Research Report 149

Prehistoric Coastal Communities: The Mesolithic in western Britain

Martin Bell

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by Martin Bell

This book is dedicated to the late **Derek Upton**

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Front cover illustration: Panorama reconstructing various aspects of Mesolithic life and activities at Goldcliff East (copyright © painting courtesy of the artist Victor Ambrus)
Back cover illustrations: (top) Footprint-track of Person 13, Site C
(bottom) Aerial photograph of Goldcliff East (Crown copyright. RCAHMW)

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Wide dissemination of the results of funded scientific research is now rightly expected and we are grateful to those who have helped us to achieve that objective. This research featured in a number of television programmes. Thanks must go to 'Time Team', particularly Tim Taylor, Michael Douglas, Professor Mick Aston, Dr Francis Pryor, Tony Robinson, Phil Harding, and Kate Edwards. We also thank Julian Richards who covered the project as part of the 'Meet the Ancestors' series and we offer our thanks for the coverage of the excavation in the BBC 'Coast' series presented by Nick Crane.

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To these and all others who have helped or encouraged our research in any way we extend our grateful thanks.

Martin Bell

Preface: the printed report and the CD *by Martin Bell*

A CD accompanies and supports the printed volume:

M Bell 2007 *Prehistoric Coastal Communities: The Mesolithic in western Britain*, CBA Research Report 149. York: Council for British Archaeology

This report presents new evidence for the later Mesolithic and early Neolithic periods in Wales and adjoining areas of western Britain, taking a wide study area including the whole of Wales and adjoining areas from north Devon to Merseyside. The coastal archaeology of the period is outlined. Detailed evidence is presented from two case areas. The first is the Severn Estuary where the results of recent excavations of Mesolithic sites at Goldcliff East are presented and compared with other Severn Estuary sites. The second case study is of late Mesolithic and early Neolithic middens in the Prestatyn area of north Wales. In both case studies there is a particular emphasis on the use of a range of sources of palaeoenvironmental evidence to reconstruct the context and nature of human activity. New evidence from the case study areas provides the basis for re-examination of earlier finds leading to the development of models for the wider study area. These particularly concern economy, settlement pattern, environmental manipulation and seasonality.

The printed report is supported by a CD which is supplied with every copy. We appreciate that not every reader will be able, or wish, to consult the CD, so our objective has been that the printed report can be read and understood without reference to the CD. The purpose of the CD is to provide a range of supporting information which will be particularly useful to the more specialist reader such as those wishing to re-examine the interpretations and conclusions, or those with a particular interest in more detailed aspects of the scientific evidence. The inclusion of the CD is advantageous in many ways. An interdisciplinary project of this kind provides a large amount of tabular data relating to the species of plants and animals present. That evidence is essential to support the interpretations reached but it would otherwise take up much space in the text and may sometimes disrupt its flow.

Inclusion of the CD also enables us to include large numbers of colour photographs and coloured plans supplementing the black and white photographs and line drawings in the printed report. In the case of some particularly important or complicated plans, they are reproduced in black and white in the printed report and colour on the CD where some of the detail is clearer and can be magnified. The colour photographs are especially valuable in the reporting of the human and animal footprint tracks where the photographs are an important part of the primary field archive. Colour photographs are also vastly preferable to black and white for soil and sediment sequences exposed in sections, for the sediment micromorphological thin sections and in high definition images of the microwear on stone tools. The CD also enables us to include a far larger number of images of the excavations themselves, conveying a clearer impression of the methods employed, the conditions under which the work was done, as well as some scenes of field and camp life. We also include some images showing the making of television programmes about the excavation.

The CD also enables us to include a short profile of the work and background of each of the authors of the report. We do so because we think it may be helpful to the reader to know something of the background from which members of the team have approached their contribution to this project and also to be aware of other activities and publications for which they are responsible. It also gives tangible expression of the fact that this is very much a team effort, drawing on the specialist skills and commitment of many people. Most significant in this respect is the digging team who worked often under very difficult conditions, and we include some group photographs of the team as well as many photographs of them at work.

The CD is arranged in the same order as the printed report; it is divided into sections which correspond to the chapters of the report. CD 1.1 relates to Chapter 1 and is the first CD entry supporting that chapter: CD 14.7 relates to Chapter 14 and is the seventh entry supporting that chapter. Within each section the order corresponds to the order of that chapter. This means that those readers wishing to consult the CD for additional plans, photographs, tables, text etc can do so with the CD loaded on a computer in front of them simply scrolling forward to the next entry as they read the relevant section of text. For the more general reader this works equally well in providing additional colour photos etc. By making use of the index for each section and the master index for the whole CD, other sections of the CD can be easily accessed. Thus, the CD can be consulted in whatever sequence required. Buttons provide links between related pages.

Most of the tables of data are on the CD, with the exception of tables of radiocarbon dates and other information which is essential to be able to understand key arguments developed in the text. The CD also contains some more detailed supporting text. This mainly provides additional information on the human and animal footprint-tracks and also on some aspects of research at Prestatyn – especially our investigations and environmental analysis of the Melyd Avenue site which is only briefly summarised in the printed report.

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Summaries

Coastal wetland sites provide a new perspective on the Mesolithic and early Neolithic of western Britain. The area considered is Wales and adjoining areas of England from north Devon to Merseyside. Many of the submerged forests and intertidal peats in this area fall in the date range 7000–3500 cal BC. Mesolithic finds have been made in a range of intertidal contexts over the last 146 years. The contribution which coastal sites can make to our understanding of the archaeology of these periods is examined using case studies from the Severn Estuary and the Prestatyn area of north Wales.

The most detailed case study is the Mesolithic site of Goldcliff East in the Severn Estuary. Occupation areas on the edge of a former island were excavated; these had been progressively inundated by sea-level rise and sediment deposition between *c* 6000 and 4800 cal BC. Successive occupations occur in an Old Land Surface and Lower Submerged Forest, in overlying reed peat, and are buried by later laminated silts and an Upper Submerged Forest. Excavations are described at four locations. The evidence includes later Mesolithic lithic assemblages (with some evidence of lithic microwear), worked wood, and bone artefacts. Deer, aurochs, and boar were the main animals exploited and there is evidence for fishing, especially eels. Plant macrofossils demonstrate the use of resources from coastal woodland edge environments. It is argued that burning episodes in the submerged forests and reedswamp represent deliberate activities by Mesolithic communities, mainly to benefit plants resources. Human intestinal parasites (*Trichuris* sp) are the earliest recorded archaeologically and show that defecation areas were close to activity areas.

Of special significance is the preservation within laminated silts of human footprint-tracks. A large proportion of these belong to children, some as young as 3–4 years old. The presence of children in saltmarsh and mudflat environments indicates that they were fully engaged in the activities of the Mesolithic community. Footprint-tracks of animals, including birds such as the crane (that is today non-native) are associated with the human prints and provide the opportunity for comparison with the faunal evidence from animal bones. The laminated sediments are annually banded and some footprints were made in the warm and calm conditions of high summer. A range of plant and animal evidence shows that the main activity on these sites took place in late summer and autumn with evidence of some activity in spring. The density of artefacts is insufficient to suggest sedentary coastal communities living there year-round – rather it suggests periodic visits to the coast at various times of year. There is possible evidence of shelters and a wide range of activities are represented on at least two of the sites. The implication seems to be that they were short-term camps occupied for a few weeks at a time.

Dendrochronological sequences have been developed from oaks in the Lower and Upper Submerged Forests. Neither can yet be absolutely-dated but both have been reasonably precisely dated by 'wiggle-match' radiocarbon dating of a sequence of tree-rings. The trees making up successive woodland communities in the submerged forests have been planned and identified and there is detailed pollen investigation and linked sequences of insect evidence from the peats. This provides a detailed picture of coastal environmental change and the role and effects of human communities within this highly dynamic environmental setting.

The Goldcliff case study is compared with smaller-scale investigations, including detailed pollen studies, on other Severn Estuary sites at Llandevenny, Oldbury, Woolaston, and Hills Flats. The first two have produced Mesolithic lithic artefacts and evidence for the use of plant resources and all four have evidence for burning in the later Mesolithic and/or Neolithic.

Another case study is in the Prestatyn area of north Wales. Here several small mussel and cockle shell middens are dated to the later Mesolithic and early Neolithic, between 4500–3400 cal BC. The middens are stratified at the edge of a coastal wetland sequence where an Old Land Surface is overlain by tufa and peats preserving pollen, plant macrofossils, land, and marine shells. Again, the environmental context of Mesolithic activity was highly dynamic, but the character of activity remained essentially the same: short-term visits to a field camp for shellfish exploitation in late winter to early spring. Investigation of the environmental sequence here provides the opportunity to review several earlier discoveries in the Prestatyn and Rhyl areas and more widely within north Wales. These include a human skeleton at Prestatyn, which is now shown to be contemporary with the Neolithic middens. Previous discoveries on the foreshore at Rhyl are also reviewed and here fieldwork has also led to the finding of animal and human footprint-tracks.

The Severn Estuary and Prestatyn case studies provide the basis for a review of the Mesolithic and initial Neolithic in the wider research area of Wales and adjoining areas of western Britain. Discoveries elsewhere reinforce the view that submerged forests and coastal wetlands are an important source of evidence for these periods. Burning is shown to be widespread in coastal contexts. It is argued that the main axes of seasonal movement were up the river valleys and that burning took place at both the upland and coastal woodland edges. A model of seasonal movement is proposed which is more complex than earlier winter coast/summer upland models. The proposed model envisages the main activity on the coast in autumn with smaller-scale activity in early spring, summer, and at times during the winter. None of the evidence points to coastal Mesolithic sedentism hypothesised by some previous writers. Overall, the Mesolithic of this study area calls into question evolutionary models of greater sedentism and social complexity towards the later Mesolithic.

Many sites such as Prestatyn, Llandevenny, and Oldbury, but not apparently Goldcliff, show evidence of activity in both the later Mesolithic and Neolithic and on some sites there is evidence of environmental manipulation in both periods. Current hypotheses concerning the Mesolithic/Neolithic transition are reviewed. It is concluded that a significant factor determining the location of Neolithic sites is likely to have been the structure of vegetation communities created by preceding Mesolithic activity, particularly burning and the network of trackways along which people and animals habitually moved. Vegetation patterns are considered to be significant in creating continuities of activity over extended timescales, a principle which might be called the structuration of landscape by antecedent conditions. It is proposed that such continuities may be created by landscape structures whether or not there is continuity of population, economic activity or belief system involving particular landscape topographic features.

Résumé

Les sites côtiers de terres humides offrent une nouvelle perspective sur le mésolithique et sur le début du néolithique dans l'Ouest de la Grande-Bretagne. Les régions prises en considération sont le pays de Galles et les zones adjacentes de l'Angleterre, du Nord du Devon au Merseyside. Nombre des forêts submergées et des tourbes intertidales dans ces régions se situent dans l'échelle des dates allant de 7000 à 3500 avant J.-C. Des découvertes mésolithiques ont été faites dans divers contextes intertidaux durant les 146 dernières années. Ce que peuvent apporter les sites côtiers à notre compréhension de l'archéologie de ces périodes est examiné par le biais d'études de cas provenant de l'estuaire de la Severn et de la région de Prestatyn au nord du pays de Galles.

L'étude de cas la plus détaillée est celle du site mésolithique de Goldcliff East dans l'estuaire de la Severn. Des zones d'occupation au bord d'une ancienne île avaient été fouillées; ces zones avaient été progressivement inondées par la hausse du niveau de la mer et le dépôt de sédiments entre environ 6000 et 4800 avant J.-C. Des occupations successives se produisent dans une surface d'ancienne terre et dans la forêt submergée inférieure, dans la tourbe de roseaux les recouvrant, et sont enterrées sous des vases stratifiées en fines couches ultérieures et sous une forêt submergée supérieure. Les fouilles sont décrites à quatre endroits. Les indices comprennent des ensembles de pierre de la fin du mésolithique (avec quelques indices de micro usure des pierres), du bois façonné, et des objets fabriqués en os. Les cerfs, les aurochs et les sangliers étaient les principaux animaux exploités, et il y a des indices de pêche, tout particulièrement des anguilles. Des macrofossiles végétaux témoignent de l'utilisation des ressources provenant des environnements des lisières de forêts côtières. On soutient que les épisodes de brûlis dans les forêts submergées et les marécages de roseaux représentent des activités délibérées entreprises par des communautés mésolithiques, principalement dans le but de favoriser les ressources végétales. Des parasites intestinaux humains (Trichuris sp) sont les plus anciens relevés par l'archéologie et montrent que les zones de défécation étaient proches des zones d'activités.

La préservation, au sein de vases stratifiées en fines couches, de traces d'empreintes humaines est tout particulièrement significative. Une grande proportion de ces traces sont celles d'enfants, dont certains n'ont que 3 ou 4 ans. La présence d'enfants dans des environnements de marais salants et de laisses de vase indique qu'ils participaient à part entière aux activités de la communauté mésolithique. Des traces d'empreintes d'animaux, y compris des oiseaux tels que la grue (qui n'est plus un oiseau autochtone à l'heure actuelle) sont associées aux empreintes humaines et offrent la possibilité de faire une comparaison avec les indices de faune représentés par les os d'animaux. Les sédiments stratifiés sont en bandes annuelles et certaines empreintes avaient été faites lors des conditions chaudes et calmes du milieu de l'été. Tout un éventail d'indices végétaux et animaux indique que les principales activités sur ces sites avaient lieu à la fin de l'été et en automne et il y avait des indices témoignant d'une certaine activité au printemps. La densité des objets fabriqués ne suffit pas pour suggérer que des communautés côtières sédentaires vivaient là toute l'année – elle suggère plutôt des visites périodiques de la côte à diverses saisons de l'année. Il y a des indices possibles d'abris et une grande variété d'activités est représentée dans au moins deux des sites. Ceci paraît sous-entendre qu'il y avait des camps à court terme, occupés pendant quelques semaines de suite.

Des séquences dendrochronologiques ont été développées à partir de chênes dans les forêts submergées inférieure et supérieure. Ni l'une ni l'autre ne peut être datée dans l'absolu mais toutes deux ont été datées relativement précisément par une datation au radiocarbone par 'appariement des ondulations' [wiggle-match] d'une séquence de cercles des arbres. Les arbres qui constituent des communautés successives de bois dans les forêts submergées ont été planifiés et identifiés, et il y a

une enquête détaillée sur le pollen et les séquences liées d'indices d'insectes provenant des tourbes. Ceci fournit un tableau détaillé des changements de l'environnement côtier, et du rôle et des effets des communautés humaines au sein de ce cadre environnemental extrêmement dynamique.

