Chapter 1

The archaeology of prehistoric coastlines: an introduction

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In this volume we have sought to bring together studies which highlight the peculiar advantages of coastal environments as a focus for investigations of prehistoric human behaviour. These advantages are of two kinds. First there are methodological advantages, arising from the type of archaeological evidence available on prehistoric coastlines, as compared with inland situations and terrestrial resources. This evidence refers to a wholly different category of organisms and ecological relationships for human exploitation, and has been subjected to different conditions of preservation and bias. It offers different possibilities (and limitations) in investigating the relationship between the availability of natural resources and the organisation of those resources for human ends, and should therefore help to illuminate the nature of the directing forces and constraints on long-term patterns of change in the human exploitation of the natural environment. Secondly there are substantive advantages, opportunities to examine from a different perspective important transitions in the broad sweep of biological and cultural evolution. Many of these transitions, from the expansion of our hominid ancestors into new continents to the development and dispersal of early agriculture and the rise of complex state-societies, have been critically influenced by the ecological conditions for human population growth and dispersal in coastal environments.

Underpinning both sorts of advantages is an important general feature of coastlines. They are a classic illustration of the ecological concept of an ecotone: a boundary zone at the junction of two major ecosystems, which combines some of the characteristics of each, as well as developing unique characteristics of its own which are a product of the zone of overlap. Some of the advantages of the coastal ecotone for human subsistence are: variety of marine and terrestrial resources within a limited geographical area; a suite of organisms unique to the intertidal zone of the coast edge, including molluscs, crustaceans and edible seaweeds; potential abundance and concentration of food supplies in the case of some of the marine resources; and more productive conditions for terrestrial plants and animals because of high water tables, more equable climatic conditions or forest-edge effects. To these may be added the natural bounties of the sea shore, such as stranded sea mammals and sea birds beached by storms, breeding activity or other factors. Medical research also emphasises the benefits of coastal occupation in terms of improved nutrition, growth and resistance to disease. Access to marine foods ensures a ready supply of protein and trace elements such as iodine, absence or scarcity of which can lead to serious limiting effects on hinterland populations and in some cases to deficiency diseases such as kwashiorkor and goitre.

It is hardly surprising that attractions such as these should have been seen by some as influential factors in human development, from the earliest hominid origins (Hardy 1960,

Morgan 1972) and Pleistocene colonisation of new continents (Sauer 1962, Bowdler 1977) to the appearance of sedentism and social complexity among Holocene hunters and gatherers (Yesner 1980b, Rowley-Conwy 1983, Price and Brown 1985, this volume chapter 9), the development of agriculture (Sauer 1952, Binford 1968) and the rise of civilisations (chapter 11). However, a marine-oriented view of human development has rarely been greeted with much enthusiasm, whether through lack of evidence – especially in the earlier periods of the Pleistocene, through equally plausible hypotheses of terrestrial origin, or through a reluctance to shed nineteenth-century orthodoxies of evolutionary development with their bias towards land-based models of hunting, herding and crop agriculture (chapter 11). Indeed, some quite sophisticated ecological arguments have been marshalled in support of the view that the world's coastlines have been a peripheral influence on the course of human prehistory (Osborn 1977b).

From the point of view of the long-term record, one major limitation of coastal evidence which should be recognised at the outset is its extreme rarity before the Holocene. This has been variously attributed to removal of evidence by marine submergence and erosion or to lack of interest in, or less intensive utilisation of, coastal resources by earlier human populations. Decisive evidence which would resolve the matter is not yet available. There are, however, a number of indications which suggest that the attractions of the coastal zone were recognised and taken advantage of throughout the earlier periods of human prehistory, though not necessarily in the same way as is indicated by the abundant evidence of Holocene shell middens. Because the issue of Pleistocene coastal exploitation affects the interpretation of later coastal economies, we discuss it in greater detail below. Nevertheless the fact remains that most of the evidence of prehistoric coastal settlement is confined to recent millennia within the Holocene period.

Within the Holocene greatest prominence and interest has usually been given to the shell mounds and shell middens of non-farming peoples, such as the Mesolithic middens of north-west Europe and their equivalents in other parts of the world. This is reflected in the main emphasis of the subsequent chapters, which concentrate on the simpler and earlier types of coastal economies – the coastal hunters and gatherers, and indeed on the variability masked by that less than satisfactory label. Chapter 10, however, deals explicitly with coastal farmers, and chapter 11 with a coastal state-society, while two other chapters (8 and 9) refer to evidence for features such as sedentism and storage, which are conventionally linked with the development of agricultural societies. Here we shall comment briefly on some of the advantages of coastal evidence for the study of prehistoric economies and ecological relationships, and on some of the issues which highlight the role of the coastal zone in human prehistory and which are central to the detailed case studies examined in subsequent chapters.

Methodological advantages of coastal studies

The structure of resource variability

Coastal environments present a highly structured and visible pattern of resource availability which throws into sharp relief the problems and possibilities of archaeological interpretation. The many marine species that occur along the coast edge and in inshore waters are highly varied in their behaviour patterns and accessibility to human predation, highly specific in terms of their habitat requirements, and subject to a variety of spatial and temporal controls. In terms of accessibility, resources cover the whole range of possibilities from large, mobile food parcels such as marine mammals, whose capture may be dangerous and uncertain, and require elaborate skills, technology, transportation and social organisation, to small sessile organisms on the shore edge, such as mussels, which can be collected and eaten by a solitary individual without the need for any special skill or equipment at all. Local spatial contrasts occur between exposed rocky points, sheltered bays and river estuaries, each with its own distinctive community of species. The availability of many species is also affected by temporal cycles at a variety of scales: tidal, seasonal and inter-annual. These characteristics offer two advantages: (1) a detail of archaeological reconstruction of prehistoric subsistence economies; (2) a measure of the degree to which available resources were actually made use of, and integrated within a subsistence economy.

