Coastal Research Library 20

Geoffrey N. Bailey
Jan Harff
Dimitris Sakellariou *Editors*

Under the Sea: Archaeology and Palaeolandscapes of the Continental Shelf

cost
EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

Springer

Coastal Research Library

Volume 20

Series Editor
Charles W. Finkl
Department of Geosciences,
Florida Atlantic University,
Boca Raton, FL, USA

The aim of this book series is to disseminate information to the coastal research community. The Series covers all aspects of coastal research including but not limited to relevant aspects of geological sciences, biology (incl. ecology and coastal marine ecosystems), geomorphology (physical geography), climate, littoral oceanography, coastal hydraulics, environmental (resource) management, engineering, and remote sensing. Policy, coastal law, and relevant issues such as conflict resolution and risk management would also be covered by the Series. The scope of the Series is broad and with a unique cross-disciplinary nature. The Series would tend to focus on topics that are of current interest and which carry some import as opposed to traditional titles that are esoteric and non-controversial. Monographs as well as contributed volumes are welcomed.

More information about this series at http://www.springer.com/series/8795

Geoffrey N. Bailey • Jan Harff
Dimitris Sakellariou
Editors

Under the Sea: Archaeology and Palaeolandscapes of the Continental Shelf

Springer

Editors
Geoffrey N. Bailey
Department of Archaeology
University of York
York, UK

Jan Harff
Institute of Marine and Coastal Sciences
University of Szczecin
Szczecin, Poland

Dimitris Sakellariou
Institute of Oceanography
Hellenic Centre for Marine Research
Anavyssos, Greece

ISSN 2211-0577 ISSN 2211-0585 (electronic)
Coastal Research Library
ISBN 978-3-319-53158-8 ISBN 978-3-319-53160-1 (eBook)
DOI 10.1007/978-3-319-53160-1

Library of Congress Control Number: 2017938016

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

COST is supported by the EU
Framework Programme Horizon 2020

COST (European Cooperation in Science and Technology) is a pan-European intergovernmental framework. Its mission is to enable break-through scientific and technological developments leading to new concepts and products and thereby contribute to strengthening Europe's research and innovation capacities. It allows researchers, engineers and scholars to jointly develop their own ideas and take new initiatives across all fields of science and technology, while promoting multi- and interdisciplinary approaches. COST aims at fostering a better integration of less research intensive countries to the knowledge hubs of the European Research Area. The COST Association, an International not-for-profit Association under Belgian Law, integrates all management, governing and administrative functions necessary for the operation of the framework. The COST Association has currently 36 Member Countries. www.cost.eu

geoff.bailey@york.ac.uk

Preface

This volume is one of two volumes that are the outcome of a conference held at the University of Szczecin in September 2013 to mark the end of the SPLASHCOS Action. SPLASHCOS—Submerged Prehistoric Archaeology and Landscapes of the Continental Shelf—is a research network funded under the EU's COST (Cooperation in Science and Technology) programme as COST Action TD0902 (TD standing for Trans-Domain), which ran officially from November 2009 to November 2013. The conference itself served two purposes: first, to review progress in the work of the Action over the preceding 4 years and, second, to act as an open scientific meeting for anyone interested in the conference themes whether or not they were formal SPLASHCOS members. In the event, the meeting drew over 100 participants from across Europe and from further afield in Australia, China, South Africa and the USA.

The aim of this volume is to present a selection of the papers from the Szczecin meeting that cover the various themes addressed during the SPLASHCOS Action. It is aimed at all those with an interest in the sea floor of the continental shelf and the archaeological and social impact of sea-level change—especially archaeologists, marine scientists, geographers and cultural-heritage managers, but also commercial and governmental organisations, policymakers and interested members of the public.

The original aims of the SPLASHCOS Action, as set out in the COST Memorandum of Understanding, were to promote research on the archaeology, climate and palaeoenvironment of the drowned landscapes of the European continental shelf; to stimulate collaboration across national and disciplinary boundaries; to bring together interested parties from the worlds of academic science, commerce and government; to encourage participation and training of young and early-stage researchers; and to facilitate exchange of ideas, planning of research projects, application for research funds and dissemination through publications and other media. Target audiences included not only the disparate scientific disciplines concerned with researching the continental shelf—archaeology, marine geology, geophysics, biology, climatology, palaeoenvironment and oceanography—but also wider audiences including government officials responsible for the marine environment and its cultural heritage, industrial operators working on the seabed, funding agencies, school children and a wider public. In short, our aim was to promote an emerging new field, variously labelled as 'submerged landscape archaeology', 'submerged prehistoric archaeology', 'continental shelf archaeology' or 'continental shelf prehistoric research', as an integrated discipline in its own right, and to plant it more firmly on the international research agenda and in the wider public consciousness.

COST Actions are the longest-running form of European funding, intended to foster coordination of research and transfer of ideas and expertise across national boundaries within Europe and its neighbouring countries. Funds are provided for regular meetings, workshops, conferences, training programmes, research planning and coordination and publication, but not for the conduct of new research programmes (see http://www.cost.eu/about_cost). During its 4-year history, the SPLASHCOS Action grew to include 25 member states and an active membership of over 120 individuals from a wide

range of institutions and disciplines. The Management Committee, comprising representatives from all member states, with Geoff Bailey and Dimitris Sakellariou as elected chair and vice-chair, respectively, held 8 major meetings in different European centres and a number of smaller workshops, organised 16 training schools or smaller short-term missions that provided experience and training to 65 early-stage researchers, stimulated a wide range of publications and successful applications to national and European funding agencies for new research and created a strongly international and interdisciplinary sense of common purpose. Details of SPLASHCOS activities and achievements can be found on the dedicated website at http://www.splashcos.org/.

In practice, activities were focussed around a core group of individuals who led the work through four formally constituted Working Groups (WGs): Archaeological Data and Interpretations (WG1) led by Anders Fischer; Environmental Data and Reconstructions (WG2) led by Jan Harff; Technology, Technical Resources and Training (WG3) led by Ole Grøn and Tine Missiaen; and Commercial Collaboration and Outreach (WG4) led by Julie Satchell. Some of this work is in preparation for publication elsewhere, notably the work of WG2 and WG1, dealing, respectively, with the Quaternary geology and palaeoenvironment of the European continental shelf and the underwater archaeological record. These volumes are intended to provide a comprehensive overview of the current state of knowledge around the European coastline and in all the major marine basins. A third volume already published is the outcome of a conference session organised at the 34th International Geological Congress in Brisbane in 2012, with papers made available online in 2014 and the final volume published in 2016 as a special publication of the Geological Society of London: *Geology and Archaeology: Submerged Landscapes of the Continental Shelf* (edited by Jan Harff, Geoff Bailey and Friedrich Lüth), which includes examples from across the world. Web-based guides to techniques and resources and to collaboration with marine industry are available online on the SPLASHCOS website, and a searchable website with maps and information about all known underwater prehistoric archaeological sites in European waters has recently been posted online at http://www.splashcos-viewer.eu.

The original conference was structured around the Working Groups, and we have adopted that structure as a basis for organising this volume, but with some modification in the light of the contributions finally delivered. All the chapters have been extensively rewritten, updated, comprehensively edited and independently reviewed. The geographical focus is primarily European, but we have not attempted to include a comprehensive range of examples from all the marine basins around the European coastline—that is the task of the other SPLASHCOS volumes. Our chapters focus on issues of method and interpretation and on wider issues of management and outreach. They also include examples from other parts of the world, and many of the discussions of method and interpretation presented here, though focussed on European case studies, have worldwide relevance.

