronze Age; mostly from hoards but also contexts that suggest domestic use. These include two beads from the wooden platform dwellings within the palisaded enclosure on a lake shore at Clonfinlough, Co. Offaly in the Irish Midlands; the dendrochronological evidence suggests that the construction and occupation of the site may have extended from 917 to 886 BC (Waddell 2010, 224).

The substantial use of amber in Ireland during the Late Bronze Age contrasts with the situation in Atlantic France, where it is curiously absent from the archaeological record during the same period. Odder still is the fact that this coincided with evidence of what appears to be renewed contacts between various Atlantic regions, such as:

- Iberia and France (e.g., Carp's Tongue swords)
- Iberia and Ireland (V-notched shields)
- Iberia and Scandinavia (copper)
- Ireland and Scandinavia (U-notched shields, goldwork, and possibly amber).

A possible explanation for this is offered by Waddell (2010, 271–2), who notes that some of the amber in Ireland from this period may have travelled from eastern Britain. The relative dearth of amber material in southern Britain, however, suggests that Irish-Scandinavian trade may have favoured a route via northern Britain; a theory supported by the

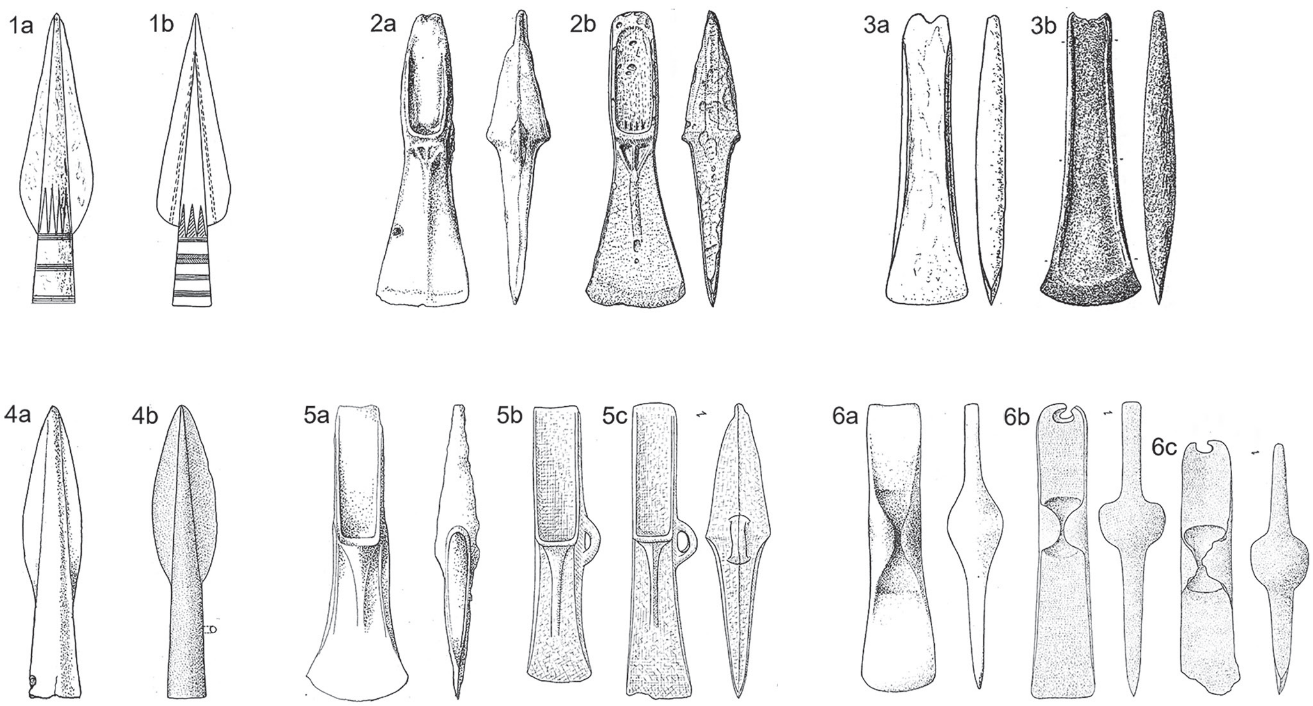


*Figure 2.8. Material from Scania that resembles Middle Bronze Age to early Late Bronze Age metalwork from Atlantic France: 1a. a spearhead from Bunkeflo, Malmö with similar decoration as a type Tréboul spearhead from the Ille-et-Vilaine* département *of Brittany (1b) (after Oldeberg 1974, no. 515; Briard 1965, fig. 25.7); 2a. a decorated palstave from Välluv, Bårslöv compared to a type Normand palstave from La Chapelle-du-Bois-des-Faulx (Eure) (2b) (after Oldeberg 1974, no. 103; Briard & Verron 1976, 91, fig. 1); 3a. a flanged axe-head from Örum, Hörup resembling axe-heads of type Martillac from the Gironde areas (3b) (after Oldeberg 1974, no. 341; Couderc 2017, fig. 9); 4a. a spearhead from Arries echoing a type Rosnoën spearhead from Rennes (Ille-et-Vilaine) (after Oldeberg 1974, no. 10; Briard 1965, fig. 51.3); 5a. an unlooped palstave from Malhög, Flädie that resembles type Rosnoën looped palstaves from Kergoustance, Plomodiern (5b) and Plouyé (5c) (both Finistère) (after Oldberg 1974, no. 165; Briard 1965, figs 50.1–2); 6a. a median winged axe-head from Katslösa, Kvistofta that shares typlogical similarities with type Rosnoën winged axe-heads like from Plouyé (Finistère) (6b) and Lac de Grand-Lieu (Loire-Atlantique) (6c) (after Oldberg 1974, no. 165; Briard 1965, figs 50.5–6 (Oldeberg (1974) illustrations courtesy of Kungl. Vitterhetsakademien; Briard (1965) illustrations courtesy of Editions ATLA-Travaux du Laboratoire, Rennes University; Briard & Verron (1976) and Couderc (2017) illustrations courtesy of the Société Préhistorique Française).*

presence in north-east Ireland and south-western Scotland of Højby type socketed axe-heads.

## Conclusion

Due to the lack of extensive analyses of lead isotope ratios of copper-based material from Atlantic France, it is difficult at present to determine the region's involvement in the copper trade in any great detail. However, other forms of evidence can give strong indications of general trends of contact and exchange over time. The variscite beads found in the Neolithic tombs in the Gulf of Morbihan, for instance, attest to the existence of early maritime connections with the Iberian Peninsula from the mid-5th millennium BC. Typological parallels also point to the region's connectivity in later periods. Coinciding with the spread of the Beaker package *c.* 2500 BC and the introduction of copper metallurgy along the French Atlantic façade, material such as the Palmela points indicate strong Iberian influences, and possible evidence of potential exchanges between the region and Armorica. A possible example of a Chalcolithic import into north-west France is the teardrop-shaped axe-head found on the island of Les Moutons.

With the adoption of tin bronze, a certain Iberian influence may be detected in the large daggers from the Lothéa barrow, Quimperlé (Finistère) and, more substantially, in Early Bronze Age gold and silverwork. These strong connections, however, appear to wane in the Middle Bronze Age; a development that may reflect the redirection of trade routes away from the French Atlantic façade to the north Channel coast for the procurement of British copper (e.g., Great Orme mine). During the early phases of the Late Bronze Age, Iberian connections seem to remain extremely limited until *c.* 1000 BC onwards, when renewed contacts with western France appear in the form of Iberian palstaves, followed by various types of Carp's Tongue sword during the last century of the Bronze Age, *c.* 800 BC.

The relations between Ireland and Iberia appear more limited during the Beaker Chalcolithic period, indicated by the absence of Palmela points on the island and the lack of recognisable Iberian copper metalwork. Despite this, the early copper mining techniques at Ross Island may suggest some influence or knowledge from northern Spain while the similarities in early goldwork (discs and basket-shaped ornaments), reveal direct Beaker period contacts bypassing Atlantic France. After a lull in contact during the Middle Bronze Age, direct contacts with Iberia appear to be renewed in the Late Bronze Age, as demonstrated by the V-notched shields represented in both regions and the presence of common Atlantic feasting equipment (e.g., flesh-hooks).

Due to the difficulties in identifying Baltic amber, the role of Scandinavia in the early period of the Atlantic amber trade is still debated, nonetheless, some currents of exchange, or inspiration, can be detected in the bronze and goldwork. Relations between Scandinavia and Ireland may have been established as early as the Irish Chalcolithic with some copper axe-heads from Scania exhibiting insular typological similarities. The presence of a possible Ballyvalley type bronze axe-head from Fredsø in Jutland (Denmark) may reflect trade along the amber route *c.* 1900–1700 BC as suggested by Butler (1963). The recovery of what is interpreted as Baltic amber from Armorican barrows, may imply the extension of Nordic/Scandinavian trade routes as far south as the French Atlantic façade. However, it is not until the Middle Bronze Age that potentially recognisable Armorican material appears to travel northwards as far as Scania. Evidence of contact with Atlantic France, Britain, Ireland, and Iberia during the Late Bronze Age points to a period of intensification in the exchange of metal resources and technology across the entire Atlantic network in which the trade in amber must have played an important role.

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# 3

# Using direct and indirect evidence of boats and boatbuilding for understanding the nature of seafaring in Atlantic Europe *c.* 5000–500 BC

*Boel Bengtsson*

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*This paper asks questions of what types of boats were used in prehistory along the Atlantic European façade and explores ways by which gaps in our current state of knowledge of these vessels can be filled. Regular seafaring in open water and along coasts where safe harbours are few and far between, places certain demands on boats, their maintenance, and the skills of their crew. Recent research into trade and the migrations of peoples and ideas now indicates that such regular seafaring goes back much further in time than the current record of prehistoric boats within the region would suggest. Therefore, the existing fragmented evidence for vessels and their means of propulsion requires a new approach, whereby we examine what basic knowledge they convey of what would have been needed to make boats more suitable for long distance seafaring, while contemplating the possibility that certain forms of boat technology and maritime expertise might have endured over a long time or been lost and regained. In this process, indirect evidence for boats, boatbuilding technologies, and seafaring need to be considered. Scandinavian rock art, for example, corroborates local boatbuilding technology, the use of paddles and steering oars found within the archaeological material, but also suggests the use of not yet archaeologically verified means of propulsion such as sail. Finally, this paper proposes a more hands-on approach in building reconstructions for the development of consistent categorization of different types of vessels for use in different environments.*

## Introduction

The aim of this chapter is to present a brief outline of the direct and indirect evidence for seagoing vessels and their means of propulsion in Atlantic Europe before *c.* 500 BC. At the most basic level of understanding, the construction of boats is a function of available resources, boatbuilding technologies, tools, and needs (Adams 2003; Bengtsson 2015). However, what general assumptions we may have about boatbuilding and design are not always reflected by the archaeological record. Our direct evidence of prehistoric boats is entirely dependent upon the preservation conditions offered by the environment in which they were once placed or abandoned. Such specific alkaline and anaerobic, often waterlogged, conditions do not discriminate between whether a boat was fully functional, or half started, new or old, nor whether it was built by a novice or an experienced boatbuilder under ideal conditions backed by an infrastructure that could supply the builder with whatever he needed, or whether it was constructed under constraints and in haste.

A famous parallel, albeit from a much later period, is the *Vasa* armed galleon, built to be the flagship of the Swedish navy. Due to a combination of naval engineering errors and a royal command for more cannons, the final vessel ended up being taller and less stable than initially intended and, as a result, keeled over in a wind gust and sank on its maiden voyage in Stockholm harbour in 1628 (Cederlund 2006). Without historical sources however, this ship might have been assumed to have been just that, the crown in the jewel of the Swedish navy that foundered in a freak accident rather than as a result of a flawed design. This is why there is need for caution when assessing general seafaring abilities based on a single find, especially when the expertise, resources, and motives for building a particular type of vessel are likely to have changed over time.

For this reason, this chapter will focus on what kind of boat technology and resources were required to build and maintain vessels that would have been sufficiently seaworthy to sustain regular contact across open waters or along unsheltered coasts. Where possible, indirect evidence will also be considered, especially in cases that can be corroborated by real finds, while making comparisons with historic use of boats within the region, while drawing parallels with relevant ethnographic evidence.

Maritime technology and navigational skills have played pivotal roles for the movement of peoples, goods, and ideas throughout history. This especially holds true in prehistoric times when inland waterways and sheltered coasts often offered quicker and safer transport than land routes. Boats were integral to the development of ancient Egypt, where the Nile provided not only water for drinking and irrigation but also the main means of transportation. In Britain, different types of watercraft were used to maintain vital communication with sites such the *c.* 1000–800 BC Must Farm settlement. Despite being located on the fens, a vast and growing wetland area, this settlement was evidently prosperous and well connected. The surviving bronze tools and glass beads imply links with wider, far reaching trade networks with which the large on-site textile production was perhaps used as barter (Bengtsson 2015; 2017; Glass 2016; Gray 2016; Knight et al. 2019).

## Emerging coastal and open-seafaring skills – adapting to a more demanding environment

Boats, such as the nine logboats at Must Farm that were used on the sheltered inland waterways of the fens, did not have the same requirements to withstand waves and winds as would seagoing vessels. However, these kinds of vessels were, at least initially, most probably adapted for use on the sea (Bengtsson 2015, 80; 2017, 123). The more exposed and deep a stretch of water is, the bigger and potentially more dangerous are the waves. This has a direct bearing on a vessel's stability and its likelihood of capsizing or filling up with water and potentially foundering. Likewise, without the mellowing effect on wind strength provided by friction with land vegetation, winds coming from the direction of open expanses of water are invariably stronger, which, depending on the waves, will affect how much effort or power would be required to propel it in a desired direction. The length of these windows of opportunity, when the wind and wave conditions are favourable, will depend upon the nature of the craft, and how it is propelled and used.

These are some of the reasons why lee coasts, islands, and archipelagos are so valued by seafarers since they offer longer windows of opportunity for safe passage in small open vessels compared to more open coastlines. They can therefore be likened to nurseries for the development of increased seafaring capabilities, where relatively simple boats can be adapted for use in increasingly difficult waters while reducing the risk of, for example, hypothermia or foundering due to breakage (Irwin 1990, 90; McGrail 2004, 171; Bengtsson 2015; 2017). With sea conditions in Atlantic Europe often very variable and unpredictable this is also the very reason why ancient seafaring is believed to have overwhelmingly favoured the relative safety of keeping within sight of land. This allowed them opportunities to locate distinct landmarks as waypoints, enabling them to determine distances and course, and to seek out safe landing sites during adverse changes of weather (see also McGrail 1983).

Despite the relative hostile environment of open sea in comparison to coastal or inland seafaring, evidence for the consumption of deep sea fish, such as bluefin tuna and swordfish, from Zealand, Denmark, suggests that seafarers may have developed the necessary skills for ocean fishing as early as the 6th millennium BC (Enghoff et al. 2007; Ravn 2022, 18). Perhaps the clearest evidence for sea travel, however, is provided by recent studies of the spread of megalithic stone monuments. The phenomenon, which is now believed to have originated in north-western France around the mid-5th millennium cal. BC, spread relatively rapidly in three main phases along coastal waterways and across open water to places as far away as Iberia, northern Italy. and islands off the European mainland such as Corsica and Sardinia, the British Isles, and Scandinavian islands such as Öland and Gotland in the Baltic Sea (Fig. 3.1A) (Schulz Paulsson 2019, 3463–4). At around the end of this period, the Bell Beaker phenomenon, named for a particular bell-shaped drinking vessel, shows similar signs of maritime contact. The earliest examples of Bell Beaker vessels have been found in mid-3rd millennium coastal sites on the Iberian Peninsula, after which they appear to have spread southwards to Morocco and northwards along the European Atlantic façade, reaching the British Isles and as far north as the south-western tip of Norway by *c.* 2400 BC. The spread and location of these finds is thought to be evidence of a new and perhaps superior boatbuilding technology (Fig. 3.1B) (Cunliffe 2001; Prieto-Martínez 2008; Needham 2009; Prescott et al. 2018).

The existence of boats with seafaring capabilities becomes increasingly evident from around 2000 BC onwards. These vessels engaged in the emerging trade networks supplying tin and copper along the Atlantic façade. Bronze assemblages have been recovered from over 20 locations off the British coast (Needham et al. 2013). Each of these finds are interpreted as individual wrecking events spanning a period of *c.* 1750–625 BC. Although several of these imply cross-channel trade in second-hand

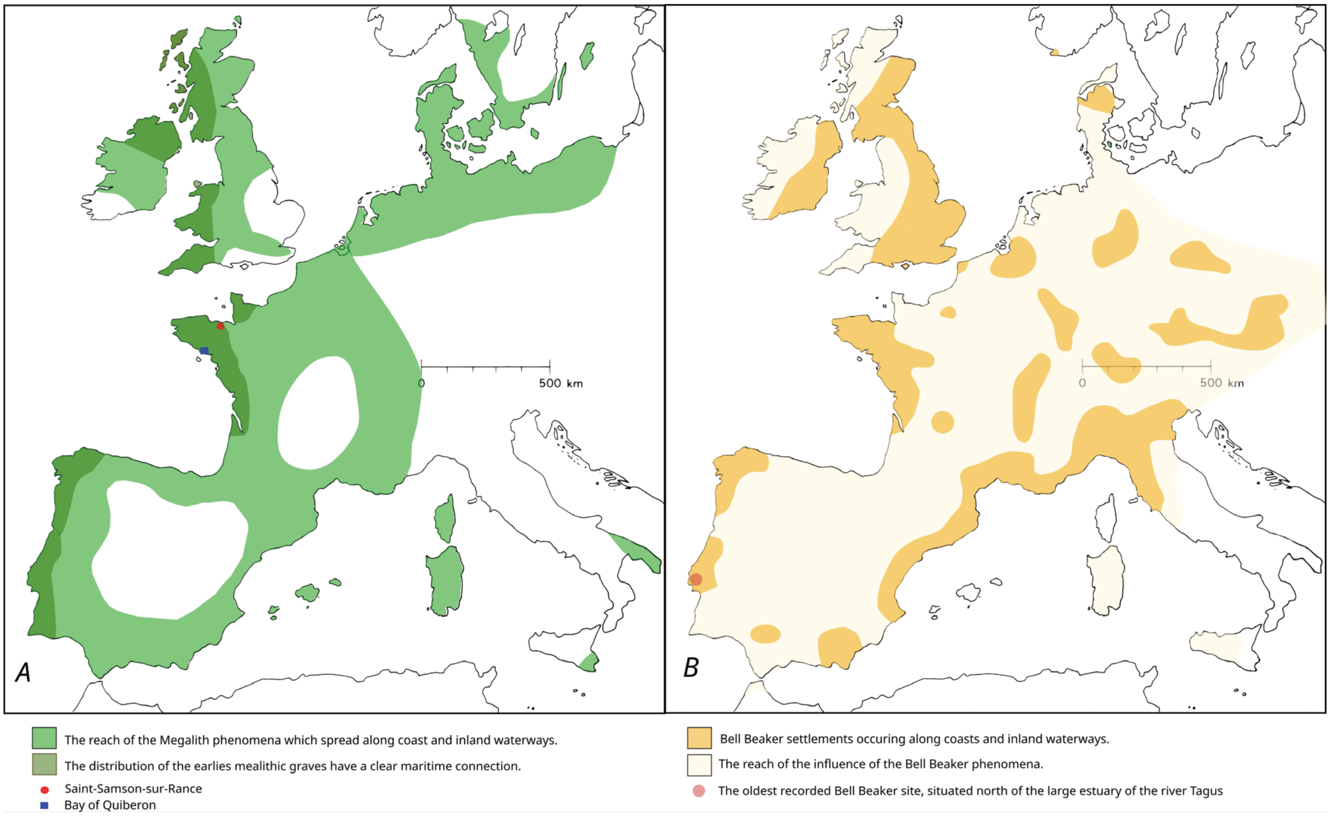


*Figure 3.1. Maps showing the extent of the megalith builders and Bell Beaker influence in Europe (after Johnstone 1980, 86; Cunliffe 2017, 121, 142; Schulz Paulsson 2019; Lemercier 2021, fig. 7).*

artefacts, the wreck site off Salcombe in Devon (not to be confused with a second assemblage in the same area which is believed to represent a separate wrecking event), contained both bronze artefacts and raw materials in the form of 40 tin and 280 copper bun-shaped ingots. This ratio of tin to copper corresponds to the ratio needed to make bronze and presents strong evidence of what must have been a well-established trade network, involving the regular shipping of individual raw metal cargoes of at least 80 kg per vessel (Wang et al. 2018). By comparison, the *c.* 1300 BC Uluburun shipwreck off the Lycian coast in the Mediterranean carried a total of 11,000 kg of bronze metal ingots – enough to provide 5000 soldiers with bronze swords (Powell et al. 2022).

Research based on lead isotope and geochemical analysis of the metal content of many securely dated Scandinavian bronzes has made it possible to identify likely sources for individual artefacts, taking into account how and when an artefact was made and whether it can be linked to a specific mine that would have been operational at that time (Ling et al. 2013; 2014; Melheim et al. 2018a; 2018b). This research now points towards yearly import rates of 2–4 tonnes of metals into Scandinavia, 30–40% of which might have originated from mines that would only have been accessible by sea along the Atlantic facade – from sources in the British Isles during the earlier phase between 1600 and 1400 BC, and from *c.* 1300–1400 BC, from sources located as far south as the Iberian Peninsula (Ling et al. 2013; 2014; Williams & Le Carlier de Veslund 2019; Bengtsson et al. 2024). If these yearly import rates are correct, and using the Salcombe wreck site as an indication of a typical raw metal cargo, this would be the equivalent to 10–20 boat loads per year reaching Scandinavia, each load enough for the manufacture of around 36 swords. Given the relative prosperity of Scandinavia in the Bronze Age, these could be low estimates (Kristiansen & Larsson 2005; Kristiansen 2018). Whichever the case, the investment in each of these shipments in terms of building and maintaining boats, training, and providing skilled men and warriors for crew and defence, in addition to amassing supplies and cargo to use as barter, would in itself have had consequences for the development of maritime technologies over the course of this period (Van de Noort 2006; Bengtsson 2017, 123; Ling et al. 2018).

Additionally, a recent study into evidence of coastal landing sites around the British Isles (Bradley 2022) provides an appreciation of the sheer number of prehistoric sites. Many of these are located in places where land elevation and other factors have preserved evidence of long-distance seafaring and communication at various periods of time.

As the examples cited above would suggest, seafaring abilities and maritime technologies in Atlantic Europe might have been, at least at certain times, more developed than the direct archaeological evidence uncovered to date implies. In southern Scandinavia, for example, there is no direct evidence of potential seagoing vessels before the Hjortspring boat of *c*. 350 BC (Crumlin-Pedersen & Trakadas 2003; Bengtsson 2015, 60–1). However, evidence of boats, boatbuilding technology, and even methods of propulsion can be obtained from many indirect sources. These include rock art, engravings on securely dated bronzes, and boat-shaped stone monuments known as ship-settings (Bengtsson & Bengtsson 2011; Artursson 2013; Wehlin 2013; Bengtsson 2015; 2017; Bengtsson et al. 2024).

## Seagoing watercraft in prehistoric Atlantic Europe

Based on direct evidence and evidence of historical use, there are mainly three types of watercraft that with relative certainty can be said to have been used on the sea in prehistoric Atlantic Europe: hide boats, logboats, and plank-built vessels (McGrail 2004; 2007; 2010a). To these three types of vessels it is tempting to add bark boats, based on the recent dating of an example from Byslätt dated to 900–800 cal. BC. Discovered in 1934 12 km inland along the river Viskan on Sweden's west coast, these fragmentary remains appear to represent a bark boat made of elm, strengthened internally with hazel rods (Lindberg 2012; Arbin & Linberg 2017, 248–9).

### *Bark boats and log rafts*

Ethnographic evidence from, for example, North America, Australia, and northern Eurasia show the ease with which bark boats can be fashioned. The basic method can be described as follows. Using often very simple stone or flint tools, sheets of naturally waterproof bark are heated, folded, and formed into a boat-like shape which is then closed at the ends with some form of string, caulked with resin, and fitted with a light internal framework of branches or twigs to ensure rigidity (Adney & Chappelle 1983; Greenhill 1995, 74; Luukkanen & Fitzhugh 2020, 9).

Although only a 3.5 × 0.6 × 0.07 m long part of the middle section of the Byslätt 'boat' was recovered (which has subsequently shrunk considerably due to a lack of proper conservation), it is assumed to have had an original length of 4–5 m; its original width and height remain uncertain (Lindberg 2012, 28; Arbin & Lindberg 2017, 245). The present condition of the remains also make it impossible to determine whether the vessel was sewn or if there is any truth regarding earlier claims about the presence of leather, iron rivets, or holes (Arbin & Lindberg 2017, 245).

Bark boats attested in the ethnographic literature are usually in the region of 2–3 m long, but larger ones of almost 11 m length, sewn together of several sheets of bark, are known to have been used for long distance trade on the vast inland water systems of North America, with similar lengths, albeit with smaller widths, attested in northern Eurasia (Greenhill 1995, 100; Luukkanen & Fitzhugh 2020, 32, 35–6).

The vast majority of these vessels are made of birch bark, most likely because of its superior ability to retain its waterproof properties for longer than other types of bark. Birch is also known for its lightness, resulting in boats suitable for a nomadic lifestyle of hunting or traversing inland river systems (Luukkanen & Fitzhugh 2020, 29, 38). There is some evidence that the Saami people of northern Scandinavia also used boats made of birch bark perhaps as late as the 1860s and, although based on oral records alone, the fact that many such accounts are recorded in different regional areas makes a past tradition very likely (Westerdahl 1985, 38, 48; Ellmers 1990, 195). These sewn vessels were said to have been very light and very fragile, well befitting their needs but these are not qualities that would have made them suitable for use on open water or for long-distance trade and it remains unclear what connection these vessels might have to the prehistoric boatbuilding traditions further south.

Nevertheless, bark as a material has undoubtedly been used extensively within Atlantic Europe from a very early period. Although heavier and less pliable than birch, elm bark is documented at several prehistoric sites in northern Europe (Johnstone 1988, 17; Luukkanen & Fitzhugh 2020, 52). At the Møllegabet site in southern Denmark, for example, a logboat dated *c*. 4900 cal. BC and containing the skeletal remains of a young man, was found to have been partly or fully covered by large sheets of elm bark (Skaarup & Grøn 2004, 36, 39). At the same site a fishing float of bark, complete with a hole for the line and decorations, was found and sheets of bark had also been used for insulating the floor inside one of the dwellings (Skaarup & Grøn 2004, 90, 99). In addition to elm, linden bark, regarded as second best to birch for making bark canoes, as well as birch and pine bark are recorded in early contexts within the region (Madsen & Hansen 1981; Luukkanen & Fitzhugh 2020, 52). Two tightly rolled bundles of birch bark, each only *c*. 6 × 3 cm, have been discovered at the *c*. 8000 BC Star Carr site in North Yorkshire in Britain (Dark 2000) and another example, comprising slightly wider and longer bundles of rolled up birch bark, has recently been found at Bouchain in northern France, at a site dated to *c*. 3400–2950 BC (Leroy et al. 2023). Located on a paleochannel of the river Scheldt, which debauches to the north into the North Sea, the Bouchain site has also revealed evidence of logboat construction and the exploitation of coppice shoots. Finally, a birch bark drinking vessel has also been found at the feet of the Egtved girl in Denmark *c*. 1400 BC (Felding 2015, 8). Thus, although it is impossible to argue for the wide spread use of bark boats across the Atlantic European region as a whole, on the basis of the single find at Byslätt, the possibility that large and relatively seaworthy bark vessels could have been built remains theoretically possible, especially if we consider the availability of their source material, the tools required for their construction, and knowledge of the properties of bark for use as waterproof containers.

The use of simple log rafts at sea in prehistory also remains conjectural. There is no historical record of rafts having been used at sea in the region and there are several practical reasons why such vessels might have been considered unsuitable for journeys in northern waters (McGrail 2004, 11). For instance, a raft would offer the crew very limited protection from wind and cold water making the risk of hypothermia a real prospect if used for more regular transportation. Based on this observation McGrail generally excludes their use at latitudes above 40° North, roughly equivalent with waters northward from, and including, the Bay of Biscay.

However, for the purpose of specific voyages in ideal conditions, while using steering oars and some means to propel the vessel in a desired direction, the possibility of their use cannot be entirely excluded either.

### *Seafaring hide boats on the Atlantic façade*

Despite a lack of firm archaeological evidence within the region to date, hide boats are likely to have been used on inland waters and on the sea over a much longer and continuous period. There are some six specific references to the use of hide boats along the Atlantic façade from Classical sources (Table 3.1). The oldest surviving source, Avienus's *Ora Maritima* of the 4th century AD, is thought to have been based on a poem dating back to the 6th century BC (Cunliffe 2001, 66). There is also the firsthand account provided by Julius Caesar who witnessed such vessels during his British campaign in 54 and 55 BC, which is perhaps the most reliable. In addition to these, the use of hide boats in British waters is mentioned in later work such as the *Navigatio*, that recounts the travels of Saint Brendan in an ox-hide boat in the 6th century AD. These accounts, in addition to the fact that this boatbuilding tradition can be traced into the modern era, suggest their long and continuous use back in time (Hornell 1938; Cunliffe 2001, 66–7; 2017, 332–3, 408; McGrail 2004, 181; 2010a, 100; MacCárthaigh 2008).

In terms of archaeological evidence, there is the tentative remains of what could be a small hide boat, *c*. 2 × 0.95 m, used as a coffin at an Early Bronze Age burial site at Fife in the British Isles (Watkins 1980), and two further possible leather coffins found at Roman period sites also in the British Isles (McGrail 2004, 181). An antler bone from Husum in north-western Germany which in the past has been interpreted as a potential frame from a hide boat (Ellmers 1980; 1984) and assumed to date to 13,000–9000 BC (see e.g., Ravn 2022, 14) has now been found to be considerably younger, dating to *c*. 5000–4000 BC (Weber et al. 2011, 290; see also Wild et al. 2023 for a recent alternative interpretation). The *c*. 1300 BC Caergwrle bowl from Wales might possibly be a crude representation of a hide boat on account of its rounded 'hull' shape and wave-like decorations reminiscent of a waterline (Fig. 3.2, below). However, the 1st century BC Broighter boat model from Northern Ireland is more likely to represent the type of vessel referred to in the

*Table 3.1. Classical references to the use of hide boats and sail in Atlantic Europe (after Cunliffe 2001, 66–7; McGrail 2007, 446–7).*

| *No.* | *Reference* | *Date* | *Quote* |
|---|---|---|---|
| 1 | Avienus *Ora Maritima* 101–6 | 6th century BC | Referring to a tribe in NW Iberia, as plying 'the widely troubled sea and swell of the monster filled ocean with skiffs of skin … marvellously fit out boats with jointed skins and often run through the vast salt water on leather' |
| 2 | Pliny, *Nat. Hist*. 4, 104 | Quoting Timaeus, early 3rd century BC | Referring to an island 6 days' sail from Britain, 'where tin is to be found', 'to which Britons cross in boats of osier covered with stitched skins' |
| 3 | Strabo, *Geog*. 3.3.7 | 2nd century BC | Writing of western tribes of NW Iberia, the natives 'used boats of tanned leather on account of the flood tides and shoal waters' |
| 4 | Caesar, *Bello Civili* 1, 45 | 56 BC (49–45 BC) | 'The keels and ribs were made of light wood; the rest of the hulk was made of woven withies covered with hides' |
| 5 | Lucan, *Pharsalia* 4, 136–8 | AD 60s | 'Osiers of hoary willow were steeped and plaited to form small boats which, when covered with the skin of a slain ox, carried passengers and rode high over the swollen river … on such craft the Venetian navigates the flooded Po and the Briton his wide ocean' |
| 6 | Pliny, *Nat. Hist*. 7, 206 | AD 70s | 'Even now in the British ocean coracles are made of wicker with hide sown round it' |
| 7 | Caesar, *Bello Civili* 1, 79–80 | 56 BC (49–45 BC) | 'The Gauls' [Veneti] ships … [had] flatter bottoms [than Roman ships] … exceptionally high bows and sterns … hulls of oak … anchors with iron chains … sail of raw hides or thin leather …' |

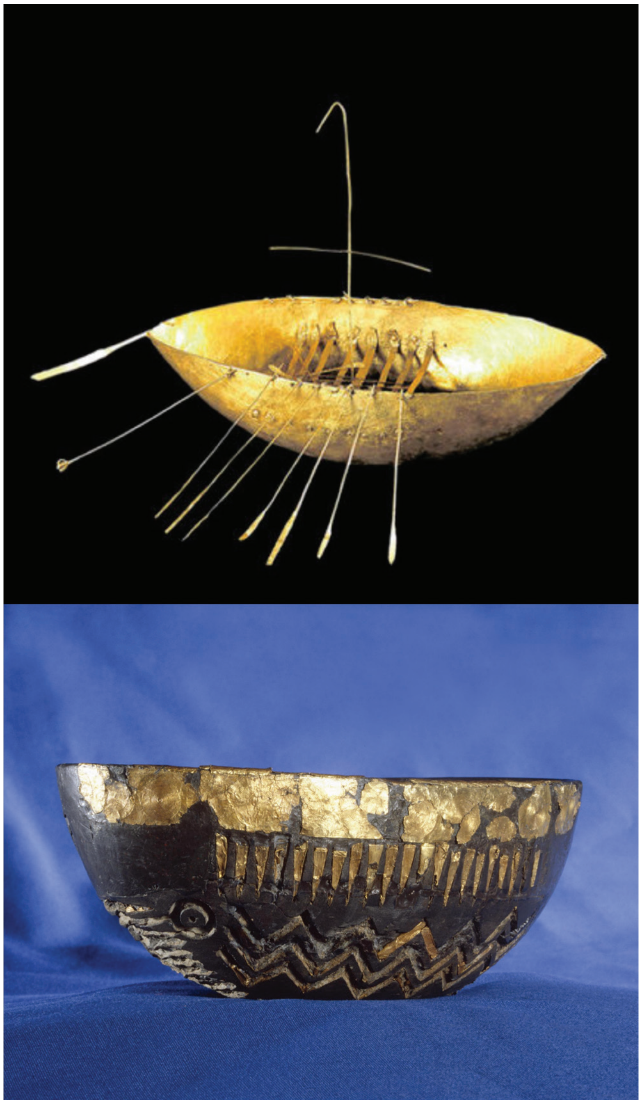

*Figure 3.2. The Broighter gold boat (top) and Caergwrle bowl (below) (with permission from the National Museum of Ireland and © Amgueddfa Cymrn – Museum of Wales).*

historical accounts (Fig. 3.2, above; Denford & Farrell 1980; McGrail 2010a, 100; Cunliffe 2017, 332). This small golden vessel was found as part of a hoard of seven golden objects of a similar chemical composition, deposited between the high and low tide lines of Lough Foyle, an inlet from the Atlantic in Northern Ireland (Warner 1999, 73, 81, 84). The vessel is furnished with eight rowing benches, seven pairs of oars, a steering oar (and space for a second steering oar), a mast with a 'hooked' top, and with a yard for a square sail, stepped amidships through a hole in the centremost thwart, a grappling iron and a forked implement, possibly used for handling a square sail (Cochrane 1902, 213; Farrell et al. 1975). Based on the number of thwarts or rowing benches, and assuming these would have been located roughly 1 m apart, the model is likely to represent a vessel that it around 4 m wide and 10–11 m long (Nance 1922; Cunliffe 2017, 334). Although this vessel has in the past been interpreted as a flat-bottomed plank-built boat of the type described by Caesar as being used by the Veneti of Brittany, its rounded hull shape makes its interpretation as a hide boat more likely (Evans 1897; Warner 1999).

How far back in time these types of vessels might have been used is difficult to know for certain, though some scholars have argued for their existence in the Neolithic or even the Mesolithic period (Cunliffe 2001, 67; McGrail 2004, 181–3; 2010a, 100). Many megalithic monuments in France are decorated with rock carvings, some of which could be representations of boats, including hide boats (Cassen et al. 2017; Philippe 2018, 575; 2019, 143). One such megalith, or stela, is located at a prominent location in the landscape and clearly visible from the first portage point upriver along the river Rance near Saint-Samson-sur-Rance. This portage point is sited approximately 2 km upriver from where the river opens into a wide and long estuary before joining the English Channel – thus creating a large, sheltered body of water that would have been ideal for the early development of seagoing craft and seafaring skills. It also seems likely that Neolithic seafarers exploited the tide, perhaps even using the local tidal bore to reach the upper stretches of the river and this first portage point (Cassen et al. 2017, 277–8).

The Saint-Samson-sur-Rance stela also offers possible clues to the interpretation of one of the more puzzling features of the Broighter boat. The monument depicts a number of boat shaped carvings but also several 'f'-shaped figures that are currently interpreted as hafted axes, along with square figures and animals (Cassen et al. 2017, 276). One of the boat images (Fig. 3.3), shows an 'f'-shape erected at its centre, providing a direct comparison with the very similar 'f'-shape or 'hook' created by the curved mast top and yard of the Broighter boat. This curious feature, which is unlikely to have been caused by accidental damage, appears to be a deliberate detail (Cochrane 1902, 213). This has led to speculation that the 'f' on the stela could be some sort of symbol other than a tool (J. Koch, pers. comm.), perhaps even a mast. Furthermore, could the 'squares' or 'fields' on the stela in fact represent hide sails, manufactured from the very same type of animals also depicted on the stela?

Caesar (McGrail 2004, 196) describes the large hide sails of the Veneti tribe who lived in the bay of Quiberon on the south side of the Finistère peninsula during the 1st century BC (see blue square in Fig. 3.1A for approximate location). It is possible that their choice of sail material relates to a much earlier tradition when both boats and potentially sails were made from animal hide. However, the question of when sail was first used in north Atlantic Europe is still very much contested, but more on this later.

Hide boats, such as coracles and curraghs, appear in ethnographic contexts around the world and are still in use in parts of the British Isles, in particular in Wales and

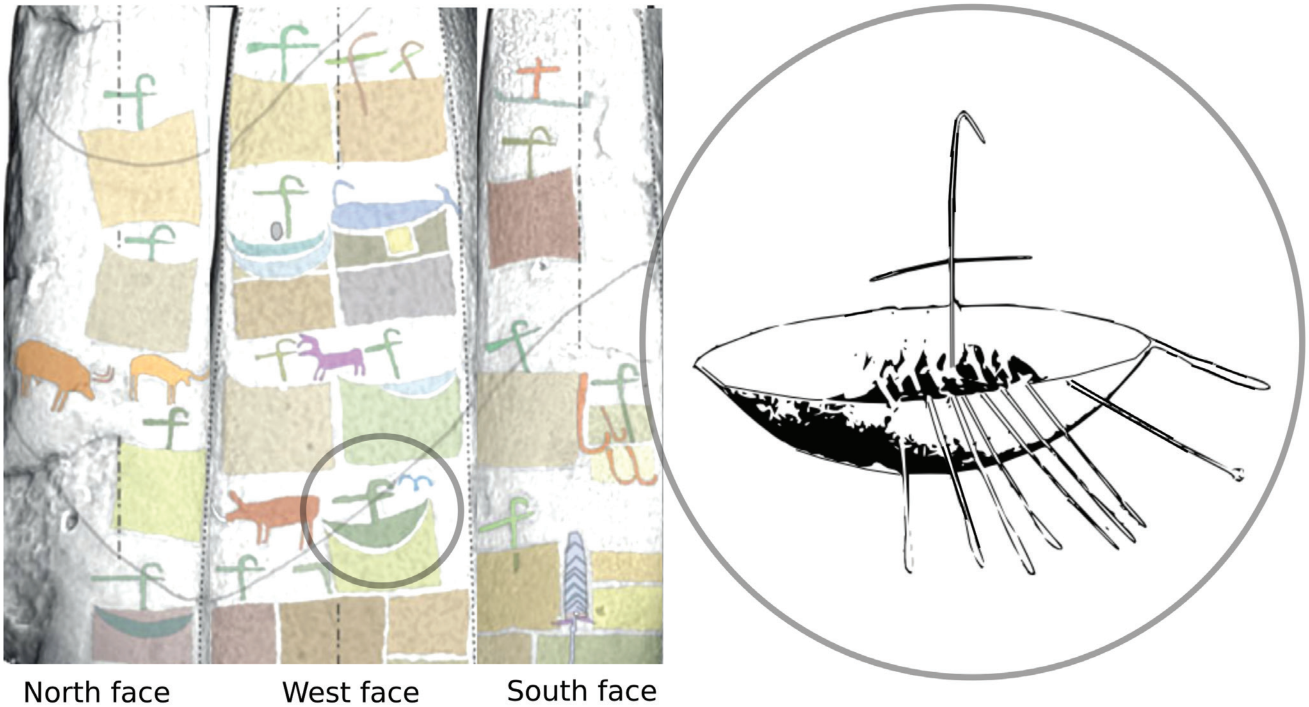


*Figure 3.3. Three faces of the Saint-Samson-Sur-Rance stela featuring boat-like objects, some of which feature central mast- like 'hooked' features reminiscent of the 'hooked' mast with yard on the Broighter gold boat (after Cassen et al. 2017, 276, redrawn after photo www.irisharchaeology.ie/2012/09/the-broighter-hoard).*

Ireland (Nance 1922; O'Neill 1940; Adney & Chapelle 1983; Petersen 1986; McGrail 2004; 2007; Luukkanen & Fitzhugh 2020). In their simplest form, their construction requires nothing more than pliable wood, such as hazel or willow rods (or even driftwood or bones), hide, grease, rope, and thread, using basic tools, such as an axe, or knife, and needle. The widespread availability of these materials and the simplicity of their manufacture make for a very versatile boat, adaptable for use under different environmental and technological conditions.

Caesar mentions the existence of keeled curraghs (McGrail 2007, 446) and a similar reference appears in the 6th century AD *Vita St Columbae* (Cunliffe 2001, 67). A drawing of a sailing curragh, or 'portable vessel of wicker ordinarily used by the Wild Irish' by Captain Thomas Phillips, suggests that keeled hide boats built on a close basket weave framework may have continued in use well into the 17th century (Fig. 3.4; McGrail 2007, 446). Whether the purpose of the 'keel' mentioned by Caesar (nr 4, Table 3.1) was to aid directional stability or simply added to protect the hide is not known. Nevertheless, the inclusion of a gentleman standing at the stern of the depicted vessel suggests it is *c*. 9 or 10 m long, thus similar in size to the Broighter boat. This stands in contrast to previous interpretations of the vessel as only *c*. 6 m long and *c*. 1.5 m wide on account of it supposedly being covered by some 25 stitched hides (Nance 1922, 100; McGrail 2007, 446–7). By comparison, in


*Figure 3.4. A late 18th century drawing of a 'Vessel of Wicker ordinarily used by the Wild Irish' (with permission from Pepys Library, Magdalene College, Cambridge).*

historical times the average coastal Irish keel-less curraghs were 6 or 7 m long and 1–1.5 m wide.

Early European visitors to Greenland in the 1800s recorded seeing local umiak-style hide boats that were in the region of 18 m long (Adney & Chapelle 1983, 76). Although these vessels were based on a slightly different construction technique to that of the curragh, there is no reason this length of hide boat could not have been built at an earlier date if driftwood or bones of sufficient size were available (Petersen 1986, 117). Neither can be it assumed that basket weave technology would prevent the construction of larger vessels, if these were needed, and it seems more likely that a boat's size would have been determined instead by the available means of steerage and propulsion.

There are certain fundamental factors that need to be considered when suggesting the use of hide boats in open sea in prehistory. One is the length of time a hide remains watertight, the second is the fact that, when wet, hides expand and the leather would need to be tightened as not to become baggy and thereby render the vessel impossible to manoeuvre or propel. The third is related to the robustness of the hull when hit by waves and the final one, the vulnerability of the hides to tearing. Beginning with the second last point, McGrail (2007, 444–7) observes that the basked-weave curraghs were 'resilient and energy-absorbing' and therefore very capable of withstanding the force of the waves. This energy-absorbing feature would potentially also create less water spray. Most historical accounts concerning the behaviour of curraghs at sea are relatively late in date and describe curraghs with a stronger, double gunnel using tarred canvas built on laths rather than hide on basket weave (Fig. 3.5; MacCárthaigh 2008; Synge 2023 [1907]).

Nevertheless, the lightness of their construction is said to allow the boat to sit on top of the waves and slide over them rather than go through them. This characteristic would make them prone to catch the wind and to drift easily, making them difficult to steer and propel if not using a combination of oars, sail, and steering oar or keel (see e.g., Synge 2023 [1907], 8, 36, 38, 40, 52, and 67 on the danger of losing an oar). The tight weave of the basket and the similarly tightly spaced 'shell' of the lath made boats used in historic times, would have helped protect the hide from being pierced from the inside and would also ensure the hull shape did not become too distorted due to water expansion of the hide or waves pressure – again all vital factors for retaining manoeuvrability.

In terms of being vulnerable to tearing, this would always be a danger in a hide boat (Coates 2005; McGrail 2007). Petersen (1986, 150–1) describes the umiak as extremely vulnerable to floating ice or wood, sharp stones, and even barnacles, and explains the vital importance of carrying rollers onboard, slightly wider than the width of the boat, to use when beaching in circumstances where the boat could not be carried.

It is possible that the forked implement on the Broighter model was used to push the boat away from potentially dangerous obstacles in the water such as rocks or floating objects. As for the curraghs, McGrail (2007) suggests that these would have anchored near the shore rather than be dragged up on land and any cargo unloaded from smaller vessels. Such vulnerability would have required early seafarers to develop certain skills of navigation, influencing their choice of landing sites.

Whereas cattle hide was used to clad historical hide boats in Ireland, skins of seal or walrus were used in areas further north. These skins are believed to have been stronger and longer-lasting (Adney & Chapelle 1983, 176) and thus better suited to local environmental conditions. It is important to note that variables such as ambient water temperature and salinity have a significant bearing on how long a hide might last. Adney and Chapelle write that a pre-oiled seal skin remains watertight for between 4 days and a week before requiring re-oiling with some kind of animal fat, whereas seams would need more regular treatment to keep watertight. Luukkanen and Fitzhugh (2020, 54) on the other hand argue that hides of walrus and seal, even when pre-oiled, start to take in water and begin to stretch after 1 or 2 days of continuous use. Therefore, the hide boats of early seafarers would have had to be brought up on land at regular intervals to dry and avoid sinking. The problem would be made worse if the shell construction was made of bone rather than wood, which is more buoyant. These restrictions would have seriously limited the use of hide boats to crossings of no more than 1–2 days.

Severin (2005 [1978]), during his re-enactment of Brendan's 6th century AD circular journey from Ireland to the America's via Iceland, used an 11 m long medieval curragh-style boat, with oak tanned ox hides rendered watertight by soaking in warm wool grease left to infuse over the course of a couple of weeks (Severin 2005 [1978], 262). His research suggested that the tanning process made the hides stronger and had the secondary effect of increasing the strength and resilience of the flax thread used to sow the hides together, whereas the impregnation of the skins in grease ensured the hides remained watertight throughout the entire journey. A large supply of sheep tallow was brought along on his trip to re-apply on seams throughout the journey as well as spare hides, ropes, and tools for maintenance – all of which serves to illustrate the importance of preparation and the maintenance involved in seafaring in general and long-distance seafaring in particular. His research also shows that the hides used in medieval times had most probably been tanned for up to a year in oak in order to remain strong enough for use on large seagoing crafts in local waters (Severin 2005 [1978], 30–1), which is important to bear in mind when making assumptions about the use of hide boats

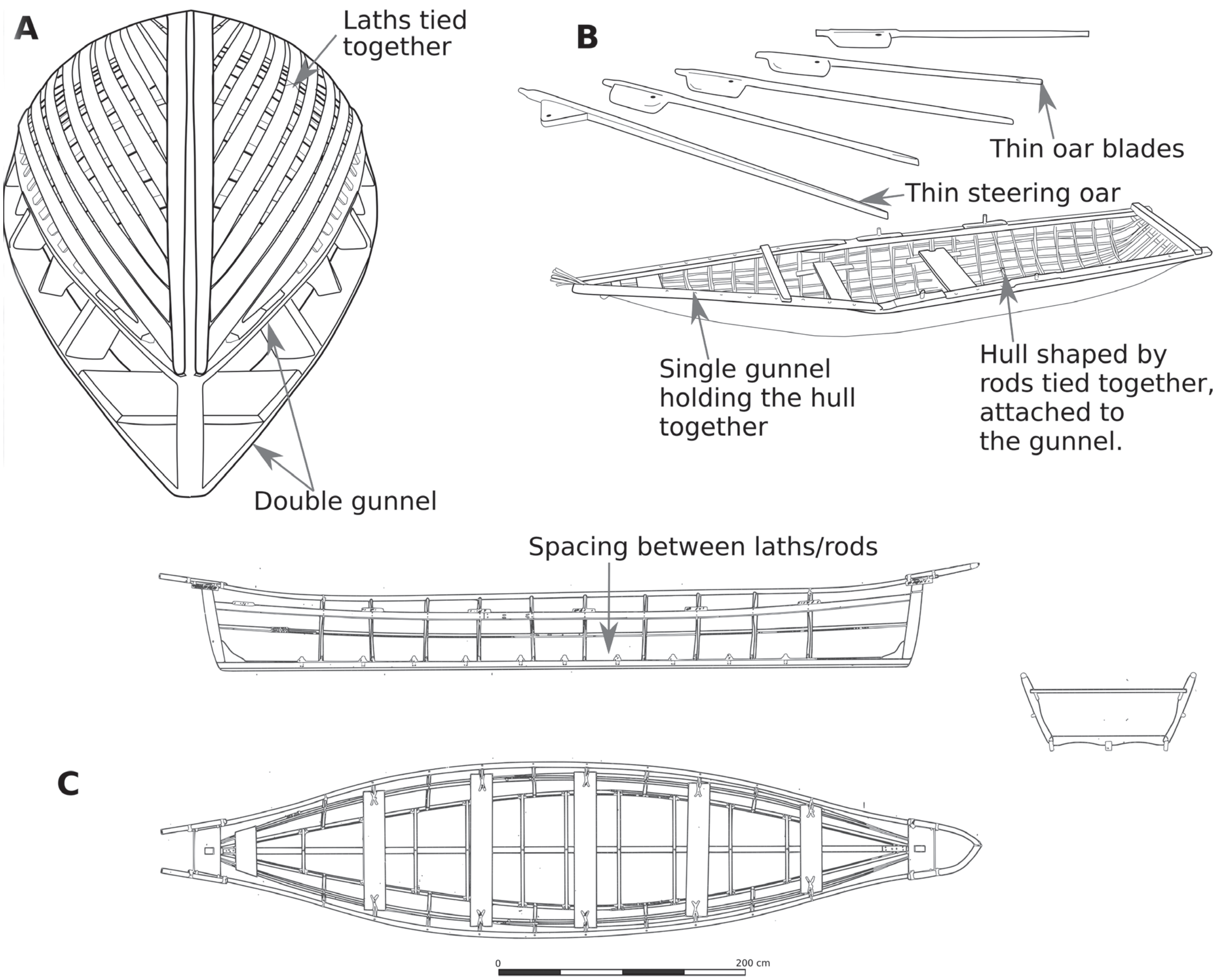


*Figure 3.5. Framework with different spacing representative of different types of hide boats. A. The hull of the 36 ft (*c. 11 m*) curragh used by Severin, with a tight framework of thin laths of ash. Also notice the double gunnel (after photo in Severin 2005, 119). B. Model of a curragh from Mulroy Bay, Co. Donegal, Ireland. Framework based on round hazel rods with larger spacing in-between individual rods (laths) than what is the case with the wicker basket-type framework seen in Fig. 3.4. Also notice the thin tips of the steering oar and the four oars (after photo in Greenhill 1995, 92). C. Line drawing of an Umiak from the Nuuk area with relatively much larger spacing in-between individual rods (after drawing by M. Gøthche in Petersen 1986, 154).*

in earlier periods. It is however very doubtful that such a journey might have been possible without the use of sail.

More recently, experimental trials in the *Brioc*, a boat construction based on Severin's 'medieval'-type curragh have revealed yet more information on the practical use and maintenance of hide boats. For example, the application of beech tar to counter the degeneration of the hull has been shown to be very effective, reducing the need for maintenance to every 6 months. Salt and saltwater have been found to have a great effect on decomposition of both hides and wood. For the hide, this is made evident by changes in its smell when, for example, entering rivers with less salinity (Ingwenog Jaouen pers. comm.).

The *Broic* has now been in use for nearly 25 years, making several journeys in the British Channel and around the British Isles and, although we do not know exactly what methods or substances were used in prehistory for maintaining hide boats, insights provided by experimental archaeology demonstrate what might have been possible, in particular in terms of the durability of hides within a marine environment. Hide boats might also have been made for single use, i.e., for one journey only. The Dene, a First Nations indigenous group in north-western Canada, used moose hides to clad boat frames of spruce that were up to 20 m long, following a tradition with roots in the 1700s when the Fort Norman trading station was established. The trading post created a new market involving the exchange of good quality fur for desirable goods such as firearms and knives. In order to trade these goods, the tribe would migrate some 500 km upriver into the mountains, using small bark canoes, to hunt moose. Some of these hides would be prepared by scraping off the meat and the outside fur, but crucially leaving the inside membrane intact. This made them stronger and naturally watertight but more prone to decomposition. When enough hides had been collected and it was time to leave, the boat hides would be soaked in the river for a couple of days while the boat frame was put together, then taken up, sewn together with sinew thread, and used to clad the boat. These boats were used on the river when the water was high and the downstream current was strong thus enabling the Dene to transport heavy loads, including entire family groups. Once the hides had been delivered for barter, the vessels were completely dissembled leaving no trace behind (www.riveroffforgiveness/building-the-boat).

### *Logboats as seagoing craft and as evidence of boatbuilding abilities*

In contrast to hide or bark boats, logboats are well attested within the archaeological record from as early as the 9th millennium BC (McGrail 2004). Although most of our evidence for these boats suggests that they were used on sheltered inland waterways, these vessels cannot be ignored when discussing the development of larger, safer, and more seaworthy vessels. Wood not only provides a naturally buoyant material (air trapped within the cells enables even relatively heavy logs of oak to float in water) and is harder and more durable than bark or leather, but also, with the right tools, woodworking knowledge, and resources, has the potential to provide better shape, size, and stability.

The earliest logboat found to date comes from Pesse in the Netherlands. This boat, made from a pine tree dated to 8760±145 BC and roughly finished, is almost 3 m long and 44 cm wide, with a bottom thickness of *c*. 8 cm and sides that are *c.* 31 cm high (Lanting & van der Plicht 1997–98, 154; McGrail 2004, 174; Louwe Kooijmans & Verhart 2007, 203). This suggests that its freeboard would have been extremely low, though experimental trials in a reconstruction seem to indicate its serviceability as a single person boat in very sheltered waters (Louwe Kooijmans & Verhart 2007, 203). Whilst early logboats were made of relatively soft wood species such as pine, lime, and alder, logboats made of harder and more durable oak became increasingly favoured by the 5th millennium BC onwards, suggesting improvements in tool capabilities (McGrail 2007, 443).

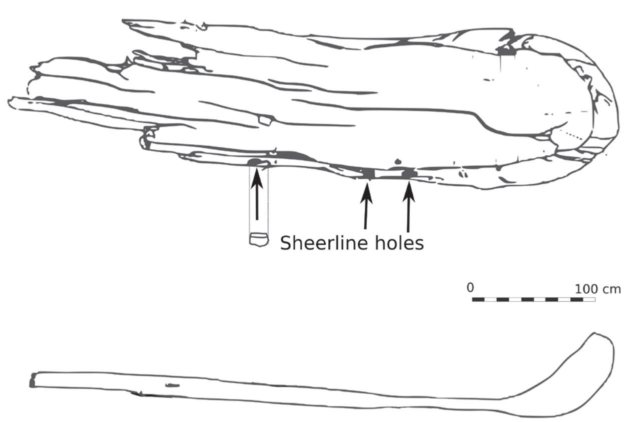


*Figure 3.6. The physical remains of the Gormanston logboat, found 1 km off-shore under 2 m thick sediments. Black arrows indicate sheerline holes. The photo shows the best preserved of these holes before the boat was recovered from the sea floor (after Brady 2002).*

#### *Logboats on the sea*

The general assumption is that the prehistoric logboats in Atlantic Europe are unsuitable for operating on the sea, or at least seriously restricted for operation on open water outside the narrowest of favourable weather windows. This is based on the fact that most of the prehistoric logboats recovered so far tend to be (a) too narrow to provide stability in waves and are easily overturned when struck from the side, (b) lack bows that are shaped to deflect waves and ride up a wave rather than go through them – a single such wave might flood the boat or turn it upside down – and (c) have sides that are too low – again allowing waves to flood the boat.

To date, only one logboat has been found within a clear marine context (Figs 3.6–3.7, Table 3.2). The remains, which consist of the stern end of an oak logboat (the surviving parts of which measure 4.2 × 1.1 × 0.7 m) were found on top of an underlying layer of boulder clay beneath 2 m of sediments during dredging for a new gas pipe between Ireland and Wales in 2002. The findspot is located approximately 1 km off the coast of Gormanston and the mouth of the river Delvin, some 40 km north of Dublin (Brady 2002, 7; Kelleher 2002). This is an area within the Irish Sea that has a very rich seafaring heritage, evidenced not least by the many historical shipwrecks recorded in the vicinity (Brady 2002). The Gormanston logboat has been dated to *c.* 1100 BC and is thought to have had an original length of around 7 m (Brady 2002; Cleary 2016). A series of holes has been identified along the remaining parts of the port gunwale (Fig. 3.6), the exact purpose of which remain unknown. Without anything further to go on, as, for example the shape of the bow, it is difficult to know whether it was indeed used for coastal portaging and foundered *en route*, or, whether it is simply the remains of a vessel that was dragged out to sea by a storm or tides and sank once the wood had absorbed enough water. Afterall, logboats are difficult to sink and where they are found at the bottom of, for example, inland lakes, they are usually weighed down with rocks (Gregory 1998).

The large size of some logboats, such as the Lurgan dugout, might imply increased stability. Dated to *c.* 2400 BC,

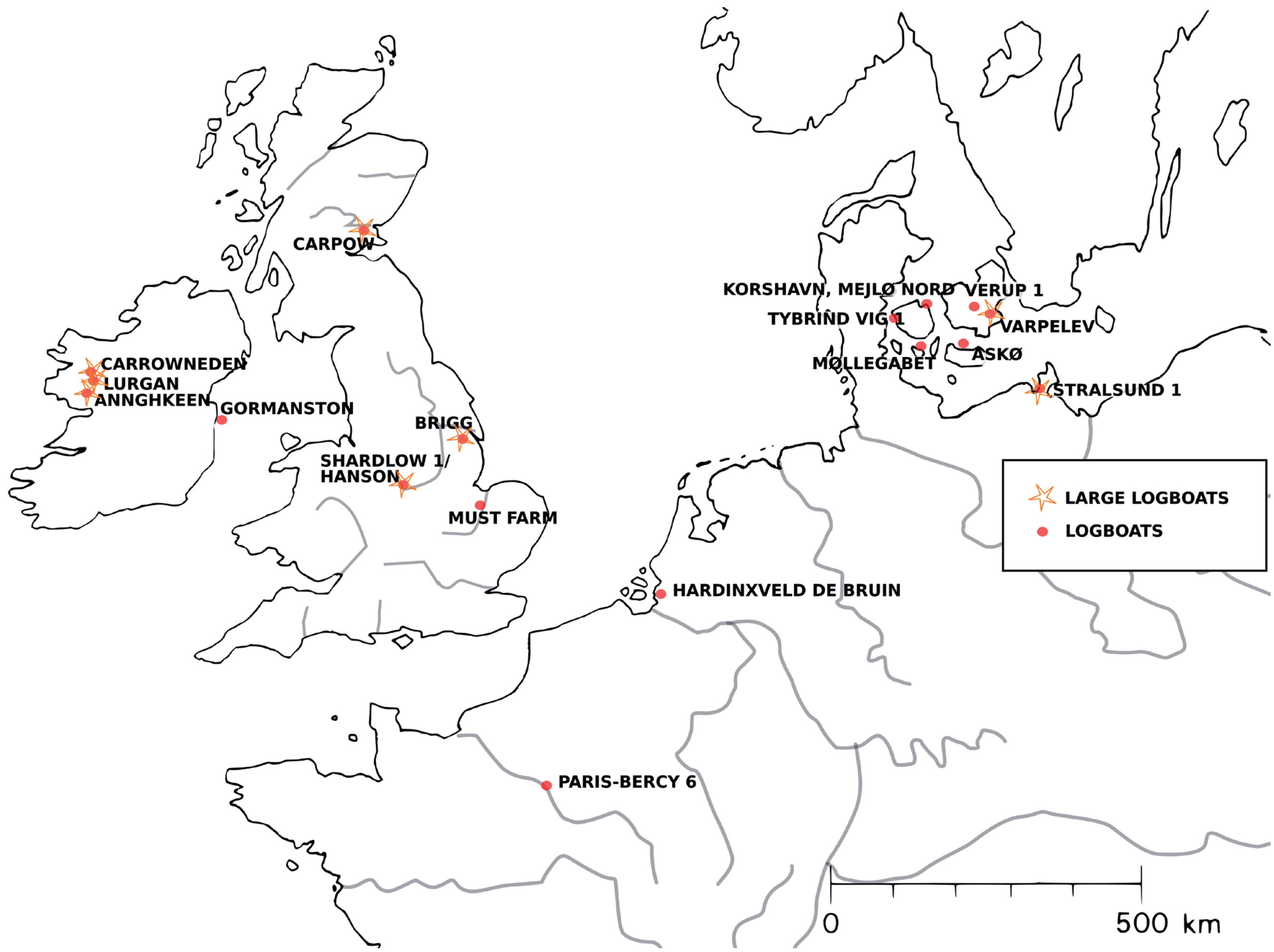


*Figure 3.7. Map showing the location of the logboats mentioned in the text.*

the Lurgan boat was also found in Ireland, in what was once a shallow lake with possible riverway connections to the Atlantic coast of Co. Galway (Figs 3.7–3.8, Table 3.2; Gregory 1998, 30). At the time of its discovery in 1902, the boat measured a maximum of 15.24 × 1.2 × 0.8 m and consisted of a rounded stern and a slightly tapering hull that followed the natural shape of the tree, ending in a rounded and pointed bow. A photo taken at the time provides an idea of how much the artefact has shrunken since its excavation. The photograph also reveals a series of holes along its gunwale, or remnants of holes of which only the lower halves are still visible. Originally, the freeboard was probably even higher, perhaps in the region of 1 m high (Fig. 3.8) (Gregory 1998). The size of the vessel is slightly at odds with its location. Neither the ancient lake nor the nearby river systems appear to have been large enough for it to have been effectively manoeuvred (Robinson et al. 1999, 907).

Alternatively, the location of the Lurgan boat might be explained by the availability within the area of a mature parent tree with a bole (from the ground up to the first branches) large enough to accommodate its full length and width. It is possible, therefore, that the findspot relates to a boatbuilding site in the near vicinity. There is some uncertainty whether the boat had been completed (Robinson et al. 1999, 907). Although the outer hull of the boat has a good finish and even shows some signs of abrasion, perhaps signs of actual use, the inside is less finely worked. Interestingly, interior tool marks suggest that it had been hollowed out using a ‘scoring and splintering process’ (Gregory 1998, 31). This is a process whereby scores are cut across the grain at regular intervals with an axe, after which wedges are used to splinter off the wood in between. Indeed, most prehistoric logboats in Europe seems to have been hollowing out using this process. Nor is the Lurgan the only large logboat dated to within this period in Ireland. The Annaghkeen logboat, found at the bottom of Lough Corrib in the same County measures an equally impressive 12.15 × 1.07 m (the sides having eroded almost completely), and is similarly dated to *c*. 2500 BC. To this we can also add the stern section of a third similar

*Table 3.2. Logboats providing evidence of technological know-how and an understanding of aspects of boat performance.*

| *Date* | *Location* | *County/country* | *Sheerline holes* | *Transom built* | *Smooth hull* | *Repairs* | *Other* | *Reference* |
|---|---|---|---|---|---|---|---|---|
| 5500–5300 cal. BC | Hardinxveld De Bruin | Netherlands | | | x | | | Louwe Kooijmans & Verhart 2007, 204–5 |
| *c*. 5250–5180 cal. BC | Korshavn/Mejlø Nord | Fyn, Denmark | | x | x | x | | Rieck & Crumlin- Pedersen 1988, 16–7, 28 |
| *c*. 5400–4240 cal. BC | Askø | Askø, Denmark | | | | x | | Ravn 2022, 24–6 |
| *c*. 4900 cal. BC | Møllegabet, | Fyn, Denmark | x | | x | | | Skaarup & Grøn 2004, 34–6 |
| *c*. 4210–4040 cal. BC | Tybrind Vig I | Fyn, Denmark | | x | | x | 12 m long bole required | Ravn 2022, 23–4 |
| *c*. 3860 cal. BC | Stralsund 1 | Stralsund, Germany | | | | | 13 m long bole | Klooss & Lübke 2009 |
| *c*. 2800 cal. BC | Verup 1 | Sjælland, Denmark | x | | x | | | Ravn 2022, 14, 25; Rieck & Crumlin- Pedersen 1988, 38–9 |
| *c*. 2570-2310 cal. BC | Lurgan | Galway, Ireland | x | | x | | >16 m long bole required | Lanting & Brindley 1996; Gregory 1998; Robinson et al. 1999 |
| *c*. 1440–1310 cal. BC | Sharlow 1/Hanson logboat | Derbyshire, England | ? | ? | ? | ? | ≥15 long bole required, integral cleat | Strachan 2010, 128 |
| *c*. 1300-1250 cal. BC | Must Farm 3 | Cambridgeshire, England | | x | ? | ? | Integral cleat | www.mustfarm.com |
| *c*. 1100 cal. BC | Gormanston | Meath, Ireland | x | | ? | | ? | Brady 2002; Kelleher 2002 |
| *c*. 1000 cal. BC | Carpow | Perth Scotland | x | x | x | x | >10 m long bole required | Strachan 2010 |
| *c*. 1000 cal. BC | Varpelev | Sjælland, Denmark | | | x | | >12.5 m long bole required | Kastholm 2012; Rieck & Crumlin-Pedersen 1988, 44–6 |
| *c*. 1000 BC | Brigg | Lincolnshire, England | | x | ? | x | ≥16 m long bole required, patch with integral cleats | McGrail 2004, 174–6 |
| *c*. 300 BC | Hasholme | Yorkshire, England | x | x | | | *c*. 15 m long bole required | McGrail 2004, 176–7; McGrail 2010b |


*Figure 3.8. Two photos of the Lurgan boat taken shortly after it was excavated (with permission from the National Museum of Ireland). Below, a line drawing of the Lurgan boat (after Gregory 1998).*


*Figure 3.9. The* King of Mochov*, a large logboat in oak moored in a sheltered bay on the Island of Siphnos, Greece (photo: Zofia Stos-Gale, 2 July 2023).*

sized logboat found at Carrowneden, in neighbouring Co. Mayo, dated to *c*. 2400 BC (Lanting & Brindley 1996; Brady 2014; Cunliffe 2017, 134). These three vessels, all made of oak, are some of the earliest logboats in excess of 10 m length found within Atlantic Europe but they are by no means unique. At Tybrind Vig on the island of Fyn in Denmark, two logboats made from linden trees, dating to *c*. 4200 BC, have been found. The first of these measures 10 × 0.5 m and the second was probably even larger (Ravn 2022, 23–4).

Large oak logboats, made from trees with boles in the region of 12–16 m tall and perhaps up to 1.9 m in diameter, have been found in intertidal contexts such as the Tay Estuary at Carpow in Scotland, the Humber tributary system (the Brigg boat), and the river Tryggvælde (the Varpelev boat) at Sjælland, Denmark (Fig. 3.7, Table 3.2) (McGrail 2004, 174; Strachan 2010, 14, 36, 58; Kastholm 2012). All three are dated to around 1000 BC and share a number of similarities in addition to their size, material, and location, most notably the existence of raised ridges on the inside bottom which may be indicative of interaction between the British Isles and Scandinavia (Kastholm 2015). The exact purpose of these large logboats may have varied. Another example, the Hanson logboat (Fig. 3.7, Table 3.2), dated to *c*. 1300 BC and originally in the region of 14 m long, is likely to have been used to transport sandstone blocks from a sandstone outcrop *c*. 2 km upriver from its final resting place (Crawshaw et al. 2016). An integral cleat on the inside of this boat suggests it might have been towed for this purpose.

It is estimated that a logboat that is over 85 cm wide can carry a crew of two per metre, if they are slim and weigh around 65 kg each (McGrail 1978). While taking into account the hollowed-out end ships, this would suggest that a boat such as the Lurgan logboat might have had a full paddling crew of 24. In order to accommodate a cargo, the crew would have had to be reduced (see e.g., Tichý 2016, 31). By comparison, the 11.2 m long and 1.2 m wide *King of Mochov*, a hypothetical reconstruction of one of the Neolithic logboats from lake Bracciano, in Italy, seem to verify this assumption (Fig. 3.9) (https://www.monoxylon.cz/en/monoxylon-iv_en/). Constructed out of a massive 330-year old oak, the *King of Mochov* provides a good idea of what a logboat with increased seafaring abilities might have looked like, with its bow shaped to deflect waves, 1 m high sides, and a large steering oar. The latter presumably helped to keep the boat in a straight line and thus ease the strain on the crew (who would otherwise have to propel the boat and steer it with each paddle stroke instead of just focusing on speed). It also highlights the disadvantage of a seagoing single hull logboat when used for regular journeys. Weighing *c.* 2800 kg and with a full paddling crew of 20, it can reach a cruising speed of 5 km/h in a gentle breeze (https://www.monoxylon.cz/en/monoxylon-iv_en/), corresponding to a travel radius of *c.* 40 km. This is almost half of what is estimated for the Hjortspring boat, which, weighing in at a mere 530 kg, was capable of reaching a cruising speed of 8.7 km/h with an estimated a travel radius of 74 km in the same time frame while carrying a total cargo (including crew) of *c.* 2500 kg (Vinner 2003, 117–9; Bengtsson 2017, 90).

So far, none of the logboats recovered in archaeological contexts has a similar shaped bow to the *King of Mochov*. One possible exception is noted by McGrail (2004, 193). He points out that an Early Bronze Age log coffin from a round barrow at Loose Howe, north-east England, is deliberately fashioned to resemble a boat while featuring details that are evocative of a seagoing vessel, including a bow with a potentially wave-deflecting shape as well as a square stern and a keel. These features suggest that the coffin represents an attempt to copy a contemporary vessel, perhaps used on the nearby river Esk (Fig. 3.10). The coffin is dated to *c.* 2000 BC, at a time when plank boats are verified in the British Isles, and the possibility that it was influenced by the shape of a contemporary vessel cannot be ignored (Jones et. al 2018).

Logboats could potentially become more stable if their sides were slightly flared outwards from the base up to the gunwale rather than being vertical. One way of achieving this shape is by making the sides thin enough so that they can be pushed outwards from the inside through a process of expansion and extension (Jensen 2018). This is only possible when the wood is heated to a point at which it becomes malleable and does not crack. Practical experiments demonstrate the precision and in-depth knowledge of wood and its properties this process would have required (Arnold 2006; Gifford et al. 2006, 58; Jensen 2018). However, while this process will increase the stability of the boat, it will not necessarily increase its cargo capacity, and firm evidence of expanded logboats are not found within European contexts before the 1st century AD, with the earliest examples averaging around 3–5 m in length and made from oak (Rieck & Crumlin-Pedersen 1988, 80–5; Crumlin-Pedersen 2018, 12–13; Jensen 2018, 40). The expanded logboats of the Haida, a First Nation group which migrated to the Haida Gwaii island archipelago, an area with large tides and huge swells coming in from the Pacific, off the north-west coast of North America in the 1700s AD, might serve to illustrate this (Moss 2008, 35, 41). Cutting local redwood trees to a length of 15 m, the Haida were able to expand the original central width of the trunk (*c.* 1.2 m) by some 60 cm by using a combination of steam, sticks, and hot stones, creating large round hulled vessels with a v-shaped bow section highly reminiscent of the Hjortspring boat (Moss 2008, 35, 41; Ling et al. 2021).

Arnold (2006) argues that Paris-Bercy 6 logboat was similarly expanded. This boat, made of oak and dated to *c.* 4700 BC, was located on a palaeo-channel of the river Seine and may have measured as much as 9 m in length. Apart from this find there is tentative evidence of fire being used to make the Hardinxveld De Bruin lime tree logboat, dated to 5500–5300 BC (Louwe Kooijmans & Verhart 2007, 204–5). In most other cases where charred areas are identified in the interior bottoms of prehistoric logboats, these have been generally interpreted as small hearths for either cooking, warmth, or the night time fishing practice of using fire to attract prey (see e.g., Klooss & Lübke 2009; Mordant et al. 2013; Philippe 2018, 585; Ravn 2022, 18).

There is no historical or archaeological evidence for the use of outriggers to increase stability in any areas outside of the Pacific, Europe included (McGrail 2007). There is, however, historical evidence for the use paired logboats on inland waterways in Europe well into the 20th century and some evidence to suggest that battens might have been attached along the outside of a hull at the waterline in an effort to increase stability (Fig. 3.11; Johnstone 1988, 48; McGrail 2007; 2010a). An experimental trial in 1954 that placed three logboats side by side with a platform carrying a large bluestone rock serves to demonstrate the ease with which such a craft could be used for transporting heavy or bulky goods (Atkinson 1956, 106–14) – at least on inland waterways that were cleared of branches and other debris that might otherwise easily catch between the hulls.

Thus, paired logboats present a more likely prehistoric method for transporting heavy cargo than, for example, a raft, providing at once better buoyancy, directional control, and protection for the crew (Johnstone 1988, 48), as and when needed. A possible disadvantage to this method is that the resulting vessel would be heavier and more cumbersome to paddle on open water, since the crew would have to propel two (or three!) boats instead of the one. However, without bows that could help the boats ride over or cut through waves, also paired logboats were most likely confined to rivers and estuaries, or, used for short distance coastal portaging under ideal conditions, perhaps towed by other boats.