Molluscs provide a good illustration of these features. They comprise a range of species from those, like abalone and scallops, which are characterised by large, meaty specimens, to the smaller gastropod and bivalve species like periwinkles and cockles. They are subject to zonation within the intertidal zone and therefore vary in their ease of accessibility to collection. Some species live high in the intertidal zone and are available at all low tides, whereas others are found only in the subtidal zone, where they are exposed only at extreme low water during spring tides. They are also highly varied and quite specific in their requirements for a suitable substrate and conditions of salinity, along a spectrum from exposed rocky shores to brackish estuarine mudflats. Hence the 'catchment' from which the shells present in a midden deposit have been derived can often be easily pinpointed.

In a study of shell middens along the southern coast of South Africa, for example, Avery (*pers. comm.*) has noted differences in the species composition of middens distributed along the same length of coastline. Some contain molluscs available at all levels of the intertidal zone. Others are dominated by abalone shells, which are only available at extreme low water, and which were probably collected in short-lived visits to particular localities at the time of the spring tides (see also chapter 3). Anderson (1981) has shown how the change in mollusc species through time in New Zealand middens represents a shift from those species which give a higher return of food per unit of collecting effort to the lower-return species, indicating increased pressure on the

molluscan food supply in response to the decline of other resources (see also chapter 8). Bowdler (1976) has also used changing frequencies of mollusc species available at different heights in the intertidal zone to infer a restructuring of the social relations of subsistence associated with middens in south-east Australia (see also chapter 4). This highly structured patterning in the availability of marine molluscs, then, offers unrivalled opportunities not only for a detail of reconstruction which can rarely be attained with other food species, but also for an examination of selectivity in choice of food items and site locations (see also chapter 2 and chapter 10).

Other marine species offer similar opportunities for the identification of seasonal patterns of exploitation. Many species of fish and sea mammal have strongly migratory patterns which mean that they are only available in inshore waters or along a particular stretch of coastline at certain times of the year. Their presence in the archaeological record of a particular site or area can therefore be used as an indication of seasonal patterns (Rowley-Conwy 1983, this volume, chapter 3 and chapter 5).

Molluscs also have optimal seasons of growth related to seasonal variations in the food supply or breeding cycles, and thus offer a better return of food at some periods of the year than at others. Because the molluscs are also usually available throughout the year, it does not follow that human exploitation will be restricted to the optimal season of growth, although this may be the preferred pattern. Where the analysis of growth increments allows an independent measure of collecting patterns, the actual season of collection can be compared with the predicted season. Discrepancies may be very informative in revealing how shellgathering is scheduled to fit in with the other requirements of the economy. Deith (1985a), for example, provides an interesting illustration of this point in her analysis of the Mesolithic midden at Morton in Scotland, which seems to have been visited intermittently at many different times of year to collect flint from the foreshore, rather than specifically to collect shellfish during their optimal season of growth (see also chapter 7). Ethnographic studies such as Meehan's (1982) also indicate that shellgathering is intensified during those seasons when other food resources are in least supply, rather than in the season when the molluscs are in best condition for human consumption. Techniques of growth-increment analysis are also applicable to some of the bony structures of fish and sea mammals (chapter 3, chapter 5 and chapter 7) and might repay further applications to test predicted patterns of use based on optimality assumptions.

Spatial and temporal contrasts in the nature of coastal and marine resources also occur at larger scales of investigation and can similarly be used to highlight detailed variations in human exploitation patterns. Spatial variation, for example, is detectable between different coastal regions with differing levels of marine productivity related to variations in coastal relief, climate and ocean currents (chapter 7). At a continental scale there are large variations in productivity from the rich, upwelling waters along the western margins of the continents (chapter 3 and chapter 11), to the unproductive marine environments of landlocked, tideless basins like the Baltic and the Mediterranean (Bailey 1982, this volume chapter 2 and chapter 10). Coastlines with offshore islands present other examples of structured patterning which can be very successfully used to highlight general trends and limitations in the organisation of human settlement and economy (Cherry 1981, Jones 1977, this volume chapter 4, chapter 5 and chapter 6).

The shoreline is also a highly dynamic zone where a number of processes come together to reproduce, alter or destroy particular landscape forms and their associated sets of resources, resulting in a variety of environmental changes operating over different time spans. It is here that equilibrium between rivers and sea level is resolved, leading to a series of erosional or depositional events of great significance to coastally based populations. The coastline is thus a very sensitive area which responds to both oceanic and terrestrial processes of change and which must in some way mediate between them. Changes of climate, vegetation and human land-use can alter stream discharges and sediment loads in rivers, and these in turn will alter the nature of river estuaries and their resources. Small shifts of sea-level, changes in the strength or direction of ocean currents, and changes in sea temperature or salinity equally influence the nature of the shore and its available resources. Tectonic and isostatic adjustments of land level relative to sea level also affect shorelines processes, while at a large scale there are the major sea-level changes of the glacial-interglacial cycle. Considerable potential exists for detecting these changes in the biological and geological records of environmental change and of relating them to the archaeological record of changes in human subsistence (see chapter 5, chapter 6 and chapter 7). In two chapters (6 and 7) this structuring of resource availability is adapted to the problem of clarifying the functional determinants of artefact variation.