The second volume arises from a parallel workshop incorporated in the Szczecin conference, representing the final meeting of the separately organised CoPaF Project *Coastline Changes of the Southern Baltic Sea—Past and Future Projection*, which ran from 2010 to 2014, in parallel with SPLASHCOS Working Group 2, led by Jan Harff and funded by the Polish Ministry of Science and Higher Education. The two projects thus have overlapping membership, but complement each other in their objectives and primary focus. In this volume, the emphasis is on examples from the marine basins of Western Europe and the Mediterranean, on archaeological investigations of submerged landscapes extending back into the Pleistocene or on the archaeological implications of environmental reconstruction. The CoPaF volume focusses on the geological and climatic conditions that have shaped changes in sea-level and coastline configuration during the past millennium in the southern Baltic and the likely trajectory of future changes and comprises contributions mainly from Germany, Poland, Lithuania and Estonia.

In producing these volumes, we thank, first and foremost, the COST Office, who provided administrative and financial support throughout the Action and funds for the Szczecin conference. We thank, in particular, the COST science officer, Luule Mizera; the COST administrative officer, Leo Guilfoyle;

the COST rapporteurs, Dr. Ipek Erzi (Scientific and Technological Research Council of Turkey, TUBITAK) and Prof. Daniela Koleva (Sofia University St. Kliment Ohridski); the COST external evaluators, Prof. Peter Veth (University of Western Australia) and Prof. Dr. Gerold Wefer (MARUM, University of Bremen); and the grant holder and administrative secretary of SPLASHCOS, Cynthianne DeBono Spiteri, all of whom gave invaluable advice and support.

We also thank the University of Szczecin for hosting the conference and generously providing facilities and hospitality and Helmholtz-Zentrum Geesthacht and Szczecińska Energetyka Ciepina (SEC) for additional financial support. We are also indebted to Prof. Andrzej Witkowski (University of Szczecin), who acted as chair of the Local Organising Committee and, together with the other Committee members, Prof. Marian Rębkowski, Dr. Przemyslaw Krajewski, Dr. Karolina Bloom, Marcin Wroniecki, Marta Chmiel and Michal Adamczyk, ensured the efficient organisation and smooth running of the whole enterprise.

We also express our gratitude to the many individual specialists who acted as peer reviewers and who have contributed significantly to the final outcome. Finally, we acknowledge the following institutions, who generously contributed towards the production of this volume: the European Research Council through ERC Advanced Grant 269586 DISPERSE, the German Archaeological Institute Berlin, the Hellenic Centre for Marine Research and the University of York.

York, UK — Geoffrey N. Bailey
Szczecin, Poland — Jan Harff
Anavyssos, Greece — Dimitris Sakellariou

Contents

Chapter 21
Postglacial Human Dispersal and Submerged Landscapes in North-West Europe

Garry Momber and Hans Peeters

Abstract This chapter examines the evidence of extensive human movements in the lands adjacent to the North Sea basin following the Last Glacial Maximum (LGM). We consider recent evidence from submerged sites in the southern North Sea and English Channel, and assess the potential for preservation of archaeological material under water by reviewing examples from coastal sites that have become exposed due to coastal change. We show how these site types hold organic sources of data that can be better preserved and survive in richer concentrations and greater quantities than material found on land. We place this evidence in geographical and temporal context to consider patterns of cultural dispersal and distribution from the late Pleistocene through to the Holocene. We demonstrate how the land would have been desirable and occupied, and how maritime pathways facilitated movement as sea level rose, resulting in wide-ranging transport networks for goods and people. The new discoveries of submerged archaeological material provide unique data that needs to be assessed if we are to gain a coherent understanding of human adaptation and dispersal across north-west Europe and particularly Britain following the LGM.

21.1 Introduction

Climate change and fluctuations in sea level during the Pleistocene enabled people to move repeatedly into north-west Europe exploiting extensive landscapes that are now underwater (Lambeck and Chappell 2001; Bailey 2004, 2011). The last recorded low stand was during the glacial maximum of the Devensian Ice Age. As this period drew to a close, large areas of the continent were accessible but frozen until the warming climate thawed the permafrost allowing vegetation to grow, animals to graze, and people to move north. As conditions became increasingly favourable, however, the melting ice caps led to a progressive rise in sea level, which, albeit with a time lag of several millennia, covered thousands of square kilometres of land to form the modern coastline.

This chapter will examine human dispersal into north-west Europe following the last glacial maximum. We will address the responses of cultural groups to the changing environments, look at evidence of mobility, the potential for occupation on the now-submerged North Sea basin and in particular the challenges faced by Mesolithic populations as their world became increasingly maritime. We will

G. Momber (✉)
Maritime Archaeology Trust, National Oceanography Centre, Empress Dock, Southampton SO14 3ZH, UK

Department of Archaeology, The King's Manor, University of York, Y01 7EP, York, UK
e-mail: garry.momber@maritimearchaeologytrust.org

H. Peeters
Groningen Institute of Archaeology (GIA), Poststraat 6, 9712 ER Groningen, The Netherlands
e-mail: j.h.m.peeters@rug.nl

G.N. Bailey et al. (eds.), *Under the Sea: Archaeology and Palaeolandscapes of the Continental Shelf*, Coastal Research Library 20, DOI 10.1007/978-3-319-53160-1_21

assess archaeological evidence from submerged landscapes and consider its significance when compared with terrestrial data with particular reference to human dispersal prior to the separation of Britain from mainland Europe. We will show how well-preserved material evidence from the submerged landscape has provided new insights into the technical ability, cultural links and dispersal patterns of the Mesolithic, and highlight the potential to provide a great deal more.

21.2 Human Movement Across the North Sea

Pioneering groups of Magdalenian hunter-gatherers moved towards northern France and into the southern North Sea (or 'Doggerland', see Gaffney et al., Chap. 20)[1] as climatic conditions allowed around 15–16,000 years ago (Miller 2012, p. 211). This was the first of numerous waves of migration to follow.

The Bølling/Alleröd interstadial or British Windermere climatic upturn from 12,700 cal BC showed an improvement in temperature and with it an expansion of human activity including the earliest evidence for re-occupation of southern Britain (Tolan-Smith 2008; Miller 2012). This warm spell was interrupted for a few hundred years between c.12,200 and 11,900 cal BC by the colder 'Older Dryas', during which northern latitudes were de-populated, but warmer conditions returned with the succeeding Windermere interstadial, and Magdalenian groups expanded into a region south of the European loess belt, extending into Belgium, north-eastern France and Britain (Jacobi and Higham 2011). The relatively rapid response to climatic amelioration indicates that populations had not retreated far, and were able to adapt easily to changing conditions. The warmer climate also saw the appearance of the Hamburgian, a tradition which is generally regarded as a subgroup of the Late Magdalenian, in the northern half of the Netherlands, northern Germany, Poland and extending as far west as Roberthill and Howburn in Scotland (Audouze and Enloe 1991; Rensink 1995; Street 1998; Ballin et al. 2010). By the end of the Windermere interstadial around 10,950 cal BC, additional groups included the Creswellian (Stapert 1985; Jacobi 1991; Barton et al. 2003), the Azilian (Bodu and Mevel 2008) and the Federmesser Gruppen (Fig. 21.1). All these groups would have had access to the North Sea Basin, which was dry land at the time.

The Creswellian forms a techno-complex that appears to be geographically centred in the drowned lands of the North Sea (Peeters and Momber 2014). The technology has been identified in the English Midlands and southern counties, in the Netherlands and possibly Belgium (Jacobi 1991; Barton et al. 2003). The Azilian, like the Creswellian, is believed to be a derivation of the Late Magdalenian. It originated in the Basque region but is also found in the foothills of the Alps, and in the Paris Basin where it persisted until the end of the Pleistocene.

