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Coastal hunter-gatherers and social evolution: marginal or central?

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Abstract

General accounts of global trends in world prehistory are dominated by narratives of conquest on land: scavenging and hunting of land mammals, migration over land bridges and colonisation of new continents, gathering of plants, domestication, cultivation, and ultimately sustained population growth founded on agricultural surplus. Marine and aquatic resources fit uneasily into this sequence of social and economic development, and societies strongly dependent on them have often been regarded as relatively late in the sequence, geographically marginal or anomalous. We consider the biases and preconceptions of the ethnographic and archaeological records that have contributed to this view of marginality and examine some current issues focusing on the role of marine resources at the Mesolithic-Neolithic transition of northwest Europe. We suggest that pre-existing conventions should be critically re-examined, that coastlines may have played a more significant, widespread and persistent role as zones of attraction for human dispersal, population growth and social interaction than is commonly recognised, and that this has been obscured by hunter-gatherer and farmer stereotypes of prehistoric economies.

1 Introduction

Coastal hunter-gatherers have proved persistently problematic for general schemes of classification or understanding, whether archaeological or ethnological (cf Palsson 1988). The addition of 'fisher' to 'hunter' and 'gatherer' in every possible permutation — fisher-gatherer-hunter, hunter-fisher-gatherer, and so on — underlines the uncertainties over the role of marine and aquatic resources, or at any rate the apparent variability in their use. The fact that marine resources include shellfish and other intertidal organisms that are 'gathered' and fish and sea mammals that are 'hunted', and that

these resources have also been incorporated into agricultural and indeed industrial economies, further blurs the classificatory boundaries. These features reinforce the impression that coastal subsistence economies with a marine component are so variable that they defy generalisation on a global scale in a way that terms like hunting, farming and pastoralism apparently do not.

In this paper we have two aims. First we attempt to capture some of this variability of coastal hunters and gatherers at a global scale, to identify what makes them elusive to generalisation, and what factors in turn have contributed to their apparent under-representation in global prehistories. We

argue that coastlines have been a primary focus for human settlement, population growth and dispersal from the earliest periods of prehistory, dynamic zones of cultural interaction and social change, and that they should be viewed not as marginal zones or barriers but as gateways to human movement, contact and cultural innovation. We should note in passing, though we do not have space to elaborate here, that the attractions of coastlines often lie as much in the improved conditions for resources on land — more equable climates, higher water tables, accumulations of sediment — as much as the marine resources at the coast edge. We discuss the vulnerability of both archaeological and ethnographic accounts to systematic biases, albeit of different sorts. We explore some of the reasons why the role of coastlines has been persistently discounted for many areas and periods of prehistory and summarise the obstacles to a fuller understanding of coastal prehistory under three headings:

- biases of the ethnographic record
- biases of the archaeological record, especially the effects of sea-level change
- preconceptions about the prehistoric ladder of economic and technological progress.

Our second aim is to examine more closely the role of marine resources in the Mesolithic-Neolithic transition of northwest Europe, with particular reference to the burgeoning new data from stable-isotope reconstructions of palaeodiet. Here we examine the contradictions between the newer laboratory analyses and the more conventional bioarchaeological sources of data as an emerging focus of debate and stimulus to new investigations, with a particular focus on the Danish evidence.

2 Varieties of coastal societies

Use of marine resources by coastal hunters and gatherers covers a wide spectrum of possibilities from almost total dominance of marine resources at one extreme to almost total dominance of terrestrial foods at the other. Shell middens, that

ubiquitous and most durable archaeological indicator of coastal settlement, range in size from surface scatters or rockshelter deposits with barely a handful of shells to huge mounds. They are associated with almost every conceivable settlement type, from fleetingly occupied locations used perhaps only for a single meal of molluscs, or as specialised shell dumps, to large permanent settlements, and with economies across the whole spectrum from specialised to generalised and from simple foraging to agriculture (Claassen 1998). Perhaps the most distinctive category that has facilitated some degree of generalisation and differentiation is the concept of 'complex hunters and gatherers'. This has been applied to those hunter-gatherer societies where abundance of marine resources supported large sedentary populations, investment in storage, and social hierarchies, with features of social and economic organisation and population densities comparable to early farming societies (Ames & Maschner 1999; Renouf 1988; Rowley-Conwy 1983).

Not all examples of such complexity are found on coastlines rich in marine resources, see, for example, the Natufians of the Levant, and perhaps the late Upper Palaeolithic mammoth hunters of the Ukraine. Nevertheless, the classic examples are on the higher-latitude coastlines of northwest Europe and North America, where highly productive marine environments are associated with relatively limited resources on land. Some of these marine-based hunter-gatherer societies appear to have had emergent trajectories of social and political development that might have reached greater levels of complexity and population growth had they not been disrupted or transformed by contact with more powerful intruders — Europeans in the case of North America and Neolithic farmers in the case of northern Europe. On some mid- and low-latitude coastlines, comparable conditions of high marine productivity have been cited as the stimulus to growth of state societies, notably in Peru (Moseley 1975) and the Arabian Peninsula (Tosi 1986), but the arguments are controversial (cf Macchiarelli 1989; Raymond 1981; Wilson 1981). In both regions heavy reliance on marine resources could arguably

have been forced on coastal communities living on the edge of arid hinterlands. In Peru crop cultivation was probably at least as important a factor in fuelling social developments as the abundance of sea fish.

The geographical extent and time-depth of these complex coastal hunter-gatherers is thus uncertain. Not all coastal hunter-gatherers that depended on marine resources automatically qualify as 'complex' societies, such as those recorded ethnographically in Tierra del Fuego or Tasmania. Some complex examples seem to have been more short-lived than others. For example, the classic archaeological example of northern Europe, the Ertebølle culture of southern Scandinavia, had a time depth of no more than about a millennium before it was transformed by Neolithic traits including crops and domestic animals. More northerly examples, where farming was slower to penetrate and less productive, persisted much later. Few coastal settlements are known before about 6000 radiocarbon years ago¹ anywhere in the world, and those early examples that can be associated with marine foods, mostly from the earliest part of the Holocene and very rarely from the late Pleistocene, are not certainly accompanied by archaeological indicators of complexity.