One plausible explanation for the holes along the upper gunwale of both the Lurgan and the Gormanston boats is that they might have served as potential attachment points when boats needed to be paired up (perhaps temporarily when boats were lying at rest). Such holes may have had multiple functions, also servicing as attachment points for covers to protect cargo and crew from rain or waves, or for fixing a paddle oar to help steer the vessel (McGrail 2010b, 2–3; Strachan 2010, 68). Faint indents on the outside of several of the sheerline holes on the Carpow logboat suggest the fastening of something with the use of wooden pegs (with the peg used in the same way as a button; Strachan 2010, 64). Similar but smaller and more numerous holes have been identified along the upper gunwale of the Verup 1 boat (dated *c.* 2800 BC) in Denmark (Fig. 3.12; Ravn 2022, 14, 25). This logboat is much smaller, measuring 5.5 × 0.5 × 0.3 m, and made of alder. A *c.* 10 cm long wooden peg with a small head positioned in close proximity to one of the holes

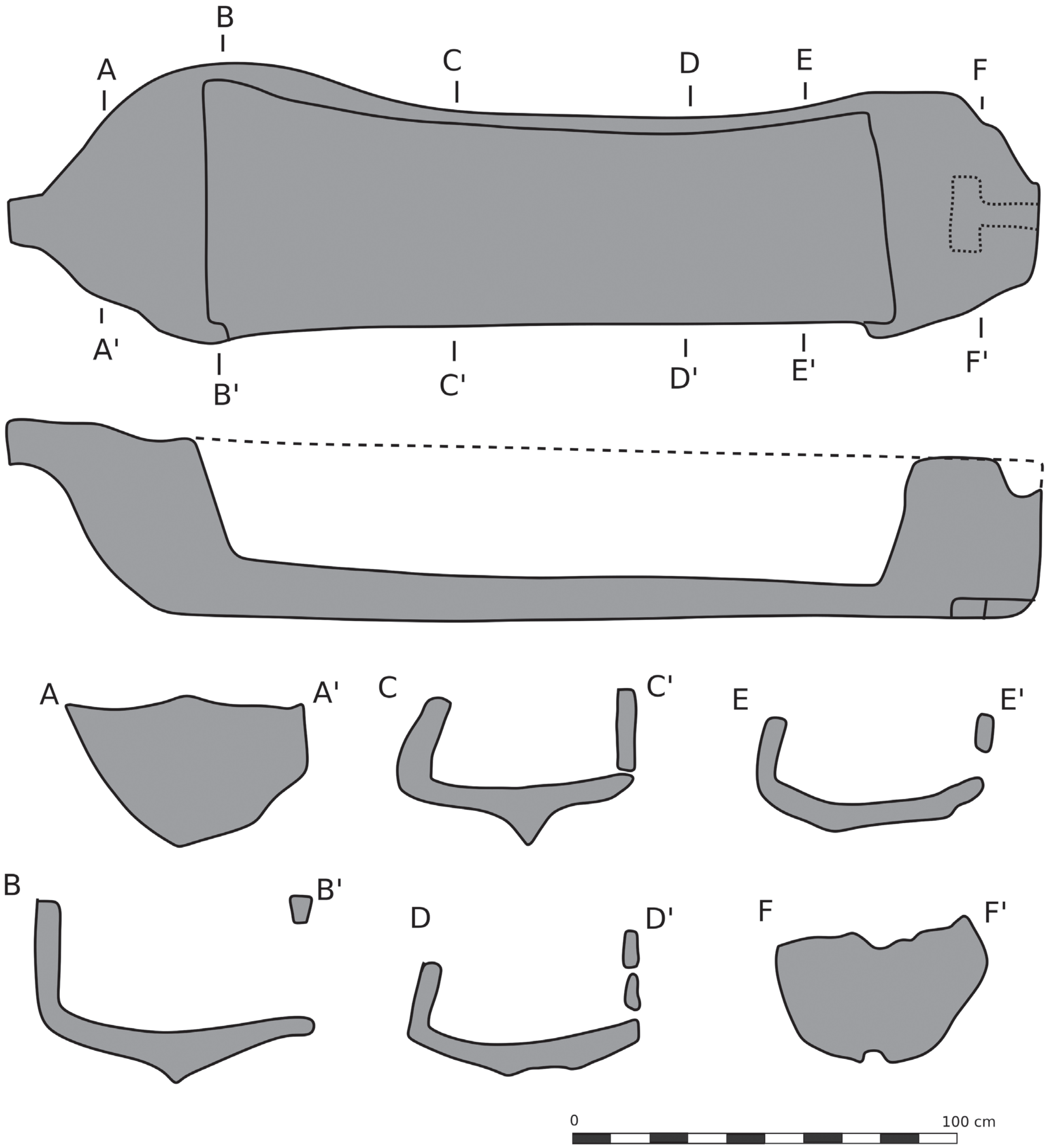


*Figure 3.10. The Loose Howe boat shaped coffin, dated to* c. *2000 BC (after McGrail 2007, 442).*

suggests it might have been used to attach an additional washstrake or moveable board to protect against sea spray (Rieck & Crumlin-Pedersen 1988, 38–9). A washstrake has also been found on the 350 BC Hanstholm logboat and it is possible the indents on the outside side of the sheerline holes on the Carpow boat might have been used for fastening washstrakes in a similar way (McGrail 2010b, 6). Another interesting feature of the Verup 1 boat is its square-shaped stern, which is 0.4 m thick, rather like the Loos Howe boat-shaped coffin, with the difference that the former has a cut-out tap (the Loos Howe coffin could be interpreted to have a similar 'tap' but this is quite uncertain). It has been

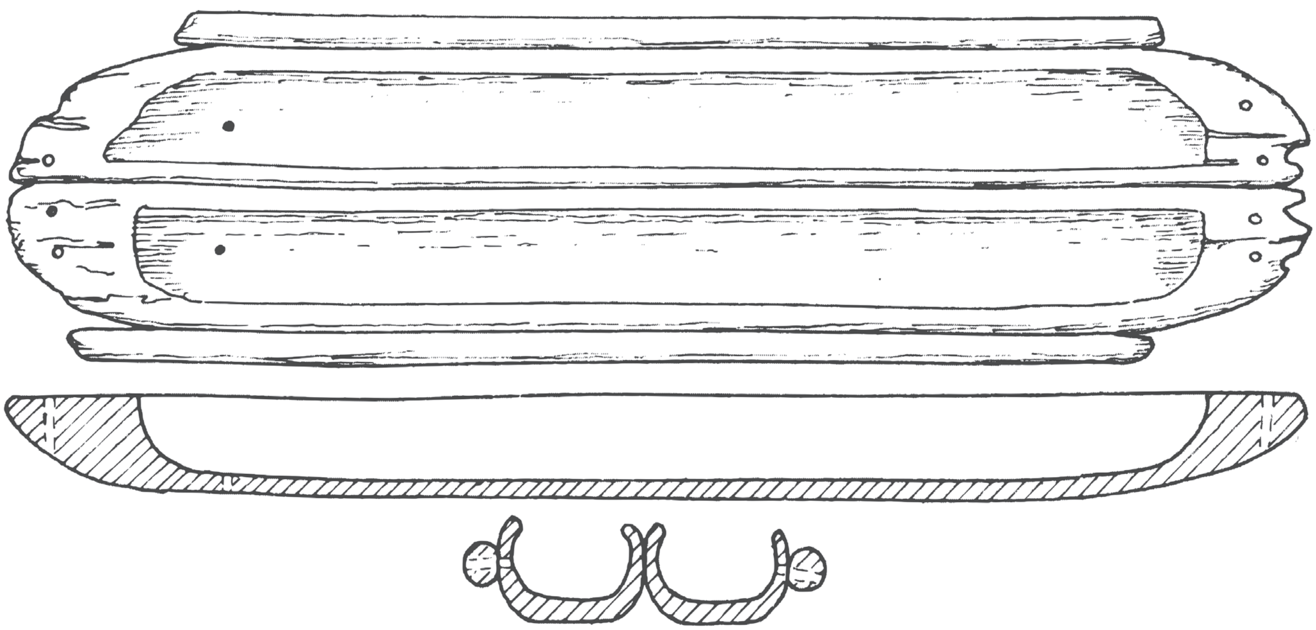

*Figure 3.11. A paired logboat from Surnuinmäki, Finland, with battens fitted along water line of the outer hull to aid with stability (after Itkonen 1942).*

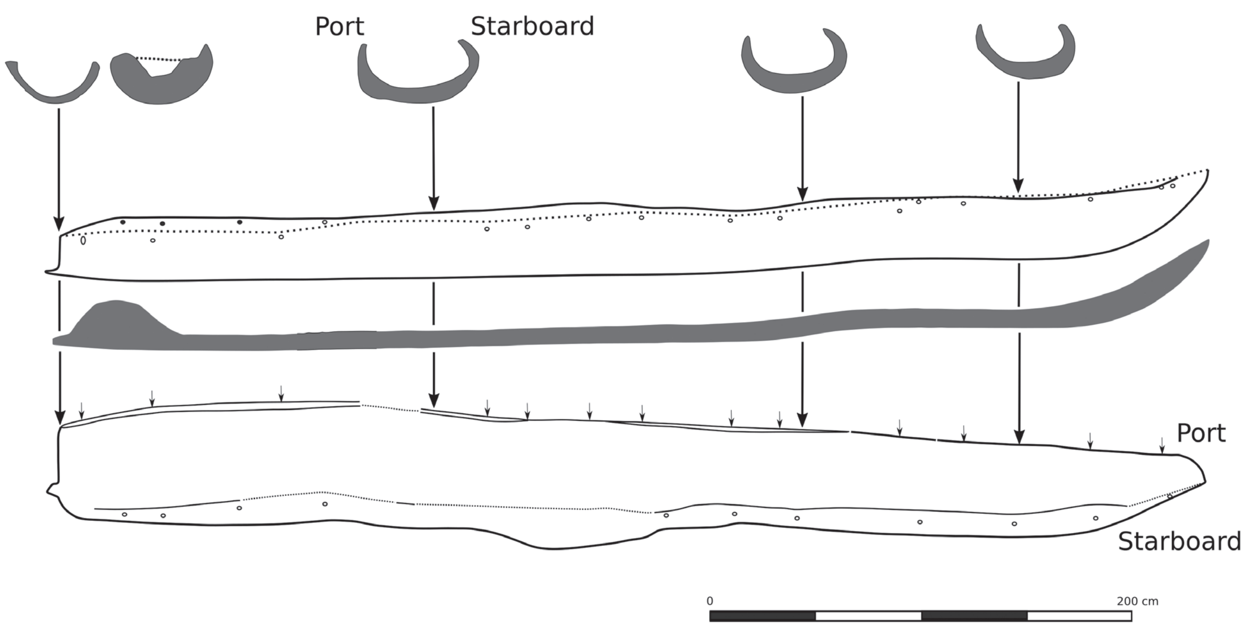


*Figure 3.12. The Verup I logboat, dated to* c. *2270 BC, made of alder and preserved to a length of 5.5 m. Sheerline holes marked by small arrows (after Crumlin-Pedersen 2003, 219).*

suggested that this tap was used to attach a steering oar (Rieck & Crumlin-Pedersen 1988, 38) but, given the size of the vessel, it remains unclear how and when this would have been needed.

Adding washstrakes to a logboat would certainly increase its seaworthiness, particularly in conditions where waves are coming from the side, but the question about the shape of the bow would still be relevant if the vessel were to be used with any regularity on more open waters. The production of moveable boards may not have required additional labour. Experiments where logboats have been hollowed out with the use of wooden mallets and flint axes clearly

*Figure 3.13. Drawing showing the sleek lines of the Hardinxveld De Bruin logboat, dated to 5500–5300 cal. BC (after Louwe Kooijmans & Verhart 2007, 203).*

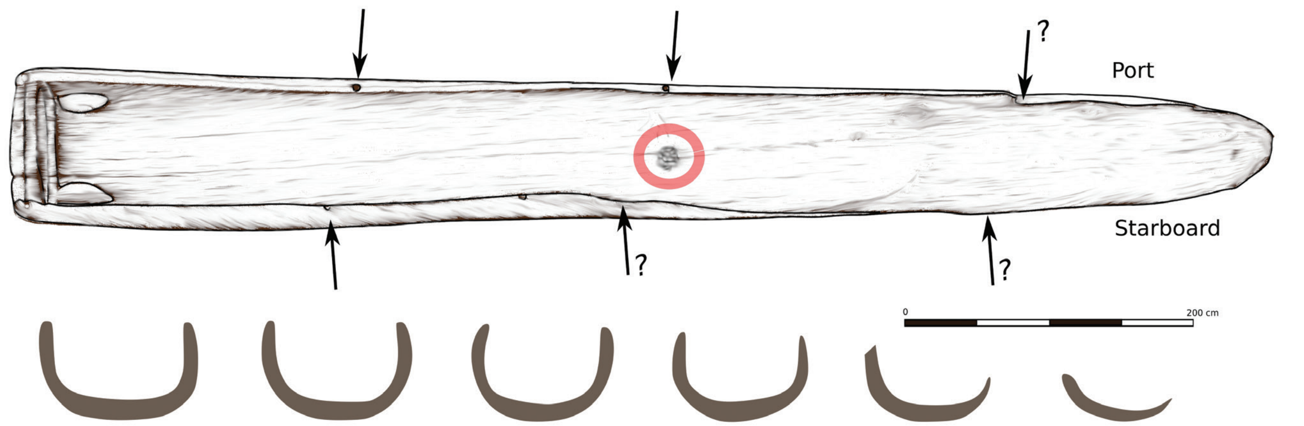


*Figure 3.14. The Carpow logboat, a transom built logboat. Black arrows indicate sheerline holes which are positioned slightly off-set on starboard compared to port side. Faint marks on the outside of these holes suggest they might have been used to attach something with a toggle (a round stick fitted through the hole used in the same way as a button). The large 'composite patch', an area with over 20 visible round daub-like patches, is circled in red. This could be the remnants of a mast step (after Strachan 2010, 59, 65–6, 68).*

demonstrate how short planks are often a bi-product of the aforementioned 'scoring and splintering' boatbuilding technique (Aurélien pers. comm.).

### *Logboats as indicators of boatbuilding technology*

Whereas it is difficult to assess whether logboats were used for more regular coastal portaging and/or more open water passages in prehistory – given the relatively limited finds of such vessels in a marine context – they offer many other insights that are interesting to note, and which might prove useful for understanding the available boatbuilding technologies of the period. One such consideration concerns the smoothness of the hull which affects the stability of a vessel as well as its manoeuvrability, both important factors for long-distance travel. There are many logboats from different areas that exhibit this trait (Table 3.2), thus indicating an understanding of this feature on boat performance. The earliest example is perhaps the aforementioned Hardinxveld De Bruin logboat, dating to the mid-6th millennium BC, the hull of which was very smooth as well as carefully and elegantly built, with sides a mere 2 cm thick (Fig. 3.13; Louwe Kooijmans & Verhart 2007, 204–5). Other examples include the *c.* 4900 BC logboat from Møllegapet, and the 200 years older Korshavn/Mellø Nord logboat (Rieck & Crumlin-Pedersen 1988, 16–17, 28; Skaarup & Grøn 2004, 34–6).

Another interesting observation concerns the repairing of holes and cracks in logboats. Typically, this involved drilling small holes around the affected area overlaid by a patch which was then sealed with caulking and resin before being secured with strings threaded through the holes. An example of this form of logboat repair is attested at Askø, where a patch of bark (34 cm long, 5 cm wide and 0.5 cm thick) was found intact while the remains of the Korshavn/Mellø Nord logboat revealed an entire 'repair kit' consisting of a piece of bark, 3-ply string, a lump of moss, and resin (Rieck & Crumlin-Pedersen 1988, 17; Ravn 2022, 24–6). This method of sewing together wood and rendering a seam watertight demonstrates an early understanding of the same basic techniques that were essential for the development of plank-built vessels (whereas sewing and rendering a seam watertight would have been essential for the development of both hide and bark boats!).

A further example of carpentry skills and boat design is evidenced by the construction of transom built logboats. The sterns of these logboat are left open, either because of rot in the parent tree or perhaps, more importantly, to reduce the weight of the boat in the aft and thus increase its loading capacity. The openings in the stern would be fitted with a transom made from a sheet of bark or a carved piece of plank, wedged into a groove with the use of moss and resin to make them watertight. Transom built logboats first appear in Denmark in the early 5th millennium BC, whereas the earliest British examples are all Bronze Age (Table 3.2; McGrail 2010b; Ravn 2022, 24; www.must-farm.com).

Resin could be also used for weatherproofing. Just as hide boats need to be greased, boats of wood and bark would have required protection from drying out in order to prevent warping or cracks which might render the boat unusable. (Warping can mean the boat cannot be steered in a straight line making it impossible to propel.) For this purpose resin or fat would have been ideal (Strachan & Goodburn 2010, 123). The Hjortspring boat was found with a lump of a pure oil-based substance, which was also found mixed with some sort of animal fat in the caulking of the boat (Crumlin-Pedersen 2003, 24). Experiments involving the *Tilia Alsie*, a reconstruction of the Hjortspring boat, provide an idea of how resin and fat might have been used as part of the regular maintenance of boats of constructed of bark and wood.

- Sheep wool saturated in a mixture of ox tallow and linseed oil at a rate of 80:20% was used to make seams watertight, with holes sealed from the inside with ox tallow.
- When on the water, ox tallow was also found to be effective for sealing leaks from the inside.
- After each on-water trial, when the boat was taken ashore, the seams were treated with a 2:1 mixture of spruce resin and ox tallow smeared on the outside.
- Prior to launching the boat was coated with a mixture of wood tar and linseed oil on the exterior and with linseed oil on the interior (Valbjørn 2003b, 80–1).
- Over time, it was found that the best way to seal the seams was to use a mixture of spruce resin and ox tallow at a ratio of 70:30% above the water line and to use a ratio of 65:35% for areas below the water line (Valbjørn pers. comm.).

A tar-like material, most probably a fat- or oil-saturated plant matter, also seems to have been used to mend holes in the Carpow logboat (Strachan 2010, 64). Apart from the slightly offset sheerline holes, the boat features a *c*. 20 cm circular area on the central of the inside, described as a 'composite patch' of at least 20 visible tar-like patches (Fig. 3.14). These patches (or indents) are not thickness-gauge holes and might be remnants of something having been erected on the spot. The location halfway along the centre of the boat, might point towards its use as a socket for a mast with the sheerline holes used for fastening the stays (Strachan 2010, 64, 68).

In addition to information on the mixtures used for maintaining prehistoric boats, lumps of resin might contain trapped hair or skin belonging to the people using the boats which, with the rapid progress within the field of aDNA, might provide exciting future discoveries.

What is clear however, is that the ability to work wood, drill holes, and make logboats of exceptional finish as well as using thread, resin and caulking material to add watertight pieces of wood (and bark) is attested within the region for thousands of years, as is the ability to fell and work on trees with boles in excess of 10 m length (Ravn 2022).

## *The plank-built vessels of the Bronze Age*

The appearance of plank-built boats in the archaeological record marks a significant change in boatbuilding technology. The remains of 14 of these vessels, dating between *c*. 2000 and 200 BC, have been recovered from a variety of coastal and intertidal contexts in the British Isles (ten examples) and Scandinavia (four) (Rosenberg 1937; Jansson 1994; Crumlin-Pedersen 2003; Van de Noort 2009, 160–1; Wickler 2019). The main advantage of this new boatbuilding technology is that it allows for better control over the size and shape of the boat, laying the foundations for the emergence of larger and more seaworthy vessels, something which is also suggested by the mainly coastal or estuarine location of these finds (Table 3.3). The term plank-built boats or vessels, as opposed to sewn-plank boats (McGrail 2004), puts more of an emphasis on the fact that these vessels are fashioned out of individual planks regardless of how individual planks are fastened, and is therefore, in my view, more accurate.

Common denominators for this technology include:

a) The use of individual planks (of mainly oak, linden tree, or pine) with integral cleats or rails, i.e., the thickness of each plank has been reduced while leaving out a rectangular (or round) shaped wooden block or rail through which a hole or series of holes have been made, the purpose of which is to attach internal strengthening devices,
b) The use of twisted withy or thin 2- or 3-ply string to sow the planks together, and
c) Caulking and resin to make watertight (Van de Noort et al. 2014).

### *British plank-built vessels*

The British plank-built boats can be characterized by a preference for oak, the use of withies of yew or willow for assemblage, and a combination of moss, bees wax, and animal fat for caulking. This stands in contrast to the Scandinavian tradition which used thinner boards and possibly softer woods, and appears to have favoured string for fastening individual planks along with resin mixed with animal fat for caulking (caulking material has not been clearly identified, but a tradition of using moss, perhaps mixed with resin, is suggested by the evidence from older finds such as the Korshavn and Askø logboats – see above) (Crumlin-Pedersen 2003; Marsden 2004; McGrail 2004; Van de Noort et al. 2014).

*Table 3.3. Evidence of plank-built vessels in Britain and in Scandinavia with comparative length tree boles available in the British Isles and Scandinavian evidence of integral cleats from a non-boatbuilding context highlighted. Britain (blue fields); Scandinavian (orange fields).*

| *Date* | Site | *Boat* | *Surviving remains* | *Reconstructed size and size tree* | *Reference* |
|---|---|---|---|---|---|
| 2030–1780 cal. BC | Intertidal Humber estuary | Ferriby 3 | 2 parts 7.7 m & 5.67 m long. Outer plank stitched with yew to fragment of lowest side strake | – | Wright et al. 2001; Van De Noort 2009; Wright 2015 |
| 1940–1720 cal. BC | Intertidal Humber estuary | Ferriby 2 | 11.4 × 0.8 m, plank with scarf, 2 parts of keel-plank joined amidships | – | Wright et al. 2001; Wright 2015 |
| | | Ferriby 1 | 13.32 × 1.67 m | 15.9 × 2.52 × 1.32 m Morgawr, 15.28 × 2 × 1 m Oakleaf, half-scale | Wright et al. 2001; Gifford et al. 2006; Van de Noort et al. 2014, 15 |
| 1870–1680 cal. BC | Mouth of River Severn | Caldicot 1 | Single plank with bases of 2 cleats, resembling keel-plank or lower side strake. Stitch-holes, similar to Ferriby & Dover boats | – | McGrail 1997 |
| 1750–1620 cal. BC | Intertidal Humber estuary | Kilnsea | Single plank with bases of 2 cleats, resembling keel-plank or lower side strake | – | Van de Noort et al. 1999; McGrail 2004 |
| 1575–1520 cal. BC | River Dour, freshwater, near mouth | Dover | 9.5 × 2.2 m | 11.7 × 2.32 × 0.84 m straight grown oak trees, with boles >12 m. Three suggested lengths for the boat, 11.7, 14.2, & 18 m. Reconstructed b oat 1550 BC/Ole Crumlin-Pedersen, half-scale | Clark 1997; Bayliss et al. 1999; Darrah 2004; Roberts 2004; Crumlin-Pedersen 2006; Dunkley 2016 |
| *c.* 1500 cal. BC | On the River Test, a tributary of the Solent | Testwood Lakes | Single cleat, size similar to Ferriby & Dover | – | Fitzpatrick et al. 1996 |
| *c.* 1300 BC | Alva Myr, Gotland | - | Now lost oak chest. 3.3 × 0.6 m featuring integral cleats | – | Floderus 1931, 287; Wehlin 2013, 184 |
| *c.* 1170 BC | River Severn estuary | Goldcliff | Fragment of plank similar to Dover/Ferriby boats | – | Bell et al. 2000, McGrail 2004, 189 |
| *c.* 1000 cal. BC | River Severn estuary | Caldicot 2 | 3 fragments | – | McGrail 1997 |
| 825–760 cal. BC | The Humber intertidal zone | Brigg 2 ‘raft’, | 5 planks, butted edge to edge | 12.2 × 2.27 × 0.34 or 0.55 m | McGrail 1981; 2004, 187; Roberts 1992 |
| c.800–200 cal. BC | The Humber intertidal zone | Ferriby 4 | *c.* 1 m long plank of alder maybe rail or washstrake? | – | Van de Noort et al. 2014, 7 |

*(Continued)*

*Table 3.3. (Continued)*

| *Date* | Site | *Boat* | *Surviving remains* | *Reconstructed size and size tree* | *Reference* |
|---|---|---|---|---|---|
| *c.* 400 cal. BC (598–413 cal. BC) | Sheltered island facing the Andfjorden | Grunnfarnes | Single naturally grown frame. Pine | Boat smaller than Hjortspring | Wickler 2019 |
| *c.* 350 cal. BC | Bog deposition, island of Als, south-east coast of Denmark | Hjortspring | 40% remains, enough to reconstruct original size, linden tree | *c.* 14 (18 with horns) × 2.04 × 0.71 m, *Tilia Aslie*. 4 straight grown, >200 yr old trees, one with bole >16m (or half of this if scarfed) | Rosenberg 1937; Rieck 1994; Crumlin-Pedersen & Trakadas 2003; Valbjørn 2003a |
| *c.* 393–38 cal BC | On the paleogeographic shoreline of the Sjalevadsfjarden facing the Bothnian Sea | Hampnas | *c.* 2 m long thwart in pine with 2 almond shaped seats, similar to those of the Hjortspring boat | Smaller than the Hjortspring boat. | Jansson 1994; Ramquist 2009 |
| *c.* 200–1 BC | Bog Helgeland p aleogeographic coast | Haugvik | Plank with paired cleats. Pine | – | Sylvester 2006, 93; 2009 |
| AD 1330s | Ely Cathedral | Cambridgeshire | Record of the use of 8 matching, nearly 21.3 m long beams for the roof. | 22.5 m tall oak trees measured from ground to first branch | Wright 2015, 120–1 |

An obvious advantage of plank-built vessels, regardless of how individual wooden parts are fastened and caulked, is that leaks that might be apparent when the boat is first launched will become less noticeable the longer the boat stays in the water due to wood expansion. This is quite the opposite to what happens in a hide boat. Experimental archaeology involving the *Tilia Alsie* reconstruction of the Hjortspring plank-built boat discovered the benefit of routinely filling the vessel with water on land a couple of days in advance of launching. This to ensured that the dried-out wood had time to re-expand, avoiding the development of cracks and leaks (Valbjørn pers. comm.).

Although integral cleats are usually associated with British (and Scandinavian) plank-built vessels (see Table 3.3), their use is not unique to this type of boat. Single integral cleats have also been found on the inside bows of logboat 3 from Must Farm, Cambridgeshire, and the Hanson logboat, Derbyshire, whereas a large crack on the Brigg logboat from East Yorkshire had been mended with a long piece of plank featuring three integral cleats projected inboard and used to wedge it in place from the inside of the vessel (McGrail 2004, 174–5; Strachan 2010, 128; www.mustfarm.com). In light of this evidence, the use of cleats as a diagnostic feature of plank-built boats should be avoided. A possible case of misattribution is suggested by the Testwood Lakes, Hampshire, vessel, dated to *c*. 1500 BC (Fitzpatrick et al. 1996), which was interpreted as a plank-built boat on the basis of the partial remains of an oak cleat. In this case, the likelihood that the vessel may have been plank-built is perhaps better inferred from the scale of the remains and its location within a paleo-channel of the river Test, which debauches into Southampton Waters and the Solent – all of which appears to point to a seagoing vessel similar in size and construction to the Dover boat, Kent (Fig. 3.15). It is also worth noting that integral cleats are found in non-boat related contexts as suggested by the Alva Myr chest from the island of Gotland (although at a location not far from the sea), but more on this later (Floderus 1931).

With regard to the dimensions of British plank-built boats, only three examples are sufficiently preserved to allow for some sort of 'minimum' reconstruction of their original size (Fig. 3.16). These include Ferriby 1, Dover, and the Brigg 2 'raft', all of which are boats that would have been *c.* 12–16 m long and 2.3–2.5 m wide (Table 3.3; McGrail 2004; Van de Noort et al. 2014; Bengtsson 2017, 58). Thus, they represent a boat type that had more than twice the width of the largest logboat, providing at once a significant increase in cargo capabilities and stability. Although it remains uncertain whether any of these three boats was used on more open waters, for coastal portaging, or even for crossing the English Channel, their findspots certainly suggest that they were built to cope with regular use within estuary environments. The Severn, Humber, and Trent estuaries are all tidal river systems which would have

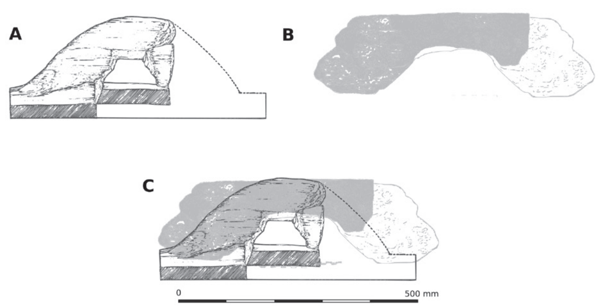


*Figure 3.15. Comparison between A. bottom cleat 313 on the Dover boat and B. the Testwood Lake cleat (actual remains shaded darker). C. shows the Testwood cleat superimposed on top of the Dover cleat (after Marsden 2004, 50 and www.wessexarch.co.uk/our-work/testwood-lakes).*

offered early seafarers similar advantages to those already described in the case of the La Rance river in Brittany, while providing sheltered enough waters to allow for the honing of seafaring skills needed for more open waters (Wright 2004, 261; Bengtsson 2017, 32, 118).

The Humber, for example, which has a very extensive inland river network to the west, including the rivers Ouse and Trent, also has one of the largest estuaries in the British Isles. Today, it's estuary is up to 12 km wide over a length of more than 40 km before debauching into the North Sea to the east-south-east. However, it is estimated that more than half of its intertidal zone has been lost to land reclamation in the last 2000 years (www.tide-toolbox.eu). This diverse environment would have necessitated many different types of boats, a point best illustrated by the many and various types of prehistoric boats discovered here – ranging from substantial logboats to several different kinds of plank-built vessels (Tables 3.2 and 3.3). It is reasonable to assume that regular local traffic must have been of sufficient scale to justify the investment in such large vessels, the development of which might also have been aided by a desire or need to trade also with other river regions along the coast, such as, for example, the Great River Ouse system some 130 km to the south (Van de Noort et al. 2014; Bengtsson 2015; 2017).

As for the construction of, for example, the Ferriby 1 and the Dover boats, there are some differences that are worth noting, including:

a) The use of a one bottom plank on Ferriby 1, and two joined planks in the Dover boat (see Fig. 3.16);
b) The bottom plank of Ferriby 1 is made in two parts (joined by a scarf), each of which also incorporates the respective bow and stern parts of the boat. In the Dover boat the bow consists of a separate 'end board' (Fig. 3.16);
c) In Ferriby 1 the shape of the bow and stern has been achieved by the carving out of these sections from within the parent tree (possible aided by heat). On the Dover boat, it is instead the curvature of the ils plank that has been shaped by carved out (Fig. 3.16);
d) The caulking on Ferriby 1 is placed within the joint between the planks whereas in the bottom plank of the Dover boat the moss for the caulking is placed on top of the mid-joint and held into place through an intricate combination of laths running in-between two raised integral rails on either side of the joint and secured with criss-crossing wedges;
e) Finally, whereas much care has been taken to achieve a good finish on Ferriby 1, the Dover boat has a much rougher appearance, more in line with a 'working boat' (Marsden 2004, 32, 37; Wright 2004; 2015; Clark 2014, 121).

It is argued that certain details of the Ferriby 1 boat, such as the finish and the way in which the withies are protected from abrasion on the underside of the hull when, for example, dragged up on a beach, indicate that it belongs to a tradition of boat construction with roots stretching further back in time (Van de Noort et al. 2014, 296). This is further suggested by the fact that Ferriby 1 was found near the remains of two earlier vessels of a similar type (Ferriby 2 and 3 in Table 3.3), indicating a degree of local continuity in boatbuilding practices over a period of at least 300 years.

The differences between the Ferriby 1 and the Dover boats however, suggests that boatbuilding technologies were undergoing continuous development during the Bronze Age, most probably at a local level where boatbuilders had a general idea of what technology to employ but used their own experiences and ingenuity to come up with solutions for particular problems, some of which were more successful than others.

Despite the degree of investment involved in the construction of Dover boat (evidenced by its use of at least four straight grown oak trees, each with a bole length in excess of 12 m and a diameter of 1.2 m at breast height), the relatively poor finish of the outer hull shows that aesthetic prestige might not have been as important as its intended function, perhaps as a barge or ferry for the transportation of heavy cargo (Clark 2004a, 313; Darrah 2004, 118; Goodburn 2004). Where the vessel may have plied its cargo is another question. The boat was found near the mouth of the river Dour, evidently deposited within a freshwater basin. However, estimates of the contemporary river and its mouth in relation to the size of the boat indicates that the boat might not have been entirely suited to such a constrained area, even if it was intended only for ferrying cargo across the bay or riding up and down the river between two points using the tide. A thin layer of glauconitic sand at the base of its interior along with the discovery of a piece of unworked Kimmeridge shale originating some 250 km to the west in the vicinity of the boat, raises the possibility that it was involved in coastal portaging. If so, it would most likely have been limited to use within gentle winds of up to *c.* 10 knots (5 m/s) and waves around 0.6 m height (Roberts 2004, 194, 210). Thus, although the sheer size of the boat and the dimensions of individual timbers has invited comparison

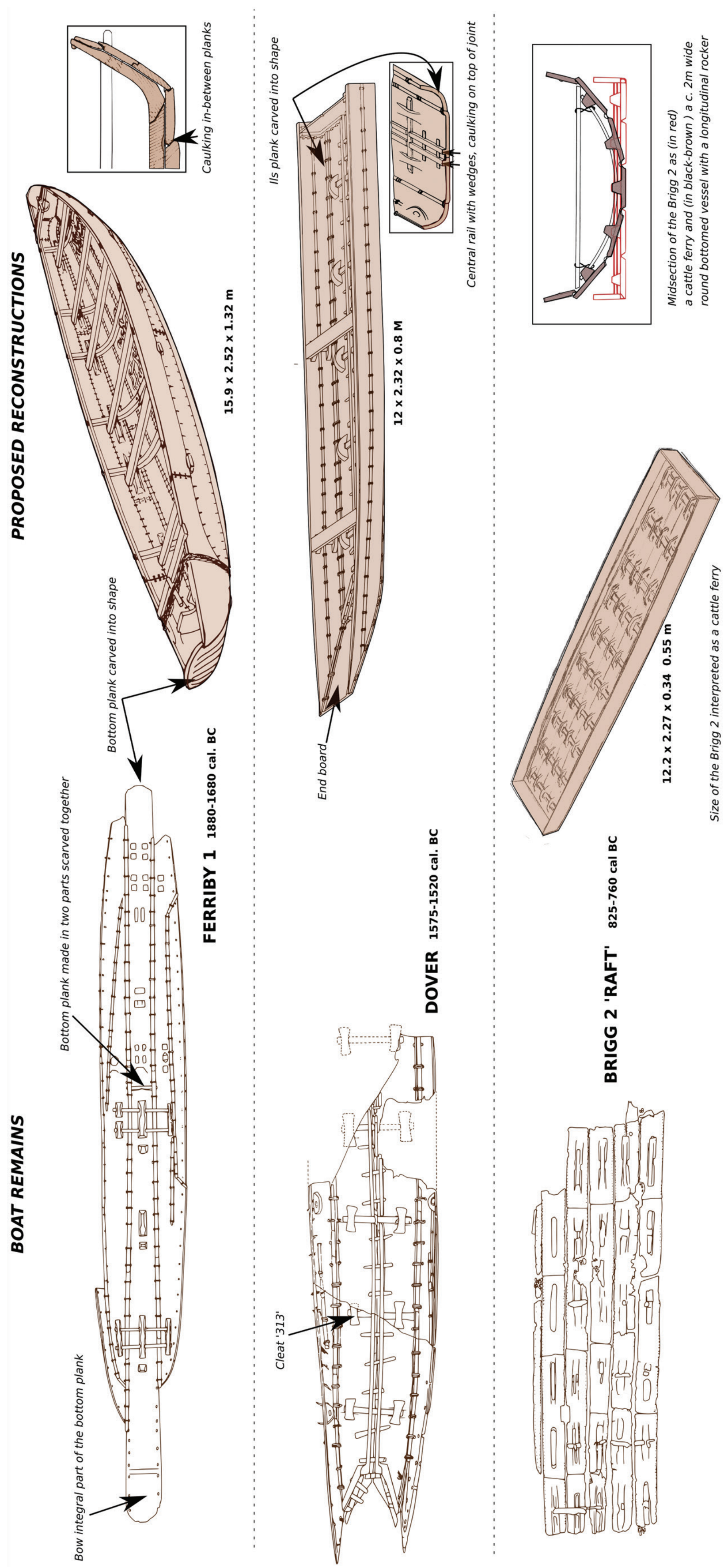


*Figure 3.16. British plank-built boats, surviving remains and proposed reconstructions (after McGrail 1985; 2004, 188; Roberts 1992; Wright 2004, 257; Marsden 2004, 89).*

with the boats of the Veneti as described by Caesar, whose strength and flat bottoms made them particularly suited for use in areas with tidal plains and beaches (Clark 2004a; 2004b, 8), the actual freeboard of the Dover vessel and the shape and height of the bow is decidedly different.

A number of reconstructions of both the Ferriby boats and the Dover boat, most of which are half-scale, appear to indicate that the vessels were both seaworthy and manoeuvrable (Gifford & Gifford 2004; Gifford et al. 2006; Van de Noort et al. 2014). Sadly, none of the publications of these hypothetical reconstructions is of a sufficient standard to allow for any comparison of their relative performance. The *Oakleaf*, a half-scale reconstruction of Ferriby 1 (Gifford et al. 2006), was tested under sail based on the assumption that two saddle features in the bottom of the original were used to secure a mast. The other two reconstructions, the *Morgawr* (Welsh for Sea-Giant), a full-scale reconstruction based on features from all three of the Ferriby boats, and the *Ole Crumlin-Pedersen*, a half-scale reconstruction of the Dover boat, have only been tested under paddle and, in the latter case, the relatively lower sheerline (and freeboard) of the half-sized vessel does not appear to have been compensated for, meaning that it was probably much easier to manoeuvre this boat than the full sized original (Van de Noort et al. 2014).

### *Scandinavian plank-built vessels*

The Scandinavian plank-built boats are also found on or near coasts (Table 3.3). Of these, the remains of the Hjortspring boat are substantial enough to allow for a confident estimate of its original shape and proportions (Table 3.3, Fig. 3.17). Dated to *c.* 350 BC, the Hjortspring is a sleek vessel of over 14 m in length that was most probably used by a raiding party engaged in a failed attack on the island of Als off the south-east coast of present-day Denmark (Kaul 2003). Although none of the planks was completely preserved due to peat digging activities prior to the boat's discovery, the bottom plank is believed to have been made in one piece, requiring a tree with a straight grown bole of over 15 m (Crumlin-Pedersen 2003, 24). However, this interpretation may be called into question since Rosenberg (1937, 73–4), in his report, could not verity whether the bottom plank was made in one or two sections. Evidence for the use of scarves for the two lower horn projections reveals a knowledge of making scarves of sufficient strength to allow for a bottom plank made in two parts should this have been required (Valbjørn pers. comm.). Nevertheless, the craftsmanship displayed by the remains indicates that the boat was part of a well-established boatbuilding tradition with roots far back in time (Kaul 1998; Bengtsson 2015).

The building method used for the Hjortspring boat began with the fashioning of a bottom plank (from one or two parent trees), long enough to extend beyond the bow and stern, on the inside furnished with ten rows of integral cleats (Fig. 3.18; Valbjørn 2003b, 71–2). To this bottom plank were attached two v-shaped endships, each hewn out of large trunks with diameters of *c.* 90 cm. These were locked in place with strong oak locks, hewn out across the wood grain, and secured with square oak pegs. At the top of each endship, there was a series of four integral cleats located just behind the locks, which also appear to have incorporated the base of the upper horn projection. The remaining hull was then finished off by the adding of two sets of strakes on either side, incorporating integral cleats in rows corresponding those on the bottom plank (E and F in Fig. 3.18), whereafter the horn projections were added (H and I in Fig. 3.18) Finally, ribs and thwarts were added.

The tree trunks used to build the *Tilia Alsie*, a full-scale reconstruction of the Hjortspring boat, were not large enough to accommodate the total width of the bottom plank, nor were they large enough to accommodate the full curvature of the side planks which lead to the reconstruction ending up with a more accentuated sheerline than the original, and hence a shorter waterline with less of the v-shaped ends of the bottom plank below the water (Fig. 3.19) (Rosenberg 1937, 86–8; Fenger 2003, 91; Valbjørn 2003a, 40–2; Bengtsson 2017, 102).

As previously mentioned, the *Tilia Aslie* has provided for a very illuminating reconstruction of the original craft's capabilities, proving that, even with the shorter waterline, the boat was very quick, manoeuvrable and fully capable of handling and turning around in waves over 1 m high without taking in an excess of water (a hazard suggested by the presence of a bailer in the original boat; Rosenberg 1937; Vinner 2003). The plough (Fig. 3.20), following along the entire gunwale of the boat from the tip of the upper horn projection, no doubt played an important role in guiding waves and water spray away from the hull and thereby limiting the amount of water coming in. Plough features as those present on the Hjortspring boat are likely to have been effective in deflecting waves that were no higher than top of the horn projection and might be one of many reasons why such projections were developed in the first place and continued to be used over such a long period (Bengtsson 2017, 124). Other important insights gained through sea trials concern the shape of the paddles which indicates an adaptation for paddling over long distances and in waves, in many cases offering better acceleration than modern paddles. Furthermore, it was found that the length of individual paddle shafts might correspond to the height of the sheerline in relation to the water surface (Haupt 2003, 119–22). Despite the lack of a keel, the reconstruction showed that the two steering oars would have functioned as effective lateral plane, in a similar way to a keel (Bengtsson & Bengtsson 2011).

The oldest evidence of a plank-built boat in Scandinavia consists of a pine rib from Grunnfarnes in northern Norway and recently dated to *c.* 400 BC (Table 3.3; Wickler 2019).

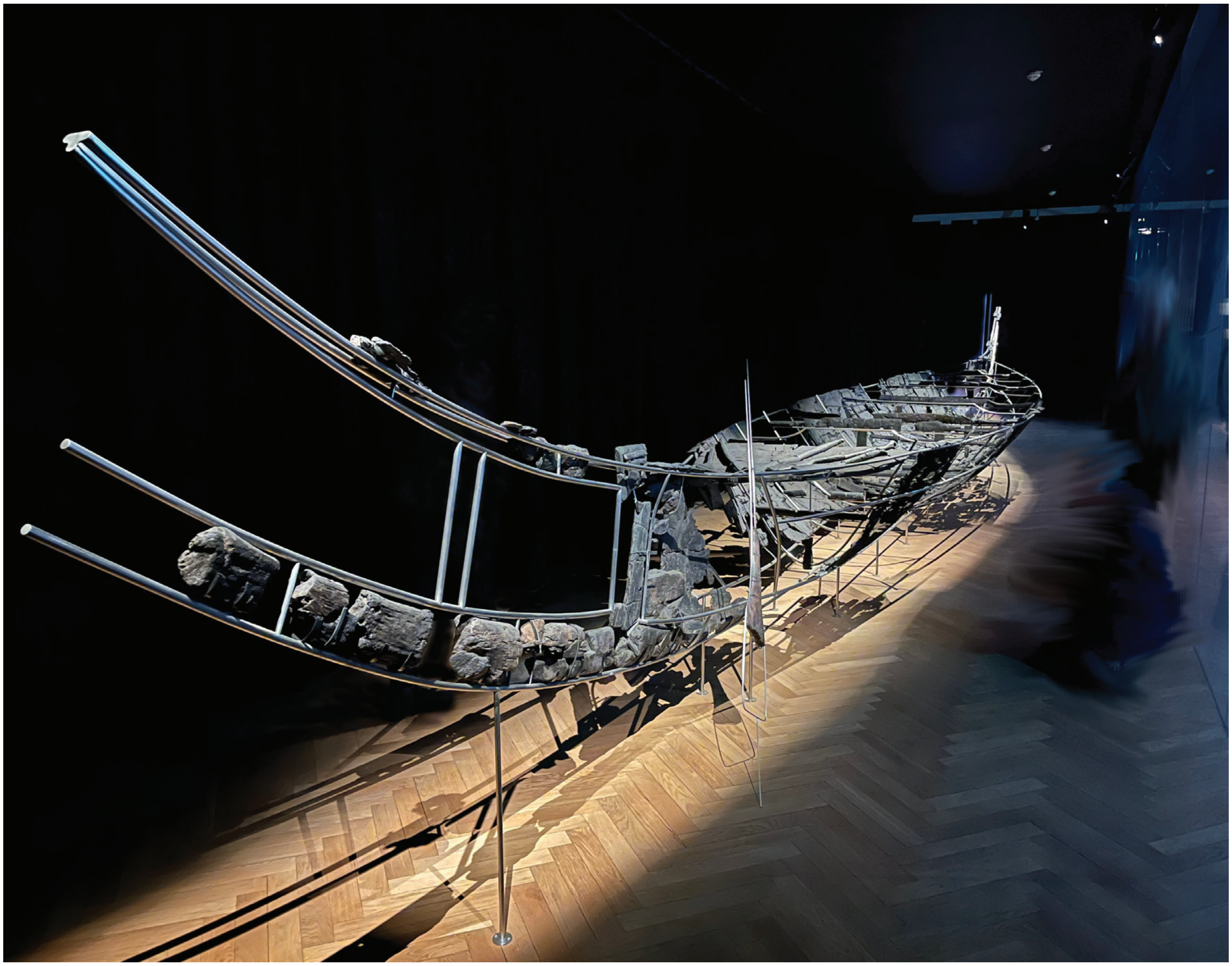

*Figure 3.17. The Hjortspring boat as it is exhibited at the Danish National Museum in Copenhagen (photo: B. Bengtsson 2023).*

The rib appears to be fashioned taking advantage of the natural shape of a pine root where it joins the tree. This find puts credence to the interpretation of a Hjortspring type thwart from Hampnäs in eastern Sweden as having been made to fit a similar type of rib (Table 3.3) (Crumlin-Pedersen 2003, 229; Ramquist 2009). Although both the Grunnfarnes rib and the Hampnäs thwart appear to belong to boats that were potentially smaller than the Hjortspring boat, naturally grown ribs, as opposed to the light framework of hazel and ash that made up the ribs of the Hjortspring boat, could theoretically indicate the existence of more substantial vessels (depending on how much a Hjortspring type framework might be upscaled). Such vessels would also perhaps require fewer integral cleats on each plank for distributing forces and thus simplify boat construction (Bengtsson & Bengtsson 2011; Wickler 2019; Fig. 3.21). For example, the individual planks on the Hjortspring boat have four cleats per plank whereas a grown rib such as the Grunnfarnes rib might only require two per plank, depending on the overall size of the vessel.

Integral cleats, essential for the plank-built technique, can be traced back to *c.* 1300 BC with the Alva Myr oak chest from the island of Gotland (Wehlin 2013, 139). A visit to Tumba and the archives of the National History Museum in Stockholm where the remains were last recorded has confirmed that the chest is now lost. However, a drawing of the find from 1931 showing the grains of the wood suggests the protruding cleats are located on the outside of the chest lid, not the inside which would have been expected had it been a repurposed boat plank (Fig. 3.22; Wehlin 2013, 139). Nevertheless, this find indicates that while boats made of oak might have been feasible at this time (and we might yet find plank-built boats of oak dated to the Bronze Age in Scandinavia) other lighter wood materials were preferred. The Haguvik piece of planking, from southern Norway, with its double lines of cleats provides further evidence that this

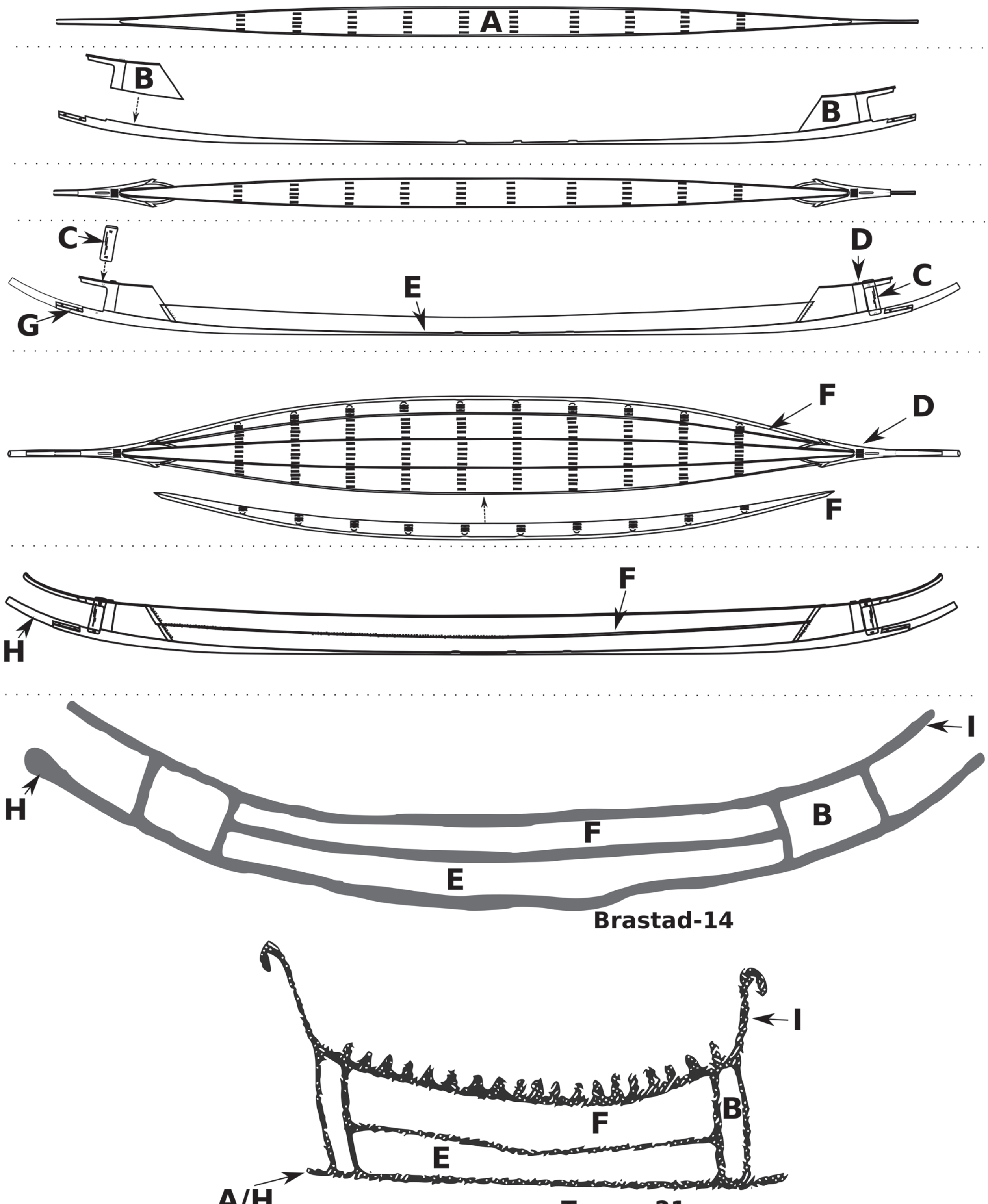


*Figure 3.18. The different parts, and sequence of assembly, of the Hjortspring boat: A. bottom plank with ten rows of integral cleats; B. v-shaped stems from which the top horn projection protrudes; C. oak lock securing stems to bottom plank; D. lower side strake; E. upper side strake; F. scarf securing lower horn projection to the protruding bottom plank; G. lower horn projection; H. upper horn projection (after Rosenberg 1937 and Kahl et al. 1971 in Valbjørn 2003b, 78). Below: Two rock carvings showing the same method of construction. Brastad-14, contemporary to the Hjortspring boat. Tanum-21, boat dating to the Early Bronze Age.*

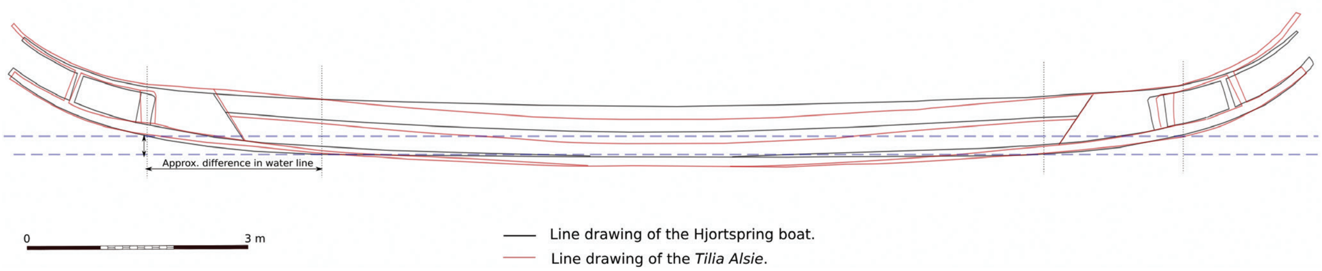


*Figure 3.19. A comparison between the sheerline and waterline of the Hjortspring boat as interpreted by Johannessen and the* Tilia Alsie *(after drawing by Hocker & Trakadas in Hocker 2003, 91).*

boatbuilding technology was widespread in the region along with the use of grown ribs.

### *Indirect evidence of boats: rock art and ship-settings*

The Scandinavian rock art, dating to around 1700–300 BC, is carved into glacially smoothened rocks and outcrops along the paleogeographic coastlines and inland waterways, or overlooking navigational routes, and offers a rich gallery of imagery including boats, swords, axes, wagons and chariots, ards, humans, and horses. The most common motif is the boat, with over 10,000 boat depictions discovered so far in the county of Bohuslän alone. The location of this imagery, often in geographical clusters within archipelagos and sheltered waterways, is probably indicative of the important role boats had within the contemporary society (Bengtsson 2003; 2015; Ling 2008). Because of the prolific use of boat imagery, including a number of examples on bronzes found in closed grave contexts, it has been possible to build up boat chronologies based on the shape of their horn projections (Kaul 1998). Studies of the carving sequence of different types of boat imagery on individual rock art panels (Sognnes 2001) and of when a certain type of boat imagery could first have been carved in relation to land elevation data (Ling 2008; 2013) have further refined these chronologies (Fig. 3.23)

As a result, the southern Scandinavian rock art chronologies can provide a general idea of when a certain type of boat might first have appeared, but to use, e.g., the proximity of a particular imagery to the paleogeographic coastline as a sole basis for dating remains problematic (see e.g., Gjerde 2021, 144). There are simply too many rock art panels that are not carved on the water's edge but are instead situated in elevated positions near or overlooking the sea for this to be a viable dating method (Bertilsson 1987; Bengtsson 2003; 2017, 11, 79).

Hence, the Scandinavian rock art material conveys important information about the boats, boatbuilding methods, and different types of propulsion (Halldin 1949; 1950; 1952; Bengtsson 2015; 2017) that can be used to complement actual finds. In this respect, the Hjortspring boat serves as an important link between reality (actual finds) and the boat depictions in the rock art by corroborating such features as:

1. The boatbuilding method, which can be traced back to the Early Bronze Age in the rock art imagery (Figs 3.23–3.24). Some of the potentially oldest boat depictions clearly show the same building method found at Tanum-21 and Tanum-75, whereas early plank-built vessels where only the side strakes are depicted are represented by examples from Askum-58, Bottna-37 and several boats from Strand Nag 41;
2. The double horn projections at each end of the boat can be traced back to the boat depicted on the Rørby sword and a carved slab from the securely dated Sagaholm grave (Fig. 3.25);
3. The use of paddles for propulsion – The Hjortspring boat was found with 16 thin bladed paddles, all individually made (Haupt 2003, 119–120). In the rock art, human figures holding paddles are sometimes clearly depicted (Fig. 3.26);
4. The use of two steering oars, one at each end of the vessel, is evident from the Hjortspring find (Rosenberg 1937, 86–8). In the rock art material, double steering devices can be traced back to the Early Bronze Age (see e.g., Strand Nag-41 in Fig. 3.23) (Bengtsson 2017, 83–4).

In addition, the bird's-eye view shape of the relatively long and slender Hjortspring boat with its v-shaped endships, is mirrored in many grave monuments of raised stones set in the shape of a boat, so called ship-settings, where horn projections are also sometimes represented (Fig. 3.27). The dating of burned bones from graves associated with ship-settings on the island of Gotland, suggests the ship-setting tradition on the island began *c.* 1200 BC, culminating between *c.* 1000–800 BC (Wehlin 2013). On the nearby island of Öland, situated between Gotland and the south-east coast of Sweden, the Bronze Age tradition of erecting these types of stone monuments appears to have included the marking out of thwarts, the number of which in relation to their overall size appear to be corresponding to the ten

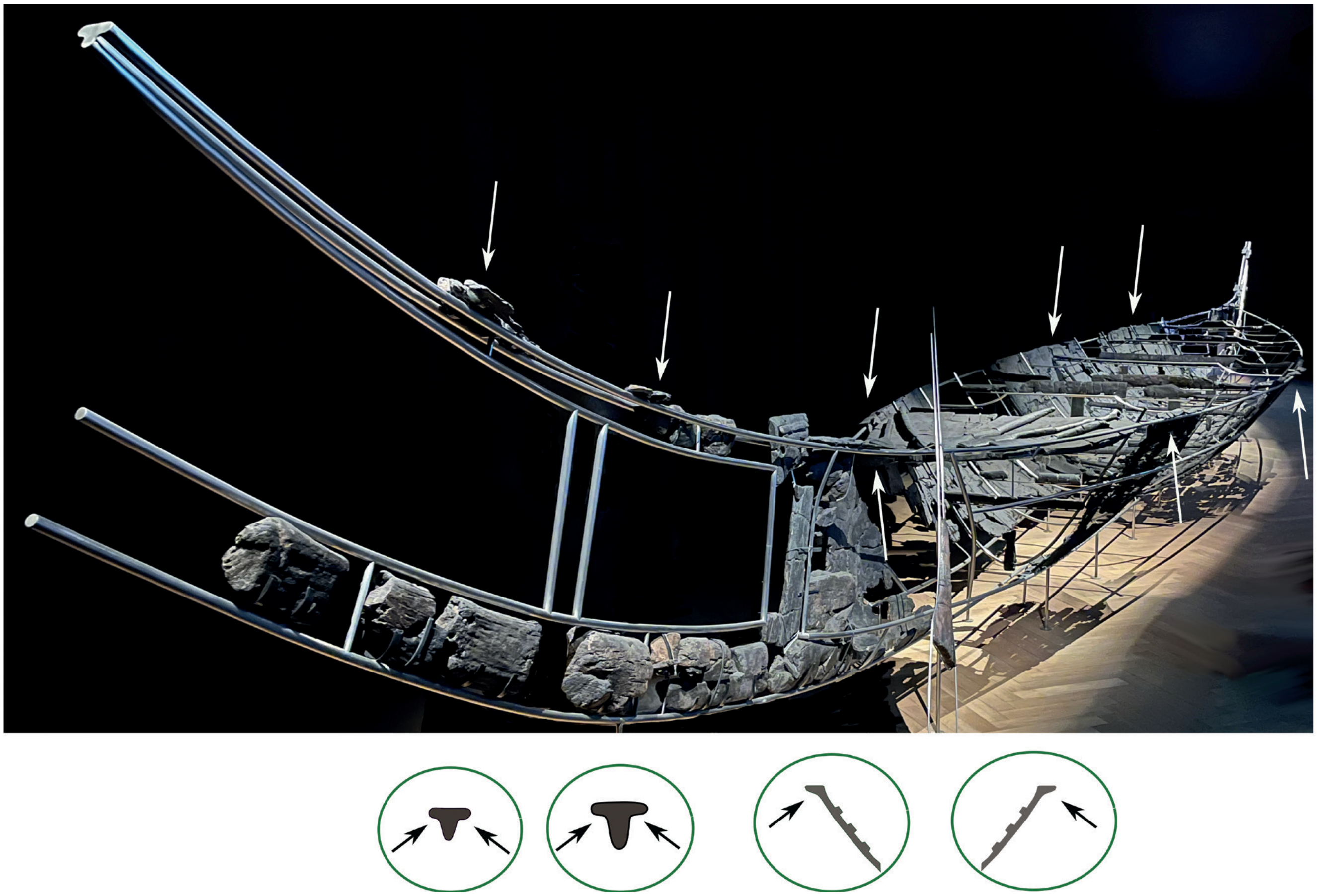

*Figure 3.20. White arrows indicating remains of the plough along the upper sheerline of the Hjortspring boat. Circled in green: black arrows pointing out the plough in relation to cross-sections of upper horn projections and gunwhale as seen on original line drawing of the Hjortspring boat (after Johannessen in Rosenberg 1937; photo: author).*

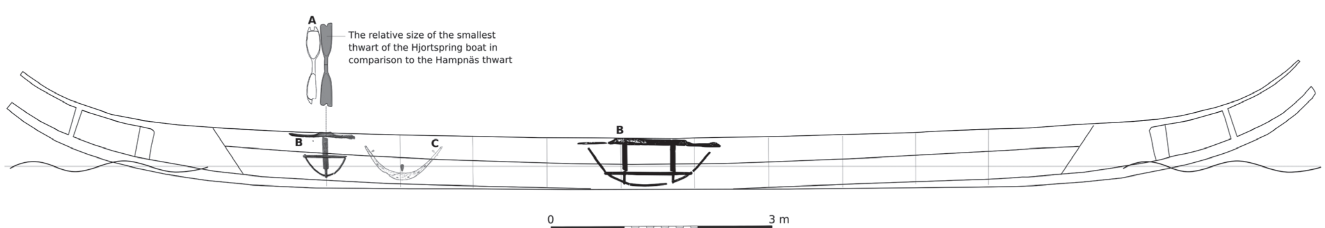


*Figure 3.21. Line drawing of the Hjortspring boat with the two ribs that were found intact at their approximate location within its hull (B). The Hampnäs thwart (A) and the Grunnfarnes rib (C) are inserted at the approximate equivalent position in relation to the Hjortspring boat (after Rosenberg 1937; Jansson 1994; Wickler 2019).*

thwarts found on the Hjortspring boat (Fig. 3.27; Wehlin 2013, 66–8; Wollentz 2013, 44–5). The so called Hässelby ship at the Köping 103 site, a fully excavated ship-setting which is believed to date to the Bronze Age, provides a good example. Originally measuring 18.3 × 3 m (including the horn projections), only five 'thwart' lines remain in the surviving half of the vessel (Johansson 1968), out of likely total of 10–11 transverse stone lines, representing an only slightly longer and 1 m wider vessel than the Hjortspring boat. Another ship-setting from Öland, at Högsrum 83, has never been excavated but has the characteristic horn projections that marks it out as a Bronze Age type boat (see discussion in Wollentz 2013). This ship-setting is 26 × 3.5 m and has 13–15 transverse lines, suggesting an even larger vessel.

Thus, despite a lack of actual boat finds within the region, indirect evidence of boats and boatbuilding technologies in combination with boat depictions in rock art and

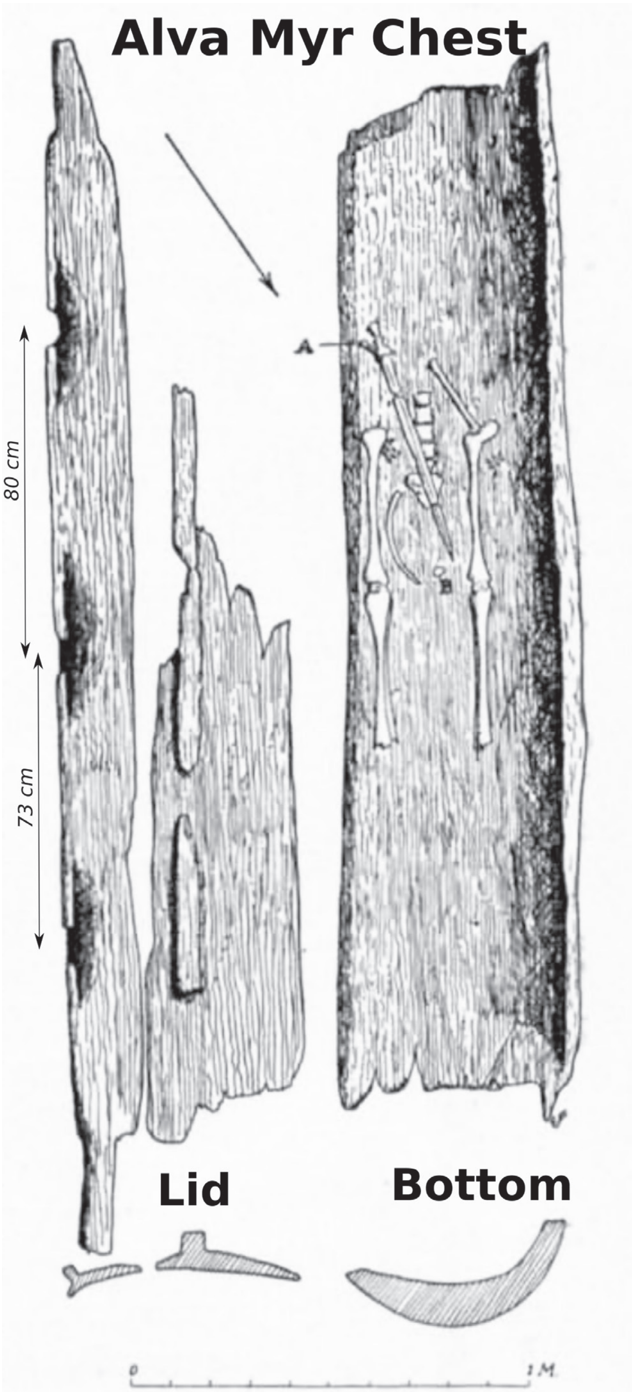


*Figure 3.22. The Alva Myr chest (after Floderus 1931, 287).*

Bronze Age ship-settings makes it possible to assume with a relative degree of certitude that double ended plank-built vessels were introduced in Scandinavia at the onset of the Bronze Age in line with the first appearance of plank-built boats on the British Isles. It also suggests that Bronze Age boatbuilders were capable of producing vessels that were considerably larger than the Hjortspring boat.

## Evidence of different methods of propulsion and steering

The region's archaeological record provides evidence of different types of paddles from *c.* 7100 cal. BC onwards (Fig. 3.28). Whereas prehistoric paddles and steering oars were probably often quite similar in terms of overall dimensions – based on a comparison of the intact parts the surviving steering oar from Hjortspring and the (marginally narrower) paddle blade found at Ferriby – narrow blades appear to be better suited for use in waves and for long distance seafaring, whether used as oars or paddles (Haupt 2003).

### *Paddles, steering, and paddle oars*

Relatively long and narrow paddle blades are found in the archaeological material already from *c*. 5400 BC, with one or two examples from Hardinxveld-Polderweg (Fig. 3.28) measuring around 75 cm in length. These relatively long paddle blades would most probably have been needed if the craft was either unwieldy (perhaps unevenly shaped) or so large that keeping it on a straight course became a problem and the blades also functioned as a steering oar. Considering the vast wetland area within which the two blades were found, it is worth contemplating why such long blades would have been needed and whether they might have served a dual purpose as paddles on high tides or for punting when water levels were lower – here the type of sediments in the sea channels might provide more information. If, on the other hand, they were used as paddles, what size vessels might they have been intended for? The relative length of the blades appears to be disproportionate to any of the boats found so far within the archaeological material pre-dating *c.* 2000 cal. BC and could, at least theoretically, represent indirect evidence of larger vessels than hitherto undiscovered.

By comparison, the blade of the steering oar on the Broighter gold boat (Fig. 3.29), is relatively longer and wider that those of the oars, suggesting long blades might have been used as steering oars. The Hjortspring boat also reveals a marked difference in size between steering oars and paddles. Unfortunately, the sole surviving steering oar blade recovered at the site was found in two non-contiguous parts thus making its overall size uncertain though an estimate of *c*. 0.75 m or perhaps even longer seems likely (see the comparison between a minimal interpretation and the actual remains in Fig. 3.28; Bengtsson & Bengtsson 2011). As such, it is interesting to note that the combined size of the two steering oar blades is not dissimilar to the size of the side rudder blade from the Nydam boat in pine (Fig. 3.28).

Paddle oars tend to be slightly wider and shorter than a steering oar, with comparable examples found in both regions. For example, the Canewon paddle oar from the British Isles, dated to *c*. 1000 BC, is similar in size and shape (*c.* 0.62 × 0.15 m) to the *c.* 3000 BC blade from Hazendonk in the Netherlands (*c.* 0.55 × 0.12 m) (McGrail 2004, 176;

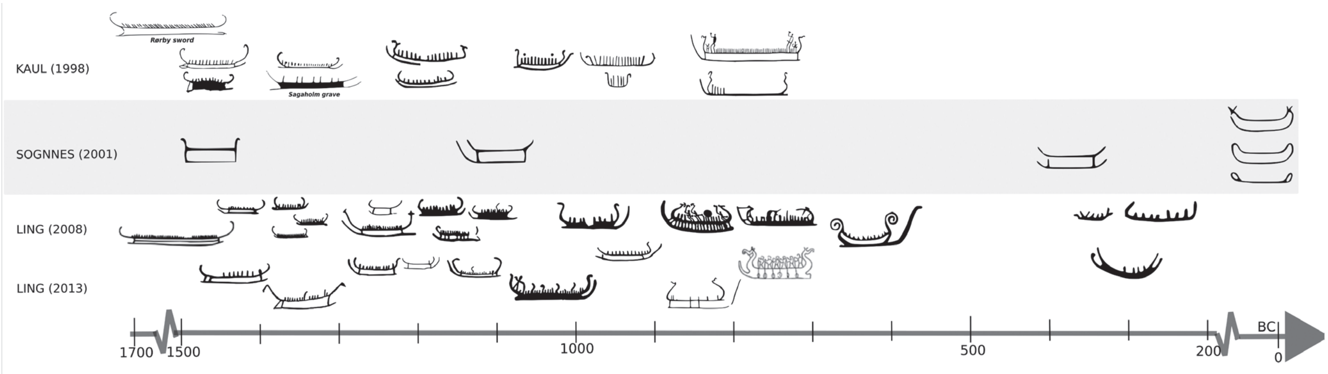


*Figure 3.23. Established rock art boat chronologies for southern Scandinavia, based on the shape of the upper and lower horn projections (after Bengtsson 2017, 85–7).*

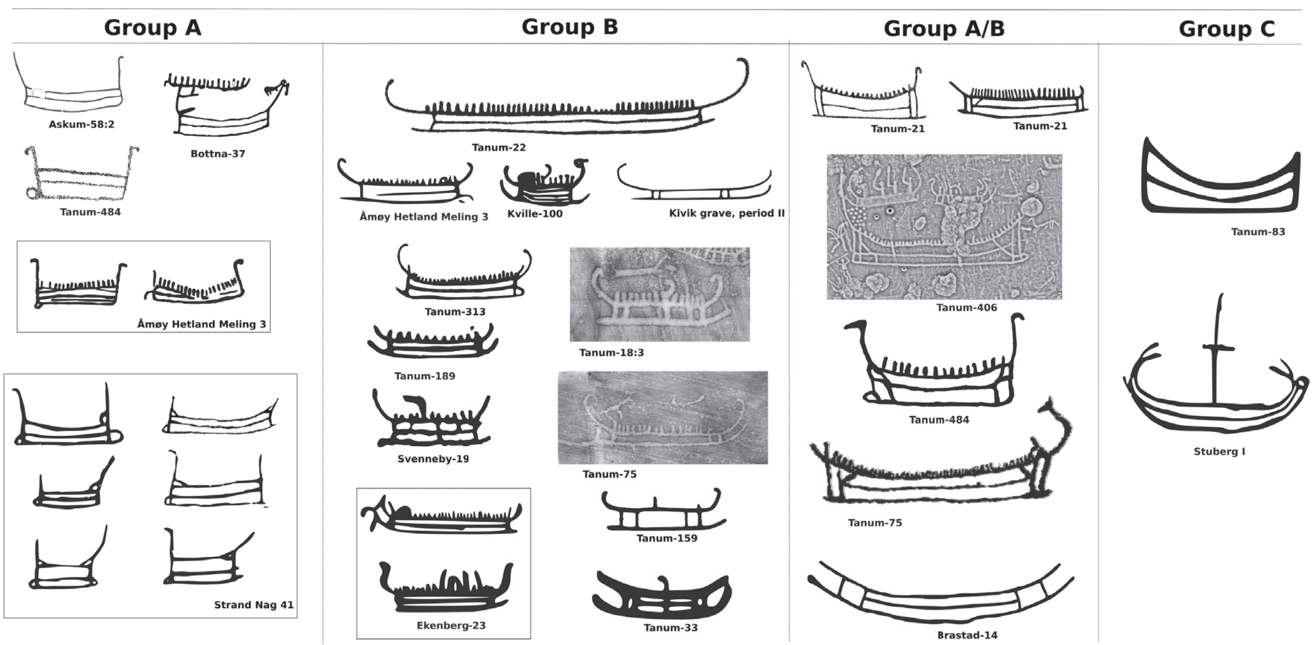


*Figure 3.24. Rock art imagery from southern Scandinavia showing plank boats, some of which also depict the v-shaped stems. Group A: early boat depictions from south-western Norway and the Bohuslän coast; Group B: plank-built boats depicting clear horn projections and/or winged (v-shaped) stems; Group A/B: early rock art boat imagery clearly mirroring the same basic boatbuilding method that was used for the Hjortspring boat whereas Brastad-14 is dated to the Pre-Roman Iron Age and features an exaggerated rocker; Group C: Late Bronze Age and Pre-Roman Iron Age (?) plank-built boats (after Bengtsson 2015; 2017 and https://shfa.dh.gu.se/).*

Louwe Kooiljmans & Verhart 2007). Here the knob on the shaft of the Canewon paddle is thought to represent the point at which the paddle oar was either attached to the boat, secured by a grommet or similar, or something to prevent the hand from slipping when holding it (Stracham 2010, 68; Stracham & Goodburn 2010, 117–19).

Another possibility is that these types of blades were used for sculling, i.e., turning the blade in a figure of eight while twisting to drive the boat forwards. Experiments in the *Brioc* for example suggest sculling might generate the same effect as up to four oars depending on the length of the oar shaft (Ingwenog Jaouen pers. comm). A newly discovered boat depiction within the Gavrinis tomb (Fig. 3.30) – built 4200–4000 cal. BC and in use until 3200 cal. BC (Cassen 2014) on a prominent elevation on an island at the mouth of the Gulf of Morbihan – appears to include what could be interpreted as a steering oar. Today, the Gulf of Morbihan is a relatively sheltered body of water covering 40 km$^2$ and dotted with more than 40 islands. With tidal currents of up to 10 knots, this environment would have provided a challenging 'nursery' for the development of seafaring vessels and it is possible that the presence of

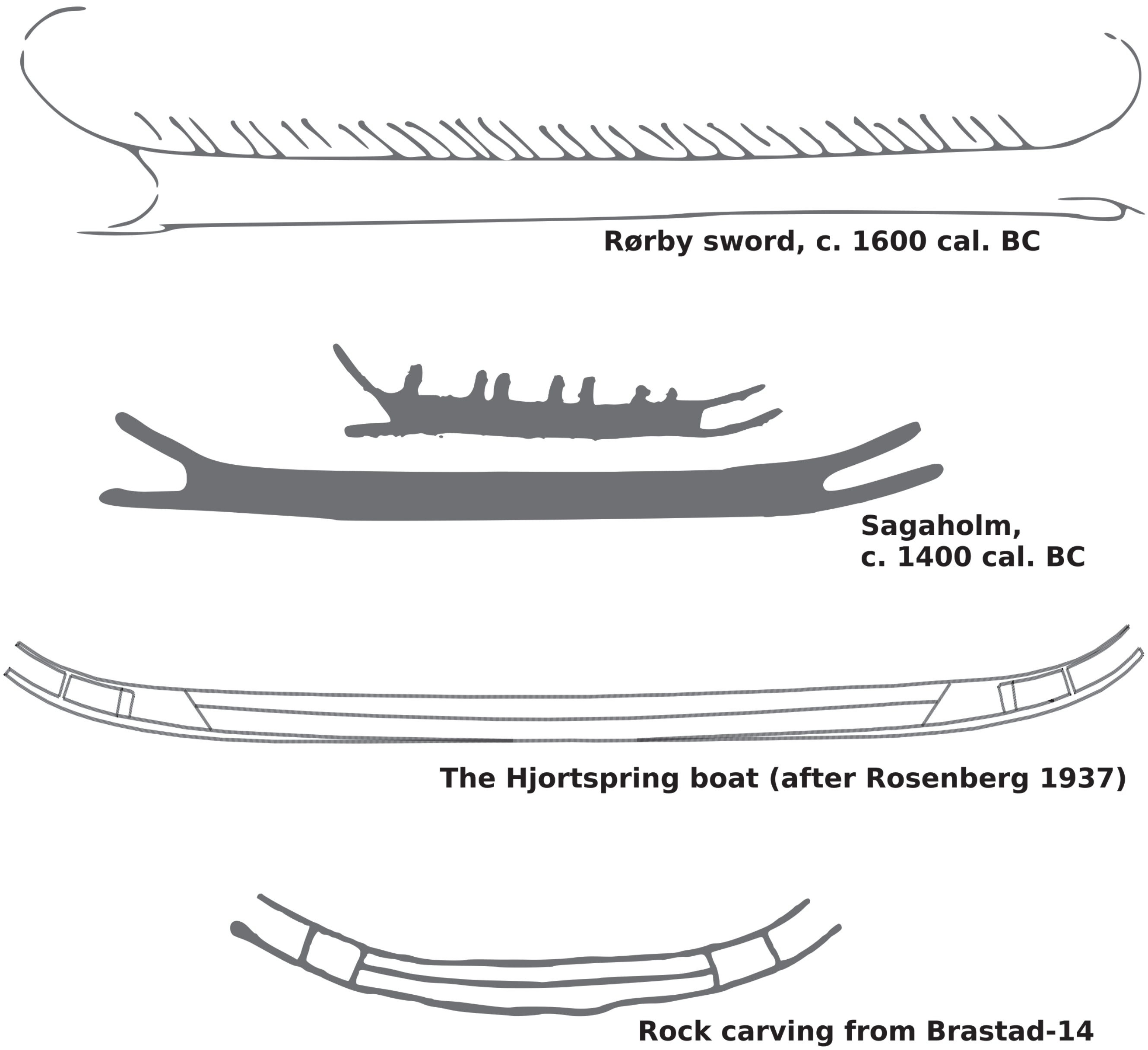


*Figure 3.25. Scandinavian boat imagery in comparison to a drawing of the Hjortspring boat (after Rosenberg 1937; Schulze 2005; Wehlin 2013; Wollentz 2013).*

the oar in the composition reflects the necessity of using a steering oar in these very difficult waters. It would be interesting know what this landscape would have looked like in 4000 BC, when the relative sea level in the region is estimated to have been 1–5 m lower than it is today (see e.g., Goslin et al. 2013). It is also worth noting that this is the same region inhabited by the Veneti in the time of Caesar.