The Federmesser Gruppen spanned the North European Plain, ranging from the Ukraine to Britain. They consumed a varied spectrum of foodstuffs and have been recorded at short-lived dwelling places located adjacent to rivers and lakes. The archaeological evidence indicates high mobility and seasonal resource exploitation (Deeben 1988; Street 1998; De Bie and Caspar 2000; Crombé et al. 2003, 2013; Baales 2004). At a regional level, the Federmesser sites of the Paris Basin and western Belgium hosted common technologies demonstrating cultural links despite distances of several hundred kilometres (De Bie and Caspar 2000; De Bie and Van Gils 2009; Miller 2012, p. 220). Furthermore, the recovery of marine shells from Bois Laiterie in Belgium provides evidence for interaction with the coastal zone that once lay to the west but is now lost beneath the southern North Sea. At the time, sea levels were around 50–60 m lower than today, putting the coastline hundreds of kilometres away and

[1] Since the area we refer to in this chapter includes the present-day land surrounding the North Sea as well as the now submerged area within it, we use North Sea as a generic short-hand reference, without prejudice to the arguments presented by Gaffney et al. (Chap. 20) in favour of the term 'Doggerland'.

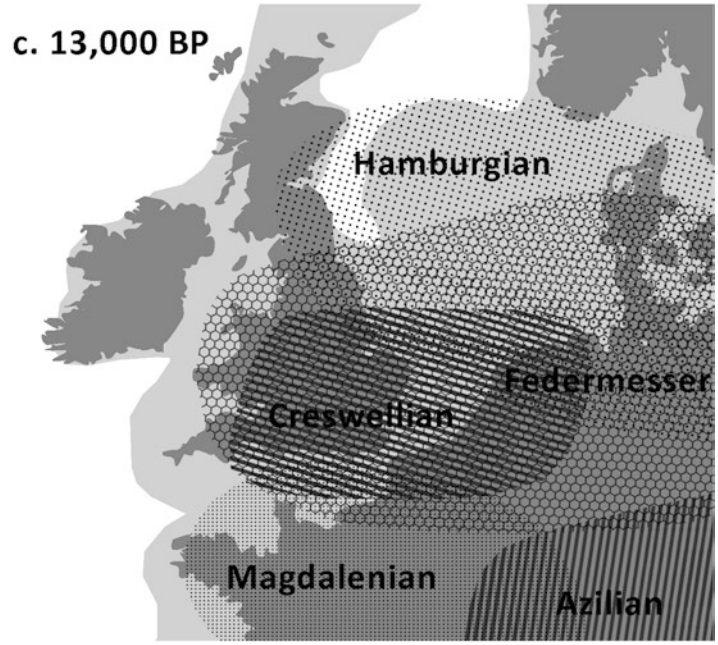

Fig. 21.1 Map showing the approximate configuration of the coastline – areas shaded light grey would have been still exposed as land at lowered sea level – and a stylised pattern of different cultures across north-west Europe towards the end of the Windermere or Bølling/Alleröd interstadial. This indicates that large areas of the southern North Sea would have been accessible for human occupation

exposing large tracts of land that would have presented ideal lowland fluvial conditions for hunting and gathering. The archaeological assemblages with artefacts made of non-local raw materials show either large territories or extensive social networks.

The Windermere interval was terminated by the particularly cold Younger Dryas stadial. Forested areas in the north were replaced with tundra and human resource exploitation had to adapt to new challenges and opportunities. As the forests retreated and the land opened up, large herds of reindeer were able to move across the North European Plain, and with them people of the Ahrensburgian, showing common characteristics that ranged from north-east France, to northern Germany and across the North Sea into Britain, where it is known as the 'long-blade' tradition (Jöris and Thissen 1997; Barton 1998; Deeben et al. 2000). During more temperate phases of the stadial, the hunter-gatherers were able to exploit ranges further north in the warmer months, generally preferring the river valleys and lakes of mature river systems. These are patterns of subsistence that are comparable to the Early Mesolithic (Arts 1988).

Evidence of marine exploitation by hunter-gatherer groups at the termination of the Pleistocene and beginning of the Holocene is negligible, which is not surprising as shorelines of that date are now drowned along with any contemporaneous coastal archaeological sites. However, recent discoveries in north-west Scotland indicate that the sea was probably used as a means of movement. Excavations at Rubha Port an t-Seilich on the Isle of Islay, western Scotland have uncovered a lithic collection of worked tools associated with volcanic ash dating to the mid Younger Dryas at 10,300–10,000 cal BC. The finds are similar to Ahrensburgian assemblages (Mithen et al. 2015 pp. 404–405) and are particularly important as they provide stratified evidence of human activity on the west coast of Scotland during the Younger Dryas. They have an added significance because access to this area from the east would only have been possible around the north of the Scottish landmass at a time when the hinterland was covered by an ice sheet. This fact, along with the distribution of comparable sites in the north of Britain (Ballin and Saville 2003; Ballin et al. 2010), and the dearth of sites in the south, has prompted Mithen et al. (2015) to argue that the movement of 'Ahrensburgian' groups into the UK was not from south to north, but rather from east to west along the coastal fringes of the land that is now drowned by the North Sea.

21.3 The Diminishing Landscape of the Mesolithic

The Holocene began with a sharp rise in temperature around 9450 cal BC (Alley 2000). For a final time, the temperate ecosystems moved back north, enriching the landscape and altering the resource base. This enabled Early Mesolithic Maglemosian groups to spread through north-west Europe. Their presence has been recorded on both sides of the North Sea basin, from Scotland to Poland (Clark 1936, 1954; Leakey 1951; Rankine 1952; Reynier 2000; Bang-Anderson 2003; Conneller 2009; David 2009). The well-watered, low lying plains with nutrient rich alluvial soils would have provided a rich environment attractive to herding megafauna and hunter-gatherer groups. However these conditions were not to last as forests spread across the landscape, sea level rise turned fluvial systems into marine estuaries and low-lying pastures were drowned. These structural changes in palaeogeography and vegetation interrupted long-established migration routes, steadily leading to the replacement of reindeer by red deer, aurochs, wild boar and other woodland mammals. The Early Mesolithic toolkit shows similarities to the Ahrensburgian, but with an increased use of broad blade microliths that reflect the modified subsistence strategies. This change is evident in Early Mesolithic assemblages from Thatcham in southern England to Star Carr in the north-east (Wymer 1958; Conneller et al. 2012).

Around 8400 cal BC a new technology arrived on the margins of mainland Britain. The prevalent Early Mesolithic broad blade technologies were now being supplemented by the narrow blade tradition of the Late Mesolithic. The earliest sites are found on the fringes of the North Sea, along the north east coast of Britain. Many were accompanied by substantial structures. These have been found at Echline on the Firth of Forth, 8450–8240 cal BC (Waddington 2015), East Barnes, around 8000 cal BC (Suddaby 2007), Howick around 7800 cal BC (Waddington 2007a), Mount Sandel in Northern Ireland at 7700 cal BC (particularly complex construction measuring Woodman 2003) and Cass–ny–Hawin on the Isle of Man c. 8200–7950 cal BC (Oxford Archaeology 2016).

The Mesolithic settlement at Howick includes a round hut structure 6 m in diameter and was repeatedly occupied for over a century on the top of a low cliff near the Mesolithic coastline. The Cass ny Hawin structure is approximately 7 m in diameter with a ring of post holes around a sub-circular hollow and an internal redeposited gravel platform. Waddington (2007b) has suggested that substantial structures such as these may have been associated with sedentary or semi-sedentary settlements focused on a mixed economy of marine and terrestrial resources in a coastal ecotone, and that this in its turn may have been a response to loss of former extensive hunting territories resulting from sea-level rise. But, equally, similar structures and adaptations could have existed on the now submerged coastlines of the North Sea lowlands; if so, they still await discovery.