The point about this increased visibility and variety of resource-patterning at the coast is the opportunity it offers for greatly improved control in testing the decision-making patterns of prehistoric people. There is currently much controversy about the nature of the determining links between people and environment. A wide range of seemingly irreconcilable theoretical and philosophical positions can be taken on the nature of these links, with the arguments tending to fall into one of two opposed camps: one emphasises the external constraints imposed by ecological relationships with the natural environment; the other emphasises the independence of 'internal' factors such as the social organisation and conceptual 'world-view' of particular peoples (Sheridan and Bailey 1981). If one strips away the polemics, the contrast is probably over-exaggerated, and we think it more realistic and more fruitful to suppose that human use of the environment is the product of interaction between a variety of 'external' and 'internal' factors, without preconceptions about the primacy of one or other side of the equation. Whatever one's opinions on these matters, however, we take it as axiomatic that empirical

investigations must depend on some measure of human selectivity, that is, some measure of what was available for use in the prehistoric environment, *independently* of evidence for what was actually used (Davidson 1983, this volume chapter 2). The difficulties of having incomplete environmental information are well illustrated by the case of the disappearance of fish from the diet of the later Tasmanian Aborigines (Jones 1978). Although this was initially thought to give an unusually clear instance of 'ecologically irrational' behaviour, alternative hypotheses of explanation have subsequently been proposed which draw on fuller investigations of the contexts of environmental change and of the economic and ecological relationships within which fishing declined (Bowdler 1980a, chapter 4, Horton 1979, Anderson 1981). Ecological frameworks of interpretation are often decried on the grounds that it is not possible to define 'ecologically rational' patterns of behaviour independently of the cultural choices and preferences of the people under study, or else that it is not possible to test such expectations against the record of what people actually chose to do. These assertions are easily used as an excuse for ignoring ecological issues rather than for evaluating them more effectively. Both assertions are over-pessimistic about what is possible in favourable archaeological circumstances. Our point here is that coastal environments create an unusually clear and sensitive framework for calibrating variations in human behaviour and for identifying the environmental component in the human decisions which underly that variation. Terrestrial economies offer fewer opportunities of this kind because of the more blurred and geographically extensive nature of terrestrial habitats and the less rigidly patterned habits of many mobile terrestrial animals.

The visibility of the archaeological evidence

Coastal occupation debris, particularly when large quantities of shellfish remains are involved, is highly visible and durable. Large shell middens are easily found, can be used successfully in estimating some aspects of prehistoric diets, and are excellent environments for the preservation of bone and other organic materials. The large basic particle size represented by mollusc shells ensures that even ephemeral visits to a particular spot will leave some visible trace, resulting in a large and varied sample of sites for analysing local and regional site structure. This same feature also means that shell middens accumulate relatively rapidly, offering the potential for finer chronological resolution of the record than is possible with naturally accumulated sediments in cave and rockshelter deposits or open sites. In some shell mounds, however, this potential is limited by the difficulties of disentangling the stratigraphic complexities created by overlapping heaps of shell. The large quantities of shells, which run to millions of specimens in the larger mounds, also provide an abundant source of hard data to which a variety of techniques can be applied: quantitative measures of changing species frequencies, measures of change in shell size, microscopic analysis of growth structures, and analysis of physical and chemical composition of the shell carbonate. Techniques such as these can indicate patterns of selectivity in exploitation, environmental conditions at the time of collection, seasonal patterns of gathering, and the degree of predation pressure imposed on the mollusc populations, data which can shed light on the wider environment and economy as well as on the shellgathering as such (chapter 10, Swadling 1976, 1977).

Shell middens can also yield much less ambiguous statements about prehistoric subsistence patterns than their interior equivalents. Consider, for example, the debates that have arisen about the agencies of accumulation of bones on archaeological sites and the effects of post-depositional destruction. How much of the carcase of a large mammal represented in a deposit by, say, four teeth and two phalanges was eaten by the people who used the site? How confident can we be that the bones were accumulated as the byproduct of human hunting or scavenging rather than by carnivores, and how much bone material has been lost by natural agents of destruction or animal gnawing? These problems are even more difficult to resolve with plant remains. With shellfish, on the other hand, it can usually be assumed with some confidence that all the shellfood represented by a midden was collected, processed and wholly eaten by people (see Deith 1985b). It is also likely that the quantities of shells in midden deposits closely approximate the quantities actually eaten. Ethnographic studies (Meehan 1982, Tregoning and van der Elst n.d.) show that shellgatherers often 'snack' whilst collecting. But the impression given is that this archaeologically invisible component is a relatively minor percentage of the total shellfood intake, and this is borne out by comparisons of modern shellfood yields with quantities of shells and rates of accumulation in archaeological middens (Bailey 1975). Hence reconstruction of the shellfood value of well-preserved middens can proceed with some confidence.

However, the excellent archaeological preservation of mollusc shells raises the suspicion that molluscs may be given a greatly exaggerated importance in the reconstruction of prehistoric diet. There is little doubt that, in those archaeological cases where the appropriate measurements can be taken, shellfood is grossly over-represented in relation to the preserved remains of other food resources, or else the shell middens are over-represented in relation to other locations of food processing and consumption (Bailey 1975). Equally it is clear that even small contributions of molluscan food may be of immense significance as a critical resource at times of general food shortage (Meehan 1982). It would be unwise to exclude any possible role for shellfood, or to assume that its role was more or less uniform throughout all coastal economies.