An important aspect of any steering device is that the person wielding it knows the direction of the blade. On the Broighter model the hole through the top end of the steering oar shaft might indicate the position of a 'handle' facilitating control of the blade. Such handles have been found in place on the steering oar belonging to the Nydam pine boat (Fig. 3.28) of the AD 290s while an example of the hole for a steering handle can be seen on an over 4 m long steering oar found at Als Odde in Mariager Fjord on the north-east coast of Jutland, dated to the 7th century AD (Ravn 2022, 66)

On the Hjortspring boat, the shafts of the two steering oars are both missing. However, several of the paddles have individually carved handles, some indicated by holes (Rosenberg 1937). Whereas these end attributes were most probably added to aid with the control of the

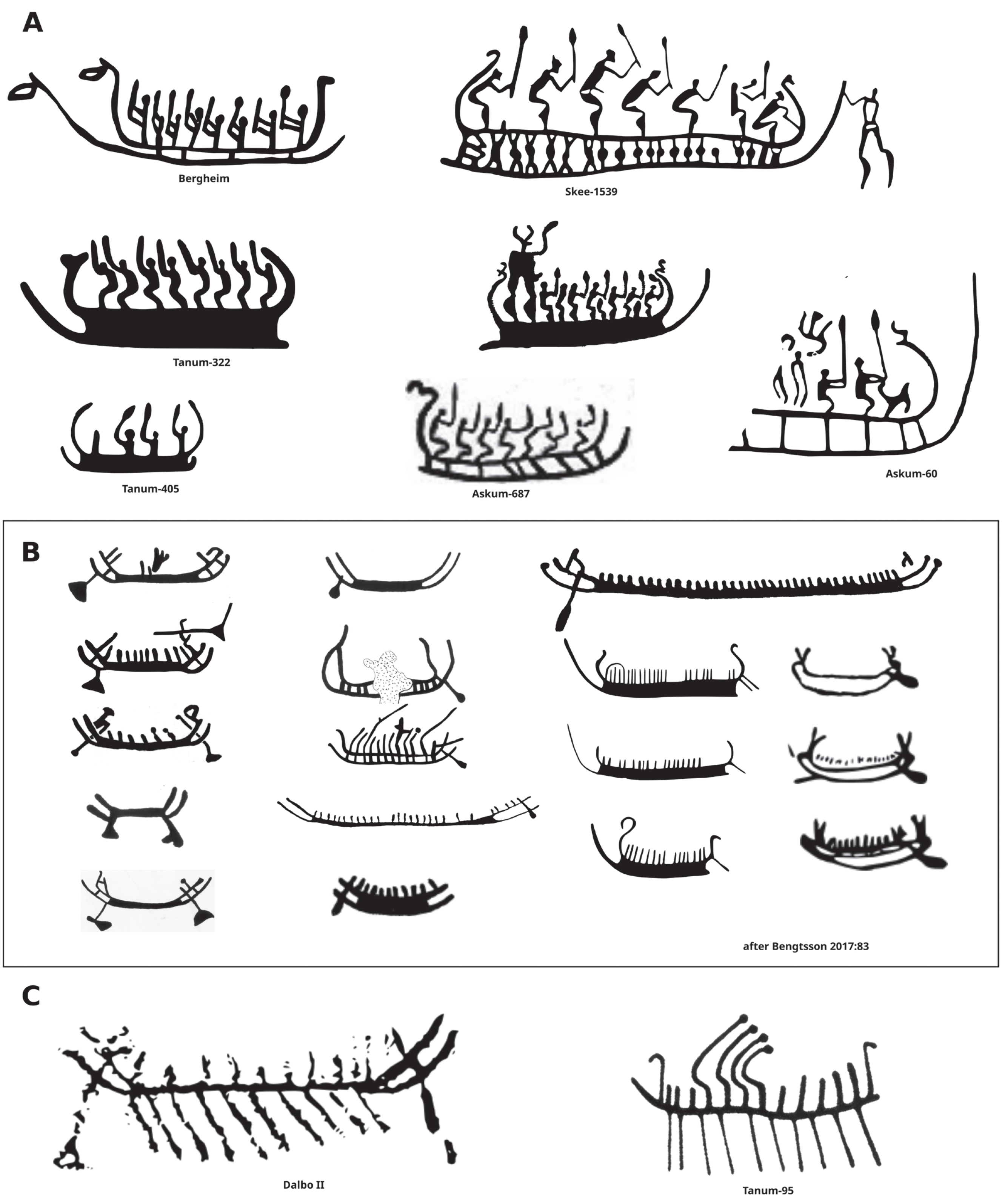


*Figure 3.26. Examples of: A. paddles; B. steering oars; and C. oars in southern Scandinavian rock art (after Bengtsson 2015; 2017).*

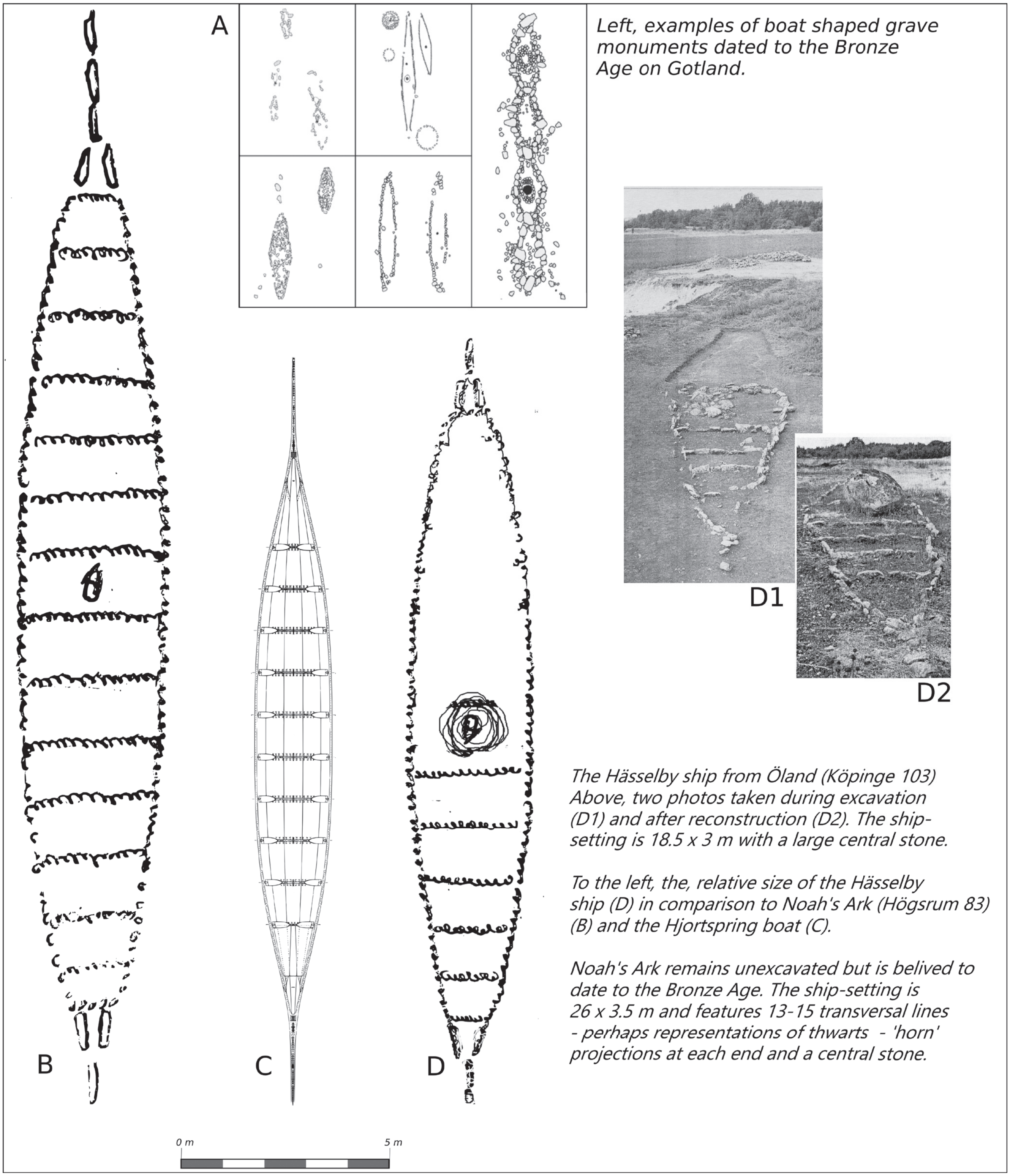


*Figure 3.27. Typical ship-settings dated to the Bronze Age from Gotland and two undated ship-settings from Öland in relation to the 350 BC Hjortspring boat (after Rosenberg 1937; Schulze & Erlandson 2010; Wehlin 2013; Wollentz 2013; photos, Lars Fredrikssen).*

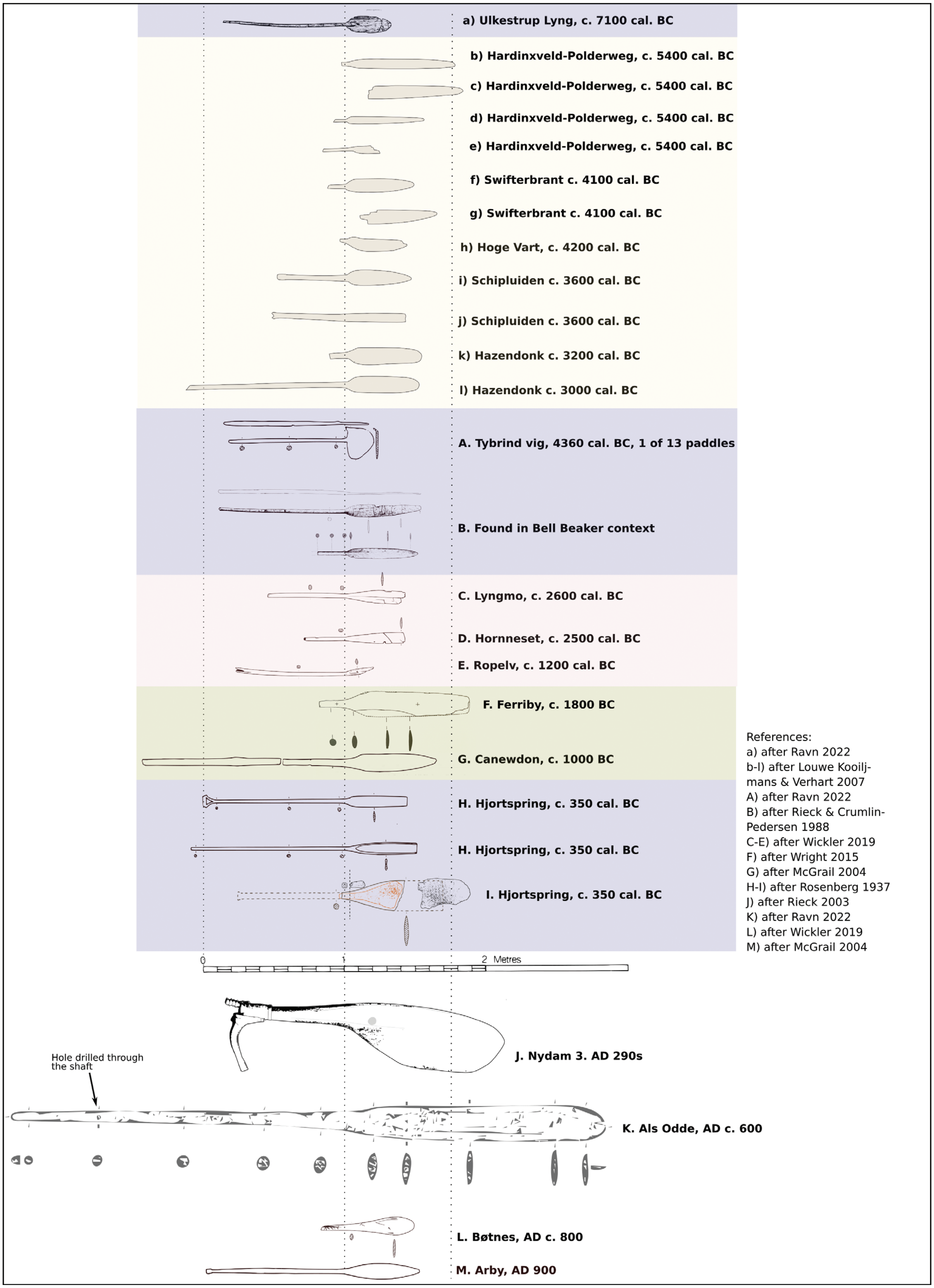


*Figure 3.28. Examples of paddles, steering oars, and oar blades from north-western Europe dating from* c. *7100 BC–AD 900 (by author).*

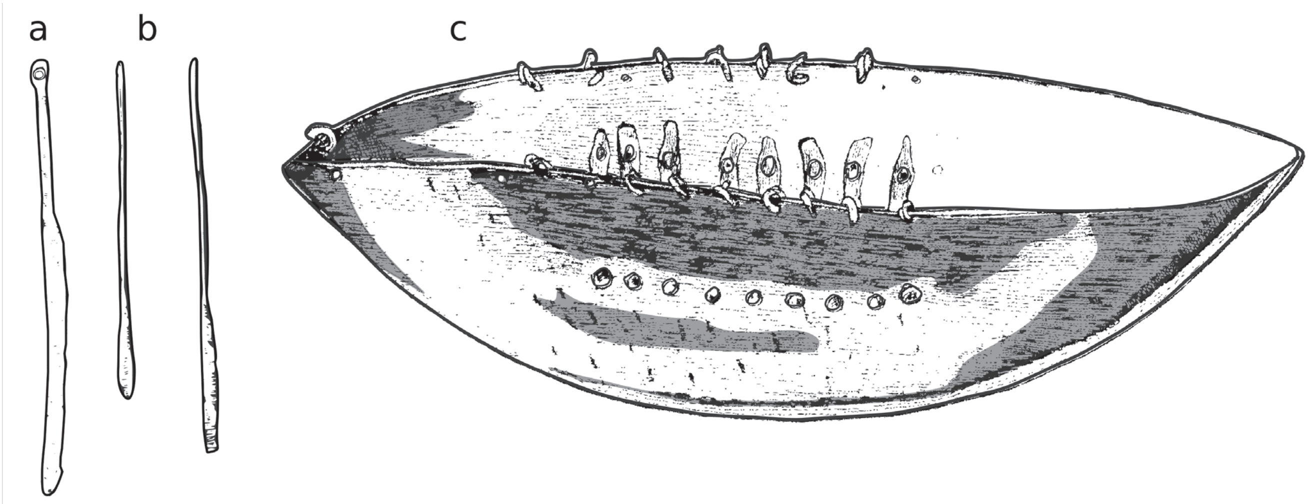


*Figure 3.29. Details of the Broighter boat showing a. the relative size of the steering oar; b. two of the paddles; b. and c. the grommets used to fasten the oars to the rail (after Farrell et al. 1975, 18).*

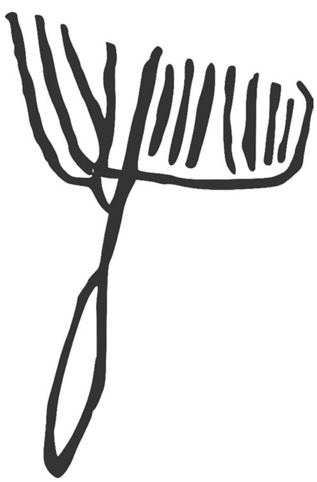

*Figure 3.30. Boat with a potential steering oar carved onto the Gavrinis tomb, Gulf of Morbihan in southern Brittany, dated to between* c. *4200–3200 cal. BC (after Cassen et al. 2017).*

direction of the blade throughout the paddling stroke (Haupt 2003, 120–3), similar carved holes on the steering oars might have been used to attach a handle. The slightly squared shape of the lower end of the shafts of the steering oars might have further aided the helmsman in 'feeling' the direction of the steering blade (Bengtsson & Bengtsson 2011).

An equally important consideration is how the steering oars were attached to the hull under different conditions. There is a marked difference between steering on a river and on the open sea. Bad weather in unprotected waters where waves roll under the boat will make it difficult and tiring for a crew to keep a vessel on a straight course, whereas on relatively sheltered river systems there is usually a potential landing site not far away for rest or shelter. Thus, if a boat is light and has a hull shape that provides good course stability, steering could theoretically, at least in sheltered waters and for short periods of time, be carried out without attaching it to a grommet or similar (where any more difficult wave or gust might be handled by a combination of strong arms and adrenalin). For open water, long distance seafaring (whether the boat is paddled, rowed, or sailed) on the other hand, effective steering would require steering oars that are fixed at one or two points (Mott 1997; Bengtsson & Bengtsson 2011; Mark 2012, 89). Again, if we consider the Broighter model, the oars and steering oar appear to be fastened with some sort of ring, perhaps representing loops of yew and rope (grommets). If the model represents a hide boat it would have been important to keep chafing to a minimum so as not to pierce the hide, but this form of attachment would have been relatively easy to add and then replace as and when needed. On a Hjortspring type boat the steering oars could have simply been tied onto the two horn projections padded with layers of leather at each end (Bengtsson & Bengtsson 2011).

### *Oars*

The Broighter boat provides indirect evidence of the use of oars within the North Atlantic European region in the 1st century BC. In Scandinavia, the earliest direct evidence for oars consists of the thole pins found integrated with the gunwale facings of the Nydam 1 boat, *c*. AD 190 (Rieck 2003, 298–9). However, the earliest indirect evidence of oared vessels comes from two or possibly three rowed vessels depicted in Scandinavian rock art, which appear to show thin bladed oars, merely outlined as lines (or potentially representing blades tips that were below the water surface; C in Fig. 3.26, above). Of these, the potentially earliest is from Tanum-95 (tentatively dated to *c*. 1300–1100 BC) whereas the other two, one from Dalbo (Fig. 3.26) and another from Harvaland in southern Norway, might be of a similar date to the Hjortspring boat (*c*. 500–300 BC; Østmo 1992; Bengtsson 2015; 2017, 69, 81, 87).

Apart from the above examples, the Dürrnberg gold boat has by some been regarded as the earliest representation of an oared vessel in the region (Fig. 3.31, A, opposite; Ellmers 1972, 105). This *c*. 6.5 cm long boat was discovered within grave contexts dated to the 5th century BC near Halledin in Austria and is deemed to represent a type of flat-bottomed river craft that was still common on continental inland waters, including the Rhine and the Danube, in the 1970s (Ellmers 1978, 1). The boat has what appear to be two short-shafted paddles or oars, with almost triangular shaped blades. These are assumed to have been mounted through grommets attached to the two sheerline holes on the starboard side of the vessel and used by being pushed away backwards to propel the boat forward (Ellmers 1978, 10–11). When the boat took on speed the oar blade would be lifted to a horizontal position and twisted 90° to avoid the blade hitting the water surface ready for a new push. However, it is not explained why two such push oars are mounted only on the starboard side (with none on the port side). Equally, it is not explained why the blades would have a triangular shape.

An alternative interpretation is that the two sheerline holes were used to mount the oars as steering oars on the outside of the hull, in which case the triangular shape might still be a problem unless used at an angle like a fin. This would have created less turbulence and hence drag. Interestingly, the same peculiar shape of steering oars can be found in rock art imagery from Scandinavia (Fig. 3.31, B), where they could indicate either a local way of steering in a 'fin mode' (this imagery is mainly from Askum on the Swedish west coast and Dalbo in south-east Norway along the same stretch of coast) or just represent a way of depicting the blade as they might appear when submerged in the water (Fig. 3.31, D and E). The same argument applies to the 4th–5th century AD boat depiction from Gotland where both steering oars also appear to be of a more triangular blade shape, but which could just be an attempt to depict the blades as they appear from the side (Fig. 3.31, C).

### *Sail*

As for use of sail within the region, the Broighter boat has been seen as the earliest indirect evidence of sail in Atlantic Europe but references to sail within credible historical sources (see Table 3.1), can push its use back to the 6th century BC (McGrail 2007, 447). In Scandinavia, the earliest direct evidence of sail date to the 8th century AD. However, new research into Scandinavian rock art reveals the existence of what can be interpreted as local boat types furnished with mast- and sail-like attributes already in the Early Bronze Age (Bengtsson 2015; 2017). This imagery includes not only boats that can be dated to different time periods but can be found at sites in most major rock art regions across southern Scandinavia. In fact, boat depictions that include details such as masts, rigs, or sail are found in more regions than boats that feature visible paddlers. Based on this observation, it likely that the use of sail had a much greater continuity within the region, where it was most probably used as a complement to paddling and later rowing (Bengtsson & Bengtsson 2011; Bengtsson 2015; 2017; Bengtsson et al. 2024). The earliest boat depicted with a mast-like feature is found in Vendsyssel in north Jutland where it was carved onto the trunk of a living tree around 1550 BC (Marstrander 1963, 351–2; Bengtsson 2017, 85). If comparing the Scandinavian imagery to similar imagery found along the European Atlantic façade it appears that use of sail was already widespread across the region during the Bronze Age (Figs 3.32–3.33).

This might lend some credibility to the interpretation of the two 'saddle' features on Ferriby 1 as potential mast steps as well as the interpretation of the large composite patch in the Carpow logboat as a crude mast step. If correct, both cases represent rare examples of where the use of sail might have left tangible traces, something which has proved very difficult to identify within the archaeological record as a whole (Strachan 2010, 68; Bengtsson 2015; 2017, 56–7).

## Discussion and scope for future research

This chapter has tried to shed light on the available evidence for the types of vessels that were 'ploughing' the prehistoric Atlantic European coasts, as Avenius once so vividly put it (Table 3.1). Within the region, there is clearly an imbalance between the direct archaeological record of seagoing vessels and vessels that were used exclusively within inland water systems. Of the latter, there is an overwhelming bias towards the logboat. These two imbalances can easily be explained by the higher chances of wood preservation within inland wetland contexts. Therefore, it is equally clear that the existing record of archaeological boat finds cannot be taken as fully representative of all the different types of boats that were used on either the sea or indeed on inland waterways.

Early written sources provide indirect evidence of sailed hide boats within the region by at least the 6th century BC, whereas direct archaeological evidence from the British Isles and indirect evidence from Scandinavian rock art suggest that plank-build boats were widespread by the onset of the 2nd millennium BC.

It is tempting to make a connection between the spread of the Bell Beaker phenomenon in the mid-3rd millennium

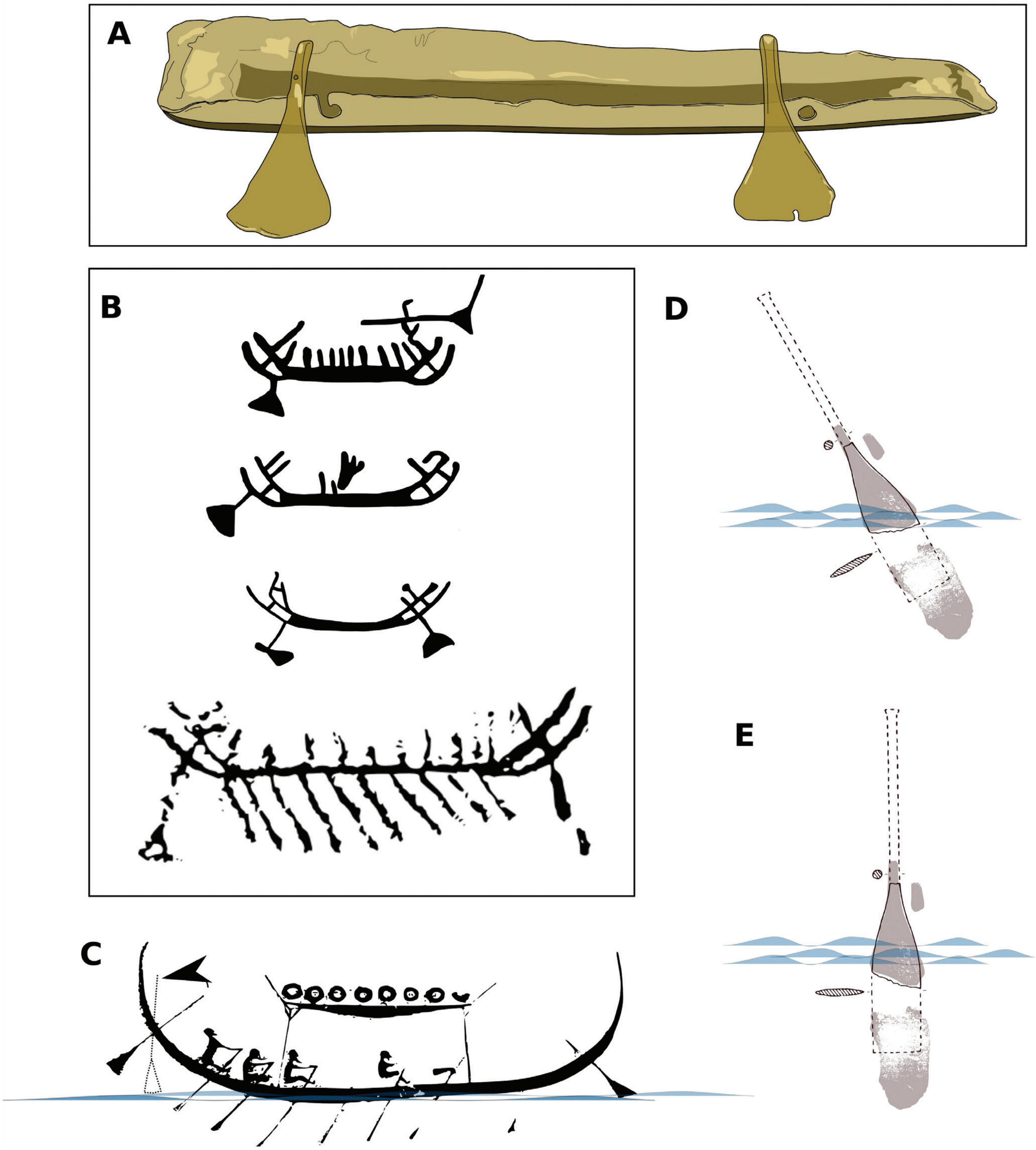


*Figure 3.31. Triangular shaped paddle/steering oar blades or visual representation of the blade as submerged in the water. A. A small,* c. *6.5 cm long boat of gold from Dürrnberg by Hallein in Austria, with two paddles or oars attached to one side; dated to the 5th century BC (after photo in Ellmers 1978, 2); B. Scandinavian rock art imagery of boats with triangular shaped steering oars (after Bengtsson 2015; 2017); C. Rowed vessel on Gotlandic picture stone, 4th or 5th century AD, with waterline inserted and forward steering oar adjusted to a practical steering angle (after Rieck 2003); D. The Hjortspring steering oar blade submerged at an angle, giving the illusion of a triangular blade above the waterline; E. The same blade at a more vertical (and effective) angle.*

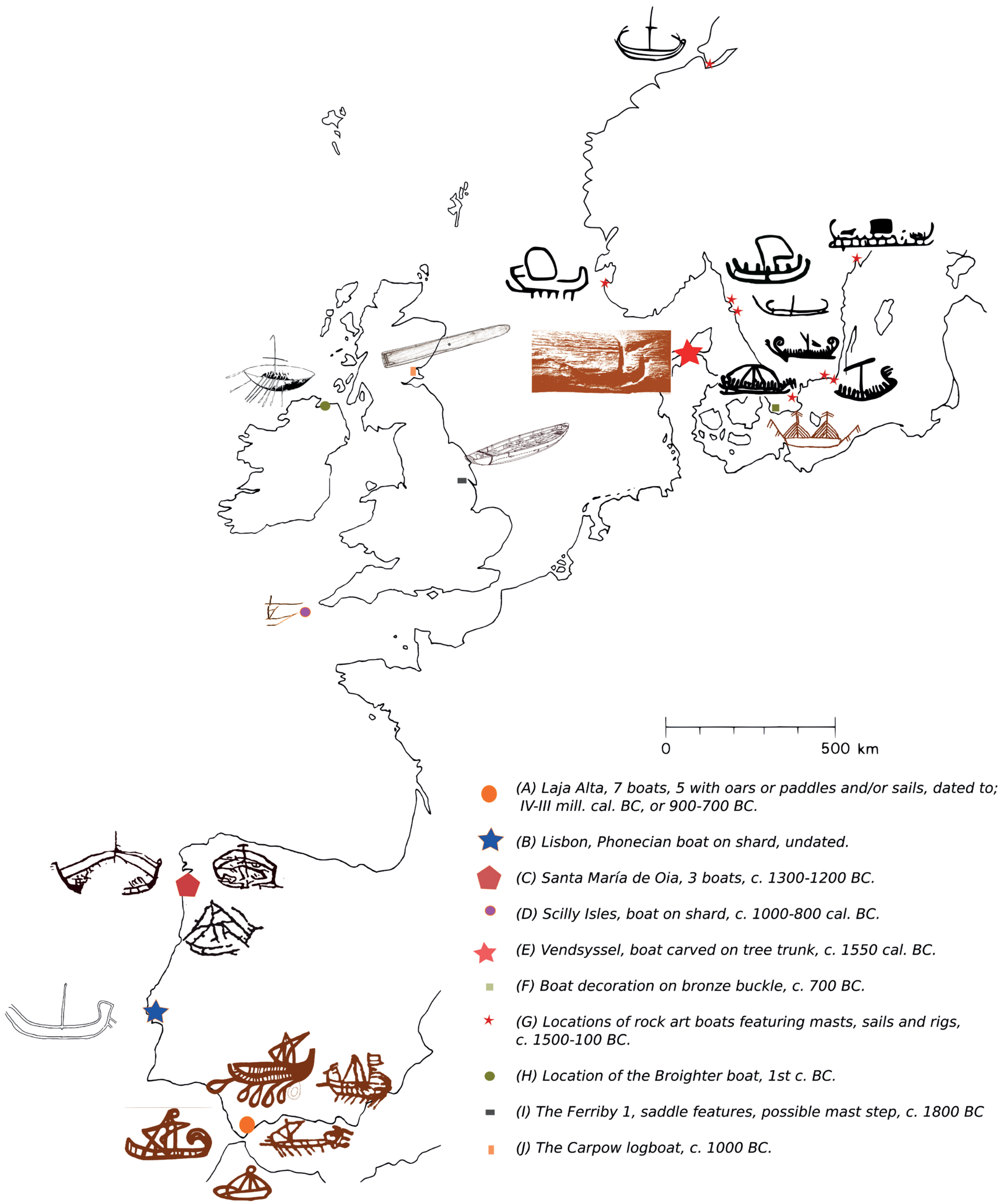


*Figure 3.32. The geographic location of boats and boat imagery suggesting the use of sail in Atlantic Europe, Scandinavia, and southern Iberia in prehistory ((A) after Rey da Silva 2014, 387–9; Morgado et al. 2018; (B) after Cunliffe 2017, 281; (C) after Rey da Silva 2014; Cunliffe 2017, 207; (D) after photo in Johns & Taylor 2011, 48; (E) after Bengtsson 2017, 87; (F) after Bengtsson 2017, 87; (G) after Bengtsson 2015; 2017; (H) McGrail 2004, 182; (I) Gifford et al. 2006; (J) after Strachan 2010, 66).*

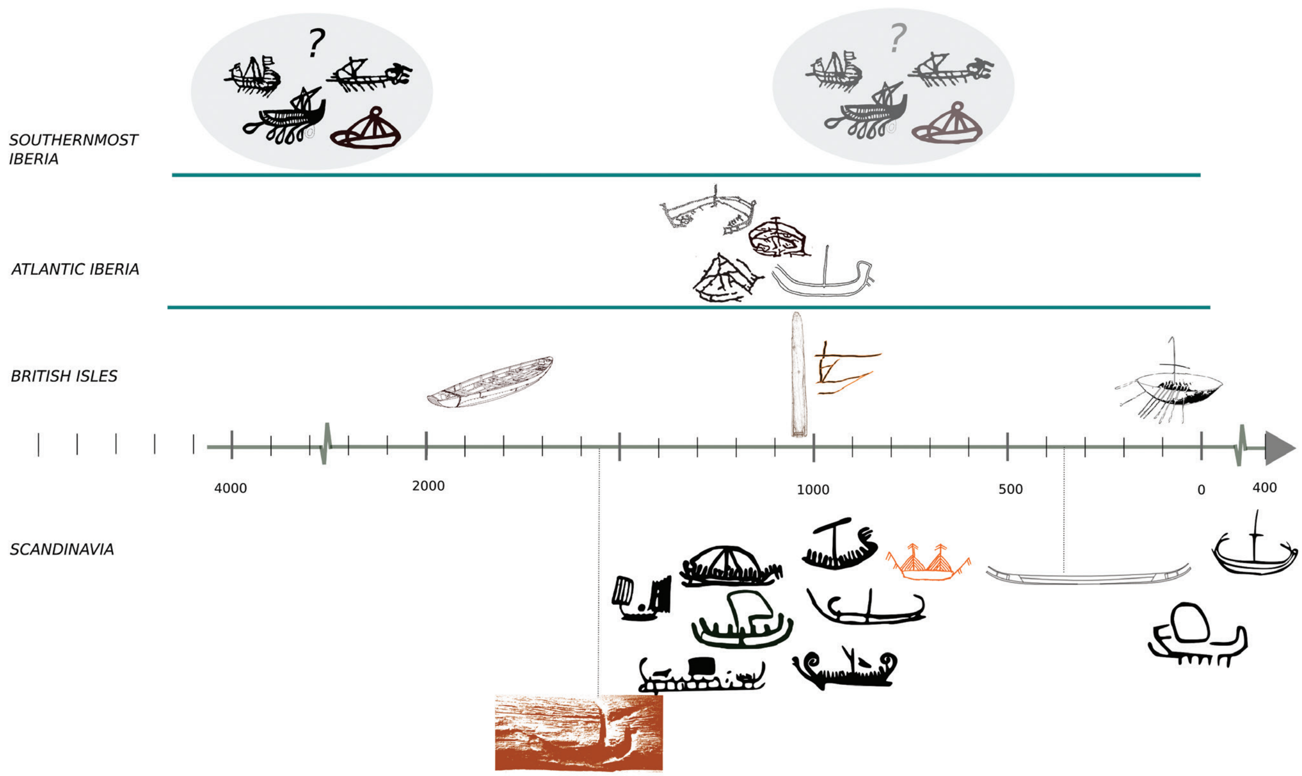


*Figure 3.33. Time line for depictions of boats with masts, rigs, and sails in Fig. 3.32 in relation to the Broighter model, Ferriby 1, the Carpow logboat, and the Hjortspring boat.*

BC with this new boatbuilding technology. The earliest Bell Beaker contexts in south-western Norway, for example, appear to coincide with indirect evidence of what might be early plank-built vessels of the same type as the Hjortspring boat, at local rock art sites (Figs 3.1, 3.16, and 3.23). Such a transfer of technology might have occurred quite rapidly provided the preceding local and regional boat technologies were of a sufficient standard (Renfrew 1986; Leeuw & Torrence 1989; Bengtsson 2017, 125). The extensive logboat evidence indicates this might have been the case. Already in the 6th millennium BC logboats from sites in the Netherlands and Denmark (Table 3.2) provide evidence of an understanding of the effect a smooth and even hull shape has for reducing drag and improving boat performance, in effect making the boat quicker and easier to handle. Although these boats were most probably used for hunting on sheltered inland waters or within archipelagos, they reveal a level of knowledge that would have been essential for attempting to construct boats capable of undertaking long-distance voyages along coasts and across more open waters.

At around the same time, the first transom built logboats appear, providing evidence of an understanding of the relationship between boat weight and cargo capabilities. Their construction also demonstrates an ability to join pieces of wood and make joints watertight by means of caulking. Likewise, the evidence of boat repairs indicates an ability to drill holes and suggests that rope making and sewing skills were already on a par with standards seen in later, more advanced boatbuilding contexts.

Stray finds of prehistoric paddles and/or steering oars might further be used to deduce the potential size of the boats that were used, as indeed the indirect evidence provided by, for example, boat models, rock art, and ship-settings.

The present study suggests a number of new research avenues. For instance, research of archaeological sites in wetland areas, such as Bouchain, might shed light on prehistoric forestry management including coppicing, which may be related to boatbuilding. These sites are complex and take time to excavate and evaluate. Another important source of new information regarding prehistoric boatbuilding technologies and methods of propulsion may be gained through revisiting existing museum collections where long forgotten objects, often collected before the advent of radiocarbon dating, have been left to collect dust (McGrail 2010b, 8; Wickler 2019). Questions regarding the need for constant maintenance of boats and how this might have impacted how and where boats were used also deserve greater attention. Here ethnographic evidence in combination with experimental archaeology is of paramount importance.

A direct hands-on knowledge of seafaring demonstrates that, whether following the coast or traversing open water, the longer the sea journey the better prepared a crew needs to be. The risk of being unable to reach a safe haven in the event of an emergency, caused by damage to the vessel or changes in weather or visibility, puts greater emphasis on speed, course stability, and the ability to handle rough sea and waves. This is particularly relevant in the case of vessels that are propelled by muscle power alone since this source of power is inconstant and 'non-renewable', meaning that paddlers will become tired over time and, in the absence of shelter or respite, would struggle to keep the bow to the wind. This difficulty could be ameliorated by attaching something bulky or heavy to the bow of the boat, thereby slowing the drift at that end of the vessel. These are the common constraints presented by seafaring in open water, regardless of history, and the smaller the boat the more obvious these constraints are going to be. Nevertheless, as we have seen, the archaeological evidence suggests that these constraints were overcome at a very early point in time.

One obvious way of offsetting the limitations of man-powered propulsion is the adoption of the sail, a 'renewable' and, depending on the wind, potentially non-exhaustible power source. If the boat has a steering oar, this method of propulsion would make a fundamental difference in the ability to travel long distances. Whereas features in the Ferriby 1 and the Carpow logboat could indicate the use of sail, the Scandinavian rock art suggest it might have been widespread by *c*. 1500 BC. Suitable sail materials could have included hide and even bark, but also different types of woven cloth (Bengtsson 2017, 124–6). In the Mediterranean, the use of sail was widespread by at least 2000 BC but some researchers argue that the Marmotta logboats, from Lake Bracciano north of Rome, might indicate use of sail already in the 6th millennium BC (Kingsley, cited in www.livescience.com). There is also some discussion as to the age of the sail boats painted onto a wall in the Laja Alta cave near Gibraltar, which might date back to the 3rd or 4th millennium BC (Morgado et al. 2018). Whichever is the case, any one encounter between seafarers from the Mediterranean world and those from the European Atlantic world could potentially have led to the transfer of sail as method of propulsion, and we know that such interactions happened much earlier than any direct archaeological evidence have led us to hitherto assume (Fig. 3.32).

While the pros and cons of experimental archaeology have been much debated in the past, and rightly so, the continuous research into boatbuilding technologies and materials at, for example, the Viking Ship Museum in Roskilde, Denmark, has demonstrated the overwhelming wealth of insights that can be gained through this form of research (Andersen & Andersen 1989; Vadstrup 1993; Andersen et al. 1997; Sørensen 2001; Crumlin-Pedersen & Olsen 2002; Bengtsson 2017, 92). Likewise, the knowledge gained by the Hjortspring guild in all aspects of boat construction and performance over the years since building the *Tilia Alsie*, has greatly increased our understanding of prehistoric boats (Crumlin-Pedersen & Trakadas 2003; Valbjørn 2003a). A similar long-term approach in building and testing is needed to fully understand the potential and limitations in the use of boats of the Mesolithic, Neolithic, and Bronze Age, taking into account material aspects, technologies, maintenance, as well as navigation and the potential purpose of such vessels (where supported by e.g., evidence of migrations or trade across open stretches of water).

In addition, we need a new framework to properly assess, categorize, and compare different types of prehistoric vessels used at a given time in coastal regions and river systems along the European façade. For this we need to use the evidence available to build prehistoric type boats from a long-term perspective, enabling the build-up of experience in how to handle and maintain these boats. Valid research questions could include e.g.,: what are the typical characteristics and limitations of a hide boat in comparison to a logboat or bark boat? How do they handle waves? How easy are they to manoeuvre? How long do they last? How much can they carry? How far can they travel using different methods of propulsion? And, how vulnerable are they in specific environments? By systematically recording boat performance these differences should become apparent while a proper evaluation of the raw materials would enable a much more informed understanding of the nature of regular seafaring within Atlantic Europe in prehistory.

Since the basic environment in which prehistoric vessels and seafarers operated has not changed significantly from today (notwithstanding changes to coastlines through erosion and sedimentation, and local changes in sea level) it should be possible to use modern oceanographic data to simulate how, when, and with what regularity a particular type of vessel could have been employed.

In short, the scope for further research is enormous.

## Glossary

Amidships – in or around the middle part of a boat
Bole – the trunk of a tree
Bow – foremost part of a boat
Caulking – material inserted between two timbers to make a joint watertight
Cleat/integral cleat – a protruding block of wood on the inward facing side of a plank perforated to allow a timber or rope to pass through. Also known as integral cleat.
Displacement – the weight or volume of water a boat displaces when afloat
End board – a plank used to close to forward end of a Dover type boat
Endship – either end of a boat (bow or stern)

Freeboard – the vertical distance between the top of the hull sides or sheerline and the waterline. Usually measured amidships

Grommet – strands of rope laid in the form of a ring

Gunwale – the upper edge of a boat's hull

Gunnel – the upper edge or railing of a boat. Similar to gunwale but usually made up of several parts while providing rigidity to a hull construction

Ils plank – a transversely curved plank that forms the transition from bottom part of a boat to the side parts of a boat

Lath/rod – thin rectangular lengths of wood, used for making the framework for a hide boat

Parent tree – tree from which a logboat or particular boat part was made

Port – the left-hand side of a boat when facing forward

Port hole – a hole cut through the hull of a boat

Prow – see bow

Punting – the propulsion of a boat by using a pole from a standing position in a boat

Resin – a hard, sticky substance secreted by trees and other plants

Scarf – a joint designed to join two pieces of wood lengthwise by tapering or shaping their ends to fit together, ensuring strength and continuity in the resulting structure

Sculling – the holding of an oar or steering oar with both hands making a figure of eight motion of the blade in the water while twisting, thereby emulating the movement of a fish tail

Seacraft – boat

Sheerline – the upper edge of a boat's hull seen as the silhouette when viewed from the side

Shell – the outer shape of a boat. On a hide boat usually made of hides sewn together.

Spacing – refers to the distance between individual rods or laths when discussing the construction of hide boats

Starboard – the right-hand side of a boat when facing forwards

Stern – the opposite to bow

Strake – a single plank or course of planks that stretches from bow to stern of a vessel

Tar – also called pitch, is a dark brown or black viscous liquid substance produced by the dry distillation of organic matter such as coal, wood, or peat.

Thole – a wooden pin projecting upwards from the sheerline, used as a pivot for an oar

Transom – a transverse board or plank fitted and made watertight, usually at the stern end of a boat

Washstrake – a plank fitted to the upper edge of a boat to keep out spray and water

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4

# Larger boats, longer voyages, and powerful leaders: comparing Maritime Modes of Production in Scandinavia and California

*Mikael Fauvelle & Johan Ling*

*Island and coastal societies around the world followed several unique developmental pathways that allowed for the formation of economically and politically complex systems. In this paper we argue that marine resources allow levels of intensification comparable to that of terrestrially focused societies, while seaworthy boats amplified the ability of emergent leaders to trade and raid over long distances. Many of these factors are summarized in the Maritime Mode of Production (MMP), a model which explains the development of decentralized chiefdoms in Scandinavia through the nexus of mobile wealth, advanced boat technology, and maritime trading and raiding. These characteristics are shared by other early maritime societies such as those in British Columbia and Northeast Asia, suggesting that the MMP may have wide cross-cultural applicability as a pathway towards social complexity. By using the MMP to help explain the development of social complexity in another well-documented maritime society, the Chumash of southern California, we argue that innovation in watercraft technology combined with the ownership of boats by emergent elites led to a powerful positive feedback system which propelled the formation of maritime chiefdoms along similar trajectories to those hypothesised for Bronze Age Scandinavia. We use this comparison as a springboard to evaluate the applicability of the MMP as a comparative model for the development of social complexity in maritime societies around the world and suggest promising areas for future research.*

## Introduction

Traditional narratives describing the development of social complexity have been challenged over the past several decades by archaeological research carried out in island and coastal regions around the world (Kristiansen & Larsson 2005; Erlandson & Fitzpatrick 2006; Needham & Clark 2009; Gill et al. 2019a). While the well-trodden terrestrial path which traces the origins of agriculture to the formation of sedentary complex societies remains a staple of most archaeological textbooks, it is increasingly apparent that many societies followed alternative routes to political and economic complexity (Hayden 1995; McIntosh 1999; Alt 2010; Ling et al. 2018a; Austvoll 2020; Delance & Feinman 2022). Understanding the variety of ways in which cultures maintained social complexity remains a major challenge for archaeology, and crucial for our understanding of how the profoundly unequal society in which we now live developed. (Kintigh et al. 2014; Graeber & Wengrow 2021). Island and coastal societies provide excellent case studies with which to explore alternate pathways to complexity as the unique resources and transportation possibilities afforded by these marine environments allow for different opportunities to those found in terrestrial regions. In this chapter we adopt a cross-cultural approach to explore how the characteristics of island and coastal environments can enable unique modes of production that concentrate power in the hands of watercraft owning elite and can lead to the formation of powerful maritime chiefdoms.

Many of the unique factors that can facilitate the formation of seafaring chiefdoms have recently been summarized in the Maritime Mode of Production (MMP) model proposed by Ling and colleagues (see Ling this volume, Chapter 5). The model was developed primarily to explain the political economy in Bronze Age Scandinavia, denoted by political control of agropastoral production, maritime trading and raiding, regional alliances, and slaves to fill labour gaps at farms. A key feature of the Scandinavian MMP was the interaction between the domestic and the political economy (Fig. 4.1). This is demonstrated by the presence of two important sectors: the land-based agropastoral sector, linked to individual farmsteads, and the sea-based maritime sector, linked to the boat unit. In order to participate in trade networks and warfare, Scandinavian groups relied on both of these sectors, but due to social and environmental differences, some regions specialized more in one than the other. As a result, there was a division of labour and exploitation of comparative advantages between regions with different types of environment and social organization, ranging from coercive to co-operative social settings (Feinman 2017; Austvoll 2020). For example, the more co-operative social settings can be found along the coasts of western Sweden and Norway in regions that had easy access to timber, while more coercive social systems prevailed in areas where timber was harder to come by, such as the heavily deforested and densely populated agropastoral region of Jutland (Ling et al. 2018a). The latter regions benefited from agropastoral production which led to an increase in wealth and power, evidenced by the amount of metal they used (Kristiansen 2000). Elites exploited and regulated the comparative advantages between the regions and formed confederates of trading and control over prestige products (Earle et al. 2015).

According to the MMP, the development of seaworthy boats allowed emergent leaders to enrich themselves through the control of flows of wealth from maritime trading and raiding. This led to the formation of maritime chiefdoms focused on seafaring, boat ownership, and long distance travel. As the proceeds from trading and raiding could be channelled towards greater investment in boat construction, this model presents a positive feedback system in which wealth is increasingly concentrated in the hands of a boat owning elite. Although the MMP was originally developed to explain the formation of Scandinavian chiefdoms, the model has also been used to explain the expansion of the Maritime Bell Beakers in Atlantic Europe (Kristiansen & Earle 2022) as well as other maritime societies around the world. Hudson (2022), for example, has recently suggested that the MMP can be used to explain the political economy of chiefdoms in Bronze Age Japan whose warrior elites relied on an agropastoral subsistence economy but obtained bronze and other wealth through maritime connections. Applying the MMP to other case studies can help us understand which aspects of the model have the greatest cross-cultural applicability and enable our wider understanding of the origins of social complexity in maritime societies.

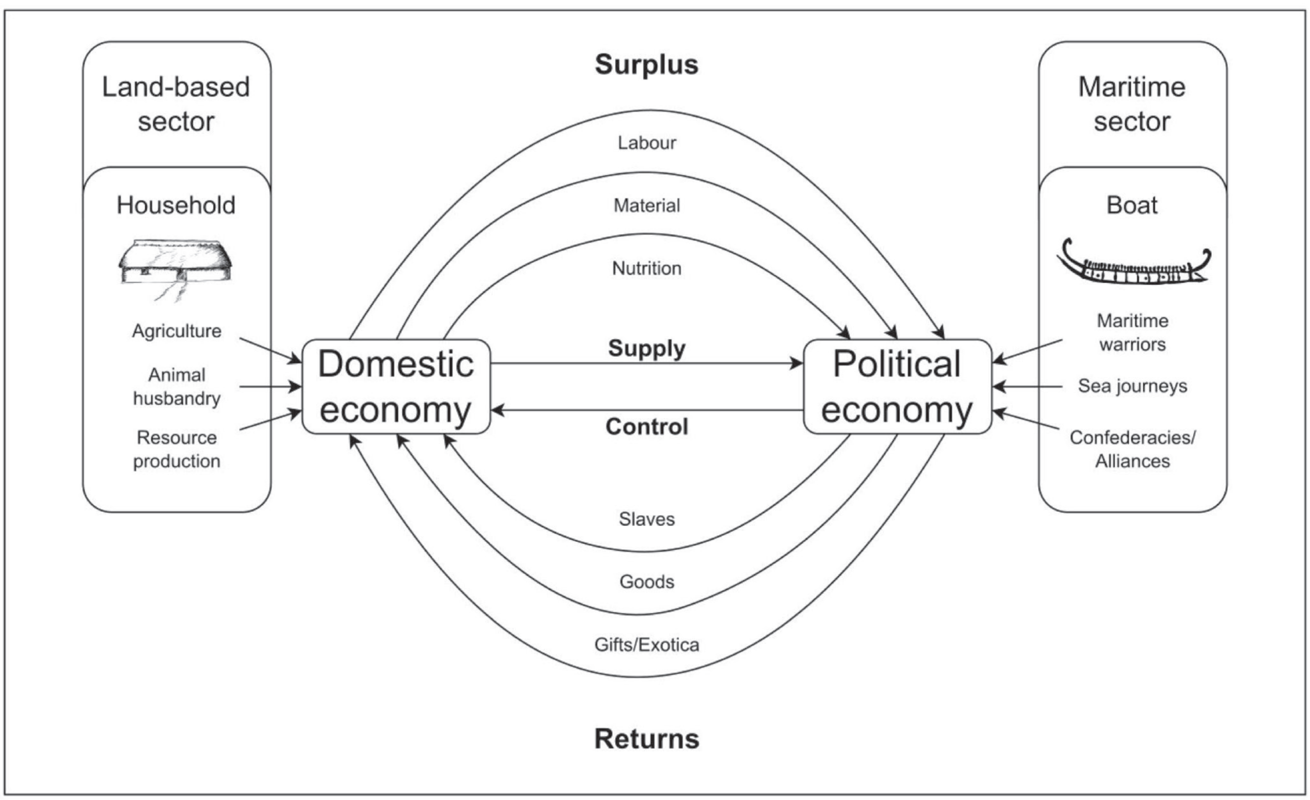


*Figure 4.1. Illustration of the Maritime Mode of Production, showing the integration and the dialectics between the domestic and political economy (after Horn et al. 2024).*

This chapter examines the formation of maritime chiefdoms in southern California from the perspective of the MMP and makes comparisons between southern California and Bronze Age Scandinavia. The Chumash people of southern California's Northern Channel Islands and adjacent mainland coast were complex maritime fisher-hunter-gatherers who lived in sedentary chiefdoms from at least 1300 AD until their integration into the Spanish colonial system in AD 1782. In order to navigate the Santa Barbara Channel, the Chumash employed highly advanced sewn-plank boats (Fig. 4.2), which were in use by at least AD 500 (Hudson et al. 1978; Gamble 2002; Fauvelle 2011).

The Chumash share a number of features in common with the Bronze Age Scandinavian MMP. As well as utilizing very similar boat technologies, both cultures can be defined as network oriented chiefdoms with a high degree of focus on maritime trade. There is even evidence that the Chumash developed boat guilds in the forms of secret societies[1] analogous to those inferred in Bronze Age Scandinavia. However, there are also important differences between the two societies which makes the southern Californian case study an excellent opportunity to test the wider application of the MMP model. In the case of the Chumash, we can push the limits of the MMP comparison further by examining its applicability to a society with a hunter-gatherer rather than agricultural subsistence base. This presents the intriguing possibility that control of boats, rather than agropastoral production, was the most important factor in the evolution of the MMP over space and time. Conversely, by using the detailed information available for Chumash maritime social organization and elite control of boats we can theorize similar scenarios in the Scandinavian Bronze Age.

In this chapter we examine the ways in which the MMP applies to both Bronze Age Scandinavia and southern California while also highlighting some areas of difference. Specifically, we argue that the positive feedback loop created when elite boat owners funnelled the proceeds of maritime travel back into boat construction gave rise to a set of conditions that led to the formation of maritime chiefdoms. This process has a high degree of cross-cultural applicability in many different world regions.

## The Scandinavian Maritime Mode of Production

The Maritime Mode of Production was originally formulated to explain the formation of maritime chiefdoms in Bronze Age Scandinavia (Fig. 4.3). These chiefdoms comprised dispersed polities characterized by individual farmsteads spread across the landscape at a density of 1–3 farms per square kilometre. The relatively low density population that supported these systems is estimated to be 12–15 persons per $km^2$ in the most densely populated areas, such as Jutland and Scania, and 4–6 people in more sparsely populated places, such as Bohuslän or Östfold (Ling et al. 2018a). The size of individual chiefly polities varied, but in the Thy region of Jutland they could encompass between 50 and 400 $km^2$, with populations ranging between 600 to upwards of 5000 individuals, although chiefly polities of between 1000 and 2000 individuals were the most common (Earle & Kolb 2010, 64–5).

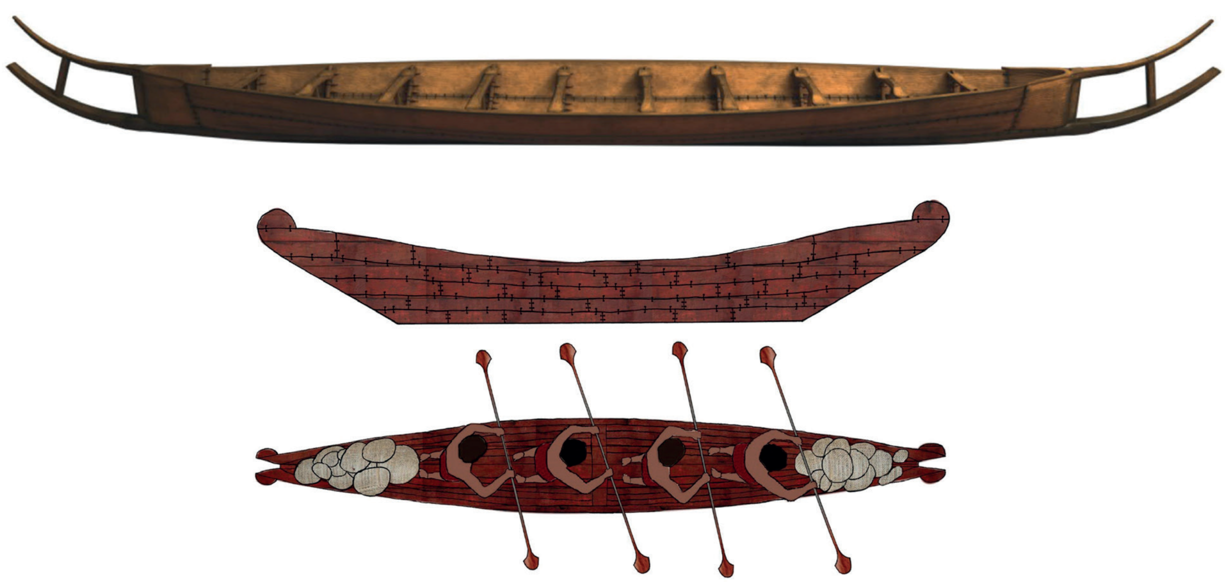

*Figure 4.2. Comparison of sewn-plank boats in Scandinavia and California. The model of Hjortspring boat is above, while a drawing of a Chumash plank canoe is depicted below. Both ships are shown scaled to size, with Hjortspring having an interior length of 13.6 m while large Californian canoes were up to 9 m in length. (Hjortspring boat model credited to Richard Potter, used with permission; California canoe drawing by Mikael Fauvelle and Jaymee Ngernwichit).*


*Figure 4.3. Map of Denmark and southern Sweden showing regions mentioned in text (map by Mikael Fauvelle).*

The ability of Bronze Age elites to amass wealth is evidenced by the thousands of burial mounds and large cairns that dotted the Bronze Age landscape. These graves, some of which contain large quantities of imported metal wealth including bronze swords and daggers, average several metres in height and would have required substantial investment in terms of labour to construct (Olsen 1990; Johansen et al. 2004; Kristiansen 2010). This impressive political economy was based on a series of regional interactions and interdependencies, with metal transported to Scandinavia from as far afield as the Iberian Peninsula, and timber for ships moving between regions within Scandinavia (Ling 2014; Ling et al. 2014). These relationships were supported by four key elements outlined by the MMP model (Ling et al. 2018b, 501–3). Each of these elements is described briefly below.

*Boat construction and crewing.* The long distance voyages that underwrote the political economy of Bronze Age Scandinavia depended on the construction and crewing of reliable open-ocean watercraft. These were likely sewn-plank boats of a similar design to the Early Iron Age Hjortspring boat from Denmark (Crumlin-Pedersen 2003). Thousands of boat carvings dating to the Bronze Age show clear design similarities to the Hjortspring boat, suggesting the long continuity of this type of watercraft. Constructed from drilled and lashed logs waterproofed with pitch, these boats would have required considerable resources, knowledge, and labour to build (Crumlin-Pedersen 2003). Based on modern reconstructions, it is estimated that the construction of a Hjortspring-like boat may have taken up to 6500 man-hours (Valbjørn 2003). Crewing boats would also have been costly, as major trading or raiding parties could have comprised as many as 10–20 boats, each crewed with between 60 and 100 men (Ling 2014). If we assume that each crew member represented the contribution of a single household, assembling such numbers would have had a seriously deleterious effect on the resources of a small to medium sized chiefdom. During the era of the larger Viking Age boats, upwards of 70 men are estimated to have needed nourishment while at sea for periods of up to four months. Such an undertaking would have required 460 persons to produce an extra year's worth of surplus (Bill 2008, 170–1). Bronze Age boats were smaller, the largest could hold a crew of 20; but even this relatively small number would require a substantial amount of investment, at least one year's surplus from 100 producers. The implications for labour organization and the demand for slaves in these societies will be explored later. Considering the materials and labour needed to build and crew these boats, it is likely that only very powerful individuals would have had access to their use. Equally, the costs and risks involved in setting to sea in plank boats must have been outweighed by the potential rewards indicating, yet again, the value placed on rapid access to the resources of the Scandinavian waterways and the Atlantic façade.

*Surplus agricultural production*. In order to finance the production of boats and compensate boat crews, chiefs would have needed to funnel surplus agricultural production into feasts and gifts for their followers (Ling et al. 2018a). Surplus production of animals and grains would also be required to feed labourers diverted from the fields to support boat construction and maintenance. Agriculturally productive areas, therefore, would have been at an advantage for this purpose. Despite being disadvantaged by the lack of local timber resources, areas such as Thy in Jutland would have been well placed to meet the costs of high rates of boat ownership. Many of these exchange goods may have been directed towards boat-building areas such as Tanum in Bohuslän, that had abundant timber resources but less productive agricultural land (Ling et al. 2018a).

*Imports of metal wealth*. One of the primary goals of long distance seafaring during the Nordic Bronze Age was to bring metal wealth to Scandinavia. Metal was central to the Bronze Age way of life, providing weapons, chiefly prestige items, and daily tools. As none of this metal came from local sources, this required a massive import of bronze and tin over considerable distance (Ling et al. 2013; 2014). It is estimated that at least one metric tonne of bronze would need to be imported to Scandinavia every year to replace the wear on bronze axes in Denmark alone (Ling et al. 2018a). Lead isotope signatures point to remote European origins for most of this metal, including sources from Wales, the Iberian Peninsula, Sardinia, and the Italian and Austrian alps (Ling et al. 2014). While metal from the Alpine region could have been transported via riverine systems and partly overland, copper from Iberia, Sardinia and Wales, and tin from Cornwall must have been transported by boat along the Atlantic Façade. This means that Bronze Age leaders able to build and crew large seaworthy boats would have been uniquely positioned to benefit from the import of two of the most important commodities of the period.

*Exports of amber and slaves*. In order to acquire such massive quantities of metal wealth Scandinavian leaders needed high value exports that were desired in the metal producing regions of southern Europe. Amber was likely an important trade item, as it is abundant in Scandinavia and would have provided a highly portable and high value prestige commodity. Amber can be sourced using infrared spectrometry and many finds of Baltic amber have been identified in the southern European regions from which bronze and tin was exported (Ling et al. 2014). Slaves would have provided another, potentially vital, traded resource. The same ships and crews required to carry out long distance trade would have been perfect for raiding coastal settlements along the Atlantic façade and throughout Scandinavia. Whether obtained through exchange as tradable commodities or as a direct result of raiding, or a combination of both, the traffic in unfree labour seems to have been a two-way affair, involving the movement of people north–south and vice versa. During the Early Iron Age, the presence of northern European slaves in the Mediterranean is suggested by the presence of blonde individuals on Etruscan wall paintings (Briggs-Nash 2002).

The importance of long distance trading and raiding also fuelled a positive feedback loop that prompted the enslavement of greater numbers of people. In order to conduct long distance voyages, more labour had to be transferred from the agricultural to the voyaging sectors. With such a shift in labour, who filled the agricultural labour gap? Viking-era historical documents, as well as ethnographic accounts of maritime ranked societies, indicate that slaves often filled this gap and constituted an important part of the economy (Ling et al. 2022). Some scholars argue that the large and complex Bronze Age farmsteads were built and organized in order to house slaves within a certain part of the building (Mikkelsen 2020). Other researchers argue that various burial findings in southern Scandinavia suggest the presence of Bronze Age era slaves. Barrows and cairns were reserved for the top segment of the society, around 20% of the population, whereas commoners and possibly slaves were sometimes buried in simple flat structures, pits, and gallery graves (Bergerbrant et al. 2017; Ling et al. 2018a). Other evidence of slaving can be found in Bronze Age Scandinavian rock art (Ling et al. 2018a, 504). These slaves would have been highly valued in southern Europe and the Mediterranean and presumably their exchange would have provided a high return in metal wealth.

Recently, Ling and colleagues (2022) have used and advanced the MMP to argue that the evidence of interaction between Tanum/Bohuslän and the Limfjord/Jutland region reflects the presence of a transregional political elite network with exclusive access to advanced knowledge about boatbuilding, long distance exchange, and warfare. In this context, we argue that the transregional boatbuilding guilds (i.e., secret societies, with representatives from both Tanum and Jutland) organized boatbuilding and maritime long distance exchange, warfare, slavery, and various forms of ritual activity (Ling et al. 2022). Extrapolating this theory further, we contend that these transregional guilds also created the rock art found in the Tanum/Bohuslän area as part of a seasonal ritual process associated with the transmission of knowledge relating to navigation, boat construction, watercraft maintenance, warfare, religion, and cosmopolitan affairs (Ling et al. 2022). As noted earlier, the presence of trade guilds or secret societies focused on boatbuilding is a common feature of maritime societies with parallels in the Chumash culture of California (see below).

The Scandinavian Bronze Age MMP was based on the ability of powerful leaders to finance the construction and crewing of plank-built boats that facilitated trading and raiding for high value resources that were needed to support the Bronze Age political-economic system (see summary of Scandinavian MMP in Table 4.1). A major component of the Scandinavian MMP was regional interdependence and

*Table 4.1. comparisons between the Scandinavian and Californian MMPs.*

| *Characteristics of Scandinavian MMP* | *Applicability to Californian MMP* |
|---|---|
| Low density populations interconnected by exchanges of wealth | **Applies:** although Chumash villages had larger populations than Nordic Bronze Age settlements |
| Warriors able to raid, trade, protect, & intimidate | **Applies:** Chumash chiefs were known to have warrior retinues |
| Agricultural sector with productive lands & autonomous households | **Not applicable:** Hunter-fisher-forager society, although intensification of nuts & marine resources provided high returns |
| Slaves as an exchange commodity & labour to expand surplus production | **Partially applies:** there were no slaves in Chumash society, although surplus commoner labour was funnelled into trade good production |
| Maritime sector with specialized knowledge of boats | **Applies:** boatbuilding knowledge was highly specialized |
| Ownership of boats by chiefs who supported their construction | **Applies:** chiefs directly financed & sponsored the construction of boats |
| Entrepreneurial voyages overseen by chiefly captains | **Applies:** entrepreneurial voyages were a major activity for Chumash chiefs |
| Raiding along voyaging routes for slaves & other valuables | **Not applicable:** raiding was practised by Chumash chiefs but it was not focused on resource accumulation as in the Nordic Bronze Age |
| Transfer of wealth to chieftains who owned boats & financed voyages | **Applies:** ethnohistoric documentation of chiefs receiving proceeds from activities in boats they financed |
| Gift exchange by chieftains to establish networks of power and alliance | **Applies:** prestige exchange & feasting was a major component of chiefly activity |
| Boat guilds in the form of secret societies | **Applies:** brotherhood of the Tomol controlled the knowledge needed to build a plank canoe. |

complementarity. The high level of agricultural production in northern Jutland in present-day Denmark provided surplus production needed to amass both material resources and manpower for boat building and crewing. Resource rich areas such as Bohuslän in present-day Sweden provided boatbuilding expertise and raw materials in the form of abundant timber for planks and pine pitch for caulking. Crewed plank boats could raid for slaves and trade down the Atlantic coast, bringing back much-needed metal wealth to Scandinavia. This wealth would then fuel the expansion of the leaders who financed boat construction, providing a positive feedback loop that financed the formation of maritime focused chiefdoms.

## The Chumash case study

The Chumash of southern California provide an excellent ethnohistoric and archaeological case study with which to examine the cross-cultural applicability of the MMP (Fig. 4.4). By the time of the region's Late Period (AD 1300 –1782), Chumash society was organized into chiefdoms of a comparable size and population to those of Bronze Age Scandinavia (Johnson 1988; Arnold 2001; Gamble 2008). Chumash society was less dispersed than that of Bronze Age Scandinavia, with major centres of chiefly power accommodating up to 1000 people in sedentary villages. Chiefs often controlled a number of secondary centres, each containing upwards of several hundred inhabitants, resulting in polities of several thousand people. The Chumash people lived in a region that included the Northern Channel Islands as well as the mainland coast and adjacent interior stretching roughly between Malibu and Pismo Beach. Some of the largest village centres were located on islands and the mainland coast of modern Santa Barbara. Unlike the Scandinavian example discussed above, the Chumash were a Stone Age society, with metallurgy not being adopted until after the Spanish conquest. Maritime trade between the islands and the mainland coast formed a major part of the economic system underpinning Chumash society, in much the same way as long distance seafaring

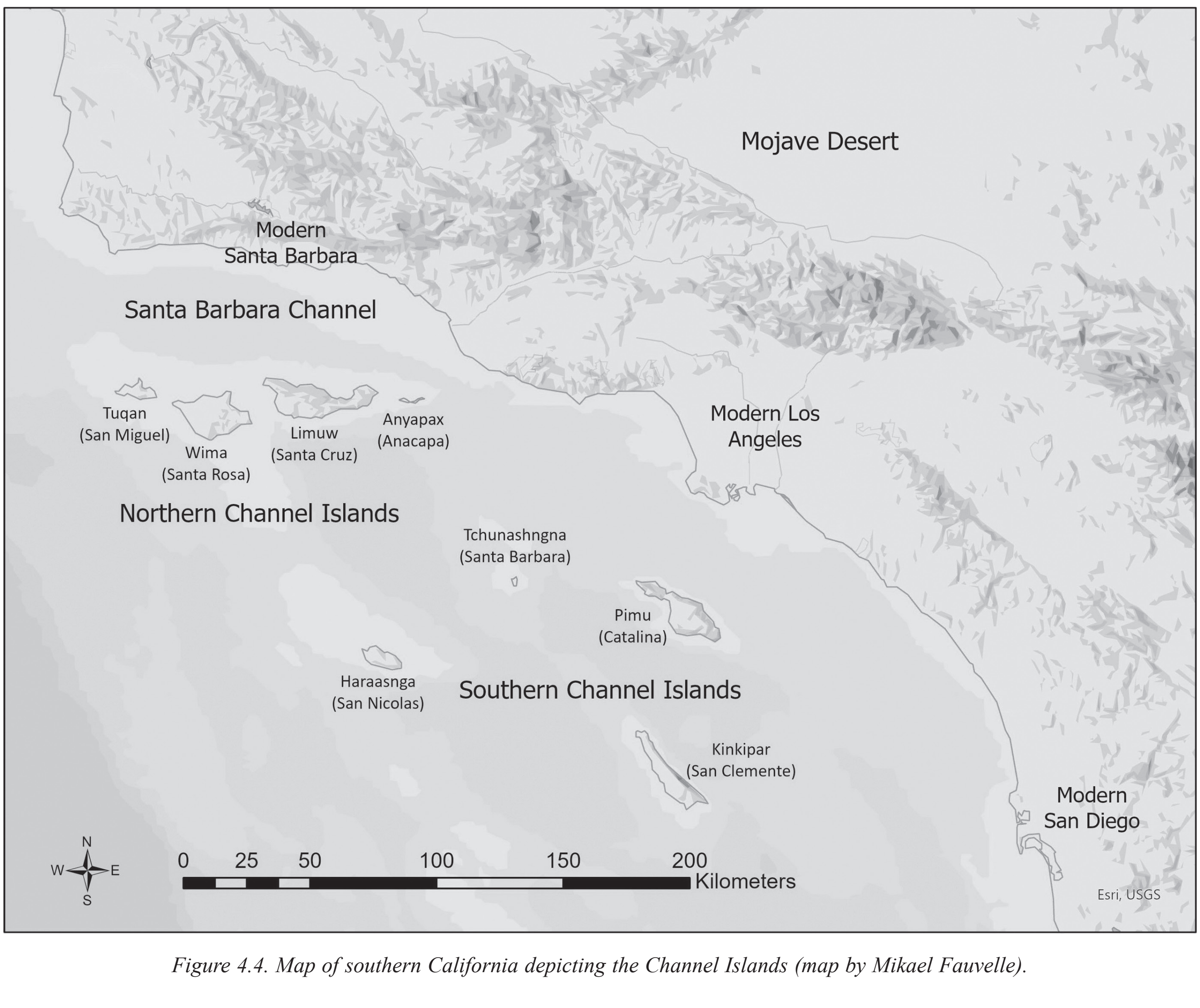


*Figure 4.4. Map of southern California depicting the Channel Islands (map by Mikael Fauvelle).*

supported the political economy of Bronze Age Scandinavian chiefdoms.

Much of what we know about pre-Colonial Chumash society is informed by a wealth of ethnohistoric and ethnographic documentary evidence composed in the centuries following the incorporation of the Chumash into the Spanish Empire in 1782 (Bolton 1930; Simpson 1961; Blackburn 1975; Hudson et al. 1978; Brown 2001). Spanish accounts discuss encounters with powerful chiefs, who wore distinctive clothing, owned fleets of plank canoes, and held lavish feasts for their followers (Arnold 2001; Brown 2001; Gamble 2008). Powerful Historic Period chiefs such as the famous *El Buchón* also commanded retinues of warriors (Brown 2001, 721–3; Smith & Fauvelle 2022, 148–9). Status in Chumash Society was inherited and there was a clear division between commoners and elites depending on lineage affiliation (Gamble et al. 2001; Fauvelle & Somerville 2024). Only members of elite lineages were able to join important organizations such as the powerful *'antap* society, which controlled esoteric ritual knowledge and organized public ceremonies, and the Brotherhood of the *Tomol*, which controlled access to knowledge related to boatbuilding (see also Chapter 6 on secret societies in this volume by Chacon et al.). While ethnohistoric records provide an excellent picture of the of Late and Historic Period Chumash society, the question for archaeologists is what processes led to the formation of these powerful political hierarchies.

One of the key components that underwrote the Chumash political-economic system was the circulation and use of shell bead money (King 1990; Arnold 2001; Gamble 2020; Fauvelle 2024). Chumash shell money was shaped and drilled form Olivella shells (*Callianax biplicata*). These shells were strung on strings that were measured at set lengths to denote different values for purchases. In the Historic Period, for example, two and a half hand-width length of beads was equivalent to the value of a Spanish silver coin (Woodward 1934, 119). The centre for shell money production was on Santa Cruz Island, where millions of beads were produced by highly skilled specialists over the course of the region's Late Period (Arnold & Munns 1994). The scale of this production was such that Santa Cruz was often referred to as the region's shell money 'mint' (Arnold & Graesch 2004, 7; Gamble 2011, 232). Shell money was traded across the Santa Barbara Channel and down the mainland coast, where it was used in daily exchanges, deposited in burials, and traded further throughout the American West (Smith & Fauvelle 2015; Fauvelle 2024). Demand for island produced shell beads in coastal communities and across the wider region provided a major force driving maritime trade throughout much of Californian prehistory.

In exchange for shell beads, numerous items were traded from the mainland coast across the Santa Barbara Channel (King 1976; Fauvelle & Perry 2019; Fauvelle & Perry 2023). Arnold (e.g., 1992; 2001) has argued that the primary trade good flowing from the mainland to the islands comprised of staple food items, but recent scholarship has suggested that trade in food was limited and mostly focused on supplying feasts, rather than on daily consumption (Fauvelle 2011; 2013; Fauvelle & Perry 2019; 2023; Gill et al. 2019a; 2019b). The need to provision feasts and facilitate ritual consumption was a major driver of trade, with high value items, such bone instruments, soapstone effigies, charm stones, and other components of shamanic toolkits, moving across the channel (Fauvelle & Perry 2023). Lithics would also have been an important trade resource, with obsidian and steatite both having been imported to the Northern Channel Islands from mainland sources (Fauvelle & Perry 2019; 2023), while antlers and bone tools would also have been traded across the channel, as deer and other large terrestrial mammals were absent on the islands. One of the most important categories of trade item, however, was likely to have been boatmaking material, such as asphaltum (bitumen) and milkweed cordage; the best sources for these critical materials being found on the mainland coast (Fauvelle 2011; 2014).

To carry out all of this robust cross-channel trading, the Chumash employed one of the most advanced watercraft used in pre-Columbian North America: the sewn-plank canoe. Bearing strong technological similarities to the sewn-plank boats of the Scandinavian Bronze Age, the Chumash sewn canoe was made from redwood or pine planks, sewn together with milkweed fibre, and caulked with a mix of natural asphaltum and pine pitch (Hudson et al. 1978). The Chumash plank canoe was called the *tomol* in the Chumash language, while a similar boat built in the Los Angeles region by the Tonga people was called the *Ti'at*. Both of these southern Californian plank canoes were smaller than those built in Bronze Age Scandinavia, averaging around 7 m in length compared to the 14 m long interior length of the Hjortspring boat. Able to reach up to 8 knots at full speed (but often traveling at a slower speed of 4 knots), the plank canoe's main advantage was speed, enabling it to travel across the Santa Barbara Channel within the hours of daylight (Fauvelle 2011). The boat's large cargo capacity also ensured abundant space for ferrying goods or people across open ocean. By the Historic Period, virtually all open-ocean traffic in the Santa Barbara region took place in plank canoes and boat ownership had become a prerequisite of chiefly and elite status in the region.

Fully formed plank canoes were likely to have been in use by as early as *c.* AD 500, as evidenced by asphaltum canoe plugs, boat effigies, and dated canoe plank fragments (Gamble 2002). Although some evidence of economic and political complexity including social ranking and the possible use of shell money dates to before this period (Gamble et al. 2001; Gamble 2020), it was only in the centuries after the innovation of the plank canoe that the maritime trading system of the Santa Barbara Channel intensified into something resembling the highly interdependent system observed in the ethnohistoric period (Arnold 2001; 2004; Fauvelle 2011). Highly standardized and labour intensive cupped shell beads started to be produced on the islands in *c*. AD 1150 and were subsequently traded to the mainland in massive numbers (King 1976; 1990). This development corresponded to an increase in regional population and settlement size (Arnold 2001; 2004; Kennett 2005; Jazwa et al. 2019). By around 1300 most scholars agree that the Chumash were already organized into political hierarchies that could be described as simple chiefdoms (Arnold 2001; 2004; Kennett 2005; Gamble 2008). As will be argued below, a maritime mode of production based on trade using plank boats was central to the formation and political-economic functioning of these Pacific chiefdoms.

## The Californian Maritime Mode of Production

Like the Scandinavian MMP outlined above, the Californian MMP describes a political-economic system centred on chiefly control over sea-based trading and characterized by a high degree of regional interdependence and complementarity. Through the control of boatbuilding and use, entrepreneurial chiefs were able to monopolize open-ocean transport, reaping the benefits of trade between different regions and resources connected by water. In addition to parallels in the boatbuilding technologies employed and comparable degrees of socio-political organization, the processes leading to these social formations were highly similar in both locations. The elements supporting the Californian MMP are outlined below:

*Boats and boat production.* Chiefly control over boat use and boatbuilding was a key element of the Californian MMP. All Chumash chiefs owned canoes and only members of high social standing were able to amass the resources needed to build one. Based on the time needed to build modern plank boat replicas, it is estimated that over 500 man-hours were needed to build a single average sized *tomol* (Hudson et al. 1978; Fagan 2004). The large amount of labour required together with the fact that many canoe building materials were highly valuable made the construction of canoes something that only elites could afford (Fauvelle 2011). Only a select few were allowed to participate in canoe building, as the knowledge needed to build the canoe was restricted to the Brotherhood of the *Tomol*, membership of which was limited to individuals from elite familial lineages (Hudson et al. 1978). *Tomol* owners could allow others to use their canoes but, in return, expected control of the redistribution of any profits from fishing or trade (Hudson et al. 1978, 130). As the plank canoe was the only Chumash watercraft that was used to cross the Santa Barbara Channel, control over canoe use enabled Chumash chiefs and elites to gain a monopoly over the exchange of goods between the region's island and mainland. Needless to say, control over this trade would have provided Chumash chiefs with a means to amass economic and political power.

*Surplus production of trade goods.* Intensive trade across the Santa Barbara Channel was made possible by surplus production on both the islands and the mainland. On the islands, specialized artisans produced surplus shell beads by the millions, the majority of which were traded across the channel to the mainland. Bead workers were sponsored by elites in a form of attached specialization (Arnold & Munns 1994) and supported other industries such as the production of bead microdrills (Sunell & Arnold 2019). On the mainland, surplus food in the form of dried acorns was also an important trade good supplied to the islands (King 1976). Although the scale of acorn exchange across the channel never made a major contribution to island subsistence (Fauvelle 2011; 2013; Gill et al. 2019b), it was likely an important item of consumption at feasts, ritual occasions that may also have been linked to the building of boats (Fauvelle & Perry 2023). As was mentioned above, other ritual goods probably accompanied the exchange of surplus foods for feasts from the mainland coast to the islands.

*Imports of tar and prestige goods.* One of the most important goods traded to the Channel Islands was almost certainly tar, which was used for waterproofing canoes (Fauvelle 2011; 2014; Fauvelle & Perry 2019; 2023). The Chumash distinguished between two types of tar: *woqo*, which was of the highest quality and mined from the ground, and *malak*, which washed up on the beach from underwater seeps (Hudson et al. 1978, 51–2). Ethnohistoric sources indicate that only *woqo* was of high enough quality to waterproof boats, yet no sources of *woqo* existed on the islands, making tar a critically important cross-channel exchange good. One of the largest tar sources in Chumash territory was located at Carpinteria, which was known as a major centre for Chumash boatbuilding. It is possible that finished boats produced at Carpinteria and other mainland beaches were themselves important trade items sent to the islands (Fauvelle 2014; Fauvelle & Perry 2019, 203). Some of the best sources of tar exist outside of Chumash territory in the Mckittrick area, and ethnographic and historical accounts detail a rich trade in tar cakes between the local Yokuts people and the coastal Chumash (Latta 1949). Also imported to the Chumash region from adjacent areas were cotton blankets and polychrome ceramics from the American South-west (Smith & Fauvelle 2015). These exotic items would have been prized as important status symbols for Chumash elites.

*Exports of shell beads*. Shell money was the grease to the wheel that allowed the entire Chumash political-economic system to function. The centre of shell bead production was on Santa Cruz Island, from where beads were traded across the Santa Barbara Channel then carried up and down the coast and across the region's interior desert to destinations further inside the continent (Smith & Fauvelle 2015). The great demand for Chumash shell beads across western North America was a major driving force for the Chumash economic system, leading Fauvelle to describe the region as having an 'export-driven' economy (Fauvelle 2011, 151). Although some 'counterfeit' beads were produced on the mainland, the vast majority were produced on the islands, reflecting perhaps the islanders' pre-occupation with maintaining an export surplus in valuable products in order to guarantee access to critical boatbuilding materials and ritual items. The fact that beads were used as money also facilitated a great deal of market-like exchange within the channel region (King 1976), much of which was conducted in goods that needed to be transported by water across the Santa Barbara Channel.

To summarize, the Californian MMP was characterized by entrepreneurial canoe owning chiefs who traded goods back and forth across the Santa Barbara Channel and between the region's islands. Ritual products and raw materials from the mainland were exchanged for labour intensive shell beads from the islands. Profiting from this trade allowed chiefs to cement their power, in part by funnelling their wealth into the financing of larger fleets of plank boats. Boat ownership was not only a status symbol in its own right, but also allowed access to the entrepreneurial voyages that financed boat construction. The powerful connection between chiefly control over plank canoes and a bustling maritime trading economy was the dynamo that fuelled the formation and maintenance of Chumash chiefdoms. As was the case in Bronze Age Scandinavia, Chumash Chiefs were engaged in a Maritime Mode of Production that was cantered on the capacity of sea-going transport to fuel economic expansion and the intensification of political hierarchies.

## Comparisons between the Californian and Scandinavian MMP

One of the most important components of both the Scandinavian and Californian MMPs was the ability of elites to monopolize the construction and use of seaworthy boats. Through the ownership of boats, elites were able to control the redistribution of affluence acquired through maritime trade, creating a positive feedback mechanism that allowed boat owners to further entrench their positions as entrepreneurial elites. In both the Scandinavian and Californian case studies, we see an explosion of maritime activity and political-economic intensification following the innovation of sewn-plank canoes. As building these more advanced boats required more knowledge, labour, and material wealth than the skin boats, dugouts, and reed boats that preceded them, it was difficult for non-elites to sponsor their construction. This spurred a growing divide between those with the ability to construct boats and those who depended on the boats owned by others to access imported wealth and resources. Watercraft innovation can therefore be seen as an essential catalyst that stimulates the rapid creation of systems of hierarchy in maritime exchange networks.

Another important parallel between the Californian and Scandinavian MMPs is the high degree of regional interdependence and complementarity that was integral to both systems. For the Scandinavian MMP, high rates of agricultural production and proximity to Atlantic trade routes made Jutland a centre for the financing and crewing of plank boats that were built with timber from the resource rich coast of Bohuslän (Ling et al. 2018a). A similar dynamic was in place in southern California, with islanders specializing in the production of labour intensive, value added shell beads, while the mainlanders provided raw materials for building boats and surplus food for feasts (Fauvelle 2011; 2014; Fauvelle & Perry 2019). In both cases, maritime trade routes facilitated the transfer of goods between complementary resource areas, intensifying the economic activities of both areas. The ability of maritime societies to quickly and easily transfer resources between complementary resource zones is a key component of the Maritime Mode of Production that is certain to see wide cross-cultural applicability.

Both the Californian and Scandinavian MMPs were also highly dependent on interactions with neighbouring regions. In Scandinavia, Bronze Age elites depended on the inflow of metal wealth from southern Europe to fuel their political and economic system. For the Chumash, it was the high demand for shell bead money across coastal California and beyond that drove the production and export of vast quantities of shell wealth. One difference, therefore, was that the Scandinavian MMP was largely import oriented, while the Californian MMP was more export oriented. The regional scale of each MMP presents another major difference, with the combined regions of Jutland and Bohuslän alone vastly exceeding the area of the Californian archipelago. Population densities in each case study were relatively similar, however, and in both cases the MMP allowed for the formation of political hierarchies in relatively dispersed and low density populations.

The biggest difference between the Scandinavian and Californian MMPs concerns the role of raiding and violence. As fully documented in the Viking Period and in the model proposed here for the Nordic Bronze Age, maritime raiding was a central component of the Scandinavian MMP as it provided a means of obtains slaves that were traded south in exchange for metal wealth. A large crew of a Nordic plank boat would have provided a fearsome raiding party, easily take advantage of the complex coastlines of the Scandinavian archipelago to mount surprise attacks. In California, warfare and raiding were also important chiefly activities, yet practically all documented violence took place on land

(Gamble 2008, 250–61; Smith & Fauvelle 2022, 148–50). This may be due to the fact that the open coastlines of southern California would have made sneak attacks via the ocean fairly difficult. Alternately, we may simply be missing accounts of sea based raiding in the ethnohistoric record. A significant difference between the two MMPs, however, is the lack of slavery in southern Californian prehistory. While there is some documentation of slavery among adjacent groups in the Mojave Desert, there is no evidence that slavery took place on the coast (Smith & Fauvelle 2022, 156–7). Rather than slave taking, it seems the objective of Chumash warfare was primarily to terrorize political rivals or possibly to control important resource and trading areas (Gamble 2008, 274). The expansion of political power through the Californian MMP was therefore focused almost entirely on trading rather than raiding as a means to accumulate wealth.

