

to see within some of the general trends, developing and persistent areal or regional traditions, which generally seem to cover smaller areas than in the preceding Palaeolithic. Some typological approaches have thus assumed an essential 'proto-ethnic' territorially based identity to explain similarities in regional material cultures and practices. Some, notably Rozoy (1978, 1998) and Newell et al. (1990), have used these to identify 'bands' and 'tribes', either through lithic typologies or 'ornaments' from burials, but both social structure and the nature of sociocultural boundaries are likely to have been variable across both time and space. The nature of social organisation in terms of kinship or other entities, and its relationship to material culture, is unlikely to have been either clear-cut or stable, and a more porous notion of groups and social networks may be more appropriate for much of the Mesolithic.

Is there any unity to a Mediterranean Mesolithic? Many coastal or partly coastal communities may have developed similarities of outlook towards notions of travel, cardinal points, distance, or islands, for example, reinforced or stimulated by a related repertoire of cosmological understandings (Barth 1987). But axes of cultural contact, 'borrowing' and variation (which may have been gradual rather than bounded) surely ran in many directions both inland as well as seawards and along the coast. A suitable metaphor for the Mesolithic of the Mediterranean may be that of a mosaic or constellation, in which different communities or societies are seen less as variations on an underlying theme such as environment or adaptation, but, rather, as kaleidoscopes of cultural contingency, interrelatedness and historical depth – a challenge to our archaeological imaginations and methods.

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Chapter 14

Mesolithic Europe: Overview and New Problems

Geoff Bailey*

In drawing together the many rich and diverse strands of new evidence presented in the preceding chapters, we comment briefly on two themes. First, we outline a sketch of the main trends in the Mesolithic, with emphasis on those features that appear from a comparative overview to represent the most striking or novel features associated with the period. Second, we comment on what appear to us to be emerging as unresolved problems or promising avenues for future research.

Comparative Overview

The contributors to this volume are essentially unanimous in their view that the Mesolithic is best treated, at minimum, as a unit of time, whose upper and lower boundaries are arbitrary, disguising technological, social, and cultural continuities across the boundaries, and changes and innovations that occurred between them. The date of 9500 cal BC, traditionally taken as the end of the Ice Age in Europe, is now clearly seen as an arbitrary boundary across a continuum of environmental and cultural changes that extend well back into the Last Glacial period. From an archaeological point of view, there are good reasons to extend the narrative of postglacial developments back to about 13,500 cal BC with the onset of the warming trend initiated by the Late Glacial interstadials, and perhaps back to about 17,000 cal BC, when sea level first began its sustained rise from a low still stand of approximately -130 m at the Glacial Maximum. Already in southern Europe in this earlier period, human groups were beginning to move into new territory at higher altitude with climatic amelioration in pursuit of mountain resources such as ibex and chamois (Bailey 1997, Straus this volume, Pluciennik this volume), and perhaps on the evidence of coastal cave sequences in Spain (Straus this volume) to take a more serious interest in marine resources. Both these trends become more marked with time and are defining characteristics of Mesolithic exploitation patterns in many regions.

* Department of Archaeology, University of York, UK.

Sea-level rise would have exerted a wide range of effects from at least 16,500 cal BC through until the time when the sea reached its present position at about 5000 cal BC. Rising sea levels would have led to progressive inundation of the continental shelf, removed extensive areas of lowland territory, breached land connections, notably that between Britain and mainland Europe, brought existing hinterlands within reach of milder 'oceanic' climates and culminated in the creation of entirely new coastal landscapes. The palaeoecological and palaeogeographical impact of sea-level rise, and its effects on the preservation or visibility of earlier coastal archaeological evidence, would have differed in different regions but would have been far-reaching everywhere, especially where the continental shelf is shallow and extensive as in the Northwest. Here, large areas of hunting territory were lost, but in compensation were replaced by the creation of shallow inshore waters, indented coastlines, and offshore islands and archipelagos offering more productive and more easily accessible supplies of fish, sea mammals and intertidal molluscs, and of course they also were replaced by more productive hinterlands as well. Although most of these effects of sea-level rise have long been recognized, their impact on patterns of human settlement, both direct and indirect, is perhaps even wider than is generally allowed for in archaeological interpretation – and more complicated to measure.

As the ice retreated, new territory became available, and faunal and floral habitats changed, creating a complex mosaic of variable patterns that changed in different ways and at different rates in different regions. Many of the animal species of former significance moved their ranges northwards, as with reindeer and horse, or became extinct, as with mammoth and bison, and were replaced by forest or forest-edge species such as elk, red deer, roe deer, cattle, and wild boar, or chamois, ibex, and saiga antelope in more open or mountainous terrain, according to regional and local circumstances. From about 13,500 cal BC onwards, settlements associated with hunting of reindeer and, later, horse, cattle and elk, became established across newly occupied territory in the North European plain in a broad swathe from the British lowlands in the west to the steppes of Ukraine and Russia in the east (Dolukhanov this volume, Tolan-Smith this volume, Zvelebil this volume), including the now submerged bed of the North Sea on the evidence of an antler harpoon dredged up from the Leman and Ower Bank and dated to 11,600 cal BC (Tolan-Smith and Bonsall 1999). This also was the period that saw decisive occupation of the polar regions of East Siberia (Pitul'ko 1995) and the first unequivocal evidence for the expansion of human populations into the Americas (Dillehay 2000). Another notable innovation of this period, albeit one that first developed beyond European borders, is the use of pottery, with early dates in the 13,500–12,000 cal BC range now recorded from China, the Russian Far East, and Japan (Habu 2004, Kuzmin et al. 2004).