Comparability of coastlines

The following chapters are organised in the form of a series of regional case studies drawn from many parts of the world, with little more to unify them than their focus on the coastal zone, rather than being centred on a few methodological or theoretical themes. This stems partly from

deliberate policy on our part, and partly from features inherent in coastal data. Any comparative approach drawing on a wide range of disparate examples steers a difficult course between two extremes. On the one side there is the risk that regional case studies will tend to emphasise what is local and particular to the given area or period under study (and to the local archaeological tradition of study) at the expense of general issues or principles which may have a wider significance. On the other side there is the risk, common to many attempts at cross-cultural generalisation, that the particularities of each context will be minimised to such a degree that each case study is reduced to some sort of common denominator which exemplifies the operation of general laws or uniformities, regardless of the local and historical context.

Coastal data obviate some of these risks by virtue of their inherent similarity. In general, marine organisms are not subject to physical barriers to movement and dispersal to the same degree as terrestrial ones. They have not been subjected to biogeographical partitioning and geographical isolation to the same extent, nor as a consequence to the same degree of evolutionary change and diversification. The molluscs, crustaceans, fish and sea mammals around the coastlines of the world present a fundamentally similar pattern of behaviour and ecological relationships, and familiarity with the coastal ecology of one part of the world will readily facilitate study of others. Shell middens also pose a set of common practical problems of excavation and analysis which have stimulated a methodological literature international in its scope. All of this provides a common base line for encouraging comparative studies on a global scale.

In asserting the value of such a comparative approach, we should emphasise that it is not our intention to court the misunderstandings which attend the promotion of general laws. It is obvious that there is a wide range of variability in the coastal economies discussed in the following chapters, as in other spheres of human activity. By controlling for some of the variables, for example by comparing patterns of behaviour within a broadly similar environmental and ecological framework, we may be better able to understand the variability of human response, and hence better to understand each case study in its historical and ecological context. Rather than viewing variability as an obstacle to wide-ranging comparisons, or as an undesirable end-product of comparative study, we view the combination of variable human behaviour within a framework of globally comparable environmental conditions as a very valuable intellectual resource for making controlled comparisons. Prehistoric coastlines are unusually well suited to serve such an objective.

Substantive issues

The Holocene transition

Most of the issues examined later in this book have to do with the nature of variability in coastal economies and in particular with patterns of long-term change on a variety of time-scales. Overshadowing all of these issues is the question of just what sort of change is implied by the widespread appearance of shell middens and other indications of coastal and marine adaptation during the Holocene. This is a matter for debate and is often expressed as a contrast between two opposed views. One view is that the Pleistocene evidence has largely been destroyed or obscured by sea-level changes, and that later evidence is simply the first archaeologically visible expression of patterns of activity that have a far greater antiquity. The opposed view is that, notwithstanding the loss of some evidence, there is a genuine trend towards a broadening of diet to include marine resources and an intensification of marine exploitation, and that this is of great significance in terms of global population growth and economic changes. Three specific questions need to be addressed here: (1) what sort of coastal and marine habitats were available for human exploitation in earlier periods of the Pleistocene; (2) in what ways, if at all, were these exploited by earlier human populations; (3) what is the likelihood that the archaeological evidence of these earlier activities has been removed.

In treating the first question, a major complicating variable is environmental change. Oscillation of global sea-levels through an amplitude of ~ 100m in response to the glacial–interglacial cycle has clearly caused major disruptions in the nature and availability of coastal environments over long time-spans, to say nothing of the smaller-scale environmental effects at the coast edge which were discussed above. It is arguable that the stabilisation of world sea-levels during the Holocene, combined with modern climatic conditions, has created widespread coastal and marine habitats favourable to human subsistence on a scale which cannot be matched until one goes back to the previous interglacial period ~ 120,000 years ago. Inundation of the continental shelves to provide fertile, shallow seas, favourable conditions of temperature and salinity under a modern climatic regime, and stabilisation of shore-edge processes long enough to allow the development of shallow mudflats and rock platforms in inshore areas, are just some of the factors which could be invoked in support of this view from a global perspective. However, our reconstructions of the long-term history of coastal environmental change are still largely a matter of informed guesswork, although recent developments in techniques for underwater exploration (van Andel and Lianos 1984, this volume chapter 2) and improved palaeoclimatic reconstructions (CLIMAP 1981) hold out a real prospect of filling in some of the very large blanks in this area of our knowledge.

The other two questions are difficult to treat separately. How, after all, are we to evaluate earlier use of past coastlines if the archaeological evidence, on which assessment must depend, has been destroyed? How, for that matter, are we to test the belief that evidence once existed but has since been destroyed, as opposed to the belief that it never existed at all? In our view it is premature to suppose that the archaeological record we have at present is essentially complete and unbiassed. For one thing we think the likelihood that earlier

evidence is under-represented is very high, if only because of the likely effects of sea-level change. Systematic exploration for submerged Pleistocene data has scarcely begun. Techniques of underwater investigation are capable of being adapted to archaeological survey (Masters and Flemming 1983), and there are reasons for thinking that sites such as shell middens may be better preserved underwater than on land, where they are exposed to all the depredations of natural and human agents of destruction (Ceci 1984). Pleistocene shorelines exposed by rapid tectonic uplift in areas such as New Guinea, or shorelines formed at earlier periods of high sea-level offer other possibilities for investigation. Caves on present-day coastlines with deeply stratified sequences extending back to the preceding period of high sea-level, such as the African sites of the Haua Fteah (McBurney 1967) and Klasies River Mouth (Singer and Wymer 1982), provide some direct clues about early use of marine resources.