The large huts found on the British mainland during the early stages of the Mesolithic are not dissimilar to contemporaneous sites in continental Europe, particularly in Denmark in association with the Kongemose and the Ertebølle periods (Pedersen et al. 1997; Grøn 2003; Skaarup and Grøn 2004; Jenson 2009). The comparable structures, along with analogous lithic technologies, express a cultural link that extended across the North Sea basin. These links are clear in the archaeological record until soon after c.7000 cal BC when stone tool technologies in Britain and mainland Europe diverged. It should be noted that the archaeological record to date in Britain is skewed towards inland sites as coastal and estuarine sites that may have existed before the sea level stabilised around 3500 cal BC are now mostly drowned. Discovering such sites is problematic as they are not easy to locate, and assumptions that most would have been lost to erosion has stifled the motivation to look. However, a brief evaluation of known underwater archaeological evidence and coastal palaeo-landforms provides an insight into the potential of sites that could remain below water.

21.4 Insights from a Drowned Palaeolandcsape

South of Howick, at the mouth of the River Tees and on the beaches around Hartlepool, reamins of submerged forests are intermittently revealed in the intertidal zone. At Withensea, an exposed prehistoric landscape of tree stumps became known as Noah's Woods following its discovery in 1839, and an intertidal forest running for about 20 km between Grimsby and Skegness was recorded even earlier in the eighteenth century (Tann 2004; Hazell 2008). These prehistoric land surfaces remained hidden, protected and unknown until natural erosion exposed them. Traces of Mesolithic human activity can be found in such contexts and comprise not only worked flint, but also footprints (Jacobi 1976; Waughman et al. 2005; Bell 2007; Sheppard 1912). Other artefacts include a Late Palaeolithic barbed bone point and a Mesolithic barbed antler harpoon from below the low water mark at Hornsea, in the Tees estuary, and another found close to the low tide mark at Barmston (Brigham et al. 2008). In addition, there are midden deposits and a worked red deer antler from the Tees Estuary dated to 6750 ± 180 cal BC (BM-80) (Waughman et al. 2005, p. 8), and a wealth of Mesolithic artefacts in and adjacent to the low-lying east coast ria estuaries from the Humber to the Thames (Wymer and Robins 1994; Wilkinson and Murphy 1995, pp. 90–98, Bridges 1998, pp. 6–8; Brennand et al. 2003; Robertson et al. 2005). Indeed, wherever investigations are carried out beneath coastal peat deposits, either well preserved environmental or prehistoric archaeological material is found.

The sites dating back thousands of years demonstrate the length of time material can survive in stable environments. Preservation can be excellent in sheltered tidal inlets where rising sea levels force up the water table, protecting palaeoenvironmental deposits by forming anaerobic peat bogs, mires and sedimentary sinks. The process is incremental resulting in the deposition of a continually thickening blanket of sediment within the networks of channels. Many finds have come from flooded fluvial systems that followed courses into the North Sea basin. These buried palaeo-features are difficult to detect unless they become exposed on stretches of coastline where the balance has shifted from sedimentation to net erosion. Underwater, these sites are obviously even more difficult to find but the recovery of prehistoric artefacts and ecofacts from the North Sea during the last 100 years has demonstrated that comparable geomorphological conditions exist (Clark 1936; Coles 1998; Flemming 2004; Gaffney et al. 2009; Chap. 20, Sturt et al., Chap. 28). However, it has not been until recent geophysical surveys in the North Sea and the English Channel, that geo-archaeologists have been able to identify a complex of channels, plains, wetlands and estuaries associated with the rivers including the proto Thames, Solent and now obsolete Bytham River (Gaffney et al. 2007; Gupta et al. 2008) and in some cases associated archaeological material, such as the Lower/Middle Palaeolithic finds from the A240 site (Tizzard et al. 2014).

Similar palaeo-landscapes occur on the east side of the North Sea, notably within the Rhine/Meuse estuarine complex. Palaeolandscape modelling of in-filled channels in the adjacent Flevoland area has aided interpretation of the Mesolithic-Neolithic landscape (Peeters 2007). Evidence from the back-barrier, intertidal and coastal peats show how archaeological material can survive beneath land that is now covered by subsequent deposits, and in some cases, by the sea. A submerged example was found at the mouth of an estuary at the Maasvlakte-Europoort, the Netherlands, where geo-archaeological interpretation of the buried landscape led to the discovery of the Yangzte Harbour Mesolithic site in Rotterdam Harbour (Vos et al. 2010). Over 500 bone and antler implements, mainly harpoon points with parallels to Star Carr, Britain, and Hohen Viecheln, Germany, were collected from this area in the 1970–1980s (Glimmerveen et al. 2004; Verhart 2004). The recent investigations in the harbour during the development of the Yangtze extension zone between 2005 and 2014 demonstrated the presence of a Mesolithic occupation site on a sand dune with an intact Late Glacial to Mid Holocene sequence in 22–17 m of water dated to 7500–5800 BC (Vos et al. 2010; Moree and Sier 2015). In 2011, excavation recovered 46,067 plant remains and artefacts, indicating the exploitation of tubers, nuts, fish, birds and mammals (Peeters et al. 2015). The presence of Wommersom quartzite and amber indicate movement or trade links that reached at least 147 km to

the east (Moree and Sier 2015 pp. 198–194). Water transport would have facilitated mobility and movement of goods through this estuarine and coastal seascape, and by the early fifth millennium BC widespread distribution of antler mattocks around the fringes of the North Sea indicates the development of extensive maritime networks (Elliot 2015).

Bouldnor Cliff is another key site that casts a unique light on questions of human dispersal in the Late Mesolithic (Momber et al. 2011; Momber 2014). The archaeological material lies 11 m below Ordnance Datum off the north-west coast of the Isle of Wight in the Solent (Figs. 21.2 and 21.3). Excavations here have been limited, yet the discoveries give tantalising glimpses of material culture and a lithic assemblage showing similarities and links with the continent. One retouched tool is an obliquely blunted blade similar to the Azilian category of 'une piece tronquée' recorded from sites in the Paris basin (Tomalin 2011, p. 152). The same type of blade is also found at the Powell site at Hengistbury Head (Barton 1992, p. 229). By contrast, a detached cutting tip of a bifacially prepared flint axe blade has been carefully formed with shallow skimming flakes. The regular blade edge has a weak S-shaped profile and the cross-section of the axe is a shallow ellipse. 'The care and symmetry displayed in this work is usually associated with Neolithic craftsmanship. The occurrence in a Mesolithic context is certainly unusual but perhaps not without Continental analogy (Tomalin 2011, p. 152). Axes and picks were used extensively in the region and many have been dragged up from the Solent during oyster fishing. Detached tranchet axe flakes were also found at Bouldnor Cliff. The abundance of finds in the Solent compares favourably with sites from northern France with similar tools, for example at the Mesolithic site of Acquiny (Eure) on the Lower Seine dated at 6510 + 170 cal BC and with the Middle Sauveterrian 'pics à crosse' at Grotte de Larchant south of the Seine (Hinout 1989a). After the beginning of the Atlantic Period around 5500 cal BC, picks are also present at the Final Tardenoisian site of Ferme de Chinchy at Villeneuve-sur-Fère (Hinout 1989b), at the Montmorencien site of Ile de la France, la Forêt de Montmorency (Guyot 1998), and at St Reine de Bretagne (Kayser 1989).