L'étude de cas de Goldcliff est comparée à des enquêtes à plus petite échelle, y compris des études détaillées du pollen, portant sur d'autres sites de l'estuaire de la Severn, à Llandevenny, Oldbury, Woolaston, et Hills Flats. Les deux premiers sites ont fourni des objets fabriqués en pierre du mésolithique et des indices d'utilisation des ressources végétales, et tous les quatre ont des indices de brûlis à la fin du mésolithique et / ou au néolithique.

Une autre étude de cas se situe dans la région de Prestatyn, au Nord du pays de Galles. Ici, plusieurs petits amas de coquilles de moules et de coques sont datés à la fin du mésolithique et au début du néolithique, entre 4500 et 3400 avant J.-C. Les amas sont stratifiés au bord d'une séquence de terres humides côtières où une surface d'ancienne terre est recouverte de tuf calcaire et de tourbes préservant des pollens, des macrofossiles végétaux, des coquilles terrestres et des coquilles marines. Une fois de plus, le contexte environnemental des activités mésolithiques était extrêmement dynamique mais le caractère des activités restait essentiellement le même : des visites à court terme à un camp sur le terrain pour l'exploitation des coquillages à la fin de l'hiver et au début du printemps. Une enquête sur la séquence environnementale qui se trouve ici a donné la possibilité de faire le point sur plusieurs autres découvertes antérieures dans les régions de Prestatyn et de Rhyl, et de façon plus générale dans le Nord du pays de Galles. Elles englobent un squelette humain à Prestatyn, dont on a montré à l'heure actuelle qu'il est de la même époque que les amas néolithiques. Des découvertes antérieures sur l'estran de Rhyl sont également réexaminées et, ici, le travail sur le terrain a également mené à la découverte de traces d'empreintes animales et humaines.

Les études de cas de l'estuaire de la Severn et de Prestatyn fournissent la base pour la mise en revue du mésolithique et du début du néolithique dans la zone de recherches plus large du pays de Galles et des régions adjacentes de l'Ouest de la Grande-Bretagne. Des découvertes dans d'autres lieux renforcent l'opinion que les forêts submergées et les terres humides côtières constituent une importante source d'indices pour ces périodes. On montre que les brûlis sont répandus dans les contextes côtiers. On soutient que les principaux axes de mouvements saisonniers se faisaient en remontant les vallées fluviales et que les brûlis avaient été faits en lisière des bois des hautes terres aussi bien que des bois des côtes. On propose un modèle de mouvement saisonnier qui est plus complexe que les modèles précédents d'hiver sur la côte et d'été dans les hautes terres. Le modèle proposé envisage l'activité principale sur la côte en automne et une activité à plus petite échelle au début du printemps, en été et à certains moments de l'hiver. Aucun des indices n'indique une sédentarité côtière durant le mésolithique qui serait conforme à l'hypothèse de certains écrivains antérieurs. Dans l'ensemble, le mésolithique de cette région d'étude met en question les modèles évolutionnaires d'une complexité sociale et d'une sédentarité plus importantes vers la fin du mésolithique.

De nombreux sites tels que Prestatyn, Llandevenny, et Oldbury, mais apparemment pas Goldcliff, montrent des indices d'activité à la fin du mésolithique ainsi qu'au néolithique et, sur certains sites, il y a des indices de manipulation environnementale pendant les deux périodes. Les hypothèses courantes concernant la transition du mésolithique au néolithique sont réexaminées. On conclut que la structure des communautés de végétation créées par une activité mésolithique antérieure, tout particulièrement les brûlis et le réseau de sentiers le long desquels les gens et les animaux se déplaçaient d'habitude, constitue probablement un facteur significatif déterminant l'emplacement des sites néolithiques. On considère que les modèles de végétation sont significatifs en ce qui concerne la création de continuités d'activités sur des échelles de temps prolongées, un principe qui pourrait être intitulé la structuration du paysage par les conditions antérieures. On suggère que de telles continuités peuvent être créées par les structures du paysage, qu'il y ait ou non une continuité de population, d'activité économique ou de système de croyances entraînant l'existence de particularités topographiques spécifiques du paysage.

Zusammenfassung

Küstenfeuchtgebiete eröffnen uns neue Perspektiven zur archäologischen Erforschung des Mesolithikums und frühem Neolithikum in Westen von Großbritannien. Das hier behandelte Gebiet erstreckt sich über den Küstenstreifen in Nord Devon im Süden über Wales südlich bis nach Merseyside im Norden. Viele der überfluteten Wälder und Torfschichten sind nur bei Ebbe sichtbar und wurden auf 7000 bis 3500 cal vor Chr. datiert. Über einen Zeitraum von 146 Jahren wurden Funde aus dem Mesolithikum in verschiedenen Gezeitenzonen entdeckt. Den Beitrag, den diese Küstenfunde zu unserem Verständnis der Archäologie dieses Zeitabschnittes machen können, wird anhand von Fallstudien aus der Severn Mündung und den Küstenstreifen in Prestatyn in Nord Wales untersucht.

Die meisten Details stammen aus einer Fallstudie einer mesolithischen Fundstelle aus Goldcliff East in der Severn Mündung. Siedlungsspuren am Rand einer damaligen Insel wurden freigelegt; diese wurden im Zeitraum von 6000 und 4800 Jahren vor Chr. nach und nach durch Anstieg des Meerespiegels überflutet und einsedimentiert. Eine Serie von Siedlungsphasen werden beschrieben, die früheste aus der 'Old Land Surface' (die älteste

Bodenschicht), und dem 'Lower Submerged Forest' (unterer überfluteter Wald). Ausgrabungsergebnisse aus vier Arealen werden beschrieben. Fundgruppen bestehen unter anderem aus Steinwerkzeugen (zum Teil mit Abnutzungsspuren), bearbeitetem Holz und Artefakte aus Knochen. Rotwild, Auerochsen und Wildschwein waren die wichtigsten Jagdtiere, außerdem gibt es Beweise für Fischfang, vor allem Aale. Pflanzenreste bezeugen die Nutzung des Saums der früheren Küstenwälder. Es wird argumentiert, daß mesolithische Siedler für Brandepisoden in den überfluteten Wäldern und Schilfgebieten verantwortlich waren, um die Vegetation zu nutzen. Menschliche Darmparasiten (*Trichuris* sp) werden zum ersten Mal in einem archäologischen Zusammenhang identifiziert, und es wird gezeigt, daß sich der Toilettenbereich in der Nähe der anderen Aktivitäten befanden.

Von besonderer Bedeutung sind die gut-erhaltenen menschlichen Fußspuren aus den laminierten Sedimentschichten. Viele davon stammen von Kindern, manche erst 3–4 Jahre alt. Spuren von Kinderfüßen deuten darauf hin, daß die Kinder voll in die Aktivitäten der Erwachsenen im Salzmarsch und Watt mit einbezogen waren. Spuren von Tieren, wie zum Beispiel Kranich (die heute nicht mehr einheimisch sind), sind mit den menschlichen Fußspuren zeitlich übereinstimmend und geben uns die Gelegenheit, Vergleiche mit den Tierknochen zu erstellen. Die laminierten Sedimente haben dünne jährliche Schichten und einige der Fußspuren stammen aus der wärmeren und ruhigen Phase des Hochsommers. Die Vielfalt von Pflanzen und Tierüberresten deutet darauf hin, daß die wichtigsten Aktivitäten hauptsächlich im Spätsommer und Herbst stattfanden, einige aber auch im Frühling. Artefakte sind nur spärlich verbreitet und lassen vermuten, daß die Bewohner nicht ganzjährig ansässig waren – es handelt sich vielmehr um regelmäßige Besuche der Küste zu verschiedenen Zeitpunkten. Es gibt Überreste von Hütten und an mindestens zwei Fundplätzen können verschiedenartige Aktivitäten nachgewiesen werden. Daraus wird gefolgert, daß es sich um kurzfristige Lager handelt, die für nur einige Wochen bewohnt wurden.

Dendrochronologien wurden mit Hilfe der Eichen aus dem Unteren und Oberen versunkenem Wald erarbeitet. Sie sind zur Zeit noch nicht absolut datiert, aber beide wurden durch Radiocarbondatierung einer Jahrringsequenz so präzise wie möglich datiert. Die Bäume, die Teil einer sukzessiven Pflanzengemeinschaft in den überfluteten Wäldern bildeten, wurden kartiert und identifiziert, und mit detaillierten Pollenstudien und Insekten aus den Torfschichten verbunden. Das Resultat ist ein detailliertes Bild der Umweltveränderungen im Küstengebiet und der Rolle, die die Menschen in diesem dynamischen Lebensraum gespielt haben.

Die Fallstudie aus Goldcliff wird mit kleineren Studien aus dem Gebiet der Severn Mündung verglichen, unter anderem auch detaillierten Pollenstudien aus Llandevenny, Oldbury, Woolaston und Hills Flats. Bei den ersten beiden wurden Mesolithische Steinwerkzeuge und Hinweise zur Nutzung von Pflanzen gefunden und alle vier Fundplätze hatten Brandepisoden im späten Mesolithikum und/oder Neolithikum.

Eine weitere Fallstudie wird aus Prestatyn in Nordwales beschrieben. Abfallhaufen von kleinen Mies- und Herzmuscheln und wurden auf 4500 bis 3400 Jahre vor Chr. datiert, also auf das späte Mesolithikum und frühe Neolithikum datiert. Die Abfallhaufen liegen deutlich stratifiziert am Rand des Küstenfeuchtgebietes, wo ein Paläoboden von Kalktuff und Torf bedeckt wurde, in denen Pollen, Pflanzenreste, Land- und Meeresmuscheln gut erhalten sind. Auch hier finden Mesolithische Aktivitäten in einer hoch-dynamischen Umwelt statt, aber die Art der Aktivitäten war prinzipiell dieselbe: Kurzzeitige Besuche in einem Lagerplatz, wo im Spätwinter und Frühsommer hauptsächlich Muscheln gesammelt wurden. Die Untersuchung der Umweltveränderungen gibt die Möglichkeit, Vergleiche mit mehreren früheren Entdeckungen aus dem Gebiet um Prestatyn und Rhyl, als auch im weiteren Umfeld in Nordwales anzustellen. Eines dieser Funde ist ein Menschenskelett aus Prestatyn, daß zeitlich mit den Abfallhaufen aus dem Neolithikum eingegliedert werden kann. Frühere Funde entlang der Küste in Rhyl werden hier rezensiert und durch weitere Geländearbeiten wurden Fußspuren von Menschen und Tieren entdeckt.

Die Fallstudien aus der Severn Mündung und Prestatyn bilden den Grundstein für die Neubesprechung der Archäologie des Mesolithikums und Neolithikums im Raum Wales und angrenzenden Gebieten im Westen von Großbritannien. Entdeckungen aus anderen Fundplätzen bestätigen die Annahme, daß die überfluteten Wälder und Küstenfeuchtgebiete eine wichtige Beweisquelle für diese Periode bilden. Brandrodung war in der Küstengegend weit verbreitet. Es wird argumentiert, daß die Hauptaxe der saisonalen Wanderungen flußaufwärts war, und daß Brände sowohl in den Hochlagen als auch an den Rändern der Küstenwäldern stattfanden. Ein Modell der saisonbedingten Wanderungen wird vorgeschlagen, in dem vorhergehende Modelle von Winter/Küste, Sommer/Hochland weiterentwickelt werden. In dem hier vorgestellten Modell finden die wichtigsten Aktivitäten an der Küste im Herbst statt, und kürzere Aktivitäten am Frühlingsanfang, Sommer und zu bestimmten Zeiten auch im Winter. Es gibt keine Beweise, daß es seßhafte Bewohner an der Küste gab, wie von einigen ehemaligen Autoren hypothesiert wurde. Modelle in denen vorgeschlagen wird, daß eine Evolution zur Seßhaftigkeit und sozialer Komplexität im späteren Mesolithikum stattfindet, werden hier in Frage gestellt.

An vielen Fundorten, wie Prestatyn, Llandevenny und Oldbury, aber anscheinend nicht in Goldcliff, gibt es Hinweise auf Aktivitäten die sowohl im Spätmesolithikum als auch im Neolithikum stattfinden und an einigen Fundstellen können Eingriffe in die Umwelt in beiden Perioden nachgewiesen werden. Aktuelle Hypothesen, die sich mit dem Übergang vom Mesolithikum zum Neolithikum beschäftigen, werden diskutiert. Es wird gefolgert, daß ein wichtiger Faktor in der Standortwahl im Neolithikum die Struktur der Vegetationsgemeinschaften war, die im Mesolithikum geschaffen wurde, insbesondere durch Brandrodung und die Schaffung von einem Wegenetz, entlang denen sich Menschen und Tiere bewegten. Vegetationsmuster werden als wichtiger Faktor für zeitliche Kontinuität angesehen, ein Prinzip, das auch 'Strukturation der Landschaft durch vorhergegangene Bedingungen' genannt werden kann. Es wird vorgeschlagen, daß sich die Kontinuität aus der Landschaftsstruktur heraus ergaben hat, unabhängig davon, ob eine Kontinuität der Siedlung, ökonomischer Aktivität oder Glaubenssysteme bestand, für die bestimmte topographische Merkmale genutzt wurden.

Crynodeb

Mae corsdiroedd arfordirol yn cynnig perspectif newydd ar gyfnodau Mesolithig a Neolithig gorllewin Prydain. Yr ardal o dan ystyriaeth ydy Cymru ac ardaloedd cyfagos Lloegr, o ogledd Dyfnaint i lannau Merswy. Mae nifer o goedwigoedd boddedig a mawnogydd rhynglanwol yn yr ardaloedd yma wedi eu dyddio i'r cyfnod rhwng 7000 a 3500 cal CC. Yn ogystal, mae nifer o ddarganfyddiadau Mesolithig dros y can mlynedd a hanner ddiwethaf yn hanu o diroedd rhynglanwol. Archwylir cyfraniad safleoedd arfordirol tuag at ein dealltwriaeth archaeolegol o'r cyfnodau yma gan ddefnyddio astudiaethau lleol o aber yr afon Hafren ac ardal Prestatyn yng ngogledd Cymru.

Mae'r astudiaeth fwyaf manwl yn canolbwyntio ar safle Mesolithig Goldcliff East ar aber yr afon Hafren. Fe gloddiwyd mannau ar ochr cyn-ynys a oedd wedi eu effeithio gan ddyddodiadau lefelau uchel y môr rhwng tua 6000 a 4800 cal CC. Mae yna anheddiadau olynol ar wyneb yr hen dir, y goedwig danddwr isaf ac ar fawn-dir corsen sydd wedi ei orchuddio gan silt laminedig â'r goedwig foddedig uchel. Mae pedwar safle yn cael eu disgrifio. Mae'r dystiolaeth yn cynnwys casglidau lithig Mesolithig diweddaraf (yn cynnwys engreifftiau gyda microdreuliad), pren wedi ei weithio ac arteffactau asgwrn.