Stone industries were characterized by tanged points for hafting on the ends of spear or arrow shafts, and by 'knife' blades with curved and blunted edges. Variations in the proportion of these artefacts and minor differences in morphology of the key artefact types have given rise to a variety of cultural labels, Kukrekian, Butovian and Kudlevian in Russia and the Ukraine, Swiderian in Poland, Hamburgian, Bromme, and Ahrensburgian in northern Germany and Denmark, and Federmesser and Creswellian in the Low Countries and Britain, respectively. Whether these represent different cultural traditions associated with different founding populations, stylistic markers of distinct social groupings, functional adaptations to different types of weapons and prey species, or simply local names for similar entities, remains poorly understood. The smaller and lighter tanged points of the Ahrensburgian, associated with the final cold phase of the Younger Dryas period between about 11,000 and 9600 cal BC could well have been used as arrow points, since actual wooden bows have been recovered from this period. At any rate, the similarities across this vast territory are as impressive as any differences, with relatively small settlements, specialised toolkits of stone and

antler and a considerable degree of mobility. Importation of raw materials for making artefacts from favoured sources over long distances reflects both the extended lines of communication in small mobile populations engaged in the early stages of colonizing new territory and perhaps also the fact that there was neither time nor necessity to devise ways of working with less suitable materials available nearer to hand.

As we move across the chronological boundary of 9500 cal BC, into a period characterised in many regional sequences as Early Mesolithic, there is little obvious break in technological terms with the preceding period, although there is greater diversity of raw materials, techniques of stone working, and tool types. The manufacture of microlithic stone tools made from bladelet segments, with removal of the bulbar end by the microburin technique or by truncation, was already widely established in the Late Glacial, and continued into this period. What is new is the proliferation of new geometric forms, particularly triangles and crescents. Many of these were most probably used to provide replacements for arrow tips, and the bow and arrow was widely in use throughout Europe during this period. Some also may have been used as replaceable components in other multipart tools such as knives with antler, bone, or wooden handles. There also was a general diversification of artefact-types made from stone, bone, antler, and wood, including macrolithic tools, many of the organic materials made visible for the first time by occupation of wetland locations with waterlogged deposits and excellent conditions of preservation. Picks, axes, or mattocks of worked antler, and axes and adzes made of flaked flint or other stone are widely in evidence. Many were presumably used for working timber in those regions where the expansion of forest made available a new or more abundant source of raw material. Others may have been used for digging the ground (Zvelebil this volume, Straus this volume) or processing sea-mammal carcasses (Bjerck this volume). Harpoons of bone or antler and bone fishhooks attest to new techniques for exploiting marine and aquatic resources. Wooden artefacts include dugout canoes, paddles, fish weirs, spear and arrow shafts, sledge-runners, skis, and timber-framed houses. Artificial dwelling structures are more widely in evidence and range from lightly built tent-like structures to substantial stone or timber-built constructions, depending on available raw materials, climatic conditions, and permanence of settlement. Early examples are Mount Sandel and Howick in northern Britain (Tolan-Smith this volume), Ulkestrup and Holmegård in Denmark (Blankholm this volume) and Vega in Norway (Bjerck this volume).

On those areas of the North European plain first occupied in the preceding Late Glacial, there was a consolidation of settlement across this extensive lowland region, with more sites, greater use of local raw materials, a wider range of game animals and a marked preference in site locations for lake-edge settings (or greater visibility of evidence in such locations), represented by the Maglemosian sites of Denmark and England (Blankholm this volume, Tolan-Smith this volume), and by similar material further east, as before characterised by a multiplicity of local culture-names – Komornice and Neman in Poland, Narva and Kunda in the Eastern Baltic, Sandarna in southern Sweden, Suomusjärvi in Finland, and Ienevian in Russia (Zvelebil this volume, Dolukhanov this volume). Riverine settings on the large river systems also attracted settlement, notably on the Danube (Jochim this volume, Bonsall this volume), the Dniestr and the Dniepr (Dolukhanov this volume), with evidence of freshwater fishing from an early date. Further north, there was renewed expansion of settlement along the Norwegian coastline and into the more northerly regions of Britain, in both cases with a marked maritime character.

In south-central and southern Europe, the microlithic and geometric character of the stone tool industries is a more prominent feature, perhaps reflecting in these regions, or at any rate in the sites that are best represented, smaller and more mobile settlements and continuing emphasis on hunting. There is, of course, some variation in primary characteristics and local culture labels,

including Beuronian in the Danube basin (Jochim this volume, Svoboda this volume), and Azilian and Sauveterrian in France, with the locally named variants, Montadian and Montclusian, in the south (Valdeyron this volume, Pluciennik this volume). In Spain and the Mediterranean more widely the picture is more variable, with microlithic industries often described as Epigravettian (Pluciennik this volume), and a macrolithic component of simply flaked stone picks around the Spanish and Portuguese littoral including the Asturian 'pic', often associated with limpet-gathering, and the Mirian cobble axes of Portugal, which may have been used for shellgathering, plant food collection or woodworking (Straus this volume). Other amorphous flake assemblages that do not fit any of the classic cultural labels also occur, for example in Franchthi Cave, where they may have been used for the preparation of fishing equipment or the processing of fish. Much of the variability in these southern European regions may relate to local variations in site function or activities.

Coastal sites remain rare in this Early Mesolithic period, with the notable exception of Norway in the north, where isostatic uplift has preserved early-dated shorelines (Bjerck this volume) and, to a lesser extent, Scotland (Tolan-Smith this volume). Other early coastal sites are the Asturian middens of Northern Spain, where marine shells are present in abundance from about 8200 cal BC, apparently representing a culmination of a trend to increased shellgathering that extends back into earlier millennia, and some early-dated open-air coastal sites with marine shells in Portugal (Straus this volume). Fish remains and marine molluscs are represented from an early date at the Franchthi Cave (Pluciennik this volume). Also dated to this period is the coastal site of Laspi 7 on the Black Sea, where however, the shell remains are predominantly of land snails (Dolukhanov this volume). Deposits of terrestrial snail shells are a characteristic feature of many other sites across Europe, particularly in the south.