The Californian case study contrasts with the situation on the Pacific Northwest Coast, where there are several examples of coastal areas with slave economies (Suttles 1958; Drucker 1965). The Haida of the Northwest Coast, for example, were a ranked society, engaged in long distance marine exchange and warfare. They possessed seaworthy watercraft technology capable of moving vast numbers of people as well as heavy cargoes over long distances, and relied on slaves, partly as labour for boatbuilding but mostly for fishing and other activities (Ling et al. 2022). Thus, the Haida culture can be seen as yet another articulation of the MMP and constitutes an intermediate form with some features closer to the Scandinavian Maritime chiefdoms than in the Chumash case study. A possible explanation for Bronze Age Scandinavia and Haida having slaves but not the Chumash is that the former groups planned substantially longer maritime excursions and possessed larger vessels, which required a significant shift in people from households to boats, and therefore slave labour could have been used to cover the resulting gap. An alternate explanation, recently argued by Wengrow and Graeber (2018), proposes that the Pacific North-west and northern Californian (not Chumash) indigenous groups developed in a form of schizmogenesis, with the highly independent foragers of California and the (so they argue) more 'hierarchical groups' of the North-west; developing in mutual opposition or contradiction to each other. More research is needed to better understand the cross-cultural importance of slavery in Maritime Modes of Production and the relationship between slave taking, raiding, and long-distance voyaging in different maritime societies around the world.

## Conclusions and future directions

In both Bronze Age Scandinavia and pre-colonial California strikingly similar Maritime Modes of Production allowed for the formation of hierarchical chiefdoms in low density seafaring societies. In both areas, the use of plank-built boats allowed for longer and faster voyages, which expanded the capacity of entrepreneurial elites to acquire wealth through maritime travels. Through controlling the construction and crewing of boats, elites in both regions were able to monopolize open-ocean trade, creating a positive feedback system in which boat owners rapidly increased their social status relative to other members of society. Regional complementarity was also key for the development of social processes in both areas, with rapid transport by boat allowing resources from different areas to be readily transported within the political-economic system. Together, the combination of a maritime environment with a network oriented burgeoning elite led to the development of highly similar MMPs in both California and Scandinavia that set the stage for subsequent political-historical trajectories in each region.

The processual elements shared by the Scandinavian and Californian MMPs have strong parallels in many other island and coastal societies that have existed around the world throughout history. The transformative power of boats coupled with the resource patchiness that characterizes many maritime environments provides a powerful pathway towards social complexity for island and coastal societies. Mark Hudson (2022), for example, has recently described how the importance of maritime trading and raiding in Bronze Age north-east Asia had strong parallels with the Scandinavian MMP. Likewise, Fauvelle and colleagues have highlighted the importance of boatbuilding, ownership, and long distance trading for the Okhotsk culture of Hokkaido and Kuril islands, suggesting parallels with seafaring in southern California (Fauvelle et al. 2023). Other societies across the Pacific and Indian oceans also used sewn-plank boats and may also have been characterized by localized MMPs (Clausen 1993; Shaikh et al. 2012). It is notable that the innovation of sewn-plank technology throughout the world is often (but not always, see work by Águila and colleagues (2021)) correlated with the emergence of a political hierarchy, a pattern that points to the significance of the MMP model and indicates the importance of future cross-cultural and comparative research.

The parallel processes that characterize the Maritime Modes of Production described for Scandinavia and California illustrate the importance of understanding how maritime and aquatic pathways to social complexity differed from those in terrestrially focused societies. The unique capacities afforded by maritime transport allowed for the formation of economic and political complexity without the presence of large or concentrated agricultural populations. Understanding how maritime pathways to complexity differed from, were comparable to, and interacted with terrestrial processes is important for building archaeological and anthropological models for early social evolution. Considering the strong parallels between the Californian and Scandinavian MMPs, it is certain that other island and coastal regions also followed similar patterns towards a variety of complex social formations. Future work is needed to fill in these comparative case studies and to build a better picture of how maritime encounters shaped the historical trajectories of coastal societies around the world.

### Note

1 Here we use the term 'secret societies' as this is a well-established concept in the anthropological literature (Hayden 2018; Ling et al. 2018b). In reality, the title 'secret society' is a misnomer. In fact, a more accurate description of this sort of sodality would be 'a society with a secret' -- a secret that granted members power, protection, and wealth. Secret societies were prevalent in traditional cultures on all five continents and were a significant feature of the ethnographies of many of the most prominent ethnologists of the 20th century (Hayden 2018; Ling et al. 2022) The boat building societies discussed in this chapter were secret in the sense that they controlled esoteric and specialized knowledge but were politically active and well-known groups. It might therefore be more accurate to describe them as guilds or trade societies (Ling et al. 2022).

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5

# The Maritime Mode of Production in relation to self-sufficiency, reciprocity, and comparative advantages

*Johan Ling*

*The Maritime Mode of Production (MMP) constitutes an important theoretical model for the programme Maritime Encounters and is exemplified in several contributions to this volume. The dialectics between the political economy and the domestic economy are key components of this theory. However, other aspects of this model, such as self-sufficiency, reciprocity, and comparative advantages, require closer examination. Cross-cultural considerations of these can be made at three levels of integration: the family, the community, and the regional polity. The Scandinavian Bronze Age case offers an intriguing illustration of farm independence and local and regional investments in maritime technology that involved long distance metal trading in this environment. To what degree was self-sufficiency maintained at household, community, and regional levels of economic integration in this system? What impact did the law of comparative advantage, particularly as it related to transportation technology, have on self-sufficiency? What impact did domestic vs. political economies have on self-sufficiency at the three degrees of integration indicated above?*

## Introduction

Self-sufficiency can be considered cross-culturally at three scales of integration – the household, the community, and the regional polity. In this context the Scandinavian Bronze Age case constitutes an interesting example of farm independence and local and regional investments in maritime technologies involving long distance trade of metals. The key question is the degree to which groups at each level were economically independent, meaning that they produced what they needed. From an elemental level, we know that some degree of independence probably exists at each level in all societies and can be expressed by the nature and number of consumables in food, technology, and wealth objects coming from outside each unit. For example, for an individual society that we will be considering, we could say that the household produced 90% of its food, 60% of its basic technology, but almost none of its prestige goods. A similar analysis could be applied to both the local community and the regional polity. The differences that we observe cross-culturally probably represent significant contrasts in political economies and strategies.

Focus on self-sufficiency of the family unit comes from Karl Polanyi's concept of the householding unit (ranging from the peasant farm to the rural feudal estate) as both a producer and a consumer. Householding meant self-sufficiency, and he identified it as the basic 'principles of behavior' anchoring economy in social organization, alongside reciprocity and redistribution, prior to the advent of commercial exchange (Polanyi 1944, 47–53). Sahlins (1972) dwelt on these issues further in his seminal work on *Stone Age Economies* and coined notions about the Domestic Mode of Production (DMP). Three primary aspects may be used to summarize the DMP: family labour force divided by gender and age, basic technology, and limited production targets based on maintenance. Another notion important for our case is Marx and Engel's underspecified Germanic Mode of Production (GMP) (Marx 1953; Engels 1972). In the GMP, the political economy was agrarian based and highly decentralized. The GMP consisted of autonomous households that formed independent production units (Marx 1953, 79; Gilman 1995), coalitions of households were further organized in tribal assemblies, and hereditary leadership were based on military and judicial activity. The Scandinavian Bronze Age long-house tradition (Artursson 2015) probably represents well such a model archaeologically. However, in our model for Bronze Age Scandinavia we prefer to replace both the GMP and DMP terminology with the concept Maritime Mode of Production (MMP), which is consistent with theories that posit the likelihood that the chiefdoms of the Nordic Bronze Age cultures were relatively decentralized despite their complexity (Earle 2002; Kristiansen 2010). This model helps to understand an alternative path to institutional formation in decentralized chiefdoms with low population densities, mobile warriors, and long-distance trading and raiding in valuables, weapons, and slaves.

Before we proceed to Bronze Age Scandinavia as our illustration, we distinguish between the political economy and the domestic economy. Of course, these sectors are strongly interdependent, but they represent different strategies and objectives (Earle 1997; 2002). The domestic economy encompasses a variety of productive activities carried out by a domestic unit to provide resources for biological and cultural reproduction. The political economy, on the other hand, is predicated on elites extracting surpluses to support their agendas and institutions (for example to fund monumental construction, acquire exotic goods, finance attached specialists, build public works, etc.). In this view, the political economy is built on productive surpluses that extend beyond what the domestic unit need for biological or cultural reproduction (Earle 2002). But the main question is how the domestic economy versus the political economy can be connected to self-sufficiency, in terms of the household, the community, and the regional polity. The reason to maintain self-sufficiency is, of course, the ability to fulfil your own objectives without reliance on others, whom you cannot fully control. The most obvious reasons to engage with outside actors involve comparative advantages (Ricardo 1817; Rowlands & Ling 2013; Ling et al. 2017) between households, communities, and regions based on their access to resources, knowledge, technology, and the like. A key factor determining the comparative advantages among economic units involves environmental advantages, the freedom of movement, ownership of resources, and technologies of transport. Each can be seen as a transaction cost making economic dependency more costly.

## The Scandinavian case: the MMP model and regional comparative advantages

Maritime raiding and trading in Bronze Age Scandinavia were linked to low density agrarian societies, in which farmstead self-sufficiency was a rule. Chiefs' farms, however, were able to control better lands and intensify production with additional labour as a means to generate surpluses that, in turn, were used by chieftains to control a political economy based on wealth finance derived from distant maritime expeditions, raids, and the accumulation of metal wealth. Scandinavian societies were the great raider-traders of the North Atlantic. During the Bronze Age their economy rested upon a Maritime Mode of Production (MMP) (Ling et al. 2018; Horn et al. 2024) and this economy affected self-sufficiency at all levels in society (see next section). Particular properties of the MMP relevant to Scandinavia are the fusion of agropastoral and maritime forces of productions (Fig. 5.1). Thus, to comprehend this new economy, we have to envision two key sectors in the emergent political economy, one the land-based agropastoral sector connected to the house unit and the sea-based maritime sector, connected to the boat unit. To participate in expanding international trade, Scandinavian groups apparently depended on both sectors but, because of social and environmental differences, some regions specialized more in one or the other. The result was a regional division of labour and comparative advantages between regions with varied forms of environments and social organizations, spanning from more coercive to co-operative social settings (Feinman 2017). Moreover, it created opportunities for elites to create confederates of exchange and control over prestige goods, and all this transformed the societies into expansive political machines (Earle et al. 2015).

## Bronze Age trajectories of social complexity

Scandinavian Bronze Age societies had rather low population densities with farmsteads that were largely independent. The densest populated areas indicate a population of about 12–15 per $km^2$, less dense areas about 4–6; This equals a total population of *c*. 300,000–500,000 people in Scandinavia (Holst et al. 2013; Horn et al. 2024). Settlements, graves, and hoards together with topography indicate that the regions were divided into smaller political units/chiefdoms that were about 30 km across, although they could vary in size depending on whether these were coastal or inland. Patterns of households and burial monuments both suggest the emergence of social hierarchy in southern Scandinavia in the Early Bronze Age. All societies were stratified, reflected in burials and sizes of farmsteads, metal wealth, and rock art, with chieftains, warriors, and free farmers at the top followed by commoners and slaves (Ling et al. 2018; Horn et al. 2024). With unfree labour working on the farms, free farmers could raise and support warriors to participate in long distance exchange for metal and raiding.

Archaeological evidence indicates that different regions had varied forms of social organization, spanning from coercive to co-operative strategies (Austvoll 2018). Coercive groups used the wealth generated by their large scale agropastoralist activities to invest in long distance exchange. Cooperative communities located in more mountainous areas or in more sea-based coastal communities were forced

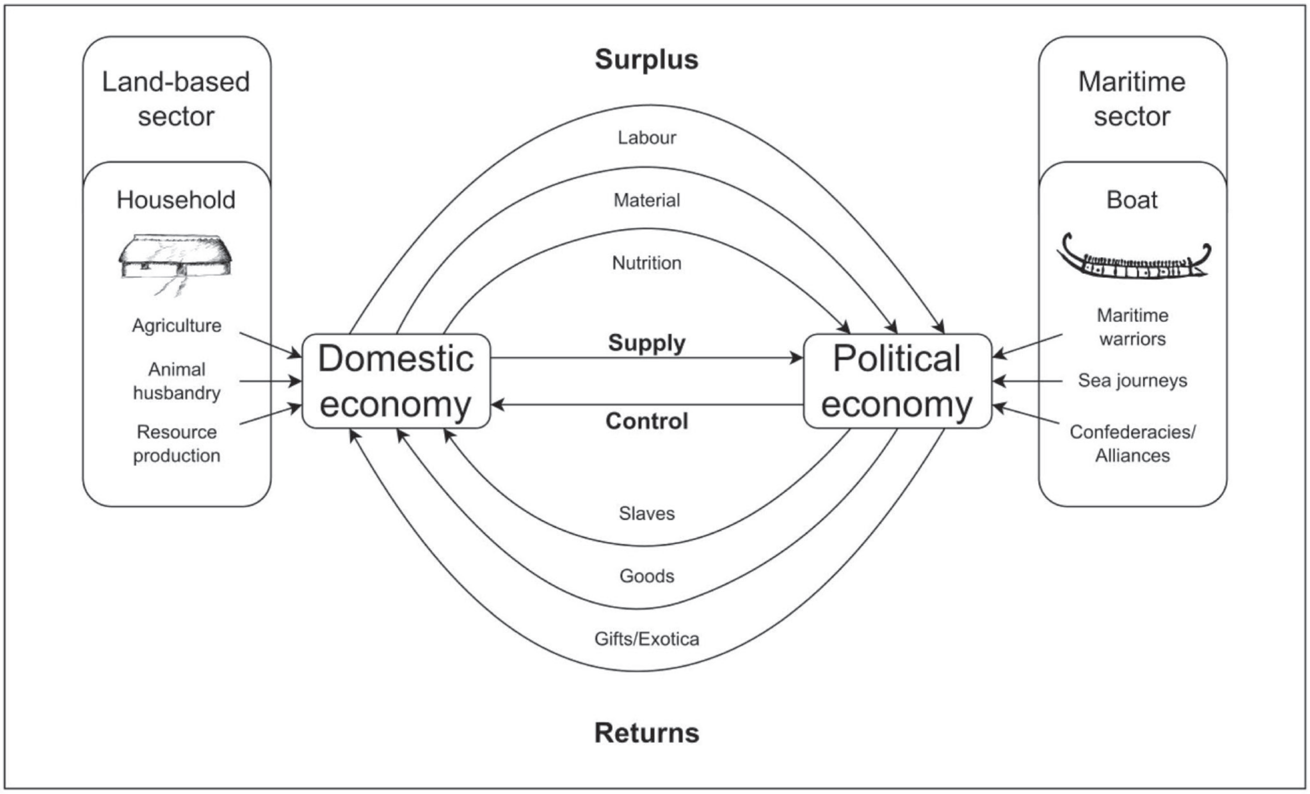


*Figure 5.1. Illustration of the Maritime Mode of Production, showing the integration and the dialectics between the domestic and political economy (after Horn et al. 2024).*

to resort to a more diverse economy which included agropastoralism along with hunting, fishing, and timber extraction. For this latter strategy to succeed, increased co-operation would have facilitated trade which was essential for survival (Austvoll 2018). For example, the more co-operative social settings in coastal Sweden and Norway had access to fish and timber, while timber was already scarce in some of the most deforested and populated agropastoral regions, such as in the north-western Jutland in Denmark or Scania in Sweden (Ling et al. 2018). The latter regions had a far more coercive social setting and had a clear comparative advantage in terms of agropastoral production, which in turn led to an accumulation of wealth and power reflected in metal (Kristiansen 1998; Austvoll 2018).

Thus, archaeological data points to a high level of self-sufficiency for households, communities, and regional polities in both coercive and co-operative regions. Due to the lack of village structure, the Scandinavian Bronze Age example exhibits an exceptionally high degree of farm independence, as well as local and regional investments in nautical technology including long distance metal trade. In the following, I will try to concretize how self-sufficiency took shape at three scales of integration – the household, the community, and the regional polity. I will focus especially on the archaeological evidence from Thy in the Limfjord area of Jutland, Denmark, as exemplifying a more coercive region mostly based on the land-based sector and the rich rock art area of Tanum in Bohuslän, Sweden, as exemplifying the more co-operative region maritime sector. Important for our case, archaeological evidence of interaction exists that links these rather remote areas.

## Thy as exemplifying a coercive region founded on the land-based sector

In areas such as Thy, located in northern Jutland, production was based on individual farmsteads that showed a high degree of self-sufficiency (Bech et al. 2018; Kristiansen 2018). Farmstead density was 1 per km$^2$ and locally higher (Bech et al. 2018). With a household consisting of 8–10 extended family members and perhaps 3–5 slaves, population density of 12 per km$^2$ seems reasonable (Holst et al. 2013; Mikkelsen 2013). The farmsteads formed the basic element in the land-based agropastoral sector; comprising two major elements: cattle breeding and agriculture. While cattle breeding had been of major economic importance since the migration of the pastoral Corded Ware groups to Scandinavia, about 2500 BC (Kristiansen 1998), an important change took place at the onset of the Bronze Age in that agriculture became also of key importance.

Archaeobotanical evidence points to an augmented focus on arable agriculture during the Bronze Age given that different corps were used to maximize cultivation on the same sites. This development created a more predictive, expansive, and stable economy (Iversen 2017). The increased focus on agriculture led also to larger sizes of the long houses (Artursson 2015; Iversen 2017). Central to each farm was a three-aisled residence (Bech et al. 2018). Most were about 18 m long with wattle-and-daub walls; some were smaller. A few chieftain halls were over 30–40 m long and constructed of massive roof-supporting posts and plank walls, probably decorated elaborately with carving, as known for Viking halls (Artursson 2015). It has been claimed that chiefs funded the construction of both large farmsteads and barrows, while free farmers and slaves carried out the labour on a community basis (Earle 2018).

Most scholars argue that each ordinary farmstead produced about 60–80% of its food, and about 50–60% of its technology (pottery and stone tools such as flint sickles and stone hammers). The foodstuff consisted to 80–90% of agropastoral products and the rest of fish and wild game (Bech et al. 2018). However, chiefly farmsteads showed an even higher degree of self-sufficiency and produced about 90–100% of their own food and 80–100% of technology. Given the lack of village organization, chiefly farms worked in its place as co-ordinating nodes for these communities that ensured both local and regional production, exchange, and distribution of complex technology such as working tools of bronze or stone or precious objects of flint, bronze, or amber.

A specific form of flint dagger was produced in Jutland that became widely distributed in Scandinavia but also other regions in Northern Europe. Some 80 of these daggers have been recorded in Tanum (Apel 2001; Ling et al. 2018) and recent research in Thy recovered raw amber collected for export (Earle 2018). Bronzes also constituted an important product for exchange both as functional tools for local demands and swords and other precious objects for regional and transregional trade (Melheim et al. 2018). Moreover, by provisioning animals and grain for specialized labourers and feasts for ordinary farmsteads, a chiefly farm could have crafted a microregional dependency of farms with supporting warriors and could that in turn could have financed boatbuilding and long distance exchange of metals (Ling et al. 2022).

## Tanum as exemplifying a co-operative region based on the maritime sector

More co-operative communities located in sea-based coastal communities, such as Tanum in the region of northern Bohuslän in west Sweden, lacked the wealth producing potential that was present in the agropastoralist communities and were forced instead to resort to a more diverse economy which included some agropastoralism along with fishing, hunting, and timber extraction (Ling et al. 2018). Tanum is singularly distinctive for the highest concentration of Bronze Age rock art in Europe. Nearly 2000 boat images have been documented there.

Deforested early in the Bronze Age, the area of Tanum likely served for agropastoralism but also for timber production for boats. In fact, the Tanum region shows both indirect and direct evidence of timber production and boatbuilding, making it one of the most ideal regions for export of boats and timber in the Bronze Age (Ling et al. 2018). During this period, we suggest that perhaps fewer than one household per 2 km$^2$ existed here, with a tentative population density of less than 4–6 per km$^2$. The ordinary farmstead was somewhat smaller than in Thy and comprised about 12–15 m in length. Still, we argue that each ordinary farmstead produced about 60–80% of its food, and about 30–50% of its technology (pottery and stone tools such as hammers). The foodstuff consisted of 60–80% of agropastoral products, fish comprised up to 30–40%, and the rest of wild game (Ling et al. 2018; Kristiansen et al. 2020).

In contrast to Thy, marine resources were far more essential in Tanum for local houshold self-sufficiency, as demonstrated by cultural layers containing fish bones and hooks, as well as fishing scenes on rock art (Ling 2014). The importance of boats for these communities was probably as distinctive as that seen in the Haida Culture of the Canadian Pacific, where they were used for trade, warfare, long distance exchange, fishing, and hunting (Ling et al. 2021). As a result, a significant number of households in these communites were involved in boat construction.

Boatbuilding was complicated, involving collective labour and logistics to exploit remote woodland appropriate for boats. Experimental archaeology has shown that Bronze Age plank-built canoes of about 20 m length would have required about 6500 man-hours to build (Ling et al. 2018). Finance for boatbuilding likely came from local chiefs, who then owned the boats. In order to supply groups for boatbuilding and for long distance raiding and trading, labour had to be transferred from fieldwork to the maritime sector. As described by historical documents in the Viking Age, slaves apparently filled farm labour gaps and there is much in favour of the suggestion that similar actions took place in Tanum during the Bronze Age. Large chiefly farmsteads, such as those in Thy, have not yet been recorded in Tanum; but the presence of large cairns, precious bronzes, and rock art, as well as the strong evidence of regional and transregional interaction and exchange, indicate that they must have existed in the area. An important difference at Tanum when compared to the Thy region is that flint did not exist as a natural source. Despite this, flint tools such as sickles, scrapers, and daggers, were among the most common type of tools attested at the farmsteads which means that flint had to be traded in from areas such as Thy. Bronze tools and weapons were also imported from Thy (see below).

## Evidence of reciprocity between the regions of Thy and Tanum in the Bronze Age

The following findings point to interaction between the more land-based region of Thy and the more sea-based region of Tanum. Both the flint daggers and bronzes recovered in Tanum were produced and imported from the Thy region (Ling et al. 2018). The high number of bronzes found in the Thy area, as well as their shared metal signatures with the ones in Tanum, indicates that this region served as the major transit zone for the distribution of metal to west Sweden during the Bronze Age (Ling et al. 2019). But what could possibly have been traded in the opposite direction?

We posit that during this time period, aggrandizing agropastoral households from the Thy region established a trade in timber and possibly in boats with the timber-rich region of Tanum in western Sweden (Ling et al. 2022). For example, pollen analysis of samples from western Jutland dating to after 1500 BC show evidence of rapid deforestation resulting from the expansion of local agropastoral activities (Bech et al. 2018). This situation resulted in an increased demand for timber that would have been used in the construction of boats and long-houses (Ling et al. 2018). In fact, there is evidence indicating that groups in Thy used driftwood for their long-houses because of the shortage of timber (Bech et al. 2018).

But why should the Thy region trade timber with the Tanum? In fact, Tanum could potentially have been one of the regions that provided Thy with timber and boats, when their forests were depleted by 1300 BC. The earliest written evidence from the 12th century AD indicates that northern Bohuslän traded timber and boats with Jutland in exchange for agropastoral products (Ling et al. 2022). The Tanum region was also deforested from around 1600 BC, and some of this deforestation may have been caused by timber trade with the Thy region. In fact, the Tanum region shows both indirect and direct evidence of timber production and boatbuilding, making it one of the most ideal regions for exporting boats and timber to the Thy region in the Bronze Age. First, the Tanum area has the largest concentration of depictions of Bronze Age boats in all of Europe: 10,000 in total. Secondly, the Tanum area has the highest concentration along the west coast of Sweden of shaft-hole axes of stone and bronze as well of stone hammers presumably used for timber construction and boatbuilding (Austvoll 2018). Thirdly, statistical analysis shows a correlation between tools for boatbuilding with the presence of rock art boats, near ancient seaways and/or rivers in the Tanum area (Ling et al. 2024). Other more concrete evidence of shipbuilding includes fire-cracked stones from seaside pits. Analyses of the wood found in these Bronze Age shoreline pits show that the types of wood are the same as were used in the construction of prehistoric boats (Petersson 2009). Moreover, ethnographic studies document the use of fire-heated stones for the steaming of wood to be used in boatbuilding, particularly for the keel and the side portions of traditional watercraft (Ling et al. 2024).

If local Tanum people were involved in the building and manning of boats, then we must consider their compensation. Chieftains from Thy could have provided special foods (like meat) and drink for the feasts and gifts such as bronzes, cattle hides, and flint from Thy. We assume that the households in the aggrandizing Thy area used their agropastoral surplus for competitive feasts that distributed gifts in the form of metals for gifts and therefore, exercised influence over the more cooperative Tanum region (Ling et al. 2022). Thus, the development of a political economy based on flows of wealth between these regions (such as bronze from Thy and boats from Tanum) created the interdependence of regional chiefs and their network of supporters.

## Summary

With the use of two case studies, I have tried to exemplify self-sufficiency In Bronze Age Scandinavia at three levels: the local household, the community, and the regional polity. Environmental benefits, freedom of mobility, resource ownership, and transportation technology are all important factors in determining comparative advantages between these regions, communities, and chiefly households. I hope that this chapter can stimulate cross-cultural comparisons in the light of the theme of self-sufficiency at the mentioned level. I hold that it is important to make cross-cultural comparisons in order to show variation in subsistence and political economies and thereby be able to model and discuss different distinctive economic formations cross-culturally, despite ongoing debates on how and why cross-cultural comparisons should be made (Reybrouck 2000; Altschul et al. 2018; Hayden 2018).

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6

# The origins of secret societies and their contribution to the rise of social complexity

*Richard Chacon, David Dye, Brian Hayden, Johan Ling, & Yamilette Chacon*

*Cross-culturally, shamans are believed to have the capacity to supernaturally cure and cause sickness. For this reason, shamans are both universally admired and feared. When a person dies, or when a shaman's patient fails to recover, shamans are often accused of practising sorcery on a targeted individual. In turn, shamans were/are sometimes killed as a result of such accusations. We propose that such transegalitarian cultural contexts, in which surpluses were produced and competition over wealth and power increased, exacerbated accusations against shamans who might stand to benefit from individual misfortunes or recoveries. Under these conditions, to protect themselves from being physically attacked, ritual specialists formed sodalities, which offered mutual aid and protection to their members. In this sense, such shamanic defence alliances formed the basis of secret societies. In addition to providing shamans with protection, ritual sodalities typically claim privileged access to the ancestors, other-than-human beings, or other supernatural beings. The leaders of secret societies often charge fellow villagers exorbitant fees in exchange for various services, including memberships that confer access to coveted esoteric knowledge of the supernatural world and the secrets of healing and dramatic legerdemain. Thus, ritual sodalities serve as culturally sanctioned mechanisms for extracting wealth and funneling surpluses from villagers. We suggest that over time, the wealth, status, and power of aggrandizing secret society leaders grew vis-à-vis fellow transegalitarian villagers resulting in some of the first steps towards the rise of social complexity. In sum, we propose that similar practices of aggrandizement, along with the adoption of similar protection measures, were employed in the distant past by leaders of transegalitarian societies, such as those operating in Scandinavian polities during the Bronze Age.*

## Introduction

Given the apparent importance of secret societies in explaining many of the dynamic political and social changes over the last 30,000 years (Hayden 2018), the origins of secret societies acquire considerably more theoretical relevance than describing simple culture area traits or historical trajectories as was popular in the mid-20th century. In *The Power of Ritual in Prehistory: Secret Societies and Origins of Social Complexity*, Hayden (2018) provides a brief discussion on the origins of ritual sodalities. Suggestions in the earlier literature range from secret societies as outgrowths of tribal initiations (Loeb 1929; 1933); as developments from warfare (Boas 1897; Wissler 1916a; 1916b; Ernst 1952; Anisimov 1963); as transformations from bands of elders (McIlwraith 1948b); and as elaborations of shamanism (Wissler 1916a; Bean & Vane 1978). These suggestions were all relatively speculative, lacked any clear way of demonstrating the likelihood of one model over another except by noting similarities of traits, and left unexplained why such developments toward secret societies should have taken place. We contend that the formation of secret societies greatly facilitated the rise of social complexity in the ancient world because it provided leaders of transegalitarian societies – including Scandinavian Bronze Age polities – with culturally sanctioned pathways for extracting surpluses from fellow villagers. Transegalitarian societies are neither egalitarian (with widespread sharing and little private control over resources), nor stratified societies (with hereditary rights to ownership of resources, wealth, and social positions). They do exhibit ownership over resources with resulting inequalities in wealth and power, but these positions are individually achieved and not hereditary or class-based and are generally limited to village level influences, rather than regional polities (Hayden 2014). Examples include many ethnographic tribal communities, Neolithic communities, and Iberian Bronze and Iron Age communities (e.g., Garrido-Pena 2006), as well as many similar Scandinavian communities.

We would like to advance the discussion of secret society origins by adding some new ethnographic observations to the mix of ideas and by suggesting a plausible driving force that could explain the relatively common development of secret societies in transegalitarian societies around the globe. Although secret societies may have had several different origins in different places, we find the origin model that posits secret societies emerging from shamanistic practices especially compelling. In particular, we propose an underlying reason for the creation of ritual sodalities in which shamanism became a high risk practice, especially when it became lucrative and promoted social inequality. Shamans in transegalitarian societies were often highly competitive and hence typically worked as solitaries (Anisimov 1963; Stépanoff 2019). However, we are suggesting that as material benefits increased for shamans, so too did risks, leading some individual practitioners to seek protection from bodily harm by forming secret societies or shamanic sodalities that functioned as mutual aid/protection societies. This situation, we contend, created a powerful dynamic that led to ritual sodalities playing key roles in the rise of social complexity cross-culturally.

Drucker (1941), Wissler (1916a), along with Garfield and Wingert (1977) were some of the early proponents of the view that shamans were keys to understanding the advent of secret societies. Following this line of thought, Chacon et al. (2020), Dye (2020; 2021), and Hayden (2018), further documented the antiquity, pervasiveness, and importance of ritual sodalities cross-culturally and noted the many similarities between shamanism – if not the explicit identification with shamanism – and secret societies. Of note, while the term ‘ritual sodality’ may encompass other types of ritual organizations besides secret societies, the term is often used interchangeably with ‘secret societies.’ We will begin by noting a major distinction in the organization of shamans and then we will examine the role and social position of shamans in transegalitarian contexts.

## Non-hierarchical vs hierarchical shamans

The distinction between non-hierarchical versus hierarchical shamanic practices has been poorly addressed up to the present, yet it is a critical element in considering the roles of shamans and social complexity. In his comparative analysis of Siberian shamanism, Charles Stépanoff (2019) is probably the most articulate in this respect. Stépanoff distinguishes between two fundamentally different kinds of shamanism: 1) *non-hierarchically organized shamans*, as reflected in the practice of ‘dark tent’ (aka ‘shaking tent’) rituals; and 2) *hierarchically organized shamans* as represented by ‘light tent’ ritual performances. These hierarchically organized shamans generally corresponded to hierarchical or even stratified social organizations (typical of the herding societies that entered Siberia about 1000 years ago), versus older Siberian hunting societies that were much more egalitarian, but nevertheless had some non-egalitarian traits like slavery or other characteristics (Stépanoff 2019).

## Non-hierarchical Dark Tent shamans

Contrary to most depictions of shamans, the societies in which shamans conducted Dark Tent rituals did not involve a shaman’s voyage into supernatural realms in order to cure the sick, but rather focused on shamans’ ability to bring supernatural entities into the performance tent and to communicate with them, especially as it concerned forest animals and spirits (Stépanoff 2019, 91–5). In the Dark Tent, a lone shaman transmitted to his public some ideas about relations with animals and the master of animals or supernatural gamekeeper.[1] Individuals used their own imaginations to visualize or to interact with the spirits in total darkness. The spirits unpredictably could intrude upon anyone at any time and often entered into discussions with various individuals. Shamans were identified by their natural abilities and predilections for contacting supernatural forces and there was no investiture ceremony or excessive costs for becoming a shaman (Stépanoff 2019, 118, 401). These were societies primarily pre-occupied with survival by hunting in Boreal regions. Shamans engaged in subsistence work like everyone else (Stépanoff 2019, 386). They operated in *relatively* egalitarian societies often with heterarchical social organizations, and Stépanoff suggests that the Dark Tent ritual may represent part of an ancient cultural substratum among the Paleo-Asian language groups of Siberia, a cultural substratum that also extended into the North American Boreal regions (Stépanoff 2019, 100, 111–14, 120, 159).

## Hierarchical, Light Tent shamans

It is the Light Tent shamanic rituals that epitomize most descriptions of Siberian shamanism. In contrast to the Dark Tent, the Light Tent was a one-person theatrical performance replete with elaborate regalia, sound effects, dances, and a story. The story was highly scripted, usually involving a cosmic journey out to do battle with malevolent spirits in their realms (in contrast to the spirits coming to the Dark Tent to meet individuals). The chants and cosmologies of shamans in Light Tents were learned by rote. The shaman was the intermediary between spirits and people (rather than the spirits interacting directly with people in the Dark Tent ritual). While the Dark Tent ritual was *relatively* more egalitarian, the Light Tent ritual was more clearly hierarchical.

Shamans directed all aspects of ritual life while the attendees at the rituals played relatively passive roles as observers, almost like television audiences (Stépanoff 2019, 116–20, 176–7). The Light Tent rituals and shamans were largely used by Altaic linguistic groups which expanded into Siberia about 1000 ago (Stépanoff 2019, 124), apparently from pastoral origins which usually exhibited substantial levels of hierarchical socio-economic and political organization.

In the past, before Russian authorities eliminated clan leaderships, most groups with hierarchical shamans had considerable wealth, rich compared to poor families, a hereditary clan-based aristocracy, and had slaves. Shamans were not only appointed by clan leaders and defended the interests of clan aristocrats, but they sometimes even served as both clan shaman and clan head (Anisimov 1963, 119, 122). These stratified societies also tended to have costly brideprices, the Kirghiz paying up to 1000 cattle for a presumably elite bride in the 9th century (Stépanoff 2019, 184, 197, 406). While most authors attribute these hierarchical developments to the economics of herding animals, the role of the fur trade and metals in creating wealth and social complexity also needs to be considered as a major force (see Hayden 2021, 44–5). It is even noted that one of the main gifts to Evenk shamans were 'valuable furs' (Anisimov 1963, 122). In societies with the Light Tent rituals, shamans became indispensable for family and community rituals, and they were paid handsomely for all services to the extent that they did little subsistence work (Stépanoff 2019, 385–6, 393). According to the ideological claims that shamans promulgated, they had exclusive access to the spirit world with up to nine ranks of access, each with its own costly paraphernalia and feasts, the highest rank being extreme in this respect (Anisimov 1963, 119; Stépanoff 2019, 389–91). These latter costs were described as 'demented ostentatious expenditures' by the Russians (Stépanoff 2019, 389). Interaction with the spirit world was portrayed as dangerous, leading to madness or death for the uninitiated. Attempts to contact spirits, or even touching a shaman's drum could result in madness, sickness, or death (Anisimov 1963, 116; Stépanoff 2019, 132–3, 137–8). This is remarkably similar to the claims of Californian secret societies in which ordinary people could die from touching the sacred cape of the head of a secret society (Kroeber 1932, 328). Thus, hierarchical shamans had exclusive access to spirits, ritual equipment, and high level socio-political connections while ordinary people were dependent on shamans, almost as in caste system ideologies that threatened intrusions into sacred realms with danger or death (Anisimov 1963, 117).

Of critical importance for the discussions that follow, shamans using the Light Tent ritual acquired their status and roles via inheritance (from previous shamans in their family) rather than on the basis of individual abilities. They underwent apprenticeships culminating in costly initiation feasts involving rich costumes or regalia weighing up to 40 kg, as well as acquisition of equipment like their costly drums. Thus, only wealthy families were able to train their children to become shamans (Anisimov 1963; Stépanoff 2019, 386). In fact, the elaborateness of the shaman's regalia was used to evaluate clan prosperity (Stépanoff 2019, 389–91). These shamans were flamboyant and were strongly represented in most of the hierarchical Siberian groups. In many respects, they were like a priesthood, except that there was no organizational structure since all Siberian shamans were rivals and tended to work as solitaries (Anisimov 1963, 120; Stépanoff 139–41, 177). Furthermore, in groups like the Evenk, some shamans did no curing and were even skeptical about the supernatural; rather, they treated shamanism as a priest-like ceremonial role that could bring them social and material benefits (Anisimov 1963, 115, 119, 120–1). In contrast, Dark Tent shamans had no special regalia, masks, or drums (each family could possess a drum). And anyone with a penchant for the supernatural could try to play the role of a shaman or interact with the supernatural without any need for large expenditures, an ancestral source, or fear of danger from spirits (Stépanoff 2019, 141–4, 151, 155).

In the Amazon, Hugh-Jones (1994) noted a similar distinction to the hierarchical vs non-hierarchical types of shamans which he referred to as 'Vertical' (hierarchical) vs 'Horizontal' (heterarchical) shamans. A similar distinction might also be made in North America between the Boreal, 'Shaking Tent' (Dark Tent) shamanic practices as were common among Athapaskan and Algonkian groups, versus the more hierarchical shamanic practices of the more complex hunter-gatherer societies of California and the Northwest Coast. Thus, the powerful role of the shaman seems to be part of a cultural complex that emerged with the development of societies with transegalitarian or even stratified socio-economic characteristics. Since we propose that secret societies emerged from shamanic contexts that conveyed major material advantages to practitioners (as typifies transegalitarian societies), our discussions of shamanic roles and risks pertain almost entirely to the more hierarchical (Light Tent) types of shamanism, except where noted otherwise.

In fact, there are many commonalities between the hierarchical Siberian shamans and secret societies that make the origin of the latter seem like a very easy transition from the former, perhaps two variants of the same basic underlying dynamics. The common traits of both hierarchical shamans and secret society memberships often include:

- costly initiation feasts which only wealthy families could afford (hence the predominant occurrences in societies that produced surpluses);
- the employment of costly ritual paraphernalia, including drums, rattles, and symbolic weaponry;
- lucrative recompense for all services;
- ranking of statuses with increasing costs for rising in ranks;
- membership exclusive to high status individuals from high ranking corporate groups;

- close association, or overlapping membership, with the major power brokers in communities;
- feuding and rivalry between members or shamans (as is to be expected when material benefits are substantial);
- claims of protecting or benefitting their respective social groups;
- the claimed exclusive access to supernatural forces and the dangerousness of those forces for the uninitiated who lacked adequate training;
- claims of esoteric knowledge and rules concerning secrecy;
- public performances featuring 'virtuosity trickery' and 'mystical charlatanism' (Anisimov 1963, 121) based on dramatic legerdemain theatrics to demonstrate connections to supernatural powers;
- elaborate costuming, paraphernalia, and regalia;
- the use of masks;
- a profusion of iconography and art used to manifest spirit ideology resulting in great art traditions (vs its minimal use in Dark Tent contexts: Stépanoff 2019, 423–5); and
- the occurrence as part of transegalitarian or stratified cultural constellations including significant bride prices and socio-economic inequalities (compare Stépanoff 2019, 386–93 and Hayden 2018).

We now turn to the examination of the role and social position of shamans.

## Shamans as healers

Among Native Americans, shamans were responsible for curing supernaturally caused illnesses (Garbarino 1976). For example, among Great Basin and South-western groups, shamans were believed to heal 'the sick and could appeal to the spirit world on behalf of the people' (Garbarino 1976, 206). Similarly, 'Choctaw doctors [shamans] heal the sick by conjuring their (personal) spirit to ascertain if the sick person will get well' (Dye 2023, 62). Along these lines, Amazonian shamans 'manipulate the spirit world; cure the sick with magic … diagnose illness and prescribe a magical remedy; and generally intercede between humans and spirits in the context of health versus sickness …' (Chagnon 2013, 119). 'Shamans performed these cures … by chanting, drumming, dancing, tobacco smoking, and the like …' (Garbarino 1976, 377). Among the Amazonian Shuar (formerly Jivaro), the principal role of a shaman was 'that of a curing doctor' (Stirling 1938, 117). In large parts of North and South America, shamans often cure the sick by way of ritual chanting and ingesting hallucinogens (Garbarino 1976; Harner 1984; Chagnon 2013).

## Status, wealth, and fear of shamans

On the positive side, their ability to interact with the spirit world and bring benefits to communities such as healing, meant that shamans were/are often treated with respect, if not fear (Stirling 1938; McIlwraith 1948a; Garbarino 1976; Harner 1984; Descola 1996a) For example, among California Indians, '[t]he shaman was often the most powerful and respected person in the community' (Garbarino 1976, 173). Among the Bella Coola (Nuxalt), a shaman 'is said to be able to recall a spirit that has left its body, and thus caused illness … It is believed … that shamans can see the position of a person's tally post, and so judge the length of his life' (McIlwraith 1948a, 573). Bella Coola shamans were also believed 'to obtain the power either from the visitation of a ghost [spirit] in this world, or by a journey to the lands of shades below … shamans alone are able to lift the barrier and discourse with the ghosts of those who have departed … Shamans can learn what the dead require and so transmit the knowledge to the relatives of the deceased' (McIlwraith 1948a, 577). However, shamans were also greatly feared because they could inflict sickness and death on people (Hayden 2018, 96, 104). In addition to the deference they enjoyed, shamans often charged fees for conducting ritual activities (Stirling 1938; Kroeber 1976; Harner 1984; Descola 1996a; Dye 2023). Among the Amazonian Shuar (formerly Jivaro), shamans were believed to 'have the power to send sickness into people as well as the power of calling it forth, a fact which makes the *wishinu* [shaman] the most feared and the most respected member of his tribe' (Stirling 1938, 117). As Garbarino (1976, 151) summarizes it, '[b]eing able to contact the spirit world was a means of raising one's status and increasing prestige and wealth, for clients paid for shamans' services' (see also Eliade 1964; Rogers 1982; Hayden 2018).

Payments to shamans ranged from tobacco among the Anishinaabe (Ojibwa) (Ritzenthaler 1963), to freshly killed deer among the Miwok (Powers 1877), and even enslaved people among the Haida (Corlett 1935). In effect, among the Blackfoot, '[s]hamans or medicine men often became wealthy by charging high fees for successful cures' (Garbarino 1976, 269). Likewise, among the Yurok, 'successful healers were respected and commanded high fees for curing …' (Garbarino 1976, 178). In fact, being a ritual specialist among the Yurok was so lucrative that shamans frequently urged their 'relatives to try to acquire "pains" – shamanic powers – because wealth was easily got thereby' (Kroeber 1976, 35). Moreover, Native American ritual specialists today continue to receive payments from their clients. In 2012, the US Internal Revenue Service declared that the 'payments a tribe makes to an Indian medicine man to use traditional practices to treat a tribal member's disease are not included as income by the tribal member receiving the treatment' (Friedman 2012).

Among the Siberian Evenk, shamans were given the best foods at events, they sat at the side of the clan head, their reindeer were pastured and brought back again, they were allocated the most productive areas to use (e.g., fishing sites), fish dams were made for them, ritual tents were constructed for them, they received up to four reindeer for performance sponsors, they were given food, and often gifts – most notably 'valuable furs' (Anisimov 1963, 99, 121–2).

Among the Amazonian Shuar, apprentices seeking to become shamans found it necessary to pay their tutors 'a high price' (Stirling 1938, 117). Presently, among the Amazonian Achuar (Shiwiar), shamans remove invisible blowgun darts called *tsentsak* (believed to cause sickness) from the bodies of their patients and for this, they gain 'both riches and respect' (Descola 1996a, 280). In one instance, 'a reputed [Achuar] shaman who had done a healing session to restore a hunter's "wind" did not hesitate to demand a feather crown, *tawaspa* [*tawasamba*], in payment for his services. This prestigious ornament – which he was indeed given – is an Achuar's most valuable possession, and its exchange value far exceeds that of a shotgun' (Descola 1996b, 259–60).

Additionally, among the Amazonian Shuar, the ability to demand payment for curing activities has spurred some individuals to become shamans. 'Informants uniformly ascribe this trend to the desire of [Shuar] individuals to acquire "white men's valuables," especially machetes and firearms …This development has been facilitated by the fact that the shamans can successfully accumulate goods because of the layman's fear of asking them for gifts' (Harner 1984, 201).

Richard Chacon further documented how shamans extract wealth/surplus from fellow villagers among the blowgun hunting Achuar of Ecuador. In February of 1996, a young girl in the village developed a very high and prolonged fever. To obtain a cure, the father took his sick child to no fewer than 11 different shamans for treatment (Table 6.1). The expenditures listed in Table 6.1 were tabulated in May of 1996.[2] While $211 dollars as total payment may not seem too costly from a contemporary Western perspective, one must keep in mind that the father in question was a subsistence blowgun hunter (i.e., he did not hold a cash-paying job).[3] Hence, these expenditures constituted an extremely heavy financial burden on the Achuar father and his family.[4]

*Table 6.1. Payments made to 11 shamans from February–May, 1996.*

| *Shaman* | *Payment* | *$ USD* |
|---|---|---|
| Domingo Carrera | 1 blowgun (worth 100,000 Sucres) and 10,000 Sucres | 35 |
| Eladio | 1 muzzle loading shotgun (worth 250,000 Sucres) | 79 |
| Seveto | 5,000 Sucres | 2 |
| Cervantio | 15,000 Sucres | 5 |
| Ventura | 10,000 Sucres | 3 |
| Otoniel | 1 *tawasamba* (feather crown worth 100,000 Sucres) | 32 |
| Aguasanta | 30,000 Sucres | 9 |
| Unzakwa | 30,000 Sucres | 9 |
| Balti | 5,000 Sucres | 2 |
| Francisco | 1 blowgun (worth 100,000 Sucres) | 32 |
| Aragon | 1 chicken (worth 10,000 Sucres) | 3 |
| Total | | $211 |

## Shamans as malevolent ritual specialists/ sorcerers/witches

In contrast to the beneficent aspect of shamans, there is also a darker side (Whitehead 2002). According to Kroeber (1976), Native American shamanic power is considered as being both beneficent and malevolent. 'Whether a given shaman causes death or prevents it is merely a matter of his inclination. His power is equal in both directions … Witchcraft and the power of doctors [shamans] are therefore indissolubly bound up together' (Kroeber 1976, 853). Thus, a shaman 'who has the power to heal also has the power to destroy and that power to destroy could be deployed by a prophet as well as a witch' (Dye 2023, 65). Thus, in the Americas, as elsewhere, many Native American groups believed that certain ritual practitioners engaged in sorcery/witchcraft designed to cause sickness in their intended victims (Walker 1971; 1989; Garbarino 1976; Kroeber 1976; Dye 2021; 2023), and, indeed, they were often employed to kill enemies. For example, the Choctaw traditional belief system attributes misfortune/illness to the actions of a *hopaii* or witch (O'Brien 2002; Dye 2023). Consequently, since a shaman was thought to have close ties to the spirit world, 'he could use those ties to cause good or harm. He was both respected and feared' (Garbarino 1976, 99). As Shimony (1961, 267) notes, a basic maxim for the Iroquois is 'whoever is close to Indian medicine is close to witchcraft'.

Similarly, some Algonkian shamans were believed to be 'practitioners of evil because they had … power; shamans were respected, but they were often feared as well' (Garbarino 1976, 311). Additionally, California Indians 'believed shamans could control weather and cure disease, and often feared as well as respected them: the shamans' contact with the supernatural made them dangerous as well as powerful' (Garbarino 1976, 173). Along this line, in the mid-1950s, Navajo elders determined that sorcerers had caused a flu epidemic by tapping into the perceived inherent power of local prehistoric rock art. Specifically, two anthropomorphic figures appearing on a specific panel located near their reservation were suspected of being used by sorcerers to spread illness. Therefore, to neutralize the threat, the rock art figures in question were destroyed by chiselling (Schaafsma 2013). As with individual shamans, in many instances, ritual sodality leaders also claimed to have the power over life and death (McIlwraith 1948a; 1948b; Hayden 2018).

In many cases, it was believed that the purpose for shamans causing sickness among community members was so that the shamans could exact high prices for the resultant cures (Hayden 2018). As just one example among many others, it was believed that Yurok shamans 'themselves make people sick in order to earn fees' (Kroeber 1976, 67). It was also held that when Yurok ritual specialists were called to treat a patient, shamans would often 'leave at least one pain in him [the patient], that after this has grown they may be summoned with another fee' (Kroeber 1976, 67). Furthermore, '[w]itchcraft practices had deep roots in Mississippian social logic and have continued in descendant communities to the present day' (Dye 2021, 152).

Present-day researchers conducting ethnographic fieldwork in Amazonia report that many traditional tribal groups believe certain shamans are involved in malevolent ritual practices which produce sickness in targeted individuals (Harner 1984; Chagnon 1992; 2013; Descola 1996a; 1996b; Chacon 2007). Among the Amazonian Yanomamö, disease and deaths are attributed to harmful magic conducted by sorcerers (Chagnon 1992). Among the Achuar, 'shamans are credited with being able to kill from a distance' (Descola 1996b, 10). In general, the ethnographic record shows that throughout the Americas, shamans were/are commonly blamed for outbreaks of disease and/or deaths (Swanton 1918; 1932; Stirling 1938; Walker 1971; 1989; Garbarino 1976; Kroeber 1976; Harner 1984; Chagnon 1992; 2013; Descola 1996a; 1996b; Chacon 2007; Dye 2021; 2023).

## Hazards of being a shaman

Given that shamans were widely credited with the ability to cure and the ability to kill, it was only logical that they could be blamed for the deaths of their patients and that sometimes, 'shamans were killed when a patient failed to recover' (Garbarino 1976, 378). Among the Shasta, particularly unsuccessful shamans were killed (Kroeber 1976) while a chronically unsuccessful shaman among the central and southern California Indians 'was thought to be giving prima facie evidence of evil intent and earnest attempts to kill him almost invariably followed' (Kroeber 1976, 853). For this reason, shamans 'have much to fear when they undertake the case of a sick person who is a chief, for if he dies after they have conjured, the doctor's relatives say that he has bewitched the patient, and if the doctor escapes after he has been condemned to death, they say that he had bewitched him and that fate has erred; so in all ways he runs the risk of being killed' (Swanton 1918, 61–2; see also Swanton 1932). Similarly, '[t]he Mohave are astoundingly frank in telling how they kill their doctors or shamans and some of the latter reciprocate with unforced declarations of the harm they have done' (Kroeber 1976, 778).

Puebloan peoples of the American South-west believed that witches/sorcerers live off the souls of the living and that '[w]itches are the primary cause of serious illness and death' (Darling 1998, 738). Consequently, Puebloans were known to torture and kill sorcerers. 'The method of execution is typically clubbing and occasional stoning … In some instances it is apparent that the individual expires from the prolonged torture and bludgeoning as part of the interrogation' (Darling 1998, 742). Among the Puebloan Zuni, in the late 1800s, out of 24 people who were accused of being witches, 14 were executed with two individuals being stoned to death (Darling 1998, 741–2).

There is evidence supporting the idea that the Cherokee destroyed a hereditary, secretive, priestly group prior to the first half of the 18th century (Lankford 2008, 14–16). This group called themselves Anikanos and because of 'their wickedness, however, the people rose up and put them all to death' (Fogelson 1984, 257). In a similar vein, the Muskogee, during the Creek War of 1814, assassinated five traditional shamans, because they represented 'the highly feared class of spiritual beings known as water cannibals, dangerous killer beings that resided on the bottom of rivers and ate their human victims' (Martin 1991, 127).

The slaying of perceived sorcerers continued into the modern era. In 1901, a Choctaw individual named Solomon E. Hotema was charged and subsequently convicted on three counts of murder in a US district court. According to Dye (2021, 131), '[a] rash of sudden deaths in 1898 and 1899, resulting from an outbreak of meningitis, greatly alarmed the Choctaw community, including Hotema, whose only son, Jonah, had died in the spring of 1899'. In an effort to identify the individuals responsible for this outbreak, Hotema consulted a Choctaw ritual specialist 'known for his ability to root out and incriminate witches' (Dye 2021, 132). Once the perpetrating sorcerers were identified by this trusted 'medicine man', Hotema armed himself with a Winchester shotgun and recruited two accomplices who helped him track down and kill the three individuals believed to be responsible for the outbreak.

## Killing of Amazonian shamans

In Amazonia, shamans believed to be responsible for outbreaks of disease and/or deaths are similarly targeted for killing (Descola 1996a; 1996b; Chacon 2007).[5] Among the Amazonian Shuar '[i]n time of war an attacking party always attempts to kill the shaman … of their enemies as early in the fight as possible, so as to free themselves from possible injury by the spirits he controls' (Stirling 1938, 115). In the early 1960s, an Achuar shaman living along the Pastaza River was believed to be the cause of illness in the region. Consequently, he was encircled by villagers and beaten to death with wooden stools (Pita Kelekna, pers. comm. to R. Chacon, 2019). Descola reports that an Achuar man killed a shaman who was believed to have been 'responsible for various afflictions that had recently struck his group' (1996a, 281).

In the mid-1980s, an Achuar shaman was believed to be responsible for an outbreak of sickness in the region. Convinced that this particular shaman was conducting sorcery, two Achuar warriors killed him. The killing of this shaman was considered by many villagers to be a legitimate act of 'self-defence' on the part of the two warriors (Chacon 2007).

In 1996, an Achuar shaman was blamed for the sudden death of a seemingly healthy young woman, and he was subsequently killed. In this same year, an unidentified individual was caught in the act of stalking an Achuar shaman. This unidentified man likely had the intention of killing the shaman in question (Chacon 2007).

In 2005, an outbreak of paralytic rabies occurred in a particular Lowland Kichwa village and this resulted in the deaths of seven individuals. Villagers concluded that a local shaman was responsible for the tragedy and so they bound, tortured, and killed him, and proceeded to mutilate his body before throwing his corpse into a local river (Chacon 2007, 527).

Over the course of his fieldwork, Richard Chacon was made aware of a particular Achuar shaman who was targeted for killing. This shaman was ambushed and he suffered a shotgun blast to the hand. As a result of this attack, the wounded shaman fled deep into the jungle for safety. The Achuar claim there is no way to get at this shaman him because he is believed to be 'supernaturally protected' by a wall of energy. R. Chacon was also informed of an Achuar shaman who was stoned to death because it was believed that this shaman was responsible for supernaturally causing the deaths of many villagers. The shaman's body was never recovered because, reportedly, it was chopped into small pieces and thrown into a local river. Moreover, when Amazonian Waorani children died of sickness, 'their kin sought revenge by attempting to kill the entire family of the suspected shaman. This was in part to prevent the possibility of counter attacks' (High 2012, 138–9).

## Killing of sorcerers as justifiable homicide

For many Native American groups, the killing of perceived malevolent shamans or witches/sorcerers was part of a 'deeply embedded cultural ethos in which the prevailing social logic both sanctioned witchcraft [sorcery] accusations and called for identifying, pursuing, and subsequently murdering those suspected of engaging in witchcraft practices' (Dye 2021, 133). Thus, among the Shasta, '[t]he repeatedly unsuccessful shaman met the usual fate: a *justified violent death*' (Kroeber 1976, 303, emphasis added). Likewise, among the Achuar, '[t]he murder of a shaman reputed to be a sorcerer is considered legitimate by just about everybody – including his closest relatives, who fatalistically accept that this is more or less the destiny to be expected by anyone in the dangerous profession' (Descola 1996a, 347). While conducting interviews among the Achuar, R. Chacon repeatedly recorded the fulsome approval, on the part of villagers, of all attempts to kill individuals suspected of engaging in sorcery. In fact, Achuar men who have killed shamans suspected of being sorcerers enjoy elevated social status (Chacon 2007). We contend that ritual specialists in Scandinavia operating during the Bronze Age likely faced similar reprisals for similar reasons.

Additionally, the killing of shamans seems to increase during times of stress brought about by epidemics, deaths, conflicts, and/or famines. For example, Chacon reports that 'in 1997 three [Amazonian] shamans believed to have been responsible for an outbreak of disease in the [Achuar] region were reportedly killed over a three month period' (Chacon 2007, 526). As previously mentioned, the killing of an Amazonian shaman took place in 2005. In July of this year, villagers concluded that a shaman from a neighboring community was responsible for a local outbreak of paralytic rabies and so they proceeded to execute this medicine man (Chacon 2007, 526–7).

## Seeking safety in ritual sodalities: the birth of secret societies

The ethnographic record reveals that a lone shaman operating in a transegalitarian setting can extract wealth and surpluses from fellow villagers in exchange for services. However, the ethnographic record also reveals that a lone shaman may readily be killed if he/she is suspected of engaging in sorcery. This reality plausibly motivated shamans to increase their chances of survival by seeking out and forming 'mutual aid/protection' alliances with other ritual specialists residing nearby. The effectiveness of such pacts could have been bolstered by its members publicly proclaiming that they were now part of a shamanic alliance/brotherhood whose members claimed to enjoy privileged access to supernatural powers by way esoteric ritual knowledge which they publicly displayed in putative displays of supernatural power. The effectiveness of this defence alliance would have increased with their prohibitions against any intrusion into the organization's affairs, their sanctions against any questioning of the organization's operations or demands for support, and their establishment of close relationships with powerful political people in communities. Any attack on a member would have been met with rapid and effective retaliation by all.[6] With such an agreement and organization, shamans would have transformed themselves from being extremely vulnerable ritual specialists operating in isolation into to a tight-knit shamanic secret society that not only claimed access to supernatural powers but that also diligently protected its members through exclusivity and secretiveness. We argue that ritual practitioners in Scandinavia during the Bronze Age likely formed similar defensive shamanic alliances/brotherhoods in response to similar threats.

One of the critiques that could be raised about this theory of secret society origins is that in transegalitarian settings where secret societies operate, there are also ritual specialists usually referred to as 'shamans', who operate independently and are not part of secret societies. One possible explanation for this may be due to the inability on the part of these shamans to pay the exorbitant admission fees required for acceptance into local secret societies. Indeed, secret societies generally confine their activities to the most lucrative ritual aspects of communities such as costly rituals to maintain community survival, and the most expensive curing ceremonies. Their main interest is gaining wealth and power; they leave all lesser rituals such as lesser divinations and minor cures to local, poorer, lower ranking ritual specialists such as diviners and herbalists. Secret society members often adopt the epithet of 'shaman' (e.g., among the Kwakwakawakw, Nuuchahnulth, Pomo, Chumash, Wappo, Maidu, Iowa, and others in Hayden 2018, 47, 95, 157), which is understandable if at the outset it was groups of shamans who created secret society organizations. However, their primary concern with wealth and power meant that many members had few natural talents for dealing with the supernatural or for healing, and training became rote or was by way of psychotropically induced means. As a result, secret society members became much more like priests who conducted the major community rituals. This is yet another common feature with Siberian shamanism where hereditary clan shamans perform all the most lucrative rituals and perform more like priests, while other shamans with natural proclivities for dealing with the supernatural are considered weaker, less effective, less valuable, and could not be considered for the role of clan shaman (Anisimov 1963, 115–16).

Another problematical issue might be raised with respect to the lack of secret societies in most of Siberia. This apparent absence may be due to the strong development of clan socio-economic structures that not only subsidized and promoted their own shamans but were probably strong enough to protect their designated shaman from attack. At least among the Evenk, shamans were 'appointed from the clan leaders' (Anisimov 1963, 109). Such powerful clans, primarily among herding, socially stratified Altaic groups that entered Siberia about 1000 years ago (Stépanoff 2019) may not have existed in early phases of the development of cultural complexity in the Western Hemisphere. In other cultural areas, such as the American South-west, the northern Northwest Coast, and Vanuatu, secret societies did not develop in places where there were strong clan organizations; secret societies only developed where clans were somewhat weaker (Webster 1932, 146, 152–3; Speiser 1996, 302; Ware 2014; Hayden 2018, 350). While not all authors attributed this pattern to the causal factors we suggest, they all note the mutually exclusive occurrence of powerful clans and secret societies (or ritual sodalities), even viewing them as competing for the control of power.

In our view, in situations where there were no pre-existing stratified kin groups to defend, underwrite, and control their ritual specialists, the formation of coherent mutual protection organizations of shamans would have provided considerable benefits. In addition to personal protection, such organizations amalgamated shamans from different kin groups thus expanding the group's power beyond the individual kin groups to which each member belonged – i.e., the organizations could have expanded their economic, political, and social base considerably and exerted greater pressure on the populace to produce as well as surrender more resources for putative essential ritual purposes.

In support of this model of secret society origins, there is substantial evidence of defensive coalitions being formed by groups that felt threatened. In fact, archaeologists, cultural anthropologists, and historians have documented coalescent societies in Africa, Amazonia, Indonesia, Mesoamerica, and North America (Kowalewski 2006). The coalescing of societies or their remnants in times of social stress, such as droughts, epidemics, feuds, successional disputes, interpersonal conflicts, and wars, requires in-group based decisions to solve the immediate problems of safety and security, and to establish the long term viability of political, ritual, and social institutions. 'For example, during North America's Coalescent Period (AD 1716–1759), diverse indigenous peoples of the Southeast sought refuge within militarily powerful Catawba/Esaw settlements.[7] These refugees included the Cheraws, Congarees, Peedees, Sugarees, Waterees, and Wahaws (Davis and Riggs 2004; Heath 2004)' (Chacon & Mendoza 2012, 471). Moreover, ritual sodalities tend to emerge with increases in the internal or intrapolity diversity of coalescent communities and thrive in multiethnic and multilinguistic environments (Ware 2014), and secret societies are frequently multi-ethnic and multi-linguistic (Hayden 2018).

Other examples of group formation for self defence include pre-Contact southern Plains groups, which coalesced in a climate of exacerbated conflict, intensified political practice, and increased exchange (Vehik 2002). The Cheyenne (Hoebel 1978) and Mandan (Wood 1967) constitute coalescent societies that elaborated their clan systems and ritual institutions to dampen intrapolity conflict, to organize coalitional proactive aggression against enemy polities, and to promote interconnected elite coalitions. In the American South-east, Mississippian coalescent societies have been well documented in the Alabama River Valley (Regnier 2014), the Lower Arkansas River Valley (Wiewel 2014), and the Upper Tombigbee River Valley (Galloway 1995). Mississippian coalescence provided increased protection and safety in the face of greater interpolity aggression and competition. Coalescence in the post-contact era resulted in the formation and transformation of ethnic identities in the face of colonial aggressions (Waselkov & Smith 2017). For example, coalescence promoted the amalgamation and formation of polities including the Apalachee, Catawba, Cherokee, Choctaw, and Creek (Cobb 2019). Reduced population levels in the post-Contact South-east required amalgamation for political stability and social reproduction (Ethridge & Schuck-Hall 2009). However, it should be noted that Mississippian polities were engaging in coalescence from the beginning as witnessed at Cahokia

(Emerson 2018). In the American South-west, coalescence by ancestral Puebloan groups allowed ritual sodalities to thrive (Ware 2014). Thus, elites may arrange and legitimize social linkages by constructing and empowering exclusive and secretive institutions based on coalescence.

In consequence of the formation of defensive alliances among ritual specialists, we expect that those who assumed leadership positions within secret societies would have been able to conduct healing rituals for which they could safely charge fellow villagers high fees; and they would have been shielded from threats when their efforts failed. In addition to healing fees, such ritual sodality leaders and members were able to amass personal wealth by extracting secret society membership fees and advancement fees from fellow villagers, as well as requisitioning goods for community protection rituals without fear of retaliation (more on this below). Given this and the other advantages of secret societies, the stage was set for the rise of social complexity.

## Aggrandizing leaders of secret societies

A lone aggrandizing individual operating in a transegalitarian setting runs the risk of being subjected to various levelling mechanisms (Chacon forthcoming). Some of these mechanisms may have lethal consequences as the following example illustrates: Among the Melanesian Kapauku, 'people go so far as to kill a selfish rich man [Big Man] because of his "immorality." His own sons or brothers are induced by the rest of the members of the community to dispatch the first deadly arrow. *'Aki to tonowi beu, inii idikima enadani kodo to niitou* (you should not be the only rich man, we should all be the same, therefore you only stay equal with us)' was the reason given by the … people for killing …[a Big Man] who was not generous enough' (Pospisil 1958 cited in Sahlins 1963, 293). We suggest that solitary aggrandizing leaders faced similar levelling mechanisms in Scandinavia during the Bronze Age. In contrast, aggrandizing leaders operating under the protection of powerful networks of ritual specialists – i.e., secret societies –could engage in aggrandizing activities without great fear of being killed. Ritual sodality membership provided these aggrandizing leaders with a *culturally acquiesced* pathway for extracting wealth and surpluses from fellow villagers. It should be emphasized that this ritually organized tactic may not have been the only one used to protect ambitious individuals from popular resistance to strategies meant to promote individual self-interests. Hierarchical shamans backed by powerful clans (as in Siberia) and reciprocal feasting involving debt networks could also serve many of the same functions of advancing self-interests of a minority accompanied by considerable protection from threats (Hayden 2014). However, secret societies certainly seem to have been one of the most effective strategies for achieving these goals and thus were relatively widespread in transegalitarian communities.

Contrary to the often alleged functional/system serving/benign nature of secret societies (and of ritual in general), the actual function of ritual sodalities was to 'dominate society by the use violence or black magic' (Hayden 2018, 43). In effect, secret societies were exploitative in nature and ritual sodality leaders strived to produce 'fear, awe, and acquiescence on the part of the uninitiated populace' (Hayden 2018, 43; see also Hayden et al. 2023). As just noted, secret society leaders were able to extract great wealth and surpluses from fellow villagers. For instance, the Bella Coola (Nuxalk) required large payments for entry into each ritual sodality rank (more on Bella Coola secret societies below). Similarly, among the Nuuchahnulth, initiation fees for novices were given to chiefs who redistributed the largess to secret society members (Boas 1897). Some secret societies even openly extorted wealth from individuals with impunity by claiming that they had stolen the souls of non-members from whom they exacted payments to have the soul returned. Payments might be so excessive that 'secret societies could draw off substantial portions of the surplus production of a large section of an entire community' (Hayden 2018, 44–5).

## Bella Coola (Nuxalk) secret societies and rock art

The secret societies operating among the Bella Coola (Nuxalk) were known for having been particularly powerful (McIlwraith 1948a; 1948b). Thus, to better understand how ritual sodalities functioned, during the summer of 2022, Johan Ling, Richard Chacon, Brian Hayden, Brenda Gould, Cecilia Lindhé, and Yamilette Chacon conducted ethnographic fieldwork among the Bella Coola (Nuxalk).

According to Nuxalk members, secret society leaders went to great lengths to keep non-initiated individuals away from areas where members held meetings and/or engaged in ritual activities. In fact, one informant stated that, in the past, a guard was placed at the trailhead to an isolated site where ritual sodality leaders would regularly meet. This guard's task was to see to it that only secret society members had access to such a significant place. This centre for ritual activity, marked by a dense concentration of petroglyphs, is located on Thorsen Creek.[8] The presence of rock art at this site is important because ethnohistoric and ethnographic data firmly link secret societies to the creation of rock art (McIlwraith 1948a; Chacon et al. 2020; Hayden et al. 2023). This particular ritual sodality meeting place is found approximately 1 km from the nearest village. Thus, the Thorsen Creek site, with its rock art panels, was located at some distance from human settlement.[9] This configuration ensured that Bella Coola secret society members at Thorsen Creek would have enjoyed the requisite privacy for conducting esoteric rituals and for the transmission of arcane knowledge to fellow ritual sodality members.

Furthermore, Bella Coola ritual sodalities 'not only commanded the most awe, but instilled fear and terror in non-members' (Hayden 2018, 47; Hayden et al. 2023). For example, among the Bella Coola, the *Sisauk* Secret Society claimed to have very powerful supernatural connections and members believed that such links could be enhanced via repeated initiations (up to ten times) (McIlwraith 1948a; Hayden 2018). The important Bella Coola ritual sodalities were ranked and promotion to a higher rank required large payments (Hayden 2018). Initiation into the Bella Coola *Sisauk* Society was costly and 'paying for people to care for initiates in seclusion was a high expense … Costs were in the form of skins, blankets, food, boxes, baskets, slaves, canoes, and unspecified other items' (Hayden 2018, 52).

## Scandinavian Bronze Age secret societies and rock art

Chacon et al. (2020) along with Ling and colleagues (2018; 2020; 2022) argue that secret societies were operating in Scandinavia during the Bronze Age. As previously mentioned, ethnohistoric and ethnographic data firmly link secret societies to the creation of rock art (McIlwraith 1948a; Chacon et al. 2020). We propose that the Bronze Age petroglyphs found in the Tanum/Bohuslän region of Scandinavia were carved by secret society members (Ling et al. 2018; 2020; 2022; Chacon et al. 2020).[10]

Additionally, we suggest that Scandinavian secret societies organized long distance trading expeditions to secure coveted metals during the Bronze Age (Ling et al. 2018; 2020; 2022; Chacon et al. 2020). Ling and colleagues (2018, 168) posit that the petroglyphs found in the Tanum/Bohuslän region 'likely represent esoteric [secret society] initiation rituals or specific rites conducted for the success or expeditions and/or actual events that may have taken place during the course of voyages'. However, it is important to note that, as was the case among the Bella Coola, rock art panels at Tanum/Bohuslän are not found in close proximity to village sites. Typically, petroglyph sites were located 1 km or more from settlements.[11] Thus, we argue that the petroglyph locations in the Tanum/Bohuslän area likely served as ritual sodality gathering places. This configuration would have ensured that Scandinavian Bronze Age secret society members operating in the Tanum//Bohuslän region would have enjoyed the requisite privacy for conducting esoteric rituals and for the transmission of arcane knowledge to fellow ritual sodality members.

## Privileged access to the supernatural

Aggrandizing leaders of ritual sodalities were able to safely accumulate personal fortunes by convincing fellow villagers that their respective secret societies enjoyed privileged access to the ancestors or other-than-human beings by way of esoteric knowledge and/or inheritance. While ancestor veneration can occur for a number of reasons, such as claims to resource ownership or as a means of controlling younger generations, the relatively common focus on ancestral powers in secret societies seems to have a unique structural function. As Speiser (1996, 302–4) observed in the New Hebrides, secret societies are structured so that they transcend the limits of kinship groups. By requiring inheritance of supernatural power from ancestors, and by specifying which ancestral spirits filled roles in the secret society pantheon, this ensured that specific kinship groups were represented in the secret society thereby extending its scope of power over multiple kinship groups and often multiple communities. While this structural focus on ancestors may not be present in all secret societies, it is, nevertheless, very common.

Even a cursory review of the literature reveals that ancestors have long been venerated as sources of power and wealth and are often the object of supplication, veneration, and worship, as well as the subject of corporate institution legitimacy such as ritual sodalities (Helms 1998; Insoll 2011). For example, North American Northwest Coast secret societies based their legitimizing ideologies on other-than-human beings who conveyed supernatural powers to specific ancestors who, in turn, could bestow these powers to descendants – given appropriate training and wealth – who, in turn, could become members of secret societies. Thus, ritual sodality membership was predicated on feasting obligations, genealogical connections, and wealth payments (Hayden 2018). Kwakwaka'wakw secret society dances demonstrated a person's claims to power, privilege, and the ancestral conferring of powers to one's descendants (Drucker 1941). Demonstrations of powers bestowed by ancestors, deities, and guardian spirits included dramatic legerdemain performances such as being scalped while dancing, cutting off one's own head and then being brought back to life, standing on hot stones, and walking on fire or water (Boas 1897; Drucker 1941; Olson 1954). Such demonstrations showcased a secret society member's supernatural powers derived from his ancestors' encounters with other-than-human beings. For example, in the American South-west, Hopi Katcina spirits are associated with clan ancestors who serve as mediators between Pueblo people and the deities (Ware 2014). Katcinas are the focus of Hopi secret society performances in which the ancestors are propitiated for the group's well-being. Katcina spirits supplicated by Katcina ritual sodalities hold important roles in curing, rainmaking, and warfare (Webster 1932). Thus, secret society members claim to possess privileged access to these ancestors and to materially benefit their communities (and themselves or their kindreds) from such access.

## Discussion and conclusions

As previously stated, we posit that the formation of secret societies greatly facilitated the rise of social complexity in antiquity because it provided leaders of transegalitarian societies with culturally sanctioned pathways for extracting surpluses from fellow villagers and initiated the process of concentrating political power across kinship groups. More specifically, the role that secret societies played in the rise of social complexity in Scandinavia during the Bronze Age has been put forth by Chacon et al. (2020) along with Ling and colleagues (2018; 2020; 2022). We propose that a major catalyst for the development of social complexity in Scandinavia during the Bronze Age was the formation, on the part of local ritual specialists, of defensive shamanic alliances/brotherhoods in the form of secret societies. The establishment of such ritual sodalities enhanced the ability of ritual specialists/secret society leaders to extract surpluses from fellow transegalitarian villagers with impunity and in safety.

In sum, we suggest that the decision on the part of ritual specialists to form shamanic defensive alliances gave rise to secret societies in many instances. The model we present explains both the how and the why of this development, plausibly triggered by the ability of transegalitarian groups to produce surpluses resulting in competition to control wealth. Ritual sodalities certainly must have allowed aggrandizing leaders/ritual specialists to conduct healing rituals in relative safety and to charge high fees with impunity. The creation of secret societies would have provided a culturally sanctioned justification for leaders to amass personal or family wealth by way of curing fees, membership, or advancement payments, community ritual services, and outright extortion. By claiming privileged access to ancestral powers due to esoteric knowledge and by repeatedly staging dramatic demonstrations of powers bestowed by ancestors, aggrandizing secret society leaders/ritual specialists attempted to convince fellow villagers that they possessed the ability to supernaturally protect communities. By promoting this ideology, and with the mutual protection provided by society membership, secret society leaders/ritual specialists would have been able to further circumvent societal levelling mechanisms which enforced egalitarian norms. Over time, the wealth, status, and eventually power of aggrandizing secret society leaders/ritual specialists grew vis-à-vis that of fellow villagers resulting in one of the main avenues by which social complexity emerged, including multi-community ritual-political organizations that we suggest became chiefdoms and states.

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### *Notes*

1 For a comprehensive review of the widespread belief in animal masters/supernatural gamekeepers, consult Chacon (2023).

2 During the course of R. Chacon's fieldwork, the exchange rate averaged 3173 Sucres per $1 USD.

3 As part of the father's ongoing efforts to help his sick daughter, in 1998, he sought the aid of two additional ritual specialists. He paid a shaman named *Tserimbo* 10,000 Sucres in exchange for treatments while another shaman named *Cuji* was paid 1 blowgun (worth 100,000 Sucres) for his services. With this, a total of 13 shamans received payment of some kind in exchange for their ritual knowledge and curing practices.

4 Eventually, Western doctors determined that the young girl was suffering from encephalitis. She survived her ordeal but today she walks with a noticeable limp as a result of her prolonged illness.

5 The actual names of all native Amazonians in this chapter have been withheld and replaced with names that are untraceable.

6 We propose that this deterrence strategy was very similar to the Article 5 collective defence posture adopted by NATO member countries (NATO 2022).

7 Catawba warriors were considered as being among the most accomplished fighters in south-eastern North America (Heath 2004).

8 This site is described by McIlwraith (1948a, 177–8). See also Ling et al. (2020).

9 According to Hayden (2020, 125), typically, secret society meeting and ritual locations were located 1–2 km from habitation sites.

10 The Tanum/Bohuslän area contains Europe's largest concentration of prehistoric rock art (Ling 2008).

11 See Note 9.

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7

# Maritime *memoria*: navigating Bronze Age rock art

*Cecilia Lindhé*

*Scandinavian rock art, generally attributed to the Nordic Bronze Age (1700–500 BC), has a strong connection to the prehistoric coastline with examples often found etched by bays and fjords close to the water. The imagery links these sites to maritime practices essential for long-distance trade and naval warfare. This chapter argues that rock art served as a mnemonic device for seafarers, facilitating the memorization and practice of critical skills for navigating treacherous waters. Using ancient rhetorical techniques such as* memoria *(artificial memory),* ekphrasis *(to tell in full), and* ductus *(directed movement), the chapter suggests that these rock art sites were designed to guide and instruct through the movement of people across the landscape, creating an embodied experience of learning. By engaging with the rock art sites and moving through these sites, participants likely built a visual memory that informed their actions at sea. By applying ancient rhetorical theory to the rock art, it might be possible to develop new approaches to understanding the directional function of rock art in the landscape, enabling us to move away from a definition of the sites merely as a collection of images and toward a focus on the connection between clusters of images and sites in the landscape.*

## Introduction

The imagery of Scandinavian Bronze Age rock art frequently refers to maritime activities, with ships being among the most common figurative depictions. Further, Scandinavian rock art, generally attributed to the Nordic Bronze Age (1700–500 BC), has a strong connection to the prehistoric coastline with examples often found etched by bays and fjords close to the water. Recently, it has been suggested that rock art was made by transregional guilds in order to transmit knowledge about navigation, long distance trade, and boatbuilding skills (Ling et al. 2022). These guilds might have been involved in the trading of metals across long distances, transporting large amounts of copper to Scandinavia from remote locations such as the British Isles, Central Europe, and Iberia. To meet these demands, Bronze Age communities made significant investments in long distance trade, in the form of shipbuilding and crews capable of making lengthy sea and riverine voyages (Kristiansen & Larsson 2005; Ling et al. 2018; Varberg et al. 2019).

When these warrior mariners left their native regions, they were involved in exceedingly dangerous activities such as journeying to faraway places with new languages and other modes of conduct, all of which had to be renegotiated (Ling 2014). And the seascape posed an even greater danger. Hence, having a profound understanding of navigation and different seascapes must have been crucial. But where and how did these mariners learn about how to travel to faraway places? This chapter will focus on maritime practices and the spatial and temporal qualities of ancient rhetorical cognitive mnemotechnics such as *memoria*, *ekphrasis*, and *ductus* to demonstrate how rock art might be regarded as educational sites for various maritime endeavours.[1] In the following, I shall argue that the usage of *memoria* must have been critical for Bronze Age seafarers in order to put into practice essential knowledge about naval warfare and navigation.[2]

The hypothesis presented here is that some of the rock art sites served to educate, persuade, and perhaps even overpower visitors, with the aim to teach and practice, for example, navigation, martial arts, hunting, and knowledge about travels and distant places. The mere depiction of maritime activity on the rocks and their proximity to the sea do not provide sufficient evidence to support the argument advanced in this chapter, namely that the rock art could serve as teaching sites. Consequently, I will argue that bizarre or unusual imagery specific to each location may have been intentionally employed to memorize warfare and navigation methods. In the sections that follow, I will provide a concise overview of the prominent maritime themes, clarify the rhetorical approaches employed, and demonstrate how they might be used to shed light on how the rock art sites can be interpreted as locations for learning and remembrance. To summarize, I will briefly address a motif that has not yet been connected to the marine environment, particularly in terms of navigation.

