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Eurasian Prehistory Guest Editors:

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EARLY SEAFARING AND THE ARCHAEOLOGY OF SUBMERGED LANDSCAPES

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Abstract

Sea level change has been a near-continuous accompaniment to human settlement in all coastal regions throughout the history of human existence on this planet, with sea levels persisting at levels at least 40–60 m below present for most of the time and sometimes dropping to more than twice this depth. This fact has far-reaching consequences: for the reconstruction of past coastlines and oceanographic conditions; for the submergence of coastal and peri-coastal settlements associated with evidence for seafaring and marine resource exploitation; for the consequent loss of relevant evidence and the bias this introduces into the surviving archaeological record; and for an understanding of the environmental and socioeconomic impact of sea level rise at the end of the last glaciation. In this chapter, I chart the increasing acceptance of the need to research the palaeo-shorelines and submerged landscapes of the continental shelf in the face of prolonged scepticism that this is feasible or worthwhile, and discuss the evidence now emerging for why this is important, and how it can be explored further.

Key words: submerged prehistoric landscapes, sea-level change, underwater archaeology, palaeoshorelines, climate change

INTRODUCTION

For most of human history on this planet over the past 2 million years, sea levels have been substantially lower than the present in response to the repeated expansion of the continental ice sheets. High sea levels like the present were of short duration, persisting for no more than about 10 per cent of the time, with sea levels oscillating around depths of 40–60 m below present for most of the Pleistocene and periodically plunging to over 100 m at glacial maxima. This simple fact has been known for more than 40 years, at least since the time when Shackleton and his colleagues first demonstrated that the continuous climatic signal recorded in the stable isotope composition of the deep-sea sediment record provides a dateable and accurate proxy measure of global sea level variation (Shackleton, 1967, 1987; Shackleton and Opdyke, 1973). We now know that between about 16,000 and 6,000 years ago sea level rose from a low stand of - 130 m to the present level, steadily engulfing coastal and lowland territories comprising an area of land that in Europe alone is equivalent to some 40 per cent of the present land area. The archaeological consequences of this long-established fact are profound and far-reaching; and yet they have been slow to penetrate the wider understanding and interpretation of world prehistory.

Evidence that people were capable of crossing sea barriers in the Pleistocene has been available for much the same length of time, beginning with radiocarbon dated evidence in the 1960s that people had made sea crossings of at least 60 km during the last glacial period to reach Australia (Mulvaney, 1964; Bowler *et al.,* 1970). Shorter sea crossings have been claimed for much earlier periods, notably human entry to the island of Flores some 0.8 million years ago (Morwood *et al.,* 1998), and more recently for short crossings to offshore islands in the Mediterranean

(Ferentinos *et al.,* 2012). Whatever the merits of these claims – and some remain *sub judice* in the absence of agreed dates for the artefacts in question – and whether they imply purposeful seafaring, accidental crossings, or something in between, it is clear that a human capacity for sea crossings extends far back into the Pleistocene in association with periods of lower sea level than present, and that, in principle, the temporal scope of an investigation into seafaring needs to be defined accordingly.

It must follow logically from this knowledge of sea level variation and the likely time-depth of sea travel that if we wish to know about the deeper history of human interest in coastal territory and marine resources, and the long-term history of seafaring, we must face up to the fact that most of the relevant evidence before the establishment of sea level at about its modern position 6,000 years ago is missing – either lost forever, buried on the seabed, or known only from fragmentary data visible on the present-day coastline (for example, in the form of marine food shells in Upper Palaeolithic layers of coastal cave deposits such as Franchthi Cave, or from the importation of raw materials from offshore, also famously attested at Franchthi Cave by the presence of Melian obsidian at about 11–12,000 years ago; Perlès, 1999). Sites such as these must have been some distance inland from the coastline at the time, and thus represent a severely truncated body of relevant evidence.

Even today the implications of this large gap in the prehistoric record for our current understanding continue to be discounted, or viewed with a mixture of grudging acknowledgement and scepticism. In 1998, Tjeerd Van Andel (in Ammerman and Biagi, 2003:340), a pioneer in the use of acoustic technology to reconstruct the details of the submerged landscapes and shoreline habitats offshore at the Franchthi Cave (Van Andel and Lianos, 1984a,b; Shackleton and Van Andel, 1986), expressed caution about the prospects for discovering underwater archaeological material. More recently, Atholl Anderson (2012), an expert in Pleistocene voyaging and marine exploitation, has questioned whether the growing number of finds of underwater material in Europe and the Mediterranean tell us anything significantly new that we did not already know from terrestrial archaeology.

In this chapter I address briefly the reasons for this chronic scepticism and some of the key developments that have marked a progressive change in the climate of opinion, why submerged landscapes and coastlines are important and likely to provide evidence that cannot be obtained on land, especially in relation to the question of early seafaring, what we can expect to find under water, and how we can go about looking for that evidence.