The organic material at Bouldnor Cliff includes some 80 pieces of worked wood. Some timbers have been fashioned by tangential splitting (Fig. 21.4) while others contain enigmatic workings and cuts for which there are no comparisons in the UK. Recent investigations have uncovered the edge of a platform or collapsed structure, made mainly from tangentially split timbers together with some radially split round-wood (Figs. 21.5 and 21.6). There is no other comparable structure in the Late Mesolithic record in the UK. Another piece measuring 0.94 m long and 0.41 m wide dated to 6240–6000 cal BC (Beta 249,735) represents a fragment of a much larger timber that was converted from the trunk of a tall slow-grown oak that would have been a couple of metres wide and several tens of metres high (Taylor 2011). Collectively, the artefacts from the site and their relationships indicate

Fig. 21.2 Garry Momber, Maritime Archaeology Trust, with flints recovered from the sea floor after eroding from the submerged 8000 year-old Bouldnor Cliff site

Fig. 21.3 A selection of flakes and bladelets recovered from the seabed at the Bouldnor Cliff site

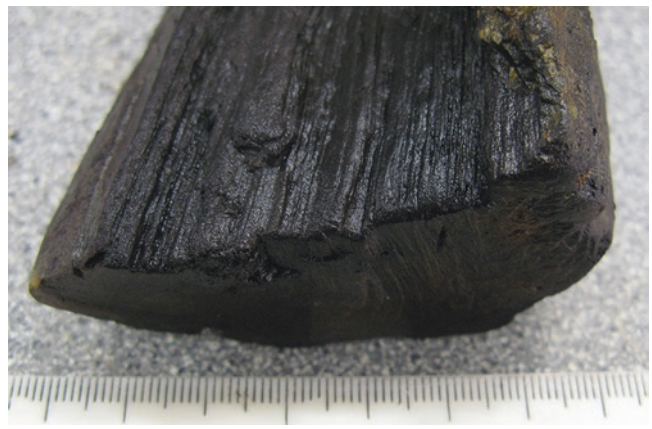

Fig. 21.4 Tangentially split round wood from the Bouldnor Cliff timber assemblage. Scale in cm

wood working, most probably for constructing a log boat. The wood working technology used to split the oak tangentially is of particular interest because this is something that is not seen again in the UK until the Neolithic, when it is used in the construction of the Haddenham long barrow at c. 3600 cal BC (Evans and Hodder 2006, pp. 185–87).

Pioneering extraction of sedimentary ancient DNA (sedaDNA) has revealed further information about activities on the site at Bouldnor Cliff (Smith et al. 2015). Samples were recovered from an

Fig. 21.5 Edge of a platform or collapsed structure consisting of tangentially split timbers alongside radially split round-wood

Fig. 21.6 Split and trimmed timber from the platform or collapsed structure at Bouldnor Cliff

archaeological horizon within a relict fluvial sand-dune context that was capped by peat deposits (see Gaffney et al., Chap. 20). The find demonstrates the presence of cultivated einkorn wheat at a UK site over 2000 years before agriculture is conventionally supposed to have reached Britain (Malone 2001). The distance of many hundreds of kilometres from any contemporaneous sites where einkorn was grown makes the discovery controversial and further evidence from sites that would help bridge the gap is needed. However, the presence of an outlier extending beyond the known frontier of Neolithic expansion is not impossible, given the pattern and rate of dispersal of einkorn in continental Europe, and the acknowledged mobility of Mesolithic groups as discussed above.

21.5 Discussion

The common cultural signatures seen on both sides of the present-day North Sea from the Magdalenian to the Late Mesolithic indicate extensive interconnections across the now-submerged landscape of the North Sea Basin. The range of Late Palaeolithic sites shows how the area was traversed by the Hamburgian culture while a Creswellian technocomplex was centred at its heart. The recolonisation was interrupted by climatic downturns but human populations were quick to reoccupy land once conditions improved. It would therefore appear that populations did not retreat far, and it is possible that the lowland areas of the North Sea Basin afforded a population refuge during periods when higher ground was climatically inaccessible, notably for the Federmesser and Ahrensburgian groups. The fluvial and alluvial systems made the plains mineral-rich and attractive for a range of resources including herds of reindeer or other large mammals. The extent to which these areas were exploited remains largely unknown as the landscape and coastlines have since become inundated. However, the presence of marine shells at the Federmesser site of Bois Laiterie in Belgium demonstrates interaction with the coastal zone through long distance movements or inter-group exchange (see also Larsson, Chap. 11 for similar indications in southern Scandinavia).

At the beginning of the Holocene, when the broad-blade Maglemosian extended to the north and west, it is probable that these groups also had the capability to move along coastlines and exploit marine resources. The isotope evidence from canine bones at Star Carr shows a diet containing seafood indicating connection with the coastline (Clutton-Brock and Noe-Nygaard 1990; Chatterton 2003; Fischer et al. 2007).

As the transgression advanced and the water rose, people evolved new strategies to make use of the changing conditions. The arrival of Late Mesolithic groups in northwest Britain in the middle of the ninth millennium BC was possibly a response to a loss of territory in the lowlands to the east. Watercraft are likely to have been used to facilitate the movement of people and resources although direct evidence is largely lacking at present. The archaeological evidence shows how networks expanded along coastal routes and boats would have allowed people to travel long distances to new territories relatively rapidly through an expanding system of coastlines and river estuaries. Waddington (2015) cites supporting evidence for a maritime dispersal in the pattern of dates and distribution of early narrow-blade technologies at the beginning of the eighth millennium BC along the north-east coast of England and lowland Scotland, around the north coast of Scotland, then south to Ireland, the Isle of Man and Caldey Island in the Bristol Channel off the coastline of south Wales.

A later southerly dispersal appears to have taken place in the south and east of the British mainland, showing connections with northern France and Belgium. These relatively late arrivals to the British mainland followed a more southerly route from the northern French region. It is uncertain whether the pathway into southern England was purely terrestrial or involved maritime travel along coastlines and rivers but most Late Mesolithic sites are associated with rivers or estuaries and recent discoveries on the Isles of Scilly show how developed maritime abilities appropriate to Atlantic waters were present by the beginning of the 6th millennium BC. The discovery of microlithic trapezes typologically linked

to the Belgian region provides direct evidence for movement between the Islands and mainland Europe by boat around 6000 BC (Garrow and Sturt 2015), most likely via the south coast of England in the vicinity of the Solent and Bouldnor Cliff.

It is against this backdrop that the Bouldnor Cliff finds gain added significance, providing insights into human dispersal and links with mainland Europe at a time when the most likely pathways of movement were dominated by the progressive encroachment of estuarine and coastal conditions. Bouldnor Cliff contains a material culture that shows similarities with mainland Europe, wheat that must have been derived from Europe, a wood-working technology that is more akin to the Neolithic than the Mesolithic and microlithic trapezes similar to those in France and Belgium. It is therefore plausible to suggest that goods and cultural influences reached the Isle of Wight from western France or the lower Rhine Basin with the aid of watercraft via estuaries and coastlines at the western end of the 'proto-English channel' before Britain was finally separated from the European mainland.

21.6 Conclusion

The body of evidence in the archaeological record serves to demonstrate the value of the submerged landscapes to resolve questions about human occupation and dispersal across north-west Europe following the LGM. First, the high level of mobility, subsistence patterns and cultural links across the North Sea basin demonstrate the very strong likelihood that it was occupied and was the focal point of at least one techno-complex. As such, archaeological investigation within it could give information that would make our understanding of these cultures less fragmentary and indeed necessary if we wish for a coherent appreciation of post-LGM human occupation patterns.

Secondly, the evidence has a great deal to tell us about the use of coastal resources, adaptation to an increasingly marine environment and development of maritime skills as the sea level rose. Sea level rise was persistent throughout the Early Holocene and as such, most Mesolithic coastlines where this evidence is to be found now lie underwater.

Thirdly, it is the drowned landscapes that hold the data needed to provide insights into the cultural changes that followed the separation of Britain from mainland Europe. Bouldnor Cliff is an example of a site with high levels of technical skill that shows evidence of cultural links to the south-east and the west. It was occupied just before the network of rivers between Britain and the continental landmass was disrupted by the creation of the North Sea. This was a mature landscape rich in resources before it was drowned and the ensuing coastal squeeze forced its inhabitants to retreat upslope or migrate elsewhere.

Finally, the preservation potential for fine organic material and organic artefacts is invariably greater than in terrestrial deposits. It is a very rich archive that can provide high concentrations of archaeological material of a type that has rarely survived on sites in present-day terrestrial locations.