Yr anifeiliaid a fanteisiwyd arnynt oedd Ceirw, Bualod Mawr a Baeddod, ac y mae yna dystoliaeth fod pysgota hefyd yn bwysig, yn arbennig ar gyfer Llyswennod.

Mae astudiaeth o ficroffosilau planhigion yn dangos sut roedd yr amgylchedd coedwigol ac arfordirol yma yn cael ei ddefnyddio gan bobol y cyfnod. Mae'r dystiolaeth, o bosib, yn dangos fod llosgi wedi bod yn dechneg a ddefnyddiwyd gan bobol Mesolithig i hybu tyfiant o blanhigion newydd yn y coedwigoedd a'r corsydd. Mae olion parasitiaid (ee.*Trichuris* sp) o goluddion pobol Mesolithig hefyd yn dangos fod mannau carthu yn agos i'r safleoedd byw ac ymysg y cynharaf a recordiwyd erioed.

Un o'r darganfyddiadau mwyaf arwyddocaol yw'r olion traed, rhai ohonynt yn perthyn i blant 3–4 mlwydd oed, a ddarganfyddwyd o fewn y siltiau laminedig. Mae presenoldeb plant ar y môrfau heli a'r fflatiau llaid yma yn awgrymu fod plant ifanc yn cymryd rhan weithredol ym mywyd y gymuned Fesolithig. Mae olion traed anifeiliaid, yn cynnwys adar fel y Goran, sydd yn absennol ym Mhrydain erbyn heddiw, yn cynnig y cyfle i wneud astudiaeth gymharol gyda'r esgyrn anifeliaid darganfyddedig. Mae'r dyddodiadau laminedig yn fandog, fesul blynyddoedd, ac mae'n bosib gweld fod rhai o'r olion traed wedi cael eu gadael yn ystod tymor cynnes yr Hâf. Yn wir mae'r dystiolaeth o'r anifelilaid a'r planhigion hefyd yn dangos taw yn ystod yr Hâf a'r Hydref oedd y rhan fwyaf o weithgareddau arfordirol yma yn digwydd, gyda thipyn llai yn ystod y Gwanwyn. Awgryma dwysedd yr arteffactau fod yr anheddiadau yma yn dymhorol yn hytrach na pharhaol. Mae'n bosib fod yna olion cytiau, neu gysgodfannau, ynghyd â amryw o weithgareddau amrywiol ar ddwy safle o leiaf. Mae hyn oll yn awgrymu fod yna wersylla dros-dro ac achlysurol wedi bod yn yr ardaloedd yma.

Datblygwyd cyfres o ddyddiadau dendrocronolegol Derw o'r coedwigoedd boddedig isaf ac uchaf. Er nid yn ddyddiadau diamod mae'r gymhariaeth radiocarbon yn rhesymol. Mae'r coed boddedig hefyd wedi cael eu dynodi a'u recordio ynghyd ag astudiaeth fanwl o'r paill a'r pryfed cysylltiedig. Mae'r gwaith yma, felly, yn dylunio'n fanwl newidiadau'r tiroedd arfordirol a rôl y cymunedau oedd yn ymweld â'r amgylchedd deinamig yma.

Mae astudiaeth Goldcliff yn cael ei gymharu gydag astudiaethau eraill o aber yr afon Hafren; megis Llandevenny, Oldbury, Woolaston a Hills Flats. Darganfyddwyd arteffactau lithig Mesolithig a thystiolaeth o ddefnydd o blanhigion yn y ddwy safle gyntaf ac y mae yna olion llosgi llysdyfiant yn y bedair safle yn ystod y Mesolithig diweddaraf a'r Neolithig cynnar.

Ardal Prestatyn, yng ngogledd Cymru, ydy'r ail le â astudiwyd. Yma mae yna domenni Cregyn Gleision a Chocos wedi eu dyddio i'r Mesolithig diweddaraf a'r Neolithig cynnar (4500–3400 cal CC). Mae'r tomenni yma, ynghyd â phaill, microffosiliau a chregyn môrol a thirol, wedi eu darganfod o fewn haenau ar ochr dilyniant corsdir arfordirol, lle mae hen wyneb y tir wedi ei orchuddio gan fawn a thwffa. Eto mae'r cyswllt amgylcheddol, sydd yn cynnwys tystiolaeth o olion dynol yn ystod y cyfnod Mesolithig, yn ddeinamig ac nid yn anhebyg i aber yr afon Hafren. Mae yna ymweliadau dros dro â gwersylloedd yn ystod y Gwanwyn cynnar i hel cregyn. Mae astudiaeth o'r dilyniant amgylcheddol lleol yma yn gyfle i fwrw golwg ar gyn-ddarganfyddiadau eraill o ardaloedd Prestatyn, Rhyl a gweddill gogledd Cymru. Mae'r rhain yn cynnwys sgerbwd dynol o Brestatyn, sydd yn gyfoesol â'r tomeni Neolithig, ac olion traed anifeiliaid a phobol o flaentraeth Rhyl.

Manteisiwyd yn yr astudiaeth fanwl yma, ar y

cyfle i adolygu'r cyfnod Mesolithig a'r Neolithig cynharaf yng nghyd-destun Cymru ac ardaloedd eraill o orllewin Prydain. Mae darganfyddiadau eraill yn profi fod coedwigoedd boddedig a chorsdiroedd arfordirol yn ffynhonellau gwybodaeth pwysig ar gyfer y cyfnodau yma. Roedd yna ddefnydd o dân yn yr ardaloedd arfordirol. Mae'n debyg fod patrymau bywyd bobol y cyfnod yn cynnwys symudiau tymhorol i fyny dyffrynoedd afonydd yngyd â llosgi llysdyfiant yn yr ucheldiroedd ac ar ymylon y coedwigoedd arfordirol. Mae'n awgrymiedig fod y model sy'n cysylltu yr arfordir gyda anheddiadau'r Gaeaf, a'r ucheldiroedd a'r Hâf, angen ei adolygu. Yr Hydref ydy'r prif gyfnod sy'n gysylltiedig â gewithgareddau arfordirol. Ond mae yna dystiolaeth fod yna ymwelidau hefyd yn y Gwanwyn, yr Hâf a weithiau yn y Gaeaf. Ond nid yw'r dystiolaeth yn dangos fod gweithgareddau'r cyfnod Mesolithig wedi ei ymwreiddio'n barhaol ar yr arfordir fel â awgrymir gan rai awduron. Yn gyffredinol mae'r astudiaeth hon yn cwestiynu'r model esblygedig o fywyd ac anheddiadau sefydlog yn arwain at gymdeithas ddatblygiedig tuag at ddiwedd y cyfnod Mesolithig.

Mae'r dystiolaeth o nifer o safleoedd fel Prestatyn, Llandevenny ac Oldbury, ond nid Goldcliff, yn dangos fod yna anheddiadau wedi bodoli yma yn ystod y Meolithig diweddaraf a'r Neolithig, a fod llywio esblygiad yr amgylchedd yn rhan o fywyd dynol yn y ddau gyfnod. Mae'r damcanieathau diweddaraf ynglyn â'r trawsnewidiad Mesolithig i'r Neolithig yn cael ei adolygu. Un o'r casglidau mwyaf arwyddocaol yw fod safleoedd anheddiadau'r Neolithig wedi ei ddylanwadu gan weithgareddau'r cyfnod blaenorol, yn enwedig effeithiau llosgi'r llystyfiant a'r rhwydwaith o lwybrau a ddatblygwyd ar gyfer anifeiliaid a phobol. Mae debyg hefyd fod patrymau llystyfiant ardaloedd yn dylanwadu ar weithgareddau pobol dros gyfnod hir a bod y tirwedd a'r defnydd ohono wedi ei lywio gan amglylchiadau'r gorffennol. Awgrymir fod parhad wedi ei greu gan ffurfiant y tir, boed yna barhad yn y boblogaeth, gweithgareddau economaidd, credoau (wedi eu cysylltu gyda ffurfiau topograffig) neu beidio.

1 The Mesolithic and Neolithic in the coastal zone of western Britain *by Martin Bell*

A very remarkable circumstance occurred. The sandy shores of south Wales, being laid bare by the extraordinary violence of a storm, the surface of the earth, which had been covered for many ages, reappeared and discovered the trunks of trees cut off standing in the very sea itself, the strokes of the hatchet appearing as if made only yesterday. The soil was black and the wood like ebony' . . . (it looked) like a grove cut down, perhaps at the time of the deluge

Giraldus Cambrensis (*c* 1191; 1908 edition)

1.1 Introduction

The submerged forests (Figs 1.1–1.2) and drowned landscapes of western Britain have long excited the curiosity of those who, like Geraldus Cambrensis (above), have sought to understand the origins of the landscape around them. This report shows how these drowned landscapes contribute to our understanding of the hunter-gatherer communities of the Mesolithic period and the transition to farming in the Neolithic. New evidence is presented from the main case study sites at Goldcliff East in the Severn Estuary. These are exceptionally preserved with evidence of wood and bone artefacts, human and animal footprint-tracks, and a wealth of environmental and economic evidence. The contribution of coastal wetland sequences to our understanding of the Later Mesolithic and Neolithic is further illustrated by a second case study area at Prestatyn in north Wales. Such studies are by no means unique, and comparable potential is demonstrated by smaller scale work on other Severn Estuary sites. The new finds also enable earlier discoveries, made over a period of 150 years, to be placed in a new and wider context.

The coastal peats of western Britain have produced many Mesolithic finds. Most were made by chance under difficult intertidal conditions which meant they were not, at the time, investigated in detail. The potential of these drowned coastal sites was highlighted in the successive reviews of the Mesolithic in Wales by Wainwright (1963) and Jacobi (1980) and in south-west England by Jacobi (1979). Thirty years ago David Clarke (1976), in a challenging essay on the Mesolithic, highlighted our ignorance of plant use and argued that research effort should be concentrated on the wet Mesolithic sites of southern Britain. Even today such studies have hardly begun and wetland sites on the western coastal fringes of England and Wales barely figure in the wider literature on the Mesolithic of Britain and north-west Europe. This research represents a response to the challenges laid down by these earlier surveys.

One of the limitations of prehistory in this period, which this monograph seeks to address, is of a literature quite sharply divided along both period and specialism lines. The Mesolithic literature is lithic-dominated and generally quite separate from the palaeoecological literature. The Neolithic literature only discusses the Mesolithic background in the most general terms, and is mainly focused on tombs and monuments and the spatial distribution of artefacts, all seen as evidence of social relations. Again, there is a parallel discourse on pollen analysis and clearance which is generally quite unrelated to the literature which has a social emphasis, and commonly makes very different assumptions about the nature of Neolithic society.

1.2 The research area

The core of the wider research area (Fig 1.1) is Wales, but since the focus is on coastal and maritime aspects, water may have united as much as divided communities, so immediately adjacent coastal areas are included. To the south this includes the south shore of the Severn Estuary and Bristol Channel as far west as Hartland Point in north Devon. This enables comparison with Westward Ho! where there is a key Mesolithic site and wetland sequence (Balaam *et al* 1987a) and the intensively investigated wetland sequences of the Somerset Levels (Coles and Coles 1986). Similarly, to the north, the coastal wetlands of Merseyside, investigated as part of the North West Wetlands Project (eg Cowell and Innes 1994), are included as far north as Lytham St Anne's, on the Fylde. This comprises a key area for the study of sea-level and coastal environmental change (Tooley 1978) and one which has produced extensive evidence for human footprint-tracks (Huddart *et al* 1999).

Within this broader context, there is a major focus on the Severn Estuary in the south of the area and the results of new excavations to the east of the former Goldcliff island are presented. Previous excavations of Mesolithic and later sites west of the island were reported by Bell *et al* (2000). This report includes briefer treatment of other contemporary sites in the Severn Estuary at Llandevenny, Woolaston, Oldbury, and Hills Flats (Chapter 19). A second study area around Prestatyn and Rhyl in north Wales was the subject of smaller-scale excavations and a programme of environmental work which facilitates reappraisal of finds made over 100 years. Work in the two study areas is put in a wider

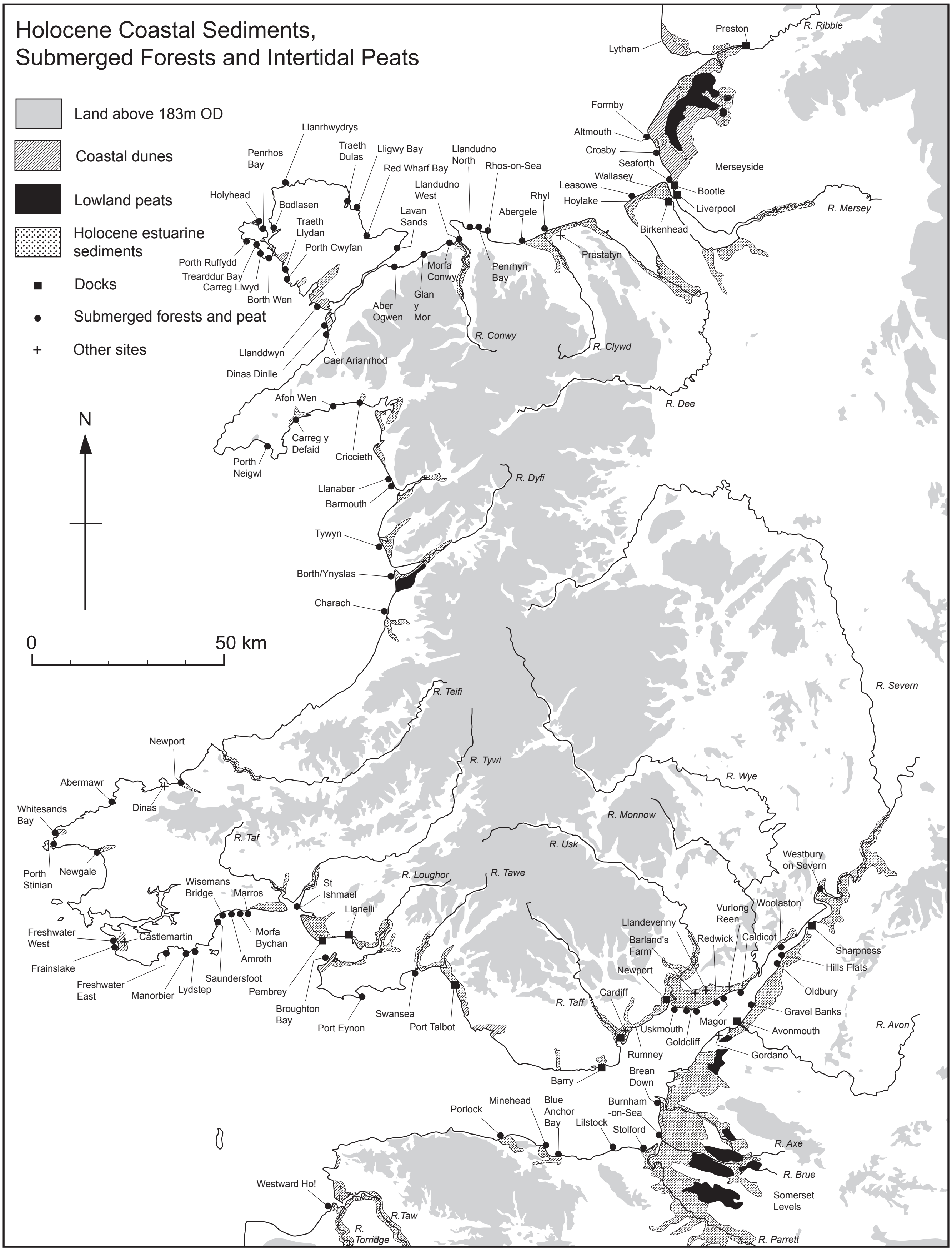


Figure 1.1 Wales and adjoining areas of western Britain showing the locations of Holocene coastal sediment sequences, submerged forests and intertidal peats, sediment sequences revealed by dock construction, and other key coastal environmental sequences (for sources, dates, and associated archaeological evidence see CD 1.2) (graphic S Allen)

context by a review of the later Mesolithic and the transition to the Neolithic in Wales and the adjacent areas. For readers unfamiliar with the geography of the study area CD 1.1 is a map of the main geographical areas.