## Maritime imagery on rock art

How are we to explain the abundance of maritime imagery? For instance, Tanum (Fig. 7.1) in west Sweden claims the highest density of Bronze Age ship images in Europe, comprising around 10,000 ships of diverse chronology, style, and size (Kaul 1998; Ling 2014; Milstreu 2017). Initially, some of these sites were created in close proximity to the sea. However, over time, the sea retreated, and they became disconnected from their original maritime context (Ling 2014).


*Figure 7.1. Scandinavian map with the Tanum World Heritage rock art site circled and the region of Bohuslän marked in grey (map modified after Ling 2014).*

The rock carvings often allude to water, although this association can take numerous forms (Bengtsson 2004; Bradley 2009) and recent analyses indicate that the panels were organized in alignment with the natural trajectory of water across the rock surface (Horn et al. 2022).

Several scholars have discussed the strong connection between Nordic Bronze Age rock art and the maritime landscape (Coles 2006; Ling 2014; Nimura 2016) and the likelihood that the human figures depicted in these images correspond to seafaring warriors (Ling & Toreld 2018). The images reveal ship crews engaged in a variety of activities such as kneeling, sitting, raising paddles, holding weapons, or blowing horns. There is often a difference in scale between individual warriors; some figures appearing smaller than others, with larger figures frequently put near the bow, possibly indicating the importance of their role on the ship. Could they be the navigators? Several ships are pictured in relation to sun crosses (Tossene 73:1, Foss 6:1, Kville 100:1), and certain ships have even been classified as sun ships (Svarteborg 11:1; 13:2, Tossene 945:1).[3] Sun or wheel crosses are commonly found in rock art and are frequently seen alongside ships, sometimes towards the prow, possibly representing celestial navigation.[4] Most of the images of ships do not allude to the domestic sphere, however, there are exceptions, such as a motif that has been interpreted as a fishing scene (Kville 151:1). Certain imagery may be associated with ritual preparations or initiation before departure at sea (Ling 2014), and ships are common on bronze artefacts (Kaul 1998).

However, once again, how can we elucidate the abundance of maritime imagery? Johan Ling (2014) has emphasized the maritime characteristics of rock art, indicating that it was produced in correlation with certain social rituals and occasions. These may encompass ceremonial customs pertaining to journeys, initiation rituals intended to fortify the crew, and ceremonial observances linked to nautical endeavours. Richard Bradley also highlights the correlation between rock art and the enduring practice of linking the flow of water with ceremonial rituals (Bradley 2009, 134–5). Therefore, it would be simplistic, if not inaccurate, to assume that the emphasis on maritime activities was solely motivated either by practical considerations or as ritual practice. Instead, it could be fruitful to compare the abundance of ships in Scandinavia with, for example, maritime practice in the Pacific (Bradley 2009), and this will be further explored in the final section of the chapter.

## Theorizing *memoria* and rock art

In ancient rhetoric *memoria* was a technique that associated mental representation to familiar locations. The use of mnemotechnics can for example be seen in archaic catalogue poetry, most notably in Homer's *Iliad* where we find the enumeration of ships (cf. Fig. 7.2) with crews of 20, 50, and 120 rowers (*Iliad* ii. 484–785; ii. 786–877). Through its arrangement, which includes the rhythmic structuring of the text and the recurrence of formulae, familiar visual and fictional representations coalesce in such a way that they serve as mnemonic aids to an orator or bard and the audience alike.[5] Before the development of writing, the practice of memorization held significant prominence and knowledge of *memoria* was crucial. The technique of associating mental representations to spatiality has a very long history, however, we know with certainty that it was practised by the Greeks and systematized by the Romans.[6]

The rhetorical practice of *memoria* focused on combining physical space with mental representations, thus linking memories to familiar places to improve the ability to recall information quickly (Quintilian 11. 2. Sqq; Carruthers 1998; 2008; Yates 2010; Lindhé 2015; 2016). In her influential study, Mary Carruthers (2008) describes *memoria* as a conceptual motor for the organization and motivation of thought. Central to this way of thinking is not how truthfully the images represent, but rather their 'cognitive utility', that is, if they can be used as sites upon which it is possible to build or invent new content and, of course, to be able to recall important information as vividly as possible when needed (Carruthers 1998, 72).[7] Carruthers explains further: 'One may conveniently think of this activity in spatial terms, as if memories have been stored in a variety of places and must be called together in a common place where we can become aware of them, where we can "see" them again and know them in the present' (Carruthers & Ziolkowski 2002, 1). There are several ways in which Carruthers' definition of *memoria* and my perspectives on rock art are connected. However, before I provide further examples, there are some additional considerations to be made when it comes to rhetorical mnemotechnics.

In ancient Greece, rhetoric was taught in school through the *Progymnasmata*, a series of rhetorical exercises, and one of the aims of education was to be able to speak *ex tempore*.[8] That meant the ability to recall a situation so strongly and immediate that it was visible to the mind's eye. When an orator spoke about a place, a monument, or an event unseen or unfamiliar to the audience he was supposed to use details to create a visual image 'in the mind's eye' of the listeners. To be able to accomplish this, the rhetorical practice of *ekphrasis* (description) was an essential device.[9] The goal of *ekphrasis* was *enargeia*, or vividness which meant to make the motif alive for the spectator to 'see' what was before him (Webb 2009; Lindhé 2013). But a defining feature of *ekphrasis* was not just an effective use of verbal description, but also immediacy and immersion through the senses since *ekphrasis* is defined by the assumption of a live audience and emphasizes the sensory engagement of the listener (Kennedy 2003).[10] Pictorial visualization would of course be strengthened in the presence of actual images that can guide the orator through the narrative and help the audience to visualize the events of the story. Here, the speaker's gestures might play a part but, of course, and when it comes to the rock art the framing of nature, the cracks in the rock, the flow of water, the rising and setting of the sun, and sound from the surrounding nature would have a similar effect as 'created seeing through hearing' (Kennedy 2003, 35). The speech was intended to be compelling and visually captivating, transporting the audience to the setting of a battle, a hunt, or a voyage navigating by the celestial bodies. The goal was to ensure that the knowledge was so deeply embedded in the audience's consciousness that it enabled them to readily retrieve it when needed. So, in this sense, *memoria* serves two functions. On the one hand when a speaker delivers a presentation during which he provides for example navigational instructions to the crew, which in turn might include details such as specific skerries, shoals, star constellations, and perhaps also enemies that might be encountered along the way, with such precision that the audience is able to be transported to the geographical sites and situations. And on the other hand, these memory images should be stored in the crew's minds, readily to be recalled when needed out on the open sea.

*Figure 7.2. The so-called 'ship catalogue', from the site Tanum 12:1, at Aspeberget (photo: Åsa Fredell; source https://shfa.dh.gu.se/image/110954).*

Related to *memoria* and *ekphrasis*, is the rhetorical concept of *ductus*. It translates as ‘directed motion’ and is the process by which a work leads an audience through its formal patterns moving the spectator, listener, or performer through its structures, similar to travelling through stages along a route rather than witnessing the entire thing from a distance (Carruthers 2010, 190). One moves through a composition, whether of words or images, directed by the stylistic features of its parts and their formal arrangement; *ductus* emphasizes flow, movement, direction on a journey, or path, with many types of challenges along the way. *Ductus* emphasizes ways of finding by organizing any composition as a journey through a linked series of stages, each of which has its own flow (its ‘mode’ or ‘colour’), but also moves the whole composition along. The ‘colours’ or ‘modes’ are like the segments of an aqueduct (a word derived from *ductus*), transporting water but also altering its direction, slowing it down, speeding it up, and bifurcating as it proceeds along its ‘route’ or ‘way’. A person following the *ductus* sees the ‘colours’ as phases to the *skopos* or goal. Every composition should be viewed as a journey during which one must continually progress (Carruthers 1998, 80–1). The surface topography of the rocks, including characteristics like fissures, ice lines, and natural flows of water, have been recognized as ritually crucial structural components of rock art, such as portals to an imagined underworld or as interplaying with the features of the natural surroundings (Nordenburg 2004; Horn et al. 2022). This could be taken further by reflecting upon *ductus* as a condition for navigating on and between rock art sites. Prior to exploring this topic, however, it would be useful to provide some further clarification on *memoria.*

## Special places and bizarre images

In rhetoric, the regulations for specific locations, where memories were to be stored, were quite clear. The instructions provided in *Rhetorica Ad Herennium*, the earliest known book on *memoria*, argues that the technique of artificial memory involves the utilisation of specific *loci* (places or backgrounds) and *imagines* (pictures).[11] Moreover, *Ad Herennium* states that those who have been trained in mnemonics are able to ‘set in backgrounds’ what they have heard, and then recall the information directly from these backgrounds through memory.[12] By backgrounds the author refers to scenes or sites that are set off on a small scale, complete and striking: ‘so that we can grasp and embrace them easily by the natural memory – for example, a house, an intercolumnar space, a recess, an arch, or the like’ (*Ad Herennium* 3.16. 29–30). The backgrounds should be placed in deserted or non-crowded areas (*Ad Herennium* 3.16. 31), and the fact that the rock art is often found in special places in the landscape, away from settlement and mundane life (Ling et al. 2018), and further display both a selective and sometimes unique set of images suggest that they may have fulfilled a similar need to practise memory techniques in the landscape.

The pictures, then, that are to be inserted into the backgrounds *should not* come from everyday life because they are ordinary and banal and we generally fail to remember them, according to *Ad Herennium*. Rather, they should be as bizarre as possible, have a comic effect, be striking or disfigured in one way or another to ensure our remembering. Naturally, it is impossible to determine what was regarded unusual or strange in Bronze Age societies. However, the absence of depictions of everyday life in rock art suggests that such scenes did not evoke memory. Thus, the fundamental principle of the visual mnemonic system, as described in *Rhetorica ad Herennum*, is arranging identifiable objects in visually striking combinations or juxtaposing them against familiar architectural backdrops. In a way, the rock art sites may be compared to the backdrops or panels mentioned, where a warrior, mariner, or navigator would immediately have to insert sequences of visually arresting pictures so they could swiftly recall how to handle a scenario when needed. It must have been essential to be able to promptly memorize instructions in order to handle various situations, such as battle, hunting, or seafaring. Also, the rock art locations would be useful for an orator when teaching a group of mariners before setting out to sea. Furthermore, the author of *Ad Herennium* underlines the necessity of visual sequences being understandable regardless of order, whether left to right, right to left, centre to outer, or any other arrangement. The rock art sites are dynamic, they have been changed and updated over thousands of years (Milstreu 2017; Horn & Potter 2020) and the logic behind the structure of the images is that they should be read/used by whoever happens to need the space for *memoria*. They should, just like *Ad Herennium* states, be possible to start from any point, any image depending on the aim set out by a person in charge.

Numerous connections may be found between Bronze Age rock art and the spatial dimensions of *memoria, ductus*, and *ekphrasis* described above. By fusing memory practices with the creation of rock art, this activity may have prompted the need for mobile groups to remember locations and places in the landscape/seascape, establishing a connection to groups who engaged in long distance movement and navigation. It is tempting to see that the rock art sites could have fulfilled the need to memorize and communicate skills connected to maritime long distance exchange. These skills included not only navigation but also martial arts, trading codes, and other cosmopolitan matters connected to interaction and exchange. In keeping with this, it could be relevant to consider the rock art sites, with numerous ship depictions, as a kind of maritime mnemotechnies, that was conducted by a group of mariners before an oversea expedition. Taking this into consideration, I will now examine three interconnected locations using the rhetorical framework described above.

## The great warrior, the pole swing, and the net figure

The rock art panels are designed in a manner like stages, allowing the spectators to stand in front, typically along the seaside. However, the positioning of the images also necessitates physical movement between the panels. This suggests that they might be constructed in this way so that the different clusters of images should be followed in a certain order, but also that is something that might change over time (Bradley 2009). In this context it could be useful to recall what I stressed above regarding *Ad Herennium*'s statement about *memoria* and random order. The backgrounds and pictures were to be read or followed in any sequence, independent of their location in a succession of backgrounds. Users should have the ability to move ahead or backward or start from any group of images. This also makes sense if we consider that the sites were re-carved and superimposed over thousands of years (Milstreu 2017; Horn & Potter 2020). They had to be adapted not only to certain times and cultural situations but were perhaps also aimed to function for any teacher/orator/leader who travelled there and used the sites to his own ends. For example, people might construct their own *ductus* through the different backgrounds by going back and forth between images, building their own situations, expanding and reshaping them to suite the specific aim of the current situation. *Ductus*, as directed motion described above, expresses authorial choice but also allows the viewers to choose their own way within its possibilities. Movement must have been essential with the various places serving as stations along a route, each having its own goal, depending on which path you chose.

In the following, I shall refer to three sites as *loci* or backgrounds, and their various carvings as images. I will try to locate the bizarre or remarkable images on each site and trace links between them using the logic of *ductus*, as well as address memory processes overall. The three rock art sites were selected for their unique maritime setting during the Bronze Age, which is important for examining *memoria* related to navigation and maritime activities. All the sites were made in shallow coastal bay areas, featuring images from both Early and Late Bronze Age periods, and had a direct link, either physical or visual, to the water (Fig. 7.3). The most effective way to access these locations was by boat rather than on land. One of the sites, Gerum (Tanum 311:1), had an extremely close connection to the sea and has therefore been the subject to shoreline dating. For instance, Ling argues that the low altitude of the panel (at 14–16 m asl) makes it possible to divide the images on the panel to three chronological phases (Ling 2014). In addition, the Bronze Age sea must have been mirrored against this specific panel, which would have created an intriguing visual effect that gave the sense that the images on this panel were dynamic and ever changing rather than static. This impact likely also influenced the subsequent example, Lövåsen, which had a similar maritime setting, although it was not as drastically low lying as the previous one. Here, five panels are situated at around 17 m above sea level, indicating that the shoreline reached the lowest section of these panels during the Early Bronze Age. During the Late Bronze Age, the water had receded, leaving a little strip of beach between the cliffs and the shoreline, making it a convenient site to pull up boats. In the third example, Sotetorp, there was no direct proximity to the water since the panels were situated around 200 m away. The panels' high altitude of roughly 30–40 m above sea level suggests, on the other hand, that the sea was visible from the site during the entire Bronze Age (Ling 2014).

### *The great warrior: naval battle*

Turning first to Lövåsen (Tanum 321:1, 325:1), the site spans over 30 m and features eight panels with numerous finely carved ships and representations of warriors and acrobats, as well as other beings and designs. In the lower right section there is a bizarre image of a great warrior – his presence governs the whole site. This so-called 'shaman' warrior is identified by distinctive features including a prominent phallus, bird-like headdress or plume, and an energetic body posture. He carries either an axe or a hammer and his head resembles a bird's face, maybe representing a mask. Although not positioned at the heart of the panel, he exerts dominance and establishes the tenor for the entire site, which I suggest is a naval battle.

The theme of this particularly powerful warrior may also be seen in one of the ships depicted in the central part of the site, all in accordance with the idea of *ductus*, which suggests that visual elements are reiterated or elaborated on (Fig. 7.4 & 7.5). There are other elements that might be regarded as bizarre, such as the freestanding huge leg that is positioned over two ships (Fig. 7.6). Again, true to the principle of *ductus* via repetition, an almost identical limb is replicated at an elevated location, centrally positioned among many ships. Adjacent to the ships are two additional severed legs, and to the left of one ship is a graphic portrayal of a human who seems to be severed at the waist (Fig. 7.5). One may remember the suggestion in *Ad Herennium*, that images should be distorted in some way to aid with recollection. At first glance, the site may seem disorganized to contemporary viewers, yet this may be intentional. It may represent the chaos of battle, with a fleet of no fewer than 40 ships.

At the north central area of the site (Tanum 325:1), and adding to the chaos, there is one ship with a body floating above and, higher, up a complex figuration with linked boats and falling intertwining humans above the ship. The acrobats

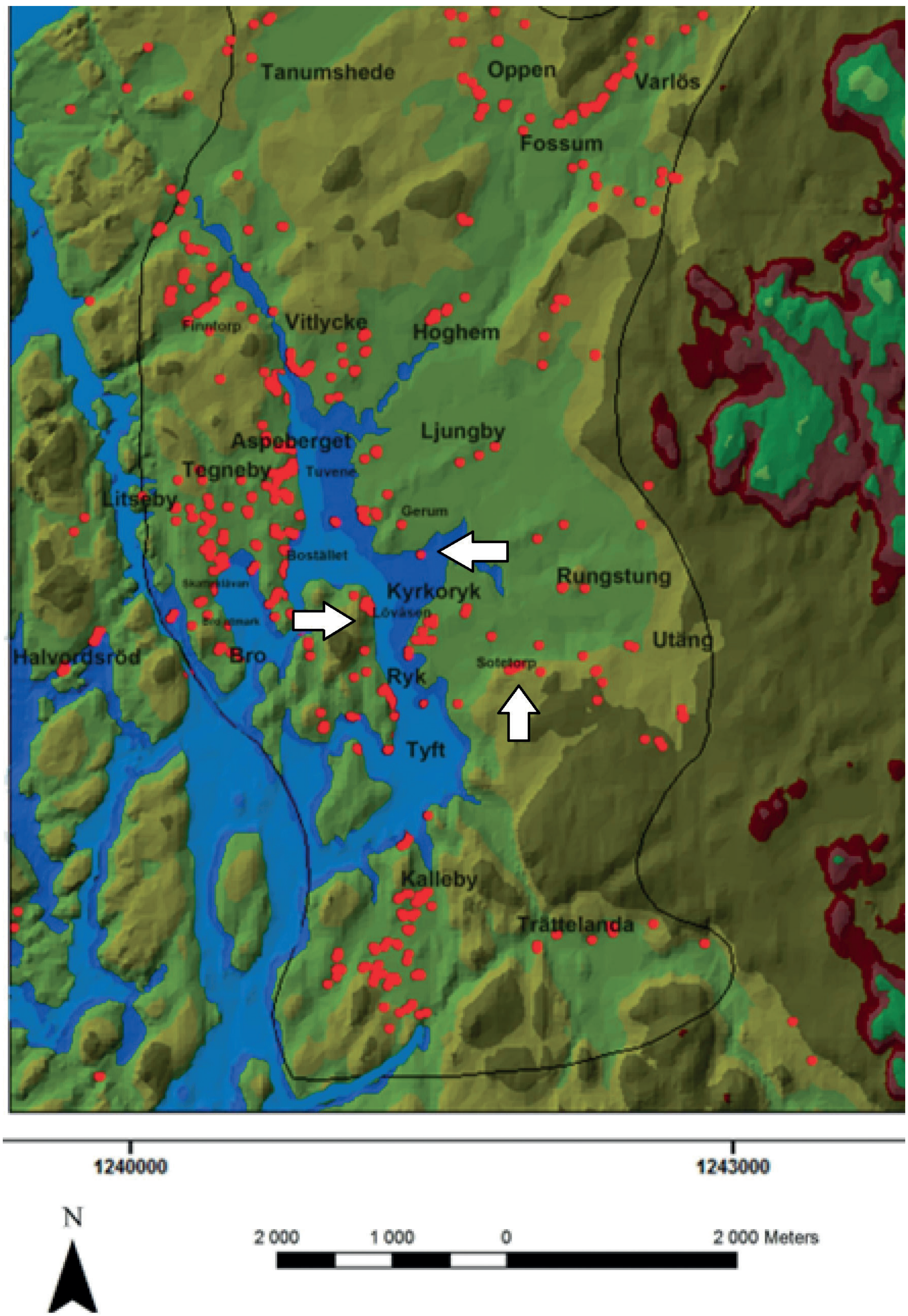


*Figure 7.3. Map of the Tanum World Heritage illustrating the Bronze Age landscape. The Early Bronze Age shoreline is shown in dark blue, the Late Bronze Age in light blue. The three sites studied in this chapter are indicated by white arrows, while red dots designate the locations of all the rock art (map modified after Ling 2014).*

*Figure 7.4. The so-called 'Shaman', the large bi-horned, phallic warrior at the site Tanum 321:1 (photo by Ellen Meijer; source: https://shfa.dh.gu.se/image/133954).*

*Figure 7.5. Ships, warriors, and other features at the site Tanum 321:1 (photo: Tanums Hällristningsmuseum, Underslös: source: https://www.rockartscandinavia.com/loevaasen-pp47.php).*

or vaulters performing over the ships have been analyzed extensively over time, often likened to Minoan bull leaping (Fredell 2003; Ling & Rowlands 2015) and associated with dance and ritual (Kaul 2007). I believe that the vaulters play a crucial role in this site, embodying both war-ritual and combat imagery to support the site's overarching goal. I suggest that the detached limbs, the vaulters, and the falling or twirling human figures represent warriors falling in battle at sea. Before analyzing the site more closely, I want to compare it to the depiction of a famous naval battle that has similar imagery and energy (Fig. 7.7 & 7.8).

The scene in question is dated to 1175 BC and depicts the sea battle between the Egyptians and a group of invaders (also named as the Sea People or Northerners) and is found in the Great Temple at Medinet Habu (Nelson 1943; Sandars 1978). The battle was a disaster for the invaders (Sandars 1978, 124). The narrative of the war is related in a series of seven scenes, beginning with (1) the 'reception centre', where eligible men are enlisted, documented, allocated to their respective units, and provided with their equipment; next, (2) they embark on a march towards the enemy and upon encountering the invaders on land, a battle ensues (3) then follows a lion hunt (4) and the naval battle with the enemy fleet (5) which is essential to our analysis here. Following the naval battle there is a celebration of victory that involves the identification and mutilation of prisoners (6). Finally, the captives are presented before the Theban Triad (7), (Nelson 1943, 40).

The warriors depicted in the naval battle scene are armed with swords and shields and the water all around the ships, both above and below, is full of drowning men. There are indications that the space surrounding the vessels have been painted as representing water: 'Most probably, the background of this section was originally painted green with zigzag black or blue lines running across it to indicate water. This was the Egyptian method of depicting fresh water, like the river or a pond, and presumably the same convention would be used of a bay or river mouth by the sea' (Nelson 1943, 45). Further, the scene depicts boats with stems that end with birds' heads, two of the attacking boats are manned by men in horned helmets and three, including a capsized boat, by men in high headdresses, the so-called feathered crowns. Certain ships look attached because the warriors toss grappling hooks onto the enemy's sail (Sanders 1978, 127), much like the interconnected ships at Lövåsen (Fig. 7.5). Additionally, numerous warriors do somersaults above and around the ships, like the acrobats at Lövåsen (Fig. 7.8).

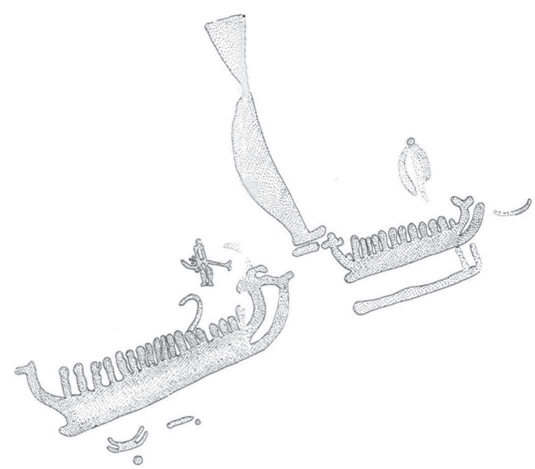

*Figure 7.6. Freestanding leg above two ships at the site Tanum 321:1 (documentation after Coles 2006).*

Thus, we have a similar depiction of a chaotic scene to what is found at Lövåsen, such as the intricate web of boats and warriors, bodies moving and floating in all directions, 'acrobats' in somersault movements above and around the ships. Although here it depicts not acrobats but rather dead or wounded warriors. Thus, the dismembered body pieces found under the ships at the Lövåsen site might be deceased warriors who drowned, while the figures known

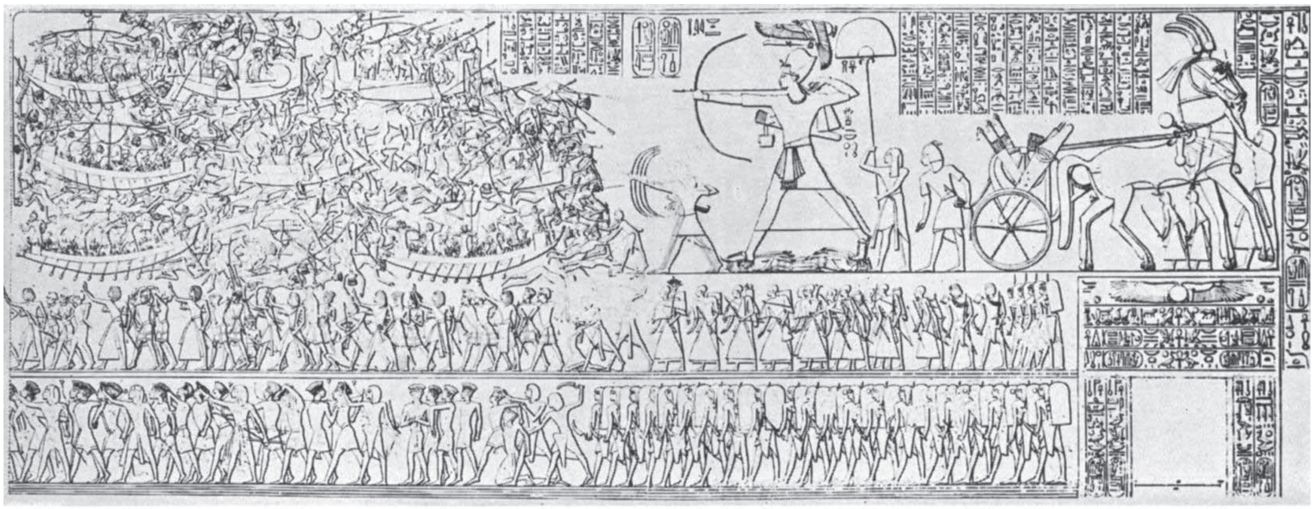

*Figure 7.7. The naval battle as portrayed at Medinet Habu (after Nelson 1943, 41 fig. 1).*

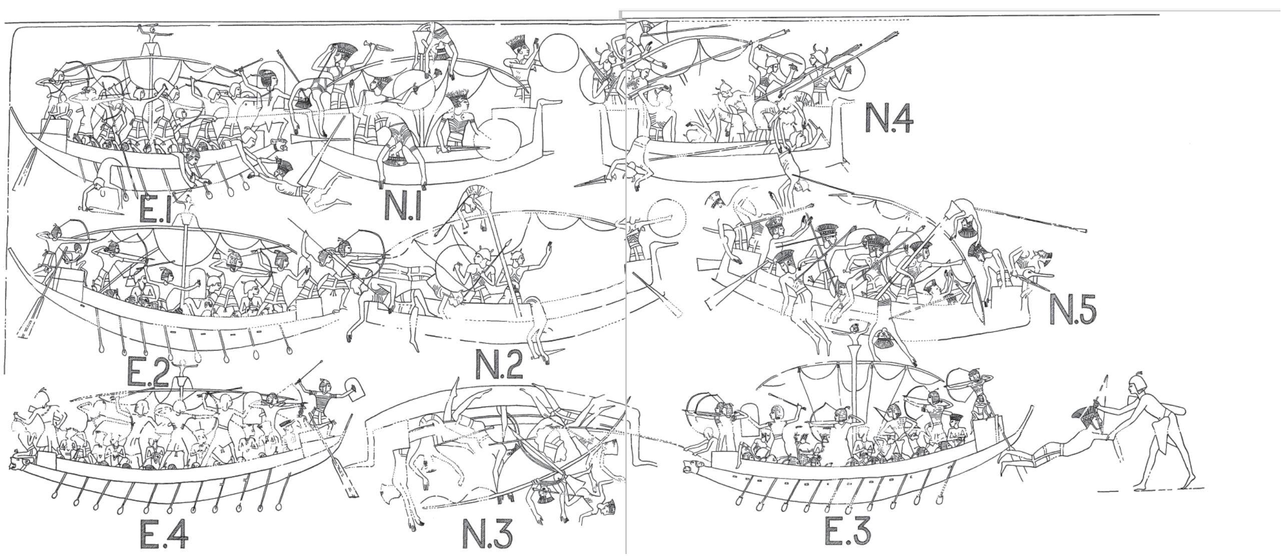


*Figure 7.8. The scene of the naval battle with the figures of the floating bodies removed (after Nelson 1943, 46 fig. 4).*

as acrobats may depict either fallen soldiers or fighters engaged in combat. However, the scene on the Lövåsen relief is presented in a more extensive and varied way and is not as intricate and sequential as the reliefs at Medinet Habu, a distinction that might in part be attributed to the differences between oral and text-based societies (on the difference between the oral and text-based societies see Ong 1982; Goody 1987; Fredell 2003). Additionally, it is worth noting the juxtaposition of the colossal Pharaoh figure in the upper right corner with a bird positioned above his head, in comparison to Lövåsen's warrior who, although being physically separated from the main action, has a commanding presence over the site (Fig. 7.4 & Fig. 7.7). It is noteworthy that a significant number of the boats and other figurative elements found in the Lövåsen images may be attributed to the same period in the Bronze Age (Period III–IV) as the reliefs at Medinet Habu.

The imagery on the Lövåsen panel is interconnected and forms a sequence that guides us through many aspects of maritime combat, encompassing not only battles but also initiation rituals and navigation. This sequence is repeated in other examples from Gerum and Sotetorp, which also include similar arrangements of 'acrobats' and ships. As we shall see below, the iteration of these images at these three sites links them to one another. This aspect introduces another facet of *ductus*: the power of a group of related images to form a sequence or pathway to and between the sites.

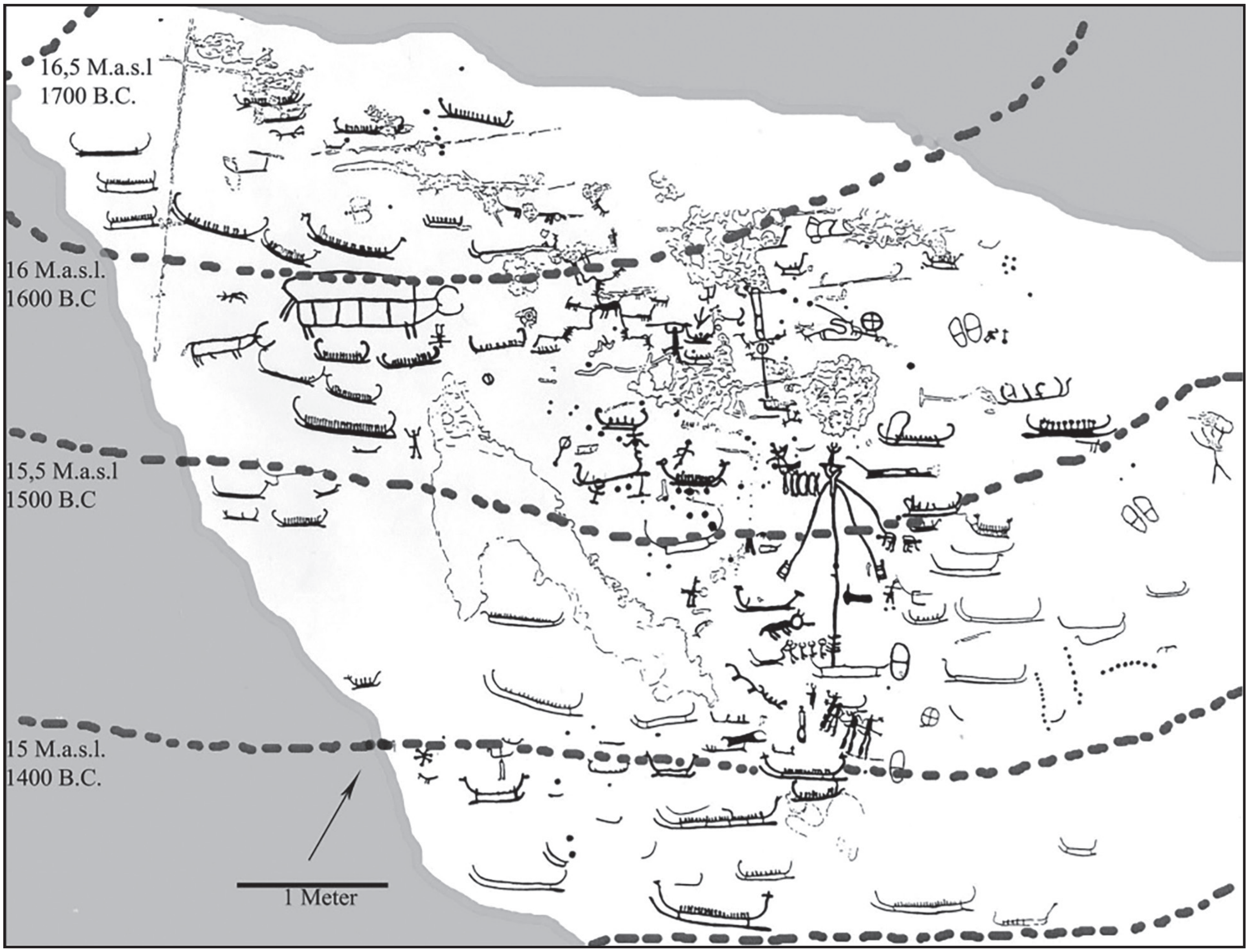


*Figure 7.9. The panel Tanum 311:1 in Gerum, showing when the different parts of the panel arose from the sea in the Bronze Age (after Ling 2014, 91).*

### *The pole swing: war ritual*

The panel in Gerum (Tanum 311:1) is located in a small ravine a short distance from the Gerum river and about 300 m from Lövåsen. It has an extraordinarily low location, so when the initial carvings were made the lower parts of the panel were still covered by water (Ling 2014; Fig. 7.9). The relief depicts 95 boats, 43 anthropomorphic figures, 28 animals, 16 foot- or shoe-soles, and 187 cupmarks (Horn & Potter 2019). Gerum includes some remarkable figures and combinations (Fredell 2003, 164; Kaul 2004) but let us begin with the bulls. On the top left of the panel is a large bull accompanied by another bull and surrounded by a fleet of ships. The bodies of both bulls closely resemble the shape of a ship hull. The vertical lines in the body of the larger bull are directly parallel to the rows of cleats of the two ships below the 'bullboat'. Such cleats were used to fasten lashings to stabilise the hull of these boats. The whole scene, depicting ships with horn-like in-turned prows and the bulls, could be seen as hybridizing a herd and fleet on the move perhaps staged for a special maritime event (Ling & Rowlands 2015). To the right of this ensemble is a unique arrangement of animals (dogs according to Fredell 2003), that are interconnected in a circular formation, similar to the linked ships and warriors at the Lövåsen site (Fig. 7.5), thus following the logic of *ductus* where images repeat, condense, or expand on a certain path. So, following the *ductus* of warfare, this might be a depiction of war ritual where the bulls could represent war ships.

Thus, the Gerum site's overall *ductus* is geared towards the ritual of battle. The animals that are intertwined in a swing-like circular structure are reminiscent of the intertwined ships at Medinet Habu (Fig. 7.7 & Fig. 7.8) particularly the central image, which depicts a horned warrior sitting atop a pole, with several other humans or animals clinging onto the pole's ropes. Where the pole appears to be anchored to a ship, a row of horned soldiers advances or maybe boards it from underneath. A huge bull and an additional row of horned soldiers seem to be moving towards one of the ropes (Fig. 7.9). The scene is the most cited on the panel and has either been interpreted as a maypole or a swinging pole (Almgren 1927; Fredell 2003; Ling & Rowlands 2015; Horn & Potter 2019). Drawing on Ling's (2014) idea that the pole and the warriors represent an initiation procedure undertaken by maritime warriors, the pole swing might be interpreted as signifying a rite of passage – the progression from one level to the next. This may be compared to, for example, ancient Greek myth, where the swing signifies a deep ritual practice in which death and rebirth are intimately related to the ceremonial rite of swinging, proceeding from one stage to another, which has many magical and cathartic qualities (Doria & Giuman 2016). Let us look at the image more closely. Warriors and bulls are visible approaching from the left side, both from the bottom and the top, maybe entering the swing. The main imagery to the left of the pole consists of ships, warriors, and bulls. On the right side of the pole, a human figure has been released from the swing and seems to float freely in the air, presumably approaching the next phase in the initiation ritual. Further, to the right of the free-floating human figure, there are foot-soles, in fact most of the foot-soles (if not all) are found to the right of the pole and not in relation to the bulls and warriors. The dominant imagery to the right of the pole consists of ships, foot-soles, and a few sun crosses that are particularly noticeable. These images may imply the next phase in the process of *memoria*, leading to either Lövåsen for sea battle preparation, or Sotetorp for training in navigation.

### *The net figure: navigation*

About 500 m south of Gerum and Lövåsen at the foot of a large hill, at a south-facing location, there is a sizable section of all together nine rock art sites. The area in question is called Sotetorp and holds some remarkable images. The sites are located at an elevated position, about 30–40 m above sea level, showing altogether that these were not directly connected to the shore in the Bronze Age. Nevertheless, the proximity to the seaside was within a short distance of around 300 m, and all the rock art locations here overlooked the same shallow bay as those in Gerum and Lövåsen (Fig. 7.3). I will limit the analysis of Sotetorp to three of the panels or backgrounds, namely Tanum 356:1, 357:1, and Tanum 361:1. The first (Tanum 356:1), is located on an almost vertical surface and consists of about 13 ships and a couple of human figures, but what draws our attention is the scene at the bottom left. The scene captures three ships, the top depicts a large ship with two bi-horned warriors in the ship's fore and aft, both holding axe-like objects in one hand and making some kind of gesture with the other arm (Fig. 7.10). Particularly interesting is the warrior in the ship's fore who has a distinct hand with visible fingers that is held upright as if he is signalling direction. I will return to the possible significance of this below. Between these two prominent warriors, the rest of the crew has been shaped in a rather anonymous way in the form of crew lines. A human figure performs a somersault over the ship, as the carver skilfully captures the figure with remarkable zeal, tension, and motion.

An additional site (Tanum 357:1), located 15 m west of the previous one depicts a similar scene with two armed warriors, placed in the fore and aft in a boat, and an anonymous crew in the form of lines with dots as their heads (Fig. 7.11). Unlike Tanum 356:1, the helmsman is seated but pointing his weapon at the crew. Two acrobats are depicted above the ship and seems almost as if they are flying above the ship. Again, this reminds us of the depictions of the floating maritime warriors that were observed above at Medinet Habu and Lövåsen. Across the three sites we have seen both recurring and diverse depictions of basic themes like ships and warriors, as well as striking and unusual images. The importance of repetition in the *ductus* is also evident in the images of the vaulters or floating warriors at both Lövåsen and Sotetorp. The vaulters are impressive and likely helped with the memory process. However, there is one image that captures the tenor of the whole site.

The final example in Sotetorp (Tanum 361:1) is located at a slope 70 m uphill from the previous one and in the context of rock art, this image is peculiar and highly distinctive. The image portrays a substantial net-shaped structure hanging between two vessels, with a hand visible above the ship at the bottom (Fig. 7.12). Net figures from Bohuslän are rare, with only a few examples available. However, there is another net figure in the region that stands out due to its anthropomorphic formation where the figure features arms and hands (Fig. 7.13, Tanum 365:1). Various interpretations have been proposed regarding what the net and boats signify, ranging from the tale of Thor's catching of the Midgard Serpent to regular fishing (Almgren 1927). It is tempting to again make a comparison with the Medinet Habu reliefs. As stated above, the hieroglyphs accompanying the reliefs at Medinet Habu also describe how the Northerners were caught in a net set up by the Egyptians and then 'butchered, and their bodies hacked up' (Nelson 1943, 43, quoting Edgerton & Wilson 1936). In addition, the last relief scene at Medinet Habu (5) depicts the victorious moment and shows the counting of hands seized from the defeated enemies (Nelson 1943, 40). Here, then, we can observe similarities between the net, the hands, and maritime endeavours. However, instead of further examining the parallels between the two portrayals, I want to focus on another maritime feature that relates to the net and subsequently also to the hand.

Many ancient seafaring societies have depicted sea journeys using net-like symbols, sometimes made from branches or drawn in the sand. Each line represents a specific distance

*Figure 7.10. The photo shows two of the ships with bi-horned warriors and acrobat performing a somersault above one of the ships at the site Tanum 356:1 (photo: Tanums Hällristningsmuseum, Underslös; source: https://shfa.dh.gu.se/image/110413).*

*Figure 7.11. Armed warriors, placed in the fore and aft in the ship, and an anonymous crew in the form of lines with dots as their heads, above two acrobats performing somersaults at the site Tanum 357:1 (photo: Tanums Hällristningsmuseum, Underslös; source: https://shfa.dh.gu.se/image/109000).*

travelled over the ocean. Additionally, other Oceanian examples, including the stick charts of the Marshall Islands, provide support for this claim (Collinder 1943; Lewis 1972, 245–9; Finney 1998; Fig. 7.14). By use of a conceptual compass based on wind patterns and celestial navigation, the Oceanians were able to visualize the arrangement of the islands and mentally chart out the paths between them:

> In the Marshall Islands, competent navigators created 'stick charts' to represent islands and their impact on ocean waves by observing how islands altered the pattern of the swells. The charts were utilised for educating novices and as mnemonic tool before a journey. However, when these navigators embarked on their journey, they did not bring any tangible representations of islands, celestial positions, or swell patterns to assist them. (Finney 1998, 443)

The analogy to rock art imagery does not seem far-fetched, and something that Axel Emanuel Holmberg developed quite early (Holmberg 1848, 107), given that the need to easily recall and communicate distances, places, and positions at sea would have been equally essential throughout the Bronze Age and, naturally, a necessity in an oral society. The images of boats and net figures on the rocks might have served as a method of mnemotechnics, disseminating essential information regarding distances, locations, and stages at sea to both people going on sea voyages and those striving to gather and pass on this knowledge. The navigator's knowledge and recollection of several natural elements such as sea- and land-marks and the celestial bodies would have been a crucial skill that had to be quickly activated during perilous sea voyages. Instantly recalling what had been practised previously would have been essential for survival. Placing an image of a star formation, nautical skills, or other crucial information on a transparent backdrop would aid in the mariner's recalling of the procedure. It would have been

*Figure 7.12. Net figure on the site Tanum 361:1, connected to two ships, note also the depicted hand figure at the lower left part of the net figure (photo: Gerhard Milstreu; source: https://shfa.dh.gu.se/image/133953).*

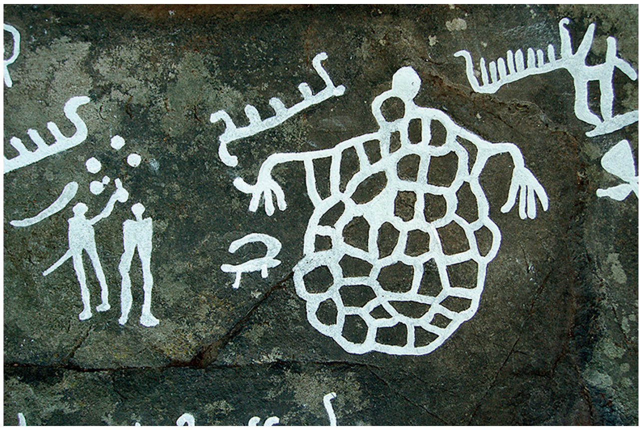

Figure 7.13. Anthropomorphic net figure depicted with two hands and a head at the site Tanum 365:1, in Trättelanda, Tanum (photo: Gerhard Milstreu; source: https://shfa.dh.gu.se/image/109003).

Figure 7.15. Freestanding stone with a hand design, ship and four lines at the site Tossene 832:1 (photo: Sven-Gunnar Broström & Kenneth Ihrestam; source: https://shfa.dh.gu.se/image/125136).

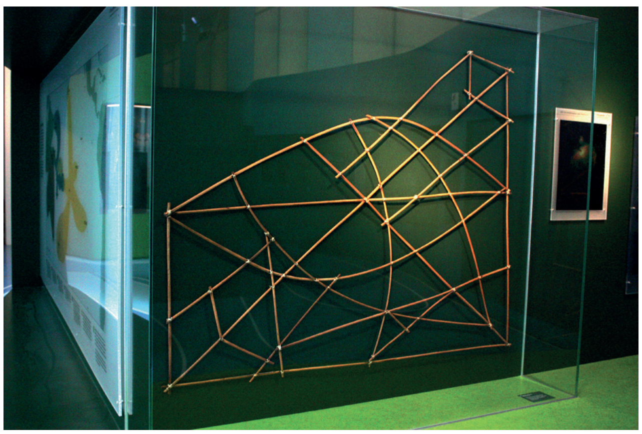

Figure 7.14. Stick chart from Marshall Islands in Überseemuseum Bremen (source: https://commons.wikimedia.org/wiki/File:%C3%9Cberseemuseum_Bremen_2009_063.JPG).

Figure 7.16. Anthropomorph with an enlarged hand figure as extension of the arm at the site Tossene 375:1 (photo: Sven-Gunnar Broström; source: https://shfa.dh.gu.se/image/133806).

necessary for the mariner to visualize the images vividly in his mind, including all its associated intricacies. Let us compare with other oral societies once again. For instance, in Polynesia, a navigator needed to be aware of a detailed star chart that included rising and setting stars connected to the intended route in order to calculate an exact direction. Polynesian navigators needed to know around 200 different star formations, and the learning process is described as taking place in several houses to make them easier to recall (Lewis 1972). As previously discussed, it is possible that the rock art site had a similar purpose, with the panels acting as backgrounds or architecture where images were placed for easy and quick recall.

And last, I want to go into further detail about the hand that is seen in the net figure picture (Fig. 7.12). Rock art often depicts a variety of hand forms, such as isolated hands, hands held in the air by adorants, and maritime warriors with raised hands, etc. Furthermore, there are also depictions of human figures with raised hands or hand designs connected to boats. These are most common in Tossene, a parish around 30 km south of Tanum, which also, remarkably, has the highest number of discovered so-called hand stones (Fig. 7.15).[13] It is crucial to emphasize that the Tossene parish is situated in a significant maritime location along the coastal area of Bohuslän. Additionally, all maritime transportation was required to travel through this vital narrow strip of land. Navigation around this isthmus was historically regarded as quite risky (Ling 2014). At the Tossene 375:1 site, there is a depiction of a human figure holding a sizable handheld gadget that also seems attached to a boat (Fig. 7.16) and at Skepplanda 20:1 there is a similar depiction of a freestanding hand figure at the prow of the ship (Fig. 7.17). The gadget could be interpreted as a prolongation of the arm and hand or alternatively as some kind of sun compass (cf. the sun stone and Viking navigation).[14]

Tossene 17:1, which shows a boat with the aft prow ending in a hand figure, is another version on the same theme, although here there are no persons associated with

*Figure 7.17. Hand figure depicted at the prow of a ship at the site Skepplanda 20:1 (photo: Andreas Toreld; source: https://shfa.dh.gu.se/image/112762).*

the motif (Fig. 7.18).[15] These images might be connected to the art of navigation, and I will further explore this below. Navigation theory was largely transmitted orally by skilled navigators, and it has traditionally been a highly specialized and enigmatic profession. Early navigation had to be dependent on the bare hand, which was the main instrument, and it may be used to calculate a route by measuring the angle of a celestial arrangement, such as the sun, planets, or stars (Cunliffe 2017, 66). Again, let us turn to maritime ethnographies and initially those that have been carried out along the south-east coast of China. Here the mariners rely on their fingertips as an essential 'instrument' for determining the height of the stars in the sky (Chunming 2021, 199). With only five naked fingers, fishermen on the South Island of Qingla in Wenchang County, Hainan, estimated the height of the North Star (Big Dipper) above the horizon:

> They extended their right hands above sea level, expanding the palm with its center forward and the thumb downward, the end of the thumb was tangent to the sea-sky connection line and the little finger upward, then the observed corresponding positions of North Star on this palm rule such as the index finger, middle finger, ring finger, and little finger respectively indicated the heights of one zhi, two zhis (half palm), three zhis and four zhis (one palm) of the star above the horizon. (Chunming 2021, 200)

This ancient navigation technique is still practised in the South Pacific (Lewis 1972 19, 158; Chunming 2021, 214, 219).[16] Furthermore, it has been suggested that the Vikings employed their hands and the extension of their right arm for navigating (Collinder 1943, 93; Haasum 1974, 100). This suggests that they acquired knowledge of different angular measures that could be taken with their hands from practical experience. Also, within astronomy the hand seemed to play a crucial part. It is possible that angular distances were estimated by extending the hand at arm's length in front of

*Figure 7.18. Hand figure depicted as an extension of the prow in a ship from the site Tossene 17:1 (photo: Sven-Gunnar Broström & Kenneth Ihrestam; source: https://shfa.dh.gu.se/image/123840).*

*Figure 7.19. Large anthropomorph with his arm and large hand overlaying the ship at the site Tossene 923:2 (photo: Lasse Bengtsson; source: https://shfa.dh.gu.se/image/125849).*

the eye. This practice may be reflected in the later use of the word *δακτυλος* (meaning 'finger' or 'finger's breadth') in astronomy to represent the degrees of totality in an eclipse, with 12 'fingers' indicating a total eclipse (Dicks 1970, 10).[17]

Now, let us return to the rock art. There are several images in the open-air sites that show the same kind of positioning of the hand and arm as the descriptions above. For example, the Tossene 923:2 image shows a huge human figure with its arm and large hand overlaying or becoming part of a boat (Fig. 7.19); the ship's keel extension is altered to resemble a human arm and hand. Furthermore, Tossene 427:4 depicts the arm of the human figure as an integral part of the ship's keel (Fig. 7.20). Images of the hand is prevalent in Bronze Age rock art but has not previously been associated with the maritime domain or more specifically with navigation. I suggest that the images of the hand and arm above relate to the hand as an important device in ancient navigation techniques and, further, that it formed a crucial component in the *ductus* of maritime war battle, ritual, and navigation.

*Figure 7.20. Anthropomorph with raised arms attached to the keel extension of the ship at the site Tossene 427:4 (photo: Sven-Gunnar Broström & Kenneth Ihrestam; source: https://shfa.dh.gu.se/image/128304).*

Richard Bradley has also connected the maritime practices in the Pacific with Scandinavia. He writes:

> Here archaeologists confront a similar problem. Over an enormous area extending across South-east Asia and Micronesia the ship provides a means of transport vital to long-distance trade. At the same time, the boat is used as a metaphor for the organization of individual communities, and a means of passing between the worlds of the living and the dead. Just as the ship is a symbol associated with Bronze Age cemeteries in Scandinavia, in the Pacific people may be buried in stone settings in the form of seagoing vessels. (Bradley 2009, 130)

Bradley concludes that the similarity between the geographically distant continents arises from the distinct importance of water transportation and the diverse methods by which it has been ceremonialized. Thus, Bronze Age communities most likely understood and used the marine environment within a cognitive framework that blended sophisticated ceremonial and ritual features with real-world experience gained from long distance travel.

## Conclusion

This chapter has tried to highlight the possibilities that the rock art sites had a pragmatic and practical function, particularly when it comes to the maritime realm. It has been suggested that the rock art sites could have been used as places not only for teaching maritime practices but also to tell stories about perils and adventures at sea. It has also been argued that the sites might have served as memoranda when the mariners were out at sea – either at war or navigating. By engaging with the art and moving through the architecture of these ritual environments, participants may have built up a visual memory of their movements around the rocks in the landscape that could have provided them with theoretical knowledge and strategies to overcome future troubles at sea. One could say that the sites offer instruction via *memoria* and exploration via *ductus*. So, though in rhetoric *ductus* is an aspect of arrangement or disposition, it pertains always to some guiding movement within and through a work's various parts. Thus, the notion of *ductus,* of conducting oneself through the spaces of the landscape or the architecture of rock art: guided along the way by images or objects, is essential not only to *memoria*, but also to the experience of open-air rock art. One must move around and between the sites guided along the way by the positioning of images or by the connections between the sites in the landscape, between which people moved perhaps in process or as part of rite or learning process. It would have been a bodily effort, much like conducting oneself through the spaces of architecture in a medieval cathedral: 'From portal sculpture to stained glass, from screen to altar imagery' (Crossley 2010; see also Lindhé 2016). Similarly, the rock art must be worked through, not just experienced as an object from a distance.

Interpreting Bronze Age rock art via the logic of a linear narrative framework might limit the dynamic aesthetic of rock art. This logic assumes that there is a certain sequence in which the many motif clusters in the rock should be read or understood.[18] Conversely, if we employ the mnemotechnics of ancient rhetoric, where memory practice was linked to a broad, random place orientation, frequently based on locations in the landscape or in different architectural forms, this technique approaches the narrative setting of the rock art at the sites more closely. The sites could have worked as an intricate and complicated layout to direct those navigating through them down a variety of potential paths, each of which provides a profound experience – one must walk the pathways to understand their significance (cf. Bradley 2009; Carruthers 2010). And they might differ depending on the aim of the specific occasion, such as an initiation rite, preparation for a hunt or voyage at sea. Thus, rock art was not stable throughout time, it was updated, re-used, and re-imagined (Horn & Potter 2020). With rhetoric it might be possible to develop new approaches to understanding the directional function of rock art in the landscape, enabling us to move away from a definition of the sites merely as a collection of images and toward a focus on the connection between clusters of images and sites in the landscape.

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## *Notes*

1 According to Helen Farr (2010), there has been a major emphasis on boat construction, shipwrecks, underwater excavation, and conservation in prehistoric maritime research: ‘As such the process of seafaring and the light it can shed on social organization …, cognition, early quantification and prehistoric spatial and temporal understanding have been missed’ (Farr 2010, 19).

2 While the examples primarily focus on maritime aspects, it is likely that *memoria* also were of similar importance in other fields such as hunting, ritual practices, and warfare.

3 In the following, all the referenced rock art sites, such as Tossene 73:1, Foss 6:1, and Kville 100:1 etc, can be accessed by the open-source database SHFA: https://shfa.dh.gu.se/

4 Currently, I am writing an article that investigates the depiction of sun or wheel cross symbols in connection with celestial navigation in the rock art of the Scandinavian Bronze Age.

5 The catalogue is a characteristic of ancient epic poetry, and lists are used for invocation, administration, and memorizing. In an epic poem, the catalogue can, for instance, expand the story’s time and place, as well as the poet’s authority by showing the audience his extensive knowledge of a topic. See for example Crosset (1969); Gaertner (2001). Catalogues are a common feature found also in historical and didactic texts, see for example, Armayor (1978).

6 According to Roman legend, the *ars memorativa* was invented by Simonides, a Greek lyric poet of the 6th–5th centuries BC. Cicero tells the story of how Simonides attended a supper held by the affluent Scopas, who had requested that a poem be sung in his honour. Scopas was displeased when Simonides finished delivering the tribute and began arguing over the previously agreed upon payment. While Simonides is contemplating the new amount, two men approach him and insist that he goes outside. Shortly afterwards, the building’s roof collapses, causing such devastation that it was impossible to distinguish the badly mangled visitors. As a result, the friends of the deceased proposed burying them all together. This was prevented by Simonides who had the ability to identify every person by their placement at the table. The Simonides legend illustrates the rhetorical practice of *memoria*, where memory images were to be stored in a spatial framework to enhance memory recall and allow for the speedy retrieval of stored knowledge: see Cicero (*de Oratore* 2.86.351–54).

7 *Memoria* has received significant attention among interdisciplinary art historians due to a collection of influential books authored by Mary Carruthers. This chapter is partially based on her discussions about the concept, although her studies of the artistic mnemonic are confined largely to early medieval art.

8 Only four handbooks of *Progymnasmata* remain, credited to Aelius Theon, Hermogenes of Tarsus, Aphthonius of Antioch, and Nicolaus the Sophist (Kennedy 2003).

9 Etymologically, *ekphrasis* originates from Greek *ek* (out) *phrazein* (to explicate, declare) and meant originally ‘to tell in full’.

10 In *Progymnasmata*, Hermogenes describes *ekphrasis* as an expression that brings about sight through sound: ‘Virtues (*aretai*) of an ecphrasis are, most of all, clarity (*saphêneia*) and vividness (*enargeia*); for the expression should almost create seeing through hearing’ (Kennedy 2003, 35); Theon writes that ‘Ekphrasis is a descriptive (*periegematikos*) speech which brings (literally “leads”) the thing shown vividly before the eyes’ (see Kennedy 2003, 45; Webb 2009, 51). *Periegematikos* is an adjective that equates the speaker with a guide that shows ‘the listener around the sight to be described, similar to how Pausanias led the reader around Greece in his *Periegesis*’ (Webb 2009, 54). It must be remembered how vivid description worked in the minds of the audience, and Ann Vasaly, suggest that ‘ancient, nonliterate society may well have possessed powers of pictorial visualization much greater and more intense than our own’ (Vasaly 1993, 99).

11 Artificial memory, in contrast to natural memory, is the result of intentional training rather than being inherently linked to cognition. See *Rhetorica ad Herennium* (3.16.28–30); Cicero (*De Oratore*, 2.354–60); Quintilian (*Institutio Oratoria*, 11.2). Aristotle also briefly mentions the use of mental pictures in mnemotechnics in *On the Soul* (427b 18–20) (Webb 2009, 110–13; Carruthers 2008; Yates 2010).

12 He compares these backgrounds or settings to wax tablets or papyrus, where the images are very similar to letters (*Rhetorica Ad Herennium* 3.16.30). Particularly interesting in connection to rock art is how the author uses wax tablets as an example of a setting. Plato’s *Theatetus* is regarded as the first work to establish the concept of the seal-in-wax model of cognition. However, it is important to note that Plato acknowledges his role as an elaborator on a metaphor that had already been present in the works of Homer. Mary Carruthers summarizes the idea of the seal in wax as ‘basically a model of inscription or incising, as writing is incised upon a clay or wax or stone surface’ (2008, 25).

13 In Scandinavia several hand stones that most frequently depict vertical lines, a hand, and a ship, have been found in connection with burial sites. Joakim Goldhahn has written extensively on the hand stones and shows that the hand symbolism was diverse and related to several phenomena in the later Bronze Age. However, he mainly relates them to burial practices; nonetheless, he suggests that the hand motif from the landscape’s open panels is up for debate (Goldhahn 2009, 10; see also Hansen (2020) for an extensive overview of hand stones in Scandinavia). The hand is depicted in two distinct formats: on so called hand stones and in open-air rock art, here I will focus only on the latter ones and return to the hand stones and navigation in an up-coming article.

14 According to Larsen (1973, 162) as cited in Haasum (1974, 100), the boat could function as a peel plate and had peel markings on the top table that could be seen from a certain location on board. The sagas refer to an object known as the *sunbraet* or the sun table. In Ramskou’s interpretation (1966, 27–8), the solar *braet* is described as a disc that is not tightly attached. Ramskou also states in a subsequent phrase (1969, 49) that to measure the height of the sun, it is essential for

the instrument to be held in the hand. The identical analysis is provided by Almgren (1967, 11; see also Haasum 1974, 100).

15 Almgren (1927) has interpreted the formation in the ship as a tree, or a maypole. However, the 'tree' depicted on Tossene 17:1 is one of its kind and displays five fingers. There are other sites, for example Tossene 73:1 and Foss 6:1, where there are tree formations confirmed by other iconography, cf 'Tree-carrying ships' (Baltzer 1881–1908).

16 See for example: https://itboat.com/articles/4891-in-the-footsteps-of-the-brave-moana

17 Much of this may be found in the elementary handbooks of astronomy written by Geminus in the 1st century BC and by Cleomedes in the 1st century AD (Dicks 1970).

18 Further, knowledge of the right way in which to read the signs, abstract as well as naturalistic, on the rocks could also have been dependent on the audience and change over time. For a discussion about the distinction between naturalistic and abstract imagery in Scandinavian rock art, see Bradley (2000, 64–80).

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# 8

# Archaeology and science: the impact of lead isotope analyses on the archaeological discourse of metal trade for the Scandinavian and British communities in the 3rd–1st millennia BC

*Zofia Anna Stos-Gale & Johan Ling*

*Recent research projects based on lead isotope and chemical analyses of Bronze Age artefacts from Scandinavia prove unequivocally that the local ore deposits had not been used and that the earliest copper-based metals are isotopically consistent with the copper from the Welsh mine in Great Orme, the Austrian Alps, and the Slovak Ore Mountains. However, from the 2nd millennium BC the majority of artefacts made of tin-bronze found in Scandinavia, England, and Ireland, have the geochemistry and lead isotope compositions characteristic of the copper ores found in the Italian Alps, Sardinia, and southern Spain. Given the fact that the largest copper and tin deposits in Europe are located in the Iberian Peninsula these results should perhaps not be unexpected; however, the discovery of Iberian copper in Scandinavia, the British Isles, and Ireland in bronze artefacts of 1400–800 BC is nevertheless startling, challenging earlier thinking about Bronze Age maritime networks and Iberia as a metal producing region.*

## Introduction

In the early 2nd millennium BC copper metallurgy in Europe expanded across the continent and the alloy of copper and tin – bronze – became the most sought-after metal for making tools and weapons (Earle et al. 2015). An advanced metallurgical industry emerged in Scandinavia about 1700 BC, where the skill of local bronze craftsmen is attested by numerous finds of spectacular bronzes such as swords, axes, lures, and shields (Vandkilde 1996; Kristiansen & Larsson 2005; Harding 2007). The remains of casting in the form of crucibles and moulds from Bronze Age workshops have also been found, including droplets of bronze, copper, and tin (Ling et al. 2014). However, in comparison to all these finds, there are surprisingly very few examples of copper ingots (Melheim 2015; Ling et al. 2013; 2014). Based on this observation, it was originally proposed that copper was sourced from local ore deposits in Norway and Sweden (Frietsch et al. 1979; Prescott 2006). However, recent research using the most up-to-date analytical methods has proven that over 900 copper alloy artefacts from Scandinavia dating back to the Bronze Age could have not been made from the copper ores found in Scandinavia (Ling et al. 2013; 2014; 2019; Vandkilde 2017; Melheim et al. 2018a; Nørgaard et al. 2019; 2021). These results were initially obtained by the 'Moving Metals project' based at the University of Gothenburg (Ling et al. 2013; 2014; 2019; Melheim et al. 2018a) and have provided fresh insights into metal supply and trade networks, as well as new theories on the role of Scandinavians in the Bronze Age pan-European metal exchange systems.

New evidence has challenged earlier typologically based assumptions about the origins of Bronze Age artefacts found in Scandinavia, suggesting not only the use of metal from the expected sources of copper ores in the Austrian Alps, the British Isles, and the Slovak Ore Mountains but also the use, from the second half to late 2nd millennium BC onwards, of metals imported from the Italian Alps, Iberia, and Sardinia (Ling et al. 2014; 2019; Melheim et al. 2018a). Even more unexpected is the discovery of copper from Cyprus in Scandinavia (Ling et al. 2014; 2019). These efforts have inspired a new era of theories, models, and debates on provenance, production, and consumption of copper and long distance exchange.

The research project Maritime Encounters focuses on maritime links arising during the 3rd–1st millennia BC between the Atlantic north and south-western metal producing areas. Previous research projects at the University of Gothenburg (Ling et al. 2013; 2014; 2019; Melheim et al. 2018a), together with research conducted in other European countries (Schreiner 2007; Pernicka et al. 2016; Nørgaard et al. 2019; 2021; Williams & Le Carlier de Veslud 2019; Artioli et al. 2020; Berger et al. 2022; 2023) has considerably advanced our knowledge of Bronze Age Europe by identifying the provenance of the copper used in different regions, using combined chemical and lead isotope analyses. These research projects revealed a growing and, by the mid-2nd millennium BC, increasingly integrated trade system of metals and other commodities (Earle et al. 2015). In Ireland and Britain, rising demand for copper coincided with a decline in insular mining, where the mines in Parys Mountain, Copa Hill, and Alderley Edge ceased production, leaving only the Great Orme mine as the major source of copper in the period 1600–1000 BC (Williams 2023, fig. 4.19). Around 1400 BC the increased demand for high purity copper for making tin bronze swords created a selective market for copper from the Italian Alps, Sardinia, and southern Spain (Ling et al. 2019). Recent research indicates that copper from the Iberian Peninsula was one of the sources replacing British copper from about that time (Ling et al. 2024; Berger et al. 2022). Also, at this time, Baltic amber appears in Iberia in the vicinity of known copper mines (Díaz-Guardamino et al. 2022). An important aspect of the trade between the peoples of Scandinavia, Ireland, the British Isles, and Iberia is the role of the inhabitants of Atlantic France and the possibility of their participation in the metal exchange. This relationship is also included in the Maritime Encounters project.

Iberia is very rich in copper, lead, and silver ores, but knowledge of their exploitation before the Roman period is very limited. The surveys of possible ancient mines in the last 40 years indicated that mining in the Bronze Age was intensive (Hunt Ortiz et al. this volume, Chapter 9) but the exact localities of many Bronze Age mines and their period of exploitation are still not known. Answering, at least partly, this research question is also one of the aims of the Maritime Encounters project.

## Scientific evidence for Bronze Age metal trade between Scandinavia, the British Isles, and Iberia

### *Lead isotope and chemical analyses of ores and artefacts as comparative fingerprints*

In 1982 it was proposed that the origin of copper could be found by comparative analyses of the isotopes of lead present in copper ores and smelted copper (Gale & Stos-Gale 1982; Stos-Gale 2018). The lead isotope analyses of lead and silver had been used previously for identifying the source silver used in the Bronze Age Aegean and later Archaic Greek silver coins (Gale et al. 1980; Gale & Stos-Gale 1981). The methodology is based on the differentiation of lead isotope compositions in minerals formed at different times. This method has been used by geologists since the 1970s to date the formation of rocks and minerals but, in archaeology, is used by comparing the lead isotope ratios in ancient metal artefacts with the data available for the ore deposits (Pernicka 2014; Gale & Stos-Gale 2000; 2002; Artioli et al. 2020; Killick et al. 2020). The elemental compositions of minerals in copper and lead/silver deposits can be very similar in different geographical regions, but also very different in the same deposit (Schreiner 2007). Also, the minor and trace elements present in copper ores divide during smelting of copper between metal and slag, therefore they do not reflect directly the composition of the ore (Tylecote et al. 1977). However, the lead isotope compositions of ore deposits are strongly differentiated across Europe (Blichert-Toft et al. 2016, fig. 3) and the lead isotope ratio of lead from the ore does not change during smelting and melting of metal.

It needs to be emphasized that the lead isotope ratios by themselves do not provide the direct answer to the questions of the provenance of ancient metals in the way, for example, as radiocarbon dates. Each lead isotope composition of the artefact has to be considered together with its chemical composition and then compared with the geochemistry of the ores in the deposit which has lead isotope ratios consistent with this artefact. Additionally, there is a necessity of assessing if this deposit that seems consistent with the geochemistry of the metal could have been exploited in the period when the artefact was made. Archaeometallurgical surveys of ancient mines often provide very reliable dates of their exploitation (Stos-Gale 1989; Artioli et al. 2016; Pernicka et al. 2016; Williams 2023).

Currently the comparative database of lead isotope ratios of copper and lead/silver ore deposits in Europe consists of more than 10,000 lead isotope ratios. Comparisons are most efficiently done using TestEuclid calculations (Ling et al. 2014) to select ore deposits with minerals isotopically close to the artefact's and then a further procedure that includes plotting the groups of data points and considering the geochemistry and antiquity of mining of selected mineralizations.

In the early stage of the research into the lead isotope provenance of metals this method provided results that challenged the established archaeological theories as to the sources of copper in the Mediterranean during the Bronze Age, including the Cypriot origin of copper oxhide ingots found on Sardinia (Stos-Gale & Gale 1992; Stos-Gale et al. 1997; Hauptmann 2009), the exploitation of copper occurrences on the Cycladic islands (Stos-Gale 1989; 1998; Gale & Stos-Gale 2008), and the mines in Lavrion (Gale et al. 2009). The 20 years of research in Oxford into the sources of metals used in the Mediterranean during the Bronze Age indicated that different regions relied mostly on their own sources of copper and there was no widespread recycling of copper based alloys (Stos-Gale 2000).

The research into lead isotope provenance studies of ancient metals in Oxford provided a considerable database of lead isotope compositions of copper, lead, and silver ores from the Mediterranean, Bulgaria, and the British Isles. These data were initially published in consecutive volumes of the Archaeometry (1995–1998) and in 2010 in the first digital open access database OXALID (http://oxalid.arch.ox.ac.uk). Following this initial research, another strong group applying the lead isotope and chemical analyses to provenance ancient metals emerged in Germany. Their archaeometallurgical research in central Europe and in Turkey, based on fieldwork and chemical and lead isotope characterization of multi-metallic ores, has considerably increased the available comparative database (Seeliger et al. 1985; Wagner et al. 1986; Pernicka et al. 1993; 2016; Niederschlag et al. 2003; Höppner et al. 2005; Schreiner 2007). The lead isotope data for ore deposits obtained in the archaeometallurgical research has been greatly supplemented by numerous publications by geologists who use the lead isotope ratios for the purpose of establishing the geochronology of the ore formations. Such publications provided a large body of data for ores in France, Germany, Italy, the Iberian Peninsula, and Scandinavia. Unfortunately, there is no overall open database of published lead isotope ratios that can be used for archaeological provenance research, apart from the OXALID and the data for the Iberian Peninsula recently complied and made available by the University of the Basque Country (IBERLID: http://www.ehu.eus/ibercron/data/IBERLID.xlsx).

However, everyone pursuing this line of research has developed their own independent databases that currently include about 10,000 lead isotope ratios of the ores and archaeological slags from the European and some Near Eastern copper, lead, and silver mines. There are also several thousands of published lead isotope data, mostly relating to the chemical compositions of prehistoric metal artefacts from Europe and the Near and Middle East. There is also a growing interest in this research in China and another large database of non-European metal sources is being developed. Recently Klein et al. (2022) suggested an introduction of a ‘modern’ lead isotope database that might provide a breakthrough in research in this field.

## Copper used in Northern Europe in the Bronze Age: ores from the Western Mediterranean or merely from Mitterberg and the Slovak Ore Mountains?

Since 2010 at the University of Gothenburg a team of archaeologists, archaeometallurgists, and geologists from Sweden, Norway, and England have conducted research using lead isotope and trace element analyses to study the origin of bronze artefacts from Scandinavia. The interpretation of these analytical data has been updated over time (Ling et al. 2024) due to new publications of reference data, but it was possible to demonstrate without a doubt that none of the Scandinavian copper deposits was used for the bronze objects. However, one major concern of the interpretation of these data was that the lead isotope and chemical data of the analysed bronzes have not revealed the predominance of copper originating from the Central European ore deposits.

In 2016 Pernicka and his colleagues published an important paper describing their archaeometallurgical research in the region of Mitterberg (Pernicka et al. 2016) that has long been acknowledged as one of the major producers of copper in the Austrian Alps during the Bronze Age (Eibner-Persy & Eibner 1970; Eibner 1972; 1974). In this paper they published for the first time large datasets of the chemical and lead isotope analyses of ores and slags from these mines and included a substantial discussion emphasizing the importance of the region for supplies of copper in Bronze Age Europe. However, the analyses show that amongst the Scandinavian bronzes, only those that can be dated to about 18/1700–1500 BC are isotopically consistent with the ores from Mitterberg (Ling et al. 2019; Nørgaard et al. 2019; 2021). Also, the claims of the use of Fahlerz copper as the most common source of ore in Early Bronze Age Europe are somewhat over-reaching due to the fact that there is no evidence of such copper in the Mediterranean (Mangou & Yoannou 1997; 1998; 1999; 2000; Rovira Llorens et al. 1997) or in Britain (Rohl & Needham 1998 and OXALID).

In many of the papers published by this group there is too much reliance on comparisons of elemental compositions of ores and artefacts in order to claim that lead isotope compositions of ores from various deposits ‘overlap’ greatly, while ignoring the fact that the ‘overlaps’ in the trace elemental compositions of ore deposits are much more pronounced (Pernicka et al 2016, 37). This approach, and the belief in their theory of strong contacts between Scandinavia and central Europe that procured copper from Mitterberg and Slovak Ore Mountains, result in ignoring the lead isotope patterns of the bronzes dated to 14/1300–500 BC published by Ling (Ling et al. 2014). However, a new publication of the lead isotope and chemical analyses of copper ingots from the Salcombe Bay wreck in south-west Britain demonstrated that they are also consistent with the ores from Spain or Sardinia (Berger et al. 2022). It is now clear that the large group of Scandinavian bronzes that have lead isotope ratios in the same range as the Salcombe metals and which were disputed by Pernicka et al. (2016) are not consistent with the ores from the Slovak Ore Mountains but with those from Spain and Sardinia. The mineral deposits on Sardinia are largely lead/silver ores, the copper ores are in great minority and their exploitation in the Bronze Age is still under investigation (Stos-Gale 2023).

In the next two years following the first publications of chemical and lead isotope analyses of bronzes from Scandinavia by the Gothenburg team, another important set of publications appeared containing the results of archaeometallurgical surveys and lead isotope data for the ores and Bronze Age copper slags in the Italian Alps (Addis et al. 2016; Artioli et al 2016). These publications revealed that many of the bronzes from Scandinavia that we interpreted as consistent with the ores from Spain and Sardinia are also consistent with the lead isotope ratios of the ores from the Italian Alps in the region of Trentino-Bolzano (Melheim et al. 2018a; 2018b; Ling et al. 2019).

It is no surprise that the lead isotope ratios from the copper-lead-silver mineralizations in the south Sardinia, south Spain, and the copper ores from the Italian Alps can be quite similar, because they have been formed at similar times, between 470–750 million years ago. However, a careful examination of the lead isotope data for these ores shows that the 'overlap' is not absolute (Fig. 8.1). The lead isotope data for the ores from the region of Trentino-Bolzano (defined by Artioli et al. (2016) as different geological phases in the Eastern Alps) form a nearly straight line on the plots to $^{206}Pb$ that cuts through some of the data for the ores from Spain, but is quite separate from the distribution of the ores from Sardinia. Figure 8.2 shows the comparison of the ratios to $^{204}Pb$ for the same ore and copper slag samples. Here the data points for the ores from Valsugana VMS and some ores from the Alcudia Valley and Badajoz in southern Spain seem to overlap, but some of them differ on the plot to $^{206}Pb$.

However, there is no possibility of deciding between some of the Spanish ores and the ores and slags from the Italian Alps and, at present, there are not enough available chemical analyses of the ores from either of these regions to make geochemical comparisons, so it has to be accepted that in some cases there is a possibility of either of these deposits being the source of copper for the given artefact. The plots of data on Figure 8.2 also clearly demonstrate the difference between the ores from Mitterberg, Great Orme, and the Slovak Ore Mountains and the ores from the Italian Alps and southern Spain.

## The ore deposits in Spain and their exploitation in the Bronze Age

Geologists and metallurgists have been writing about ancient mining in Spain for over a century. The first to suggest that copper and silver mining in Spain started in prehistoric times were the Siret brothers in their book published in 1890. In 1935, Oliver Davies wrote in his book on *Roman Mines in Europe*: 'For about a century before and after beginning of the Christian era Spain was the most important metal-producing country of the world; Pliny says, with some exaggeration, that nearly the whole land abounds in gold silver, lead copper and iron' (Davies 1935, 94).

In 1970 Leonard Salkield published a detail discussion of the ancient slag heaps in southern Spain, concentrating mostly on the region of Huelva, where the most important mine in Spain, Rio Tinto, has been known to produce copper and silver since Roman times. South-west Spain was also the focus of the first modern archaeometallurgical survey by Rothenberg & Blanco-Freijeiro, who concluded that: 'After an apparently long period of cultural stagnation in south-west Iberia reflected in total absence of any remains of this period at the metallurgical sites investigated by the survey, the Late Bronze Age appears as a period of renewed and wide spread mining and metal making' (Rothenberg & Blanco-Freijeiro 1981, 170). Some years later Marcos Hunt surveyed and analyzed numerous ores and prehistoric metal artefacts from the region of Huelva (Hunt-Ortiz 2003).

The copper and lead/silver deposits are not confined to Huelva in south-west Spain. There are many mining sites east of Huelva in the region of Jaen (Marcoux 1998), in the Los Pedroches mountains (Santos Zalduegui et al. 2004), and Alhamilla mountains and along the Gudalquivir river (Saez et al. 2021). More copper ores are found in the south-east in the Betic Cordillera region (Arribas & Tosdal 1994) and in the province of Badajoz. So far none of these copper mines has been extensively surveyed archaeometallurgically and practically all published lead isotope data were made for geochronological research.

What is really lacking for a scientific assessment of metal extraction activities in the later part of the Bronze Age is the presence of slag heaps dated to this period, the most important evidence of metal smelting. In this respect the archaeometallurgical research in Spain is very different from the research carried out in the last 50 years in Cyprus (Stos-Gale et al. 1998), the British Isles (Williams 2018), or the Austrian and Italian Alps (Weisgerber & Goldenberg 2004), where the slag heaps and mines have been thoroughly explored and, in many cases, prehistoric activities have been dated. There is no doubt that such later Bronze Age smelting sites exist in Spain, as has recently been proved by the excavation at Las Minillas (Hunt Ortiz et al. this volume, Chapter 9) and it seems that more such sites might be published in the near future. Obviously, such findings should also be accompanied by an extensive lead isotope and chemical analysis programme. However, the numerous finds of copper based artefacts from archaeological sites dated to the Bronze Age do not leave any doubt as to the extensive metallurgy taking place in the south and west of the Iberian Peninsula, perhaps in different regions at different periods (Rovira Llorens et al. 1997; Hunt Ortiz 2003).