Despite the limited number of sites, the evidence for early human activity on the drowned lands of the continental shelf is significant and tangible. It remains an understudied archive of data that can contribute to our understanding of human dispersal, colonisation and behavioural variability. The sites have demonstrated that organic material and DNA- rich sediments can survive and remain well preserved for many millennia. These results are causing us to rethink the technical abilities of our Stone Age ancestors. The remains at Bouldnor Cliff and the targeted discovery in Yangtze Harbour indicate that there could be many more well preserved sites entombed within the submerged palaeo-landscape. The next question is where to find them. An understanding of geomorphological changes in response to rising sea levels can help target areas where the circumstances for preservation were greatest and where the environments remained stable (see in particular Hepp et al., Chap 14, Karle and Goldhammer, Chap 15, and Gaffney et al., Chap 20 for relevant work in the North Sea Basin. Many such examples are present along and offshore of the modern coastline and many of these landscapes survive

underwater. Once we have sufficient data about these offshore landforms and we can use the evidence from currently known sites to relate human activity to the landscape, the resulting models should help us pinpoint sites with the highest potential.

Acknowledgements We thank the Department of Archaeology, University of York, and the DISPERSE Project (Grant No. 269586) funded by the European Research Council (ERC) under the EU Seventh Framework Programme, for providing intellectual and managerial support and research time for Garry Momber. We also thank Geoff Bailey and Clive Waddington for detailed comments that have helped to improve the text. We would also like to thank the Maritime Archaeology Trust under whose umbrella the work has continued for over eighteen years. This is DISPERSE contribution no. 34.

References

Alley RB (2000) The younger dryas cold interval as viewed from Central Greenland. Quat Sci Rev 19:213–226

Alley RB, Marotzke J, Nordhaus WD, Overpeck JT, Peteet DM, Pielke RA, Pierrehumbert RT, Rhines PB, Stocker TF, Talley LD, Wallace JM (2003) Abrupt climate change. Science 299:2005–2010

Arts N (1988) A survey of final Palaeolithic archaeology in the southern Netherlands. In: Otte M (ed) De la Loire à l'Oder. Les civilisations du Paléolithique Final dans le nord-ouest Européen. Archaeopress, Oxford, pp 287–356

Audouze F, Enloe J (1991) Subsistence strategies and economy in the Magdalenian of the Paris Basin, France. In: Barton N, Roberts A, Roe D (eds) The Late Glacial in north-west Europe: human adaptation and environmental change at the end of the Pleistocene, CBA Research Report, vol 77. Council for British Archaeology, York, pp 63–71

Baales M (2004) Local and regional economic systems of the Central Rhineland Final Palaeolithic (Federmessergruppen). In: Crombé P (coord) Section C 7.1. Landscape-use during the Final Palaeolithic and Mesolithic in NW-Europe: the formation of extensive sites and site-complexes. In Crombé P, Vermeersch P (eds) Actes of the XIVth UISPP Congress, University of Liège, Belgium, 2–8 Sept. 2001, BAR International Series 1302. Archaeopress Oxford, pp 3–10

Bailey GN (2004) The wider significance of submerged archaeological sites and their relevance to world prehistory. In: Flemming NC (ed) Submarine prehistoric archaeology of the North Sea. Research priorities and collaboration with industry, CBA Research Report, vol 14. Council for British Archaeology, York, pp 3–10

Bailey G (2011) Continental shelf archaeology: where next? In: Benjamin J, Bonsall C, Pickard C, Fischer A (eds) Submerged prehistory. Oxbow Books, Oxford, pp 311–331

Ballin TB, Saville A (2003) An Ahrensburgian-type tanged point from Shieldaig, Wester Ross, Scotland, and its implications. Oxf J Archaeol 22:115–131

Ballin T, Saville A, Tipping R, Ward T (2010) An upper palaeolithic flint and chert assemblage from Howburn Farm, South Lanarkshire, Scotland: first results. Oxf J Archaeol 29:323–360

Bang-Anderson S (2003) Encircling the living space of early postglacial reindeer hunters in the interior of southern Norway. In: Larsson L, Kindgren H, Knutsson K, Loeffler D, Akerlung A (eds) Mesolithic on the move. Oxbow Books, Oxford, pp 193–204

Barton RNE (1992) Hengistbury head, Dorset, Vol 2, the late upper palaeolithic and early mesolithic sites. Oxford University Committee for Archaeology Monograph 34, Oxford

Barton R (1998) Long blade technology and the question of British Late Pleistocene/Early Holocene lithic assemblages. In: Ashton N, Healy F, Pettitt P (eds) Stone age archaeology. Oxbow Books, Oxford, pp 158–164

Barton R, Jacobi R, Stapert D, Street MJ (2003) The Lateglacial reoccupation of the British Isles and the Creswellian. J Quat Sci 18:631–643

Bell M (2007) Prehistoric coastal communities: the mesolithic in western Britain, CBA Research Report, vol 149. Council for British Archaeology, York

Bodu P, Mevel L (2008) Enquête autour des lames tranchantes de l'Azilien ancien. Le cas du niveau inférieur du Closeau (Rueil-Malmaison, Hauts-de-Seine, France). L'Anthropologie 112:509–543

Brennand M, Taylor M, Ashwin T, Bayliss A, Canti M, Chamberlain A (2003) The survey and excavation of a Bronze Age timber circle at Holme-next-the-Sea, Norfolk, 1998–9. Proc Prehist Soc 69:1–84

Bridges E (1998) Classic landforms of the north Norfolk coast. The Geographical Association, Sheffield

Brigham T, Buglass J, George R (2008) Rapid coastal zone assessment, Yorkshire and Lincolnshire. Bempton to Donna Nook. English Heritage Project 3729. Humber Archaeology Report 235. Humber Field Archaeology and English Heritage. https://archaeologydataservice.ac.uk/archiveDS/archiveDownload?t=arch-868-1/dissemination/pdf/RCZA_vol_1_Bempton_to_Donna_Nook/RCZA2a2breport.pdf