CHANGING VIEWS

An awareness that a landscape of earlier human activity might exist beneath the sea can be traced back at least to a late 19th century interest in the partially submerged forests around the coastlines of England (Boyd Dawkins, 1870; Reid, 1913). The invention of SCUBA in the 1940s greatly expanded the accessibility of the shallower parts of the seabed to professionals and amateurs alike, but the archaeological research resulting from this invention mostly concentrated on evidence of shipwrecks and harbour installations of recent millennia. Drilling of the continental shelf, particularly in North America, also highlighted early on how deeply submerged were some late Pleistocene coastlines and the potential archaeological significance of this drowned territory (Emery and Edwards, 1966). However, exploration of the seabed as a former landscape of human occupation proceeded only intermittently for most of the 20th century, and in piece-meal fashion as a result of chance finds or by-products of industrial exploitation on the seabed (Evans *et al.,* 2014).

In 1981, Pat Masters and Nicholas Flemming convened the La Jolla symposium to focus attention on the implications of sea level change and the prospects for survival of underwater evidence and systematic exploration amidst a mood of growing optimism (Masters and Flemming, 1983). However, only Denmark and Israel had an emerging tradition of expertise at this time (Larsson, 1983; Raban, 1983). These have continued to be major centres of activity in subsequent decades, and then mainly on sites in shallow water and therefore of relatively late date, most famously in Denmark with the Mesolithic underwater sites of Tybrind Vig and Møllegabet II, first discovered in the 1970s, and more fully excavated in the 1980s and 1990s, with their remarkable conditions of organic preservation (Andersen, 1985, 2013; Skaarup and Grøn, 2004), and in Israel at the PPNC underwater village of Atlit Yam (Galili *et al.,* 1993).

For the broader archaeological community, especially those concerned with Palaeolithic and Mesolithic archaeology, low sea-levels have continued to be seen as significant mainly in creating land bridges between land masses and offshore islands that would otherwise have remained disconnected. Maps of Palaeolithic and Mesolithic site distributions and Pleistocene dispersals rarely show the position of the palaeoshoreline, or else present the submerged shelf as a blank and largely featureless area – about which little can be known beyond very broad generalization.

Bryony Coles's paper in 1998 (Coles, 1998) marked a significant shift of interest by giving the submerged shelf of the southern North Sea a name and an identity, filled out with palaeoenvironmental and topographic detail and archaeological implications. 'Doggerland' (named after the fishing grounds of the Dogger Bank), and representing a clump of low hills in an extensive coastal lowland when sea level was lower, captured the wider imagination, and ushered in a period of renewed investigation in the North Sea, notably the pioneering work of Gaffney *et al.* (2007, 2009) in using the seismic records of the hydrocarbon industry to reconstruct maps of the submerged late Pleistocene and early Holocene landscape (see also Flemming, 2004; Benjamin *et al.,* 2011a). Other significant developments during the new millennium were the UNESCO Convention of 2001 on the Protection of the Underwater Cultural Heritage (www.unesco.org/new/en/culture/themes/underwater-cultural-heritage/), the expansion of new technologies of underwater acoustic survey and remote sensing driven by commercial needs, and the growth of collaborative relationships between archaeologists, heritage managers and industrial operators, often involving significant funding or assistance in kind to meet the legal requirements for mitigation work in conjunction with major industrial activity such as laying pipelines, building wind farms, gravel extraction, and harbour construction (Bailey *et al.*, 2012).

A further stimulus to the intellectual motivation for underwater exploration came from an articulation of the case for the significance of marine resources and coastlines much further back into the Pleistocene than had generally been acknowledged previously (Bailey and Parkington, 1988; Erlandson, 2001; Bailey and Milner, 2002; Bailey, 2004a,b), and a growing recognition that the evidence for a seaborne colonization of Australia and New Guinea in the Pleistocene was not simply a precocious and somewhat peripheral Antipodean curiosity, but symptomatic of a deep history of seafaring and sea crossings with worldwide implications (Anderson *et al.*, 2010). In Europe now there is a critical mass of marine scientists, archaeologists, heritage managers, and palaeoclimatologists interested in the submerged archaeology and palaeoenvironments of the continental shelf; they come from many different disciplines, countries and research institutions, with new discoveries, new networks of collaboration, new projects and new funding (Benjamin *et al.*, 2011b; Bailey *et al.,* 2012; www.splashcos.org), and that degree of engagement is widening to a global scale (Evans *et al.*, 2014; Harff *et al.*, in press).

The reasons for this history of long-standing neglect and ongoing scepticism are discussed at greater length elsewhere (Bailey and Milner, 2002; Bailey, 2004a,b, 2011) and centre on three deep-rooted beliefs, which I summarize briefly here as a prelude to more detailed discussion:

1. Little evidence has survived the destructive effects of sea level rise and submersion, and what evidence can be found can make little difference to our understanding of the main developments of world prehistory;

2. The main thrust of human social evolution has been conquest and expansion on land, culminating in the Neolithic Revolution, and this is the key transformation to be explained in the bigger picture of world prehistory, before which there was little by way of prelude – perhaps at most a few millennia that witnessed a growing interest in marine resources – and from which all other developments subsequently flowed. This belief is especially potent in the Eastern Mediterranean context, where proximity to the

Fertile Crescent, and the question of agricultural origins and dispersal, overshadows almost every other consideration;

3. Underwater work is extremely expensive, logistically complex, and high-risk in terms of the likelihood that it will lead to results commensurate with the investment of time and effort.