1.3 The Mesolithic problem

The Mesolithic occupies half of the Post-glacial period, from 9600 to 4000 cal BC, thus about the same amount of time as everything from the Neolithic to the present day. It can be argued that this is the most neglected period archaeologically in Wales and England. Whatever measure we use: number of research projects, funding, number of excavations etc, the period is very poorly represented. A reputable archaeology of Wales published as late as 1965 has a gap between the end of the Ice Age and the Neolithic (Foster and Daniel 1965). Recently the 200th edition of the magazine *Current Archaeology,* celebrating the discoveries over the last twenty years, devoted only 0.2% of that edition to the Mesolithic (Selkirk 2005).

The period has for long been dominated by the exceptionally preserved early Mesolithic site of Star Carr in Yorkshire excavated by Grahame Clark between 1949 and 1951 (Clark 1954). This site has stimulated more reinterpretations than perhaps any other (eg Clark 1972; Legge and Rowly-Conwy 1988 and references therein): recent work continues to produce important new evidence of Mesolithic burning and the seasonality of activity (Mellars and Dark 1998), which has been a significant catalyst to environmental aspects of the work reported here.

The archaeology of the Mesolithic period is overwhelmingly dominated by lithic scatters from fieldwalking (Wymer 1977). The situation revealed by a recent survey of south-east Wales is typical: sites are numerous, almost all are unstratified, only a tiny number have been excavated and almost none have produced any organic evidence or bone (Locock 2000).

This is not the case beyond England and Wales. Major advances in our understanding of the period in Scotland build on the results of earlier work on the middens at Morton (Coles 1971) and Oronsay (Mellars 1987) and include recent work such as the Southern Hebrides Project (Mithen 2000a) and Scotland's First Settlers Project (Hardy and Wickham-Jones 2003). Dramatic advances in understanding the Mesolithic of Ireland reflect a progressive programme of excavations in estuarine, riverine, and coastal locations by Woodman (1977, 1985; Woodman *et al* 1999). Increasingly the archaeological importance of the drowned landscapes of the North Sea is recognised (Coles 1998; Flemming 2004). The relative paucity of the English and Welsh Mesolithic is even more evident when compared to sites in neighbouring areas of continental Europe (Larsson 2003), especially Denmark (Andersen 1987), The Netherlands (Louwe Kooijmans 2001a, 2001b) and Belgium (Crombe 2005). Clear lessons from areas where major advances have taken place are the importance of wetlands and coastal environments and more specifically the need for a geoarchaeological approach to identify those sedimentary contexts which have the potential to preserve well-stratified sites of relevant date.

It has been argued by Bell *et al* (2006) that evidence from two key types of sedimentary sequence, riverine and coastal, could transform our understanding of the Mesolithic. The riverine sediments of southern England are particularly important in relation to the early Mesolithic *c* 9000–7900 cal BC, when thick sequences of calcareous sediments and peats built up in some river valleys, notably tributaries of the Thames, such as the Kennet. Coastal sediment sequences, which are the subject of this report, offer particular potential for research on the last two millennia of the Mesolithic *c* 6000–4000 cal BC. These sequences comprise old land surfaces, peats, submerged forests, and estuarine silts laid down in the final stages of the very rapid sea-level rise in the first half of the Holocene. The sediments contain occupation sites, activity areas, footprint-tracks, shell middens etc. The potential of the coastal peats has been highlighted in surveys of coastal archaeology in England (Bell 1997) and Wales (Davidson 2002). This later Mesolithic coastal evidence thus complements the early Mesolithic lowland lacustrine and riverine evidence at Star Carr, Thatcham (Wymer 1962) etc. The transition from the early to the later Mesolithic is marked by changes to a narrow blade microlithic technology around *c* 7900 cal BC (David and Walker 2004) and all the sites considered here postdate that change.

1.4 Submerged forests and Holocene coastal sediments

Figure 1.1 shows the location of the known submerged forests and intertidal peats in Wales and adjoining areas. A supporting digital archive (CD 1.2) provides details of each site. In total 75 intertidal peats and submerged forests are recorded in the mapped area. These draw on a range of sources including antiquarian accounts, Geological Survey Memoirs, and surveys in selected parts of the region, notably a thorough survey of Gwynedd (G Smith *et al* 2002). Most submerged forests are infrequently exposed by storms. Some, recorded long ago, may no longer survive, but it is surprising how many sites last recorded decades before, or even a century ago, do still reveal exposures when visited under appropriate conditions. Thus the mapped sites should all be considered as areas with significant archaeological and palaeoenvironmental potential.

Also shown on Figure 1.1 are exposures of Holocene coastal sediments. With the rising sea levels in the Holocene, valleys which were deeply incised during the Pleistocene became flooded estuaries. Thus, over the last two millennia of the Mesolithic, marine influence would have extended inland over virtually all of the shaded areas on Figure 1.1. That produced a coastline significantly more indented and complex than today's, with extensive ecotonal environments rich in resources for human communities. These estuaries contain up to 15m of Holocene fine-grained minerogenic sediment and peat. The expanses of Holocene sediments shaded on Figure 1.1 are most extensive in the Somerset Levels, Severn Estuary, and Merseyside – but even many of the smaller exposures seen elsewhere are of considerable palaeoenvironmental and archaeological importance. The sediments mapped on Figure 1.1 are of three main types:

i) On the inland margins of the larger wetlands there are exposures of peat. Those of sufficient size to be mapped are in the inner margins of the Somerset Levels, in the valley of the Dyfi at Borth Bog and in the north-west English wetlands. The map greatly underestimates the widespread distribution of coastal peats since most sites are too small to be mapped at this scale and most peats are buried by later estuarine sediments. Extensive peats are, for instance, almost totally buried on the north side of the Severn Estuary and in many of the other Holocene sequences.
ii) Estuarine alluvium, generally silts, which form extensive blankets seaward of the peats and in many areas bury earlier peats. Where estuarine alluvium buries peat it indicates a marine transgressive phase. Where peat is developed over estuarine alluvium it represents a marine regressive phase.
iii) Blown sands which in places form coastal barriers partially separating the estuarine sediments from direct marine influence. One of many areas where dunes are well-developed is on the coast of north-east Wales, in the Prestatyn and Rhyl areas considered in detail in Chapter 20.

1.5 The history of submerged forest research

Research on the submerged forests and intertidal peats can be divided into six stages which are broadly chronological. The first might be called the age of the eclectic polymathic scientist. These writers in the 18th and 19th century were fascinated by submerged forests, in part for the very reason prefigured in the much earlier remarks of Giraldus Cambrensis at the beginning of this chapter. His observations are calculated, from the historical information he gives, to have been made in AD 1172 (Knightley 1988). Giraldus speculated that the forests may have been drowned at the time of the flood. The sites had a relevance to the great debates of the 19th century between the catastrophic and uniformitarian schools of geology, which were of such importance in establishing the antiquity of humanity and thus the foundations of prehistoric archaeology (Grayson 1983). Many of those who were involved in research on submerged forests and related coastal contexts nationally were significant figures in the development of geology, archaeology, and scientific thought more generally: Charles Lyell; Richard Owen; Thomas Huxley; Philip Gosse; Richard Fenton; W Boyd Dawkins; and William Pengelly. Nineteenth-century records of submerged forests in the study area are mostly of a geological and botanical nature, although the first archaeological finds from one of the sites were made at Porlock in 1861 and there was a steady stream of archaeological finds subsequently, with many in the later 19th and early 20th century.

The second phase of recording and research relates mainly to the work of the British Geological Survey from about 1890. Dock excavations revealed deep stratigraphies including peats in the mouths of the main rivers on thirteen sites in the area mapped on Figure 1.1. These excavations were mostly made between *c* 1850 and the First World War and reflect the great hey-day of British merchant shipping from western coastal ports. These observations, together with other records of submerged forests, were noted in the Memoirs of the Geological Survey. A catalyst in the involvement of the latter body seems to have been excavations at Barry Docks in 1895, which revealed a basal Old Land Surface with a submerged forest overlain by four peat layers. The sequence contained a polished axe, worked flints, and bone needles. That sequence, thinning against the bedrock of Barry Island, is strikingly similar to that reported in this monograph from Goldcliff island. The Barry sequence was published by Aubrey Strahan (1896) with a report on plant macrofossils by Clement Reid. Strahan had an interest in archaeology, was responsible for mapping the South Wales Coalfield, went on to become Director of the Geological Survey, and was knighted in 1919 (Howarth 2004). At Newport dock, excavations produced a human skull, now dated to the Neolithic (Keith 1911; Bell *et al* 2000), and the docks of Merseyside and Preston have produced extensive finds of animal bones and human skulls (Huddart *et al* 1999). Many other dock excavations also produced fine sequences containing archaeological finds (as recorded on CD 1.2). Further systematic work on submerged forests in Pembrokeshire was done in the first half of the 20th century by two members of the Geological Survey, A Leach and T Cantrill, whose observations include many records of associated archaeological finds (Chapter 1.10).

The wealth of mainly 19th-century observations on submerged forests was synthesised in a fine book by a member of the Geological Survey, a notable pioneer of palaeobotany, Clement Reid (1913). His preface acknowledges that the subject was one in which 'several sciences have an interest and these are somewhat liable to be neglected'. In Reid's day opinion held that the submerged forests were the result of subsidence of the land by up to 70ft (21m).

Surprising as it may seem today, the role of glacio-eustacy (a rise in sea level caused by the melting of glacial ice sheets) was not at that time recognised. Even so, Reid made the extremely important, and generally overlooked observation that the submerged forests seemed to contain nothing later than polished axes and these great coastal changes must therefore have taken place before the Bronze Age. His synthesis did a great deal to encourage interest in, and recording of, submerged forests in the earlier 20th century.

The third phase of submerged forest research came with the application by Harry Godwin of the then new technique of pollen analysis to coastal peat beds with pioneering work in this study area at Borth (Godwin and Newton 1938), Swansea Bay (Godwin 1940), and the Somerset Levels (Godwin 1941). His national coastal researches were synthesised (Godwin 1943) and later formed part of a wider review of British vegetational history (Godwin 1975). Research on the Somerset Levels peat sequence was continued by Beckett and Hibbert (1978) and Caseldine (1984). On the Welsh side of the Severn Estuary the pioneering pollen study of A G Smith and Morgan (1989) at Goldcliff East follows in the palaeobotanical tradition. Notwithstanding the pioneering work of Reid, Godwin, and others, the specifically coastal peats have received nothing like the attention given to more inland peat basins or the blanket peats of the uplands, as the distribution of palaeoenvironmental work in Wales shows (Caseldine 1990, fig 11).

The fourth phase of research in the 1960s–80s was principally focused on studies of sea-level change. This involved radiocarbon dating of intertidal peats which produced curves representing Holocene sea-level rise. Tooley (1978) produced a pioneering study for north-west England centred on the Lytham area (at the northern limit of Fig 1.1). Hawkins (1971; 1973) produced curves for south-west England, and Heyworth and Kidson (1982) for south-west England and Wales. Sea-level related research continues with the development of increasingly well-dated sequences which now often employ biological indicators such as forams to identify the position of the dated sample within the tidal frame. Recent studies include the work of Huddart (1992) and Zong and Tooley (1996) on the north-west English coast, ongoing work by J Scourse and M Roberts (pers comm) on the sea-level and coastal change in Menai Strait, and the development of well-dated sequences from Porlock (Jennings *et al* 1998) and the Axe Valley (Haslett *et al* 1998).

The fifth phase of research developed directly from Heyworth's sea-level study and explored the potential of submerged forests for dendrochronology. Heyworth's (1985) PhD thesis investigated dendrochronological and palaeoecological aspects of submerged forests at Stolford and Borth with smaller scale studies at Marros, Clarach, Llanaber, Porth Neigwl, and Lleiniog. Tree-ring sequences from this research provided material for what in a British context was a pioneering programme of radiocarbon dating at Stolford and Borth, designed partly for tree-ring calibration and partly for analysis of changing concentrations of carbon 14 through time (Campbell and Baxter 1979). In parallel with this submerged forest work was a programme of dendrochronological research from the mid-1970s on the prehistoric trackways of the Somerset Levels (Morgan 1988). Hillam *et al* (1990) succeeded in linking the submerged forests at Stolford and Woolaston and the Neolithic Sweet Track, thereby establishing dates for both submerged forests and the precise date of 3806–07 BC for the construction of the Sweet Track. Dendrochronological research continues with the work of Nigel Nayling (Chapter 8).

The sixth stage of research on the submerged forests and coastal peats is marked by programmes of archaeological fieldwork and excavation. This began with excavation at Westward Ho! in 1983 (Balaam *et al* 1987a); it developed with the research of Lewis (1992) in Pembrokeshire; and continued with work at Goldcliff (Fig 1.2), the latest phase of which is reported here.