In the long perspective of prehistory on the world scale, it appears that coastal hunter-gatherers, especially those with a heavy dependence on marine foods, were for the most part geographically marginal or relatively late phenomena. There are, to be sure, differences of opinion, reinforced by geographical biases. In Europe and the countries bordering the Mediterranean, where the long time ranges of the Pleistocene record loom large, and the Mediterranean basin itself provides some of the least productive inshore waters in the world, marine resources tend to be viewed as marginal (Gamble 1986). In the Americas, productive coastal waters are far more widespread, and the view that they would have been a natural focus for human settlement is more widely held (see Fagan 1998:171, who also cites Gamble 1986). On all coastlines, however, evidence of intensive marine exploitation before the Holocene is absolutely rare. The prevailing impression is that prehistoric

populations resorted to aquatic resources, and especially marine ones, only when compelled to do so by scarcity or decline of resources on land or human population growth. Indeed an earlier generation of interpretations marshalled some impressive theoretical arguments invoking social, environmental and demographic variables to explain this relatively late appearance of intensive marine-based coastal settlement (Binford 1968; Cohen 1977; Osborn 1977; Yesner 1987). As we argue below, this impression may be quite misleading.

3 Ethnographic biases

Ethnographic accounts are subject to the intrinsic fact that coastlines are attractive to all societies of whatever social or economic level, and are often zones of intensive settlement, interaction and change. Coastal hunter-gatherer societies are therefore always likely to have been in the front line of contact with Europeans or indeed expanding pre-European peoples and cultures, and hence the first to be disrupted, displaced or transformed by such contact. It is thus questionable as to whether there is such a category as a typical or pristine coastal hunter-gatherer society, and if so whether it has ever been observed as such in the ethnographic and historical records of the last 300 years. This problem is compounded by the preconceptions that influenced the interpretations of early European travellers and observers and by the tendency of archaeologists to select ethnographic analogies that fit the preferences of the day.

Nineteenth century accounts were strongly influenced by Charles Darwin's dramatic descriptions of Tierra del Fuego (Darwin 1839). Everything about the surviving Indian tribes of this coastline, confined, so it seemed to Darwin, to the stones on the beach and forced to wander from spot to spot in search of food, struck him as 'wretched' and scarcely human. His judgement is well summed up in the memorable aphorism that 'To knock a limpet from the rocks does not require even cunning, that lowest power of the mind' (Darwin 1839:235–6). Even the Northwest Coast Indians of

north America were consigned by nineteenth century ethnologists to the lowest level of savagery (Morgan 1877). These notions were imported into European prehistory by Sir John Lubbock, who compared the Mesolithic inhabitants of the Danish kitchen middens with the Indians of Tierra del Fuego (Lubbock 1865). The idea that the European Mesolithic was the last gasp of an enfeebled hunter-gatherer stage of development, with communities driven to huddle on lake shores and river banks or on coastlines with a 'low level of culture' persisted in the mid-twentieth century writings of Grahame Clark, Mortimer Wheeler and others (Clark 1952; Evans 1969; Wheeler 1954).

More recently, a re-interpretation of the Northwest Coast Indians of North America has supplanted Tierra del Fuego as the ethnographic role model for archaeological interpretation. The prehistoric midden dwellers of Scandinavia have been rehabilitated as complex hunters and gatherers, practising a wide-ranging subsistence on sea and land, with food storage, sedentary settlements, high population densities and burial of their dead in cemeteries (Renouf 1988; Rowley-Conwy 1983).

Geographical bias plays a role here. Many of the world's coastlines that have the most productive environmental conditions for heavy dependence on marine and intertidal resources, such as shallow continental shelves and upwelling currents, are at high latitudes or in other parts of the world that were only colonised by prehistoric human populations relatively recently (Perlman 1980). The high latitude coastlines of North America and northern Europe and Asia, the eastern seaboard of North America, southern South America, and New Guinea and Australia all have some of the richest marine conditions for fisheries, sea mammals and shellfish in the world. Indeed the relative richness of marine resources at high latitudes, combined with relatively unproductive conditions on land, probably played a key role in opening up these inhospitable territories to human colonisation. Yet most of these areas not only have relatively recent prehistories of human colonisation compared with the main centres of Old World prehistory, but many

also did not witness the introduction of agriculture and urbanisation until the expansion of Europeans in the modern era. Thus many areas of the world with some of the richest ethnographic (and archaeological) evidence of marine-based hunter-gatherer coastal societies seem to have remained essentially peripheral to the main currents of world prehistory and cultural evolution until a very recent period, at least as viewed from the main centres of agricultural and urban development. It is hard to resist the notion that hunter-gatherer coastal societies were not only marginal in the literal sense that they occupied the margins of the continental landmasses, but marginal in terms of global geography and cultural development.

4 Archaeological biases

The archaeological record is afflicted by major issues of differential preservation, site taphonomy and visibility, especially in relation to coastal geomorphology and sea-level change. These tend to further emphasise the relative lateness and geographical marginality of coast-oriented pre-agricultural societies.

The extreme rarity of coastal evidence before the closing stages of the late glacial, and the explosion of prehistoric coastal sites and shell middens after 6000 BP, has been a powerful influence on archaeological thinking, and has often been accepted as an historical fact in need of explanation. However, the rarity of evidence before the modern period of high sea levels that began about 6000 BP is almost certainly a function, at least in part, of destruction or inundation of earlier evidence by subsequent sea level rise. From a palaeogeographical perspective, it seems more plausible to suggest that the surviving coastal record is simply the most recent temporal fragment of a much longer history.