These beliefs focus on three key questions: (1) what sort of evidence has survived the process of inundation and can be recovered from under water; (2) why this evidence is important; and (3) how underwater investigations can be pursued more effectively and integrated with studies on land. I consider each of these questions in turn.

WHAT UNDERWATER EVIDENCE HAS SURVIVED?

At first sight the likelihood that any material could survive the process of submergence seems most improbable. The destructive effects of wave action in the surf zone and the turbulent currents that act in shallow water would seem likely to pulverise, disperse, or destroy almost all material in their path except, perhaps, the most massive and resistant objects such as a stone structure. Even the gentle lapping of the waves along the shorelines of tide-less and protected basins might be expected, in time, to eat away at soft sediment or more consolidated deposits such as shell mounds, to say nothing of the destructive impact of storms. Yet, it is clear that many sites and landscape features have been preserved under water, so that the notion that everything must be destroyed is clearly wrong.

There is no shortage of material on the seabed. Literally tons of bones of ice age fauna, including mammoth tusks and teeth, and also the occasional stone artefacts, are currently being brought ashore by Dutch trawler fishermen operating in the southern North Sea (Glimmerveen *et al.,* 2004), and this includes the recently recovered parts of a Neanderthal skull (Hublin *et al.,* 2009). Similarly, the pioneer tradition of underwater Mesolithic archaeology developed in Denmark and more recently in Germany is an outgrowth of the large amount of finds that were already known about from industrial dredging activity in the early decades of the 20th century.

The archive of known underwater finds and sites has, in fact, been steadily growing over several decades through a combination of chance finds and systematic underwater exploration and excavation (for surveys see, in particular, Flemming, 1983a, 1998; Bailey and Flemming, 2008). Excluding shipwrecks and submerged harbour installations from recent millennia, a recent compilation of already known material in European waters coordinated by the SPLASHCOS network (www.splashcos.org) has identified a minimum of 2650 underwater archaeological finds from the prehistoric period (Fig. 1). This number could easily be doubled if we include material found in the intertidal zone. This work is ongoing and data is still being collated from a number of countries participating in the network. When completed, it will include the dates and other details of the material at each find location, and will be publically available as a searchable record through the European Union's Geo Seas web portal (www.geo-seas.eu).

The material recovered occurs at all depths: from the intertidal zone out towards the edge of the continental shelf, and in age from the Lower Palaeolithic handaxes of the A240 site in the North Sea (Tizzard *et al.,* 2011) to the submerged Aegean Bronze Age settlement of Pavlopetri with its street plan and its stone structures (Henderson *et al.*, 2011). The nature of the artefacts preserved ranges from delicate finds such as the Mesolithic footprints preserved in intertidal sediments on the west coast of Britain (Bell, 2007) to the extensive Mousterian lithic assemblages of La Mondrée near Fermanville off the Normandy coast (Cliquet *et al.,* 2011), and from unstratified items dredged up from the seabed by chance in drill cores or trawler fishermen's nets such as the flaked stone artefact from the Viking Bank in the North Sea (Long *et al.,* 1986) and the famous 'Colinda' Mesolithic harpoon (Clark, 1936), to *in situ* material preserved and excavated in stratigraphic context, as in the case of the underwater Mesolithic settlements in Denmark.

The Danish evidence is justly famous, with sites such as Tybrind Vig and Møllegabet II demonstrating a remarkable array of organic artefacts preserved in the anaerobic conditions of submerged marine sediments. At Tybrind Vig, finds include four dugout canoes made from lime tree trunks, one with a small hearth in the