1.6 Relating intertidal and inland wetland sequences

The submerged forests and intertidal peats are exposed in sections eroded through the Holocene fills of valleys and embayments which frequently extend far inland. Dock excavations and boreholes show that the deeper valleys, incised by either glacial erosion, or fluvial incision to lower glacial sea levels, are cut down to bedrock at the following depths: Tawe –36m; Milford Haven –20m; Dee –18m; Mersey –12m; Clwyd –12m; and the Cadoxton at Barry –10m (Wedd and King 1924; Godwin 1940). The sections exposed intertidally provide a window into what lies buried inland. This is particularly important because coastal wetlands are under intense development pressure as greenfield sites, especially adjoining major port facilities at Avonmouth, Cardiff, and the Mersey Ports. Development pressures also apply more widely; the discoveries at Prestatyn (Chapter 20) preceded housing development on coastal wetland. It is important that, rather than creating a conceptual boundary along the chance position of present sea walls, we envisage the intertidal exposures and what lies inland as part of a seamless continuum (M J Allen and Gardiner 2000; Oxley 2000).

Coring programmes have proved valuable in linking together intertidal and inland sedimentary sequences. Pioneering with regard to the wider stratigraphic relationships of foreshore submerged forest exposures was Godwin's (1940) study in Swansea Bay in which foreshore peat was related to a 20m-thick sequence behind a dune barrier, which included up to six peat layers at the margin of Crymlyn Bog. Allen's (2001) synthesis of data

Figure 1.2 *A tree in the Lower Submerged Forest at Redwick being sampled by Nigel Nayling for dendrochronology (photo E Sacre)*

from 882 boreholes in the Gwent Levels has been of great value in establishing the buried Holocene stratigraphy inland of the intertidal exposures. Kidson and Heyworth (1976) have mapped the buried topography of the Somerset Levels. The relationships between intertidal and coastal wetland stratigraphy have been investigated in detail at Porlock (Jennings *et al* 1998), Stolford (Kidson and Heyworth 1976) and Brean Down (Bell 1990, 2002; Haslett *et al* 2000). In the Severn Estuary at Goldcliff a particularly complicated sequence of intertidal peats dating between the Mesolithic and the Iron Age has been related by coring to a sediment sequence behind the seawall (Bell *et al* 2000). In Pembrokeshire, Lewis (1992) investigated the narrow valley at Abermawr and showed that submerged forest deposits exposed in the foreshore related to the basal part of a long Mesolithic to recent peat sequence in the bog behind a pebble barrier. The valley at Clarach also produced a long sediment sequence stretching back to the late glacial, of which a submerged forest formed part (Heyworth *et al* 1985). At Borth, the coastal submerged forest forms the basal wood peat element of what later developed into a large raised mire, which survives behind the coastal barrier of pebbles and sand (Wilks 1979). In north Wales the coastal peats at Rhyl and their relationship to wetlands inland of the coastal barrier are considered in Chapter 20. The sedimentary sequences of the Wirral and Sefton have been investigated in detail by the North West Wetlands Project but these can only be related in a rather general way to submerged forests to seaward, which were excluded from that survey (Cowell and Innes 1994). In the Formby and Lytham areas foreshore peat exposures are put in a wider stratigraphic context by extensive programmes of coring in the reclaimed coastal wetlands inland, mostly as part of extensive programmes of research related to sea-level change (Tooley 1978; Huddart 1992).

1.7 Coastal peats, sediments, and archaeology

Drawing on the history of coastal research and the coring programmes, Figure 1.3 has been prepared as an idealised model to illustrate some of the main sedimentary contexts and typical situations in which Mesolithic finds are made. It is a bird's-eye view of an imaginary stretch of coast. In the foreground of the plan we see an extensive stretch of now reclaimed coastal wetland, such as we find in the Severn Estuary or the Prestatyn/Rhyl areas of north Wales, both considered in this monograph. The section illustrates the quite complex sequences which are found in parts of these extensive wetlands. In the background of the plan view is a smaller valley containing Holocene sediments such as we find round the coast of Pembrokeshire, the Lleyn Peninsula, Anglesey etc. A typical sequence in both the extensive wetland and the smaller valleys has at its base Pleistocene Head (or within the former ice margins till – overlain by Head), on which a basal soil developed at a time of lower sea level in the Holocene. Today this soil is often exposed in patches close to low tide.

Growing on this basal soil there is often a submerged forest of large mature oaks around which peat formed as water tables rose in response to rising sea level, leading ultimately to the demise of the primary forest. A number of other peat layers occur at intervals through the Holocene sequence separated by layers of minerogenic silty clay. The basal peat formed during the initial transgression phase (ie when spring tides first covered that site); the later peats formed as a result of regressions, phases of reduced marine influence (ie when the sites were less frequently covered by the sea). The minerogenic silts between the peats formed during transgression episodes of increased marine influence. Since marine influence increases seaward, the silts thicken in that direction. Terrestrial conditions are increasingly prevalent landward, so the peats thicken and merge in that direction. When, as a result of the inter-relationship between these factors, the build-up of organic matter exceeds the rate of sea-level rise, then an extended period of peat formation may occur. There is then a succession of plant communities from reedswamp to fen woodland and eventually raised bog, as Godwin (1975) demonstrated in the Somerset Levels and Borth, and as Smith and Morgan (1989) first demonstrated at Goldcliff. These wetland sequences are interrupted in places by former drainage channels, now represented by palaeochannels which are seen meandering across the intertidal zone. In our hypothetical example the lowlying wetlands are separated by rocky headlands and on the slopes of these hills are slope deposits which often cover earlier Holocene buried soils and are in turn often developed on Pleistocene Head, till, or raised beach deposits. In the smaller more distant valley, a dune system has blocked the valley to seaward and a more extensive dune field also blankets a neighbouring slope inland, again sealing a Holocene buried soil.

1.8 Sea-level and coastal change

Using the sea-level curves for the region and the evidence of submarine contours from hydrographic charts, the changing position of the coast during the Mesolithic can be plotted (Fig 1.4). It should be noted that this diagram only identifies the more prominent buried offshore valleys. Some cannot be represented at the scale shown, others are not shown because they are part-filled with Holocene sediments. This means that drowned river valleys would, at the dates shown, have extended significantly further inland than the general line of the coast shown. This is evident from the deeply incised valleys revealed by previously discussed (Chapter 1.6) dock excavations and boreholes. Further consideration of

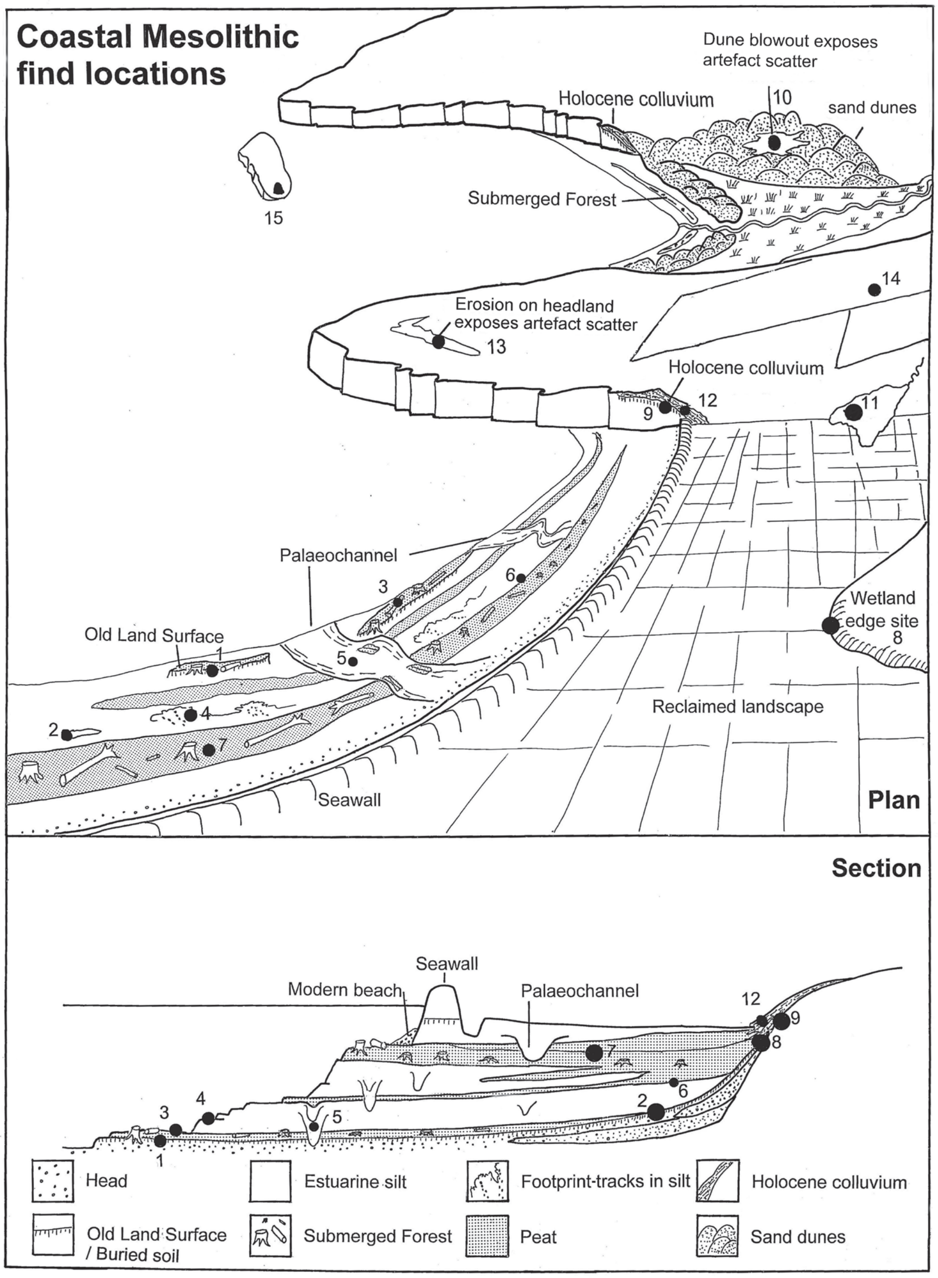


Figure 1.3 Schematic georarchaeological diagram showing in bird's-eye view plan and section some of the main types of Holocene coastal sediments and types of context in which Mesolithic finds have been made (for description of these contexts and examples of the sites reported see CD 1.3) (graphic M Bell)

this problem of buried channels occurs in relation to both the Goldcliff (Chapter 18.2) and Prestatyn areas (Chapter 20.1.1). Despite the inevitable over-simplification of palaeo-coastline reconstruction at this scale, the exercise is important, both for appreciation of the changing geography of the area and to establish whether sites were, or were not, coastal at the time of their occupation.

At the broad British Isles scale, coastal change with sea-level rise has been reconstructed by Shennan *et al* (2000) and Lambeck (1995) has looked particularly at the changes of the late glacial and early Holocene. Early in the Holocene sea level stood at around 30 fathoms (–55m), thus at this time the Bristol Channel and Severn Estuary did not exist, the coast stood just west of Lundy, the whole of Cardigan Bay was dry land and likewise Liverpool Bay in the north. By about 9000 cal BC sea level stood at around 20 fathoms (–37m), a small proto-estuary had started to form between Ilfracombe and Gower, the headlands of Pembrokeshire were in places probably within 5–8km of the sea, and both Cardigan Bay and Liverpool Bay remained largely dryland. By 7500 cal BC sea level stood at around 10 fathoms (–18m) and sea extended into a very narrow Severn Estuary. Sites on the coasts of Gower and Pembrokeshire, the Lleyn, and Anglesey were by now close to the

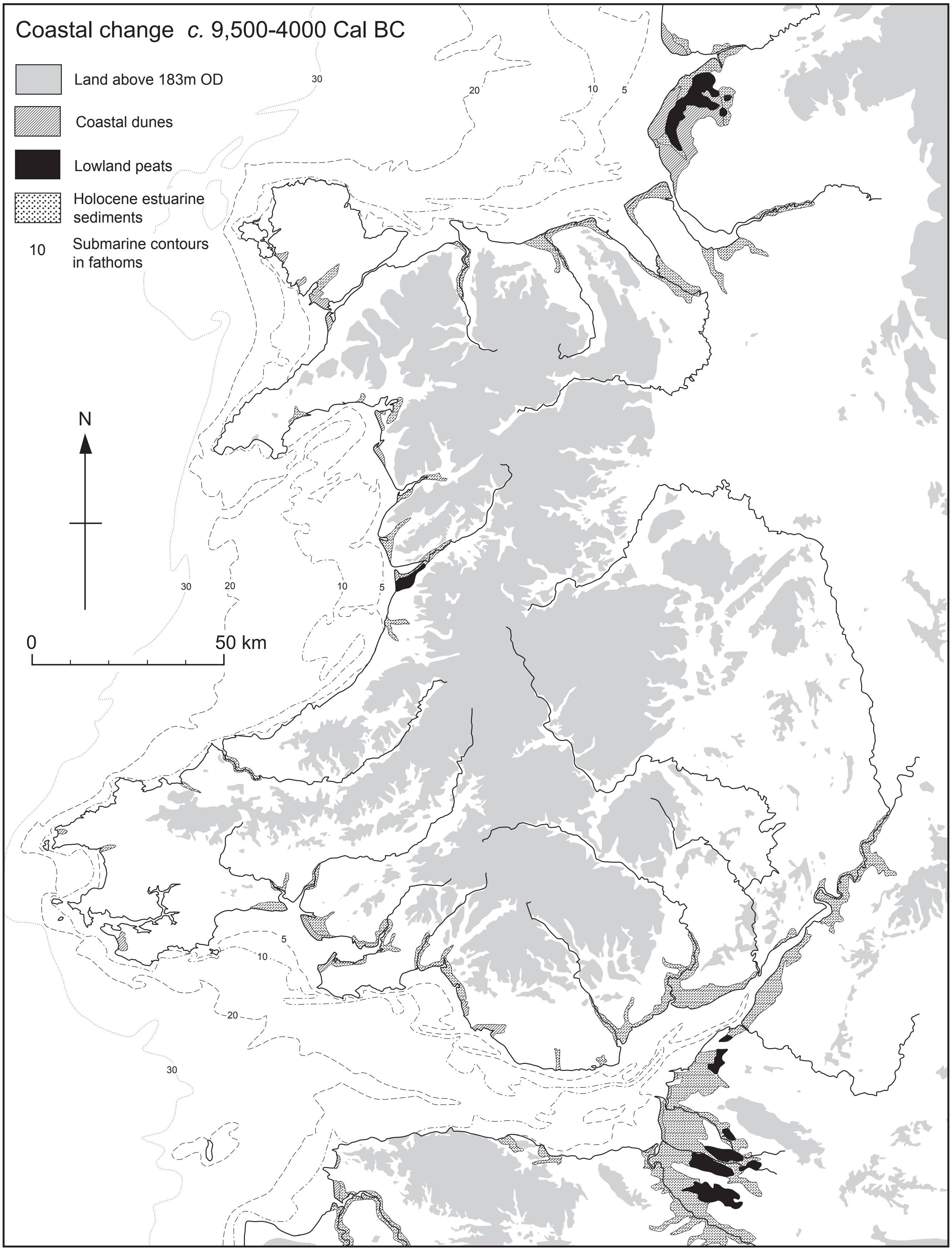


Figure 1.4 Submarine contours at 30, 20, 10, and 5 fathom intervals demonstrating coastal change between the end of the last glaciation and c *4000 cal BC (graphic S Allen)*

sea. Even so, about a third of Cardigan Bay and Liverpool Bay remained dryland. The dates for the basal submerged forests and associated sites (see Chapter 1.9 below), are those at which sea-level rise crossed roughly the position of the present coast. This took place about 6000 cal BC in the Severn Estuary. Thereafter marine influence extended inland over what are now the reclaimed coastal wetlands and up valleys covering, by about the late Mesolithic, most of the area of peat and estuarine sediments on Figure 1.4. Thus, late Mesolithic sites which stood on the inland margin of those shaded areas would at the time of occupation have been coastal: examples of such sites at Prestatyn and Llandevenny are discussed in Chapters 19 and 20.