It seems unlikely to us that the features of the coastal ecotone were not made use of in some way by earlier human populations at many periods in the Pleistocene. Indeed the resources available in many coastal environments would, we think, have conferred significant evolutionary advantages in terms of individual growth and reproductive success on any population capable of exploiting those resources. In addition to the advantages of a diverse, concentrated food supply, coastlines also facilitate population dispersal and interchange. The attractions of a coastal routeway have also been argued for the colonisation of new territory, from Africa to Europe, for example (Sauer 1962), and from Asia to Australia (Bowdler 1977), as a line of least resistance and a source of familiar resources in an otherwise unfamiliar landscape.

One objection to this view of coastal adaptation is that many marine resources involve a high cost – physical, technological or social – compared with terrestrial resources, or a high risk of failure because of difficulties of capture. This is certainly arguable for many species of fish and sea mammals. These require a degree of technological ingenuity and social organisation which could well have been beyond the intellectual capacity of earlier human populations; or else demand a cost in terms of physical danger or investment in skills which might have been a chronic disincentive until a very late period in prehistory (Osborn 1977b). However, this objection minimises the other advantages of coastal settlement, and in particular the potential role of marine molluscs that can be gathered along the coast edge (Perlman 1980).

Molluscs are of particular interest here, because many species are easily collected with minimal equipment, involve no significant processing costs other than an ability to crack open a shell, and are usually easily available throughout the year as a predictable and reliable source of fresh protein. In favourable circumstances the concentration of food can be very high indeed. The black mussel, *Choromytilus meridionalis*, which clusters in large colonies along the rocky shorelines of southern Africa, can give an annual yield of ~ 100 kg live weight per m^2. In the Burry Inlet of South Wales, cockles (*Cerastoderma edule*) harvested from the tidal mudflats give yields of up to 226 tons live weight per km^2 (Hancock and Urquhart 1966), sufficient to provide the calorie requirements of nearly 5000 people-days. Set against this is the fact that a large part of the mollusc weight is inedible shell, and large numbers have to be collected to supply a given food equivalent – approximately 1000 cockles for one individual's daily calorie requirements, for example, or 50,000 cockles to supply the calorie equivalent of a medium-sized land mammal.

Systematic data on the costs and benefits of various resources have been compiled within a framework of ecological and optimal foraging theory to show that marine resources generally and molluscs in particular are low in the scale of preferred foods, because of high risks or costs of exploitation, and would have been avoided until more attractive resource options had been fully taken up or exhausted (Osborn 1977, Perlman 1980; cf. Winterhalder and Smith 1981). It is tempting to take this line of theoretical argument a step further and to use it to explain the allegedly late appearance of marine resources in the archaeological record of prehistoric subsistence. The temptation should be resisted. Quite apart from uncertainties about the completeness of the archaeological record, discussed above, there are serious theoretical flaws in the argument. Provided only that individuals can collect at least enough mollusc food for their own daily requirements, which is not in doubt, the desirability of engaging in the effort required will depend on what other foods are available and how easily they can be obtained in a given context. Very few terrestrial environments supply a regular and predictable supply of terrestrial plant and animal foods throughout the year. Seasonal cycles of availability or accessibility are the norm and recurrent episodes of food shortage are widely recorded. Food storage offers one solution to the problem, but depends on the availability of a concentrated surplus at an earlier season, and also involves an additional processing cost, as well as the risks and uncertainties of spoilage, loss or exhaustion of the stored food before the reappearance of fresh supplies. Shellfood, because of its perennial availability, provides an ideal buffer during periods of food shortage. In this context the effort of collecting a thousand molluscs may be a small cost to bear if the alternative is no food at all. Betty Meehan's (1982) study of the Anbara shellgatherers of northern Australia makes this point very clearly. Numerous anecdotal indications in other coastal ethnographies underline the value of molluscs as a critical resource to even out irregularities in other food supplies or as an emergency resource in time of severe shortage. What is at issue here is *not* the inappropriateness of optimal foraging theories as such, but of relative cost : benefit ratios measured under *average* conditions (or artificial ones), without regard to the modifying effects of seasonal extremes. A similar contrast needs to be drawn between costs and benefits to different individuals within a human group as opposed to the average costs and benefits for the group as a whole. Age and sex differences have a bearing on physical strength and physiological requirements, and social rules affecting the

differential distribution of high-risk, high-status foods such as hunted meat, may make low-risk, low-status, high-cost resources like molluscs more attractive to some individuals than to others (Bowdler 1976).

Finally, consideration should be given to economies where hunting is not practised at all. The collection of 50,000 molluscs may seen an undesirable alternative to the efficient capture of a single large land mammal. However, if recent claims are taken into account (Binford 1985), it could be argued that very little hunting was practised before the appearance of anatomically modern *Homo sapiens sapiens*: most human populations before this obtained most of their terrestrial large-mammal protein from the meat or marrow scavenged from the kills of other predators. In these circumstances molluscs clearly would be a relatively more attractive option for coastal hominids. Clement Meighan's (1969) 'anonymous hero' who 'ate the first oyster' (p. 417) could well have been one of our earliest ancestors. It is significant that the earliest well-documented coastal sites in undisturbed context have remains of mollusc shells, Terra Amata at ~ 300,000 years being one of the best known (de Lumley 1975).