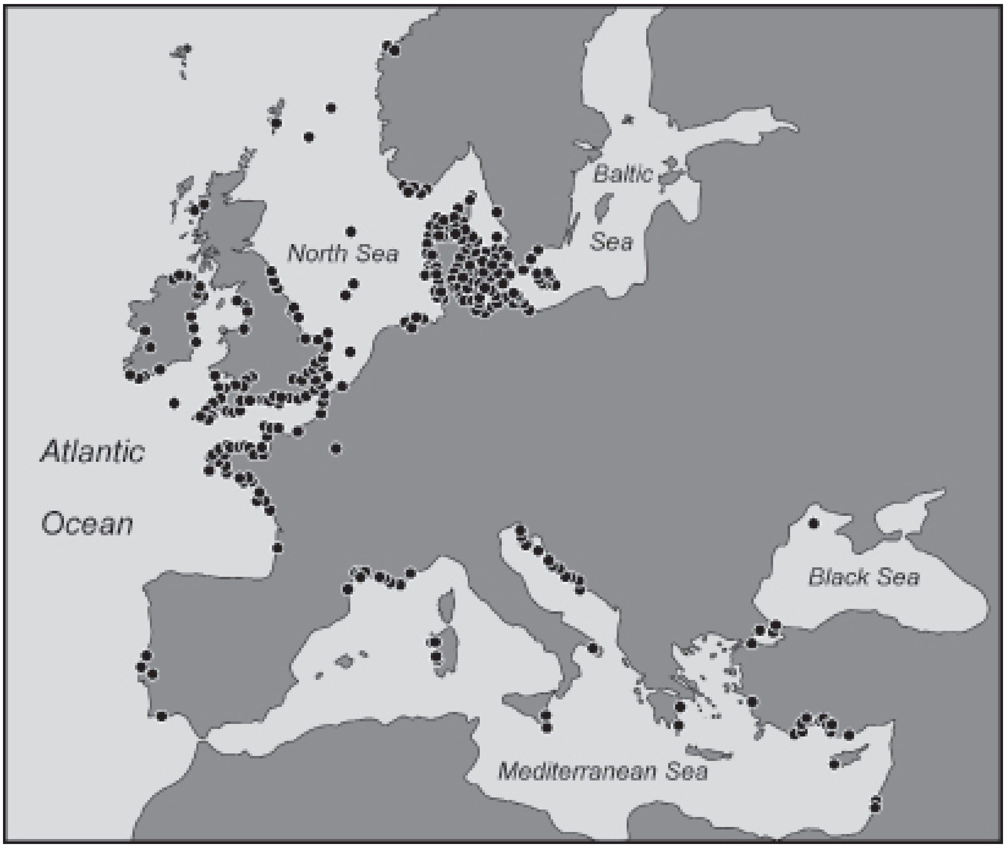

Fig. 1. Map of Europe showing the general location of currently known underwater prehistoric settlements and archaeological material. The total number of locations is at least 2650, and the black circles can only give a generalised indication of locations and concentrations of sites in particular regions. A final data set with site details is being completed and will be made available on the web (see text for further information). Information compiled by the SPLASHCOS network and made available courtesy of Anders Fischer and Hauke Jöns

stern, and a number of paddles made of ashwood, including four decorated with abstract designs. Other finds are hazel wood stakes used in constructing fish weirs, a wickerwork trap for catching eels, wooden bows and arrows, fragments of plaited twine and rope, and pieces of fabric woven from plant fibre (Andersen, 1985, 2013). At Møllegabet II, remains of a dwelling structure were recovered and a boat burial as well. Both sites yielded numerous other remains of organic implements, animal bones, plant remains, and human burials.

Many hundreds of similar finds have been recovered in Danish waters (Fischer 1995a, 1997, 2004, 2007; Pedersen *et al.*, 1997; Grøn, 2007; Andersen, 2009). Of particular interest are the submerged remains of fish weirs, good examples of which occur at the Mesolithic Rønstenen site and at the Neolithic Nekselø site (Fischer, 2007). In the latter case, the remains represent a fish weir constructed of wickerwork panels supported at intervals by vertical hazel poles and extending out from the shore for several hundred metres, suggesting that Neolithic fish weirs were larger and stronger than their Mesolithic counterparts.

Similar conditions of preservation and a wide range of finds are found further to the east in the German sector of the Baltic. Some twenty underwater Mesolithic and Neolithic sites excavated in the Wismar Bay by the SINCOS project (Harff and Lüth, 2007) have provided a similar array of material culture, and detailed evidence of palaeo-economy, documenting changing environmental conditions with rising sea level. An added bonus here is that the archaeological evidence, with its potential for high resolution reconstructions of changing conditions in the marine environment and a detailed radiocarbon chronology, has helped to create a more detailed record of sea level change than would otherwise have been possible, contributing to improved predictions of future sea-level rise.

The concentration of finds in Denmark and Germany reflects, in part, the long tradition of underwater research and training on prehistoric material and the number of specialists engaged in it, but similar material is beginning to be discovered elsewhere. At Bouldnor Cliff on the Isle of Wight in southern England, a submerged Mesolithic site has been found with extensive remains of worked wood, some of which are associated with boat construction (Momber *et al.*, 2011). Other work is now being organized and developed throughout the European coastal sector (Bailey *et al.*, 2012), with particular groups of finds and emerging centres of expertise in Croatia (Benjamin *et al.*, 2011a), the Black Sea (Filipova- Marinova *et al.,* 2011), and in various scattered locations in the eastern Mediterranean of relevance to the theme of this volume in the Adriatic, Ionian and Aegean Seas and the Eastern Mediterranean waters of Turkey, Cyprus and Israel (Flemming, 1983b; Gifford, 1983; Galili *et al.*, 1993; Ammerman, 2010; Ammerman *et al.*, 2011; Henderson *et al.*, 2011; Özdoğan, 2011; Galanidou and Sakellariou, in press).

At Atlit Yam off the Israeli coastline, excavations in the 1990s demonstrated the presence of a settlement with a stone-lined well, dwelling structures and evidence of fishing, domestic livestock and cereal cultivation. Human skeletal remains from burials also showed elbow abrasions and muscle markings typical of exertions associated with rowing, and auditory exostoses, a pathological bone growth associated with diving in cold water (Galili *et al.,* 1993). Additional material is now being recovered from more recent investigations (Galili and Rosen, 2011).