1.9 Dates of the submerged forests

Radiocarbon dates are available for 31 of the 73 submerged forest or intertidal peat sites (42%) mapped on Figure 1.1. The dates are plotted on Figure 1.5 and detailed on CD 1.2: the dates plotted are those for the earliest peat on each site. Twenty-eight of the dates (90%) fall in the range 7000–3500 cal BC. This demonstrates that most of the inter-tidal forests and peats are later Mesolithic to early Neolithic in date, highlighting their potential for research in these periods. Exceptions are: Pen-y-bont, Newport, Pembrokeshire (a soil with Mesolithic artefacts buried by Bronze Age peat, Lewis 1992); an Iron Age peat at Rumney; and Llanaber, Gwynedd (an intertidal peat and associated trackway formed in the medieval period, Musson *et al* 1989). Where there were extensive wetlands, peats continued to form intermittently during marine regressive phases much later, up to the Iron Age in parts of the Severn Estuary, where they are exposed intertidally at Goldcliff and Rumney (Bell *et al* 2000; Allen 2005). The Somerset Levels present a comparable story of peat formation from the late Mesolithic/early Neolithic to the Iron Age except that here the thick peat deposits are well inland of the present coast and only thinner peats of Mesolithic date extend to the intertidal zone at Stolford, Burnham-on-Sea, and Brean Down.

Of particular importance is the precise dendrochronological dating of a group of sites in the Severn Estuary and Bristol Channel to the Mesolithic/Neolithic transition. Thus, the submerged forest at Stolford has been dated to 4052–3779 BC and that at Woolaston has, with recent extensions to its date range as part of the present project, been dated to 4096–3699 BC (Hillam *et al* 1990; Brown *et al* 2005; Nayling pers comm). The submerged forest at Borth has recently been dated to 4184–3981 BC (Nayling 2002). It is also notable that beyond the Severn Estuary all the finds from below, and within, intertidal peats of the mapped area appear to be Mesolithic or Neolithic. The only exception is a whetstone, said to have come from the Swansea submerged forest (Stevens 1928). So, whilst some of the 75 sites mapped in Figure 1.1 may well be more recent, the available evidence suggests that most are Mesolithic or Neolithic.

1.10 The context of archaeological finds in the submerged forests and coastal wetlands

Figure 1.3 illustrates some of the main types of sedimentary context in which Mesolithic finds are commonly made in coastal situations. The sequence in which these types are numbered is not intended to be stratigraphic or chronological. Examples of each of these contexts with appropriate references are given on CD 1.3. The first discovery of stone artefacts associated with a site in the study area was made at Porlock, Somerset in 1861 (Boyd Dawkins 1872); followed by the finding of lithics at Westward Ho!, north Devon, in 1866 (Bate 1866; Ellis 1866), as well as shell middens and lines of stakes in 1870 (Hall 1870) – this site continues to be productive (Balaam *et al* 1987a). Flints were also found below the submerged forest at Minehead (Boyd Dawkins 1870) and a flint was found in clay below the forest at Whitesands Bay by Hicks (1885). A Neolithic stone axe from the dock excavations at Barry in 1895 has already been note d (Strahan 1896). An antler mattock came from below the submerged forest at Rhyl in 1910 with further discoveries in the 1920s (Chapter 20).

The main new discoveries in the first half of the 20th century came from the work of Leach (1913; 1918) in Pembrokeshire. He identified submerged forests at twelve sites; lithic artefacts were found at three of these – Amroth, Frainslake, and Lydstep. Leach identified three sedimentary contexts in which lithic finds were repeatedly made:

i) soils and silts below the submerged forests, where most of the lithic artefacts and charcoal were found (Context 1);
ii) the peats themselves (Context 3);
iii) 'soil drifts' which were exposed in cliff sections at the head of beaches (Context 12).

At two sites particularly evocative discoveries were made within the peat (Context 3/7): at Lydstep, the skeleton of a boar apparently associated with two microliths – a wounded animal which had escaped to die in the swamp (Leach 1918); at Frainslake, a windbreak of wood formed one side of an area of charcoal 4.5yds (4.1m) long, which is likely to represent a temporary shelter (Gordon Williams 1926). At Pen-y-bont, Newport, lithic artefacts were later reported from a land surface below peat (Context 1) by R Thomas (1923).

A number of the early writers on this theme were clearly struggling to put their finds into a wider context and were equivocal as to whether their finds were Ice Age or Post-glacial; for example Gordon Williams (1926) on Pembrokeshire and F G Smith (1927) on finds at Prestatyn. The principal

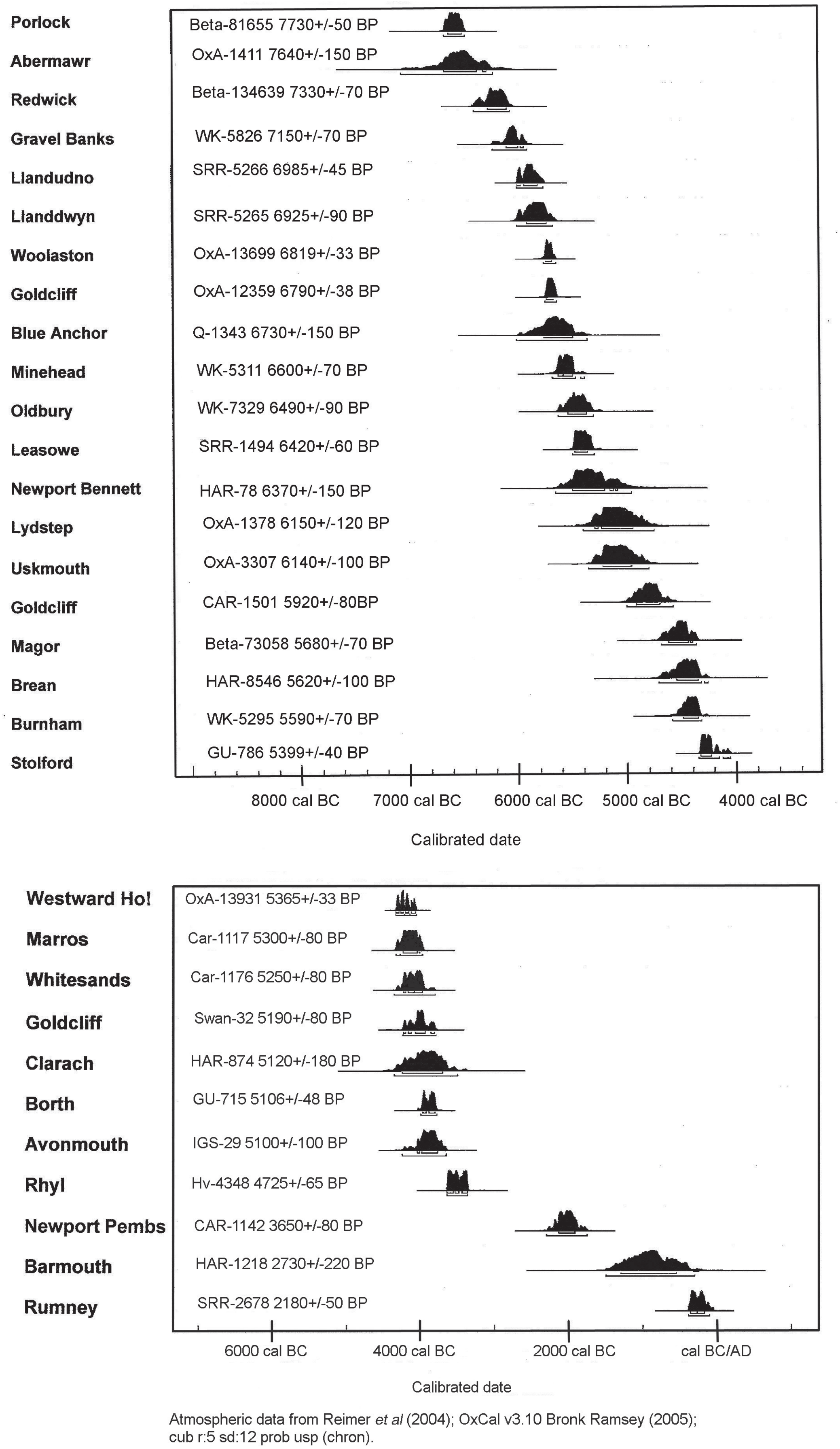


Figure 1.5 Calibrated radiocarbon dates for the earliest peats, wood, or other contexts on the sites mapped in Figure 1.1 and listed in CD 1.2 (Note: many sites have multiple radiocarbon dates; these are included thus ◆ on CD 1.2. For additional dates see references listed there)

problem was that although the term Mesolithic was first used by Westropp (1866), it was not clearly defined and only came to be generally recognised as a distinct cultural stage (following the Pleistocene and before farming) with the writings of Grahame Clark in the 1930s (Clark 1932, 1936). In writing about the Pembrokeshire intertidal sites Leach perspicaciously observed that the rarity of defined artefact types and the lack of 'beautifully made arrowheads and polished axes' which were found up on the plateau (eg in Contexts 13 and 14) suggested a culture distinct from the late Neolithic or Bronze Age (Leach 1918, 59). Surprisingly Clark did not make a great deal of the Pembrokeshire sites, noting that they were numerous but the industry was not very rich and they seldom represent more than very transitory occupation (Clark 1932, 48). He gave greater consideration to the richer, but less well-stratified, lithic assemblage on a rocky outcrop just above Aberystwyth Harbour (Context 13) and the site stratified below tufa (Context 11) at Bryn Newydd, Prestatyn, which he later published (Clark 1938, 1939). That site is upslope of the later Mesolithic site at Prestatyn reported in Chapter 20.

It was only with the later research of Wainwright (1959, 1963) on the Mesolithic of western Britain that the archaeological significance of the discoveries made by Leach and others in Pembrokeshire became recognised. Wainwright made additional finds below intertidal peat at Little Furznip (Context 1 and 6) and excavated Mesolithic sites below coastal dunes at Freshwater West and Frainslake (Context 10; Wainwright 1959; 1962).

Two synthetic papers by Jacobi were also of great importance in highlighting the significance of the coastal Mesolithic and in particular the intertidal finds: one on the south-west peninsula (Jacobi 1979), the other Wales (Jacobi 1980). Jacobi's synthesis prompted renewed investigation of the Westward Ho! midden site in 1983–84 (Balaam *et al* 1987a). That highlighted the potential of middens for the preservation of a wide range of palaeoenvironmental evidence. In this area Mesolithic middens are few: at Freshwater West (Wainwright 1959), Caldey caves (Lacaille and Grimes 1955), and the Prestatyn examples reported here in Chapter 20. Jacobi's synthesis also laid foundations for further research by David (1990) involving extensive excavations of the cliff top site at Nab Head (Context 13) and a review of the Welsh Mesolithic. The research of Lewis (1992) had its focus on a similar geographical area to David's work in Pembrokeshire but took an environmental approach involving pollen and sedimentary investigation of submerged forests and coastal peats at Abermawr, Whitesands Bay, Newport, Castlemartin, Marros, and Lydstep. Lewis reported earlier finds of lithic material below the submerged forest at Abermawr (Context 1) and at the same site lithics below coastal dunes (Context 10). He also investigated the environmental context of aurochs finds from Whitesands Bay and dated Leach's Lydstep pig find with its associated rod microliths to the very end of the Mesolithic 4350–3940 cal BC. Lewis's work represents an important source of comparison for the sites discussed in this volume, focusing as it does on the cliffed and embayed coast of Pembrokeshire between the archaeologically rich area study areas reported here in the Severn Estuary and north Wales.

Another important milestone was the Somerset Levels Project which ran from 1975 to 1989; this included work on lithic scatters on areas of dryland (Context 14) adjoining the wetland and revealed many Neolithic and Bronze Age trackways and excellent environmental sequences. Mesolithic flint scatters were abundant on the sandy Burtle Beds, of Ipswichian interglacial date, which lie within the wetland but surprisingly these mainly date to the early Mesolithic period before sea-level rise brought coastal influence near; they are therefore dryland, or river valley edge sites (Coles 1989; Brown 1986). Significant later Mesolithic sites are found on the very edge of the wetland (Context 8) at Chedzoy (Norman 2003) and Birdcombe (Gardiner 2000). The Somerset Levels Project did not reveal any Mesolithic sites with organic preservation. The subsequent North West Wetlands Project from 1990 to 1995 also produced a wealth of environmental evidence for the Mesolithic and Neolithic as well as the lithic scatters on dryland adjoining the wetlands, but again Mesolithic sites with organic preservation were not found.

Given subsequent discoveries it is surprising how late research on the Severn Estuary archaeology began. Despite very extensive intertidal peat exposures the estuary is hardly mentioned in the extensive submerged forest literature of the period up to about 1970. Locke (1970–71) published an important paper establishing a relationship between intertidal peats and sediment sequences from boreholes inland and noting some significant archaeological finds. It was only, however, in the 1980s, with the definition of a Severn Estuary-wide sedimentary sequence (Allen 1987b; Allen and Rae 1987), that it became clear that many archaeological discoveries, which at that time were being made by Derek Upton (dedication in CD introduction), were stratified in prehistoric sediments. For the Mesolithic these included the discovery of human footprints in silts (Context 4) at Uskmouth and Magor (Aldhouse-Green *et al* 1992), the former overlain by peat dated 5460–4960 cal BC. An unstratified antler mattock radiocarbon dated to a similar date was found nearby (Aldhouse-Green and Housley 1993). Derek Upton, together with Bob Trett, also identified a lithic site below intertidal peat west of Goldcliff headland. Radiocarbon dating showed this was also later Mesolithic and the site was excavated in 1992–94 and has been previously published (Bell *et al* 2000). That site (here called Site W) is only 500m west of the complex of Mesolithic sites published here and that excavation forms the background to the research at Goldcliff East reported here.