A very important group of sites for this discussion is the Pleistocene shell mounds on the coastline of south-east Africa (Klein 1977). Some are open sites with dates beyond the range of ^{14}C dating and thus at least 50,000 years old, while the basal midden at the Klasies River Mouth Cave has been dated to the interglacial stage at ~ 120,000 years ago (Singer and Wymer 1982). These early deposits contain concentrated masses of shell and in this respect resemble the local Holocene shell middens. But they differ in the almost total absence of fish and flying birds. At Klasies River Mouth aquatic resources are, however, represented by penguins and seals, apart from the molluscs. This is especially interesting because both species are vulnerable to simple techniques of human predation, penguins because they are flightless and seals because they spend some periods relatively immobile on the sea shore. Both also suffer casualties during the breeding months, when many individuals are washed ashore and can be taken with little effort or skill. Sea-bird mortalities affect cormorants, gannets and penguins, and during the summer breeding months mortalities occur among over-strained adults as well as among chicks and nestlings. A seasonal mortality peak is also recorded for the Cape fur seal among individuals of weaning age. The young are born in early summer and weaned in winter, when the mothers must support rapidly growing foetuses. The juveniles must fend for themselves in the rough storms of the Cape winter, and large numbers are washed ashore dead or exhausted. Weak birds or seals can easily be despatched with informal tools such as sticks picked up on the beach. The body-part distributions and age and seasonality profiles of the seal and penguin remains at Klasies River Mouth would repay detailed examination to test the hypothesis that they are the product of washed-up individuals scavenged from the sea shore.

It would obviously be mistaken to suppose that, because most evidence of Pleistocene coastal utilisation is unavailable to study, it could not have existed. Equally it would be mistaken to suppose that, because there is some Pleistocene evidence, all Pleistocene coastal economies were organised in the same way as their Holocene counterparts, with exploitation of the same types of marine resources in the same way and with the same degree of intensity. Some Holocene middens appear in the archaeological record as soon as the late glacial sea-level rise brought the sea shore close enough to known archaeological sites to ensure abundant representation of marine food remains within their deposits. This could be argued, for example, in the case of long cave sequences along the rocky coastlines of northern Spain (Clark and Straus 1983), of the Cape coast of South Africa (chapter 3), and of Tasmania (Jones 1977). The presumption here is that the coastal economy had already been in existence in developed form for some millennia previously, with the earlier evidence now resting on some submerged coastline. On other coastlines, however, there is a time-lag of many millennia in the Holocene before the appearance of the earliest coastal shell middens, despite the availability of marine and coastal resources at an earlier period and apparently favourable conditions of archaeological preservation. In some of these cases time-lages in the establishment of estuarine and inshore environments favourable for large colonies of molluscs is the critical factor (Bailey 1983, Beaton 1985). In other cases cultural or demographic factors may be relevant variables. As is discussed below, the pattern of Holocene coastal economies is not a uniform one, nor does it show a unidirectional trend through time. A similar degree of variation is likely for earlier periods in the Pleistocene.

Patterns of change within the Holocene

This theme is a major consideration for many of the following chapters, and questions of environmental change loom large in many of the discussions, although these are far from being the only factors that have contributed to temporal patterns.

One obvious factor promoting change is straightforward environmental change which affects the distribution of species habitats. Change of sea temperature (chapter 3, chapter 5 and chapter 6), or changes in inshore sediments resulting from the subtle interplay of minor sea-level changes and isostatic rebound effects (chapter 5 and chapter 7) are commonly cited factors which have altered the availability or productivity of marine resources.

Indirect environmental changes are those climatic or other environmental factors which affect the terrestrial resources available for exploitations, and thus have an impact indirectly on patterns of coastal and marine exploitation. The reduction in terrestrial animal biomass on the Cape coast with the climatic changes of the early Holocene (chapter 3), the contraction of the coastal plain in California with the final stage of sea-level rise and the consequent reduction in seed plant habitats (chapter 6), and the expansion of dense rainforest in Tasmania (chapter 4), are all examples of negative indirect environmental effects, which, by reducing the availability of

terrestrial resources, had an impact on the exploitation of marine resources.

As Glassow *et al.* point out (chapter 6), environmental changes, especially negative ones affecting the productivity of terrestrial resources, do not of themselves predetermine the direction of economic change, although they may be critical factors affecting the timing of change. Human populations can respond in different ways to environmental stress of this kind. One response is to intensify the use of marine resources which were previously available but neglected or exploited less intensively. A case for this sort of response is made by Yesner (chapter 5) and Glassow *et al.* (chapter 6). Anderson's discussion of the decline in moa hunting in New Zealand (chapter 8), and its relationship to subsequent changes in marine exploitation, offers a similar type of explanation for the sequence of events in New Zealand, although in this case the decline in the supply of terrestrial resources appears to have been due to over-exploitation rather than to environmental deterioration.