It is now widely accepted that at the maximum of the last glacial about 18,000 BP, sea level was about 120 m below the present, and that the late glacial sea-level rise associated with melting of the continental ice sheets reached the modern level about 5000 to 6000 BP (Chappell & Shackleton

1986; Lambeck & Chappell 2001; Van Andel 1989). It follows that most shorelines dating from before 6000 BP are by definition now submerged and some distance out from the present shoreline. Early Holocene and indeed late Pleistocene shell middens are occasionally preserved as a consequence of elevated site locations adjacent to steep shorelines, especially on rocky coastlines with coastal caves and rockshelters. But the quantity of marine food remains tails off as one moves back in time from the uppermost levels into the earlier Holocene and Pleistocene, most probably as a function of increased distance to the contemporaneous shoreline at lowered sea level, rather than because of real reductions in the consumption of marine foods (Bailey & Craighead in press). Even on coastlines with steeply shelving submarine topography and a narrow continental shelf, last glacial shorelines at the maximum regression would have been 5 to 10 km distant from the present ones, taking the optimum location for shell middens and intensive exploitation of marine resources well out beyond the present shoreline. One has to go back to about 125,000 BP to reach the previous period of high sea level equivalent to the present day. Indeed lowered sea levels have been the norm throughout human prehistory, and periods of high sea level like the present one are relatively infrequent and short lived episodes on the Quaternary time scale. It follows that most of the locations that might provide evidence of prehistoric maritime cultural activity and intensive marine-based palaeoeconomies, especially for the lowest sea levels, are now lost to view, and that any surviving evidence lies submerged on the seabed.

Several lines of evidence reinforce that view. On many coastlines the earliest evidence of coastal sites with substantial evidence of marine resources coincides with the period at which sea-level rise approximated the modern level. Significantly earlier coastal sites or shell deposits are now coming to light on coastlines that have undergone tectonic or isostatic uplift, notably in Norway (Rowley-Conwy 2001) and the Red Sea basin (Walters et al 2000). Deep coastal cave sequences in South Africa have

produced evidence of substantial shellgathering associated with much earlier periods of high sea level (Deacon & Shuurman 1992; Henshilwood et al 2001).

Isostatic rebound can have more subtle effects at the regional scale. For example, the clustering of Mesolithic shell mounds in southern Scandinavia and Scotland reflects, at least in part, the fact that these coastlines have undergone isostatic rebound, bringing shorelines of about 6000 BP above the present level, whereas the shorelines of comparable date further south are now submerged. This is most obvious in Denmark where all the Ertebølle shell mounds are in the northern part of the country and Ertebølle coastal sites on the southern shorelines of similar date are now submerged (Andersen 1985).

It is clear that submarine evidence can be preserved and examined in a systematic manner, both from research in Denmark and elsewhere, and underwater coastal sites at least from the early Holocene are now being discovered and explored in various parts of the world (Fischer 1995). Substantial shell mounds comparable to those of mid-Holocene and later date have yet to be found in these earlier contexts. But it is now increasingly accepted that the utilisation of intertidal, marine and aquatic resources was not confined to the late Holocene, but may have been a widespread characteristic of much more ancient human palaeoeconomies (Erlandson 2001; Mannino & Thomas 2002). Flemming (Werz & Flemming 2001) has recently noted that some 300 submarine archaeological sites are now known off the coasts of Europe, north America, Australia and Japan, with dates ranging from 5000 to >45000 BP, and at depths of up to 145 m and offshore distances of up to 50 km. It is time that more serious attention was devoted to the investigation of this underwater world (Bailey in press).

Another factor that distorts the archaeological record is the over-emphasis on shellgathering that results from the accumulation of shell mounds by many coastal peoples. Shell mounds of impressive size have often dominated discussions of coastal archaeology and do indeed appear in very large

numbers in many parts of the world from 6000 BP onwards but are almost unknown before that². However, their occurrence depends on at least two factors that can vary quite independently of economic reliance on marine resources. The first is the availability of productive shell beds associated with estuarine mudflats or other extensive intertidal zones that provide sufficient quantities of material to generate substantial deposits as by-products of subsistence activity over hundreds of years. Such conditions are by no means uniformly distributed. Many coastlines offer much more limited quantities of molluscan food. In some cases difficulties of access to the shoreline result in the consumption and dumping of shells in dispersed locations rather than as concentrated deposits. Shallow coastlines with river estuaries and lagoons that offer the most productive conditions for extensive shell beds are also geomorphologically unstable. There are often considerable time lags after the stabilisation of sea level before sufficient sediment accumulates to create suitable ecological conditions for intertidal molluscs, and continued sediment accumulation may eventually remove them (Chappell & Grindrod 1984; O'Connor 1999).

Where accurate quantification has been undertaken, it is clear that the amount of shellfood represented even by the largest shell mounds is actually quite modest in relation to supplies of other marine and terrestrial resources. In some cases fishing clearly provided far more in the way of protein and calories than shellgathering to say nothing of terrestrial hunting and gathering (Bailey 1975). Coastal sites lacking shell deposits but with evidence of marine exploitation are regularly reported in the archaeological literature. In Denmark, there are at least 400 known shell middens on the isostatically uplifted shorelines in the north of the country, and probably more that have been submerged in the south, but there are apparently even more coastal sites without shells (Andersen 1993, 2000). However, the sites lacking shells tend to attract less interest because of poorer preservation of organic materials and food remains.

The second factor is the influence of social rules

and rituals regarding waste disposal. The reasons for repeated use of specific locations for shell dumping may vary. In some cases, mound growth may have been simply the long-term effect of repeated use of a preferred location. The dramatic steep-sided mounds of the tropics such as those of northern Australia and southern Brazil are associated with seasonally waterlogged landscapes, and the initial tendency to upward growth appears to be related to the limited availability and extent of dry surfaces on which to camp. This explanation works well for the shell mounds of northern Australia, but not in all cases, and Robins et al (1995, cited in Bailey 1999), have argued for cultural rules of waste disposal as an additional factor in mound growth.

In addition, some of the world's most impressive shell mounds are associated with human burials, notably the mounds of California (Nelson 1909), the sambaquis of Brazil (Gaspar 2000), and many of the mounds of Mesolithic Europe, notably in Portugal (Roche 1960), Brittany (Péquart et al 1937) and probably some, at least, of the Danish sites (Brinch Petersen 2001; Kristian Pedersen, pers comm). Luby & Gruber (1999) have suggested that ritual feasting associated with burial rites may have contributed to the concentrated accumulation of shells. Whatever the initial spur to mound formation or the specific function of particular sites, it seems likely that many of these mounds, at least in their later stages of growth, acquired symbolic significance as prominent features of the landscape.