Apart from its deep stratification and the preservation of organic artefacts and environmental evidence the intertidal record has its own particular properties. Intertidal sites are gently washed by the sea so that materials of different hardness (eg wood or bone) or sediments of different particle size and resistance (eg sand, silts, peat), are differentially etched out by the tide, picking out the footprints of people and animals (Chapter 12) and uncovering wood and occupation surfaces. It thus provides a record very different, and in places very much clearer, than we can expect to find under normal circumstances on construction sites or wetland drainage ditch sections. Work in the Severn Estuary has identified additional contexts for Mesolithic finds which had not been apparent from the preceding work (Fig 1.3). In particular, there are finds in estuarine silts (Context 4) and palaeochannels with wood structures (Context 5). The present study also highlights the importance of the wetland edge (Context 8) where sites may be well stratified but less deeply buried; examples are discussed here from Goldcliff East, Llandevenny, and the Prestatyn shell middens.

1.11 Dryland and inland Mesolithic

The intertidal and coastal wetland sites, which are the particular focus of this research, are complemented by many other sites in the study area which are on dryland close to coasts and others further inland (Fig 1.6). Immediately adjacent to the coast is the class of lithic sites noted by Leach (1918) and Wainwright (1963) as occurring in soils and overlying soil drifts (Contexts 9 and 12), often exposed in coastal sections in Pembrokeshire, at Aberystwyth Harbour, Baggy Point, sites round the Lleyn Peninsula, and Anglesey. Another class of lithic scatter is found on old land surfaces below dunes as at Freshwater West and Burry Holms (Context 10). Some of the greatest concentrations of artefacts occur in hill-top situations (Context 13) which with sea-level rise later became cliff-tops overlooking the coast, as at Nab Head, Pembrokeshire, and beyond the study area in Cornwall at Trevose Head (Contexts 12–14; Johnson and David 1982). Also dominating the coast from much higher upland elevations is the site of Hawkcombe Head, Exmoor (Riley and Wilson-North 2001).

Mesolithic artefacts occur in coastal caves (Context 15) on Caldey (Lacaille and Grimes 1955), the Gower, and in more inland cave sites on Mendip, the Wye Valley and at Gop in north Wales. Several of these caves also produce human burials, which provide isotopic evidence of the often significant contribution of marine resources to the Mesolithic diet (Schulting and Richards 2002b). Indeed the distribution of finds of Mesolithic human bone shows its greatest concentration in this study area (Conneller 2006). This complements the strongly maritime focus suggested by the distribution map, a coastal focus is particularly marked in both the early and later Mesolithic in Pembrokeshire, the wetlands of Merseyside, the mouth of the Clwyd, and around Barnstaple Bay (Fig 1.1). However, the very strong coastal bias shown by early surveys (Wainwright 1963; Jacobi 1980) is no longer so pronounced, as sites are increasingly discovered in inland and upland areas (Burrow 2003; David and Walker 2004). Particularly notable is a group of largely later Mesolithic sites at the head of the Rhondda Valley (Stanton 1984); Waun-Fignen-Felen (Barton *et al* 1995); Brenig (Lynch 1993); Llyn Aled Isaf (Brassil 1989); and Bonc yn Ddol, Snowdonia (Smith 1996). Fieldwalking is also producing sites on the eastern fringe of the Welsh upland in the Welsh Marches and in the Black Mountains (Olding 2000; Burrow 2003). Other groups of sites are found in upland situations on the Cotswolds, Mendips, and Exmoor. Whilst some of the inland clusters, such as that at the head of the Rhondda, Brenig, and Llyn Aled Isaf, have both earlier and later Mesolithic flints, there is a clear tendency towards more inland and upland activity in the later Mesolithic which is seen most clearly in the predominantly later Mesolithic character of the assemblages in the Cotswolds (Saville 1984) and Mendip (Norman 1982). It is also noticeable that clusters of inland sites show a tendency to be in the accessible hinterland of areas of the coast with concentrations of activity and this suggests a model of movement between coasts and high ground using river valleys as axes of movement. There are two really noticeable blank areas on this distribution map. One is along the great coastal sweep of Cardigan Bay, broken only by the Mesolithic site at Aberystwyth Harbour (Thomas and Dudlyke 1925). The submarine contours (Fig 1.4) show that sites of all but the late Mesolithic in this site will be submerged. Even so, the lack of sites is striking and is born out by areas of Cardigan Bay where the writer has searched for flints finding few, so there was perhaps a sparsely utilised area between the much more densely settled landscapes seen along the south and north coasts of Wales. There is a scatter of find spots in the Cambrian Mountains inland. The other notable blank on Figure 1.6 on the English side of the Welsh Marches is explained entirely by the fact that sites have not been plotted east of the dotted line marked on Figure 1.7 although one survey suggests Mesolithic sites are few in this area (Stanford 1980).

1.12 Mesolithic research questions

Mesolithic research frameworks have been prepared for the British Isles as a whole (Prehistoric Society 1999) and specifically for Wales (Walker 2003). These highlight the need to identify sites with organic preservation and environmental evidence. Neither framework is very specific as to how this might be achieved and there is only passing mention of the potential of the intertidal zone which is the particular focus of this report. From the research frameworks

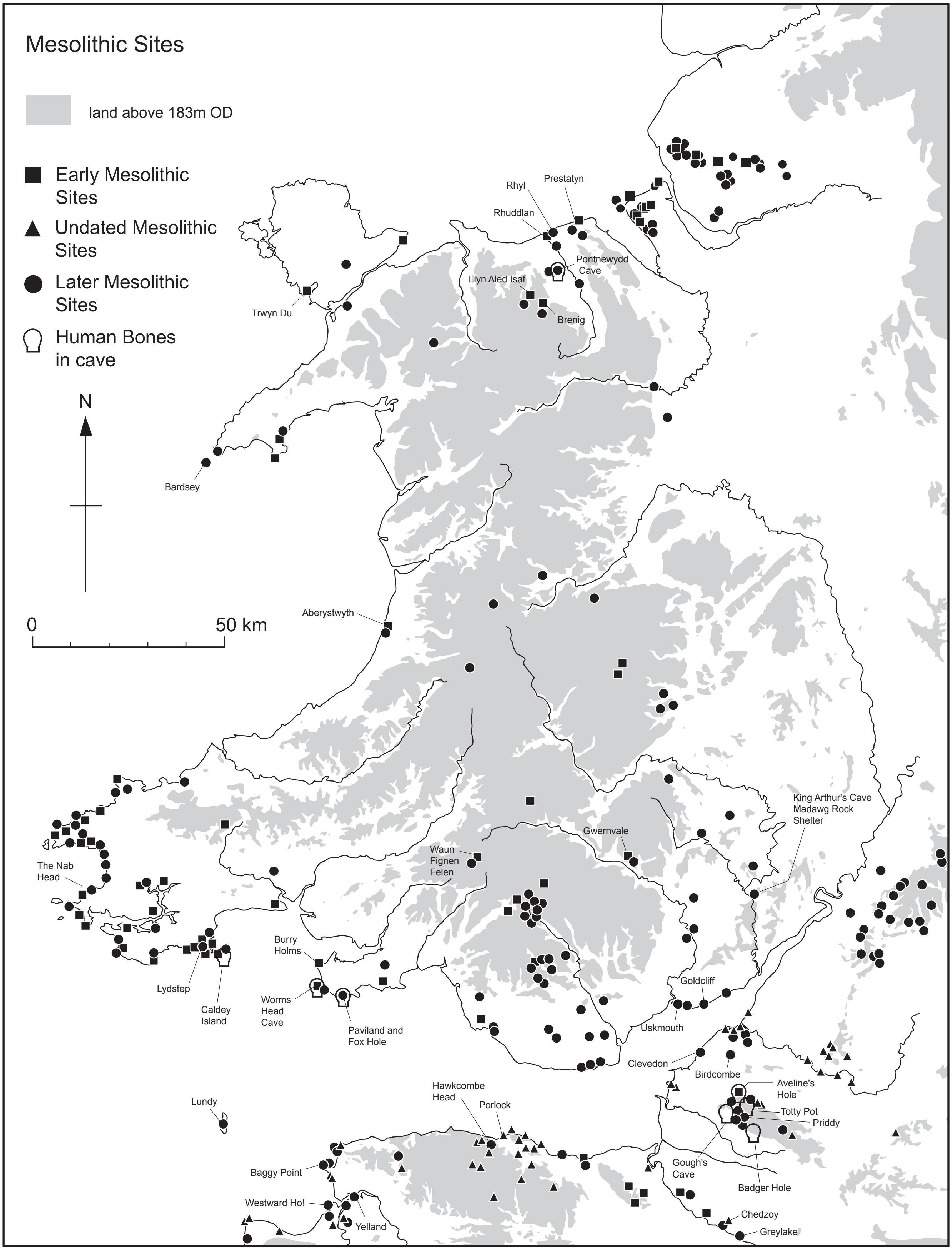


Figure 1.6 Mesolithic sites in Wales and western Britain (for sources see CD 1.4) (graphic S Allen)

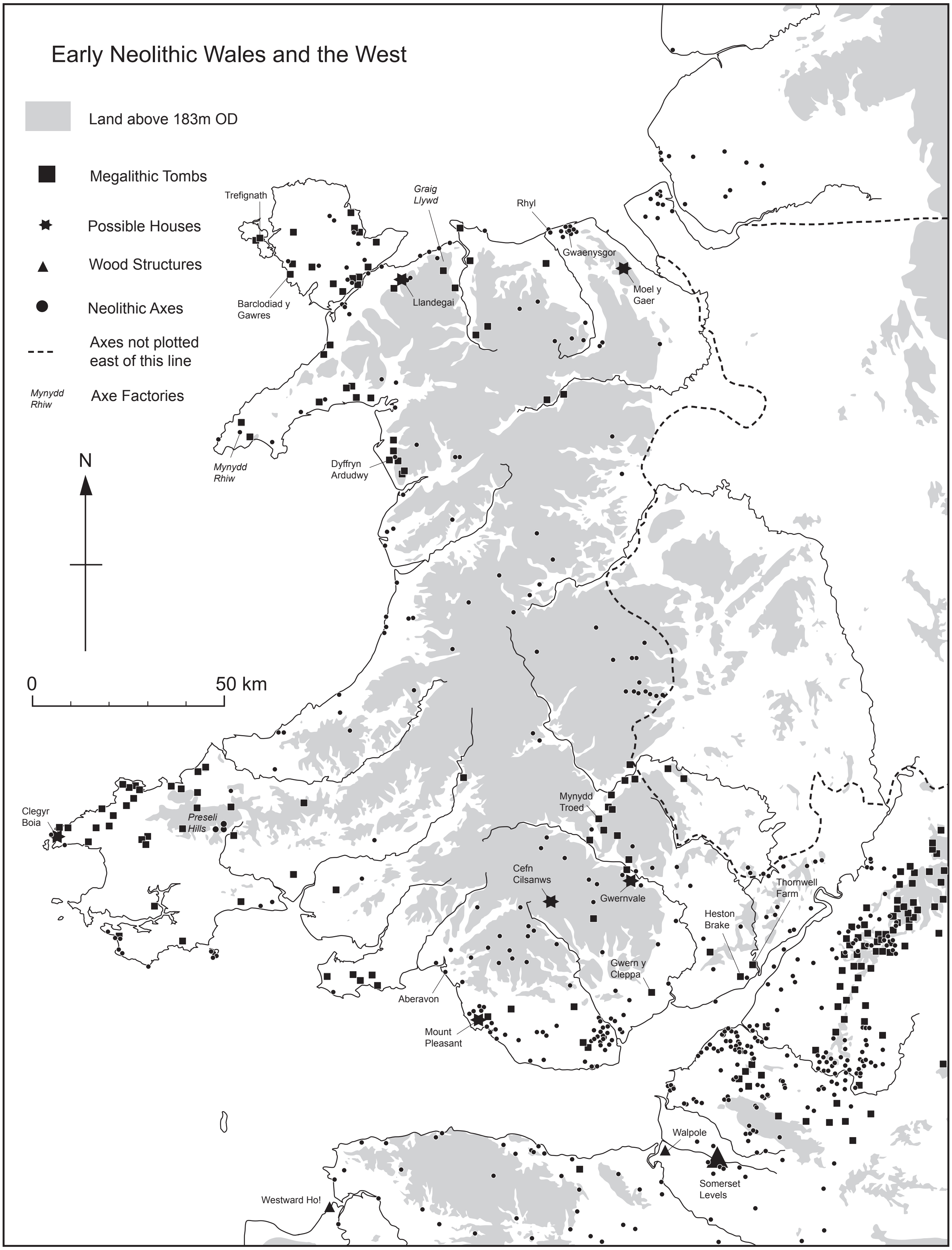


Figure 1.7 Early Neolithic sites in Wales and western Britain (for sources see CD 1.5) (graphic S Allen)

and wider literature a number of key questions can be identified which are particularly relevant to the coastal case studies examined here. How were the lives of Mesolithic communities affected by environmental changes in the coastal zone? What was the role of plant resources? Is there evidence of seasonality or sedentism? What can we say about territory and patterns of movement? It has been argued that Mesolithic communities altered their environment by the use of fire in the Welsh upland (A G Smith and Cloutman 1988) – but is there any comparable evidence from the lowland and coastal zone? Is there evidence for material cultural change, increased social complexity, and sedentism in the later Mesolithic?

An important background survey to the research reported here is a recent review of the Welsh Mesolithic by David and Walker (2004). In the introduction it was noted how polarised much of the literature is between Mesolithic and Neolithic accounts. It is particularly welcome, therefore, that the National Museum of Wales has recently prepared a catalogue of the artefact collections they hold for both periods in a single volume (Burrow 2003). Both the Burrow volume and David and Walker's paper provide important surveys of evidence and distribution maps of sites providing a full picture of the artefactual evidence for the periods. The present volume aims to complement their artefactual emphasis with a focus on issues of environment, landscape, and human agency.

1.13 Transition to the Neolithic

Until around 1990, archaeologists – both cultural and environmental – held a consensus view concerning the transition of the Neolithic. They envisaged a rapid shift from hunting and gathering to a dependence on domestic plants and animals and a settled way of life. These changes occurred at about the time of the elm decline seen in pollen sequences, so much so that this event (*c* 3800 cal BC) was, and sometimes still is, assumed to represent the boundary between the two periods. There was a long-held supposition that the decline was caused by the gathering of elm leaf fodder for animals (Troels-Smith 1960) or clearance of elm woods on fertile soils for cereals. Evidence of anthropogenic impact, including landnam clearances (Iversen 1941; A G Smith 1981), was identified on many sites, at, or soon after, the elm decline. One of many examples illustrating this are the vegetation changes after the elm decline in Smith and Morgan's (1989) pollen diagram from Goldcliff. This model depended heavily on specifically anthropogenic interpretations of changes in the pollen diagrams, particularly the elm decline and landnam events.