From about 7000 cal BC onwards, there were further changes, which for the most part represent an elaboration of themes and trends already under way. This period saw the onset of the Climatic Optimum, which lasted for some three thousand years, with average temperatures and rainfall higher than the present, representing the full extent of deciduous forests of oak, lime, and elm, and was probably also the period in which many larger lakes reached their maximum conditions of productivity and eutrophication. This is also the period during which sea levels stabilised at about their present level, shorelines, and river estuaries adopted broadly their present configuration, and influx of terrestrial organic material and sediments began to accumulate productive mudflats for marine bivalves and nursery grounds for inshore fish. This environmental context is clearly a significant if not a sufficient factor in the development of substantial settlements on coastlines, lakes, and rivers, often with dwellings and other structures, such as Tägerup in Sweden, Sarnate on the Latvian coast, Kierikki on the Li estuary in northern Finland (Zvelebil this volume), Mirnoe I on the Black Sea and Nizhnee Veret'e I on Lake Lacha in northern Russia (Dolukhanov this volume), Lepenski Vir and Schela Cladovei in the Iron Gates region of the Danube (Bonsall this volume), and Vedbaek and Ertebølle on the Danish coastline (Blankholm this volume). Sometimes, settlements are associated with large numbers of burials, and often in the coastal context with substantial shell mounds.

Shell mounds of varying size and number are apparent in various regions, the largest and best-known grouping being the Ertebølle in Denmark, dated between about 5500 and 3800 cal BC. Over four hundred shell mounds have been recorded, the largest, as at the type-site of Ertebølle itself, several hundred metres long and several metres thick. These sites were built up slowly over many centuries of repeated use and discard of oyster shells and other refuse. The larger sites were residential bases used in all seasons of the year with a full range of artefacts including microlithic arrow barbs and flaked axes, an antler and bone industry, and pottery jars and bowls. Food remains

include sea and land mammals, fish, and fowl (Blankholm this volume). Marine resources appear to have been a major source of protein, amongst which fish rather than shellfish were the main food item, a conclusion reinforced by stable-isotope analyses of human bones recovered from coastal locations. Coastal sites without mollusc shells are just as common and probably played the same role in the settlement system, occurring on shorelines lacking local concentrations of oysters or other molluscs, with some sites representing residential bases and other sites used by specialist task groups for the extraction of particular resources.

Some of the Danish coastal settlements of this period have been submerged in shallow water because of isostatic movement, resulting in spectacular conditions of organic preservation, notably at the underwater settlement of Tybrind Vig, which produced a dugout canoe, a richly decorated wooden paddle, and large numbers of wooden stakes associated with a landing stage and a fish weir. Many other submerged sites have been discovered in Danish waters, including other examples of fish weirs, suggesting a major investment in communal facilities.

Inland sites and exploitation patterns also continued to be of importance during the Ertebølle as in the earlier Maglemosian, but their significance has been overshadowed by the more substantial evidence available on the coast, and by problems of poor preservation, stratigraphic resolution and dating of surface material in inland locations (Blankholm this volume).

Other well-studied concentrations of shell mounds are those on the small island of Oronsay in the Western Islands of Scotland, used between about 5000 and 4300 cal BC for seal hunting, fishing, and the collection of limpets – the latter perhaps for fish bait (Tolan-Smith this volume), the Breton sites (Valdeyron this volume) and the Portuguese shell mounds on the Muge and Sado tributaries of the Tagus estuary (Straus this volume). Shell mounds of comparable size are unknown in the Mediterranean region, reflecting less productive conditions for intertidal molluscs, but fishing and shellgathering are clearly in evidence, notably at the Franchthi Cave in Greece and the Uzzo Cave in Sicily, often in combination with gathering of plant foods and hunting of mammals and supporting year-round or multiseason occupations (Pluciennik this volume).

Changes less obviously or directly linked to environmental factors, but most probably linked to regional population growth, were the development or intensification of new economic niches, such as the lowland forest regions of eastern Norway and Sweden (Bjerck this volume), continued penetration of upland regions, and greater regionalisation as indicated by regional variations in stylistic or decorative features of artefacts or distribution of raw materials, notably in Denmark (Blankholm this volume) and Norway (Bjerck this volume).

Amongst the technological innovations of this period are the introduction of trapeze-shaped geometric microliths, associated in France and some other areas with the 'Tardenoisian' (Valdeyron this volume), but widely present throughout much of the wider European region from about 7000 cal BC, the use of polishing techniques for shaping axes, especially in Norway, the distribution of favoured raw materials over considerable distances from quarries such as the Hespriholmen greenstone quarry in Norway, and the production of very regular-shaped blades, also present in Norway (Bjerck this volume), which may hint at specialist craft production. Pottery also came into regular use in some areas in later Mesolithic contexts, notably in the steppe regions of Russia and the Ukraine, perhaps as early as 8300 cal BC (Dolukhanov this volume), and in the Baltic and Denmark from 5500 cal BC (Blankholm this volume, Zvelebil this volume), apparently without any accompanying evidence of introduced crops or livestock.

With regard to subsistence, plant foods have long been recognised as of considerable potential significance during the Mesolithic, but this has often proved difficult to demonstrate. Nuts, greens, roots, seeds, and fruits would undoubtedly have become more widely available with the expansion of woodlands associated with food-bearing trees, shrubs and grasses. Charred hazelnut shells are