It is not only artefacts and archaeological sites that can be recovered from the seabed but traces of whole landscapes. The most powerful demonstration of that possibility is the work of the Birmingham Palaeolandscapes Project (Gaffney *et al.*, 2007, 2009), which took the seismic records made available by the North Sea hydrocarbon industry and applied powerful computer-analytical methods to extract information on late Pleistocene and early Holocene landscapes, including details of topography, wetlands, coastlines and drainage networks. Commercial seismic surveys are intended to investigate the geological structure hundreds of metres beneath the seabed, rather than the sedimentary and topographic structures detectable in shallower sediments. More detailed reconstructions can be obtained with higher resolution methods of acoustic survey, including multi-beam bathymetry, side scan sonar and sub-bottom profiling, but these are necessarily expensive to deploy.

An example of what can be achieved in this way and the detail of the evidence that can be preserved is shown at the A240 site, in another sector of the North Sea, some 11 miles offshore of the east coast of England. Here the spoil from large-scale gravel extraction yielded Lower Palaeolithic bifacial handaxes, and collaboration between the aggregates industry and English Heritage (the Government Agency responsible for managing the underwater cultural heritage) funded targeted high-resolution acoustic survey and coring at the handaxe location, revealing a sequence of sediment-filled palaeo-channels with environmental and chronological evidence to support a date of 350–200,000 for the earliest material as well as information on the contemporaneous vegetation and environment (Tizzard *et al.*, 2011; Bicket *et al.*, 2014).

The above summary is by no means comprehensive, but it demonstrates the following three points: (1) that a great deal of material can survive from earlier coastlines and submerged landscapes, (2) that it is widely distributed, and (3) that in addition to the usual archaeological evidence of material culture, it can provide often spectacular conditions for the preservation of organic materials, and specific detail of especial relevance to seafaring that would not otherwise be obtainable. In particular, the latter includes evidence of actual sea craft and methods of propulsion, and palaeo-dietary and palaeopathological evidence directly relevant to maritime activities. Most of the evidence, and notably the more substantial finds of settlements and maritime activities, is relatively late in date, extending little earlier than the closing millennia of the Mesolithic, or the Pre-Pottery Neolithic. But that simply reflects the fact that most work has been concentrated in shallow water, which is most easily accessible to underwater exploration, regular monitoring for finds, and actual excavation. And the palaeo-coastlines formed at shallow depth are by definition late in date, reflecting the closing stages of sea-level rise before stabilisation at about 6,000 years ago. If we wanted to find earlier material extending back, say, to the earlier Mesolithic, the Epipalaeolithic or the Upper Palaeolithic, we would have to search at much greater depths and at greater distances from the present coastline. This, of course, poses much more formidable technical and technological challenges. But there is no reason to suppose that comparable sorts of sites and materials are not preserved at greater depth.

WHY IS UNDERWATER EVIDENCE IMPORTANT?

One way of answering this question is to consider what we would know about the maritime history of Britain or Greece over the past 2,000 years – to take just two European nations with particularly prominent maritime traditions – if sea level were to rise over 100 m some thousands of years into the future. In the UK, a large part of the eastern half of England would disappear beneath the sea, and many of its biggest conurbations – certainly London, Plymouth, Liverpool, Glasgow, Belfast and Dublin – along with other ports, shipyards, towns and cities and the whole social and technological infrastructure associated with settlement on the coast and its low-lying hinterlands. In Greece, only the pinnacle of the Akropolis would perhaps be clear of the surrounding water. In fact, most of the capital cities of western and southern Europe would be submerged as well as all of the industrial and port facilities associated with almost every part of the European coastline except the uplifting coastlines of Northern Scandinavia. What would our archaeologists living in such a future have by way of material evidence to infer the nature and importance of coastal zones, maritime centres and seaborne communications in the preceding millennia (assuming they had not mastered the art of underwater exploration)? Would they perhaps infer from the most easily accessible evidence in the shallow parts of the submerged landscape, and therefore the most recent in date, that intensification of maritime technology and infrastructure was a relatively recent prelude to their own, no doubt highly maritime, civilization?

The importance of the coastal zone today is not simply a function of modern technologies of engineering, communication and travel, but reflects a more fundamental ecological reality that coastal zones are in general more climatically equable and easily accessible than their remoter hinterlands – with more abundant supplies of fresh water, more extensive and fertile distribution of soils, greater ecological diversity of plant and animal life, including ecotonal effects at the junction of sea and land, and of course access to the resources of the sea shore and the shallow sea along with the opportunities for travel, transport and social and cultural interchange afforded by sea travel (Bailey and Parkington, 1988; Bailey *et al.*, 2008). It must follow then that we are missing a comparable body of evidence for earlier societies, whether they were based on hunting and gathering, farming and pastoralism or urban centres.