It follows that the distribution of shell mounds is probably a poor predictor of the distribution of coastal populations or marine-oriented palaeoeconomies. The assumption that the distribution and size of shell mounds can be used as a convenient archaeological proxy to track variations in dependence on marine resources, let alone variations in coastal population density, cannot be sustained. Absence of shell mounds does not equate with absence of marine-oriented subsistence, even less with the absence of coastal populations.

5 Archaeological preconceptions

Notwithstanding the biases noted above, many archaeologists continue to maintain a persistent scepticism about the importance of marine resources and submerged coastlines in the period before the establishment of the modern sea level, and prefer accounts of world prehistory that emphasise developments on dry land. In part this reflects the fact that evidence that could have existed but has not yet been discovered (underwater, for example) is no substitute for positive evidence in hand. In part it may be no more than a landlubber's preference for the conventional land-based narratives. More fundamentally it appears to reflect a deep-seated reluctance to abandon the hunter-gatherer/farmer classification of prehistoric societies and the ladder of economic progress that it implies. In the marine sphere, a comparable technological ladder of progress can be erected to justify the relatively late appearance of intensive marine subsistence. Both concepts reflect a residual belief in 'primitivism', the idea that earlier prehistoric populations were unable to advance further or faster because they were incapable of developing the necessary skills, or lacked the motivation to do so.

Technological devices such as boats, fishhooks and harpoons clearly play an important role in extending the range and reliability of fishing and sea mammal hunting, and facilitating transportation, social contacts and exchange of resources across water barriers. Yet none of these items is unequivocally represented by material remains in the archaeological record until the Holocene, and often quite late within that period. Their absence from the earlier record thus encourages the belief that our Pleistocene ancestors lacked the knowledge, skill or technology to exploit marine resources or make sea crossings. Much of that absence may of course reflect the fact that the locations most likely to preserve relevant technological evidence are themselves now lost beneath the sea.

However, many simple technological aids could have been used without leaving unambiguous evidence of their function. Hand-held nets and spears, and bone gorges used on the end of a line,

could have been used for inshore fishing, aided in suitable circumstances by simple brushwood dams or stone enclosures for trapping fish in shallow water. All of these features are within reach of the simplest stone technology. Many marine resources would appear to pose no technological constraints on exploitation at all — most intertidal molluscs, fish trapped by tidal movements in natural rock pools and seasonally flooded rivers, and naturally stranded sea birds and sea mammals.

The antiquity of individual items, particularly those made from perishable or rarely preserved materials such as nets and boats can only be guessed at, although the use of boats can be inferred indirectly from evidence of sea crossings. Archaeological evidence for the colonisation of Australia now demonstrates that planned sea journeys over distances of at least 60 km were taking place as much as 50,000 years ago, and has effectively undermined the preconception that seaworthy craft and navigational skills were restricted to the Postglacial period (Lourandos 1997). The belief that maritime cultural activities were necessarily absent from the Pleistocene is, thus, open to challenge.

6 The Mesolithic/Neolithic transition

The conventional reading of the transition on the coastlines of northwest Europe exemplifies many of the issues discussed in more general terms above. The role of the rich coastal and marine biotopes of Atlantic Europe in sustaining relatively dense Mesolithic populations and thereby facilitating, delaying, or otherwise moderating the introduction of prehistoric farming into Atlantic Europe has been the focus of a long-standing and unresolved debate. Marine resources are strongly implicated because they are a major feature of late Mesolithic coastal economies, but appear to be much less prominent in the early Neolithic period (Arias 1999). Explanations for the transition variously cite population pressure induced by population growth or resource decline, migration and social competition, climatic changes favouring agricultural expansion, or social and cultural

transformations in attitudes to the environment (eg, Bailey 1982; Price 2000; Rowley-Conwy 1983; Thomas 1996; Zvelebil 1986). However, there is little consensus, not least because there is no agreement about the degree of population continuity or replacement associated with the beginning of the Neolithic, nor about how rapid or how gradual were the changes in subsistence economy across the Mesolithic-Neolithic boundary.

Mesolithic shell mounds appear in large numbers after about 6000 BP and in apparently quite restricted geographical locations (mainly Denmark, Brittany, Portugal, Ireland and Scotland). Some, notably the Danish mounds, have been associated with conditions of resource abundance, sedentism and social complexity comparable to those of ethnographically known examples such as the Northwest Coast Indians. Most seem to have fallen out of use in the Neolithic period, after about 5000 BP. From this it has been inferred that the Mesolithic sequence culminated in an 'explosion' of specialised coastal economies strongly dependent on marine resources, which persisted for perhaps a thousand years, only to be transformed into or displaced by agricultural societies with much less emphasis on the marine sector.

If this reading is correct, it raises far more questions than it answers. If coastal resources are so attractive in terms of abundance, diversity and capacity to support large and stable human populations, why is the European archaeological evidence of their use apparently so limited in time and space? Why is it so rare in the earlier part of the Mesolithic sequence, so geographically restricted within the later Mesolithic, and so rare again in the Neolithic? Such an episodic pattern seems to admit of only three possible explanations:

1 the bioarchaeological evidence of site locations and food remains is too patchy to be relied on because of differential visibility and preservation

2 the distribution of marine resources is far more variable in space and time than has been previously recognised

3 individual coastal societies have varied in their use of marine resources independently of environmental opportunities because of constraints imposed by technology, social organisation or cultural preference.