widely recorded in many Mesolithic sites, but new excavation procedures using flotation and new techniques such as residue analysis of tool edges have produced a growing body of new information. In the Mediterranean, wild olives and pulses have been recovered from the Uzzo Cave, and dental caries on human teeth suggests greater intake of sugar from fruits. Wild lentils, oats, and barley are present at Franchthi (Pluciennik this volume). In the middle Danube, in contrast, few plants were found at the Iron Gates sites in spite of extensive flotation, and the lack of dental caries and the presence of heavy calculus on the teeth at Schela Cladovei suggest that there was little plant carbohydrate in the diet (Bonsall this volume). Residue analysis on stone tools from the Pod Zubem rockshelter in North Bohemia identified the presence of starch indicating contact with plant material, while seeds of a range of plants, nuts, and fruits were recovered at the Jezevčí rockshelter (Svoboda this volume). Pollen evidence in the Jägerhaus Cave in the Schwabian Alb suggests the collection of round-leafed sorrel (Jochim this volume). In the Pyrenees, seeds of leafy greens and fruits such as blackberry, hawthorn, and wild pear have been recovered from Balma Margineda, and acorns, walnuts, pine nuts, cherries, and plums at Cingle Vermell (Pluciennik this volume). Residue analysis at Font del Ros suggests the processing of acorns and hazelnuts, and charcoal evidence at La Poujade the use of wild cherries and almonds, while extensive flotation at Balma Abeurador in the south of France has produced thousands of carbonised seeds of lentils, peas, chickpeas, and fruits (Pluciennik this volume, Valdeyron this volume). Abora in East Latvia, dated between 3800 and 2500 cal BC has produced evidence of water chestnuts, hazelnuts, and hemp and pollen indicators of clearance (Zvelebil this volume), and studies of the carbon isotope composition and barium and strontium content of human bones from the Dniepr burial sites show an increase in plants foods in the later Mesolithic. At the site of Mirnoe I on the Black Sea, dated at about 5900 cal BC, blades with reaping polish were recovered, along with seeds of sorrel, vetch, *Chenopodium*, and *Polygonum* (Dolukhanov this volume), and reaping, grinding, and digging equipment is present in some Baltic sites (Zvelebil this volume).

Apart from the domestic dog, present early on, the question of indigenous domestication remains unclear. For sheep and goat and the main cereal crops, the case for an exotic origin remains difficult to dispute, although this leaves open the question of whether they were introduced by incoming farmers, or adopted by indigenous hunters and gatherers through exchange, theft, or possibly even by spontaneous dispersal northwards without human intervention. Many other animal species had been present in Europe since glacial times, such as reindeer, horse, cattle, and pig, and could in principle have been locally domesticated early on, in the sense of genetic isolation from the wild stock and selective breeding, without external influence. But whether this happened independently without the diffusion of domestic stock or the idea of domestication from the Near East remains obscure. Some earlier claims for local domestication have been rejected as the result of inaccurate observations or of stratigraphic intrusion of later material, notably with the pigs of Tash-Air in the Crimea (Dolukhanov this volume) and domesticates in the western Mediterranean (Pluciennik this volume). In other cases, DNA analyses may throw further light on the question of indigenous versus exotic origins and seem to reinforce the notion of independent European centres of local domestication for pig (Zvelebil this volume) and exotic origins for cattle but involving hybridisation with local aurochs (Götherstrom et al. 2005).

The question of local versus exotic origins may be poorly posed, resting on the assumption that there is a Mesolithic way of life without domestication, and a Neolithic way of life with domestication, and that the transition from one to the other can only have occurred on one occasion and in one restricted region. Such an assumption, along with its requirement to identify the specific ingredient that sharply differentiates the one normative mode of production from the other, would seem increasingly to belong to a discredited theory of social evolution. The broader

concept of husbandry may be a more useful way of thinking about the problem and of capturing the subtler gradations of variability apparent in the much richer range of evidence now available. In this respect, there are many indications in Mesolithic contexts of environmental modification for human benefit, including evidence of investment in facilities on a scale that might justifiably presuppose restrictive rights of access. These include communal fish weirs in Danish waters associated with tree pollarding (Blankholm this volume), seagoing boats on Atlantic and Mediterranean coastlines, and pollen evidence of woodland clearance in southern Sweden, southern Finland, and eastern Latvia (Zvelebil this volume), in the Alpine foreland (Jochim this volume) and in upland regions of Britain (Tolan-Smith this volume), presumably for the improvement of plant or animal productivity, or at any rate having that outcome if not that motivation (cf. Davies et al. 2005). Morphological evidence for tamed or captive animals has been claimed, notably for bear in France (Valdeyron this volume) and pigs in Scandinavia (Zvelebil this volume). In the latter case, the predominance of pig bones in large settlements, increased numbers of juvenile pigs in archaeofaunal assemblages, and the presence of pigs on offshore islands all point to some degree of human intervention, even if it fell short of biological domestication. If a contemporary observer at about 7000 cal BC had followed a transect across Europe from the Near East to northern Scandinavia, it is questionable whether they would have identified noticeable differences in modes of subsistence, other than different combinations of animals and plants suited to different environmental conditions, with the combination of pigs, nuts, and fish in the north forming an economic package as capable of supporting permanent and populous settlements as the combination of goats, cereals, and fish in the Levant.

Throughout this period, beginning earlier in the Southeast and progressively later in the west and north, we see evidence for greater or lesser adoption of crops and livestock, whether of resources introduced from outside Europe or locally domesticated, involving complex and regionally variable patterns of interaction between indigenous Mesolithic communities and incoming farmers, or the selective adoption by preexisting Mesolithic populations of innovations associated with farming. The extent to which the introduction of these new elements was brought about by the expansion of new people into Europe from the Near East remains unclear. The case for 'demic diffusion' remains strongest in parts of the Mediterranean and the Southeast corner of the Balkans, with mutually exclusive distributions of Mesolithic and Neolithic sites, and no evidence of interaction between them, at least initially, suggesting 'enclave' colonisation (Price 2000). Elsewhere different elements of the 'Neolithic package' were introduced or adopted selectively and separately, for example, pottery in the absence of domestic resources in much of the Baltic, and cereals in the absence of other indicators in parts of Britain, where, additionally, the scarcity of relevant direct evidence has resulted in a correspondingly high level of theoretical contestation (cf. Rowley-Conwy 2004). Extrapolations from historical linguistics and modern DNA distributions are notoriously unreliable guides to past patterns, especially when studies of modern and ancient DNA produce contradictory results (Zvelebil this volume), but there is at any rate considerable evidence for genetic and perhaps linguistic continuity across the Mesolithic-Neolithic boundary within many areas of Europe. At the same time, morphological evidence from large samples of human burials suggests considerable movement and migration of people long before the advent of agriculture (Dolukhanov this volume), to say nothing of the movement involved in the colonisation of newly available territory opened up by deglaciation.