Even during the later stages of sea-level rise in the late Pleistocene and early Holocene, sea level was still some many metres depth below the present, so that the coastal rim where we would expect the main population centres, settlements, burial grounds and harbours of a maritime society to be located are now under water. And this is even more likely to be the case in many parts of the Aegean, where tectonic effects have resulted in crustal submergence, inundating settlements of later periods, as in the already mentioned case of Bronze Age Pavlopetri and the Neolithic and Bronze Age settlements in the Bulgarian sector of the Black Sea (Draganov, 1995). Broodbank (2006:208) doubts that archaeological evidence of a maritime society would be totally removed by sea-level rise, citing the case of Franchthi

Cave, where marine shells were brought back to a cave location never more than 6 km from the contemporaneous shoreline. However, 6 km, or even 1 km, is a long way for a community dependent on boats and fishing activity to carry their food and equipment. If late Upper Palaeolithic people were going to sea, as the presence of Melian obsidian shows, we can be fairly sure that they were not hauling their boats up to the mouth of a cave, which was some kilometres inland, nor most of the subsistence resources that they obtained from the sea.

It is worth noting that the progressive increase in the representation of marine indicators in the more recent levels of the Franchthi Cave is correlated quite closely with the progressive rise of sea level and growing proximity of the cave to the sea shore (Shackleton and Van Andel, 1986; Shackleton, 1988), and also that an open-air Neolithic site was detected underwater in front of the cave by coring in a water depth of 4.5 m yielding artefacts, charcoal and organic materials, including fish vertebrae (Gifford, 1983). If Neolithic people chose to carry out some of their subsistence activities outside the cave and closer to the contemporaneous shoreline, it is likely that their Mesolithic and Upper Palaeolithic predecessors did likewise, leaving material evidence that is now more deeply submerged and further offshore. Whatever maritime indicators were deposited in the Franchthi Cave when sea levels were lower can represent little more than the tip of the iceberg of the total range of marine-based activities carried out at that time.

The palaeogeography of coastlines and offshore islands would, of course, have been transformed by sea level change in many regions. Local conditions of safe anchorage or shelter for boats, and favoured fishing grounds and marine-shell habitats, would likely have occurred in different places from their modern counterparts. Island archipelagos, which have provided such an important stimulus to a maritime way of life because of inter-visibility between islands, 'nursery conditions' for experimenting with sea travel (Irwin, 1992), greater protection from storms, mixing of currents and increased marine productivity, and the presence of unique resources such as nesting birds and sea haul-outs – these would have been, or could have been, configured quite differently at different sea level positions. The maps produced by Lambeck (1996) and Lykousis (2009) provide some insight into the dramatic nature of the transformations associated with sea-level change in the Aegean. However, it should be emphasised that these are quite generalized maps based on low resolution bathymetry and general isostatic and tectonic models, and they do not provide the level of detail with regard to the configuration of particular shorelines or smaller islands and islets at a scale that is relevant to day-to-day human activity. That level of detail would require targeted exploration designed around archaeologically focused problems, using the full array of underwater technologies including high resolution multi-beam, side-scan and sub-bottom acoustic survey, underwater cameras, and coring equipment. That research is certainly feasible but it is yet to be carried out (Galanidou and Sakellariou, in press). Without it, we are at risk of continuing to perpetuate broad generalisations founded on very limited empirical support.

The fact that obsidian from island sources such as Melos moved to the mainland in the closing millennia of the Pleistocene and early Holocene is an important 'smoking gun' for some form of sea travel in that period. But it is only the beginning of the story. And of course it does not exclude the possibility of earlier movements over the sea for which there is no equivalent smoking gun. As Nutley (2014) has observed in the Australian context, the fact of seaborne colonisation is one thing, but the coastlines which formed the launch pad for sea travel from Southeast Asia, and the locations of first landfalls in New Guinea and in Australia, are unknown and must necessarily be under water. The same applies to early sea travel in the Mediterranean. If we want to contextualize this sort of evidence – to know more about the nature and frequency of sea crossings, the settlements where maritime people lived, the nature of their economy, and to learn more about the social and economic contexts in which sea travel took place, the time depth and developmental trajectory of sea crossings, the technology used, and the early contexts out of which movements to exploit offshore obsidian arose – we need to explore the now submerged coastal zones and coastlines where most of the evidence is likely to be found.