All three factors cited above are probably implicated to some degree. Point 1 needs particularly careful consideration for the reasons already discussed. In addition, recent surveys in Ireland and Scotland suggest that coastal shell middens are more abundant and widespread than is suggested by the well-known mound clusters such as those on the island of Oronsay (Hardy & Wickham-Jones 2002; Milner & Woodman 2002). Point 2 is also likely to be a major variable. Evaluation of all these possibilities needs context-specific and systematic investigation in a case by case approach. Such a large-scale enquiry lies beyond the scope of this paper. Instead we focus on the stable isotope analysis of human bone, the results of which have recently been used to strengthen the case for point 3 by emphasising the contrast between Mesolithic and Neolithic diet. The results are striking and suggest that, for quite a large and geographically dispersed sample of skeletons in Britain and Denmark, Mesolithic individuals consistently show a marine-dominated diet, whereas Neolithic skeletons show almost no sign of a marine signal (Richards & Hedges 1999a, 1999b; Schulting & Richards 2002). The contrast has been noted even in late Mesolithic and early Neolithic individuals buried in the same location (Tauber 1981). The apparent absence of evidence for marine foods even in Neolithic skeletons buried in coastal locations suggests that people ignored marine resources even when they were easily available, and 'turned their back' on the sea. The dietary transition thus appears, on the stable isotope evidence, to have been swift, dramatic and widespread.

7 Palaeodiet and stable isotopes

The past two decades have seen a flood of papers devoted to dietary reconstructions based on stable

isotope analysis of human bone in many parts of the world (see Claassen 1998; Schulting & Richards 2002, and references therein). The technique is especially sensitive to differences in marine and terrestrial foods and the principles of interpretation have been widely described. In brief, all living matter contains compounds of carbon and nitrogen. Both elements are represented by two stable isotopes of different mass — ^{13}C and ^{12}C , and ^{15}N and ^{14}N — and the proportion of the two isotopes varies in predictable ways. Phytoplankton and marine plants that form the base of marine food chains synthesise carbon from seawater, which is enriched in the ^{13}C isotope of carbon compared to the atmospheric carbon synthesised by terrestrial plants³. The heavier isotope of nitrogen, ^{15}N , is enriched at each step in a food chain, such that herbivores are more enriched than plants, carnivores than herbivores, and so on. Since marine food chains are typically longer than terrestrial ones, many marine foods are primary or even secondary carnivores. Small samples of bone or other organic materials can now be measured by standard mass spectrometry techniques relatively cheaply. Hence isotopic techniques would seem to offer a powerful means of determining dietary differences based on different proportions of plant and animal foods and terrestrial and marine ones.

However, the results are not always uncontroversial and a number of cases have been noted where the stable isotope data seem to be in conflict with the bioarchaeological data of site locations and food remains, notably on the Cape coast of South Africa (Parkington 1991; Sealy & Van der Merwe 1992) and in the Americas (summarised in Claassen 1998). We believe that there are similar incompatibilities in the European data, since the isotope results seem to exaggerate the dietary signal in relation to other sources of bioarchaeological data. Terrestrial resources and hinterland exploitation are well-represented in the Mesolithic occupation of Britain and Denmark, and marine resources continue to play a role in the earliest Neolithic especially in Denmark, as we detail below.

Such contradictions are inclined to generate one of three responses: either the science is wrong,

the archaeology is wrong, or both are wrong in their different ways⁴. Archaeologists are often the first to prefer scientific results over archaeological ones because we are only too well aware of the biases and limitations of our own data. As often happens in the first flush of enthusiasm for a new technique, there is a strong temptation to accept the results at face value as an improvement on the inadequacies of the archaeological record. Claassen (1998:195), for example, has gone so far as to dismiss archaeological reconstructions of diet based on quantification of food remains in shell middens as 'futile', because of the potential errors involved, and to prefer isotope analysis of human bone as a more direct source of information in which 'the problems of the former largely disappear' (ibid:191).

In the history of science-based archaeology, very few laboratory-based techniques have turned out to produce unequivocal results undistorted by hidden assumptions and biases of their own. Although there is a strong and persistent desire to find a single 'key' that will unambiguously decode the past, that expectation is probably ill-founded. Tempting though it may be to assume that contradictions between the results of laboratory science and field archaeology reflect the superiority of the former over the latter, experience suggest that such contradictions highlight biases in both the science and the archaeology.

The usefulness of stable isotopes and the importance of the results cannot be overstated, and it is not our intention to cast doubt on their value, although we do draw attention to some uncertainties in the science that, in our view, require more investigation. Nor do we attempt here a comprehensive review of the field. Rather our point is that stable isotopes and archaeological food remains refer to different and incommensurate phenomena with varying degrees of error and uncertainty. Until we untangle those differences, we cannot bring the two sources of data into fruitful connection (see Bailey et al forthcoming).

The first point we make is that stable isotopes are thought to measure the protein intake of an individual in the last 10 to 15 years of their life.

Conversely food remains in archaeological middens often refer to time-averaged palimpsests of food consumption by many individuals over centuries or even millennia. That difference of resolution can, of course, be exploited to measure dietary variation at the individual level in relation to the average diet of a larger population, but we suspect that some of the contradictions between isotope data and food remains centre on this difference of scale and resolving power.⁵ Claassen, for example (1998:192) cites the example of individuals from coastal sites in Panama, where stable isotopes suggest greater consumption of marine foods at a site located inland than at an earlier site located on the coast. The individuals at the coastal site are thought to have made only brief visits there, having spent most time living in the remoter hinterland on agricultural products, whereas the later site was a sedentary settlement whose occupants had more long-term access to marine foods. It should also be added that isotope analysis is limited to individuals whose skeletons have been buried in circumstances where they have been preserved for subsequent archaeological investigation. That may weight the sample in ways that are no worse than for any other archaeological materials, but is difficult to assess except by looking for consistency across many cases and being alert to potential biases.

Secondly we take it as axiomatic that, when dealing with biological organisms, modern controlled experiments are essential to provide independent validation of the technique. The analysis of oxygen isotope variation in marine shells to measure secular and seasonal variations in temperature provides an appropriate analogy. Isotope measurements on living shells growing in known environmental conditions have proved essential to establish limits of accuracy and the circumstances in which reliable results can or cannot be achieved (cf Bailey et al 1983). Blind-testing is a further refinement that should be applied in appropriate circumstances (Milner 2001).