Whether agricultural communities newly formed on European soil by indigenous people expanded into new territory, encroaching on the resources of their hunter-gatherer neighbours, is a different matter. In several areas of Europe, notably in the Netherlands (Verhart this volume), parts of the Baltic (Zvelebil this volume), and Greece (Pluciennik this volume), evidence of

archaeological materials and human activities decreases or disappears in the final period of the Mesolithic just before the arrival of farming communities. That may indicate the abandonment of territory by hunters and gatherers in the face of expanding farmers, the reconfiguration of settlement patterning with the adoption of new patterns of economy and settlement, or the changed visibility of archaeological evidence unrelated to actual patterns of behaviour (Jochim this volume, and later). In the Baltic, the rich evidence of symbolism and ideology suggests both considerable long-term continuity of ritual and belief systems from early in the Mesolithic right through to the historical period, but also the manipulation of symbols and ritual landscapes to create a heightened sense of identity and 'difference' between neighbouring hunter-gatherer and farmer regions (Zvelebil this volume). The continuity between an ethnographic present and a prehistoric past, and the ethnographic insights into archaeological interpretation that flow from such continuity, may of course be peculiar to these northerly regions where agriculture and domestication penetrated only late or in much attenuated form. Whether this pattern is typical of other areas of Europe, and whether the methodology used to identify it can be applied elsewhere, remains to be explored.

Most authors in this volume who address the issue of the Mesolithic-Neolithic transition argue for a degree of involvement of Mesolithic communities in the new economic and social configurations associated with agriculture, and for a range of interactions between agricultural and hunter-gatherer communities in which both types of partners may sometimes have modified their behaviour, including limited use of domesticates by hunter-gatherers, perhaps as status items, continued hunting, gathering or fishing by farmers, exchange of exotic items, patron-client relationships, ideological resistance marked by elaboration of ritual and symbol, and the development of new patterns of hunting to supply new items for exchange (Zvelebil this volume, Dolukhanov this volume, Bonsall this volume, Blankholm this volume, Verhart this volume, Jochim this volume). Whether these interactions ever took the form of violent conflict is also unclear, and a case can be made that there was just as much or greater conflict in earlier periods on the basis of the number of skeletons that indicate death by violence in earlier Mesolithic burials (Jochim this volume, Dolukhanov this volume). Whether it will continue to be useful to continue to draw a major fault-line between Mesolithic and Neolithic modes of existence, or better to regard the changes associated with the Neolithic as part of an ongoing process of social and demographic readjustment and cultural innovation extending back to the Late Glacial, remains to be seen.

New Problems

What of specific highlights and possibilities for new research? Here there is a wide range of possibilities. We have alluded to some of these earlier, particularly in the social sphere (Spikins this volume), and here we elaborate just a few that seem to us to be of particular interest.

Maritime Adaptations and Differential Site Visibility

One of the persistent themes in Mesolithic narratives – and narratives of the Postglacial more widely – is the apparent explosion of evidence for marine and aquatic resources as indicated by the increase in large settlements associated with shell mounds and lake edges. In the European case, this is especially difficult to evaluate, as the most productive coastlines and lakes occur in northerly regions – the shallow basins and associated estuaries of the North Sea and the Baltic, and the lakes created by glacial retreat on the North European plain and in Scandinavia. The difficulty here is that these regions were not available for human settlement until the Holocene and the aquatic resources

associated with them did not exist before that period. To cite their exploitation as evidence of some major shift in human attitudes to the environment is to make an unequal comparison with environmental conditions in earlier periods. Even for earlier periods and more southerly regions, the earliest use of marine resources is obscured by the lowered sea levels that persisted throughout the glacial period, and hence by the removal or submergence of relevant evidence before sea level approximated its present position about 6000 to 5000 cal BC.

This problem of differential visibility of evidence is especially acute on the shallower and broader stretches of continental shelf around the coastlines of the North Sea basin and northern and western France, but even on the steeply shelving coastlines of southern Europe the shorelines of the glacial maximum would have been at least 5 km distant, far enough away to take most marine resources out of reach of sites located on the present-day coastline. Underwater survey and excavation is beginning to reveal new evidence, and various authors have argued that late Palaeolithic hunters were hunting sea mammals and fishing and shellgathering along these now submerged coastlines from an early period (Fischer 1985, 1986, Erlandson 2001, Flemming 2004).

Quantities of marine mollusc shells appear in the coastal cave deposits of northern Spain, such as La Riera and El Juyo, from as far back as the Glacial Maximum, with evidence for increased quantities in the Late Glacial period (Straus, this volume). Cueva de la Nerja in Southeast Spain contains evidence of marine molluscs, fish, seal, and birds, associated with an early stage of the Late Glacial dating between about 15,000 and 12,000 cal BC (Morales et al. 1998). Because shorelines were still at some distance from the present coastline, this is a significant indication of interest in marine resources and most probably only the visible tip of a more extensive pattern of marine exploitation, given that the Asturian shell middens with their vastly greater number of discarded mollusc shells only began to form as shorelines approached their present position (Bailey and Craighead 2003).

A notable exception to this general picture of submergence and loss of coastal archaeology is the Norwegian coast, which has undergone substantial isostatic uplift following the removal of the Scandinavian ice sheet, so that fourteen-thousand- to thirteen-thousand-year-old shorelines formed when the eustatic level of the sea was still about 50 m below the present are now elevated above present sea level along much of the Norwegian coastline.

Despite the opportunities for preservation of early coastal sites and the fact that the Norwegian coastline was ice-free from at least as early as 13,000 cal BC, there is no convincing evidence of human occupation, apart from stray and ambiguous finds, until about 9500 cal BC, when numerous sites appear all along the Norwegian coastline in association with the Komsa and Fosna cultures characterized by large numbers of flake adzes, and tanged points of Ahrensburgian type. Preservation of organic materials is almost nonexistent, so that there are few indications of the animals exploited, but the location of the sites, some of them on offshore islands, the nature of the resources available, and the need for substantial intake of animal fats for human survival in these northerly regions, indicates that marine resources and especially sea mammals must have been a major source of subsistence, whereas the flake adzes would have been well suited for scraping blubber from seal carcasses (Bjerck this volume). Substantial weatherproof dwellings were built to provide shelter during winter as at Åsgården on the Vega Islands with foundations partially excavated into the subsoil ('pit-dwellings') and stone or turf walls (Bjerck this volume).