Chatterton R (2003) Star Carr reanalysed. In: Bevan L, Moore J (eds) Peopling the Mesolithic in a northern environment, BAR International Series, vol 1157. Archaeopress, Oxford, pp 69–80
Clark JGD (1936) The mesolithic settlement of north west Europe. Cambridge University Press, Cambridge
Clark JGD (1954) Excavations at Star Carr. Cambridge University Press, Cambridge
Clutton-Brock J, Noe-Nygaard N (1990) New osteological and C-isotope evidence on Mesolithic dogs: companions to hunters and fishers at Star Carr, Seamer Carr and Kongemose. J Archaeol Sci 17:643–653
Coles BJ (1998) Doggerland: a speculative survey. Proceedings of the Prehistoric Society 64:45–82
Conneller C (2009) Death. In: Conneller C, Warren G (eds) Mesolithic Britain and Ireland: new approaches. Tempus, Stroud, pp 139–164
Conneller C, Milner N, Taylor B, Taylor M (2012) Substantial settlement in the European Early Mesolithic: new research at Star Carr. Antiquity 86:1004–1020
Crombé PY, Perdaen J, Sergant J (2003) The site of Verrebroek 'Dok' (Flanders, Belgium): spatial organisation of an extensive early mesolithic settlement. In: Larsson L, Kindgren H, Knutsson K, Loeffler D, Akerlung A (eds) Mesolithic on the move. Oxbow Books, Oxford, pp 205–215
Crombé P, Smedt P, Davies N, Gelorini V, Zwertvaegher A, Langohr R, Van Damme D, Demiddele H, Van Strydonck M, Antrop M, Bourgeois J, De Maeyer P, De Reu J, Finke P, Van Meirvenne M, Verniers J (2013) Hunter-gatherer responses to the changing environment of the Moervaart palaeolake (NW Belgium) during the Late Glacial and Early Holocene. Quat Int 308:162–177
David E (2009) Show me how you make your hunting equipment and I will tell you where you come from: technical traditions, an efficient means of characterizing cultural identities. In: McCartan SB, Schulting RJ, Warren G, Woodman PC (eds) Mesolithic horizons. Oxbow Books, Oxford, pp 362–367
De Bie M, Caspar J-P (2000) Rekem. A Federmesser camp on the Meuse River Bank. Leuven University Press, Leuvan
De Bie M, Van Gils M (2009) Mesolithic settlement and land-use in the Campine region (Belgium). In: McCartan SB, Schulting RJ, Warren G, Woodman PC (eds) Mesolithic horizons. Oxbow Books, Oxford, pp 282–287
Deeben J (1988) The Geldrop sites and the Federmesser occupation of the southern Netherlands. In: Otte M (ed) De la Loire à l'Oder. Les civilisations du Paléolithique Final dans le Nord-Ouest Européen. Archaeopress, Oxford, pp 357–398
Deeben J, Dijkstra P, Van Gisbergen P (2000) Some new 14C dates from sites of the Ahrensburg culture in the southern Netherlands. Notae Praehistoricae 20:95–109
Elliot B (2015) Facing the chop: redefining British antler mattocks to consider larger-scale maritime networks in the early fifth millennium cal BC. Eur J Archaeol 18(2):222–244
Evans C, Hodder I (2006) A woodland archaeology: Neolithic sites at Haddenham. McDonald Institute for Archaeological Research, Cambridge
Fischer A, Olsen J, Richards M, Heinemeier J, Sveinbjörnsdóttir AE, Bennike P (2007) Coast-inland mobility and diet in the Danish Mesolithic and Neolithic: evidence from stable isotope values of humans and dogs. J Archaeol Sci 34:2125–2150
Flemming N (2004) The prehistory of the north sea floor in the context of continental shelf archaeology from the Mediterranean to the Nova Zemlya. In: Flemming NC (ed) Submarine prehistoric archaeology of the North Sea. Research priorities and collaboration with industry, CBA Research Report, vol 14. Council for British Archaeology, York, pp 11–20
Gaffney V, Thompson K, Fitch S (eds) (2007) Mapping Doggerland: the Mesolithic landscapes of the southern North Sea. Archaeopress, Oxford
Gaffney V, Fitch S, Smith D (2009) Europe's lost world, the rediscovery of Doggerland CBA Research Reports 160. Council for British Archaeology, York
Garrow D, Sturt F (2015) Continental connections: concluding discussion. In: Anderson-Whymark H, Garrow D, Sturt F (eds) Continental connections: exploring cross-channel relationships from the Lower Palaeolithic to the Iron Age. Oxbow Books, Oxford, pp 166–172
Glimmerveen J, Mol D, Post K, Reumer JWF, Plicht H, Vos J, Geel B, Reenen G, Pals JP (2004) The inundated landscapes of the western Solent. In: Flemming NC (ed) Submarine prehistoric archaeology of the North Sea. Research priorities and collaboration with industry, CBA Research Report, vol 14. Council for British Archaeology, York, pp 38–43
Grøn O (2003) Mesolithic dwelling places in South Scandinavia: their definition and social interpretation. Antiquity 77(298):685–708
Gupta S, Collier J, Palmer-Felgate A, Dickinson J, Bushe K, Humber S (2008) Submerged Palaeo-Arun and Solent Rivers: reconstruction of prehistoric landscapes. http://archaeologydataservice.ac.uk/archives/view/palaeoarun_eh_2007/
Guyot A (1998) Trouvailles en grès. Bulletin 3:1–6
Hazell Z (2008) Offshore and intertidal peat deposits, England – a resource assessment and development of a database. Environ Archaeol 13(2):101–110

Hinout J (1989a) Tardenoisien et facies Mauregny dans la Bassin Parisien. In: Mohen J-P (ed) Le temps de la préhistoire, tome 1. Le temps de la Préhistoire: actes du XXIIIe Congrès Préhistorique de France. Éditions Archéologia, Dijon. Societé Préhistorique Française, Paris, pp 346–347

Hinout J (1989b) Le Sauveterrien au sud de la Sein. In: Mohen J-P (ed) Le temps de la préhistoire, tome 1. Le temps de la Préhistoire: actes du XXIIIe Congrès Préhistorique de France. Éditions Archéologia, Dijon. Societé Préhistorique Française, Paris, pp 348–349

Jacobi R (1976) Britain inside and outside Mesolithic Europe. Proc Prehist Soc 42:67–84

Jacobi RM (1991) The creswellian, creswell and cheddar. In: Barton N, Roberts A, Roe D (eds) The Late Glacial in north-west Europe: human adaptation and environmental change at the end of the Pleistocene, CBA Research Report, vol 77. Council for British Archaeology, York, pp 128–140

Jacobi R, Higham T (2011) The later upper palaeolithic recolonisation of Britain: new results from AMS radiocarbon dating. In: Ashton N, Lewis SG, Stringer C (eds) The ancient human occupation of Britain, Developments in Quaternary Science, vol 14. Elsevier, London, pp 223–247

Jenson OL (2009) Dwellings and graves from the Late Mesolithic site of Nivâ 10, Eastern Denmark. In: McCartan SB, Schulting RJ, Warren G, Woodman PC (eds) Mesolithic horizons. Oxbow Books, Oxford, pp 465–472

Jöris O, Thissen J (1997) Microlithic tool assemblages associated with long blade technology. Ubach-Palenberg (Lower Rhine area) – a case study on a Late Palaeolithic site at the boundary Younger Dryas/Preboreal. In: Fagnart J-P, Thévenin A (eds) Le Tardiglaciaire en Europe du Nord-Ouest, Actes du colloque "Chronostratigraphie et environnement des occupations humaines du Tardiglaciaire et du début de l'Holocène en Europe du Nord-Ouest", 119ème Congrès national des sociétés historiques et scientifiques Amiens 26–30 octobre 1994. Editions du Comité des travaux historiques et scientifiques, Paris, pp 611–621

Kayser O (1989) L'Epipaléolithique et le Mésolithique en Bretagne. In: Mohen JP (ed) Le temps de la Préhistoire, tome 1. Société Préhistorique Française, Paris, pp 350–352

Lambeck K, Chappell J (2001) Sea level change through the last glacial cycle. Science 292:679–686

Leakey LSB (1951) Preliminary excavations of a mesolithic site at Abinger Common, Surrey. Res Pap Surrey Archaeol Soc 3:1–44

Malone C (2001) Neolithic Britain and Ireland. Tempus, Stroud, pp 11–45

Miller R (2012) Mapping the expansion of the Northwest Magdalenian. Quat Int 272–273:209–230

Mithen S, Wicks K, Pirie A, Riede F, Lane C, Banerjea R, Cullen V, Gittins M, Pankhurst N (2015) A Lateglacial archaeological site in the far north-west of Europe at Rubha Port an t-Seilich, Isle of Islay, western Scotland: Ahrensburgian-style artefacts, absolute dating and geoarchaeology. J Quat Sci 30(5):396–416. doi:10.1002/jqs.2781/pdf

Momber G (2011) Submerged landscape excavations in the Solent, southern Britain: climate change and cultural development. In: Benjamin J, Bonsall C, Pickard C, Fischer A (eds) Submerged prehistory. Oxbow Books, Oxford, pp 85–98

Momber G (2014) Submerged archaeology and cultural responses to climatic amelioration. In: Evans AM, Flatman JC, Flemming NC (eds) Prehistoric archaeology on the continental shelf: a global review. Springer, New York, pp 194–212