The equivalent test in dietary studies is the analysis of the isotope composition of bone in individuals with known dietary histories. While some attempts have been made in this direction,

such studies are by their very nature likely to be very difficult to carry out in a rigorous manner, especially if we wish to check out the effect of mixed diets with differing combinations of marine and terrestrial protein. Imagine taking a control group of individuals who can keep a detailed record of everything they eat over a ten-year period and are then willing to sacrifice a part of their anatomy in the cause of science. Bone biopsies on living subjects are possible but very expensive. Isotope measurements can be taken on skin or hair (Iacumin et al 1998; O'Connell & Hedges 1999; White 1993), but these have very different rates of turnover to bone collagen and provide measurements of dietary variation on a weekly or monthly time scale. However, consistency between hair, skin and bone measurements on mummified bodies suggests that shorter-term feeding experiments with human subjects are feasible. Feeding experiments with dogs, whose bones in archaeological deposits are sometimes used as proxies for human palaeodiet (eg, Noe-Nygaard 1988), or laboratory rats, are other possibilities

This problem would be less acute if we could be sure that there is a linear relationship between isotope ratios and variations in the proportions of marine and terrestrial protein in mixed diets. Dietary proportions are usually estimated by plotting the extreme values associated with a purely marine or purely terrestrial diet, drawing a straight line between them, and translating intermediate values into food percentages by a simple linear conversion. However, this is at best an assumption in need of testing, and there are reasons to be cautious. Different turnover rates of protein at different periods of the life cycle, over-representation of protein consumed when young, differential uptake of different sources of protein, suppression or under-representation of the isotope signal during periods of low protein consumption, male-female differences related to lactation cycles in women, differences between collagen and apatite measurements, are just some of the factors that have been raised as possible variables (cf Parkington 1991). Without the modern controls, we have no way of checking.

An added complication is that not all marine and terrestrial organisms have the expected isotopic composition. Many intertidal molluscs and some fish are detritus feeders and take indiscriminately whatever microscopic plant material comes their way. Large quantities of terrestrial plant material can be washed into inshore waters and incorporated into the marine ecosystem (cf Nithart 2000; Riera & Richard 1996). Marine food webs are also complicated by the fact that many organisms feed at different trophic levels at different periods of the life cycle, and adult carnivores can switch diet to lower trophic levels in response to food shortages. Conversely marine detritus can be consumed by beach scavengers and enter into the terrestrial food chain (Polis & Hurd 1996). Other sorts of environmental conditions can also sometimes result in the production of terrestrial carbon enriched in ^{13}C (eg, Day 1996). Nitrogen and carbon isotope composition can also vary in relation to climatic changes (eg, Heaton 1999; Schwarcz et al 1999). These confounding factors are likely to be specific to particular contexts, but at least they can, in principle, be tested by carrying out isotope measurements on modern organisms living in known environmental and ecological circumstances or, better still, on bone, plant and shell material recovered from contemporaneous archaeological deposits.

A third problem is that the archaeological evidence of food remains and site locations from some European coastal locations suggests a much less marked dietary shift at the Mesolithic-Neolithic transition and greater continuity of settlement than is suggested by the stable isotope results. This is especially apparent in Denmark. Isotope studies (Meiklejohn & Zvelebil 1991; Noe-Nygaard 1988; Tauber 1981) present a typically sharp contrast between Mesolithic and Neolithic diets, although interpretation is complicated by the fact that most of the Mesolithic skeletons are from coastal locations and most of the Neolithic ones from inland. In any case, the archaeological evidence suggests a different picture. Many Mesolithic middens including the largest shell mounds show substantial terrestrial food remains alongside evidence of fishing, shellgathering and sea mammal hunting.

At the classic site of Meilgaard on the Jutland peninsula, where a large sample of material resulted from extensive excavations, terrestrial mammals amount to at least 30 per cent of the food supply alongside sea mammals and shellfish (Bailey 1978). Such dietary reconstructions are subject to many uncertainties of differential preservation, but marine foods, especially the molluscs, are typically over-represented in such calculations, whereas terrestrial foods are under-represented because of differential preservation and recovery. Elsewhere, where seafood dominates the remains of a particular site, it often turns out to be a specialised encampment used as only one location in a wider economic round (Rowley-Conwy 1983).

Extensive areas of the Jutland hinterland were also exploited by Ertebølle people, and many inland sites are known which would have added considerably to the terrestrial component of the diet on a regional scale. However, many of these sites are known only from their stone tools and have poor conditions for organic preservation and certainly no preserved human skeletons suitable for isotope analysis, so that little is known about this hinterland component, with the exception of the lake-edge site of Ringkloster (Andersen 1998).

Conversely marine exploitation continues into the Neolithic period. In Denmark a number of shell middens have been recorded with clear evidence of early Neolithic activity, notably at Bjørnsholm, Norsminde, Sølager and Visborg (Andersen 1989, 2000; Johansen in press), and some of these deposits, notably at Bjørnsholm, are of very considerable size. Oysters are much rarer than in the preceding Mesolithic and cockles more common, most probably reflecting change in environmental conditions. The sites also include large quantities of pottery, bone remains of wild animals, rare specimens of domestic fauna, and small quantities of fish bone. Some of these deposits are stratified above shell deposits of the preceding Ertebølle period, and suggest a continuation of the same sorts of subsistence activities, except that fish bone are much rarer.

Johansen (in press) argues that the Ertebølle shell mounds were residential sites with the full

range of subsistence activities represented, whereas the Neolithic deposits were specialist camps used for the exploitation of wild resources by farmers whose main settlements were now located further inland. Many such sites are known and are typically 3–5 km inland in locations more appropriate for farming and livestock rearing. The location of the coastal camps does not make sense unless we suppose that fishing was a major target of activity, and the rarity of fish bones in their deposits may be due to the removal of the fish for consumption at the inland settlements. This seems plausible, especially in view of the evidence for the Neolithic use of weirs and traps in other areas of Denmark. Unfortunately the proposition is difficult to test because conditions of bone preservation at the hinterland settlements are very poor, but analysis of residues on potsherds may provide a relevant avenue of investigation.