The absence of sites on the Norwegian coast before about 9500 cal BC may be for a variety of reasons. Successful exploitation of this coastal region would have been impossible without seaworthy boats. It is possible that the technology for boat construction was not known about earlier, resulting in a considerable time lag before it was invented, or that suitable materials were lacking in a largely tree-less environment. But hide-covered boats made on a framework of antler are conceivable

and appear to have been already in use on Late Glacial shorelines further south. Both antler and animal hides were abundantly available and the technology of working antler and preparing animal skins was well known from far back in the Upper Palaeolithic period. Alternatively, the high practical and social costs of investing in boat building and maintenance and in the construction of weatherproof dwellings, together with the harsh and extreme environmental conditions, was sufficient disincentive to delay the colonisation of this new territory. Climate change may also be a significant factor. At about 9500 cal BC, or soon after, the Scandinavian ice sheet, which had persisted in close proximity to the coastline, finally disappeared, opening up the hinterland to populations of reindeer. Reindeer-hunting sites appear in the hinterland at about the same time or soon after the earliest coastal sites, and the coastal regions with the largest concentrations of sites are those in closest proximity to an accessible hinterland (Bjerck this volume). In addition, the polar front shifted northwards to the latitude of Iceland, and in its wake the warmer waters of the Gulf Stream reached the Norwegian coastline, creating a more diverse and productive marine and coastal environment. Before this period, then, the resource options available for human survival may have been too narrow and too risky to encourage settlement, regardless of boat-building skills.

At about the same time, during the Preboreal period, the British Isles also witnessed a new phase of expansion northwards and westwards beyond the lowland regions of England, with a number of new settlements appearing around the coastlines of Scotland and in the Western Isles, dating from about 8800 cal BC (Tolan-Smith this volume). Ireland, which appears never to have had a traversable land connection to mainland Britain, also was occupied for the first time. As in Norway, the appearance of the Gulf Stream would have been a significant factor in improving resource productivity and attracting new settlement. Seaworthy boats would have been essential for navigating the Western Isles and especially for the crossing to Ireland, regarded as one of the most treacherous sea crossings in the British Isles. Sturdy dwelling structures also would have been essential in the harsher winter climates of the north. Faunal preservation on many of these sites is poor, but Mount Sandel in Northern Ireland has preserved evidence of salmon fishing and boar hunting, postholes indicating substantial dwelling structures and pits that could have been used for food storage. The coastal site of Howick on the North Sea coast of Northumberland in northern England belongs to this phase of expansion, and has yielded traces of a substantial timber-framed dwelling and evidence of sealing and boar hunting.

In the eastern Mediterranean, the occupants of the Franchthi Cave on the Argolid Peninsula of southern Greece were importing obsidian from the island of Melos eleven thousand years ago, which would have required a sea journey of 100 km by the direct route, or a series of sea crossings of at least 20 km by a more circuitous route. However, apart from a few limpet shells, evidence for the exploitation of marine resources does not appear in the Franchthi deposits until somewhat later in the sequence, most probably because the coastline was still too far away (Pluciennik this volume). The offshore islands of Cyprus, Corsica, Sardinia and Mallorca, the latter requiring a sea crossing of 165 km, were occupied or visited from an early period, but not Crete or Malta, indicating the construction of seaworthy vessels, although no consideration has so far been given to the manner of their construction. The Cyclope Cave on the island of Youra in the northern Sporades of the Aegean was occupied between 8300 and 7000 cal BC and has provided evidence of hunting of goats and pigs, and fishing and fowling (Powell 2003, Sampson et al. 2003, Trantalidou 2003). The site could have been reached by island hopping with sea crossings of no more than about 10 km, and it appears that the goats and pigs must have been imported. At any rate, it is clear that there was a wide network of maritime contacts and movements in the millennia preceding the arrival of domestic livestock and cereal crops from the Near East, a network that may well have facilitated the later dispersal of exotic resources.

The significance of these developments in maritime exploration, and in particular the significance of the apparent explosion in coastal settlements and marine exploitation, will remain difficult to assess in the absence of comparable evidence from earlier periods of lower sea level. And this problem will persist until systematic exploration of submerged landscapes and palaeoshorelines is undertaken using the wide range of techniques now available, including sonar surveys, subbottom profiling, coring, remotely operated cameras, and deep diving (Flemming 2004).

It might be thought that inland rivers would provide a more geologically stable environment in which to judge changes in human use of aquatic resources, but here too erosion of earlier evidence or submergence beneath subsequent layers of alluvial sediment introduce comparable distortions in the visibility or preservation of evidence (Bonsall this volume). Moreover, this issue of differential visibility or differential preservation is a more general problem, which has tended to exaggerate the significance of coastal evidence at the expense of the hinterland in a number of regions (Blankholm this volume, Verhart this volume, Straus this volume, Pluciennik this volume). Indeed, the apparent absence of evidence in many hinterlands was one factor that once gave rise to a view of Mesolithic depopulation and impoverishment, reinforcing the notion of a population driven back by the encroachment of thick or unproductive forest. In fact, the inland sites have always been there in some regions but have been difficult to identify as such because of lack of chronologically diagnostic artefacts on surface sites that cannot be dated by other means (Blankholm this volume, Verhart this volume, Jochim this volume). In other cases, as in northern Spain (Straus this volume) or Greece (Pluciennik this volume), the apparent lack of hinterland evidence reflects lack of intensive survey, or geological factors of erosion and sedimentation that have obscured or removed evidence. In both regions, there is now sufficient and well-dated evidence in inland cave and rockshelter sequences to suggest a human presence in the hinterland and the likelihood that further evidence will in due course be forthcoming.