An even more important aspect of Iberian Bronze Age metallurgy is the presence of tin ores in the western part of the peninsula. Nearly 25 years ago Craig Meredith surveyed La Mina El Cerro de San Cristobal south-west of Toledo and put forward the hypothesis of its exploitation in the Bronze Age (Meredith 2009). Further excavations of this mine dated

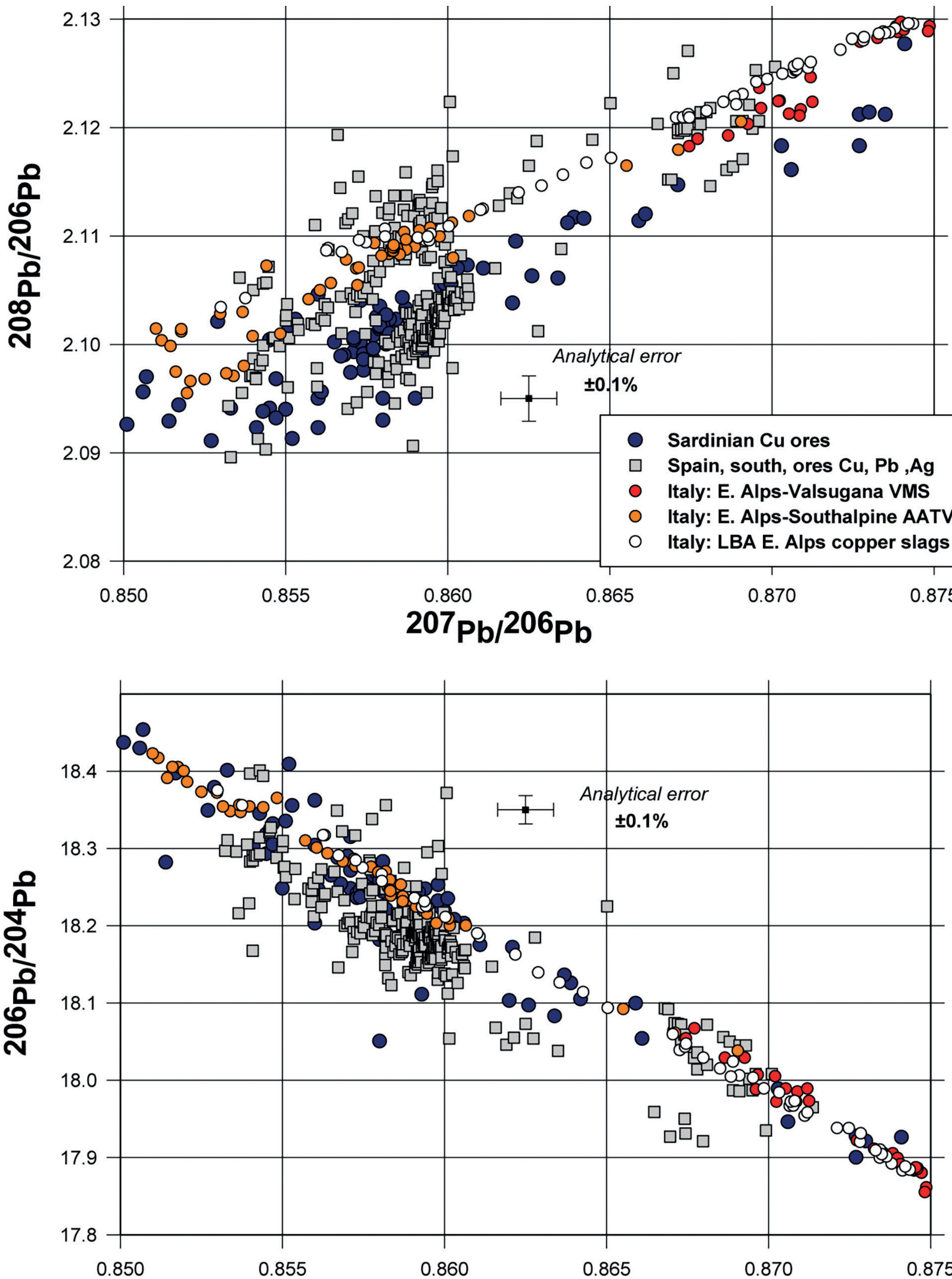



*Figure 8.1. Comparison of the lead isotope data for the copper ores from the Italian Alps with the data for the copper ores from Sardinia, and the multi-metallic ores from the south Spain, showing that these data overlap only in a certain range of the lead isotope ratios.*

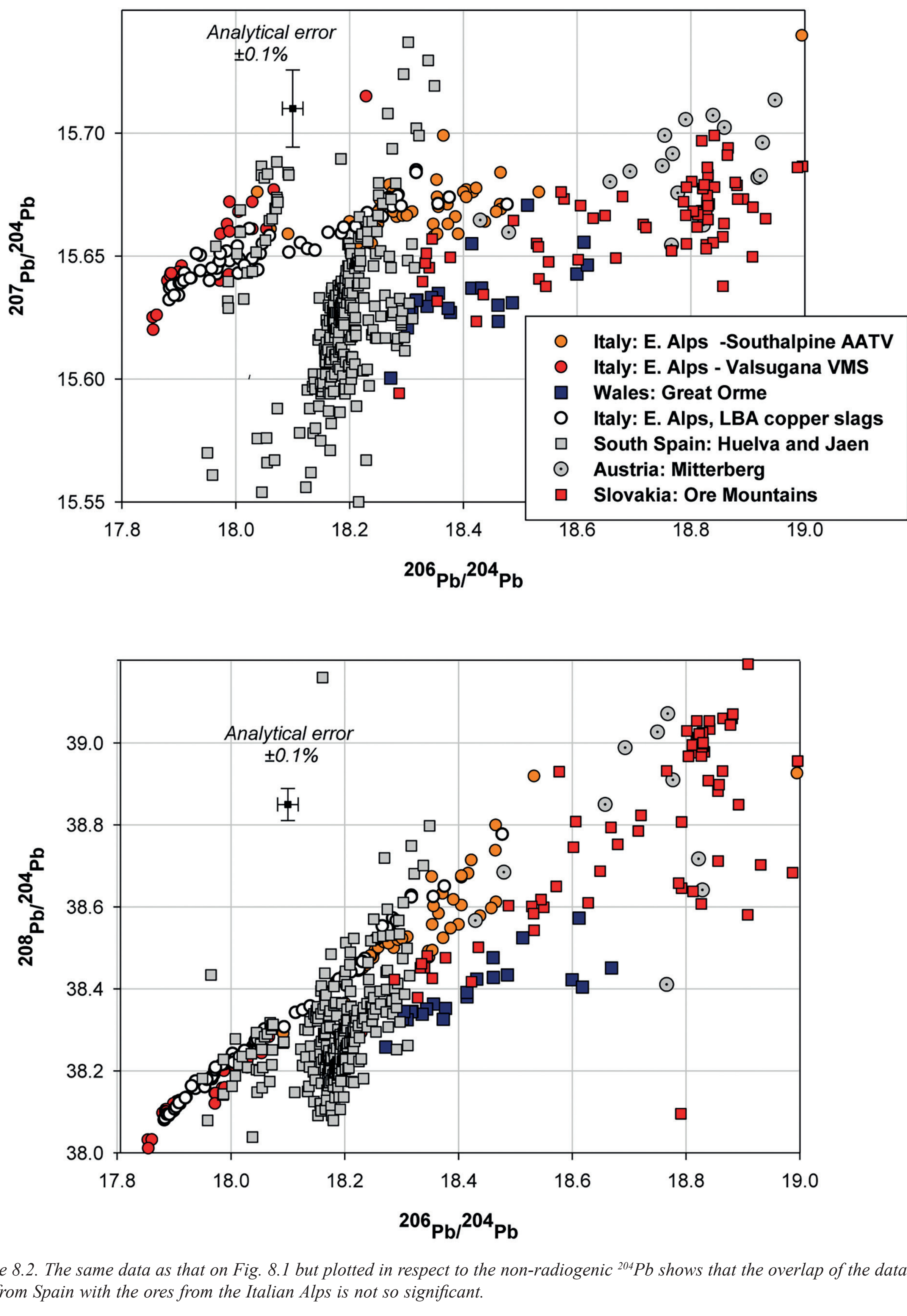



*Figure 8.2. The same data as that on Fig. 8.1 but plotted in respect to the non-radiogenic $^{204}$Pb shows that the overlap of the data for the ores from Spain with the ores from the Italian Alps is not so significant.*

the activities there to the 9th–6th centuries BC (Rodrigues Diaz et al. 2019). There is also evidence of Bronze Age production of tin bronze in Portugal (Valerio et al. 2013). It has been established that:

> the Iberian tin belt is not just much larger than the Cornish-Devonian field, it is the largest extension with tin ores available in Western Europe. Nevertheless, its importance has not been widely debated in archaeological historiography, resulting in some periods of strong affirmation, and others of almost total invisibility, depending on historical context at particular times, or on specific interests of individual researchers. (Comendador Rey et al. 2017, 133)

The understated importance of the Iberian tin belt has possibly significant implications for contact between Atlantic Iberia and Scandinavia, where it has been noted that most of the Scandinavian copper based artefacts dated later than about 1700 BC are exclusively high-tin bronzes (Ling et al. 2014; 2024; Melheim et al. 2018a).

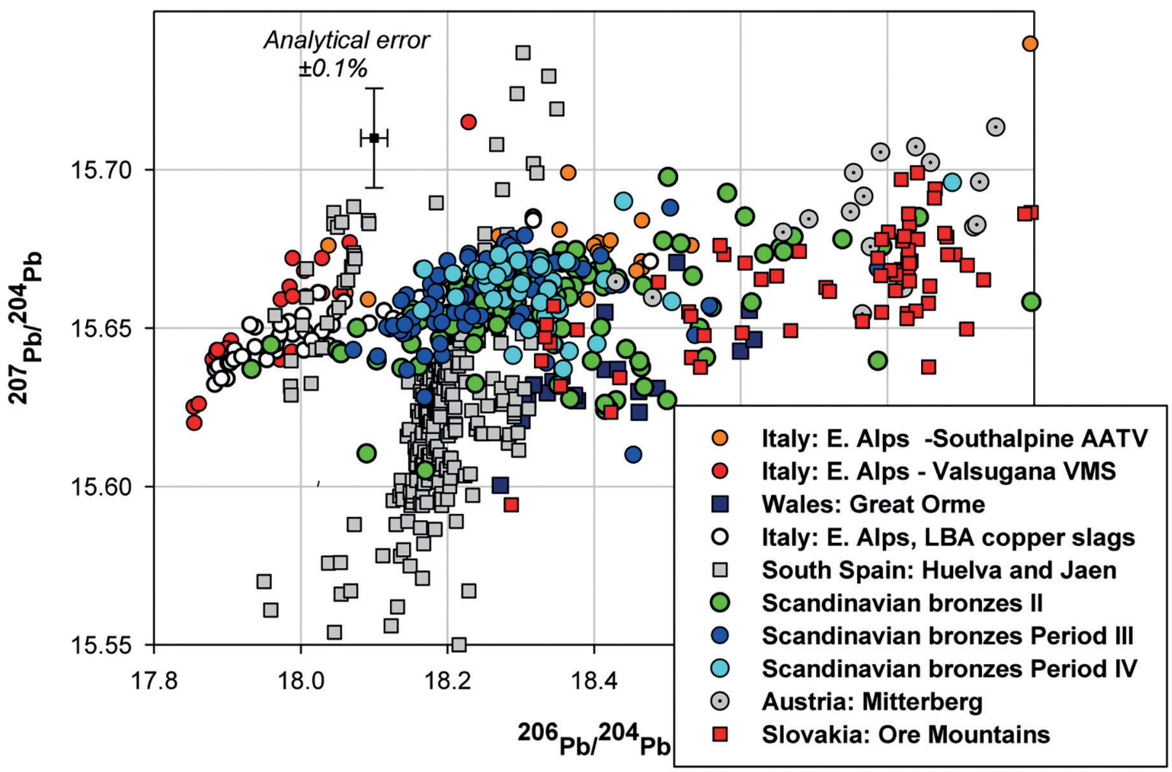
The Ossa Morena Zone in south-west of Spain is the geotectonic unit of the Iberian Massif in the south-west of the Iberian Peninsula that includes the greatest variety of types of mineralization and the largest number of ore deposits (Tornos et. al 2004). Tin ores occur in various outcrops there, as well as further west in the Portuguese part of the Iberian Massif (Marcoux 1998). The mining of tin and the production of tin bronze in the Late Bronze Age in Portugal is attested at several archaeological sites (Figueiredo et al. 2010; Valerio et al. 2013; Meunier et al. 2023) but such evidence seems lacking from Spain. While Spanish archaeometallurgy seems mostly focused on the investigation of Chalcolithic and Argaric copper metallurgy (see: IBERLID – the assembled lead isotope data for metal artefacts) the production of metals soon after 1500 BC seems, at present, to command very little attention among researchers.

## The lead isotope and geochemical evidence suggesting the origin of tin bronze imported to Scandinavia in the 2nd and early 1st millennia BC

To date, the research projects conducted at the University of Gothenburg have provided about 300 lead isotope and chemical analyses of bronzes found in Sweden, Denmark and Norway dated to about 1500–500 BC (Periods II–VI). With the continuous addition of samples to the lead isotope database the interpretation of their provenance is periodically reviewed. There are 115 analysed artefacts dated to Period II, 73 dated to Period III, and 45 to Period IV; spanning the period 1500–950 BC. The lead isotope data for these 233 bronzes form quite a compact group covering a relatively small range of the ages of the ore formations within the Pre-Cambrian to Cambrian period. Some bronzes dated to Period II have lead isotope ratios relating to the younger ores, as can be seen on Figure 8.3. The pattern of lead isotope ratios shows that, while in Period II the copper from the Great Orme, Slovak Ore Mountains, and Mitterberg is still present in Scandinavia, a large group of these bronzes is consistent with much older ores that can be found in the Italian East Alps (region of Trentino-Bolzano), Sardinia, and in the Iberian Peninsula. The group of Scandinavian bronzes with lead isotope ratios of $^{206}Pb/^{204}Pb$ between 18.2 and 18.4 is quite compact and includes some artefacts with ratios consistent with the ores from the Italian Alps and from southern Spain. The plot of the same data in respect to the $^{206}Pb$ (Fig. 8.4) shows that while some of these bronzes dated to Period II–III seem consistent with the data for the ores from Trentino-Bolzano mines, there are some artefacts, mainly with $^{207}Pb/^{206}Pb$ in the range 0.853–0.862, that are not fully consistent with the copper from Italian Alps, but fall within the ores from southern Spain. In particular, it is clear that the Bronze Age slags from the slag heaps in Trentino-Bolzano have higher $^{208}Pb/^{206}Pb$ ratios in this section of the plot and only a few of the bronzes from Scandinavia are consistent with their lead isotope ratios above the value of 2.11.

In Figures 8.3 and 8.4 the lead isotope ratios for all published mineral samples from south-west Spain have been marked with the same symbol for the clarity of the plots. However, ore occurrences in geologically different regions have different lead isotope characteristics (Fig. 8.5). In particular, the lead isotope ratios for the ores from the part of the mineralizations between Huelva and Sevilla, that include the large copper mines of Rio Tinto and Aznalcollar, group in a distinctive 'triangle' between the values of $^{207}Pb/^{204}Pb$ of 15.58–15.65 (Fig. 8.5). In the paper by Saez et al. (2021) the authors have chosen to group the ores that come from the area known to have been one of the centres of copper metallurgy between the 4th and 2nd millennium BC (Nocete et al. 2010) as the ores of 'Guadalquivir Valley', joining together various geological regions of mineralization. It seems that the bronzes from Scandinavia from Periods III–V, that have been identified by TestEuclid calculations as consistent with the ores from south-west Spain, isotopically fit very well with this 'Guadalquivir Valley' group of ores (Fig. 8.6).

One of the most significant parallels identified by the Moving Metals team (Ling et al. 2014) was that the consistency between three shields of the Herzsprung type (U-notched) from Sweden and the copper ores in the Jaen-Linares area, both in terms of Late Iron Aage and chemical fingerprints. It is striking that Herzsprung shields occur frequently on Iberian rock art stelae from the Late Bronze Age (Harrison 2004; Díaz-Guardamino et al. 2022), some of which are located close to the mining sites in southern Spain or near navigable rivers such as Guadalquivir and Guadiana, considered to be important communication routes in the Atlantic Bronze Age.



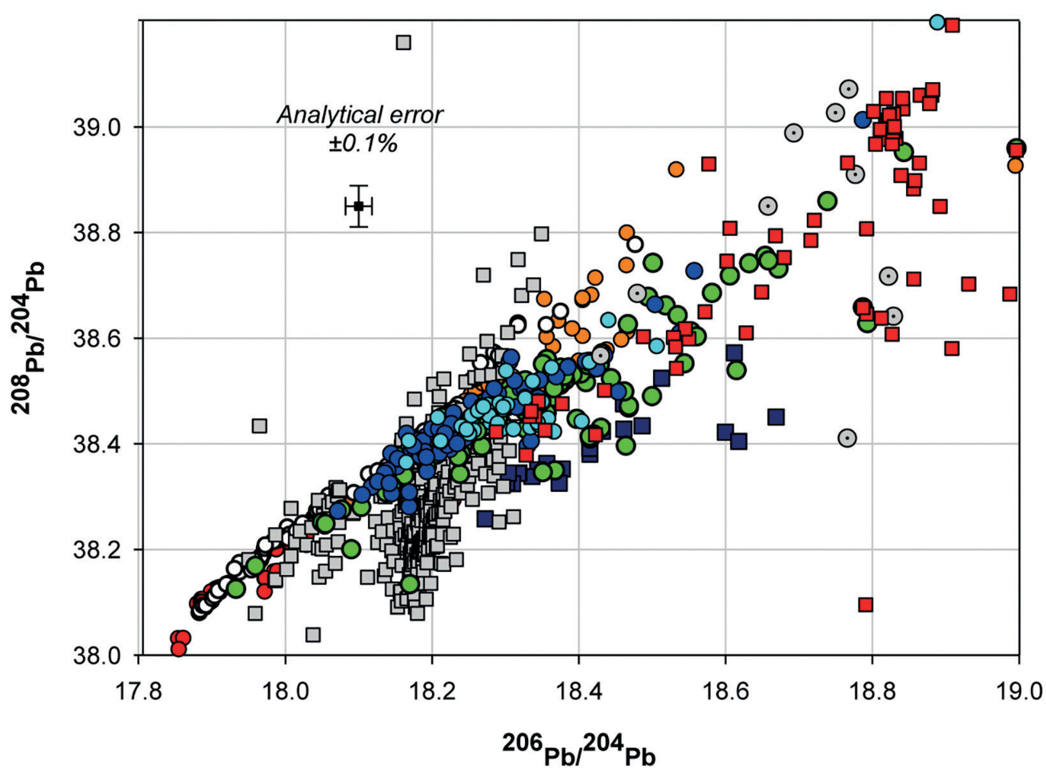




*Figure 8.3. Lead isotope data for the bronzes found in Scandinavia dated to Periods II–IV compared with data for the ores plotted on Figs 8.1 and 8.2 shows that the majority of the bronzes dated to Periods III–IV are consistent with the ores from the Italian Alps and/or south Spain. On this lead isotope plot the geological age of the ores is indicated by the $^{206}Pb/^{204}Pb$: the oldest ores have the lowest values, with the age of formations ranging from about 600 million years to about 50 million years.*

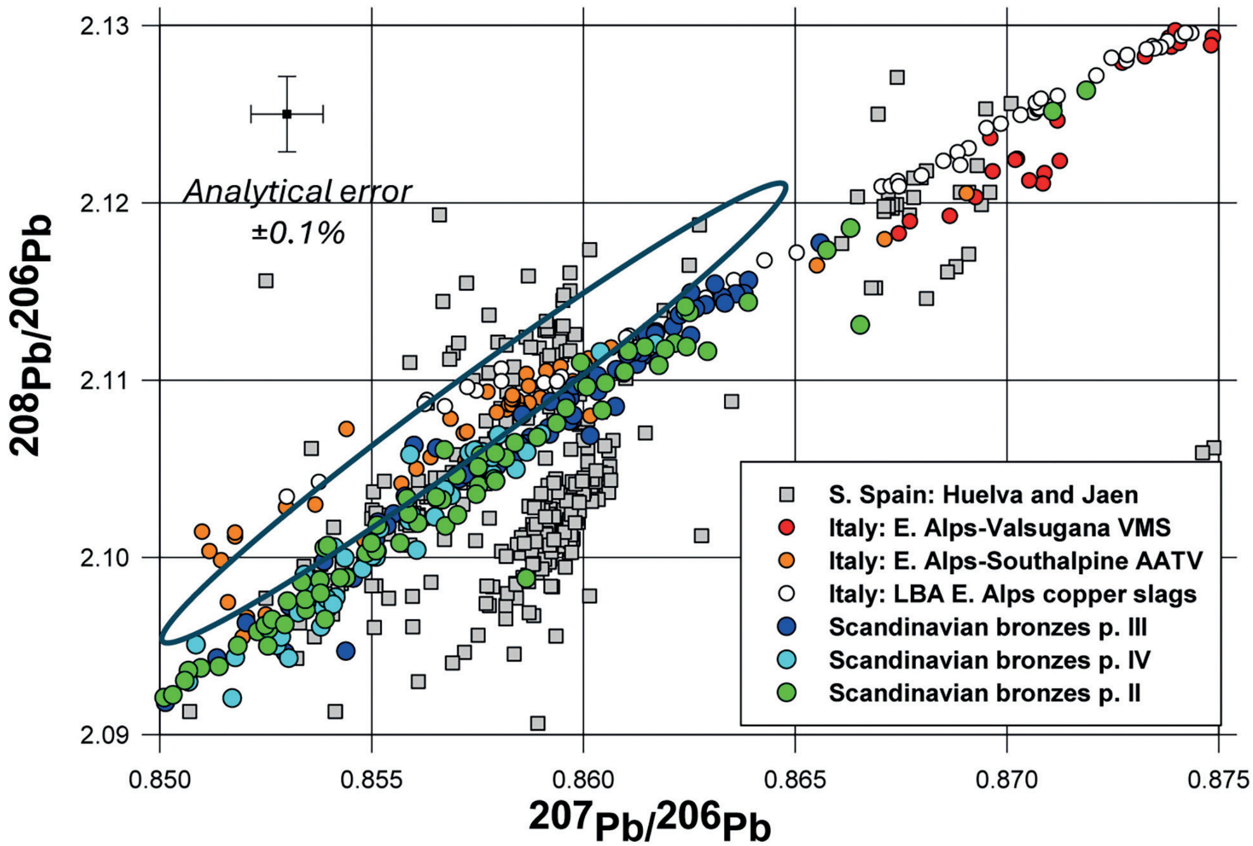



*Figure 8.4. The plot of the same data in respect to the radiogenic $^{206}$Pb shows that there is only a small group of Scandinavian bronzes that are consistent with the ores from the Italian Alps, while a large proportion of the lead isotope ratios of these bronzes are consistent with the ores from Spain.*

The hypothesis of long-distance exchange based on cultural parallels is supported by the existence of Scandinavian artefacts that are typologically similar to Western Mediterranean examples. The 'Galician palstave' from Lake Tåkern in Sweden (see Ling et al. 2024, fig. 4.5) is one such example investigated by the Moving Metals team. This form of axe, known as a double-looped palstave, was made between 1150 and 900 BC (Monteagudo 1977, pl. 86, 87, & 100). Already in the 1920s, Arthur Nordén emphasized the significance of this discovery and the connections he noticed between Scandinavian and Iberian rock art (Nordén 1925). Gordon Childe was also interested in the palstave and wrote to the curator at the Museum of Gothenburg to inquire about the circumstances surrounding its discovery. The Tåkern palstave, in his opinion, was the northernmost example of an axe type seen in places such as southern England, western France, and Sardinia (Childe 1939). The artefact is better described as an axe-shaped ingot rather than a working axe. More concretely, lead isotope and chemical analysis of the axe shows a strong degree of consistency with other Iberian bronzes dated to Middle Bronze Age–Iron Age (1300–800 BC) that in turn match a group of the Scandinavian bronzes chemically and isotopically consistent with the ores in south-west Iberia, specifically the valleys of the rivers Guadalquivir and Guadiana, where copper and tin are available and could have been smelted in the 3rd, 2nd, and 1st millennia BC.

As yet, there is no further evidence that any of these mines were exploited in the Bronze Age, though it has been noted that their proximity to river courses could have provided a convenient means of transporting the ore or smelted copper. These river valleys also mark the lines of distribution of the Warrior Stelae as recorded by Díaz-Guardamino (Díaz-Guardamino et al. 2020; 2022). A survey of the copper mineralizations in this region to determine the presence of stone hammers and copper smelting slags would provide much needed clarification.

Conversely, there is substantial evidence of copper production under different social structures in the Guadalquivir river valley during the earlier Chalcolithic period. The research conducted by Nocete et al. (2010) indicates that between *c.* 3000–2000 BC there were numerous settlements in the area, some of them fortified, as well as copper working workshops, and mining and smelting sites. The focus of that research is on two areas along the river: the Upper and Lower Guadalquivir Basin. The Lower region is at the mouth of the river with the direct access to the sea (Nocete et al. 2010, 221). Unfortunately, at present there is no information on the later Bronze Age habitation in this area. However, it seems unlikely that the well-developed metal production industry in this region would not have contributed to the supply of copper in later periods, when tin bronze started to play an important role in the economy of Europe.

The lead isotope database of the ores from south-west Spain, compiled mainly from the papers related to the geochronology of these deposits, has been annotated recently with the information about the latitude and longitude of the mines where the samples of minerals for lead isotope analyses have been collected (IBERLID; Saez et al. 2021). Therefore, when calculating the Euclidean distances between the data for the given artefact and the ore samples, it is possible to identify specific mines with copper minerals that share the closest lead isotope ratios to the artefact. The ore mineralizations that have the closest lead isotope ratios to the main group of bronzes found in Scandinavia (dated to 1500–950 BC) and are numerically consistent with the ores from south-west Spain are situated in the region between Cordoba and Jaen, covering more than 30 locations where the samples of ore minerals have been collected, including the recently excavated copper smelting site in Las Minillas and the mine of Chinflon. These bronzes from Scandinavia isotopically best match group 2A identified by Saez et al. (2021) as samples of 'massive sulphides ('pyrites, chalcopyrites, plus/minus galena'). Additionally, subgroup 2A2 includes samples of minerals from the 'Linares-La Carolina mining area near Jaen, and nearby localities of Guarroman, Carboneros, Banos de la Encina, Villanueva de la Reina, Andujar, Vilches, Cardena and Montoro' (Saez et al. 2021, 422). All these localities are approximately within the range of Longitude –3.6, Latitude 38.14 and –4.65 and 38.6 respectively (Saez et al. 2021, 4.2.2, subgroup 2A2 and Table 8.1).

## The lead isotope and geochemical evidence from the British Isles (and Brittany)

In addition to the presence of copper from Spain (or Sardinia) in the finds from the shipwrecks off the southern coast of England near Salcombe (Berger et al. 2022), the hypothesis of import of copper and also tin-copper alloys from western Iberia to Northern Europe also gains support from the lead isotope analyses of the Middle –Late Bronze Age copper based artefacts from England and Ireland (Rohl 1996; Rohl & Needham 1998; OXALID). In Figure 8.7 the lead isotope compositions of 34 of the copper based artefacts from the British Isles published by Rohl and Needham (1998; OXALID) are compared with the bronzes dated to Periods II and III from Scandinavia, and the ores from the Italian Alps and Spanish copper mines. The description of these artefacts, as published by Rohl and Needham, is listed in Table 8.1. As can be seen in Figure 8.7, most of these artefacts, together with the bronzes from Scandinavia, are isotopically consistent with the ores described by Saez et al. (2021) from the Guadalquivir Valley. They include the Middle Bronze Age palstaves from the sites in the mouth of river Thames and Britain's south-east coast: Southall, Thorpe Hall, and Langdon Bay. Also, there are in this group single artefacts from Wales and some counties in southern England, as well as further north (Cumbria and Peterborough).

It is interesting that amongst several hundreds of lead isotope analyses of copper based artefacts dated to the second half of the 2nd millennium BC there are only two that have lead isotope characteristics of the large copper mines in Huelva. Among the artefacts from the British Isles the copper ingot from Runnymede Bridge in Berkshire (Rohl & Needham 1998, Inv. No. A14 160 7) and a single Scandinavian bronze, the palstave from Denmark (Melheim et al. 2018a, Inv. No. Thisted Ke 5078), are both consistent with the ores from Rio Tinto La Joya and Cerro Muriano mines. The bronzes and copper ingots from Salcombe Bay published by Berger et al. (2022) and some of the bronzes from the same site published by Rohl and Needham (1998) are also consistent with the ores from south Spain, some of them also with the ores from Huelva, but their lead isotope ratios are out of the range of values presented on Figure 8.7.

Of additional interest is the fragment of a bronze spiral published by Rohl (No. 278 105) from Saint-Brieuc-des-Iffs in north-west France, dated to the end of the 2nd millennium BC, which has lead isotope ratios identical with the main group of all these bronzes consistent with the ores from the Guadalquivir valley (Saez et al. 2021).

Unfortunately, at present there are no more lead isotope data for bronzes from the Atlantic France, therefore we are planning a programme of lead isotope and chemical analyses of copper based alloys from this region in the next stage of our research project.

## Discussion of the archaeological evidence for Bronze Age metal trade between Scandinavia, the British Isles, and Iberia

### *Paddling or sailing to Iberia or just to the British Isles?*

Metal analyses suggest that trade routes between Scandinavia and the Western Mediterranean were formed approximately 1500/1400 BC, although there is little evidence of cultural exchange between the two regions at this time. Stronger evidence of cultural exchange emerges later, around 1300–1200 BC, with the appearance of amber in the Mediterranean and parallel forms of metalwork and rock art in both regions, implying not only an intensification of long distance trade but also the possibility of direct contact between groups in

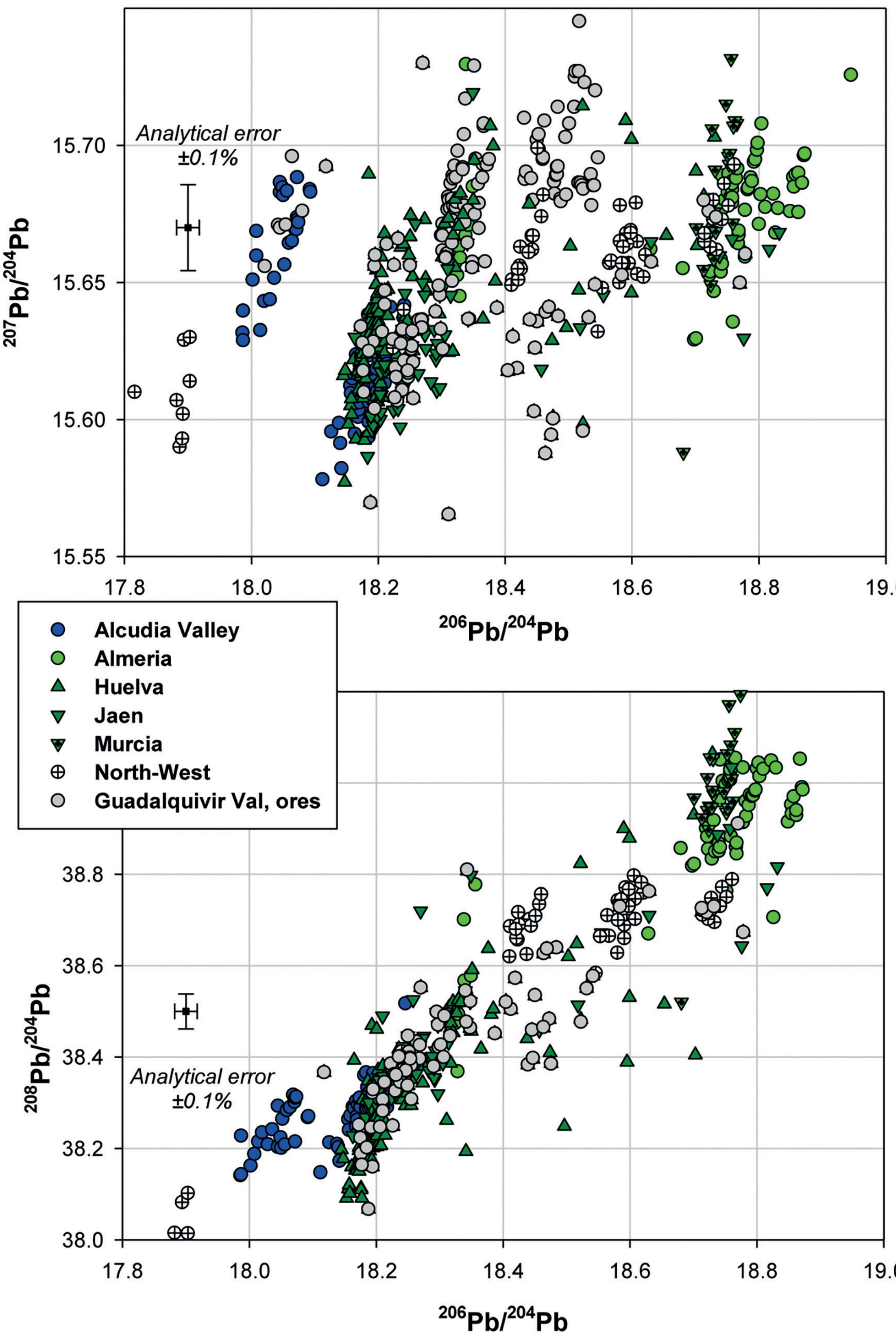



*Figure 8.5. Plot of lead isotope data for ores from different geological regions in south Spain and the group of ores assigned by Saez (et al. 2021) to the Guadalquivir Valley.*

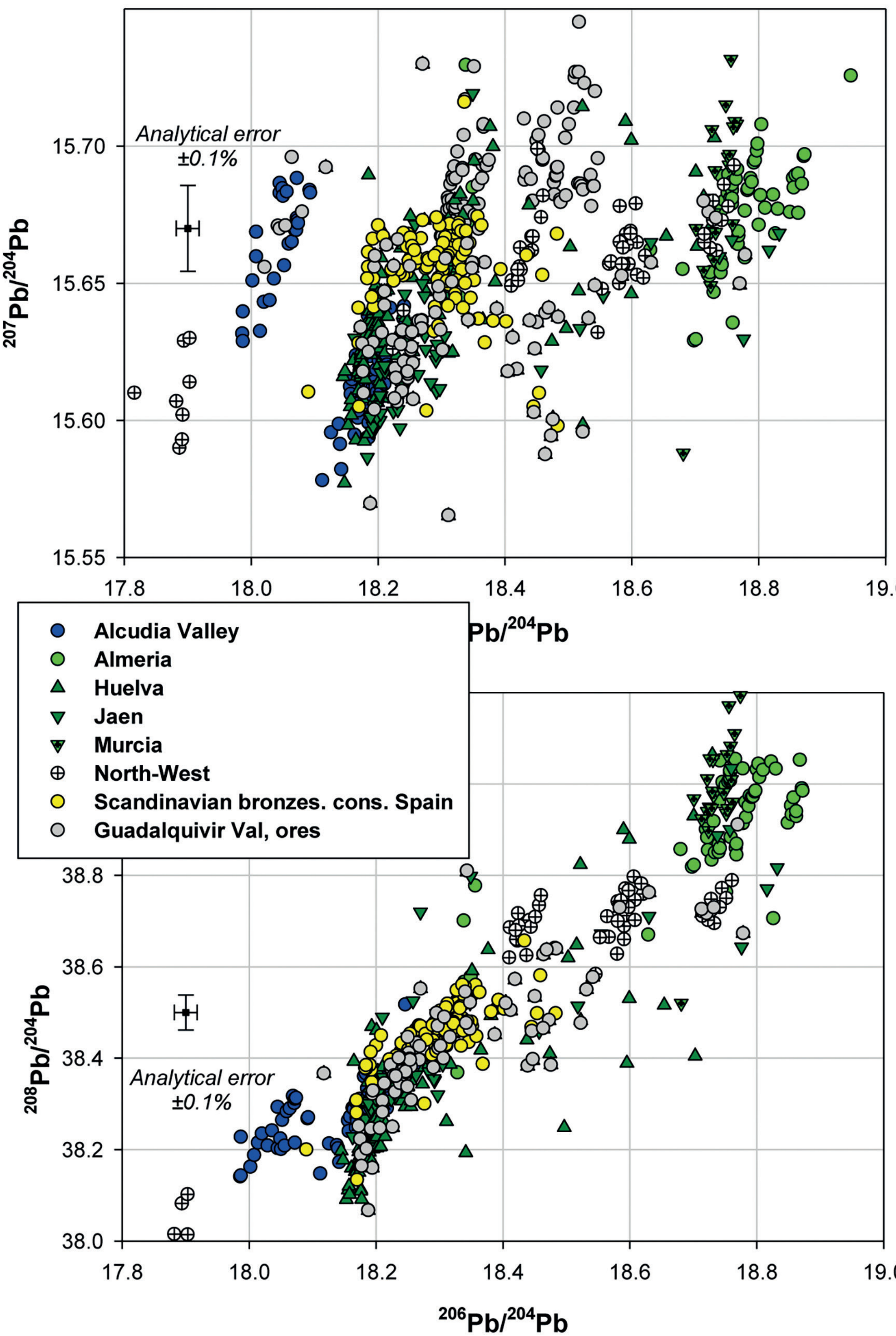



*Figure 8.6. Lead isotope data for the bronzes found in Scandinavia dated to Periods II–IV that show consistency with the ores from Spain in TestEuclid calculations compared with the data for ores from different regions in Spain.*

*Table 8.1. Descriptions of copper based artefacts from the British Isles analysed by Rohl for their lead isotope compositions.*

| *Inv. No.* | *Period* | *Chronology BC* | *County* | *Region* | *Site* | *Description* | *Collection* | *Reference* |
|---|---|---|---|---|---|---|---|---|
| Bertie 1741.3 (tip) | MBA III | 1300–1200 | Cumbria | Westmorland | Ambleside | Metal-hilted rapier: Group IV - tip | Windsor Castle Armoury 51 | Burgess 1981, no. 980; Needham 1982, no. 3 |
| BM 1911.5-15.5 | MBA II | 1400–1300 | Essex | | Burnham-on-Crouch | Palstave, unlooped (hafting-slot ribbed) | BM | Britton 1960b, GB49, no. 6; Rowlands 1976, no. 4 |
| 47.164.178 | MBA II | 1400–1300 | Wales | Powys | Cemmaes | Looped palstave III | NMW | |
| FNG009 | MBA III | 1300–1200 | Northamptonshire | Peterborough | Flag Fen | Sword point | | |
| FF 21 | LBA | 1200–800 | Northamptonshire | Peterborough | Flag Fen | Chape: the metal point of a scabbard | | |
| FNG277 | MBA III | 1300–1200 | Northamptonshire | Peterborough | Flag Fen | Sword/Knife blade | | |
| FF019 | MBA II/III | 1300–1200 | Northamptonshire | Peterborough | Flag Fen | Spearhead | | |
| Do. 130 | MBA | 1500–1202 | Kent | Dover | Langdon Bay | Median-winged axe | BM | |
| Do.123 | MBA | 1500–1201 | Kent | Dover | Langdon Bay | Median-winged axe | BM | |
| BM P1980.02-01.16 | MBA | 1500–1200 | Kent | Dover | Langdon Bay | Palstave III | BM | |
| BM P1977.04-02.52 | MBA | 1500–1200 | Kent | Dover | Langdon Bay | Palstave | BM | |
| Do. 004 | MBA | 1500–1209 | Kent | Dover | Langdon Bay | Median-winged axe | BM | |
| BM P1980.02-01.14 | MBA | 1500–1200 | Kent | Dover | Langdon Bay | Median-winged axe | BM | |
| Do. 029 | MBA | 1500–1206 | Kent | Dover | Langdon Bay | Median-winged axe | BM | |
| Do. 176 | MBA | 1500–1211 | Kent | Dover | Langdon Bay | Median-winged axe | BM | |
| Do. 003 | MBA | 1500–1207 | Kent | Dover | Langdon Bay | Median-winged axe | BM | |
| Do.146 | MBA | 1500–1204 | Kent | Dover | Langdon Bay | Median-winged axe | BM | |
| Do. 056 | MBA | 1500–1205 | Kent | Dover | Langdon Bay | Median-winged axe | BM | |

*(Continued)*

*Table 8.1. Descriptions of copper based artefacts from the British Isles analysed by Rohl for their lead isotope compositions. (Continued)*

| *Inv. No.* | *Period* | *Chronology BC* | *County* | *Region* | *Site* | *Description* | *Collection* | *Reference* |
|---|---|---|---|---|---|---|---|---|
| BM 1892.9-1.299 | MBA II | 1400–1300 | Dorset | Blandford | Monkton Farm | Palstave, looped, midrib | BM | Pearce 1983, no. 430a; Rowlands 1976, no.38.1 |
| 15.277.1 | MBA III | 1300–1200 | West Glamorgan | Langrove | Penard | Socketed axe | NMW | |
| A14 160 7 | LBA II | 1000–900 | Berkshire | | Runnymede Bridge | Ingot | | |
| BM P1983.4-2.3 | MBA II | 1400–1300 | West Sussex | Sussex Downs | South Harting | Palstave | BM | |
| BM P1983.4-2.2 | MBA II | 1400–1300 | West Sussex | Sussex Downs | South Harting | Bracelet | BM | |
| BM P1983.4-2.1 | MBA II | 1400–1300 | Sussex, West | Sussex Downs | South Harting | Bracelet | BM | |
| BM 1897.4-10.2 | MBA II | 1400–1300 | Gt. London (Middlesex) | | Southall | Palstave, unlooped | BM | Britton 1960, GB51, no. 5 |
| BM 1897.4-10.5 | MBA II | 1400–1300 | Gt. London (Middlesex) | | Southall | Palstave, one loop | BM | Britton 1960, GB51, no. 2 |
| BM 1897.4-10.4 | MBA II | 1400–1300 | Gt. London (Middlesex) | | Southall | Palstave, unlooped | BM | Britton 1960, GB51, no. 3 |
| BM 1897.4-10.3 | MBA II | 1400–1300 | Gt. London (Middlesex) | | Southall | Palstave, unlooped | BM | Britton 1960, GB51, no. 4 |
| BM 1893.2-5.27 | LBA II | 1000–900 | Kent | Thames Estuary | Stoke Hoo | Mould fragment | BM | |
| 375/5 | MBA III | 1300–1200 | Essex | Southchurch | Thorpe Hall, brickfield | Palstave, narrow bladed, class2 group2 | Southend-on-Sea Museum | Rowlands 1976, no. 45 |
| 375/3 | MBA III | 1300–1200 | Essex | Southchurch | Thorpe Hall, brickfield | Sword | Southend-on-Sea Museum | Trans Essex Arch Soc. 19, 1930, 311ff |
| BM WG 1867 | MBA II | 1400–1300 | Oxfordshire | | Wantage | Palstave, narrow blade,median rib dec. class1 | BM | Rowlands 1976, no. 4.2 |
| BM WG 1866 | MBA II | 1400–1300 | Oxfordshire | | Wantage | Palstave:Trident decoration, class3 group2 | BM | Rowlands 1976, no. 4.1 |
| 4145 | MBA III | 1300–1200 | Devon | nr Tiverton | Worth, Washfield | Socketed spearhead, pegged, leaf-shaped | Exeter Museum | Pearce 1983, no. 314c |

Iberia and Scandinavia (Murillo-Barroso et al. 2018; Ling et al. 2024). The modalities of this trading relationship have been theorised by Melheim et al. (2018b), who identify two possible scenarios of sea-based interaction between Scandinavia and Western Mediterranean during this period:

- Multi-line or down the line trading between several parties operating within the larger Atlantic networks with the British Isles as a 'hub';
- Long-distance travels conducted by one of the parties – with northern ships sailing southwards or southern ships sailing northwards, or, traffic both ways (Melheim et al. 2018b, 139).

The relative feasibility of these alternate scenarios is open to debate. For instance, one could argue that there are certain disadvantages to the networked 'multi-line' model on the grounds that it supposes the involvement of middlemen who would have added substantial costs to the trade in commodities (Earle et al. 2015). The model might also be said to conflict with our assumptions about the political economy of prehistoric societies ruled by chiefdom-like institutions who aimed to control and regulate the exchange of rare goods and were perhaps ill-disposed to sharing their monopolies (Earle et al. 2015).

Based on this line of argument, the latter theory might appear more probable but this still leaves the practical question of how long distance travel by the sea was made possible? Could groups from Scandinavia have travelled by the sea all the way down to Iberia or vice versa?

There exist numerous instances in archaeology and ethnography that demonstrate long distance marine trade (Ling et al. 2013; Spriggs 2022). For instance, the Haida Indians in British Columbia could travel up to 3000 km in a single season with the use of canoes comparable in size to the type of vessels that are argued to have been in use in Bronze Age Scandinavia (Ling et al. 2024; Bengtsson this volume, Chapter 3). However, even with the utilization of sail, which has recently been shown to have been employed in Bronze Age Scandinavia (Bengtsson et al. 2024), the journey would have been arduous and time consuming, requiring frequent stops at ports and the formation of alliances along the extensive sea routes. A more likely scenario might involve groups from Iberia and Scandinavia journeying to strategic coastal locations situated along the Atlantic coast between these terminus points. These significant marine sites may have been situated on islands or along the coast in Brittany, or alternatively, offshore in the English Channel. It is noteworthy to highlight the recent investigation conducted within the Maritime Encounters project on Late Bronze Age copper ingots. These ingots were found at significant maritime sites in southern England and the Channel Islands, including Cliffs End, Sark, Moore Sands, and locations near the tin sources in Cornwall. The new data suggest that the isotopic composition of the copper in question matches that of the copper sources found in Iberia, which are also consistent with the ingots and artifacts recovered from the Salcombe wreck, as well as many of the bronzes from Scandinavia and Poland that are dated to the Late Bronze Age (Ling et al. 2024). The findings suggest that the English Channel may have functioned as a central hub for the exchange of metals within the Atlantic network. It is possible that groups of warrior/traders from Scandinavia and Iberia would have gathered there to exchange materials such as copper, tin, bronze, and amber, Undoubtedly, the availability of tin might have played a crucial role in the development of trade routes that passed through the British Isles (Berger et al. 2022). Nordic traders likely engaged in deliberate efforts to locate trading sites that offered access to both copper and tin, potentially even in the form of pre-alloyed bronze.

## Conclusions: the trade in metals between North-west Europe and Iberia in the Bronze Age: science and archaeology

The results of lead isotope and chemical analyses of copper based artefacts from Scandinavia and the British Isles indicate that from about 1400/1300 BC there was trade in copper (and possibly tin bronze as palstaves) from the south of Iberia. Additionally, the lead isotope and chemical characteristics of these analyzed northern European artefacts indicate that the copper most likely originated from the mines located in south-west Spain along the Guadalquivir and Guadiana river valleys, a region rich in copper, lead, and silver ores.

While confirming the importance of the Iberian mineralizations during the tin bronze phase of the Late Bronze Age Atlantic metal exchange network, these results also emphasize the need for continued research in the southern Iberian region. Aside from the metallurgical data, our evidence for the ancient exploitation of the ore deposits during the second half of the 2nd millennium BC remains limited and recent archaeological investigations are only just beginning to fill the gaps in our understanding of the lifespan of individual mines and the communities that worked them. As alluded to earlier, the research undertaken by Nocete in the Upper and Lower Guadalquivir Basin documented numerous settlements, copper workshops, mining, and smelting sites (*c.* 3000–2000 BC) but so far curiously little evidence of mining activity or habitation from the period 1400–1300 BC. Current excavations conducted in collaboration with the Maritime Encounters project at Las Minillas may prove elucidating on this point. Despite the challenges posed by this multi-period site, initial radiocarbon results obtained from the prehistoric phase of ore extraction indicate a chronological range *c.* 1400–1000 BC (see Hunt Ortiz et al. this volume, Chapter 9). Again, these positive findings illustrate the potential benefits of collaborative

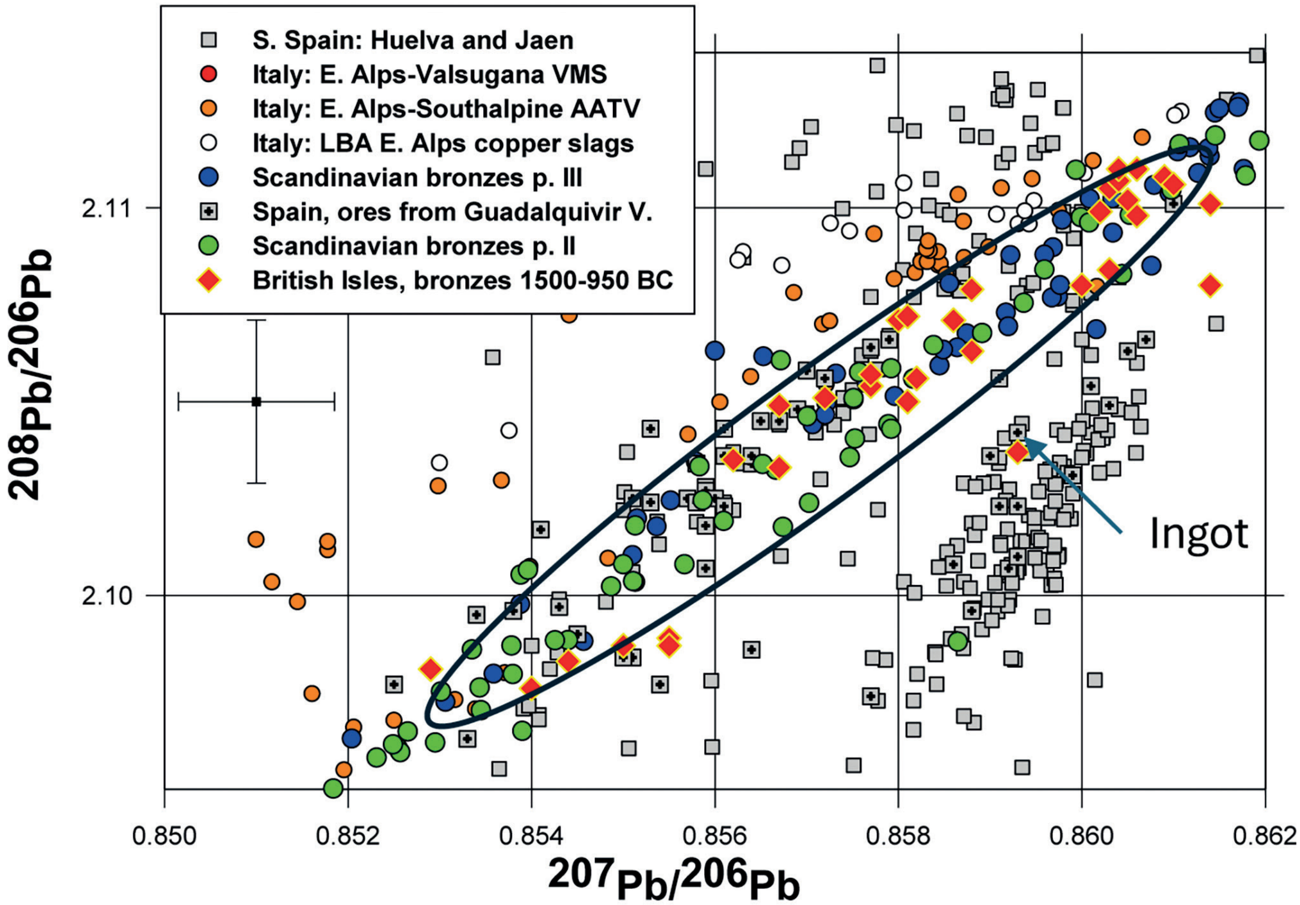



*Figure 8.7. Comparative plot of lead isotope ratios to $^{206}$Pb of the ores from South Spain, the selected by TestEuclid bronzes from Scandinavia dated to Periods II–III and contemporary copper based artefacts from the British Isles (Rohl & Needham 1998).*

scientific archaeological research and the Las Minillas team hope to extend the scope of their investigation to include other possible mining sites in the wider area. Independently of these efforts, future research should also include the exploration of the copper ore fields of southern Portugal as well as addressing the question of Iberian tin exploitation.

What is certainly less open to question, and worth reiterating, is the evidence for metal exchange and contact between Iberia, Atlantic France, Ireland, Britain, and Scandinavia during the Late Bronze Age. However, questions concerning the dynamics of travel between these regions, preferred routes, and the use of possible hubs remain to be answered.

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9

# Late Bronze Age copper mining in southern Iberia: preliminary results of fieldwork at Las Minillas (Granja de Torrehermosa, Badajoz, Spain)

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*Evidence of Late Bronze Age copper mining in south-western Iberia is becoming relevant through archaeological investigations and compositional and lead isotopes results from objects from different areas of Northern Europe, although the mineral deposits of Iberia had been very poorly studied. The first results of the excavation campaigns carried out in the mine of Las Minillas (Granja de Torrehermosa, Badajoz, Spain) in 2020, 2022, and 2023 are presented and contextualized, providing key data on the dimension and characteristics of Late Bronze Age mining. During the interval 1300–1000 BC a large effort was made to extract the oxidized copper ore, resulting in a 200 m long trench-type mining work probably using fire-setting together with thousands of stone hammers, to gather an estimated copper quantity of between 0.26 and 0.78 tonnes per year. It is hypothesized that Las Minillas, alongside other similar documented prehistoric mines in the area, could have played a key role in the copper supply system of the European Late Bronze Age, replacing the Great Orme mine (North Wales) as the main supplier of copper in Atlantic Europe at the end of the Bronze Age.*

## Introduction

Las Minillas is the name of a contemporary copper mine, located in the municipality of Granja de Torrehermosa, province of Badajoz, in the south-west of the Iberian Peninsula (Fig. 9.1). Preliminary archaeological investigation indicated that this mine had been exploited in different phases during prehistoric and historic times (Domergue 1987; Domínguez-Bella et al. 2000; 2001) and that it could have been one of the most important prehistoric copper mines in Iberia and, probably, Western Europe (Hunt Ortiz et al. 2017, 532). This chapter presents the main results of the fieldwork conducted in Las Minillas during the 2020, 2022, and 2023 seasons, although analytical results for relevant samples collected are not yet available.

The fieldwork at Las Minillas was carried out by the Department of Prehistory and Archaeology at the University of Seville in collaboration with the Maritime Encounters project (2022–2027). This project investigates four main topics, conceived as four subprojects, whose common objective is to highlight the importance of sea routes for the three phenomena that marked European late prehistory (the arrival of steppe ancestry, the expansion of the Bell Beakers, and the flow of copper and tin during the Early–Middle and Late Bronze Age). The Maritime Encounters project is the first project of its kind to offer a counterpoint to the predominant terrestrial narratives of European prehistory; a perspective that has been challenged only sporadically in a handful of earlier papers and monographs (e.g., Crawford 1936; Cunliffe 2001).

The archaeological research in Las Minillas, within Subproject 4, focuses on the hypothetical maritime connections linking Iberia with northern Europe, in particular southern Scandinavia, during the Late Bronze Age (*c.* 1400–800 BC). A key factor behind assessing the importance of this Iberian–Scandinavian/northern Europe Late Bronze Age connection

*Figure 9.1. Las Minillas location in Iberia and its surrounding landscape, with areas with the red plant Rumex bucephalophorus.*

was the discovery of similarities in the lead isotopic composition of south Iberian mineralization and Scandinavian Late Bronze artefacts (Ling et al. 2014; 2019; 2024). Seeking to explain this phenomenon with regard to the supply of metals it should be noted that before 1400 BC the demand for copper in Scandinavia would have been covered by metal production from mines in Central Europe and the British Isles, in the latter case mainly from the Great Orme mine, in North Wales (Williams & Le Carlier de Veslud 2019; Williams 2023). After 1400 BC, however, the isotopic results indicate that the mineral deposits in the south of the Iberian Peninsula became increasingly important in the supply of copper to the Scandinavian and Northern European metal industry and, by the Late Bronze Age (1100–700 cal. BC), appear to have become the dominant source of ore to these regions (Ling et al. 2014, 125–6, fig. 12); a trend suggested, for example, by the recent analysis of the copper ingots recovered from the Salcombe shipwrecks off the coast of south-west England (Berger et al. 2022, 24).

While searching for the locations of Late Bronze Age copper supplying mines in south-west Iberia, the importance of Las Minillas mine in prehistoric times was made apparent by the sheer quantity of stone mining tools (comprising more than 3200 grooved hammers based on initial estimates) documented by the preliminary surface survey in 2011 (Hunt Ortiz et al. 2017). By way of comparison, this figure exceeds by some margin the 2000 or so stone hammers recovered after decades of excavation at the main British Bronze Age copper mine at Great Orme (Lewis 1996; Williams 2023). In terms of chronology, the stone hammers recovered from Las Minillas share the same typology as those found at Chalcolithic to Late Bronze Age copper mining works located elsewhere in the Iberian Peninsula (Domergue 1987; Hunt Ortiz 2003; Arboledas Martínez et al. 2015; O'Brien 2015). The few handmade pottery fragments found in 2011, though of inconclusive type, also suggested a Late Chalcolithic–Bronze Age date (Hunt Ortiz et al. 2017).

With this limited but promising information in hand, the decision was made to study Las Minillas in greater detail; combining archaeological and geochemical analyses of the mine to better understand the relationship of its copper mineral resources to archaeologically recovered metallic objects, with a specific focus on the Late Bronze Age period at a regional, supraregional and continental level.

## Las Minillas mineral deposit

Las Minillas is located *c*. 3 km to the south of the village of Granja de Torrehermosa, an area characterized by low hills, cereal fields and a sparse vegetation of holm oaks, with the mineralized area marked by the presence of the red plant *Rumex bucephalophorus* (Fig. 9.1). Geologically the site forms part of the Ossa-Morena Zone, within the Azuaga-Berlanga mining district; an important mining field of galena and blende (Pb/Zn) vein type mineralizations. The Las Minillas mineralization is an exception in the mining district: a copper mine, consisting of an approximately 200 m long quartz vein with an N15ºE direction and mineralized with chalcopyrite as the primary ore with an extensive secondary mineralization of copper carbonates, silicates, and oxides, such as malachite, azurite, bornite, and chrysocolla, marked on the surface by reddish gossan outcrops (Hunt Ortiz et al. 2017).

Today, the surface mine works aligned along the vein are almost entirely filled in for most of its length by debris and are impossible to document without geophysical surveys and/or excavations (Fig. 9.2). Remains related to the Roman Republican presence (dated to the 1st century BC) as well as traces of contemporary underground mining activity are evident to the west of the mineralization: a ruined house made of stone masonry and bricks, and two structures corresponding to quadrangular shafts that have been recently sealed (Fig. 9.2). These three constructions are dated to the 19th/early 20th century AD, when the mine was exploited by the French *Société minière et métallurgique de Peñarroya*. An old plan of the underground works, found in the *Société minière* archives and dated to 1917, also identified ancient surface mine works (*minados antiguos*) (Hunt Ortiz et al. 2017).

A much greater impact (Fig. 9.2) on the prehistoric archaeological remains than the Roman and modern exploitation phases was produced by the construction of a water pond for livestock at the southern end of the mineralization. In addition to the ploughing of the former mining areas, significant major disturbance was also caused by the removal, over a large area and reaching down to the geological substrate, of mining debris for use as ballast in the 1990s.

## Archaeological campaigns

The initial 2020 campaign consisted of an intensive archaeological surface survey, a magnetic geophysical survey and the excavation of three trenches: Trenches 1, 2, and 3 (Fig. 9.3). The intensive surface survey alone, covering an area of 2.5 ha, identified *c*. 900 lithic tools, of which most were grooved stone hammers (Fig. 9.4). The survey also revealed an area to the south with metallurgical slags and fragments of handmade burnished pottery, some of them of the Late Bronze Age 'cazuela carenada' type. A concentration of burnished pottery sherds was also detected to the north.

The magnetometer survey, complementing the surface field survey, identified multiple areas containing anomalies (Fig. 9.5) that were later excavated with mixed results. In some cases, the results did not refer to anthropogenic activity, but rather geological features located deeper underground. Interpreted within the first group of anomalies, the magnetometer identified several underground elongated areas suggestive of pits and trenches filled with earth (Fig. 9.5: orange), several zones with evidence of combustion (Fig. 9.5: red), and two anomalies considered to have been produced by a concentration of slags (Fig. 9.5: purple) which, in the case of the one to the south, appeared to be confirmed by an abundance of slag material identified by the surface survey team.

On the basis of this preliminary information, three functional areas were differentiated and set aside for further study by excavation: the mining works, the metallurgical zones, and the habitation area. In the first 2020 season, under pandemic conditions, Trench 1 was opened up in an exploratory attempt to characterize the area surrounding the mining works, corresponding with a zone of scattered surface pottery fragments and pieces of slag. The results proved clarifying, revealing a completely altered stratigraphy to a depth of only a few centimetres above the plough-marked bedrock (Fig. 9.6A); the whole sequence containing a heterogeneous collection of pottery sherds from different periods and fragments of slag. It was also clear that the mining debris had previously been removed to be used as ballast to a geological level.

In the next, 2022, season Trench 5 was opened in the north-west of the site (Fig. 9.3) to investigate the anomaly detected during the geophysical survey which had been interpreted as produced by a slag concentration (Fig. 9.5) despite the absolute absence of surface metallurgical traces. Its excavation gave results similar to those from Trench 1: a single narrow stratum affected by the plough, with marks to the depth of the geological substrata (Fig. 9.7A). The archaeological content of this layer consisted of pieces of pottery of different periods, ranging from prehistoric to contemporary. Slags were not found, indicating that the original interpretation of the anomaly was incorrect and should be related instead to a geological feature deeper underground.

To the south, another trench (Trench 6) was opened up *c*. 10 m to the east of Trench 1 (Fig. 9.3). Located in an area of concentrated surface slag, it was hoped that some archaeological remains, possibly metallurgical structures, could have been preserved. The excavation revealed a smelting area, with fragments of copper minerals and furnace remains related to the production of metallic copper. In addition to the recovery of *c*. 300 kg of slags and numerous furnace walls fragments, a partially preserved round structure made of stones and adobe with associated burnt layers was found (Fig. 9.7B), interpreted as a furnace. Charcoal samples for radiocarbon dating were also collected, though the results from their analysis have yet to be published.

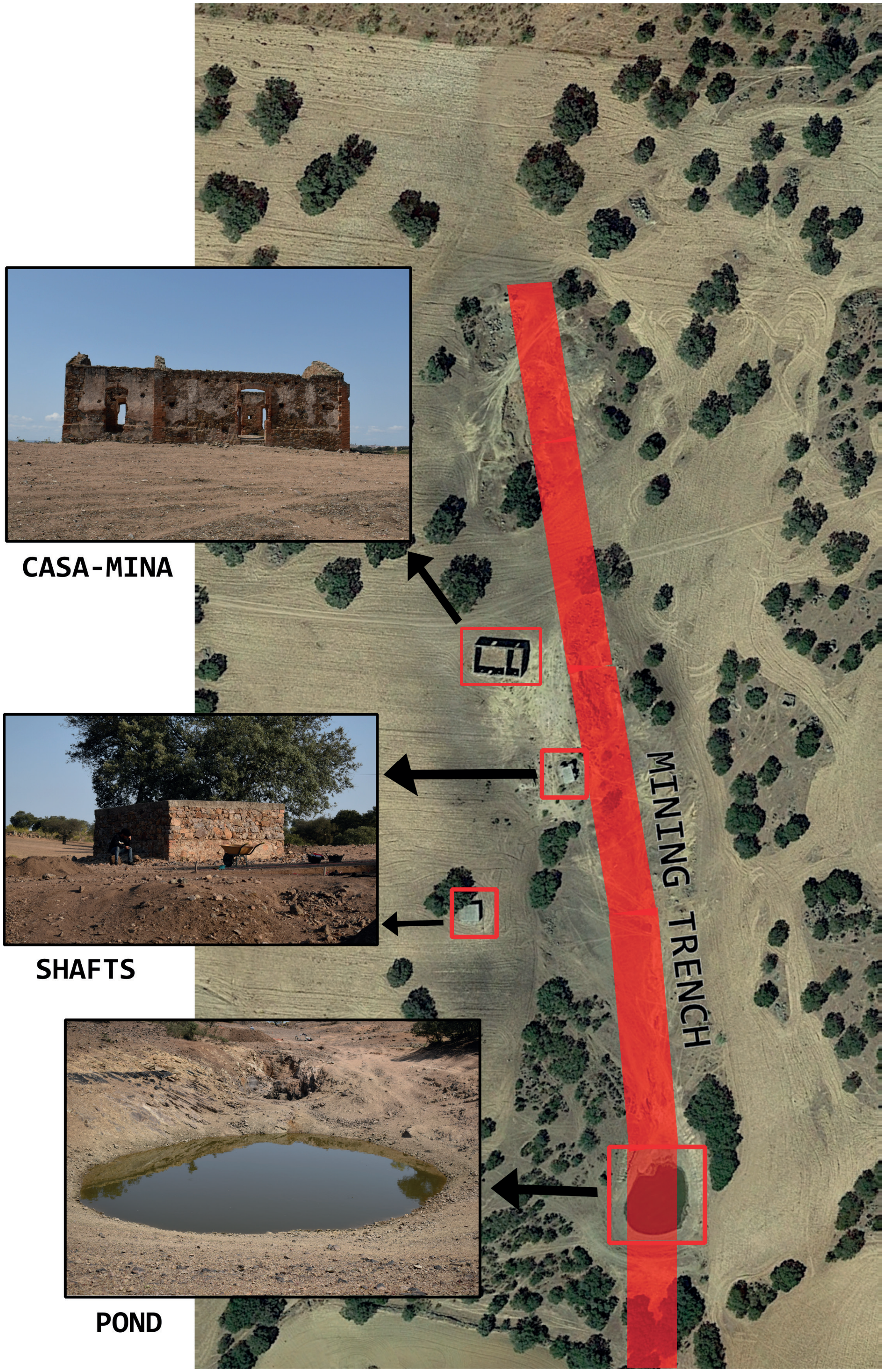


*Figure 9.2. General aerial view of Las Minillas and details of its main features: house ('casa-mina') remains, shafts, pond, and the approximate distribution of the vein type mineralization and surface mining works.*


*Figure 9.3. Plan of excavated trenches (sondeos/square) and their numbering.*

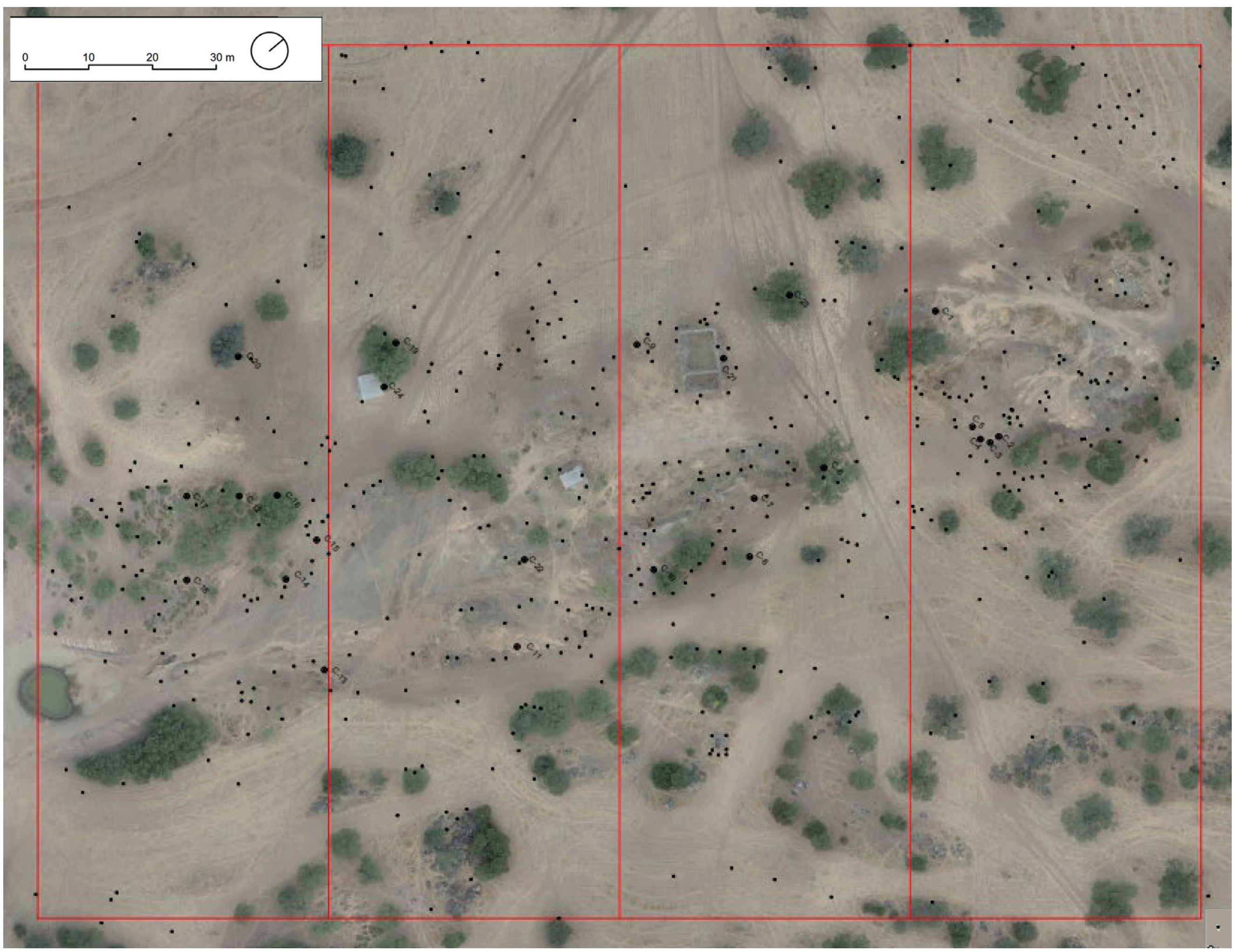


*Figure 9.4. Plan of the 2020 surface survey. Dots indicate individual stone tool locations and larger dots concentrations of stone hammers.*

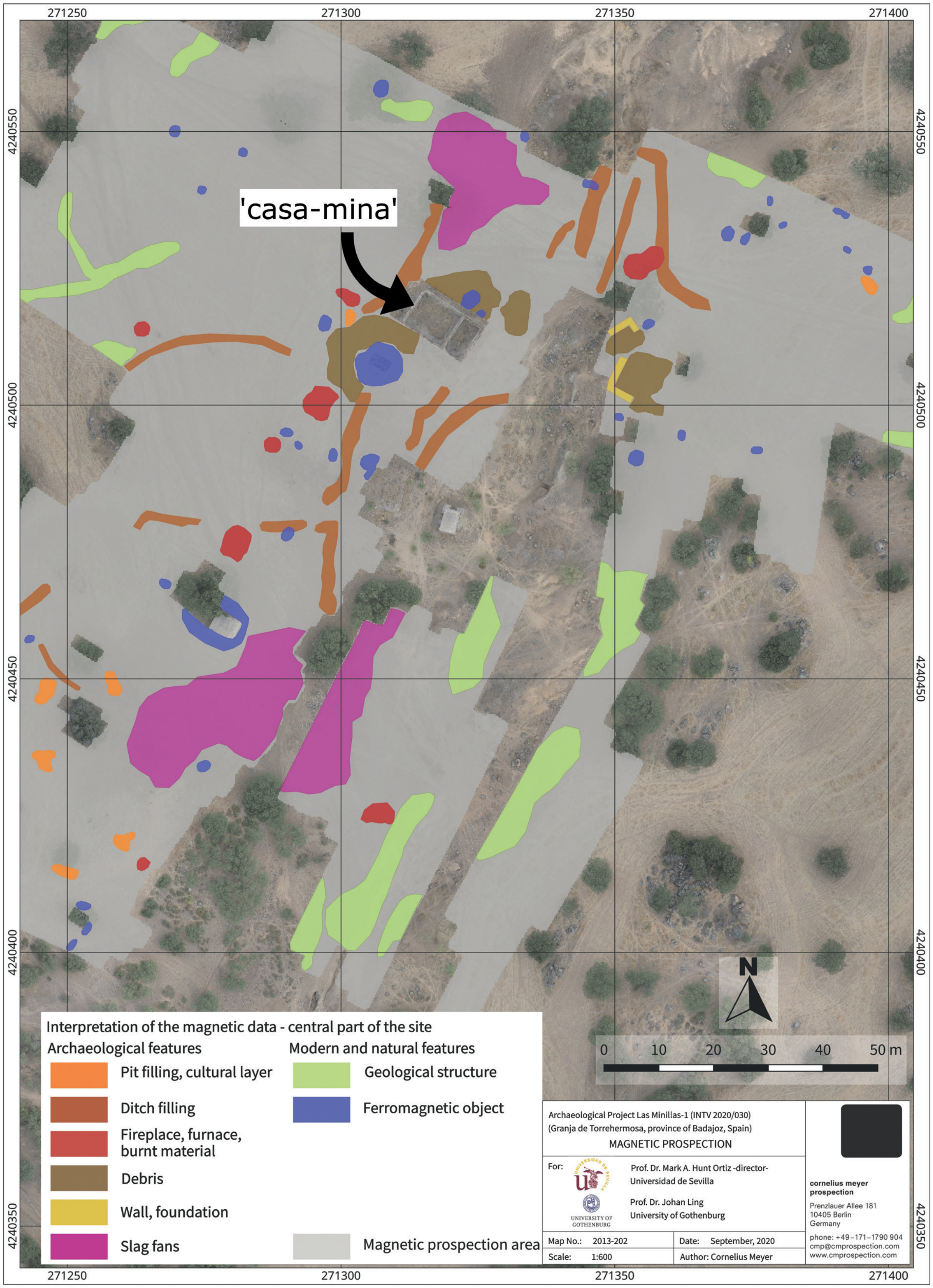


*Figure 9.5. Interpretation of the results of the Magnetometer Geophysical Survey.*

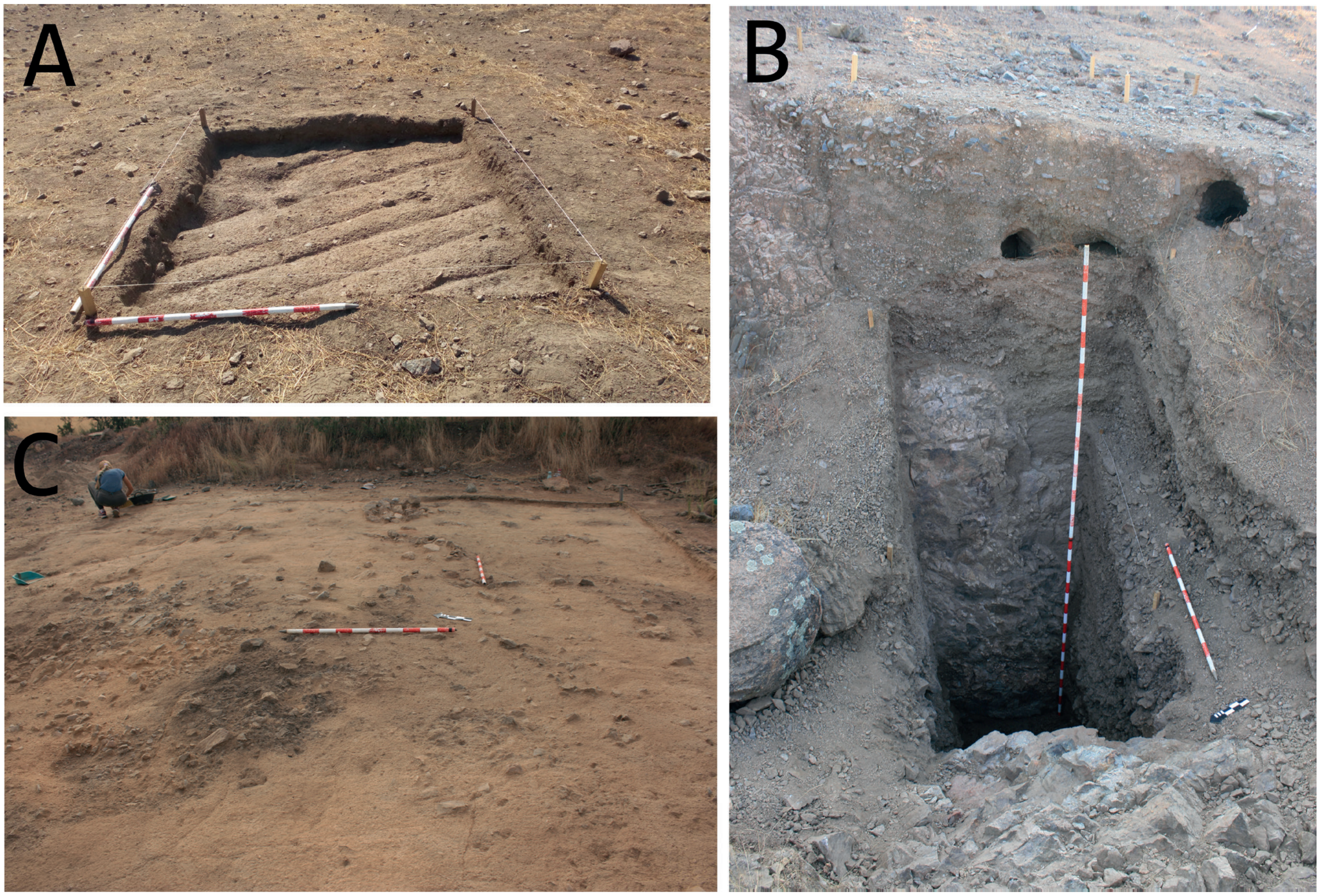


*Figure 9.6. View of the excavation of: A. Trench 1; B. Trench 2; C. Trench 3.*

The expansion of the excavation to the adjacent area, Trench 7, revealed several more remains of combustion areas with stones set in an irregular position, accompanied by modern, Roman, and Late Bronze Age pottery sherds (Fig. 9.8). The chaotic disposition of all these structures indicates a general alteration of the stratigraphy in this area but, despite this disturbance, their identification as furnaces is clear; their apparent disarrangement explained partly as the result of a continuous re-use of this space for smelting and the building of short lived furnaces on top of or next to each other, perhaps even re-using elements of previous structures. This interpretation is supported by previous research on the metallurgical debris from prehistoric Iberia which suggests that Late Bronze Age Iberian crucible furnaces would have been very simple structures that were probably used one or a few times (Gómez Ramos 1996). A furnace area that was used over a long period of time would therefore present a messy disposition of interlocking, vaguely defined structures and combustion areas, affected by post-depositional factors. In terms of dating the furnaces in Trench 7, a possible clue is provided by the general homogeneity of the slag. Unlike the later Roman tapped slag, all the slags found in Las Minillas are nodular, a feature more characteristic of Late Bronze Age technology. Needless to say, confirmation of a Late Bronze Age date for the furnace and the slag would be significant, as Late Bronze Age smelting furnaces from south-west Iberia are otherwise practically unknown and the evidence for metallurgical production areas in mines appears to be unique for this period (de Blas Cortina 2014, 70–2). However, this exceptionality also demands caution. As indicated, the area has been greatly disturbed by post-depositional processes, including animal burrows, and absolute dating of the furnace walls, slag, and associated organic material is required to confirm or refute the preliminary chronological assignment.

The investigation of the mining works at Las Minillas commenced with the excavation of Trench 2, situated transversally to the supposed disposition of the mining trench (Fig. 9.3). The objective was to characterize the mining works by excavating a complete section. The rock sides of the mining trench were identified, defined in their lower part by almost vertical walls and the interior excavated (Fig. 9.6B). The stratigraphy revealed older materials at the lower levels and contemporary ones in the higher layers indicating that the trench had been filled

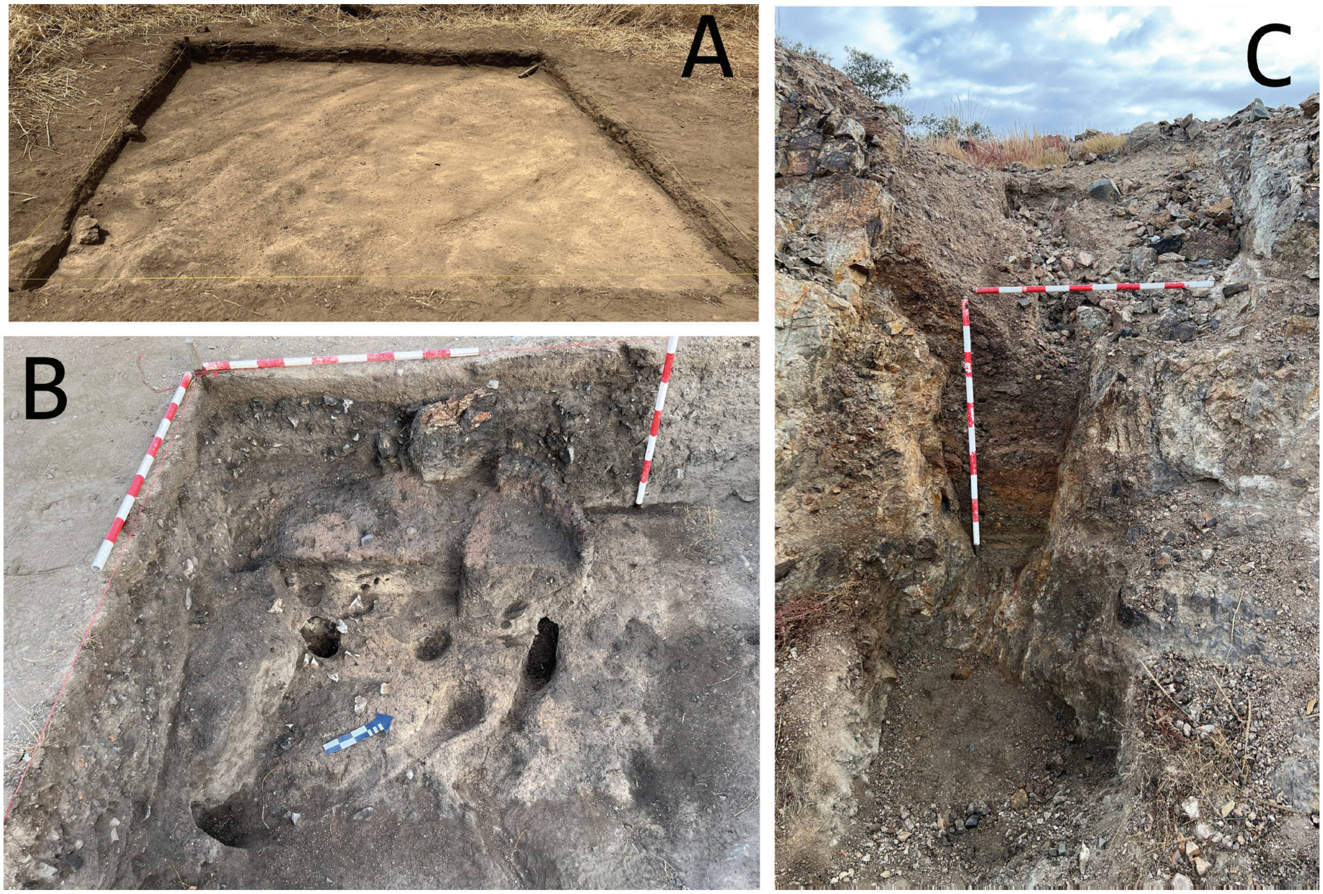


*Figure 9.7. View of the excavation of: A. Trench 5; B. Trench 6; C. Trench 12 (Pond Trench).*

in modern times. A prehistoric date for the works was confirmed by radiocarbon dating which indicated a Late Bronze Age chronology for the organic material in the lower excavated levels (Fig. 9.9). Unfortunately, after excavating to a depth of 4 m, the excavation was stopped for safety reasons, and it was not possible to reach the bottom of the mining trench.