The site of Norsminde is of particular interest in this context (Andersen 1989). Detailed analysis of growth structures and size distributions of the molluscan remains from Ertebølle and Early Neolithic levels shows interesting differences between the two periods (Bailey & Milner *in press*; Milner 2002). In the Mesolithic levels, collection of oysters was limited to a narrow season in spring. This supports Rowley-Conwy's (1983) contention that oysters played a critical role in filling a gap at a time of year when other food was in short supply. It is tempting to suggest that this might also have been an important period in the ritual calendar, with a short period of concentrated shellgathering associated with ritual feasting in the manner proposed by Luby & Gruber (1999). In the Neolithic period the season of collection is much broader, extending over the summer period, which suggests that shellgathering activities were re-organised to fit in with the different economic and social schedules of the farming calendar. The Neolithic rate of shell accumulation is just as great as in the Mesolithic, and size and age distributions of the exploited molluscs show that the Neolithic inhabitants intensified shellgathering activity in comparison with their Mesolithic predecessors rather than relaxing it.

These sorts of analytical studies of marine molluscs have often been considered controversial because of irregularities in growth patterns, difficulties of disentangling environmental from human impacts on molluscan growth, and the lack of modern experimental and control studies. In this case, however, the analytical techniques have been validated against a wide range of control studies of modern mollusc populations (Milner 2001, 2002).

Elsewhere around the coastal peripheries of northwest Europe, relevant evidence is harder to come by, but fishing has been variously documented or inferred as a concomitant of some Neolithic communities (eg, Clark 1977; Wheeler 1979). Otherwise a similar disjunction between isotope analyses and other sources of evidence is apparent, although in Portugal the isotope evidence suggests a more gradual trend (Lubell *et al* 1994), and in Sweden more varied and mixed diets (Lidén 1995)

In Ireland, shell middens of Mesolithic date have long been known, but it is only recently that new surveys along the west and north coast have revealed their full extent, with over 100 shell middens of varying date (Milner & Woodman 2002). Some are substantial shell mounds of oyster shell and other food remains with evidence of use continuing into Neolithic and later periods (Burenholt 1984). These offer the same sort of scope for more detailed analyses of changes across the Mesolithic-Neolithic transition as the Danish sites. Similar variety and potential of coastal sites is being revealed by new surveys in Scotland (Hardy & Wickham-Jones 2002).

These coastal deposits of Neolithic or later date tend to be ignored in comparison with monuments and village settlements with their much richer record of material culture and social life. In contrast Mesolithic shell middens tend to be highlighted because of their excellent conditions of faunal preservation, wide range of artefacts and well resolved chronologies in comparison with the stone-tool scatters and poor conditions of organic preservation that characterise so many other Mesolithic sites, especially in hinterland locations.

We suggest, then, that the contribution of marine resources to Neolithic and later societies

has been discounted for two reasons. First, we argue that marine resources are more archaeologically visible in the Mesolithic because of the tendency of coastal populations to locate their settlements on the shoreline close to natural shell beds and to accumulate mollusc shells in concentrated and highly visible deposits. It is possible that such mounding behaviour and consequent archaeological visibility was reinforced by ritual and symbolic associations with mounds, but this is not essential to our argument. In contrast, in Neolithic and later periods we suggest that the requirements of farming resulted in a rescheduling and relocation of settlement and economic activities. Exploitation of marine resources clearly continued in many coastal areas, but we argue that the archaeological remains of that activity were less visible because food resources were carried away from the shoreline to inland settlements or more widely dispersed across the landscape. The difficulty of evaluating these more subtle possibilities is further compounded by the rarity of hinterland settlements with good conditions of preservation and equivalent opportunities for palaeodietary analysis. In short, we suggest that more attention needs to be devoted to the differing taphonomic history and visibility of archaeological sites and residues in their wider landscape setting.

Secondly, we suggest that shell middens, and hence evidence of marine and coastal exploitation, tend to be exaggerated in Mesolithic studies, because these are perceived to be the most interesting and rewarding deposits available for study. Conversely in studies of Neolithic and later periods, shell middens are perceived as less interesting in comparison with the riches of monuments, burial tombs and village settlements. This contrast further reinforces, or is reinforced by, the tendency of Mesolithic archaeologists to concentrate on issues of diet and environment, and Neolithic archaeologists to concentrate on issues of social organisation and ritual. This divide persists to the present day and it seems that the concept of a Mesolithic/Neolithic transition results as much from a disjunction between different traditions of archaeological study as from time trends in

prehistory, a disjunction that needs to be bridged by comparable studies on both sides of the Mesolithic/Neolithic boundary.

None of this is to suggest that the shift in isotope values at the Mesolithic-Neolithic transition in various parts of Europe should be discounted as evidence of a dietary change. The general direction of change towards a greater emphasis on terrestrial protein in the Neolithic may well be correct, and indeed the archaeological evidence is broadly consistent with such a trend, notwithstanding the uncertainties that we have discussed above. Nor should we overlook the potential of the isotope data to highlight short-lived or local variations that are blurred in other sorts of data. Rather our point is that we should be cautious about relating isotope variation to dietary variation with the precision and confidence suggested by some interpretations. We should also critically assess all the available data at our disposal, both isotope and otherwise, against the widest possible range of controls and potential errors, according to the context in which they are found, before attempting more far-reaching generalisations.

8 Conclusion

This paper has focused on two rather different themes. The first is the issue of generalisation on the very large scale, especially as it relates to the search for global long-term trends and developments. The second is the techniques and methodologies by which we can reconstruct coastal palaeodiets at the very small scale of individuals, settlements and regions. The two themes are united by the common focus on coastal settlement, and by the relationship between small-scale palaeodietary studies and larger-scale generalisation.

The search for global trends implied by the title of our paper has become an unfashionable intellectual pursuit in recent decades. In part this reflects a belief that such exercises are inherently teleological, judging earlier achievements in terms of how far they compare with or contributed to later developments according to some preconceived

directionality in human history. In part it reflects the suspicion that such exercises cannot but be written from the point of view of the writer, often a Eurocentric one, and that what passes for a dispassionate survey of the general evidence is really a disguise for promoting a particular geographical or political bias. In part it may also reflect the fear that comparative studies must necessarily lead to over-simplifying generalisations that discount the specifics of regional and local context, or to merely descriptive narratives overburdened with detail. While we recognise all these potential pitfalls, we believe that the attempt should be made. Otherwise generalisations inherited from a previous intellectual era are likely to continue to exert an unrecognised and unchallenged impact on smaller-scale interpretation.