Demographic pressure resulting from population growth can initiate a similar sequence of intensification, and some evidence for this effect is discussed by Glassow *et al.* and Yesner, although there are likely to be problems in distinguishing the separate contributions of independent population growth and environmental deterioration to population pressure and subsequent intensification. To this extent some of the case studies presented here would seem to support the views of Clark (1952) and Osborn (1977b), that marine resources represent an untapped reservoir of food which was incorporated into human subsistence economies only when terrestrial food supplies came under increasing pressure. The interplay between the marine and terrestrial sectors of the subsistence economy provides an interesting field for investigation. For example, there is some indication in Bowdler's discussion (chapter 4) of the changes that followed the opening up of the Tasmanian rainforest by fire, that the pattern of marine exploitation was reorganised in response to a rescheduling of terrestrial exploitation patterns. However, it should be noted that the relationship of the marine and terrestrial components of the economy is not only in one direction. Parkington *et al.* (chapter 3) and Akazawa (chapter 7) present evidence which suggests that environmental changes caused a reduction in the availability of marine resources, with a consequent intensification of exploitation on land.

Another factor that may promote changes in the organisation of the economy is the effect of competition between neighbouring groups of people. There is some evidence for this effect in the final stages of the sequence discussed by Parkington *et al.*, when the pre-existing economy shows signs of a reorganisation of subsistence and site locations in response to the intrusion of pastoralists into the southern Cape.

Environmental variables clearly dominate discussions of economic change, either as positive factors, or in a negative sense in that other sorts of change often depend on the elimination of environmental factors. Because of the many environmental variables which impinge on the coast edge and its resources, the probability of environmental change on a time-scale of millennia is very high, and cannot therefore be lightly dismissed. Controlling for environmental change is made yet more difficult, paradoxically, as more data becomes available. The ambiguities and contradictions of different sources of environmental data are well brought out by Glassow *et al.*'s discussion of the evidence for climatic change on the California coast.

A further problem is the problem of biases in the archaeological record. Several of the sequences discussed show a hiatus of human occupation at about the period of the mid-Holocene climatic optimum, notably in California (Glassow *et al.*) and in southern Africa (Parkington *et al.*). This might be due either to destruction or submergence of sites, or to reduction in coastal population densities because of the adverse effects of environmental changes at that time. Obviously this sort of problem becomes more difficult to resolve as one goes further back in time.

A final point highlighted by contrasting case studies from different parts of the world is the possible impact on recent patterns of the previous trajectory of human occupation in the region in question. For example, the time-span of human occupation in New Zealand is about 1,000 years, in the higher latitude environments of the northern hemisphere, only available for occupation after the glacial retreat, not more than 10,000 years, and in the lower-latitude zones of well-established human occupation in the Old World, such as the coastlines of southern Europe and Africa, at least 100,000 years. In the case of New Zealand, Anderson (chapter 8) suggests that the short time-span of human occupation may be related to the relative instability of the economy and the rapidity of economic change, due to the confrontation between a 'naive' human predator and a 'naive' prey in the form of the moa which was vulnerable to over-predation. How far the greater time depth of human occupation in other areas contributed to greater stability or inertia in the interaction of human and environmental systems is a matter which remains to be explored.

Sedentism

There are a number of examples of sedentism amongst the ethnographies of non-agricultural coastal people, the best known being the American Indians of the north-west coast of North America. These are of great interest in providing an alternative perspective on the factors that give rise to sedentary life. Examples of sedentism and the features associated with it are discussed in the final four chapters of the book. From an archaeological point of view there are four issues to be examined: (1) what constitutes a sedentary economy and how far can sedentism be defined as a category distinct from seasonal mobility; (2) how effectively can sedentism be identified in the archaeological record; (3) in what circumstances does sedentism occur and when did it first appear in the prehistoric record; (4) what are the consequences of

coastal sedentism in terms of population growth and social complexity.

It is clear that in many respects sedentary coastal economies entail a whole range of features which set them apart from the conventional stereotype of the seasonally mobile hunter-gatherer. As discussed by Renouf (chapter 9), these include large settlements with permanent structures, elaborate technologies which include permanent storage facilities and effective water transport, and social hierarchies (see also Rowley-Conwy 1983). On the other hand it is clear from looking more widely at the coastal ethnographies of the west coast of North America and elsewhere that there is something of a continuum between the fully sedentary coastal economy, in which most people stay in one settlement for most of the year, and the fully mobile economy where most people make at least one move between more or less seasonal occupations in different locations. This boundary area between the two extremes is sometimes accommodated by the concept of the sedentary-cum-mobile economy, and this sort of intermediate pattern of settlement seems in fact to be very common in coastal contexts, with a greater or lesser number of the community moving to a varied number of locations in the landscape for particular resources but being tied to a single fixed base which represents the pivot of the settlement system. This type of pattern is common in California and in parts of Australia, and additional examples from New Zealand are described by Anderson (chapter 8).

Existence of such a continuum naturally poses methodological problems of identification. A wide range of seasonal indicators can be used to identify seasonal patterns in the exploitation of particular resources, and many examples are discussed throughout the following chapters. A fundamental problem with all seasonality studies, however, as pointed out by Anderson, is that while it is easy to prove the presence of people at a site in a particular season, it is much more difficult to prove their absence. Food storage and deferred consumption further complicate the picture, and there are many potential ambiguities in seasonality information which may result in the same body of data being used to support entirely opposite conclusions about settlement pattern (see chapter 9). The choice between a seasonal or a sedentary interpretation may rest as much on indirect clues, such as the nature of the structures present on a site and the variety and complexity of the artefactual data, and these sorts of indirect clues are notorious sources of circular argument.