Stable isotope analyses of human bone collagen, with their capacity to discriminate between foods from marine, terrestrial and freshwater ecosystems and from different trophic levels, will continue to make an important contribution to debates about subsistence variation. However, the results will need to take account of vagaries in the availability of human bone, questions about the degree to which particular human individuals are representative of wider populations, and unresolved discrepancies between isotope analyses and other sources of palaeodietary information (Milner et al. 2004, 2006, Hedges 2004, Liden et al. 2004, Richards and Schulting 2006).

Art, Burials, and Symbolism

Rock art was once commonly regarded as absent in the Mesolithic period, an absence taken as evidence of cultural impoverishment compared with the Upper Palaeolithic. However, rock art is notoriously difficult to date with any precision, and the prominence of Upper Palaeolithic rock art in France and northern Spain and the ability to assign it to that period owes much to the fact that it includes representations of animals of the glacial period that are now extinct, or no longer present in that region. In fact, rock art is probably a prominent feature of the Mesolithic period, but concentrated in new centres of population growth or population aggregation, reflecting the major changes in social and ritual geography that followed climate change and the opening up of new territory and the creation of new resources. Portable art is also common, including engraved bone and antler, painted pebbles, and anthropomorphic and animal figures. Some of the portable art is on wooden materials that by their very nature are only found in exceptional conditions

of preservation, and these may represent only the visible fragment of a much more widespread medium of symbolic representation.

In Norway, the succession of raised beaches created by rapid isostatic uplift provides a basis for dating by association and demonstrates that rock art was present in northern Norway by at least as early as 8300 cal BC, with naturalistic representations of elk, reindeer, bear, whale, and seal (Bjerck this volume). Many hundreds of sites have been recorded more widely in Norway and Sweden with images of anthropomorphs, deer, boats, sea mammals, bear, water birds, fish, reptiles, tracks, hunting and fishing implements, and abstract designs (Bjerck this volume, Zvelebil this volume). One of the largest such concentrations is the site of Nämforsen (4400–1800 cal BC) in Swedish Norland, which was a major focus of ritual and seasonal aggregation for settlements in the surrounding region. In southern Europe, there is the Levantine rock art of eastern Spain, with schematic and naturalistic representations including hunting scenes and humans, and the Addaura Cave in Sicily (Pluciennik this volume). Of course, many of these representations cannot be dated with any certainty and the Levantine art could have been produced in any period from the Upper Palaeolithic to the Iron Age (Pluciennik this volume) and perhaps in all periods of this broad time range. Whether the techniques of directly dating rock art that have been pioneered in Australia and South Africa (Mazel and Watchman 2003, Cole and Watchman 2005) can be applied in Europe remains to be seen. But there is no doubt that properly dated rock art sequences would add immeasurably to the interpretation of the wider cultural context and symbolic associations of Mesolithic life.

Burials are common, either in intimate association with domestic dwellings or as separately demarcated 'cemetery' areas, and comprise a wide range of evidence and types of burials including males, females and children, corpses in flexed, supine or prone positions, cremation, and evidence of ritual defleshing or cannibalism, notably the evidence of decapitation, defleshing, and separate burial of heads at the Grosse Ofnet cave in Bavaria and other caves in the region (Jochim this volume). The scatter of isolated bones in many other sites may indicate excarnation or removal of the corpse after a temporary period of lying in one place. Cemeteries, or at any rate locations used repeatedly for burial, are present early in the sequence, as at the cave of Aveline's Hole in the Cheddar Gorge of southwest England, dated at approximately 8300 cal BC, with more than seventy human burials (Tolan-Smith this volume) or the cemetery of Vasilyevka on the Dniepr at 9500 cal BC (Dolukhanov this volume), and later as at Zvejnieki in Latvia, where 315 burials have been excavated indicating repeated use between 7200 and 2800 cal BC (Zvelebil this volume), or Lepenski Vir (Bonsall this volume). Olenii Ostrov on an island in Lake Onega in Karelia, dated at about 6400 cal BC, had over three hundred burials, and the grave goods and the position of the skeletons indicate a variety of burial rites and evidence of social ranking based on age, gender, personal wealth, clan membership, and the presence of shamans (Zvelebil this volume). The Portuguese shell mounds of the Muge River are also estimated to have contained at least three hundred burials (Straus this volume), and it is tempting to suppose that the mounds themselves may have been the result of ritual feasting on molluscs and accumulation of the shells over the corpse as part of the burial rite in the manner suggested for some of the North American shell mounds (Luby and Gruber 1999), with the mounds themselves becoming visible symbols in the landscape of the burial place. In Denmark, human remains are rare in the Ertebølle shell mounds and burials are found at coastal sites lacking shell middens, notably the eighteen burials at Vedbaek in eastern Zealand and the Skateholm sites in southern Sweden, with a total of eighty-five burials including evidence of a wooden mortuary structure (Blankholm this volume).

Amongst the great variety of funerary rituals now in evidence in Mesolithic contexts, social differentiation in grave goods remains largely limited to differences of age, gender, and personal

achievement. Clear evidence of institutionalised differences in social rank that persisted independently of kin relations remains elusive, so, too, evidence of organised warfare, both commonly regarded as hallmarks of socially complex societies (Yoffee 1985, Fitzhugh 2003). Evidence of violent death is commonly reported in Mesolithic burial remains, but it is not clear that this marks a general trend over time rather than a situational response to local and regional circumstances, suggesting conflict associated with increased competition or territoriality. Nor is it clear that the Mesolithic evidence marks a significant break with earlier periods. Evidence of status differentiation in burial goods can be found in the Upper Palaeolithic, notably in the case of the adult and child burials at Upper Palaeolithic Sungir (Dolukhanov this volume), while cemeteries with evidence of violent death, are present early on in the Nile Valley (Close 1996). It is difficult to discern any general pattern in the evidence or trends through time, but the totality of the burial evidence available across Mesolithic Europe represents a rich and varied corpus of information that would repay further comparative investigation.