During the following archaeological campaigns Trenches 4, 8, 10, 11, and 12 were excavated along the alignment of the mining works. The extreme southern end of Trench 12 (the 'Pond-Trench') revealed the complete section of an V-shaped mining trench, filled in by a succession of levels (Fig. 9.7C). This complex stratigraphic sequence is now being studied by microstratigraphy specialist Dr Mario Gutiérrez (University of Jaen). Samples for radiocarbon dating were also taken. The wood remains documented in this trench could be related to the use of fire-setting in the mining operations.

Other sections of the mining works were also revealed by Trenches 8 and 10 in the south and Trenches 4 and 11 in the northern area of the site (Fig. 9.3). However, even with the help of a mechanical digger in Trenches 8 and 10, and despite digging to a depth of 4 m, it was impossible to reach the bottom of the mining trenches (Fig. 9.10A & B). Thus, so far, the bottom of the mining works has only been established in Trench 12 ('Pond Trench') (Fig. 9.7C). How deep the trench is in its entire length is still unknown, but it might have been as much as ten or more metres; the Chinflón excavated trench type mine 3B, for example, reached a depth of 11.5 m below the surface (Hunt Ortiz 2003, 71). The width of the mining works of Las Minillas, in the narrowest and deepest levels, is less than 1 m, although the sections showed significant variations in different areas.

The excavation of Trenches 8 and 10 has revealed, nonetheless, that the filling of the trenches probably took place at different moments and in different ways. The stratigraphy of Trench 8 consisted of several layers of crushed rock and sands (Fig. 9.10A), frequently of a very homogeneous calibre. These layers overlap each other and were inclined to the east and west creating approximately 45° angles with the mining trench's rock walls, possibly as a result of filling the trench with mining debris thrown from the surface into the interior. The filling of the trench could have taken place in the 1920s when Las Minillas was last exploited by underground mining, perhaps in an effort to stabilise the subterranean mine and level the surface. Contrastingly, Trench 10 (Fig. 9.10B) showed a much more homogeneous


*Figure 9.8. View of the excavation of Trench 7*

stratigraphy, made of several parallel, horizontal and similar layers indicating that the filling of the trench in this section was perhaps the result of a planned filling. In both Trenches, the excavation has revealed a mixed collection of materials from the Late Bronze Age, Roman, and modern periods that do not follow any chronological sequence, suggesting that they were scattered all over the surface and reached the trench together with the earth that fills it long after they were discarded.

Trench 11 is located to the north of the mineralization, where the mining trench appeared to be divided into two sections, northern and southern, by an apparently undisturbed area to the north-east of the *casa-mina* (see Fig. 9.3). Further investigation of the area by the magnetic survey, however, detected some anomalies (Fig. 9.5) and subsequent excavation revealed part of another mining trench, containing hand-made pottery and stone hammers within the layers. There was no time to reach the bottom of the work but the excavation fully confirmed that the northern and southern trenches form one and the same series of works exploiting the copper mineralization (Fig. 9.10C).

Regarding the habitation area, in the 2020 season Trench 3 was opened in a disturbed area of ground (Fig. 9.3) where surface survey had detected a concentration of handmade pottery. The excavation exposed the poorly preserved remains of a round hut with associated features, interpreted as post-holes and fire-places, with just a few centimetres of stratigraphy preserved in some places (Fig. 9.6C). The

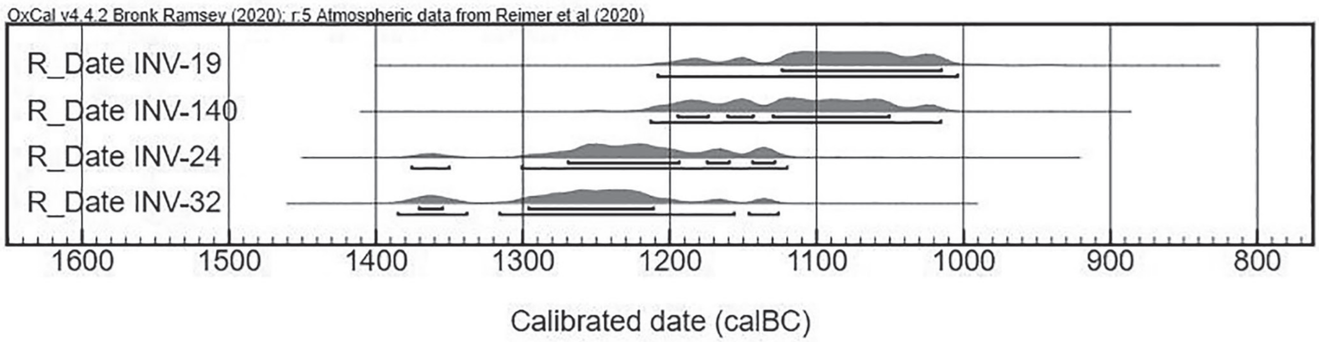


*Figure 9.9. Radiocarbon results of samples from Trench 2 and Trench 3. They point towards the exploitation of the mine during the 1300–1000 cal. BC interval.*

handmade pottery provided a Late Bronze Age chronology: sherds of burnished or smoothed (*bruñida* or *alisada* in Spanish) vessels of different types. One type, the so-called 'cazuelas carenadas' type, also found in Trenches 6 and 7, is well-known in south-west Iberia, where it is associated with Late Bronze Age contexts. Excavation inside the round hut in Trench 3 also yielded a fragmented but otherwise near complete prehistoric small handled burnished globular vase (Fig. 9.11A). A Late Bronze Age date for the hut was confirmed by radiocarbon dating (Fig. 9.9). The short lived dwelling could have served as part of a seasonal mining dwelling encampment.

The extension in 2022 of the excavation of the dwelling area in Trench 3 revealed more of the same negative dug structures: mainly post-holes; but otherwise produced very limited archaeological information. Some pottery sherds, copper mineral fragments, a few small fragments of slag, and two bones (identified both as tibia of *Bos taurus*) as well as fragments of charcoal which were recovered by flotation of the soil samples. These fragments are now in the process of being dated to confirm the chronology of the features. Samples from two circular rubefacted zones excavated in Trench 11, representing the preserved few centimetres of hearth bottoms, were also taken.

## Grooved stone mining hammers and other lithic implements

As has been pointed out, one of the remarkable features of Las Minillas mine is the large volume of stone mining hammers (Fig. 9.12) found at the site, the total number of which is constantly being added to as new areas are exposed by excavation or disturbed by ploughing. Indeed, these objects are so numerous that it is difficult to maintain a record of all of them. It is easy to estimate that several thousands of them must be scattered all over Las Minillas and some of them were even used as building stones in the 19th–20th centuries during the construction of the *casa-mina* and the walls of the shafts. With just a very few exceptions, almost all the stone hammers are made of dolerite (diabase) pebbles, a type of hard igneous rock: a widely available material which our geology specialists, Juan Cárdenas and José Antonio Lozano, traced to a number of local riverbeds and streams, 1–2 km away from Las Minillas. The manufacture of these tools was very simple: pebbles, typically of rounded/elliptical shape and variable weight and dimension (a typological study of them is now being conducted) were selected and usually modified with a simple transversal groove for hafting with a perishable material, such as bone or wood (Timberlake & Craddock 2013). Use-wear and fragmentation of the dolerite hammers is common; the presence of multiple dolerite hammer flakes being easily recognisable against the orthogneiss dominant geology of the site. Apart from the stone hammers, the only other lithic implements retrieved from Las Minillas were a few spherical or cubic shaped pestle and mortars, and two 'naviform' mills.

## Chronology of the prehistoric mining works

A general chronology of Las Minillas prehistoric mining works was initially proposed based on the typology of certain elements of the archaeological record. It has already been mentioned that the documented prehistoric pottery sherds can be assigned with certainty to the Late Bronze Age period, and, in the absence of other pottery types, we can confidently rule out an earlier phase of prehistoric exploitation.

The highly homogeneous character of the stone mining tools and even the typology of the mining works themselves (Craddock 1995; Hunt Ortiz 2003; O'Brien 2015) are also compatible with the Late Bronze Age chronology provided by the ceramics. Finally, the resemblance of the circular hut to the round huts excavated at the San Cristobal cassiterite exploitation site in Logrosán (province of Cáceres) points to a similar Late Bronze Age date. Radiocarbon dates obtained from these structures indicate a Late Bronze Age chronology (Hunt Ortiz 2019; Rodríguez Díaz et al. 2019, 209) and both sites present the same type of Late Bronze Age pottery.


*Figure 9.10. View of the excavation of: A. Trench 8; B. Trench 10; C. Trench 11.*

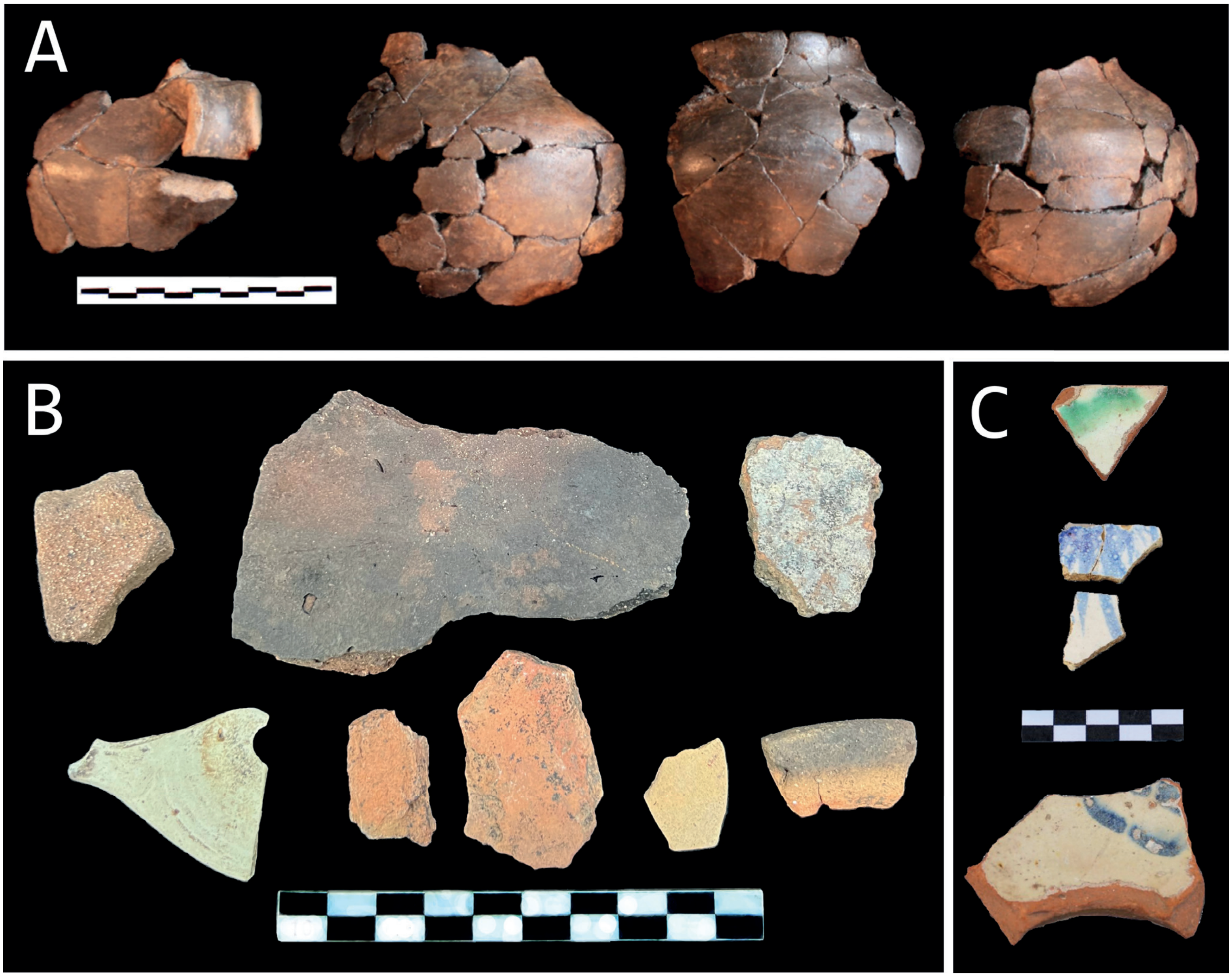


*Figure 9.11. Pottery recovered in Las Minillas: A. Late Bronze Age; B. Roman; C. modern.*


*Figure 9.12. Grooved stone mining hammers recovered in Las Minillas.*

For Las Minillas there are at this moment four radiocarbon dates, obtained in the CNA laboratory (University of Seville) (Fig. 9.9): three charcoal samples from the hut, Trench 3 (CNA-5901: INV-19, UE-3, *Quercus*; CNA-5902: INV-24, UE-5, *Rhamnus*; CNA-5903: INV-32, UE-16, *Arbutus unedo*) and one from charcoal samples from Trench 2, the mining trench (CNA-5904: INV-140, UE-5, *Quercus+Arbutus unedo*). Thus, all the charcoal samples from the mining works and hut are in the calibrated chronological range of *c*. 1300–900 BC.

Just as this article was completed, the results of 17 new samples analyzed at the SUERC Radiocarbon Laboratory, University of Glasgow, were received. Those results, that will be presented in forthcoming publications, confirm the Late Bronze Age dates for the hut remains (S-3) and for the trench-type works located in the extreme south (S-12) of the mining works. On the other hand, the radiocarbon for the charcoal samples recovered in levels excavated in the slag heap area (S-6) provided Roman Imperial and Islamic (a *fabacea* sample) dates.

## Las Minillas mine and its broad context

It has been observed that the scale of copper mining undertaken in south Iberia in the last centuries of the 2nd millennium BC cannot be accounted for by local demand alone and in order to explain this phenomenon more fully we need to expand our field of enquiry to take note of contemporary developments in the Eastern Mediterranean and Northern Europe (Hunt Ortiz & Ling 2023).

Beginning in the Eastern Mediterranean, it is generally considered that the sea routes to southern Italy would have been familiar to Mycenaean traders during the formative stages of their westward expansion. Simultaneous contact with Northern Europe is also evidenced by the amber trade (Kanta 2003, 25) which, together with the trade in metals, would have played a prominent role in the maintenance of Scandinavian relations with Mycenaean palatial societies from as early as the 16th century BC (Vandkilde 2022, 330). In Iberia, the presence of Baltic amber has been traced to the last quarter of the 2nd millennium BC, after which it appears to have progressively replaced, somewhat contradictorily for a Mediterranean exchange network, the supply of Sicilian amber (Murillo-Barroso et al. 2018).

Depictions of cargo and warships from the Late Bronze Age Eastern Mediterranean are well known from frescoes and ceramic paintings but, in terms of traded commodities, the information provided by shipwrecks and the remains of their cargoes has proved especially enlightening. The most relevant examples with regard to the trade in metals are the Bronze Age wrecks excavated off the southern Anatolian coast: Gelidonya and Ulu Burun, dated around 1300 BC. Both contained a high volume of cargo of varied origin, including copper ingots of the 'oxhide' type, and tin ingots, which show that copper and tin, the basic components for the fabrication of bronze, would travel together separately (Kanta 2003, 27). The finds coincide with what is considered to be a period of consolidation in the globalization of the Mediterranean trade network around the 12th century BC. This involved the establishment of stable routes and permanent ports on the north African coast linking the Eastern Mediterranean with Sicily, Sardinia, and the Iberian Peninsula in the west; a template followed by Phoenician mariners in later centuries (Marazzi 2003, 115).

In south-west Iberia, Mycenaean ceramics dated to the 13th century BC have been excavated at the site Llanete de los Moros, in Montoro (Córdoba), in a meander of the middle Guadalquivir valley (Martín de la Cruz 2008, 292). Constituting the earliest documented component of a group of Eastern Mediterranean wheelmade ceramics and other elements in the Iberian Peninsula, similar assemblages have also been suggested at Cerro de San Juan, in Coria del Río, in the lower Guadalquivir (Ruiz-Gálvez Priego 2009, 101; Escacena Carrasco et al. 2022) and in Carmona (Pellicer Catalán & Amores Carredano 1985, 147; Martín de la Cruz 2008, 293–5), and appear to confirm the importance of the river Guadalquivir valley as a point of penetration into the interior (Martín de la Cruz 2008, 294). Into this context should also be added the carnelian beads discovered at the site of Los Castillejos, about 20 km to the east of Las Minillas. Dated to the final centuries of the 2nd Millennium BC, the presence of these objects is considered further evidence of an early Eastern Mediterranean interest in the metallic resources of northern Córdoba (Martín de la Cruz 2004, 17; 2008, 298). A similar interpretation has also been given to the *horned altar*, dated to the 14th century BC, excavated in Cerro de la Encantada. The site, which is located in Granátula de Calatrava in the province of Ciudad Real, occupies a strategic point in the Jabalón river valley, controlling the natural passes to western Andalusia via Alcudia valley and Los Pedroches (Martín de la Cruz 2008, 289–90) an itinerary through which metals (and other goods) would presumably have been moved.

In the case of the Atlantic façade and Northern Europe, the clearest indication of the existence of long distance maritime trade during this period is the evidence for the transport of copper and tin metals, perhaps the most significant examples of which are the artefacts recovered from the Salcombe shipwrecks. These two wrecks (Moor Sand and Salcombe B) have so far yielded some 400 metal objects, including various types of bronze swords, 280 copper ingots, and 40 plano-convex type tin ingots dating back to the Penard metal complex phase; with a chronology around 1300–1150 BC (Berger et al. 2022). The results obtained from the study of the chemical and isotopic copper, tin, and lead compositions of the different groups of objects, indicate that these shipments were the products of long distance trade, following the so-called Atlantic maritime route, in which the ports of southern England (particularly those in the regions of Cornwall and Devon) provided stopping points for the traffic of metal between southern and northern Europe. The existence of local deposits of cassiterite ($SnO_2$, the main tin producing mineral) in south-west Britain would also have played an important role in the establishment of these docking points. It has been argued that the Salcombe tin ingots, which show similar chemical and isotopic compositions, were probably produced locally and that British tin may well have provided the main source for contemporary ingots found on the coast of Israel as well as later examples from France and Sweden (Berger et al. 2022, 22–3).

Additionally, the 13th century BC also saw the development and expansion of a pan-European weight measurement system. Evidence of this has been found not only at Salcombe (Berger et al. 2022, 23) but also as far afield as Huelva in Spain (Ruiz-Gálvez Priego 2009, 104; 109) and Sweden (e.g., in Kiviksgraven, in the Scania region) (Ruiz-Gálvez Priego 2009, 95).

The importance of Las Minillas and other Iberian copper production centres within this tentatively described Late Bronze Age supraregional trade network has yet to be fully established but it is hoped that current research by the Maritime Encounters project will provide a clearer picture of their relevance. Key to this objective is the project's recent efforts to compile a database of lead isotope signatures from the Iberian copper mining areas. Focusing in particular on the mineral-rich regions of the south-west, the project aims to compare these profiles with the lead isotope signatures of Atlantic European Late Bronze Age metal items in order to ascertain the relationship of these artefacts to known metal producing areas (for a recent discussion of lead isotopes and provenance studies in archaeometallurgy see Radivojević et al. 2018). By incorporating the results of previously published lead isotope data as well as several hundred new samples taken from surveys and excavation, the database will provide sufficient coverage to test the hypothesis that south-west Iberia was a key producer of copper at the end of the Bronze Age, with a high a degree of connectivity to Atlantic Europe/southern Scandinavia.

Simultaneously, the Maritime Encounters project is interested in the study of the mining communities involved in the exploitation and circulation of copper through the contextual and spatial analysis of a variety of key archaeological features. The general hypothesis underpinning this study is that terrestrial corridors and rivers would have been used to transport raw materials from the mining regions of western and southern Iberia to the coast in north-west, west, and south-western Iberia, and from there to the rest of Atlantic Europe and the Mediterranean (see Berger et al. 2023; Ling et al. 2024, 25–9). These trade routes would have created conditions for reciprocity, with waterways serving as a means of exchanging new ideas and influences, if not products, from different places. Traceable expressions of this phenomenon include the Iberian warrior stelae, which marked places of sacred significance linked to settlements of high strategic value (Díaz-Guardamino et al. 2019). As well as indexing the location and spread of the mining communities involved in the extraction and flow of traded raw materials (Fig. 9.13), the monuments also appear to manifest a high degree of cultural connectivity with communities further afield, particularly northern Europe where a number of remarkable similarities to contemporary Scandinavian rock-art have been documented (Diaz-Guardamino et al. 2022; Ling et al. 2024).

## Calculation of Las Minillas Late Bronze Age copper output

Given the extent of the prehistoric mining works, it is conjectured that the exploitation of the Las Minillas mine would have introduced a substantial amount of copper into the Late Bronze Age metal flows of Europe and the Mediterranean (an approximate estimation is presented below). Evidence gathered by the Maritime Encounters project from other (possible or confirmed) Late Bronze Age mines in south-western Iberia also suggests that the region as a whole may have become Europe's primary copper production centre, superseding the output of the Great Orme mine in Britain. As earlier studies have shown, production at Great Orme had entered a period of decline during the end of the Middle Bronze Age, after the 14th century BC (Williams & Le Carlier de Veslud 2019, 1192), prior to the opening of new copper mines like Las Minillas in south-west Iberia around the 13th century BC (Fig. 9.8). Recent publications of lead isotopic analyses of European Late Bronze Age artefacts also lend support to this trend (e.g., Montero Ruiz et al. 2007, 203; Melheim et al. 2018, 137; Aragón et al. 2023; Berger et al. 2023)**;** suggesting that a sizable quantity of the copper and copper alloy objects in circulation during this period comprised copper ores sourced from south-west Iberia.

Calculating how much copper a prehistoric mine would have produced is not easy (Williams 2023, 90) and the estimates presented here must be treated cautiously as very rough approximations. It is hoped that future work using geophysical survey will enable us to produce a 3D model of the mining trenches in order calculate more precisely how much ore they contained. For the time being, our calculations are based solely on Trench 12 (Figs 9.3 & 9.7); the only section of mining trench in Las Minillas to have been excavated to the bottom. It is estimated that this trench, which is approximately 3.70 m long by 4.60 m wide and 3 m deep, could have yielded as much as 51 $m^3$ of ore. Extrapolating this figure to the rest of the mine workings is trickier given our incomplete knowledge of their dimensions; however, based on the total length of all the trenches explored at the site so far (*c.* 200 m) we can supply a crude estimate of

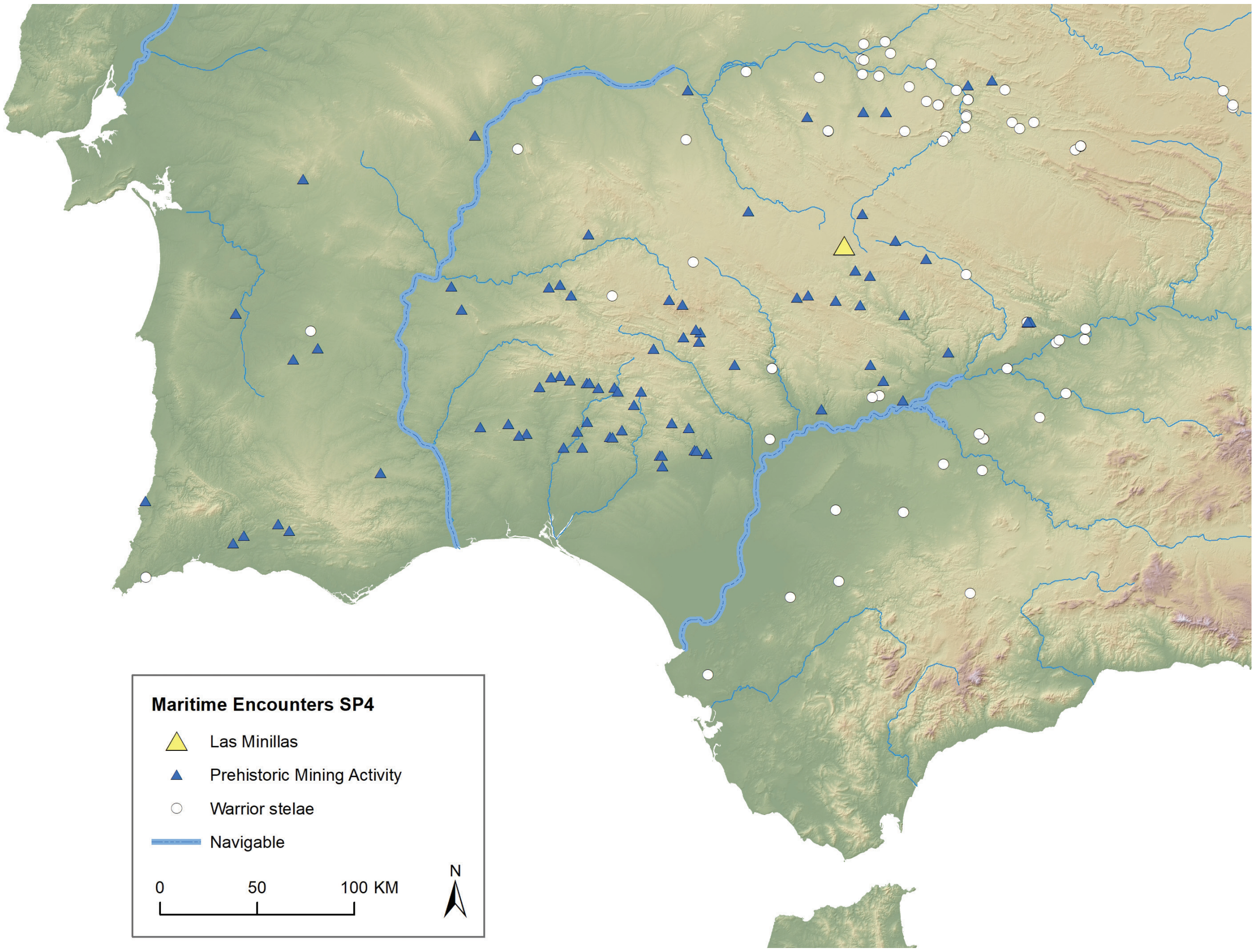


*Figure 9.13. Map of south-west Iberian mines with evidence of late prehistoric exploitation and distribution of warrior stelae (Díaz-Guardamino & Hunt Ortiz 2003, with additions).*

2756 m$^3$ of ore (51 m$^3$ ÷ 3.7 m × 200 m = 2756 m$^3$). This figure is conservative as the height given for Trench 12 is considerably less deep than the other sections of the trench, but it is also optimistic as it does not consider that the size of the ore vein was probably smaller than the trench. In any case, it is used to calculate the copper output of Las Minillas. Thus, our estimate is a simple calculation of the total volume of rock/ore extracted in Las Minillas and the amount of copper obtained from the latter. This method is the same used in Alan Williams' (2023, 89) estimations for the Great Orme's output.

Table 9.1 presents 16 output estimations or scenarios ranging from 'extremely optimistic' (scenario 16) to 'very conservative' (scenario 1) using three variables. The 16 estimations are the result of combining the values of the three variables in all possible combinations. The first variable refers to the grade or percentage of copper in Las Minillas's ore. That is the concentration of copper in the rocks extracted from the mine. Modern concentrations tend to average between 0.6% and 8%, 6.2% in the case of the Spanish Las Cruces (Sevilla) (Hunt Ortiz 2012, 8); but values in prehistory were probably higher. For our own estimations, four values are used: 0.5%, 1%, 5%, and 15%. The second variable refers to the percentage of copper lost after separating it from its ore. In prehistory this process most probably involved losing some copper that could not be separated from the ore. In the output estimations either 25% or 40% is lost. The third variable refers to the percentage of the Las Minillas vein exploited in the Late Bronze Age compared with Roman republican and later periods. In some Late Bronze Age scenarios, 40% of the vein may have been extracted; in others, as much as 85%.

After multiplying the approximate cubic metres of ore in Las Minillas (2756 m$^3$) by the average rock density (2.8 g/cm$^3$), we obtain a total number of 7717 tonnes of extracted ore. The three variables are then used to calculate how much copper was obtained in total per year during the approximately 300 year period (1300–1000 BC) Las Minillas was exploited according to the currently available evidence (Fig. 9.9). The 16 scenarios (Table 9.1) range from

*Table 9.1. Possible estimates for Las Minillas' copper output.*

| *ESTIMATION 16 scenarios (1=very conservative 16=very optimistic)* | *Total rock/ ore m³ (rough approx.)* | *Rock density* | *Total rock/ore tonnes (rough approx.)* | *VARIABLES* | | | *OUTPUT* | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | *Bulk ore grade before processing* | *% of copper lost after smelting and processing ore* | *% mined LBA* | *Tonnes of copper obtained after smelt and processing* | *Tonnes per year (300 years)* | *Palstaves per year (450gr) (300 years)* |
| 1 | 2756 m³ | 2.8 | 7717 tonnes | 0.5 | 40 | 40 | 8 | 0.026 | 58 |
| 2 | | | | 0.5 | 25 | 40 | 10 | 0.033 | 73 |
| 3 | | | | 1 | 40 | 40 | 16 | 0.052 | 117 |
| 4 | | | | 0.5 | 40 | 85 | 20 | 0.066 | 146 |
| 5 | | | | 1 | 25 | 40 | 20 | 0.066 | 146 |
| 6 | | | | 0.5 | 25 | 85 | 25 | 0.082 | 182 |
| 7 | | | | 1 | 40 | 85 | 39 | 0.131 | 292 |
| 8 | | | | 1 | 25 | 85 | 49 | 0.164 | 364 |
| 9 | | | | 5 | 40 | 40 | 79 | 0.262 | 583 |
| 10 | | | | 5 | 25 | 40 | 98 | 0.328 | 729 |
| 11 | | | | 5 | 40 | 85 | 197 | 0.656 | 1458 |
| 12 | | | | 15 | 40 | 40 | 236 | 0.787 | 1749 |
| 13 | | | | 5 | 25 | 85 | 246 | 0.820 | 1822 |
| 14 | | | | 15 | 25 | 40 | 295 | 0.984 | 2186 |
| 15 | | | | 15 | 40 | 85 | 590 | 1.968 | 4373 |
| 16 | | | | 15 | 25 | 85 | 738 | 2.460 | 5466 |

an extremely low output of 8 tonnes to 738. In the first case (8 tonnes), Las Minillas would have produced 26 kg (0.026 tonnes) of copper a year for 300 years. This meagre return, however, appears improbable given the amount of effort and investment (in the form of transporting stone hammers and the construction of furnaces and huts, etc) evidenced at the site. In the second, most optimistic, case 738 tonnes would have been extracted over the lifespan of the mine, equivalent to 2.46 tonnes of copper per year. In the case of the scenarios in the third quartile (scenarios 9–12), Las Minillas produced between 0.26 and 0.78 tonnes per year.

Alan Williams has calculated that the two richest zones at Great Orme produced between 202 and 756 tonnes during the period 1600–1400 BC (Williams & Le Carlier de Veslud 2019, 1189). This is equivalent to 1.1–3.7 tonnes per year over 200 years, far greater than the 0.026–2.46 tonnes estimated to have been produced over the 300 year lifespan of Las Minillas. Thus, in the most conservative scenario, production at Las Minillas would have been around 2% of that at Great Orme and, in the most optimistic scenario, 66%, albeit over a longer period. However, we should also bear in mind that Las Minillas was probably only one of a considerable number of mines in the region. Figure 9.13 shows 84 mines in south-west Iberia with evidence, mostly grooved mining hammers but also pottery, that they could have been exploited in the Bronze Age. In scenario 8 in Table 9.1 (our average production scenario), the annual output of Las Minillas (0.164 tonnes) is divided by the average net weight of a copper palstave (*c.* 450 g; see

Williams 2023, 91), to calculate that it could have produced 364 of these axes per year. If 25% (21) of the 84 mines in Figure 9.13 were exploited with the same average intensity in the Late Bronze Age, it would mean that south-west Iberia could have produced around 7644 palstaves per year. In comparison, in Alan Williams's most optimistic estimates, the Great Orme produced 8900 palstaves a year (Williams & Le Carlier de Veslud 2019, 1189). This estimation suggests that south-west Iberia could had been one of the most important copper sources for Late Bronze Age Europe and the Mediterranean. Evidently these calculations are an approximation. The large number of assumptions and conjectures cannot be overstressed. Future work undertaken by the Maritime Encounters project will aim to confirm or refute these ideas.

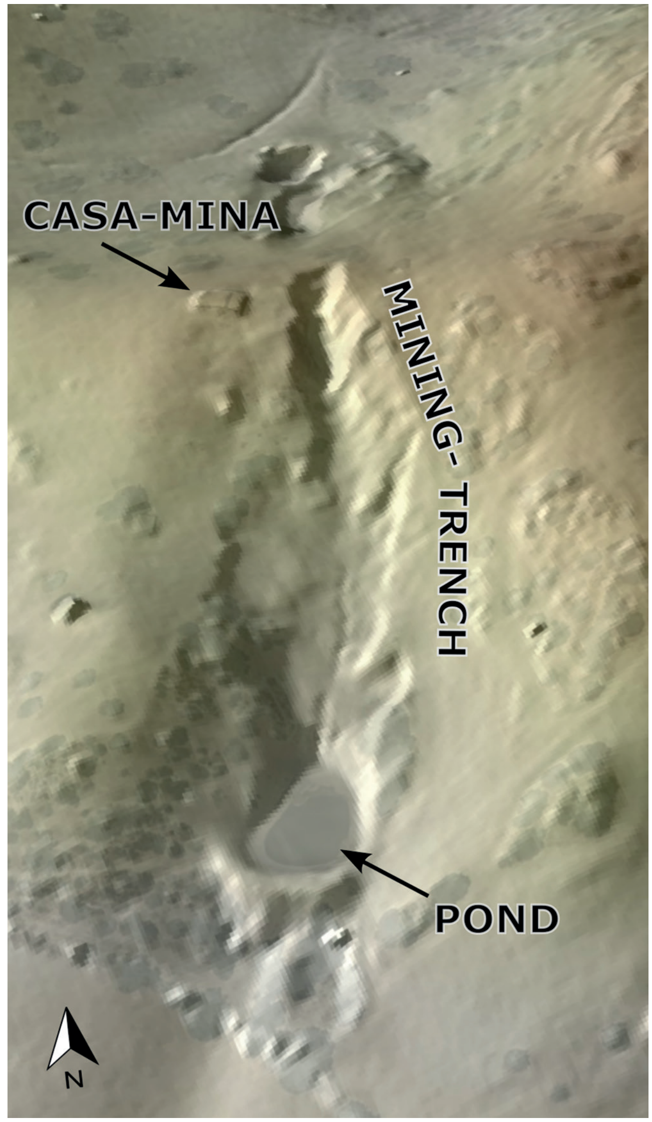


*Figure 9.14. LiDAR image showing the area of Las Minillas (modified after Kiko Sánchez Díaz)*

## Conclusions

The archaeological investigations at Las Minillas and other prehistoric mines in the south-west of the Iberian Peninsula are beginning to make clear the importance of copper mining in the region, and the geological zone of Ossa-Morena in particular (Tornos et al. 2004), during the Late Bronze Age. In Las Minillas an intense effort was made in this period (*c.* 1300–1000 BC) to extract copper ore, involving the excavation of trench-type mining works to a length of more than 200 m (Figs 9.3 & 9.14), using, most probably, fire-setting and thousands of grooved stone hammers.

The absolute radiocarbon dates available for the Las Minillas prehistoric copper mining works and the associated dwelling remains are concentrated exclusively in the range 1300–1000 BC; unlike the Chinflón mine (Pellicer & Hurtado 1980; Rothenberg & Blanco Freijeiro 1980), which extended to just before the Phoenician presence.

By applying archaeometric techniques, such as the analysis of stable metallic isotopes (Pb, Sn, Cu), combined with radiocarbon dating, the Maritime Encounters project has been able to direct its investigation to certain geological areas and to compare the character of the south-western mineralizations exploited in the Late Bronze Age with those of contemporary Late Bronze Age copper based metallic objects from Northern Europe. Despite the limitations inherent to these analytical methods (Hunt Ortiz 2003), they indicate that the copper mines of the southern Iberian Peninsula began to supply metal for the manufacture of objects used in Northern Europe from *c.* 1400 BC, gradually replacing Central European and British mines as centres of copper production. This relationship forms one of the main fields of research undertaken by the project. In addition to the excavation of the Las Minillas mine, the project is re-investigating other known mines, tentatively identified as active in the Late Bronze Age period, such as Chinflón, Cerro Muriano, and Cala, as well as conducting selective prospecting of mineralized areas in the provinces of Badajoz (were El Reventón mine was discovered), Córdoba, Jaén, and Ciudad Real, areas of the Ossa-Morena and Central Iberian geological domains where evidence of possible Late Bronze Age exploitation is also suspected (Domergue 1987; Hunt Ortiz 2003).

The dating of the Las Minillas mine workings also throws open the question of what might have stimulated the increase in the extraction of copper ore in Late Bronze Iberia after what appears to have been, on present evidence, a lengthy hiatus following the Chalcolithic–Early Bronze Age transition (Nocete et al. 2010). The emergence of external markets for Iberian copper ore, enabled by maritime connections along the Atlantic facade, provides one compelling answer to this question though whether this conclusion can be nuanced further remains the subject of active debate. As alluded to earlier, previous studies have emphasized the lack of local demand for copper, predicated largely on the absence of large weapon hoards, such as the one found in the Ría de Huelva dated to the 10th century BC (Ruiz-Gálvez Priego 1995); arguing that the presence of a local elite based on the exploitation of mineral resources in south-western Iberia is not evidenced before the Phoenician period (Ruiz-Gálvez Priego 1995, 514). This *ex nihilo* argument is now being increasingly challenged, notably by recent work by the Maritime Encounter's team. The studies of Iberian iconography, specifically the so-called warrior stela and related rock art, suggest the inception of a recognizable Bronze Age panoply in the region that is – at the very least – coterminous with the renewal of copper minerals exploitation evidenced by the Las Minillas mine (Fig. 9.13; Ling et al. 2024). Needless to say, the existence of a putative Iberian warrior elite has ramifications for the socio-political dimension of copper production during the Late Bronze Age period, aspects of which have been articulated elsewhere including this volume. Following Johan Ling's Maritime Mode of Production model (see Chapter 5), it has been argued that the need to ensure access to certain metals was a top priority for those seeking prestige and power and that long distance exchange in mineral wealth played an essential role in the establishment and maintenance of unequal social structures (Díaz-Guardamino et al. 2022, 340). Supported by analogies with later Viking period and near contemporary anthropological comparanda, this rationale should also be applied to the Late Bronze Age Iberian context and here similarities with later periods are equally instructive. Indeed, reframing an old argument about the agency of Phoenician traders in the exploitation of Iberian mineral resources, it could be said that the extraction of significant levels of copper in the Late Bronze Age suggests a greater degree of continuity with the Early Iron Age; the only real change being a shift away from copper to silver production (Hunt Ortiz 2003).

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# 10

# What genetics can say about Iron Age and Bronze Age Britain

*Nick Patterson*

*This study considers genetic events that affected Britain during the period bracketed by the arrival of Bell Beakers about 2450 BC down to the beginning of the Roman conquest in AD 43. Within this span two major population shifts occurred. A great population turnover coincided with the arrival of the Beakers bringing steppe ancestry. This was followed, in the Late Bronze Age and the beginning of the Iron Age, by the more gradual impact in southern Britain of incomers who had higher levels of European Early Farmer (EEF) ancestry than that found in the Early Bronze Age British population. The genetic impact of these newcomers gradually spread across England, but not to Scotland. When did (Proto)-Celtic speakers arrive in Britain? We argue that the most plausible time is around 1000 BC coincident with the observed genetic shift.*

## Introduction

I want to summarize what genetics has told us about Iron Age and Bronze age Britain and in particular what clues it gives us about how and when Celtic speakers arrived in Britain. I am a Brit, now getting on in years, so an alternative title to this short essay would be 'An Ancient Briton on Ancient Britain'. My current beliefs about what occurred are tentative and the reader should remember that I am a geneticist with no expertise in linguistics or archaeology, so any views I have in those fields are secondhand, though I have talked extensively to my many knowledgeable colleagues in these disciplines. The period I want to discuss ranges from the arrival of Bell-Beakers into Britain (Olalde et al. 2018) (2450 BC) to the conquest of England by the Romans (AD 43).

## A brief review of the genetic history of Britain prior to the arrival of Romans

Early post-Glacial Britain was populated by Mesolithic hunter-gatherers. Around 3850 BC farmers arrived in Britain whose genetics match that of mainland Europe at that time. There are no major genetic shifts in Britain (though important cultural changes) until the arrival of Bell Beakers (see Olalde et al. 2018 for detail about the Beaker Phenomenon and its genetic impact on Europe). In mainland Europe about 500 years earlier than the arrival of Beaker people in Britain, there had been a movement of pastoralists from the Pontic-Caspian steppe into Europe bringing in distinctive steppe genetics (Haak et al. 2015), and very probably Indo-European language.

By about 2000 BC the basic genetic structure of Europe was set – a mix of genetics from three sources: hunter-gatherers, first farmers, and Steppe pastoralists. Of course there have been many subsequent demographic changes, but the genetics of 2000 BC are broadly similar to that of Europe today, at least before very recent immigration. That is very different from the pattern in 3000 BC.

We begin with a Principal Components (PCA) plot (Fig. 10.1) projecting genetic British samples older than the Iron Age onto axes formed from modern Eurasia. The reader does not need to understand the detailed procedure here but should realize that the symbols and colours are just to improve clarity. The actual plotted location is independent of the population labels. Note that we have no samples genetically intermediate between Beakers and British Neolithic farmers, suggesting little contact between these groups.

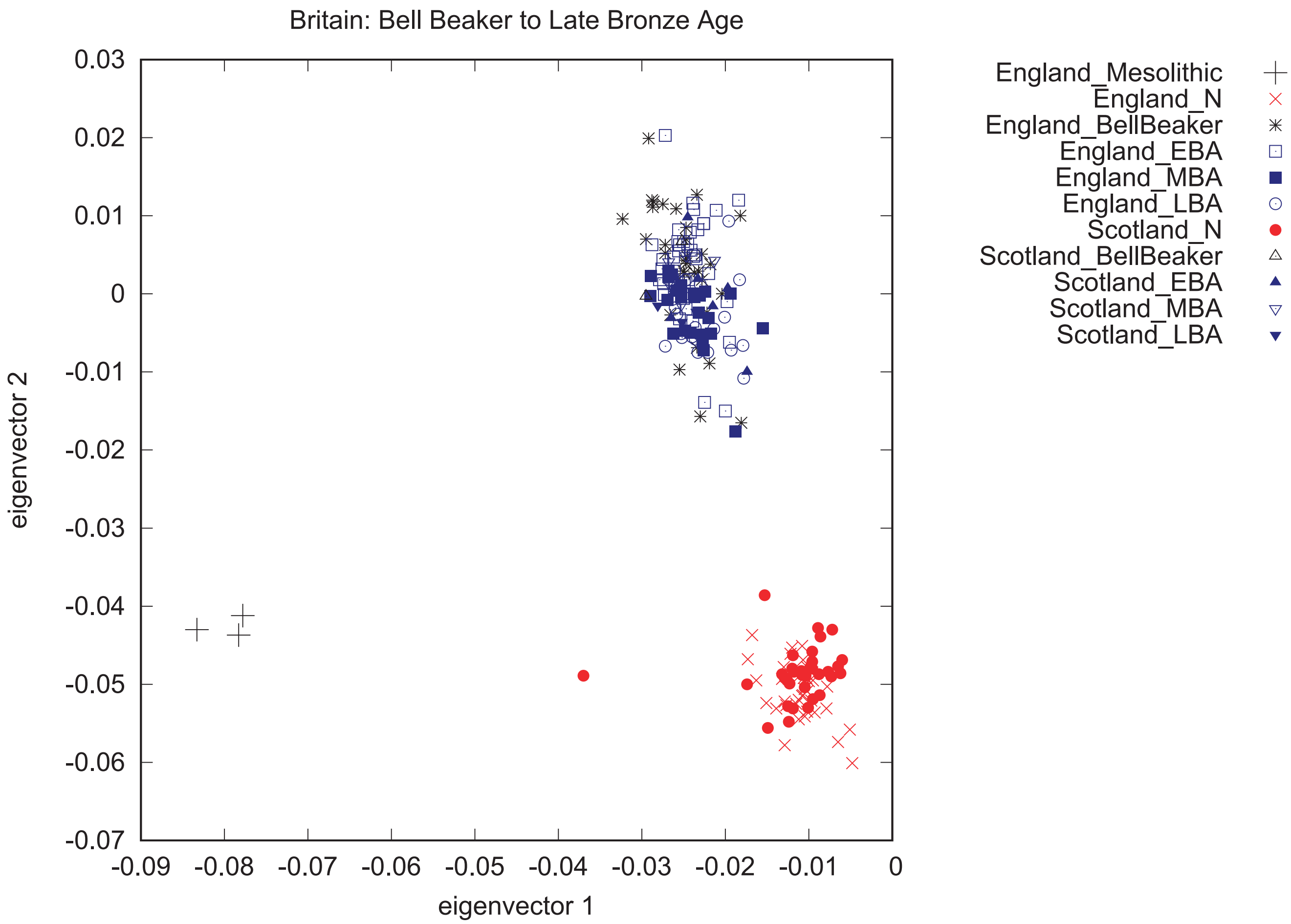


*Figure 10.1. Principal Components (PCA) plot projecting British genetic samples older than the Iron Age onto axes formed from modern Eurasia. There are three very clearly separated groups of points. The Bell Beaker and Bronze Age samples form a cluster. There is some genetic variation within, but no clear structure relating to, culture or date.*

## Bell Beakers and the Early Bronze Age in Britain

The Bell Beakers in Britain are extremely similar genetically to those present in northern France and the Netherlands but can be distinguished from Beakers in Central and Eastern Europe and also from those in Iberia. This makes it highly probable that British Beakers travelled to Britain directly from north-western Europe. Beakers in Britain have at least half their ancestry distally originating from the Pontic-Caspian steppe, while the pre-Beaker British agriculturalists have no detectable steppe ancestry at all.

Our male British Beakers samples all have a Y-chromosome allele not found in our mainland samples at the time of Beaker movement into Britain. This makes it likely that they originate from a small area not yet sampled for ancient DNA. Nevertheless, there is substantial genetic variation among the Beakers and early Chalcolithic samples from Britain. This suggests that there was some genetic inhomogeneity among the Beaker arrivals. A patrilocal culture with large scale exogamy would fit our genetic data.

Remarkably the pre-Beaker agriculturalists do not seem to have made any significant genetic impact on the post-Beaker peoples of Britain. This is in contrast to the arrival of steppe ancestry in mainland Europe (from Yamnaya pastoralists about 3000 BC) where the resulting cultures such as Corded Ware do have significant ancestry from middle Neolithic European populations. The British early Bronze Age (Early Bronze Age) looks as though it is genetically a simple descent from the British Beakers so there is no evidence for more movement from the mainland in the early 2nd millennium. Ancient DNA has shown that quite sharp changes in the genetics of a region have occurred more frequently in human history than many had believed. Here are three scenarios each of which can be an explanation.

1. The new arrivals brought with them a technology or culture which increased the carrying capacity of the land and allowed a substantial increase in population. The new arrivals simply outcompeted the original inhabitants, and there may not have been very much violence.

2. A natural disaster (for instance an epidemic or large change in climate) weakened the original culture which could put up little resistance when new arrivals appeared. It is interesting that plague has been found in Britain around 2000 BC (Swali et al. 2003). It seems plausible that this might have been brought into Britain by Bell Beakers (plague was endemic on the steppe: Rasmussen et al. 2015). Perhaps plague helped collapse the old pre-Beaker society.
3. An 'invasion' or repeated and perhaps extensive small raids made the old culture impossible to maintain.

## First sign of further movement from mainland Europe into Britain

A main source for the following material is Patterson et al. (2022). We have four remarkable samples dating to the Late Bronze Age from two sites (Margetts Pit and Cliff's End) in Kent. Isotope analysis suggests a non-local origin, and the samples have more Early European farmer ancestry than our British Early Bronze age samples. Radiocarbon dates here are not very precise, but suggest that the Margetts Pit samples are from around 1150 BC (Patterson et al. 2022) while the Cliff's End samples are later, from about 900 BC (McKinley et al. 2015). We may well be seeing here first generation migrants into south-eastern Britain from mainland Europe.

We can model our British Late Bronze Age samples as a mixture of Early Bronze Age and Margetts Pit/Cliff's End ancestry. The most probable scenario is that in the Late Bronze Age there was a steady stream of arrivals from mainland Europe into southern England (especially Kent) causing a shift in the genetics and culture. The migrants had less Steppe ancestry than Early Bronze Age Britain, and this caused a genetic north–south cline in Britain still present today (Leslie et al. 2015; Galinsky et al. 2016). In the later Iron Age (after about 500 BC) there is no evidence of further genetic contact between mainland Europe and Britain, until the arrival of the Romans. We have not determined the likely sources of the peoples moving into Britain. Samples from the Knoviz culture (now in Czechia) provide a good statistical fit, as do samples from several locations in France. Our sampling of mainland Europe around 1000 BC is thin, and if more data become available we hope to revisit the issue. Paradoxically the genetic analysis of Europe is much easier for periods before 2000 BC than later, because different European groups are much more strongly differentiated in the earlier period.

Genetics does provide some insights into British culture in the Bronze Age and Iron Age. As an example, the allele inducing lactase tolerance rose rapidly in frequency in England after 2000 BC, under strong positive selection. It rises in frequency also in central Europe, but 1000 years later. This suggests some difference in dairying practices between England and mainland Europe and presents a challenge to archaeologists. As another important example, the Margetts Pit genetics spread through most of England (but not Scotland) suggesting exogamy among the various cultures in England. One likely exception is the Iron Age 'Arras' culture (Mathieson Stead 1979) of East Yorkshire, where we see evidence of mating being primarily within the culture, causing substantial genetic 'drift'. There has been recent technical progress on inferring demographic history (especially ancestral population size) and an analysis of Arras data (Fournier et al. 2023) provides strong evidence that the culture was largely endogamous and that this is different from the rest of Iron Age England.

## Different dynamics of population movement

The arrival of Bell Beakers in Britain seems to have been an event in which substantial numbers of people arrived over a short period. The population genetics of the Beaker sites across England and Scotland all look similar, suggesting a common origin. Bell Beakers arrived in Ireland at around the same time, though it is not clear if the immediate source of the Irish Beakers is Britain or continental Europe. Nevertheless, we do have genetic profiles of a few samples from the Early Bronze Age in Ireland, who do not appear very different genetically from Early Bronze Age in England.

In contrast, the genetic shift occurring in England at the end of the Bronze Age and beginning of the Iron Age seems to have been a much more gradual process, probably extending over hundreds of years. Furthermore, the total genetic impact of the new arrivals was far less than the major shift that occurred with the coming of the Beakers. Since we do not know the source population for the later genetic shift we cannot estimate the extent of population replacement, but it is unlikely to have been much more than 40%.

## The origin of (proto)-Celtic

The available data (archaeological, linguistic, genetic) do not provide a clear answer to where and when Celtic originated. Indeed, we may never know for sure. However, if the shift to Celtic is correlated with a genetic shift, which is probable, though far from certain, then the only plausible dates are either around 2400 BC. with the arrival of Bell Beakers, or in the Late Bronze Age at around 1000 BC. with the movement from mainland Europe identified by Patterson et al. (2022). I favour the more recent event since, as late as the Roman period, insular Celtic and Gaulish were not very divergent (J. Eska, pers. comm.). In addition, the 1000 BCE event and a movement from France into Britain fit both the genetic data and the recent proposal of a Celtic origin in France by Sims-Williams (2020). One argument against this is that the later movement made no substantial impact in Scotland, so it is unclear how Brittonic Celtic reached Scotland.

It would take us too far afield to outline all the evidence, but it is overwhelmingly likely that Indo-European language arrived in Europe with the steppe migrations around 3000 BC and took another several hundred years to reach Western Europe. This is the so-called 'Steppe Hypothesis'. This makes Cunliffe's proposal (2018) of (proto)-Celtic spoken on the Atlantic coast in the 4th millennium very unlikely. But a version of *Celtic from the West* in which Celtic arises on the Atlantic coast in the late 2nd or sometime in the 2nd millennium is not obviously excluded by genetic evidence.

Summing up, genetics now offers new evidence on how a language group such as Celtic spread but will rarely be decisive on its own, and cannot and will not answer all the questions we would like to ask.

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# 11

# Cross-disciplinary considerations: ‘hedge’, ‘hull’, ‘fool’, and the triumph of linguistic palaeontology

*John T. Koch*

*The archaeogenetic support for the Steppe Hypothesis of the Indo-European homeland lends incidental support to the earlier methods that had led to the same conclusion independent of genetic evidence. Perhaps the chief amongst these is that called ‘linguistic palaeontology’, which is based on inherited vocabulary shared among related languages. Confirmation of linguistic palaeontology’s efficacy opens the way to using this method to locate other reconstructed languages – such as Proto-Celtic and Proto-Germanic – in time, space, and the archaeological record. The study includes case studies of three words:* *kaghyo-/ā *‘unsettled enclosure’,* *kup-s-o-, *kŭ̄p- *‘ship’s hull’ < ‘beehive’, and* *dhrūto- *‘jester, buffoon’.*

## Background: an earlier project and ongoing research

The e-book *Celto-Germanic: Later Prehistory and Post-Proto-Indo-European vocabulary in the North and West* appeared in late 2020 (Koch 2020) as a research output of the project ‘Rock Art, Atlantic Europe, Words & Warriors (RAW)/*Hällristningar, språk och maritim interaktion i Atlantiska Europa*’, funded by the Swedish Research Council (*Vetenskapsrådet*). Work in this area has continued as part of the programme ‘Maritime Encounters: a counterpoint to the dominant terrestrial narrative of European prehistory/*Maritima möten: en kontrapunkt till den dominerande landbaserade berättelsen om europeisk förhistoria*’, supported by Riksbankens Jubileumsfond. The intention of this continuation of the research is to expand and refine the dataset, i.e., the inventory of inherited words limited to Celtic and Germanic languages, reaching a better understanding of the history and original meanings of specific words to see how that might throw new light onto aspects of later prehistory along the Atlantic façade, from Scandinavia to Iberia. This chapter presents three case studies, as first fruits of that ongoing research, showing how items of historical linguistic evidence can be brought together with archaeology and archaeogenetics to develop interpretations and hypotheses.

## Some statistics: CG, CG+, and NW

One advantage of creating a broad-based Celto-Germanic (CG) dataset – to be expanded and refined in continuing research and as a foundation for in-depth case studies on individual words – is that it is large enough to be interrogated meaningfully for statistical analysis. Because of the research that has been carried out in the meantime, the following statistics will differ somewhat from those in *Celto-Germanic* (Koch 2020). CG words, defined as unique to Celtic and Germanic or showing innovations unique to Celtic and Germanic, total 175 examples. CG+ words include the foregoing, then, added to that total, words attested and innovations of words also found in one or both of Italic (in most cases Latin) and/or Balto-Slavic. Note that in this definition, it is not the same a North-west Indo-European (NW), which is more inclusive and would thus have a greater total. NW words would include those attested in any two or more of the following: Germanic, Italo-Celtic, and/or Balto-Slavic. So to be counted as NW, a word could have no attestation in Celtic or Germanic, or conceivably both, being found only in Italic and Balto-Slavic. Because many linguists think that Italo-Celtic formed a Post-Proto-Indo-European branch (Cowgill 1970; Ringe et al. 2002; Kortlandt 2007; Weiss 2012; Schrijver

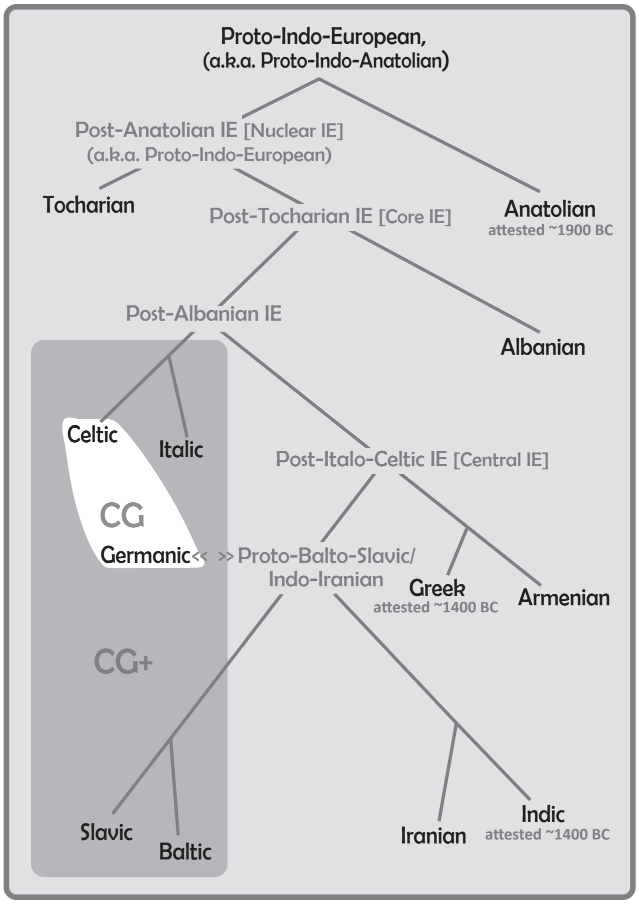


*Figure 11.1. Tree model of first-order branching of Indo-European based on Ringe et al. (2002) with overlays to suggest prehistoric interaction of dialects producing the phenomena of North-west Indo-European and Celto-Germanic word sets (J. T. Koch).*

2016; versus Watkins 1966; Clackson & Horrocks 2007) and most think this for Balto-Slavic, words found only in Italic and Celtic or Baltic and Slavic cannot be counted as NW, as they only certainly share a narrower common ancestry. The current total of CG+ words is 284. Therefore, a high proportion of those are CG – i.e., Celtic and Germanic only – 175 or 61.6%, a disparity that is probably significant in indicating especially intense and/or prolonged contact between those two branches or their dialectal forerunners.

Words whose Germanic forms show signs of having been borrowed after the operation of Grimm 1 and/or Grimm 2 have been excluded. These are the prior two of the three known collectively as 'Grimm's law' (Fulk 2018, 102–12):

Grimm 1 *p, *t, *k, *k$^w$ > *f, *þ, *h, *h$^w$
Grimm 2 (*b,) *d, *g, *g$^w$ > (*p,) *t, *k, *k$^w$
Grimm 3 *bh, *dh, *gh, *g$^w$h > *b, *d, *g, *g$^w$

Of the 175 CG words, 88 or 50.3% were clearly part of Pre-Germanic before the operation of Grimm 1. A further 37 or 21.1% show earmarks of predating Grimm 2. Because some words include consonants that could show both changes, these totals and percentages cannot simply be added. 104 or 59.4% of the 175 CG words show Grimm 1 and/or Grimm 2. The other examples do not have the relevant consonants. As explained below, the Grimm 3 change is usually not diagnostic. Thus, for 71 or 41.6% of the CG words, other criteria must be considered in assigning them to prehistory. For example, a word attested in two or three of Goidelic, Brythonic, and Continental Celtic is more likely to go back to prehistoric period. Likewise, on the Germanic side, a word found in two or three of Gothic, West Germanic, and North Germanic is more likely to be old. Conversely, a word or specific word form or usage attested only in two languages that were in close contact in historical times, such as Brythonic and English, is open to suspicion of late borrowing if the criteria of sound laws are inconclusive (Fig. 11.1).

Which languages each of the CG words are attested in make for an interesting and probably significant statistical pattern: 133 of the 175 (76.0%) are attested in Old Norse; 120 or 68.6% are attested in Old and/or Middle English; 110 or 62.9% in Old High German or Middle High German. On the Celtic side, 142 or 81.1% are attested in Old and/or Middle Irish and 134 or 76.6% in Brythonic. Note that in their respective language families North Germanic and Goidelic show the highest proportions of CG words (Fig. 11.2). These are languages that were not in direct contact at all in historical times until about AD 800 and it is unlikely that many if any Viking Period loans have slipped into the CG corpus undetected. If the largest proportion of the corpus was the result of contact in Central Europe in the Iron Age, the relatively low count in High German – spoken where that contact took place – would not be predicted.

A major impetus for studying Celto-Germanic vocabulary together with Bronze Age archaeology within multi-disciplinary research projects is that numerous societal or cultural concepts or items of material culture designated by CG words can be related to Bronze Age material culture and society (89 words = 50.9%). A large subset of that group (75 words = 42.9%) can be related to motifs on Bronze Age Scandinavian rock art or Iberian warrior stelae (most often both).

### Post-Proto-Indo-European, Pre-Celtic and Pre-Germanic, Proto-Celtic and Proto-Germanic, degrees of mutual intelligibility

Since the sound change known as Verner's law (Fulk 2018, 107–12) is 1) conditioned by the Proto-Indo-European (PIE) position of the accent and 2) operates on the output

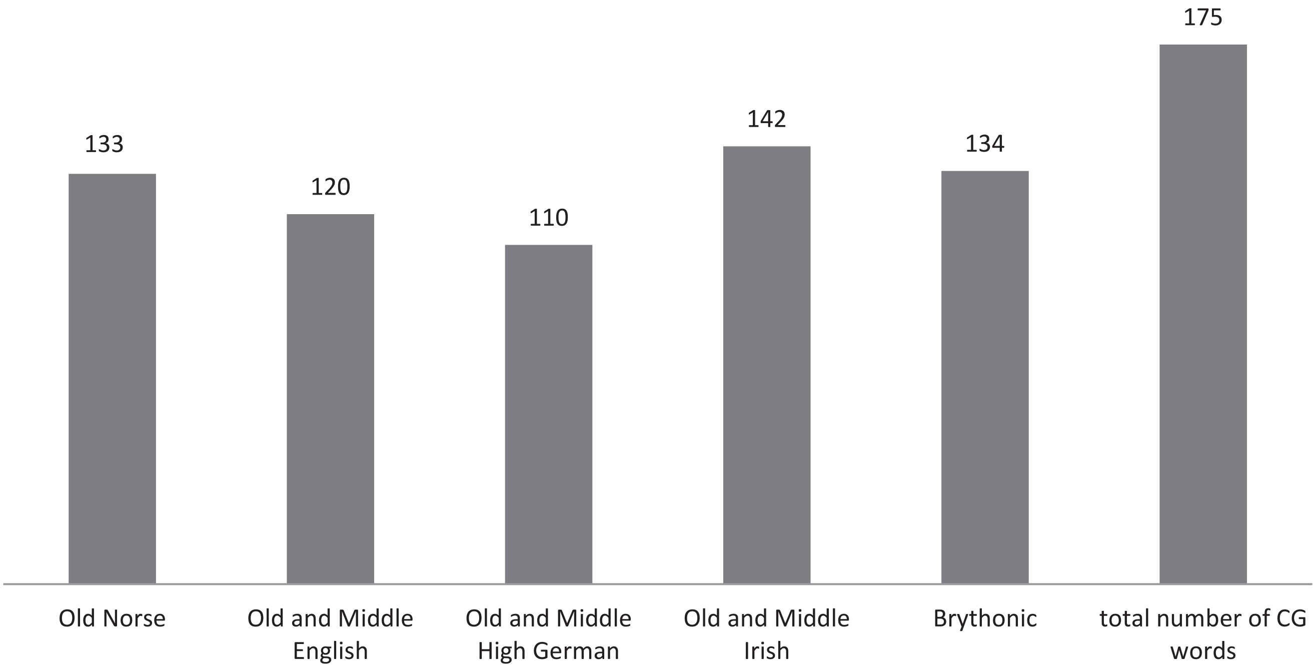


*Figure 11.2. Attestations of the 175 Celto-Germanic words in well attested medieval languages: Old Norse, Old and Middle English, Old and Middle High German, Old and Middle Irish, Brythonic (Old and Middle Welsh, Breton, and Cornish) (J. T. Koch).*

of Grimm's law, that means that the CG words entered Pre-Germanic at a time when Pre-Germanic had not yet generalized the Proto-Germanic word-initial stress accent but still retained its earlier position. Now, taking these facts together, it is seen that the bulk of the CG corpus dates to the stage when the consonant systems of Pre-Celtic and Pre-Germanic had not yet greatly diverged and the two languages were not accented differently. At such a stage we would expect these Post-Proto-Indo-European branches to have retained a relatively high degree of mutual intelligibility. A socio-linguistic context for this situation is the intensity of long distance contact indicated by both gene flow and evidence for metal trade found in the Middle to Late Bronze Age. The precondition for the divergence of the two branches and breakdown of Pre-Celtic/Pre-Germanic mutual intelligibility came at Bronze-Iron Transition, after which the long distance copper trade was greatly diminished and the gene flow into southern Britain largely ceased.

## Semantics in collaborative research

In any cross-disciplinary collaboration involving historical linguistics the off-putting nature of that discipline will be an obstacle. Most of what we do – phonetic and phonological description, linguistic reconstruction, the formulation and sequencing of sound laws, etc., etc., along with a knowledge of several pre-modern languages – cannot be emulated by researchers outside linguistics. Often they struggle in vain even to understand. Experience at cross-disciplinary meetings, conferences, or research projects, or teaching undergraduate modules with no prerequisites will prove this point.

Semantics, the domain of meaning, is the exception. When it comes to what the words refer to – items in the man-made and natural world, social roles and institutions, beliefs and ideology – archaeologists will not only find the work of the linguists more accessible, but their own input will be essential. Linguistics alone cannot tell us, for example, exactly what kind of 'wheel' a reconstructed word with that meaning referred to, or where or when in time and space and the archaeological record that item might or might not be found. The upshot of the foregoing thoughts is that in the research of the cross-disciplinary Maritime Encounters programme – while full-spectrum historical linguistics remains essential (with sound laws, phonological reconstruction, and so on) – foregrounding semantics is likely to repay the effort, supplying our colleagues in archaeology with accessible data and stimulating feedback from them that may prove decisive in determining what exactly a word originally meant and where and when that meaning arose.

## The Indo-European homeland problem and the 'archaeogenetic revolution'

Although historical linguistics and archaeology have both focused intensely on aspects of European prehistory for well over a century, effective collaboration has proved a formidable challenge. For those many years, the Indo-European proto-language and the prehistoric stages of its dialectal branches have been reconstructed in great detail and, though these models have continued to evolve, the main outlines discerned by the pioneers of modern philology have generally held up. On the other hand, it was rarely possible to situate these reconstructed proto-languages in a more-or-less universally convincing way in time and space, mapping them on to archaeological cultures.

The obvious case in point is the overarching question of the Indo-European homeland, which long remained unresolved, though perhaps no longer. Among many competing hypotheses there were, up to about a decade ago, two mutually exclusive contenders, neither of which enjoyed a decisive advantage: a model in which Indo-European spread with pastoralism from the steppe of what is now Ukraine and south-west Russia ~5000 years ago (Gimbutas 1970; 1981; 1997; Mallory 1989; Anthony 2007) and the model associating the expansion of Indo-European with the expansion of farming from Anatolia from ~9000 years ago (Renfrew 1987; 2013; Gray & Atkinson 2003; Bouckaert et al. 2012; 2013; Heggarty et al. 2023).

This standoff appeared to be going nowhere fast until what is sometimes called the 'archaeogenetic revolution' intervened, notably in the shape of the simultaneously published studies of Allentoft et al. (2015) and Haak et al. (2015), which appeared clearly to confirm the Steppe Hypothesis, or some version of it. In the fast pace that this startling new evidence had to be absorbed, the main takeaway was that the homeland of post-Anatolian Proto-Indo-European was more probably the steppe ~3500×3000BC than Anatolia ~8000×7000 BC (cf. Lazaridis et al. 2024). But a question important for subsequent research has not been so often raised. The Steppe Hypothesis already existed before the full genome sequencing of ancient DNA. Why was it right? Was it just the luck of a coin toss? Or were its methodology and theoretical assumptions better and more correct from the outset?

At the stage before the archaeogenetic revolution the main difference between the two arguments was that the Steppe Hypothesis relied heavily on 'linguistic palaeontology', whereas the Anatolian Hypothesis discounted that evidence. Linguistic palaeontology is again semantics. For example, attestations in several of the Indo-European daughter languages have cognate words for 'wheel', which, including English *wheel* itself, can be reconstructed as Proto-Indo-European **k$^{w}$ek$^{w}$lóm*. Proponents of the Steppe Hypothesis argue from this that the society that spoke Proto-Indo-European had the wheel. And, then running through hundreds of such examples of reconstructed Proto-Indo-European words and their meanings, the Steppe Hypothesis envisioned a Proto-Indo-European world that corresponded to that of pastoralists on the Pontic-Caspian steppe at the Late Neolithic/Copper Age stage of development with many features (such as the wheel) absent from the Anatolian Early Neolithic ~8000×7000 BC. The counter argument from the Anatolian Hypothesis, again using the example of 'wheel', is that this word was derived from the verb **k$^{w}$el-* 'turn' – which it does – and that that 'meaning' is completely compatible with an Early Neolithic way of life and word view; words looking like reflexes of **k$^{w}$ek$^{w}$lóm* might have been generated independently after the branches had divided and they independently encountered the wheel. And so on and so forth, until the entirety of Late Neolithic/Copper Age Indo-European world could be explained away as a mirage of parallel developments between separate cognate languages with an Early Neolithic latest common ancestor. If that counter argument was fully accepted, the basic core procedure of historical linguistics – i.e., historical-comparative reconstruction – would be called seriously into question. This is not an altogether fanciful proposal. Related languages can continue to borrow/translate new vocabulary from an inherited stock in such a way as to mimic cognates, though belonging to a later cultural stage. For example, an unthinking application of the historical-comparative method to German *Sprachwissenschaft* and Swedish *språkvetenskap* could lead to the conclusion that these go back to a word meaning 'linguistics' in Proto-Germanic, their last common ancestor.

Nonetheless, beyond the provisional triumph of the Steppe Hypothesis in the Indo-European homeland debate, the archaeogenetic tie breaker is also a methodological triumph for linguistic palaeontology. And that carries potential applicability for a further wide range of questions in which archaeology and historical linguistics can be combined. For the main questions facing Maritime Encounters – namely what was ongoing in the north-western maritime fringe of the Indo-European world in later prehistory – this provides further rationale for foregrounding semantics.

## Middle to Late Bronze Age = 'Indo-European dark ages'

The Allentoft et al./Haak et al. leap forward in the archaeogenetic revolution was the easy part – the low-hanging fruit. That research involved genetically starkly different populations that had been isolated from one another for millennia. These groups also had very different ways or life and material cultures. They undoubtedly spoke different languages. With rapid gene flow from the steppe ~3000 BC, the new people entering many new areas often introduced their distinct genetic type at high percentages, double-digit intrusions, in many cases over 50%. In the case of the Afanasievo culture of the Siberian Altai and middle Yenisei, genomes approach 100% steppe component, thus virtually indistinguishable from individuals of the Yamnaya source population.

There was the good fortune that, when this genomic evidence came into the debate, it was then largely a matter of deciding between two hypotheses that been developed in detail and argued about for many years. Archaeogenetics then endorsed the contestant that had already won over many adherents on the strength of linguistic and archaeological evidence alone. By now a three-way language-archaeology-genetics (LAG) correlation is well established – cumulatively powerful but approximate and not to be taken as a claim that these three are invariably coterminous – (Post-Anatolian) Proto-Indo-European ≅ Yamnaya ≅ steppe component.

From here things get trickier. Mallory (1996) has written of an ironic 'Indo-European dark age'. Thus, between the relative certainty situating (Post-Anatolian) Proto-Indo-European among users of Yamnaya on the Pontic-Caspian steppe ~3000 BC and the even greater certainty of the early Indo-European languages were spoken as we start to find them in writing, there are considerable uncertainties. For example, the Afanasievo culture mentioned above is regarded as a good candidate for the context of the Indo-European that evolved into the attested Tocharian languages, despite a gap of 1000 km and over 3000 years between the archaeological evidence and the texts. So where were Pre- and Proto-Tocharian in the meantime? Of more immediate relevance to Maritime Encounters, Proto-Celtic has been much debated as to both time depth and location. The Beaker Complex, Urnfield Bronze Age, and Atlantic Bronze Age have all been proposed repeatedly. Are we so certain that Celtic in the Iron Age (stretching from Ireland to Iberia to Galatia) was far more extensive than Proto-Celtic in the Late Bronze Age to be sure that it could not possibly have been spoken within both the Atlantic and Urnfield Bronze Age? In the English speaking world at least, there is an ingrained notion that Proto-Celtic is to be identified with the earliest Hallstatt Iron Age in west-central Europe, Ha C1a ~800×750 BC, though this is impossibly late (Koch 2013). The findings of Patterson et al. (2022; see also this volume Chapter 10), indicating that the population of Britain was relatively isolated and stable in the period ~800 BC–AD 43, amount to highly significant negative evidence, a 'dog that didn't bark',[1] showing the British Iron Age to be a relatively unlikely context for the introduction of new language from the Continent, despite the deeply ingrained scenario 'the coming of iron' = 'the coming of the Celts'.

There are also issues of remaining uncertainties about the shape of the Indo-European family tree. For example, there is the status of Italo-Celtic mentioned above. Whether Italo-Celtic is thought of as an undifferentiated node on the family tree or something more like a chain of neighbouring dialects will of course affect how, where, and when it might be situated on a map of Bronze Europe. If the former, when and where was the split?

The archaeogenetic revolution has yet to decisively illuminate this dark age. Unlike the stark first meeting of steppe pastoralists and early European farmers, the later prehistory of the separating Indo-European branches must now be unravelled in the context of the bewildering interaction of groups with blends of steppe, EEF, and hunter-gatherer (HG) ancestry. We need to up our game.

## The transformation of southern Britain in the Middle to Late Bronze Age

An important archaeogenetic study deals with a time and place of particular interest for the Maritime Encounters programme shows a major genetic inflow (bringing a ~50% population shift) into what is now England and South Wales in the period ~1300–800 BC (Patterson et al. 2022). They find an overall rise of Early European Farmer (EEF ancestry) 31.0% to 37.9%, levelling off in the Early Iron Age from ~800 BC. For the same group, the steppe component went down 51.8% to 50.4%. At the same time, the reverse shift occurred in Iberia: steppe ancestry rose 14.9% to 21.4% as EEF declined 64.5% to 59.4% (Patterson et al. 2022: supplementary table 7). In other words, the general trend in the Middle to Late Bronze Age was towards an equalization or convergence of these ancestry types between southern Britain and south-west Europe.

Another key finding is that the rise in EEF ancestry in Britain was not due mainly to a population increase in groups with British Neolithic ancestry, but rather incomers from somewhere overseas to the south on the European mainland. Proxy populations such as Iron Age France, 'Tartessos' (south-west Spain ~700 BC), and Late Bronze Age Urnfield Central Europe are modelled. Though suggestive, none of these proxies fit exactly and, in any case, many of the genomes are too late to belong to the actual source population.

Nonetheless, it is proposed, albeit with due caution, that the incomers came in large part from what is today the territory of France and that they brought Celtic speech with them. This is possibly right. However, there other possibilities, as this case is much more complicated than that of the rapid and massive expansion of the steppe component in the 3rd millennium into regions where it had previously been altogether absent. The gene flow into Middle to Late Bronze Age Britain blended native-born and incoming groups both of whom had high levels of steppe and Neolithic farmer ancestry. And the indigenous group actually had the higher level of steppe ancestry. Because Celtic is an Indo-European language, our first thought in seeing an increase in EEF ancestry and decline in steppe ancestry is not necessarily 'here come the Celts'.

We will want answers to other questions. If the population influx bringing high levels of steppe ancestry to Britain in the Beaker–Early Bronze Age period (~2450–1800 BC) also brought an early Indo-European language, as is likely, was this a fully separated Indo-European language from that brought less than a millennium later through the same cross-Channel corridor from the Continent? Must there be two Indo-European languages – as opposed to dialects retaining a high degree of mutual intelligibility – involved in this scenario? And, if one was ancestral to Celtic, must the other not be? Must it be 'either/or'? Had the evident lull in interaction between Britain and the Continent between ~1800–1300 BC been deep enough for the sea to become a linguistic barrier as well as geographical one? How many fully separated Indo-European languages were there in Western Europe at this time? Was it impossible for the incomers and descendants of the British Early Bronze Age population to speak to another without one of them learning a second language?

## Case study: Germanic *hedge*, Celtic *cae* 'hedge, enclosed field'

To assess the implications of the population shift in southern Britain identified by Patterson et al. (2022), it is important to consider what else was happening in Britain in the Middle to Late Bronze Age. One key detail is that extraction of copper from the Great Orme mine in North Wales fell off precipitously from ~1400/1300 BC (Williams & Le Carlier 2018; Williams 2023). Its output had reached widely over Britain, but also further afield, representing, for example, one of the major sources for copper imported in Scandinavia in the period ~1700–1400 BC (Nørgaard et al. 2019; 2021). From ~1300 BC, chemical and isotopic tests show that copper from south-west Europe, most probably metal-rich Iberia, was arriving in volume in the Atlantic North, including Britain and Scandinavia (Ling et al. 2014; 2019; Ling & Koch 2018; Berger et al. 2022; see also this volume Chapters 8 & 9). That finding of course raises immediate implications when weighed alongside the Patterson et al. data. Did the two-way north–south population movement of ~1300–800 BC drive the expansion of the metal trading network? Or was it more the reverse? Or were both symptoms of a larger systemic process (Fig. 11.3)?