Broodbank (2006) in a careful and critical evaluation of the Mediterranean evidence as a whole (in any event, the part of it that has survived above modern sea level) has constructed a plausible and in some respects persuasive trajectory of increasing interest and facility in sea crossings. He recognizes hints of short sea crossings in the Pleistocene (but little evidence for sustained interest in moving to offshore islands despite geographical opportunities to do so) as well as hints of a more active drive to long-distance voyaging and the exploration of islands after about 12,000 years ago associated with the climatic downturn of the Younger Dryas, which created the need for greater mobility in search of alternative resources (Ammerman, 2010; see also Ammerman in this issue), and, in time, early seafaring on a more regular basis, which fostered the spread of early farming in the Mediterranean (e.g., Zilhão in next issue). However, we should always be careful when looking at evidence that may be subject to problems of differential visibility and preservation, which become more serious as one goes further back in time, and we should avoid falling into the trap of progressivism: that is, the belief that the long-term trajectory of change is necessarily one of cumulative and progressive development along a linear pathway from simple to more advanced, and that the past should be interpreted retrospectively in the light of what came later as a teleological process leading towards that later outcome. In addition, we should remember that the earliest currently known example of a particular phenomenon is at best a provisional date and one that may turn out in the light of later research to be a minimum. Otherwise, we risk falling into the same trap that has afflicted so much past 'origins' research in prehistory: namely, the belief that the long-term trajectory of change is a ladder of progress punctuated by revolutions, which happened when they did because previously 'culture' or 'mental abilities' were not yet ready for them, or else because of some unusual or powerful external disturbance. Such arguments not only do not explain things, but they are largely circular in nature, assuming as fact the very matters in need of explanation, and thus closing off the investigation of alternative evidence and alternative hypotheses on the grounds that there is no point in looking for contradictory evidence since we already know what happened without the need for further research.

HOW CAN UNDERWATER EVIDENCE BE RECOVERED?

The key question here is not so much how to recover the evidence in a technical sense, but where to look with a good chance of success. The 'how' is relatively straightforward if technically complex – mapping of the seabed and the sub-surface sediments and geology using acoustic instruments and vehicles with cameras, diving with SCUBA in relatively shallow conditions for exploration and excavation, technical diving with mixed gases in deeper water, and coring or grab sampling of sediments using various types of coring equipment (for an up-to-date and comprehensive survey, see Grøn and Missiaen, 2013).

The 'where' question requires more complex considerations, which involve at least four layers of investigation:

1. Reconstruction of the submerged landscape as it would have existed before inundation.

2. Predictive modelling of where people would have lived in the reconstructed landscape, or at any rate stayed long enough to deposit an archaeologically visible signature of their presence.

3. Assessment of where archaeological deposits would have been preserved.

4. Discovery of locations where the material is visible and accessible.

With regard to the first point, practical factors limit the area that one can cover. Research vessels on which acoustic and visual survey equipment can be mounted are essential, along with a skilled team capable of operating the equipment and converting the readouts of acoustic data into interpretable images. A small vessel may be sufficient in shallow water and for investigation of specific targets, but in deeper water a larger vessel with a full complement of crew, equipment and a research team is called for. Costs can quickly escalate to the order of $30,000 per day, but equally these can be mitigated through cooperation with industrial partners who have the necessary equipment and are willing to make it available for archaeological investigation (Bailey *et al.*, 2007; Weerts *et al.*, 2012).

Predictive modelling can be effective in some situations, the best known example being Anders Fischer's fishing site model (Fischer, 1995b), which identifies locations such as the mouth of inlets, where fish would be most abundant and accessible, and which has been used with success in Danish underwater survey, and adapted for use elsewhere (Benjamin, 2010). Other examples are the use of shell mounds and their associated shoreline features to target underwater locations (Bailey *et al.,* 2007), and the targeting of palaeochannels, rock outcrops, and caves known to be attractors of archaeological deposits on land (Faught and Gusick, 2011; Faught, 2014; Pearson *et al.,* 2014).

By far the most critical issues, however, are those of preservation and discovery. Here a number of factors may be involved. Stone features such as caves and rockshelters or artificial stone structures such as the foundations of hut circles (Dixon and Monteleone, 2014), rectilinear structures and street layouts (Henderson *et al.,* 2011), stone-lined wells (Galili *et al.*, 1993), and megalithic monuments (Casse *et al.,* 2011) are inherently likely to be more resistant than other materials to wave action. But even these may be damaged, displaced or buried under marine sediments. Less resistant materials are more vulnerable. Grøn (2007) notes that rapid submersion of tree trunks and wooden artefacts would ensure their preservation before they had been rotted by subaerial decay. However, rapid sea-level rise by itself is unlikely to be a major factor since it could not happen fast enough to immerse a feature (to a sufficient water depth) before it had been subjected to destructive disturbance by surf action and shallow-water currents.

More important factors are the degree of protection from wave action (for example, in protected inlets and bays) and the accumulation of protective sediments around and over the top of an archaeological and natural feature as it is being submerged. Faught (2014), for instance, has recorded the preservation of an underwater shell mound in the Gulf of Mexico, thanks to the accumulation of protective sediments around the base of the mound, whereas similar sites on the exposed coastlines of northern Australia can be destroyed by storms in a single monsoon season (Bird, 1992; Nutley, 2014). However, even exposure to severe wave action is not necessarily fatal, as Bayón and Politis (2014) have shown in the case of La Olla in Argentina, a mid-Holocene archaeological site found in the intertidal zone of a wave-exposed sandy beach and preserved because of partial burial by sand. All of these factors, which variously destroy or protect sites, are likely to be the result of highly localized conditions, and it would be unwise to extrapolate from individual locations to regional rules of thumb. As on land, so underwater, the taphonomy of site and landscape survival is a complex process. It is still at an early stage of research and understanding, and it can only be advanced by continued underwater research.