Technological Innovation and the Adoption of Pottery

Given the rapidity with which people were capable of moving into new territory – 2000 km within a few generations along the Norwegian coastline (Bjerck) – and the evidence for the widespread movement of exotic materials through exchange or trade networks over hundreds of kilometres or more in the Mesolithic – Mediterranean shells in central Europe, for example, or the exchange of flint, obsidian, greenstone, and amber over equivalent distances (Pluciennik this volume, Jochim this volume, Zvelebil this volume) – it seems unlikely that knowledge of an advantageous innovation invented in one location in Europe would not have spread rapidly to the far corners of the continent on an archaeological time scale measured in hundreds of years. From this point of view, the question arises as to why some innovations were adopted swiftly and widely and others more patchily and slowly. The microlithic trapeze, for example, appears across a very wide territory at about 7000 cal BC. Pottery, by contrast, makes a patchy appearance at different dates in different areas. Such differences can hardly be explained as a matter of differential knowledge or skill, or of cultural conservatism. The interesting studies of ideology and exchange of materials made possible by the detailed evidence available in Scandinavia and the Baltic (Blankholm this volume, Zvelebil this volume), suggest that novel items may have been much sought after because of their rarity, offering high prestige value and serving as a powerful weapon in the struggle between individual agency and social convention (cf. Spikins this volume).

Pottery is of particular interest against the background of an apparently early and widespread use in China and the Far East as early as 13,500 cal BC, many millennia before its adoption in western Asia or Europe. In that light, it may be significant that the earliest use of pottery in Europe seems to occur at the far eastern margin, in the steppe zone between the Volga and Ural rivers, between 8300 and 7000 cal BC, in the Yelshanian culture in association with hunting of aurochs, horse, deer, fishing, and collection of freshwater molluscs (Dolukhanov this volume). Pottery has usually been treated as an indicator of Neolithic acculturation or a proxy measure of a Neolithic economy without further comment. The terminological confusion created by this approach is indicated by the description of essentially the same phenomenon as Mesolithic in relation to the Danish Ertebølle, Combed-Ware Neolithic in Finland, and Forest Neolithic in the Baltic (Zvelebil this volume), and by the label of 'aceramic' or 'prepottery' Neolithic in the Aegean and the Near East. The widespread appearance of pottery in southern Scandinavia and the Baltic at about 5500 cal BC in hunter-gatherer-fisher contexts, its apparent absence in the earliest farming settlements in the

Aegean and the Near East, and the appearance of 'hybrid' Mesolithic cultures with pottery that may have been inspired by contact with neighbouring Linearbandkeramik (LBK) farmers, as with La Hoguette in France and Germany and Hardinxveld-Giessendam in the Netherlands (Verhart this volume, Valdeyron this volume, Jochim this volume), suggests a complex picture of variability that raises questions about why ceramic containers were attractive in some contexts but not others.

Pottery can be used for a variety of purposes, for storage of food or liquids, for cooking, for lighting (as in the case of the ceramic bowls used as blubber lamps in the Ertebølle), and in more elaborately shaped and decorated forms for display and the enhancement of individual or group identity (cf. Pearson 2005). The use of pottery for any of these purposes presumably also depended on the availability or easy accessibility of suitable raw materials such as clay and temper, and the suitability of alternatives made from stone, wood, or skin. The V-based pots of the Ertebølle suggest stationary facilities for storage, or perhaps cooking vessels designed to sit in some sort of framework over a fire. Some of the large pottery vessels in the Baltic were evidently used for storage of seal grease (Zvelebil this volume). A new generation of biomolecular techniques involving analysis of lipid and protein residues and isotope and trace element analysis of food crusts is beginning to identify the contents of pots, including milk, plant foods, and marine products (Craig and Collins 2000, Copley et al. 2005, Craig et al. 2005). One wonders, for example, whether the early-dated Yelshanian pots, supposedly associated with 'wild' horse, might have been used for horse milk. At any rate, a new generation of techniques and ideas is opening up the possibility of a comparative contextual and functional analysis of Mesolithic pottery that should be able to move beyond a purely culture-historical approach, and the same may well be applicable to other innovations in material culture.

Conclusion

A major driving force in the developments of the Mesolithic period was the changing environmental conditions associated with the melting of the ice sheets and climatic amelioration, which created new territories for human settlement, new supplies of food and raw materials for subsistence, a rapidly changing mosaic of new faunal and floral communities, new technological demands for tools, shelter, and transport, and new opportunities for population growth, resulting in major reconfigurations of social geography and social interaction. These changes were not merely responses to environmental forces but the exploitation of new opportunities made possible by diverse, large-scale, and all-pervasive environmental change. The growth of archaeological knowledge now makes it possible to view these 'Mesolithic' millennia as representing a period of radical change and innovation, which witnessed the emergence and synthesis of the technological, economic and social capabilities on which the later developments of agriculture, urban civilization, and long-distance trade were founded.

There will undoubtedly be different problems that appear significant to others, and new directions in which future research will develop. Some of these are indicated in the other contributions to this volume, and we have alluded to others in the social sphere in our introductory chapter (Spikins this volume). Continued survey and discovery of new sites, the more widespread application of dating methods to produce more, and more accurate dates, and new techniques of analysis and new questions that we can hardly anticipate or imagine are all likely to produce surprises in the future. What does seem clear is that the detail and range of information now available for the Mesolithic offers the prospect both of opening out to large-scale comparative studies across the whole extent

of European territory, and indeed beyond, and of focusing down to smaller-scale questions about local areas, particular sites and individual lives (cf. Warren 2005b).

In this sense, the period does retain a transitional quality, but not so much a transition associated with the demise of one dominant mode of existence and its replacement by another, but rather a transition from a world that is largely alien to us, to one that is increasingly familiar, and a transition in scale of observation from the vast perspectives of the Palaeolithic era dominated by major environmental and biological changes to the smaller-scale rhythms of everyday life and ritual that come more sharply into focus in the Mesolithic and later periods. At any rate, it should no longer be necessary to fight for the coexistence of a Mesolithic perspective alongside those from other periods and regions, or to justify the existence of Mesolithic studies as a coherent field of study in its own right. It is, moreover, one that is now full of new and varied opportunities for research.