We have found no evidence to support the notion that marine and coastal resources were wilfully ignored in the prehistoric past. Nor do we see any evidence that societies that embraced their exploitation were condemned to a marginal existence, except perhaps in very extreme climatic and environmental circumstances, where marine resources were probably all that was available to make the difference between survival and starvation. Nor do we see any evidence for a uniformity of dependence on marine resources, even within periods such as the Mesolithic of northwest Europe. Even here, the areas with evidence of substantial coastal occupation in the form of shell middens are actually of quite limited extent, though new investigations may yet show them to be more widespread than was once thought to be the case. We see no reason why Mesolithic communities in coastal landscapes should not have made use of marine and terrestrial resources in every conceivable combination and proportion, depending on local circumstances and environmental opportunities. Conditions of archaeological visibility have highlighted those areas with substantial dependence on marine and especially molluscan resources, but there were probably many more coastlines where the proportion of marine foods was considerably less.

Similar comments apply to farmers in coastal areas. The labour requirements and location of farming activities may well have resulted in a re-scheduling of activities related to naturally occurring resources, but we doubt that farmers would have ignored for long nearby marine resources as additional and complementary food supplies or as fodder for livestock.

Notwithstanding the great variability and flexibility inherent in human behaviour, there remains a strong underlying tendency to try and constrain that variability within some simple normative categories. Thus people have to be classified as either hunters and gatherers or farmers, either farmers or fishers, either Mesolithic or Neolithic, either 'coastal' or 'inland'. Even after several decades of attempts to deconstruct these categories, we note a continuing tendency to cling to the boundaries defined by convention, either by default, or perhaps because removing these familiar intellectual landmarks would open up the prospect of intellectual incoherence in the absence of alternative conceptual replacements. Marine and aquatic resources of course do not fit the conventional categories and thus provide an alternative perspective from which to subvert them. Societies at every level of social and political complexity 'hunt' fish and sea mammals and 'gather' molluscs. Even modern industrial states are, for the most part, hunters and gatherers with respect to marine resources, albeit with a more powerful technological arsenal than their predecessors.

So, far from treating coastlines as marginal, we believe along with many others that the distinctive advantages provided by coastlines, including more favourable conditions on land as well as the additional benefit of marine resources have played a significant role in all the major transformations of human development. Many have invoked the advantages of coastlines in early human origins and dispersal (Erlandson 2001; Mannino & Thomas 2002; Sauer 1962), in agricultural origins (Binford 1968; Sauer 1952) and in state development (Moseley 1975; Tosi 1986). Similar arguments have been proposed for the contribution of aquatic

resources in the Dynastic period of the Nile Valley (Luff & Bailey 2000). Indeed all the earliest of the great Old World urban civilisations are based on major river systems, with similar environmental attractions to coastlines, abundant aquatic resources and intimate contacts with adjacent coastal regions and fertile seas.

We might be tempted to ask the question as to why more coastal hunters and gatherers did not achieve greater levels of population growth and social and political complexity. This is, however, really a tautology. We suspect that many did so in prehistory, most probably by combining the advantages of a marine environment with productive conditions on land. But of course by doing so they removed themselves from our preconception of what constitutes a hunter-gatherer society, and of course from any possibility of ethnographic observation. Others, particularly the complex coastal hunter-gatherers of high latitudes or comparable areas of high marine productivity where farming remained absent or limited because of climatic constraints, continued on a separate trajectory. In some cases that trajectory might have led to levels of social and political complexity that we associate with state societies, had it not been truncated or transformed by the intrusion of more powerful economies.

In summary, we suggest that the notion of coastlines as cultural cul-de-sacs has been sustained by a combination of biases in archaeological and ethnographic records, but above

all because they do not fit the conventional categories of social and economic classification that have dominated the past 150 years of intellectual history. This notion should now be discarded, and with it the conceptual schemes that have underpinned it. What should be treated as marginal are not the prehistoric peoples who lived on coastlines, accumulated shell middens and incorporated marine resources into their diet, but the very concept of a hunter-gatherer way of life.

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¹ We refer to dates throughout this paper in terms of uncalibrated radiocarbon years before the present, (BP). An uncalibrated radiocarbon date of 6000 BP is equivalent to a calibrated date of about 7000 BP.

² Claims of early shell mounds usually refer to deposits with hundreds or at most thousands of shells. A typical shell mound of modest size from the later Holocene may contain upwards of a million shells and in the largest mounds the number runs to billions.

³ C4 plants, mostly of tropical origin, obtain carbon through a different photosynthetic pathway, which produces ^{13}C values that overlap with marine sources

⁴ The history of relations between science and archaeology provides a rich field of study in the growth of knowledge and the conflicts that can be generated by misunderstandings and preconceptions when people approach the same problem from different disciplines. There is a healthy tradition of scepticism in archaeology about scientific techniques that goes back at least as far as Stuart Piggott's famous statement that the radiocarbon date for Durrington Walls 'is archaeologically unacceptable' because it seemed far too early (Piggott 1959:289). There is an equally long tradition of uncritical enthusiasm for scientific results, shared by some archaeologists and scientists alike, that what comes out of a laboratory must be more reliable than what comes out of a messy archaeological trench.

⁵ Richards & Hedges (1999b:892) suggest that isotopes give a more accurate overall picture of the relative proportions of food than archaeological food remains because the latter refer 'to specific foods consumed at what may have been single events'. That contrast may be true of some cases but we suggest that the contrast is just as likely to be reversed, the isotopes giving us a detailed insight into one very limited portion of dietary variation, ie, the protein eaten by one or a small number of individuals in the last ten years of their life, and the food remains giving a more generalised picture of average diet for a much larger number of individuals over much longer periods of time. Parkington (1991) provides a useful elaboration of the differential resolving power of these different techniques with respect to person, time and place.