Of course, protection of an object beneath an overburden of sediment removes it from view. Sub-bottom profiling can, in theory, see through the covering of sediment, but it remains uncertain how easily or reliably such techniques can identify features of archaeological interest. Coring can also identify artefacts, charcoal and other indicators of human presence, which can then be further explored by more extensive excavation (Gifford, 1983; Long *et al.*, 1986; Faught, 2014; Pearson *et al.,* 2014). The best chance of locating material, as we as archaeologists might expect from our experience on land, is where substantial features are only partially buried, or where subsequent erosion by underwater currents has exposed the original land surface. The site of Atlit Yam was originally identified by the temporary removal of sand cover during stormy weather. Similarly, the site of Bouldnor Cliff first came to light when archaeological remains were seen eroding out of a section cut through earlier sediments by a submarine channel.

In an ideal world, reconstruction of the submerged landscape would integrate all four layers of investigation identified above. A good example of such an approach is recent work carried out during the construction of the Maasvlakte 2 Harbour by the Port of Rotterdam Authority, which required the removal of some 240 cubic millions of marine sediments (Weerts *et al.*, 2012). Here, allocation of substantial funding for mitigation work by the Port Authority, and collaboration with archaeologists, geoscientists and the

Dutch Heritage Agency, resulted in a stepwise investigation. Preliminary characterization of the submerged landscape by geological mapping and acoustic survey identified likely areas for site identification such as submerged shorelines, river deltas and sand dunes. Drilling of sediment cores in target areas revealed charcoal and other indicators in some locations, and large-scale excavation using specially adapted cranes and industrial-scale sieving resulted in the recovery of Mesolithic sites in three locations at a depth of 17–21m – with excellent preservation of organic materials (yielding dates at ca. 9,500 cal. BP) as well as stone artefacts.

Practical and financial limitations rarely allow research on such a scale, but the Port of Rotterdam work is only one of an increasing number of examples of collaboration between industrial companies and archaeologists, which is leading to large-scale research and new results (Tizzard *et al.,* 2011; Bicket *et al.,* 2014; http://www.splashcos.org/outreach/collaboration).

CONCLUSION

Despite persistent scepticism about the importance of investigating submerged landscapes and archaeology, underwater finds have steadily accumulated over the past 30 years, with a considerable acceleration of interest and discovery during the past decade. This evidence includes detail about the nature and the context of maritime and seafaring activities from early contexts, which could not have been obtained from sites on land today. The cost of underwater research remains high, but low-cost solutions to work in shallow water and collaborations with industrial partners in the case of larger-scale projects are offering new ways forward. In addition, discovering underwater sites remains challenging because of the difficulties of predicting where sites will be both preserved and exposed for study. There is no easy shortcut to success. However, as more underwater research is undertaken and more sites are discovered, our understanding of the circumstances in which archaeological materials can be found will continue to improve. And as new evidence becomes available and the level of expertise grows, the focus of our attention will be free, in turn, to move beyond technical and descriptive studies to the investigation of archaeologically significant problems – ones that demand underwater exploration and that cannot be solved in any other way. These problems include the palaeogeographical, technological, social and economic context in which the earliest experiments in sea travel arose, and perhaps most intriguingly of all the role of inexorably rising sea level in the closing millennia of the late Pleistocene and the early Holocene in the social and economic trajectory of that important time.

Perhaps the biggest barrier for many archaeologists to getting their feet wet is the psychological barrier posed by the shoreline viewed as a physical separator between the familiar world of dry land and the unfamiliar and unknown world beneath the sea. Of course, we should remember that the present day shoreline is an entirely arbitrary boundary that has frequently moved during the past millennia, and that those parts of the landscape that are now submerged and those that are still dry land are part of a seamless entity – all of which was once humanly inhabited territory and which needs to be investigated as an integrated whole.

It is a sobering comment on the slow pace of advancement that the pioneering underwater work of Van Andel and Gifford mentioned earlier in connection with the Franchthi Cave sequence took place over 30 years ago. Their preliminary results clearly pointed to the need for further research of this kind as well as the promise of further rewards. For one reason or another, their studies were not followed up, however. Here it is encouraging to note that new underwater investigations in the Franchthi area are now being planned (Julien Beck, personal communication, July, 2013) as part of a widening interest and engagement with the submerged landscapes of the Aegean and beyond.

By way of conclusion, it is appropriate in the context of Mediterranean seafaring to quote Broodbank's closing comment on the bigger picture:

> *By combining geographical insights with a continued program of field investigation, rather than assuming sweeping and universal maritime practices from an early date, we stand*

> *the best chance of finding out when, where, how and why the people of the Mediterranean first began to create their Middle Sea*
>
> (Broodbank, 2006:220)

Except that for 'geographical insights with a continued program of field investigation', I would substitute '*palaeogeographical* insights with *an intensified program of underwater field investigation*'. With that proviso, I believe that much new evidence of early maritime activity awaits discovery and that it is likely to hold many surprises.

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