Momber G, Tomalin D, Scaife R, Satchell J, Gillespie J (eds) (2011) Bouldnor Cliff and the submerged Mesolithic landscape of the Solent, CBA Research Report, vol 164. Council for British Archaeology, York

Moree JM, Sier MM (eds) (2015) Interdisciplinary archaeological research programme Maasvlakte 2, Rotterdam. Bureau Oudheidkundig Onderzoek Rotterdam, Rotterdam

Oxford Archaeology (2016) A mesolithic pit house on the Isle of Man http://oxfordarchaeology.com/news/oanorth-news/423-a-mesolithic-pit-house-on-the-isle-of-man

Parfitt SA, Barendregt RW, Breda M, Candy I, Collins MJ, Coope GR, Durbidge P, Field MH, Lee RJ, Lister AM, Mutch R, Penkman KEH, Preece RC, Rose J, Stringer CB, Symmons R, Whittaker JE, Wymer JJ, Stuart AJ (2015) Happisburgh: the earliest record of human activity in Northern Europe. Nature 7072:1008–1012

Pedersen L, Fischer A, Aby B (1997) The Danish Storebælt since the ice age – man, sea and forest. A/S Storebælt Fixed Link, Copenhagen

Peeters JHM (2007) Hoge Vaart-A27 in context: towards a model of Mesolithic-Neolithic land use dynamics as a framework for archaeological heritage management. Rijksdienst voor Archeologie, Cultuurlandschap en Monumenten, Amersfoort

Peeters JHM, Momber G (2014) The southern North Sea and the human occupation of northwest Europe after the Last Glacial Maximum. Neth J Geosci 93:55–70. doi:10.1017/njg.2014.3

Peeters JHM, Brinkhuizen DC, Cohen KM, Kooistra LI, Kubiak-Martens L, Moree JM, Niekus MJLT, Schiltmans DEA, Verbaas A, Verbruggen F, Vos PC, Zeiler JT (2015) Synthesis. In: Moree JM, Sier MM (eds) Interdisciplinary archaeological research programme Maasvlakte 2, Rotterdam, Part 1 Twenty metres deep! The Mesolithic period at the Yangtze Harbour site – Rotterdam Maasvlakte, the Netherlands. Early Holocene landscape development and habitation. Bureau Oudheidkundig Onderzoek Rotterdam, Rotterdam, pp 287–317

Rankine WF (1952) A mesolithic chipping floor at the Warren Oakhanger, Selborne, Hampshire. Proc Prehist Soc 18:21–25

Rensink E (1995) On Magdalenian mobility and land use in north-west Europe. Some methodological considerations. Archaeol Dialogues 2:85–119
Reynier M (2000) Thatcham revisited: spatial and stratigraphic analysis of two sub-assemblages from site iii and its implications for early mesolithic typo-chronology in Britain. In: Young R (ed) Mesolithic lifeways: current research from Britain and Ireland, Leicester Archaeology Monographs, vol 7. Leicester University Press, Leicester, pp 33–46
Robertson D, Crawley P, Barker A, Whitmore S (2005) Norfolk rapid coastal zone archaeological survey: part one – assessment report. English Heritage Maritime Reports, Report Number 1045. Norfolk Archaeological Unit, Norfolk. https://historicengland.org.uk/images-books/publications/norfolk-rczas/
Sheppard T (1912) The lost towns of the Yorkshire coast. Brown and Sons, London
Skaarup J, Grøn O (2004) Møllegabet II. A submerged Mesolithic settlement in southern Denmark. BAR International Series 1328. Archaeopress, Oxford
Smith O, Momber G, Bates R, Garwood P, Fitch S, Pallen M, Gaffney V, Allaby RG (2015) Sedimentary DNA from a submerged site provides evidence of wheat in the British Isles 8000 years before present. Science 347(6225):998–1001. doi:10.1126/science.1261278
Stapert D (1985) A small Creswellian site at Emmerhout (province of Drenthe, the Netherlands). Palaeohistoria 27:1–65
Street M (1998) The archaeology of the pleistocene-holocene transition in the northern Rhineland, Germany. Quat Int 49–50:45–67
Suddaby I (2007) Downsizing in the mesolithic? The discovery of two associated post-circles at Silvercrest, Lesmurdie Road, Elgin, Scotland. In: Waddington C, Pedersen K (eds) Mesolithic studies in the North Sea Basin and beyond. Oxbow Books, Oxford, pp 60–68
Tann G (2004) Lincolnshire coastal grazing marsh. Archaeological and historical data collection, Lindsey Archaeology Services Report No. 770. Lindsey Archaeological Services, Lincoln
Taylor M (2011) Waterlogged wood. In: Momber G, Tomalin D, Scaife R, Satchell J, Gillespie J (eds) Bouldnor Cliff and the submerged Mesolithic landscape of the Solent, CBA Research Report, vol 164. Council for British Archaeology, York, pp 84–89
Tizzard L, Bicket AR, Benjamin J, De Loecker D (2014) A middle palaeolithic site in the southern North Sea: investigating the archaeology and palaeogeography of Area 240. J Quat Sci 29(7):698–710
Tolan-Smith C (2008) Mesolithic Britain. In: Bailey G, Spikins P (eds) Mesolithic Europe. Cambridge University Press, Cambridge, pp 132–157
Tomalin D (2011) The assemblage of lithic artefacts from the Mesolithic occupation features on the sea floor at Bouldnor Cliff. In: Momber G, Tomalin D, Scaife R, Satchell J, Gillespie J (eds) Bouldnor Cliff and the submerged Mesolithic landscape of the Solent, CBA Research Report, vol 164. Council for British Archaeology, York, pp 139–154
Verhart LBM (2004) The implications of prehistoric finds on and off the Dutch coast. In: Flemming NC (ed) Submarine prehistoric archaeology of the North Sea. Research priorities and collaboration with industry, CBA Research Report, vol 14. Council for British Archaeology, York, pp 57–61
Vos P, Van den Berg M, Bunnik F, Cremer H, De Keine M, Maljers D, Mesdag C (2010) Geoarcheologisch vooronderzoek ten behoeve van het Yangtzehavenproject: inventariserend veldonderzoek, fase 2. Deltares, Utrecht
Waddington C (2007a) Mesolithic settlement in the North Sea Basin. A case study from Howick, north-east England. Oxbow Books, Oxford
Waddington C (2007b) Rethinking mesolithic settlement and a case study from Howick. In: Waddington C, Pedersen K (eds) Mesolithic studies in the North Sea Basin and beyond. Oxbow Books, Oxford, pp 101–113
Waddington C (2015) A case for secondary Mesolithic colonisation of Britain following rapid inundation of the North Sea Plain. In: Ashton N, Harris C (eds) No stone unturned: papers in honour of Roger Jacobi, Lithic Studies Occasional Paper, vol 9. Lithic Studies Society, London, pp 221–232
Waughman M, Donaldson M, Innes J, Tooley M (eds) (2005) Archaeology and environment of submerged landscapes in Hartlepool Bay, England, Tees Archaeology Monograph Series No, vol 2. Tees Archaeology, Hartlepool
Wilkinson TJ, Murphy P (1995) The archaeology of the Essex Coast. Volume I. The Hullbridge survey. East Anglian Archaeol 71
Woodman P (2003) Colonising the edge of Europe: Ireland as a case study. In: Kindgren H, Knutsson K, Loeffler D, Åkerlund A (eds) Mesolithic on the move. Oxbow books, Oxford, pp 57–61
Wymer J (1958) Excavations on the Mesolithic site at Thatcham, Berks. Interim Report. ADS University of York. http://archaeologydataservice.ac.uk/archiveDS/archiveDownload?t=arch-787-1/dissemination/pdf/BAJ057_PDFs/BAJ057_A01_wymer.pdf
Wymer J, Robins P (1994) A long blade industry beneath Boreal peat at Titchwell, Norfolk. Norfolk Archaeol 42(1):13–37