Seasonality techniques are of course open to the risk of being pursued as ends in themselves, and it is important to be clear about how they may contribute to wider issues of interpretation. The interest of seasonality data is not so much the evidence of seasonality *per se* as the light it casts on the nature of resource scheduling – the ways in which people decide to combine the exploitation of various resources available at different times and places. Indeed it is scheduling which seems to provide the common thread linking the sedentary and mobile variants of coastal settlement, with the emphasis in the sedentary examples on the integration of a succession of seasonal resources which occur in the *same* place, and in the mobile examples on the integration of a succession of seasonal resources which occur in *different* places. It is this feature of economic organisation which might most profitably be investigated further, especially since it also provides a link with the organisation of farming economies (chapter 10).

Another scheduling problem arises in situations where different resources become available for exploitation in different areas at the *same* time. As Binford (1980) has noted, this is a characteristic problem in high-latitude terrestrial environments, and is met by a logistic or collecting strategy, in which different task groups of individuals from the community move to different locations in the landscape to exploit specific resources, which are then cached or brought back to the base camp for later consumption. Conversely, in low-latitude terrestrial environments, where resources are available in different areas at different seasons, a foraging strategy is employed, in which the majority of people move their base camp from place to place as the resources in different areas become available (cf. chapter 3).

Food storage is an important concomitant of many sedentary coastal economies. One necessary precondition for practising food storage is the availability of a concentrated food supply at a particular season which exceeds the immediate requirements of the human population. Many coastal environments supply short-lived surpluses in the form of migratory fish and sea mammals. Other preconditions are seasons of general food shortage which provide the incentive for storing the surplus from previous seasons of plenty, and the technology for processing and storing the surplus food. From one point of view we could regard food storage as an extension of the principle of scheduling, an additional strategy – or an alternative to group mobility – for smoothing the supply of food. In terms of Binford's classification it is an activity more congruent with the organisation of logistic collectors than with foragers. Here, as in other respects, there is no clearcut distinction between the sedentary and the mobile economies, since food storage may be practised in the latter case as well as the former, most notably amongst the high-latitude hunters like the Nunamiut Eskimo. It is worth noting also that many of the best-known cases of coastal sedentism involving a large element of food storage occur on high-latitude coasts – around the northern coasts of North America, in Scandinavia, and on some of the higher-latitude coastlines of the southern hemisphere, such as the South Island of New Zealand (chapter 8). If there is any general contrast to be drawn between different types of economies, the polarity would seem to lie less along a spectrum from sedentary coastal communities who practise food storage to mobile interior communities who do not, but rather more on a spectrum from high-latitude economies, whether coastal or interior – sedentary or mobile – for whom some element of food storage is essential to survival, and low-latitude economies where a foraging mode of economic organisation prevails.

As for the circumstances which first gave rise to sedentism, broadly two views are current: that sedentism is an opportunistic response to appropriate environmental circumstances, wherever or whenever these occurred; or that it is a response to demographic stress at a relatively late stage in the prehistoric record (Perlman 1980, Rowley-Conwy 1983). The arguments for and against the second view are similar to those discussed above in relation to the view that intensive use of marine resources generally was a late development. We prefer the former view, at least to the extent that we do not see why late Pleistocene coastal environments with the appropriate characteristics should not have given rise to sedentary settlement patterns. The major problem with pursuing this idea is our general lack of detailed information about the nature of late Pleistocene coastlines. Whether sedentary economies with an element of food storage occurred before the appearance of anatomically modern *Homo sapiens sapiens* is another matter, since it is questionable whether the intellectual capacity for scheduling, forward planning and storage, which feature among the later prehistoric examples, were within the grasp of earlier human populations. But this is largely a matter of speculation at present.

The consequences of sedentism are often described in terms of sustained population growth, leading to further intensification, complexity, emigration and competition. In highly-productive marine environments such as that described by Moseley and Feldman in Peru (chapter 11), an upwardly spiralling process of development has clearly been nurtured by the immensely productive inshore fisheries of the area. However, other coastlines with an apparently comparable potential productivity seem not to have given rise to the same sort of development. One of the striking features of the high-latitude environments such as that described by Renouf (chapter 9) is the remarkable stability of settlement and economy over many millennia. Similarly, the supposition that coastal sedentism provides a favourable setting for the development of crop agriculture is not well supported by the examples to hand. The best-known cases of coastal sedentism – ethnographically known or prehistoric – come from areas which are poorly suited to crop agriculture, for example in the higher latitudes of North America, coastal California and Scandinavia. In some cases, notably prehistoric Denmark but also coastal California, the success of the coastal economies and the high population densities they were able to support seem actually to have delayed the introduction of crop agriculture rather than to have encouraged its adoption.

As to whether there is any necessary connection between sedentism and social complexity, the position is far from clear. Quite apart from the difficulties of defining complexity, one might cite examples of sedentary economies, for example on tropical coastlines, which lack complexity, or at any rate complexity of the type commonly associated with high-latitude coastal economies. As with food storage, there is a danger of postulating a necessary relationship where none exists, and of perpetuating circular arguments, in which sedentism is claimed as evidence of complexity, and *vice versa*. It may even be questioned whether sedentism is a useful, let alone a necessary, archaeological concept for identifying other facets of social and economic organisation.

On the whole, the evidence presently available is far too patchy to support the notion of a uniform Holocene trend towards coastal sedentism as a key stage in subsequent developments. Like many other features of human activity on prehistoric coastlines, sedentism seems to have participated in different temporal trajectories, with different sources of origin and different sorts of consequences. Only more extensive investigation and comparison of case studies of the type discussed in this volume will help to identify what, if any, are the common threads of development.