For an overview of British society at this stage, it is useful to quote the first paragraph of Chapter 8, 'The Productive Land in the Age of Warriors, 1500–800 BC', of Barry Cunliffe's *Britain Begins* (2013, 251):

> In the middle of the second millennium the appearance of Britain and Ireland began to change as communities started to impose themselves on the landscape, not to create monuments to ancestors or the gods but to take hold on the land itself and to tame it once and for all. Man-made boundaries began to proliferate. Regular patterns of fields were laid out: on sloping hillsides the cultivated areas were shaped by constant ploughing, while on the gravel terraces and claylands ditches were dug to define and drain the plots. Elsewhere linear earthworks running for kilometres across the landscape separated vast tracts of territory. The coercive effort needed for such endeavours implied, at the very least, that communities were working together to impose a permanent system of management on the land. In the long history of Britain this was a major revolution. We are seeing here the control of the productive capacity of the land eclipsing the manipulation of rare raw materials as the imperative driving society.

This focus on the new control of land draws attention to one CG word in particular, the original meaning of which can be teased out with the attested Celtic and Germanic forms. Thus, pre-dating Grimm 1, there are Old English *hecg* 'enclosure, hedge', Old High German *heckia, heggia* 'hedge' < Proto-Germanic **hagjō-* < CG **kaghyo-/ā*, as well as Old Norse *hagi* 'pasture with a fence, field for grazing', Old English *haga* 'hedge, enclosure', Old Saxon *hago* 'hedge', Old High German *hag* 'hedge, enclosure, dam' < the byform **hagan-* < CG **kagh-on-*. On the Celtic side, the Gaulish *caio* glosses '*breialo siue bigardio*' 'field or enclosure', which occurs as local place-name *cagiíon* inscribed on a tile from Cajarc, France, also *Caiocum* now 'Cayeux-sur-Mer, Somme', and *Matu-caium* in Noricum (Delamarre 2003, 97). In Hispano-Celtic, the place-name *Caius mons*, present-day *Moncayo,* corresponds to the Celtiberian coin legend **kaio** (A.82) (Jordán Cólera 2019, 134, 319–20, 663). In Brythonic, these correspond to 9th century Old Breton *caiou* glossing '*munimenta*' 'defensive enclosures', Middle Welsh *cae* 'hedge, hedgerow, fence, field, enclosure; clasping brooch', Breton *kae* 'hedge or embankment', Cornish *ke* 'hedge, ditch, enclosed field', all going back to Proto-Celtic **kagyo-*, which in turn goes back to **kaghyo-*, like the Proto-Germanic. It is clear enough that these must all derive from a single word with a specialized meaning, that is, rather than a natural clearing, a maintained agropastoral land with man-made enclosure – hedge, fence, or bank and ditch. None of the words range to meaning inhabited land with a house or houses, a defended settlement. So, in terms of the British landscape, as in the passage above, what is most significant about **kaghyo-* for present purposes is that it describes very specifically – in both Celtic and Germanic – something that came into existence in the British landscape and socio-economic order in the middle of the Bronze Age, but uncommon or non-existent before that. That is, a large piece of land, exploited and of value for agropastoral purposes and enclosed with man-made demarcation or barriers of some sort, but **kaghyo-* is not a defended settlement.

This example may throw some light on linguistic chronology as well. As a CG word **kaghyo-* '(hedge) enclosed agropastoral land', does not occur outside Celtic and Germanic and so is more probably Post-Proto-Indo-European, rather than having fortuitously died out in all the other branches. That this word did not yet exist


*Figure 11.3. Map showing some Bronze Age copper mining sites, artefact hordes traced to probable Iberian sources, and find spots of aDNA evidence (J. T. Koch).*

when Post-Anatolian Indo-European first expanded rapidly from the Pontic-Caspian steppe ~5000 years ago is confirmed by its limited distribution and also the fact that root **kagh-* has the vowel **a* and a root structure, both of which would have been rare, if not impossible, in PIE. On the other hand, the possibility of historical period loan-word between Celtic and Germanic can be excluded. It is widely attested in both branches. As mentioned above, it was in the Germanic word stock before Grimm's law. Nonetheless, **kaghyo-* may rest on an older Indo-European word that had not undergone the specialized development of meaning found in Celtic and Germanic. Thus, Latin *cohum* 'hollow in the middle of a yoke', Umbrian **kukehes** 'will take, get', and Albanian *ke* 'has, holds' may all reflect an earlier Post-Proto-Indo-European < PIE **kH₂gh-* 'take, catch, grasp'.

With the rising importance of enclosed fields, as implicit in the quotation above, there coincided a rising importance of labour to exploit the land more intensively. Therefore, while the shift at this time to a population with higher EEF ancestry might involve some incoming elites and possibly the introduction of a new Indo-European language, i.e., what became Celtic or specifically Brythonic, we should also consider that possibly large numbers of unfree farm labourers were involved in this gene flow. Low status or zero status individuals were possibly exchanged as commodities within the long distance networks over which metals were also traded. This possibility is consistent with the Maritime Mode of Production model (Ling et al. 2018), in which the Bronze Age society at this period is seen as closely analogous to the patterns recurring in the Viking Age 2000 years later.

## Case study: Celto-Germanic 'boat's hull' < Post-Proto-Indo-European 'beehive' < 'curved container'

The origins of the most common present-day Welsh word for 'boat' or 'small ship', namely *cwch*, could be of obvious interest for Maritime Encounters. But these have remained fairly mysterious. The word is not included in Matasović's (2009) *Etymological Dictionary of Proto-Celtic*, nor in the first edition of *Celto-Germanic* (Koch 2020). At the time of writing, the online *Geiriadur Prifysgol Cymru* (*CPC* 1959–2002) lists only the Breton cognate *couc'h* (now spelled *kouc'h*).

A suggestive clue is that Welsh *cwch* means both 'boat' and 'beehive'. Similarly, Breton *kouc'h* means both 'hull of a ship or boat' and 'top of a beehive'. In Germanic there is a word with a similar remarkable set of meanings: thus, Old English *hȳf* 'beehive', Kentish *hēve*, corresponds to Old Norse *húfr* 'hull of a ship', both derived from **hūƀiz* or **hūbiz*, which would go back to **kūp-* before the operation of Grimm 1. Although Proto-Indo-European **p* is most often simply lost in Celtic, the sound [x], which written *ch* in Welsh and *c'h* in Breton, can derive from a Pre-Celtic **p* if that sound was followed immediately by **t* or **s*. Therefore, the Greek word *κυψέλη kŭ̄psélē* 'chest, box, beehive' may offer a key linking the Brythonic word meaning both 'vessel with a hull' and 'beehive' to the Germanic word with the same two, rather distant meanings. *κυψέλη* is not the only relevant Greek word in this connection: note also *κύπελλον* 'beaker', *κόβαθος* 'cup, drinking vessel', *κύβεθρον* 'beehive'. The variation in vowel and final consonant of the root suggests that this may be a trade word borrowed repeatedly in various forms, a conclusion also consistent with meanings. Note also Latin *cūpa*, *cŭppa* 'cask, barrel, tub' and Sanksrit *kū́pa-* 'pit, hole'. The variations in forms with short and long [u(:)], also [o], and [p] alternating with [b] are hard to explain as regular outcomes from a common Indo-European proto-form. They rather suggest borrowing, possibly repeated borrowing, from a non-Indo-European language. That the attestations extend from the western branches to Sanskrit suggests that the borrowings took place in Europe before Indo-Iranian had spread to South Asia. It is also possible that a trade word is involved, designating containers for traded goods or containers that were themselves traded. A word resembling **kŭ̄p* originally meant broadly 'something holding a curved void'.

That meaning is continued with Old Breton *penn cuh* 'cranium' or 'round head-gear'. In Gaulish **CVXSVS** is found as a potter's name from Rheinzabern (ancient Rhenanae Tabernae), in which case it is probably the occupational name of a maker of ceramic containers. Phonologically, **CVXSVS** corresponds exactly to the preform Welsh *cwch* and Breton *kouc'h*, namely Proto-Celtic **kuχso-* < **kup-s-o-*. With the rise of beekeeping in the ancient world (cf. Van Sluis 2022, 23), **kŭ̄p* came also to mean 'beehive' in Post-Proto-Indo-European languages including Greek. Like Gaulish **CVXSVS**, Greek *Κυψέλος* also occurs as a personal name (for the first tyrant of Corinth, r. *c.* 655–625 BC). Herodotus (5.91) explains that as an infant *Κυψέλος*'s mother hid him in a *κυψέλος*, 'chest' or possibly 'beehive', to protect him from killers seeking to head off a fateful prophecy. The child survived and received his name from the incident.

What is uniquely Celto-Germanic is that related forms, having come to mean 'beehive', came also to mean 'hull, boat'. Considering that both Old Norse and Brythonic had many words for vessels or containers similar to boats and their hulls, it is remarkable that it was these cognates in particular that acquired this transferred sense, which points to a shared inheritance.[2] The Vikings were active in Brittany in the period AD 843–939, but by that time Old Norse *hýfr* and Old Breton *cuh* could hardly have influenced one another as forms of the same word, recognizable as such.

In the original Celto-Germanic transfer of meaning 'beehive' > 'ship's hull', a metaphor was possibly involved, in which a fierce crew rapidly disembarking and then crowding back into their vessel was likened to a swarm and hive (Fig. 11.4). Such a metaphor occurs in the Iliad:

> Just as tribes of swarming bees emerge from some hollow rock, constantly coming on afresh, and in clusters over the flowers of spring fly in throngs, some here, some there, so from ships and huts by the low sea beach marched out in companies their many tribes to the place of assembly. (2.87–93, Murray 1999; similarly Iliad 12.167–70; Aeneid 1.470–6; see further Hollingsworth 2005, 31–75).[3]

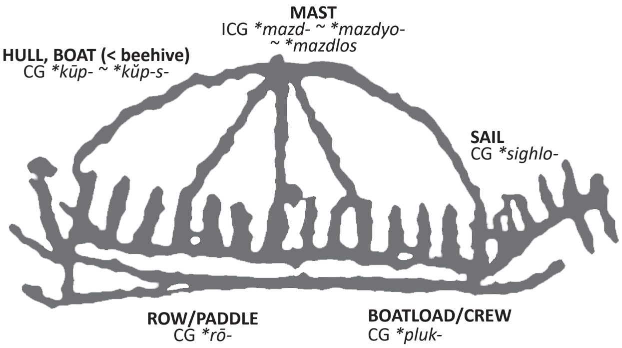


*Figure 11.4. Bronze Age rock carving depicting a sea-going vessel with a mast, rigging, and crew: Järrested, Skåne, Sweden, with reconstructed Celto-Germanic and North-west Indo-European words for the vessel and its components (J. T. Koch).*

## Case study: Grimm's law and 'fool'

In compiling the CG corpus, loan words from the historical period have been excluded. Usually, that is easy enough. Celtic words borrowed in Germanic, or vice versa, in the post-Roman Migration Period or Viking Age are usually obvious, as they will have run the gamut Proto-Indo-European to Celtic or Germanic sound laws first. So they look more like a vocabulary item in the branch they came from, rather than an inheritance traceable to Proto-Indo-European in both cases, but having a distribution limited to two neighbouring subfamilies. On the Germanic side, as mentioned above, an important diagnostic is the Germanic consonant shift, also known as Grimm's law, which comprises three linked changes – Grimm 1, Grimm2, Grimm3 (see above). Most often Grimm 3 is not relevant as a diagnostic because the path of Proto-Indo-European to Proto-Celtic also underwent the change **bh, *dh, *gh,* $*g^{w}h$ > **b, *d, *g,* $*g^{w}$. But to deem it altogether inconclusive would imply that this sound change occurred at exactly the same time in the evolution of both branches. Most of the CG words (i.e., inherited words and forms of words shared uniquely by Celtic and Germanic) behave with regards to this sound change as though **bh, *dh, *gh,* $*g^{w}h$ > **b, *d, *g,* $*g^{w}$ had happened in neither Pre-Celtic nor Pre-Germanic at the time the item became established in both branches. However, as Guus Kroonen has pointed out to me, a CG word meaning 'jester, fool, buffoon' suggests that change happened earlier on the Celtic stream, though more examples can be explained as reflecting a situation in which the change had not happened yet in either pre-branch see Kroonen 2013).

To put it another way, more of the CG corpus appears to reflect a lengthier stage that was both before Grimm's Law and also before the convergence of the voiced stop consonants and voiced aspirate stops in Pre-Celtic; this was followed by a briefer period in which the change had happened in Pre-Celtic – so that the language had evolved closer to Proto-Celtic – but Grimm 3 had not yet happened in Pre-Germanic. So, Old Norse *trúðr* glossing '*histrio'* 'juggler, fool', Old English *trūð* 'trumpeter, actor, buffoon' can be explained as derived from Proto-Germanic **trūþa-*. *trúðr*, etc., can be understood as the cognate of Old High German *trūt* 'dear, beloved',[4] reflecting Proto-Germanic **drūda-* < Pre-Germanic **dhruH-tó-*, if the word meaning 'fool' is explained as a loanword from Proto-Celtic after **bh, *dh, *gh,* $*g^{w}h$ > **b, *d, *g,* $*g^{w}$ in Celtic, but before Grimm 2 in Germanic. The meaning of Middle Irish *drúth* 'professional jester, fool; legally incompetent, idiot' is so close that a common origin is likely. Note also Middle Irish *drúthacht* 'buffoonery'. These forms point towards a Proto-Celtic **drūto-* < Pre-Celtic **dhrūto-*. As a Celtic loanword into Pre-Germanic, **drūto-* became **trūþa-* by Grimm 1 and 2 and Germanic **a* regularly from Proto-Indo-European **o*.

Middle Welsh *drut* 'reckless (in battle), furious, foolish, foolhardy, extravagant' is probably an inter-Celtic loan from Goidelic. In present-day Welsh, the word *drud* is common, usually meaning 'expensive'. But the earliest occurrences in poetry can be understood as applying to an ill-fated hero who conspicuously performed with reckless ferocity in battle, which is an understandable semantic development from an earlier sense of a performer acting like a fool or madman. The vowel of Middle Welsh *drut* implies a preform **drouto-*. A loanword from Primitive Irish **drūto-* datable to the Roman period (i.e., after Ancient Brythonic **ū* had become **ǖ* and **ō* < **ou* had become **ū*) is one possible explanation for the Brythonic form. Therefore, both the Germanic and the Welsh look like early loanwords from Proto-Celtic **drūto-* and Primitive Irish **drūto-*, respectively.

The fact that the word itself referred to an itinerate occupation possibly explains why it was prone to borrowing between cognate dialects in contact. It is also worth noting in this connection that, in medieval Irish texts, *drúth* 'fool, jester' is often confused with *druï*, genitive *druäd* 'druid'. Welsh *drud* can also mean 'druid'. In large part, these developments can be explained as the result of the similarity of the words' forms. But also, in any narrative context there would be similarities: both jesters and druids were special groups of outsiders, who would exhibit unusual behaviour and empowered to speak special truths by virtue of their status.

Returning to the implications for historical phonology, the foregoing scenario – taking into account also the bulk of the CG words in which PIE **bh, *dh, *gh,* $*g^{w}h$ behave as in native vocabulary – points to a relatively brief window when Pre-Celtic **dh* could become Proto-Celtic **d* and then, after borrowing into Pre-Germanic, become **t*, undergoing Grimm 2. Saying that this window was 'relatively brief' means that this would not be a matter of absolute chronology. Unless we are sure that the CG words arose at a steady frequency, it cannot be certain that the smaller number showing PIE *dh > Proto-Celtic *d > Proto-Germanic *t, than those showing the earlier treatment (*dh > Proto-Germanic *d), must mean that the latter were spread over a greater number of years. It may be that the earlier contact was more intense, but not necessarily longer. In fact, that the Pre-Celtic/Pre-Germanic contact became less intense is likely to be the reason that the sound systems of the two branches began to evolve away from one another.

It would not be surprising had *bh, *dh, *gh, *$g^{w}h$ > *b, *d, *g, *$g^{w}$ happened in Celtic at an absolute date earlier than the occurrence of Grimm's law. Both sound changes are prehistoric and so can't be seen in their before and after states in the written record. However, the consensus date for Grimm's law is ~500 BC and *bh, *dh, *gh, *$g^{w}h$ > *b, *d, *g, *$g^{w}$ is not one of the latest Proto-Indo-European to Proto-Celtic sound laws. For example, Isaac (2007, 62) lists it as the 11th of 25 PIE >PC sound laws. The Continental Celtic languages, which are attested in Iberia and northern Italy in the Early Iron Age, could not have had an undifferentiated common ancestor much after ~1000 BC.

## Concluding thoughts and possible ways forward

The archaeogenetic revolution has incidentally vindicated the method known as linguistic palaeontology. With this, it is important to recognize that a single example or small number of examples, like the three discussed here, can be suggestive of possible prehistoric contexts and processes, but – as with the case for the Steppe Hypothesis from linguistic palaeontology – can only be decisive cumulatively as part of a large corpus of examples. So, for example, Mallory and Adams (1997) compiled 1364 Indo-European, and the looser criteria of Pokorny (2002) permitted 2044 Indo-European roots (Mallory 2019, 36). Individual examples are always susceptible to a new interpretation in the face of new evidence or a sharper argument. On the other hand, with a larger corpus overall patterns and precedents will become apparent and, with them, the interpretations that are outliers and call for reconsideration. In other words, an approach combining breadth and depth will be needed to move forward with conviction. With the 175 CG words and 284 CG+ we approach the kind of critical mass needed to make significant progress. As a large cross-disciplinary, multi-year project and building on the *Celto-Germanic* collection of the RAW project, Maritime Encounters is in position to make significant headway with the Indo-European dark age, to find more clearly what developments and where and when these developments occurred in the gap between Proto-Indo-European and the attested languages of the north-western edge of the Indo-European world. In moving forward into this period, corresponding more or less to the Bronze Age, subtle skills will have to continue to be developed in archaeogenetic interpretation. Such new skills will not invariably lead to a clear-cut disentangling of the later prehistory of separating Indo-European-speaking groups, distinct from their non-Indo-European neighbours with whom they were in close and prolonged contact and at least sometimes show similar indices of steppe ancestry. For example, even where the non-Indo-European Palaeo-Basque and Iberian survived in south-west Europe, paternal steppe ancestry had by ~1900 BC replaced the y-chromosomes formerly prevalent in the Iberian Neolithic and Chalcolithic (Valdiosera et al. 2018; Olalde et al. 2019). A similar pattern occurs in some Dravidian-speaking parts of south Asia (Silva et al. 2017), where strongly male sex-biased steppe ancestry also reached further than linguistic Indo-Europeanization.

Future investigation should bring better understanding of how the downturn at Great Orme ~1400/1300 BC was linked to other phenomena affecting the Atlantic façade during the latter half of the Bronze Age, including the following:

1. the onset and then intensification of metal trade linking the Atlantic North and the Iberian Peninsula;
2. an intensification of agropastoral land use and systematizing of land tenure evident in Britain and Ireland;
3. the onset of large scale bidirectional north–south gene flow, which probably involved some elite groups, but also the rise of unfree farm labour as a commodity within the new economy and rising social complexity;
4. the numerous shared motifs of the warrior stelae of the Iberian Peninsula – especially the copper rich south-west – and Scandinavian rock art (both datable to the period ~1400–800 BC), reflecting a shared ethos at the terminus zones of this trade;
5. the evidence of the Celto-Germanic vocabulary suggesting that the post-Proto-Indo-European dialects of northern and western Europe had not yet diverged into fully formed and separated Proto-Celtic and Proto-Germanic (with minimal mutual intelligibility) at this time, but could still be used to communicate over wide distances across the network; and
6. subsequently, the genetic stabilization and Bronze–Iron transition, both of which affected Britain ~800 BC, reflecting a new situation in which contact between Pre-Celtic (on its way to Proto-Celtic) with Pre-Germanic fell off and ceased to act as a restraint on the emergence of Proto-Germanic as a fully separate language; in other words, it is unlikely that the Germanic consonant shift (Grimm's law) and accent shift would have occurred so long as there was regular, intense, and high status contact with speakers of Pre-Celtic >Proto-Celtic.

### Notes

1 This phrase alludes to Arthur Conan Doyle's Sherlock Holmes story 'Silver Blaze' (1892) Holmes refers to 'the curious incident of the dog in the night-time', namely that a watchdog did not bark during the theft of a racehorse from a stable, suggesting that the dog probably knew the thief.

2 English *cock* meaning 'small boat' is likely to derive from Old French *coche* 'small boat', which lacks a clear Latin origin and, therefore, may reflect a borrowing of Old Breton *cuh*.

3 I am grateful to Malcolm Nicholson for drawing my attention to these examples.

4 possibly also Lithuanian *drū́tas* 'thick, strong, deep (of voice)', though the meanings are not close.

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# 12

# Convergence *in situ*: the formation of the Indo-European branches and the Bronze–Iron transition

*John T. Koch*

*The archaeogenetic support for the steppe hypothesis of the Indo-European homeland leads to re-assessments of unresolved issues of historical linguistic theory. This study argues that the shorter time depth of the Steppe Hypothesis and what we now know about the relatively rapid and massive spread of steppe ancestry is more consistent with a 'convergence* in situ*' model for the formation of Indo-European branches. In this theory, the primary process is that of a geographically over-extended dialect continuum of shallow differentiation in which the branches formed amongst adjacent dialects within emerging socio-cultural networks during the Bronze Age. The separated branches then decisively crystalized during the Bronze–Iron transition.*

## Introduction

Particularly if we accept some version of the Steppe Hypothesis, as now supported by ancient DNA evidence (Allentoft et al. 2015; Haak et al. 2015; Anthony & Brown 2017; Reich 2018; this volume Chapter 10), the formation of the Indo-European branches will be seen as the result of processes that ran their course largely during the Bronze Age. Despite the archaeogenetic breakthroughs and ongoing advances in our understanding of the archaeological record of western Eurasia in later prehistory, mapping onto archaeological cultures of the 'proto-branches' intermediate between Proto-Indo-European and the attested languages – i.e., Proto-Greek, Proto-Celtic, Proto-Germanic, and so on – remains a formidable challenge. In large part this continuing uncertainty is due to a fundamental fact, i.e., the independence of the transmission of genes and languages. It is most often the case that a first language is transmitted from parent to child – thus genes and language together. But there is no biological imperative for this. Not infrequently, individuals or whole groups will find it advantageous to learn a second language and then pass this on to their children as a first language (cf. Koch & Fernández Palacios 2019). When this happens, the result will be genetically unrelated populations speaking the same language and closely related populations speaking different languages.

This chapter deals with a different, purely linguistic, problem that further complicates efforts to track the formation of the Indo-European branches through the Bronze Age archaeological record. There is reason to see a significant disparity between the proto-branches as reconstructed by the unalloyed historical-comparative method over the past two centuries and real languages spoken by real populations pinpointable at specific times and places in later prehistory. In other words, although Proto-Celtic, etc., can stand as invaluable tools for working out sound laws and their order, as well as indicating degrees of relatedness between attested languages, the unattested nodal points on the Indo-European family tree might be better understood as abstractions at a significant remove from the real languages spoken by real Bronze Age people.

## The dilemma of Celtic origins

As an editor of these collected research papers, I note the good fortune that they include a thought piece by the lead author of a recent archaeogenetic study (Patterson et al. 2022; this volume Chapter 10) that stands out as a milestone towards a better understanding of Europe's Atlantic façade during the Bronze Age. Patterson's contribution here frames the linguistic dilemma clearly: Celtic first arrived in the British Isles 1) either with the migration of ~1300–800 BC that brought about 50% shift in the genetic makeup of southern Britain or 2) with the entry of Beaker groups ~2450–2000 BC to Britain and Ireland, bringing up to a 90% shift when contrasted with the Neolithic genomes of the Atlantic Archipelago (Olalde et al. 2019; cf. Cassidy et al. 2016). So, broadly speaking, that would be either about 3000 or about 4000 years ago. Patterson views the later, Middle/Late Bronze Age scenario as more probable though allows that the earlier Beaker scenario cannot be ruled out.

Generally, I agree that the problem can be narrowed down in this way based on what we know so far. The fact that the data indicates a very different genetic profile in Britain and Ireland during the Neolithic – one not agreeing closely with any early Indo-European-speaking regions – together with the comparative stability and isolation of the British population in the Iron Age, ~800 BC–AD 43, makes it unlikely that Celtic or the speech forms that became Celtic arrived before ~2450 BC or after ~800 BC.

Although the archaeogenetic evidence changes forever how this problem must be considered, it is ultimately a linguistic, rather than a genetic, question. When we think about 'Celtic' in this context, this means a reconstructed language situated in the gap between Proto-Indo-European and the several attested Celtic languages. So how we think Celtic and the other Indo-European branches formed in that gap is crucial if the specialists are not to talk past one another. If migrants into Britain about 4000 years ago spoke an early Indo-European language (or languages) and those who followed about 3000 years ago did likewise, to what extent must these have been – or even could they have been – different languages? That is both a theoretical question for linguists but first and foremost it must be seen as a practical matter in the lives of Bronze Age people. If the descendants of Britain's Beaker folk could speak to the Continental incomers of the Middle to Late Bronze Age using the first languages of both groups, do we possibly have a non-dilemma?

## The Indo-European dark ages

The well attested Indo-European branches are usually reckoned as numbering ten. These are, in approximate order of their appearance in writing: Anatolian, Indo-Iranian, Greek, Celtic, Italic, Germanic, Armenian, Tocharian, Balto-Slavic, Albanian. Possible higher order unities, Italo-Celtic and Greco-Armenian, remain uncertain and controversial (Watkins 1966; Cowgill 1970; Ringe et al. 2002; Clackson & Horrocks 2007; Kortlandt 2007; Weiss 2012; Schrijver 2016). Meagrely attested languages like Thracian possibly reflect additional branches, while others may have died out leaving no records at all. Higher unities of some sort – such as the early grouping of Indo-European that became Indo-Iranian, Balto-Slavic, and Germanic (proposed in Ringe et al. 2002) – remain even less certain.

As mentioned in both Patterson's contribution and my own other paper here (Chapter 11), it remains paradoxically true that the where, when, and archaeological context of post-Anatolian Proto-Indo-European (aka, Nuclear [Proto-] Indo-European: NIE) in deeper prehistory is less mysterious than are the circumstances of many of the nodal points further down on the Indo-European family tree, even though these stand closer to the horizon of written records. Thus, the four-way correlation of post-Anatolian Indo-European ≅ the Yamnaya Cultures ≅ the Pontic-Caspian steppe ≅ the steppe genetic component is now much more firmly established than, for example, Proto-Celtic for which there is, at present, no agreed-upon archaeological culture, homeland, or genetic profile.

This problem of the Indo-European dark ages pre-dates the archaeogenetic revolution (Mallory 1996). But the sequencing of ancient genomes has, if anything, intensified the disparity between the relative certainty over the homeland of post-Anatolian Indo-European and some of its later prehistoric offspring. This is because it appears virtually impossible that the proto-branches interacted as first encounters of groups that were very different genetically, groups that had previously been long isolated from one another. The latter is what had happened when European hunter-gatherers first came into contact with farmers migrating from Anatolia or then when those early European farmers (EEF) encountered pastoralists spreading from the steppe. With populations so distinct and long isolated, we can easily minimize so far as to virtually exclude the possibility that they spoke the same language, dialects of the same language, or closely related languages.

For the central questions dealt with in Patterson et al. (2022), relating to the rise of EEF ancestry in southern Britain ~1300–800 BC and the inverse shift in south-west Europe during the same period, the possibility that all the groups involved spoke early Indo-European languages cannot be excluded. In fact, that seems more likely than not. And 'early' in this context must be understood also to mean 'still very similar'. Population movements in Bronze Age Europe more often involved contact between groups both of whom had blends of high levels of steppe and EEF ancestry. In southern Britain and the Iberian Peninsula, both the incoming and longer-established populations had mixed steppe and EEF ancestry, their proportions shifting towards convergence during the Middle/Late Bronze Age. And at this period, we are not so far removed in time – and by implication linguistic evolution – from Proto-Indo-European itself. Therefore, we cannot so easily exclude the possibility that such Bronze Age peoples in contact spoke the same language or early Indo-European languages that were still similar enough to retain a significant degree of mutual intelligibility.

## Reconstructed proto-languages and the historical-comparative method

The basic historical linguistic approach to the various prehistoric, hence reconstructed, nodes on the Indo-European family tree is to conceive of each as undifferentiated into early, middle, and late stages, and likewise lacking dialects, registers, or specialist word sets. It is as if every competent adult speaker of the language possessed exactly the same sound system, grammar, and lexicon. When scrutinizing these issues in finer detail, most linguists will of course modify or abandon such assumptions. With living languages and fully attested languages of the past – if their speakers are sufficiently numerous, occupy a sufficiently large territory, and their society has more than minimal complexity – there will be regional dialects, registers appropriate to not universally inclusive social domains, and vocabulary known only to occupational specialists (cf. Robb 1993).

The reconstruction of Proto-Celtic, Proto-Germanic, Proto-Greek, and so on with single invariable sound systems, grammars, and lexicons is an artefact of the historical-comparative method. The core idea is to reconstruct the latest common ancestor of the attested languages within the family. For example, numerous cognate words occur across the attested Celtic languages and from these one reconstructs their Proto-Celtic ancestors, reversing all the sound laws in their consistent regularity. For example, Old Irish *cenn*, Old Welsh and Old Breton *pen(n)*, Gaulish *penno-* (in names), all meaning 'head', derive from Proto-Celtic *$k^w$ennom 'head'. This is algebraic. We solve for a single X, not X, X′, and X″. And solving for a single X over the hundreds of comparable items shared across the attested Celtic languages, or cognate languages within any other family, then accumulates into something approaching fully reconstructed languages – Proto-Celtic in this example – but lacking dialects, registers, and jargons to convey specialist knowhow. So some adjustment of the basic method is necessary to bring the reconstructions into line with linguistic reality. Such an adjustment will be analogous to the calibration required to bring raw radiocarbon dates, as achieved by the primary technique, closer to chronological accuracy.

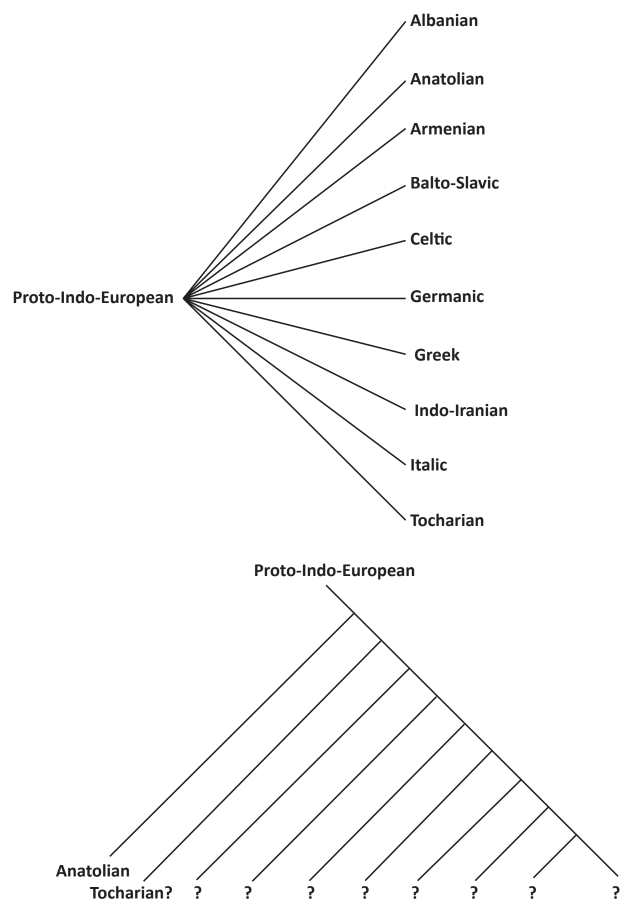


*Figure 12.1. 'Bad trees': attempting to explain the Indo-European branches using a traditional family-tree model can lead to either the very implausible primary split into ten or so primary branches or series of binary splits, which, after Anatolian and possibly Tocharian, become very difficult to put conclusively into order, as well as compressing into a plausible absolute chronology and archaeological context between post-Anatolian Indo-European (≅ Yamnaya) and the attested languages (J. T. Koch).*

## Convergence *in situ* (CIS)

At least some of this discrepancy is overcome if we adopt the different concept of the formation of the Indo-European branches proposed by Garrett (1999; 2006). As acknowledged, that proposal was to a significant degree inspired by the earlier work of another Berkeley linguist, which attempted to explain her observations: 'The striking feature of the IE family tree is the early, almost simultaneous spread of many branches from a single root' (Nichols 1998, 256) and that Indo-European 'has the greatest number of primary branches of any known genetic grouping of comparable age', which is 'the hallmark of a language family that enters a spread zone as an undifferentiated single language and diversifies while spreading' (Nichols 1997, 138; cf. Garrett 1999, 148). This interpretation can be understood as based on an analysis like Dyen's: 'As traditionally conceived, the Indo-European daughter languages (Proto-Germanic, Proto-Greek, etc.) and Proto-Indo-European constitute a simple family-tree' (Dyen 1956, 612–13). In other words, the family tree does not have an agreed superstructure of higher order binary branchings, like that proposed by Ringe et al. (1998; 2002), but rather ten or more primary branches (Fig. 12.1).[1]

Garrett's case was worked out mainly on the example of Greek, though he extended conclusions to the branched structure of the entire family, notably touching on Celtic. Ringe et al. (2002, 108) acknowledge the proposal as demanding consideration, though running generally counter to their premises. I picked up the idea, focusing on Celtic (Koch 2013). Though 'Garrett's theory' would be an accurate label for this proposal, 'convergence *in situ*' is less opaque, so CIS for short. Its gist is that a not yet much diversified proto-language spread widely and relatively rapidly to form a dialect continuum of shallow differentiation. Dialects in contact then continued to share innovations while not yet greatly evolved from the proto-language in linguistic domains including phonology and morphology. In effect, 'language boundaries' had not yet sharpened as barriers between contiguous dialects (on the language boundary concept, cf. Dyen 1956, 612). The continuum then fragmented, as new socio-cultural areas arose so that subsets of dialects within these distinct areas converged to crystallize as branches. Emerging language-based group identities played a role in this transformation, as for example, the opposition of *Ἕλληνες* to *Βάρβαροι* amongst the Iron Age Greeks (Nichols 1998, 240).

The pattern of the branches cannot be assumed to continue the first-order genetic relationships between the dialects of the initial post-spread continuum. In Garrett's words,

> ... the familiar branches arose not by the differentiation of earlier higher-order subgroups – from 'Italo-Celtic' to Italic and Celtic, and so on – but by convergence among neighbouring dialects in a continuum. Dialect continua are typical in shallow-time-depth language families … Convergence, together with loss of intermediate dialects in the prehistoric continuum, has created the historical mirage of a branchy IE family with its many distinctive subgroups. (Garrett 2006, 139)
>
> … the loss or 'pruning' of intermediate dialects, together with convergence *in situ* among the dialects that were to become Greek, Italic, Celtic, and so on, have in tandem created the appearance of a tree with discrete branches. But the true historical filiation of the IE family is unknown, and it may be unknowable. (Garrett 2006, 143)
>
> … It follows that Proto-Greek – or if this did not exist, IE speech that was to become Greek – was linguistically closer to IE than has been supposed. I suggest more generally that we should contemplate models of IE phylogeny that assign a greater role in the formation of IE branches to convergence *in situ*. (Garrett 2006, 147)

In some key respects, CIS had been anticipated by Nichols, in countering what she sees as a widely held assumption that

> PIE was spoken in some locale and spread out widely only after its break-up. (Nichols 1998, 223)
>
> … However, a minimally differentiated Common IE spread, diverging into daughter branches only after and as a result of the spread. (Nichols 1998, 256)

As a matter of time depth and homeland, CIS as formulated by Garrett then myself has been consistent with the Steppe Hypothesis of Indo-European dispersal (e.g., Anthony & Ringe 2015).[2] However, the idea that Indo-European arrived as Proto-Indo-European in the lands where the Celtic languages were later attested, and that it evolved into Celtic *in situ* there, was a feature of the Anatolian Hypothesis as set out by Renfrew, who 'would prefer to see the development of the Celtic languages, in the sense that they are Celtic as distinct from generalized Indo-European, as taking place essentially in those areas where their speech is later attested' (1987, 245; 1999; cf. Garrett 1999, 155; Renfrew 2013). But Renfrew's model involved a greater time depth, with Proto-Indo-European reaching the Atlantic façade with the first farmers, so reaching Britain and Ireland ~4000 BC (Renfrew 2000).

The archaeogenetic evidence has been widely claimed as confirming the Steppe Hypothesis, or some version of it, and so the later chronology for the Indo-European dispersal (e.g., Allentoft et al. 2015; Haak et al. 2015). This data would therefore falsify the phylogenetic approaches claimed to confirm the deep chronology of the Anatolian chronology (Gray & Atkinson 2003; Pagel &Meade 2006; Bouckaert et al. 2012; 2013; Heggarty et al. 2023). This approach has been forcefully criticized (Pereltsvaig & Lewis 2015) or, adopting different principles, has led to a chronology consistent with the Steppe Hypothesis (Chang et al. 2015). Certainly many, possibly most, historical linguists remain sceptical about methods attempting to reach absolute dates on the supposition that core vocabulary is lost at a regular rate. On the other hand, this phylogenetic research may provide useful pointers for relative chronology. Even so, with the small numbers of lexical items used, a few revised etymologies or old loanwords mistaken for inheritances can drastically shift results.

To update the Steppe Hypothesis so as to line up with the facts as known, as I now write, it is best to specify that the relevant proto-language is post-Anatolian Indo-European, also known as Nuclear Indo-European (NIE). There is recent doubt that linguistic-archaeological-genetic-geographic correspondence PIE ≅ Yamnaya ≅ steppe cluster ≅ Pontic-Caspian steppe includes the subfamily to which Hittite belongs (Lazaridis 2018; Reich 2018; Lazaridis et al. 2022; 2024), using the symbol ≅ to mean 'usually corresponds to, more or less equals'.

The reason for returning to the CIS idea now is that, since its earlier outings, advances have been made in three areas that harmonize well with it:

1. the 'archaeogenetic revolution' (note especially Allentoft et al. 2015; Haak et al. 2015; Olalde et al. 2019; Patterson et al. 2022);
2. archaeological science revealing large scale long distance movement of metals in the Bronze Age (especially Ling et al. 2014; 2019; Nørgaard et al. 2019; 2021; Williams & Le Carlier de Veslud 2019; Berger et al. 2022; Williams 2023; cf. Radivojević et al. 2018);

3. the Celto-Germanic vocabulary as studied in Koch (2020; 2024) and Chapter 11 in this book.

It may now be possible to develop the CIS idea further to better account for a range of linguistic and non-linguistic processes in Bronze Age western Eurasia.

## Mycenaean and Proto-Greek

As mentioned, Garrett's CIS proposal relied mainly on the example of Greek. It may be useful to recap in brief some of his main points. Greek is fortuitous as being well attested in several Iron Age dialects, which had been objects of intense philological study for over a century when the work of Alice Kober, Michael Ventris, and John Chadwick led to the discovery that the texts of ~1400–1200 BC in the Linear B syllabary were written in a language identifiable as Greek. Therefore, a Proto-Greek had already been reconstructed in detail before this decipherment, as the latest common ancestor of the attested dialects of the archaic and classical periods. That detailed reconstruction could then be compared with the 'honest to God' Bronze Age Greek of deciphered Linear B. And they were not identical. There were two general, and deeply significant, disparities between the reconstruction and the reality.

1. Mycenaean was not Proto-Greek or Common Greek – i.e., an undifferentiated common ancestor of all the attested dialects – but was already a dialect, showing innovations that never occurred in West Greek dialects, so effectively a Pre-Arcado-Cypriot. For example, **-ti* of Indo-European active primary verbal endings had become *-si* in Mycenaean, as in *ehensi* 'they are', a change found also in the Iron Age dialects Attic-Ionic and East Aeolic, as well as Arcado-Cypriot, but preserved in West Greek *'εντί* (Garrett 2006, 139).
2. Sound changes and morphological innovations from Proto-Indo-European that are found in all the Iron Age Greek dialects – and thus reconstructable for their latest common ancestor – had not yet occurred in Mycenaean. For example, Mycenaean appears to have preserved seven of the eight inflected cases of the Proto-Indo-European noun, whereas the Iron Age dialects had shared innovations reducing these to a system of five. Mycenaean preserved the labiovelars $*k^w$, $*g^w$, $*k^{wh}$ of Proto-Indo-European, but these have been shifted to labials in all Archaic and Classical Greek. Mycenaean also preserves Proto-Indo-European **y* and **w* in most positions (Garrett 2006, 140).

In other words, the Mycenaean situation was very unlike what had been supposed for a reconstructed Proto-Greek as a node on the Indo-European family tree. The attested Late Bronze Age language was, on the one hand, significantly closer to Proto-Indo-European than the Proto-Greek produced by the historical-comparative method applied to the Greek dialects, but, on the other, also closer to the dialectal situation of the Iron Age than had been supposed before the decipherment. Therefore, there never was a fully developed uniform Greek branch. As a matter of its general character, Mycenaean had become Greek in its vocabulary, name stock, and derivational patterns, but remained closer to post-Anatolian Indo-European in key aspects of its phonology and morphology. That means that, as Garrett claims, Proto-Greek *per se* never existed; it was a mirage, an artefact of a powerful but imperfect method. However, to throw such Neo-Grammarian reconstructions aside as altogether valueless would be a step back, as they have achieved – and continue to achieve – so much for our understanding of old texts and linguistic relationships. Rather, the reconstructions remain invaluable as pointers or approximations, two-dimensional models to render multi-dimensional realities, analogous to statistical medians and means that are sometimes useful but can also mislead in over-simplifying more complex realities.

## Application to Celtic and Germanic

If we assume that the Celtic and Germanic branches emerged in ways similar to those observed in Greek, that leads to general expectations. These include the following.

- The full gamut of Proto-Indo-European to Proto-Celtic sound changes (e.g., the weakening and loss of **p*) and those of Proto-Germanic (e.g., Grimm's law (Fulk 2018, 102–12)) would not have been complete before the Bronze–Iron transition. As the Germanic sound law known as Verner's law (Fulk 2018, 107–12) acts on the output of Grimm's law and is also dependent on the Proto-Indo-European, rather than Proto-Germanic, position of the accent, it is most likely that both the Pre-Germanic and Pre-Celtic dialects of the Bronze Age retained the Proto-Indo-European position of the accent. That inference also suggests that mutual intelligibility remained at a relatively high level (cf. Koch 2022). Effectively, the dialects that were to become Celtic and those that were to become Germanic were still dialects of a single post-Anatolian Indo-European language.
- The common Celto-Germanic vocabulary – the 175 words discussed in Koch (2020) and Chapter 11 here – implies that these Pre-Celtic and Pre-Germanic dialects were also sharing significantly in the formation of the lexicons and name stock that were to be characteristic of both branches. In this respect they were comparable to Mycenaean Greek, but in the north-west the two pre-branches were developing together within a common or overlapping socio-cultural space.
- On the other hand, Pre-Celtic and Pre-Germanic would neither one nor together have been a single unified

dialect, or even two single undiversified dialects. Some of the variant innovations that are recognized as defining characteristics of individual attested languages and subgroupings – e.g., Brythonic or North Germanic – would already have been appearing in some of the Bronze Age dialects, although the processes defining Proto-Celtic and Proto-Germanic were not yet complete. In other words, as Mycenaean was already distinct from West Greek, it is possible that there were Pre-Celtic dialects that already showed some Pre-Goidelic, Pre-Gaulish, or Pre-Celtiberian innovations.

- As we have no evidence for a language-based Greek identity – *Ἕλληνες* versus *Βάρβαροι* – in Mycenaean, it is also likely that speakers of dialects that later became Celtic and Germanic did not have distinct language-based identities in the Bronze Age. The Celto-Germanic word **alyo-morg-* 'foreigner' can be seen from its etymology, 'one from another country, one from beyond the border', to be territorially based, rather than language based.
- There is inadequate comparative evidence to show that there had been a language-based Indo-European group identity prior to the formation of the branches. Had there been one, cognate versions of the same group name would be expected across several branches. And to imagine that such an identity existed in the absence of adequate supporting evidence could of course favour ideologies that are dangerous as well as baseless.

## Some potential advances

CIS offers a potentially better framework than the traditional Indo-European family tree model for interpreting new evidence turned up over the past decade in the following fields. An integral subcomponent of CIS is that post-Anatolian Indo-European, when as yet minimally diversified, spread rapidly over a wide territory. This premise is strongly consistent with the subsequently discovered aDNA evidence for the rapid and wide expansion about 5000 years ago of a distinctive and not widely diversified genetic population hailing from the Yamnaya cultures of the Pontic-Caspian steppe (Allentoft et al. 2015; Haak et al. 2015). As with Nichols's proposal (1998) quoted above, the break-up NIE into its branches did not precede the expansion but followed it.

After Anatolian, some linguists argue for a family-tree model in which Tocharian was the second to branch off in a binary split from residual undifferentiated Indo-European ancestral to the other branches (e.g., Ringe et al. 2002). The idea that the Afanasievo culture of the Siberian Altai and Minusinsk Basin ~3100–2500 BC represents speakers of an early Indo-European ancestral to Tocharian pre-dates the archaeogenetic revolution (Mallory & Mair 2000; Anthony 2007). It remains consistent with subsequent aDNA data, which have revealed 20 Afanasievo individuals nearly indistinguishable genetically from Yamnaya genomes (Allentoft et al. 2015; Damgaard et al. 2018; Narasimhan 2019).

Following the principles of CIS, many characteristics of the reconstructed proto-branches would have spread secondarily between contiguous dialects in an early Indo-European continuum (Fig. 12.2). In contrast, the movement which gave rise to the Afanasievo community from Yamnaya migrants was a true migration, as opposed to an expansion or territorial reshaping, in that it came into an area geographically detached from its homeland. In contrast, the other post-Anatolian Indo-European dialects remained contiguous within a territory that had widely expanded but were not broken up geographically. Therefore, Afanasievo as the best current hypothesis for a primary pre-Tocharian cultural context – unlike the settings of the other incipient branches – was not in a position to share subsequent innovations from cognate dialects in the continuum. The ability of the contiguous dialects ancestral to the other branches to continue to share innovations later will, through the historical-comparative method, have created an illusion that they were still members of an undifferentiated proto-language at a stage when they were differentiated but in continued contact.

If we continue to use a traditional family tree model together with the assumption that each prehistoric nodal point represents an undiversified proto-language, each of these will imply a discrete homeland, as well as an absolute chronological extent of some centuries. So, for example, Proto-Celtic could hardly have arisen then broken up a mere few years either side of 1000 BC. If a Proto-Italo-Celtic node is incorporated into the model that will also have had a homeland and a period of some centuries before it broke up – and similarly any higher unity, such as the theoretical undiversified proto-language left to the other side after the Tocharian branch split off.

If these nodal proto-languages are all invested with reality in time and space, an archaeological footprint, and so on, then it becomes concerning that archaeogenetics narrows the available time. By favouring a version of the Steppe Hypothesis over the Anatolian Hypothesis, archaeogenetics has now placed post-Anatolian Indo-European at its later possible date ~3000 BC. By showing the British population was relatively stable and isolated during the Iron Age (~800 BC–AD 43), archaeogenetics now shifts the arrival of Celtic from its traditional Iron Age date to the Middle to Late Bronze (~1300–800 BC) or the Beaker Period (~2450–2000 BC). Any later theoretical unities like Goidelic-Gallo-Brythonic (aka, 'Gallo-Insular': McCone 1996; 2008) could be situated in the (earlier) Iron Age but might fit more neatly in the Late Bronze Age, when archaeology and archaeogenetics show the relevant regions were in close contact. In other words, the time available for the successive splits between undiversified proto-languages has tightened, perhaps uncomfortably so, in the light of genomic evidence.

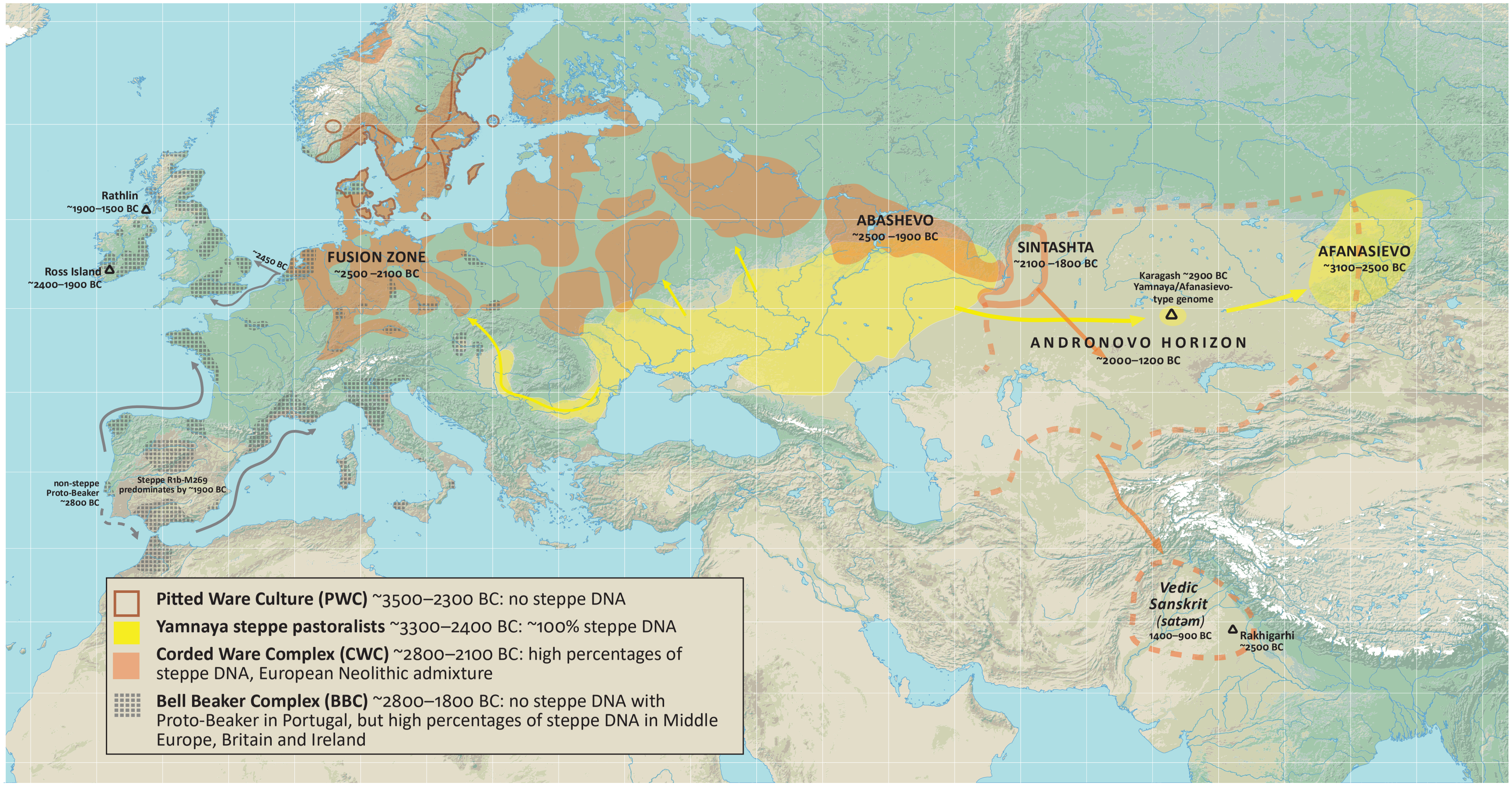


*Figure 12.2. Western Eurasia in the 3rd and 2nd millennia BC and the spread of the steppe component related to archaeological cultures (J. T. Koch).*

On the other hand, with CIS, we expect a state in the Bronze Age background of Celtic and Germanic like that directly observable with Mycenaean Greek. The dialects ancestral to these branches would still have been close to NIE in their morphology and phonology – so that many of the NIE to Proto-Celtic and Proto-Germanic changes had not yet taken place – but already dialectal, such as, hypothetically speaking, pre-Goidelic, and characteristically Celtic and Germanic in their vocabulary and name stock. In other words, a range of states and processes traditionally viewed as a sequence of discrete stages were more probably in progress contemporaneously. Proto-Celtic and Proto-Germanic *per se* would be – if not out and out mirages – theoretical abstractions lacking corresponding realities in time and space. Many of the phonological innovations defining these branches would have arisen through convergence between dialects within congealed socio-cultural areas after the Bronze–Iron transition.

If Mycenaean Greek is both already a Greek dialect (pre-Arcado-Cypriot) but effectively not yet even Greek, rather a pre-Greek Indo-European, then it would be possible for pre-Goidelic and pre-Gallo-Brythonic dialects to exist at a stage before the full range of Proto-Indo-European to Proto-Celtic innovations had spread across the dialects, in other words, before Celtic as such existed.

In Garrett's presentation, the chronology is absolute, emphasizing the fundamental difference between the Greek found in records of the 2nd millennium BC to those of the 1st, extrapolating from there an absolute chronology of the formation of other Indo-European branches.[3] However, if we bring the archaeological evidence into it and more specifically the recent discoveries about the long distance trade in copper and tin, it is then clear that the more important factor is what happened between the Mycenaean period and the Greek Dark Age, rather than the absolute dates when these events and processes occurred, thus the Bronze–Iron transition.

It is not hard to imagine why this socio-cultural and economic transformation would coincide with linguistic transformation of a continuum of NIE dialects into the separated branches. During the Bronze Age, control of a hub or bottleneck in the long distance exchange of metal was a key to power. Over the course of the Bronze Age – as metal use increased greatly in volume and high-tin bronze became the standard material for weapons, tools, and ornaments across western Eurasia (Pare 2000; Koch 2013) – the pivotal factor of dominance of metal trade over long distances rose in importance (Ling & Koch 2018; Koch & Ling 2023) (Fig. 12.3).

During this period, there would have been distinct advantages for elite groups to reject linguistic innovations that were not shared by other NIE-speaking groups with whom they maintained valuable links in the metal trade. Within the framework of the Maritime Mode of Production model (Ling et al. 2018), the ability to communicate with the terminus points of the long distance exchange networks would have provided distinct advantages to the trader-raiders and their chieftain organizers at the system's core. For example, seafarers bringing copper from Cwmystwyth, Great Orme, or south-western Iberia or tin from Cornwall to bulk consumers in Scandinavia would have found the ability to communicate along all nodal points of the network useful if not essential. A dialect continuum of NIE could function as the system's *lingua franca*.

As well as the trader-raiders and their chiefs, other key groups might have moved long distances and found NIE dialects advantageous. For example, it is likely that high status exogamous marriages cemented trading relationships within the metal exchange networks. High status fosterage and hostage exchange are also likely to have been aspects of the system. Celtic and Germanic share a word for 'hostage', derived from **gheisslo-*.

At the low end of the social pyramid, it is also likely that the intensification of land use (Cunliffe 2013) and rise of the Maritime Mode of Production (Ling et al. 2018) in the Middle to Late Bronze Age brought with them a significant factor of captive farm labour traded as a commodity along with metals. Here again, there is an Italo-Celto-Germanic word for this institution **kapto-* 'captive, (bound) slave', as well as a Celto-Germanic word for its antithesis **priyo-* 'free' < NIE 'beloved'. While these unfortunates would have lacked the social power to replace the language of their captors and overlords, they might have influenced it in the direction of preserving a pre-branch Indo-European, i.e., one lacking sharply crystallized language boundaries across a network within which numerous captives were transported.

When iron became the standard material of weapons and tools, the balance shifted. A world language was no longer an economic necessity or a valued prerequisite for warlike elite groups. Conversely, there might now be new advantages – for the cohesion of groups and their wholehearted aggressive competition towards foreign adversaries – to share a language uniquely only across a smaller region within which other innovative earmarks of social and cultural identity were also shared.

If we recognize the key milestone in the formation of the Indo-European branches as the Bronze–Iron transition rather than an absolute date towards the end of the 2nd millennium BC, that leads to the expectation that branches might have emerged from NIE at different dates in different regions because the transition occurred at different dates there (Fig. 12.4). The Bronze Age world system gradually shrank. During the sub-Mycenaean Dark Age of ~1150–850 BC, the Late Bronze cultures of the Atlantic façade, Central Europe, and the Nordic region were nearing their apogees. This time disparity may explain, at least in part, why there is the sizable store of 175 Celto-Germanic words and names, which pre-date the main NIE >Proto-Celtic and Proto-Germanic


*Figure 12.3. Approximate dates for the adoption of high-tin bronze as the standard material for tools, weapons, and ornaments (based on Pare 2000; cf. Koch 2013).*

sound changes, but these words are not more widely shared with other Indo-European languages, even those of Europe. If we suppose that the branches emerged from NIE at the Bronze-Iron Transition, that happened two or three centuries earlier for the Aegean than for Britain and Gaul, with a still longer gap before the end of the Nordic Bronze Age.

As covered in Koch (2020) and discussed here in Chapter 11, the Celto-Germanic vocabulary arose at a linguistic stage preceding the emergence of the Proto-Germanic, in other words, the emergence of the Germanic branch from late NIE. Particularly representative of this state of affairs is the Germanic consonant shift. The CG corpus comprises entirely a majority of words that clearly had been part of Pre-Germanic before the operation of Grimm's law together with a sizable minority of words that lack the consonants to show whether or not they predate Grimm's law.

Similarly, most attestations of CG words in Celtic show that the items had been in Pre-Celtic NIE before most of the Proto-Indo-European to Proto-Celtic sound laws had occurred. For example, the iconically Celtic weakening and loss of **p* occurred after the formation of the CG vocabulary:

- **pinn-* 'extremities of a living thing' > Old Irish *inn*, *ind* 'tip, point, edge, extremities of the body, tongue, point of a weapon, treetop, hilltop'; Old Norse *fina* 'fin, chaff, husk', Old English *finn*;
- **pleid-* 'strive, succeed' > Middle Welsh *llwyδaw* 'to succeed, flourish, prevail, promote'; Old English *flītan* 'to exert oneself', Old High German *flīzan* 'attempt, try hard';
- **plōro-* 'floor' > Old Irish *lár* 'ground, surface, middle', Middle Welsh *llawr* 'floor, deck, ground, platform', Breton *leur*; Old Norse *flór* 'floor of cowstall', Old English *flōr*;

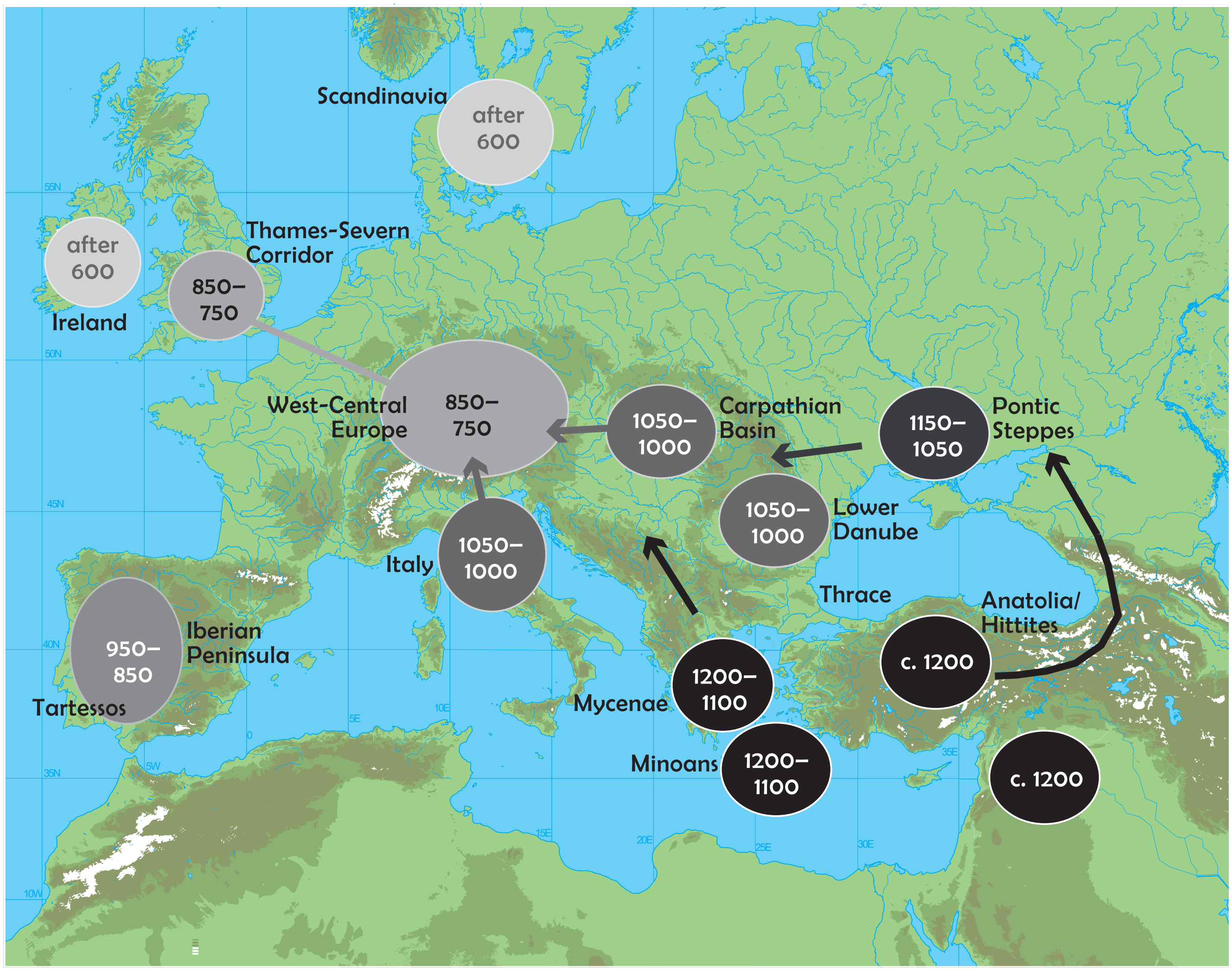


*Figure 12.4. Approximate dates for the replacement of bronze by iron in different regions of Europe as the standard material for tools and weapons (cf. Burgess & O'Connor 2008; Koch 2013).*

- **pluk-* 'boatload (of people, domestic animals, inanimate items of value)' > Gaulish *luxtos* 'load of pottery from an industrial kiln for despatch', Old Irish *lucht* 'class of people, occupants, category, boat's crew, followers, contents, ship's cargo', Old Welsh *luidt*, Middle Welsh *llwyth* 'tribe, lineage, kinship group, faction, clan, occupants, inhabitants, (full) load, ship's cargo'; Old Norse *flokkr* 'troop, host, flock', cf. Middle Dutch *vluycken* 'to transport over water';
- **poiko-* 'foe' > Old Irish *oech* 'enemy'; Old English *fáh* 'foe';
- **pot(a)mo-* 'thread, fathom' > Old Welsh *etem* 'thread', Scottish Gaelic *aitheamh* 'fathom'; Old Norse *faðmr,* Old English *fæðm* 'embracing arms, spreading arms to full extent, fathom, bosom';
- **priyānt-* 'relative, friend' > Old Breton name element *Riant-*, Welsh *rhiant* 'parent'; Gothic *frijonds* 'friend', Old Norse *frændi*, *frjándi* 'relative, friend', Old English *frēond* 'friend, loved one, relative', Old High German *friunt* 'friend, loved one';
- **priyo-*, **priyā-* 'free' > Old Breton *rid* 'free', Middle Welsh *ryδ* 'free, not in slavery, having civil and legal rights, not oppressed, not imprisoned, unrestricted, loose, gratis, lawful, generous'; Gothic *freis*, Old English *frēo*, Old High German *frī* 'free'.

The Celto-Germanic words reflect a period when dialects ancestral to Celtic and Germanic (etc.) were (a) in continued close contact, (b) at a stage analogous to Mycenaean in the formation of Post-Proto-Indo-European vocabulary and name stock, (c) thus in effect forming a common socio-cultural area speaking a chain of post-Anatolian Indo-European dialects.

From the previous points we come to the question of whether the attested Celtic languages of Ireland and Britain can more plausibly be traced back to the ~90% genetic shift associated with the Beaker Period (~2450–2000 BC) (Olalde et al. 2019) or the ~50% shift that affected southern Britain in the Middle to Late Bronze Age (~1300–800 BC) (Patterson et al. 2022).

If we extrapolate from the Greek analogy, it follows that prior to the Bronze–Iron transition (~800 BC in Britain, Gaul, and Central Europe) many of the sound laws defining Celtic as a separate Indo-European branch had yet to occur or were not yet complete. The fact that Iberia underwent the transition about a century earlier (Burgess & O'Connor 2008) may be correlated with the differentness and conservatism of Hispano-Celtic, as contrasted with the innovations shared among Goidelic, Brythonic, and Gaulish, notably the un-inflected direct relative particle **i̯o* (Koch 2016). Before the transition, there had been no sharply defined language boundaries between contiguous dialects of NIE and no sharply defined and opposed language-based group identities between contiguous Indo-European dialects analogous to the Iron Age Greek opposition of *Ἕλληνες* vs. *Βάρβαροι* (cf. Nichols 1998, 240). Note that at this later stage there was no sense, or even awareness in such terms, that groups speaking non-Greek Indo-European languages were any less *Βάρβαροι* than were speakers of non-Indo-European languages.

It is worth noting in this connection that Celtic and Germanic share and inherited word **alyo-morgi-* 'foreigner, person from across a national border'. The attestations are Ancient Nordic **aljamarkiz** (Kårstad cliff inscription, Sogn og Fjordane, Norway post-~AD 400: Antonsen 1975, §40), cf. Gothic *alja-* 'other, foreign', Old English *ele-*, Old Saxon and Old High German *eli-*; Gothic *marka* 'boundary, district, march', Old Norse *mǫrk* 'woods', Old English *mearc* 'boundary, border, march', Old High German *marca*, *marcha*; Gaulish group name *Allobroges*, singular ALLOBROX, ALLOBROXVS (Delamarre 2007, 18), Middle Welsh *allfro* '(hostile) foreigners' collective; cf. Old Irish *aile*, Middle Welsh *eil* 'other, second', Gaulish *broga* and Brythonic *bro* 'country, district', Old Irish *mruig* 'inhabited or cultivated land'.

It is not clear whether the Iron Age speakers of the Celtic branch shared – opposed to **allo-mrog-* 'foreigner' < 'one from across the frontier' – a word for themselves. *Κελτοί* was used by Herodotus ~450 BC for people near both the source of the Danube and beyond the Pillars of Hercules neighbouring the *Κυνητες* in the Algarve (Koch 2014); so the group name clearly existed and was widely used by the middle of the Iron Age. As McCone (2008) has shown *Κελτοί* was in origin not a Greek or Latin name, but a Celtic one. There is no evidence to show that the Iron Age speakers of Goidelic and Brythonic identified with this group name. But it is not safe to take that negative detail as proving that they did not. As the evidence is so slight and indirect, we cannot be certain what the prehistoric inhabitants Britain and Ireland *did not* call themselves. Furthermore, as pointed out in earlier work (Koch 2003), the use of *Gallia Celtica* for the largest part of Roman Gaul for 100 years prior to the Claudian invasion of Britain would have been a good reason for the Romans to avoid re-applying the same term confusingly to the new province and its inhabitants, whatever the Britons themselves thought 'Celt' did and did not mean.

Another way in which the Greek analogy is relevant to Celtic and other research questions of Maritime Encounters is in highlighting a situation in which the sea, such as the Aegean, rather than becoming a linguistic boundary when speakers of Indo-European crossed it, became the core of a socio-cultural area around which an Indo-European branch formed. We therefore should not automatically assume that the Channel, Irish Sea, or Baltic would at all periods have formed linguistic barriers as opposed to connective corridors. Compare Needham's (2009) concept of the Bronze Age 'maritory' around the Channel and southern North Sea (Fig. 12.5). The role of a sea in linguistic geography can change over time. For example, in the earlier 2nd millennium BC, an early Mycenaean Greek was probably already established on the mainland and separated by the Aegean from Crete, where a non-Greek, probably non-Indo-European Minoan language was spoken. But then in the Iron Age the Greek-speaking world was unified around the Aegean. Similarly, during the periods (~2450–2000 BC and ~1300–800 BC) when the high incidence of genetic outliers indicate that many people were crossing the sea from the Continent to Britain (Patterson et al. 2022), the sea might have functioned as the unifying core of a common socio-cultural area and dialect continuum. At the periods (~2000–1300 BC and ~800 BC–AD 43) during which a low occurrence of genetic outliers indicates Britain's relative stability and isolation (Patterson et al. 2022), it possible that the sea then functioned more as a socio-cultural and linguistic barrier. It is likely during these lulls fewer people were involved in seafaring or were reliant on activities for which seafaring was essential.

In their influential study, which sought to identify higher order relationships for a tree model of Indo-European, Ringe et al. (2002) recognized an anomalous position of Germanic. Their proposed explanation was that the Indo-European ancestral to Germanic formed at an early stage a close sister with that ancestral to Balto-Slavic and Indo-Iranian, suggestive of a dialect chain. Somewhat later, but still within the prehistoric period, Pre-Germanic re-oriented westwards towards the Indo-European ancestral to Celtic and Italic. In a previous paper (Koch 2020), I propose that this explanation of Germanic's background can be reconciled with a range of newer evidence. The archaeology for the spread of Indo-European, now in the light of archaeogenetic evidence, is consistent with an interpretation in which the Pre-Germanic/Pre-Balto-Slavic/Pre-Indo-Iranian chain corresponds broadly to the Corded Ware Cultures (CWC) of north-eastern Europe. The re-orientation westward of the Pre-Germanic


*Figure 12.5. Narrow seas as a cultural link rather than a barrier: Needham's (2009) Channel/southern North Sea 'maritory' and its extensions up navigable rivers (J. T. Koch).*

end of this chain can be seen as corresponding broadly the penetration into north-central Europe by Beaker groups from the mid-3rd millennium BC followed by the metal trade between northern European and the Atlantic façade now known to have intensified during the Bronze Age. The formation of the Celto-Germanic vocabulary can also be seen as fitting within this model, following the interleaving of Beaker and CWC in north-central Europe and before separation of the Proto-Celtic and Proto-Germanic branches from the late NIE continuum at the Bronze–Iron transition.

Not unlike the Indo-European macrofamily, the higher order subdivisions within Celtic are notoriously hard to arrange into a family tree model. With a succession of homogeneous proto-languages undergoing binary splits, as traditionally conceived, the mutually exclusive concepts of a genetic Gallo-Brythonic vs. a genetic Insular Celtic – ancestral to Goidelic and Brythonic, but not Gaulish – remains unresolved (Koch 1992; Matasović 2008; Lambert 2010).[4]

With CIS, the shared innovations defining Insular Celtic versus those defining Gallo-Brythonic can be seen as arising within overlapping socio-cultural areas linking dialects across a continuum. In neither case would there have been a unified and homogeneous proto-language. The population entering southern Britain from across the Channel ~1300–800 BC might have brought with them linguistic innovations included amongst the defining earmarks of Proto-Celtic or a Proto-Gallo-Brythonic. But, as undiversified proto-languages, neither of these actually existed in a particular region at a specific time. Rather, they are constructs that usefully explain the systematic relationships between attested languages and between the dialects in contact ancestral to them.

## Summary and concluding thoughts

Natural human language is enormously diverse, varying from community to community and one generation to the next, ultimately down to the level of the idiolect of the individual, which itself evolves over the course of a lifetime. Against this background, even the most useful models for the reconstruction of unattested languages will involve abstractions and over-simplifications. With this in mind, the CIS model shows stronger explanatory power than the traditional family tree model for the formation of the Indo-European branches. Holding this view does not require disposing of the concepts of Proto-Celtic, Proto-Germanic, etc., as devoid of utility, but it will transform how we think of them. They will no longer be understood as homogeneous languages reconstructable as the latest common ancestor of their attested descendants, these being the outcome of clean splits from a higher order homogeneous proto-languages, reconstructed by the same methods applied to a wider range of more distantly related attested languages. Rather than that, Proto-Celtic, Proto-Germanic, and so on are to be understood as the outcome of a series of innovations shared among related, but already differentiated, dialects within a subset of a dialect continuum that came into intensified contact in an emerging socio-cultural area. The intensification of long distance trade in copper – and then tin, after the standardization of high-tin bronze – had the effect of prolonging a stage comparable to that observable in Mycenaean Greek amongst the other Indo-European dialects of Bronze Age Europe. In other words, these dialects remained closer to Post-Anatolian Indo-European (NIE) in their phonology than is found in the proto-languages reconstructed from evidence attested from the Iron Age and later. The Celto-Germanic vocabulary reflects a stage before the branches had fully separated, as signalled by such sound changes as the weakening and loss of **p* in Celtic and Grimm's law in Germanic. The Bronze–Iron transition is not co-incidentally co-eval with the emergence of the branches, but was causal, leading to the breakup of large, diverse, and more porous socio-cultural areas, in which long distance journeys were essential and prestigious, to become smaller more ethnically differentiated ones.

The dilemma of when Celtic, or the language ancestral to it, entered the Atlantic archipelago is recast in this light. Neither the Indo-European which was probably brought to Britain and Ireland with the Beaker package or that coming to southern Britain in the Middle to Late Bronze Age would have belonged to any fully developed branch. Even at the later horizon, Celtic *per se* had not yet come into being and the languages involved were in key respects closer to NIE than to the latest reconstructable common ancestor of the attested Celtic languages. The NIE continuum was yet to fragment and the well-defined language boundaries had not yet arisen to restrain later innovations spreading across the boundaries of the crystallizing branches.

We return finally to the evidence and inferences of Patterson et al. (2022). With a traditional family-tree concept of the Indo-European branches, it would be a reasonable supposition that an undiversified Proto-Celtic – i.e., the latest reconstructable common ancestor of all the attested Celtic languages, having undergone the full gamut of linguistic changes shared by these – would have existed at about 1300–800 BC. Therefore, the migrations passing through Kent into the rest of southern Britain would be a good fit as the vector introducing this Proto-Celtic to the Atlantic Archipelago. The Beaker-package users entering ~2450–2000 BC might seem too early to be speakers of this fully formed Celtic branch. On the other hand, the Middle/Late Bronze Age migration might seem too early for the introduction of some post-Proto-Celtic unity, such as Proto-Gallo-Brythonic or Proto-Insular Celtic. But if it was simply a fully formed, but undiversified Celtic that arrived then, that leaves the problem of how Celtic arrived in north Britain and Ireland, where its supposed speakers with their elevated EEF ancestry did not go.

On the other hand, if we consider the CIS model, that will imply that, in the Middle to Late Bronze Age, the dialects that were to become Celtic were then still closer to post-Anatolian Indo-European, comparable in this way to Mycenaean. Many of the innovations defining the emergence of the Celtic branch would belong to the Bronze–Iron transition, in the same way as the Mycenaean to Proto-Greek shared innovations occurred in the parallel stage of the

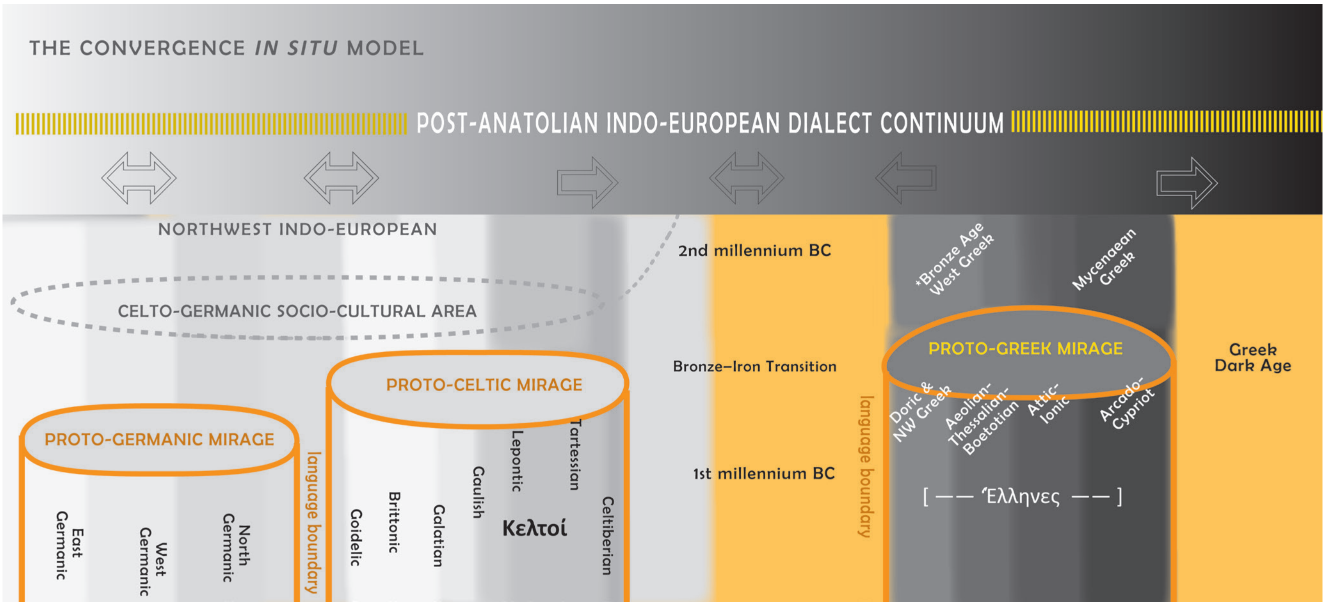


*Figure 12.6. This model illustrates the 'convergence* in situ*' concept as applied to Greek by Garrett (1999; 2006) and to Celtic by Koch (2013) and now to the Celto-Germanic phenomena.*

Greek Dark Age (Fig. 12.6). Therefore, within this model, the language of the Beaker users who drastically changed the culture and genetic makeup of Britain and Ireland and that of the newcomers to southern Britain in the Middle/Late Bronze Age were both probably (later) NIE and neither yet fully Celtic.

In short the progression was:

- first, the rapid and wide expansion of a minimally diversified post-Anatolian Indo-European,
- leading to the formation of dialect continuum across western Eurasia,
- and then the full formation of the proto-branches forestalled (for Proto-Greek, Proto-Italic, Proto-Celtic, and Proto-Germanic, at least) until the Bronze–Iron transition.

## *Notes*

1 Dyen (1956) favoured Indo-Hittite, anticipating the Indo-Anatolian model coming back into currency today (Lazaridis et al. 2022). In this family tree, Proto-Indo-European figures as a sister of Anatolian with Proto-Indo-Anatolian as their common ancestor.

2 It should be noted that the papers of Nichols cited here advocated a view, since abandoned, of an Indo-European homeland in western central Asia, east of the Caspian Sea.

3 '… early IE language spread was thus a two-phase process. In the first phase, local IE dialects acquired their specific lexical, derivational, and onomastic features; in the second phase, late in the second millennium in some cases, changes that gave dialect areas their characteristic phonology and morphology swept across those areas.' (Garrett 2006, 143)

4 If genetic Insular Celtic is indeed a mirage as proposed by Lambert (2010), one is reminded of Nichol's thoughts regarding the appearance of a close unity between Baltic and Slavic: 'The morphosyntactic and lexical conservatism of Balto-Slavic, together with some secondary areal accommodation in northeastern Europe that has increased the superficial resemblances between Lithuanian and Russian, the most studied Baltic and Slavic languages, create the impression of strong similarity between the two branches' (Nichols 1998, 246).

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