This consensus model has now been challenged on two fronts: cultural and environmental. On the cultural side the greater emphasis given to social 'post-processual' perspectives engendered scepticism of a specifically economically driven model of the transition to the Neolithic. Prehistorians favoured emphasis on the social and symbolic significance of tombs, material culture, and the domesticates themselves (Thomas 1991; Whittle 1999). A new model envisaged a gradual transition to farming with Neolithic communities seen as living an, at least partially, mobile existence, dependent largely on domestic animals, but also continuing to use wild resources, particularly plants, and only growing cereals to a limited extent. The idea of more mobile Neolithic communities was supported by the absence of Neolithic houses in southern Britain, especially in those core areas of Wessex so rich in other Neolithic monuments. The idea of a gradual transition was also supported by the limited evidence for crop growing and the discovery of plant macrofossil assemblages which showed continuing use of wild plants and some cereals (Moffet *et al* 1989) called by some a 'muesli' economy. The extent of cereal growing in the Neolithic remains a topic of debate, with some sites producing evidence for the continued use of wild resources and others producing significant quantities of domestic cereals (Fairbairn 2000).

Changing environmental interpretations of the elm decline (Parker *et al* 2002) have significant implications for the Mesolithic/Neolithic transition. As soon as researchers began to quantify the numbers of trees affected it became apparent that this would have required far more people and animals than was plausible at that date (Rowley-Conwy 1982; Rackham 1986). Furthermore, pollen of annually banded sediments at Diss Mere (Peglar 1993) showed the decline was so rapid that disease was the only tenable cause. This was probably something similar to the Dutch Elm Disease which destroyed British elms from 1965, indeed the beetle vector of that disease is reported at sites including Goldcliff East (Chapter 16) in the later Mesolithic. Rackham (2003) has suggested that disease may have been spread by the first farmers. That is a possibility, but we can no longer assume that the elm decline marks the start of the Neolithic. Indeed the notion of a sharp environmentally based division between the Mesolithic and Neolithic is also put in doubt by increasing evidence for vegetation disturbance in the later Mesolithic and by finds of pre-elm decline cereal type pollen (Edwards and Hirons 1984). One thing that makes comparison between the environmental effects of Mesolithic and Neolithic communities particularly difficult is that investigation of Mesolithic impact is overwhelmingly concentrated in the upland and moorland areas (Simmons 1996), whereas evidence for Neolithic activity is mainly focused in the lowlands. The present study, which focuses on agriculturally and climatically favourable areas of the western coastal fringe, will help to overcome that disjuncture.

Particularly relevant to our developing understanding of the transition is isotopic analysis of Neolithic burials, both in caves and in chambered tombs, and comparison with the isotopic composition of Mesolithic burial from caves in the study area. This shows a marked dietary change from the maritime focus of the Mesolithic to a predominantly terrestrial diet in the Neolithic (Schulting and Richards 2002a). We will return to the nature of the dietary change at this time in discussion of a burial at Prestatyn (Chapter 20.12).

One of the main problems in reconciling different models of the Neolithic is the quest for overarching frameworks applicable across the British Isles or more widely. Cooney (2000) has cautioned against the application of models developed in Wessex to the Irish contexts, where there is much more evidence for Neolithic houses and cereal cultivation than elsewhere in the British Isles (Bradley 2007). Many writers on the Neolithic emphasise the importance of identifying regional diversity. Hence the justification for the regional approach to the later Mesolithic and early Neolithic adopted here. The area in question lies immediately north-west of the Wessex area, where so much research has been concentrated and on which many models are based. Both areas have many Neolithic tombs. Unlike much of Wessex the study area is also rich in Mesolithic archaeology, has far more pollen evidence but far less faunal evidence for the periods in question.

It follows from the foregoing discussion that a key issue is establishing the date of the latest Mesolithic and earliest Neolithic. In Britain as a whole the latest dates for Mesolithic assemblages are *c* 4200 cal BC. In the study area the latest date for microliths was taken from the weapon which killed the Lydstep pig (5300±100 BP: OxA-1412; 4350–3940 cal BC). Some writers, emphasising evidence such as the pre-elm decline cereals, have suggested very early dates of *c* 4400 cal BC or earlier (eg Innes *et al* 2003). Kinnes (1988) was critical of the fragmentary evidence on which early dates were based and his trenchant observations remain valid. Here it is argued that we should reject notions of an early 'invisible Neolithic' and look in a literal way at the earliest groups of radiocarbon dates for traits which we associate with the Neolithic, avoiding obvious outlying dates. The earliest dates for chambered tombs in Britain are *c* 4100 cal BC and most of the dates for these tombs are in the range 3900–3100 cal BC (Schulting and Whittle 2001). The start date is consistent with those for the excavated tombs in the region (Whittle and Wysocki 1998, table 13). In Wales, Burrow (2003) concludes that the earliest Neolithic pottery dates to *c* 4000 cal BC. A recent survey by Brown (2005) of the radiocarbon dates for (mostly charred) Neolithic cereal grains in Britain shows there is very little evidence before 4000 cal BC. This dating is consistent with the two sites in Wales with early cereals: Gwernvale and Coygan Camp. In western Britain some of the earliest evidence for domestic animals seems to be sheep at Broken Cave, Devon (4930±90 BP: OxA-3205; *c* 3960–3520 cal BC) (Roberts *et al* 1996). The one good quality much earlier date is for domestic cow from Ferriter's Cove, Ireland (5510±70 BP: OxA-3869; 4495–4165 cal BC) (Woodman *et al* 1999) but so far there are no dates so early from the rest of the British Isles. On the present evidence it seems reasonable to conclude that in the study area considered here the earliest Neolithic was around 4000 cal BC (Schulting 2000), or within a century or two of that date.

The distribution of Neolithic sites is shown in Figure 1.7. A very marked concentration of tombs of the Cotswold-Severn group occurs on the Cotswold Hills in predominantly upland and inland situations. There are three notable exceptions below 50m OD overlooking the edge of the Severn Estuary Gwent Levels: at Gwern y Cleppa, Heston Brake, and Thornwell Farm. Of special interest is the only inland group of Neolithic tombs in Wales in the Black Mountains between the Rivers Wye and Usk, both of which flow into the Severn Estuary. Mesolithic sites occur in a similar area (Olding 2000). A small group of tombs occurs just west of Cardiff and there are also Cotswold-Severn type tombs on Gower. Around the Pembrokeshire coast there is a group of tombs mostly characterised as portal dolmens, which are regarded as of similar date to the Cotswold-Severn Group (Cummings and Whittle 2004). A further concentration of tombs is centred on Anglesey, extending round the Gwynedd coast of the Lleyn, up the Conwy Valley, and with one example up the former Clwyd Estuary, inland of the Prestatyn area considered here (Chapter 20), and two in the headwaters of the Dee. Thus, the distribution of Neolithic tombs has a strong coastal emphasis and many writers have drawn attention to marked similarities in the distribution of tombs and Mesolithic sites, as a comparison between Figures 1.6 and 1.7 shows.

Figure 1.7 also shows the distribution of Neolithic axes; these span the whole of the Neolithic and thus a much longer period than the main use of the tombs. Axes pick out some of the areas with tombs but show a much greater extent of inland and upland penetration which could in part reflect colonisation in the later Neolithic. There are some interesting clusters which are likely to represent particular concentrations of activity, albeit probably enhanced by the concentrated activities of collectors. These occur in the Bath area and at the mouth of the Avon, just west of Cardiff, they are associated with other flint scatters (Locock 2000) and tombs all indicating a concentration of settlement. A concentration of axes also picks out the Prestatyn and Rhyl areas discussed in Chapter 20.

An absence of Neolithic houses was noted above as one of the key pieces of evidence supporting the model of significant mobility during the earlier Neolithic. It is notable, however, that there are a number of possible domestic structures in Wales and some of the best preserved of these show similarities with the houses which are now being found in increasing numbers in Ireland (Lynch 2000).

By far the greatest concentration of Neolithic wetland activity in the mapped area is the Somerset Levels where 30 Neolithic trackways have been recorded (Coles and Coles 1986). Most notable is the

Sweet Track, dendrochronologically dated 3807/06 BC (Hillam *et al* 1990), thus within a century or two of the date suggested above for the earliest Neolithic and associated with pottery, axes, and leaf arrowheads characteristic of the period. In the Severn Estuary, by contrast, evidence of Neolithic activity is very limited to a few polished axes and in the late Neolithic or early Bronze Age wood structures at Peterstone (Bell *et al* 2000; Bell and Brown 2005). West of the Levels, the polished axe from Barry docks has already been noted and of special note is an axe still in its wooden shaft found on the beach at Aberdaron and presumably from intertidal peat (Savory 1971).

Despite many finds of Mesolithic artefacts associated with the intertidal peats of Pembrokeshire already noted, Neolithic finds are very few and none is stratified, although a polished axe was found unstratified in the intertidal zone at Whitesands Bay (Burrow 2003, 245), where Lewis (1992) recorded aurochs skulls of Neolithic date. In north Wales, finds of stone axes in intertidal contexts are recorded at Rhos-on-Sea (Burrow 2003, 139) and there are several examples from Rhyl which are discussed more fully in Chapter 20. Finds of axes and lithic scatters attest to Neolithic activity in the wetlands of Merseyside (Cowell and Innes 1994).

1.14 Conclusion

This chapter has established that the submerged forests and intertidal peats in the mapped area of Wales and western Britain are largely of later Mesolithic to Neolithic date. A history of associated archaeological finds made over 145 years demonstrates their potential to contribute to our understanding of the later Mesolithic and the transition to the Neolithic. A strong coastal emphasis is seen in the distribution of archaeological sites in both the Mesolithic and earlier Neolithic. The degree of continuity which this suggests is strengthened by a number of sites which show evidence of activity in both periods. We will particularly consider the case of Goldcliff where Neolithic activity has previously been claimed on the basis of pollen evidence. Thus the evidence and its distribution suggests a degree of continuity which might support the currently orthodox model of significant continuity between the Mesolithic and Neolithic, the continued use of wild resources and a degree of continuing mobility. Conversely, the isotopic evidence for a marked shift away from marine resources, the presence of some domestic structures similar to those in Ireland, and the apparently rather sudden onset of tomb building *c* 4100 cal BC might argue in favour of more rapid social change. These questions, along with many others specific to the Mesolithic, will be reviewed in subsequent chapters, which look in detail first at Goldcliff in the Severn Estuary (Chapters 2–18), then more briefly at other Severn Estuary sites in Chapter 19 and then the Prestatyn area of north Wales (Chapter 20). The concluding discussion (Chapter 21) returns to the broad themes outlined in this introduction with discussion of the implications of the case studies and other related research for our understanding of the later Mesolithic and transition to the Neolithic in the wider research area of Wales and western Britain.

2 The Mesolithic site at Goldcliff East: introduction to the site, the sequence, and methodology
by Martin Bell

2.1 Development of the research

2.1.1 Previous work

The following eighteen chapters comprise a developed case study of a complex of Mesolithic sites at Goldcliff East in the Severn Estuary (Fig 2.1). These sites lay around the edge of a former bedrock island (Fig 2.2) which, in the later Mesolithic, was surrounded first by forest, then by a highly dynamic wetland, sometimes reedswamp, sometimes fen woodland, and sometimes saltmarsh with open sea at high tide. This case study underpins our contention that coastal wetland sites can provide an important new perspective on the Mesolithic sites of western Britain, a topic previously dominated by poorly stratified lithic assemblages.

The significance of the Severn Estuary Levels for Mesolithic archaeology is invisible on the distribution maps of Mesolithic finds published before about 1990 (eg Jacobi 1980), nor really apparent from those maps published more recently (Aldhouse-Green 2000a, fig 1.7). Our distribution maps, particularly from this period, are maps of the territories of dedicated flint collectors whose activities reflect particular perceptions about which areas are likely to be productive of sites. The Severn was late in registering on the perceptual radar of archaeologists. The extensive peat deposits are all buried and have not been commercially cut in recent times. Surprisingly the extensive intertidal peat exposures scarcely figure in the 19th- and early 20th-century literature on submerged forests (eg Reid 1913).

A sequence of discoveries from the mid-1980s put the Severn Estuary Levels on the map and established the foundations for future research. The main person responsible for prehistoric archaeological discoveries was the late Derek Upton (dedication in CD introduction), at that time a skilled steelworker at Llanwern, a gifted spare-time archaeologist, natural historian, and pioneer of nature conservation in the Severn Estuary Levels (Bell 2005). Recognition of the wealth of archaeological evidence in the Severn Estuary led in 1986 to the establishment of the Severn Estuary Levels Research Committee (SELRC). This helped to stimulate research including a botanical investigation of the intertidal peats at Goldcliff East (Smith and Morgan 1989), which established the existence of a wetland vegetation sequence comparable to that associated with spectacular archaeological sites across the estuary in the peatlands of the Somerset Levels (Coles and Coles 1986). Smith and Morgan's study provides a vegetation sequence from the later Mesolithic to the Bronze Age, which is of great value for comparison with the sequences reported here from the Upper Peat and Submerged Forest. They did not investigate the Lower Peat and Submerged Forest and when their article was published the great wealth of prehistoric archaeology subsequently discovered at Goldcliff was unknown.

The first intertidal discovery which later proved to be Mesolithic was made 4km to the west at Uskmouth (Fig 2.2) where, in December 1986, Derek Upton discovered human footprints stratified within sediments which Allen and Rae (1987) had shown were prehistoric (Aldhouse-Green *et al* 1993). The following year (1987) Derek Upton and Bob Trett, then of Newport Museum, discovered charcoal and flint flakes below intertidal peat just west of Goldcliff headland. Newport Museum organised a recording exercise of the sediment exposure in April 1989, which was supervised by Malcolm Lillie. A radiocarbon date showed this site was Mesolithic (Parkhouse 1990). The discovery by Derek Upton, Bob Trett, and others on 31 October 1990 of wooden prehistoric structures on a peat shelf west of Goldcliff headland led to a major campaign of archaeological survey and excavation west of Goldcliff between 1991 and 1994. Eight rectangular buildings were dated to the Iron Age and there was significant evidence of Bronze Age activity in the form of planks from a sewn plank boat and evidence of skull deposition at the edge of the former Goldcliff island (Bell *et al* 2000).

As part of that fieldwork campaign an excavation was carried out in 1992–94 on the Mesolithic site discovered at Goldcliff in 1987, called here Site W, a label not used in the original report but applied here for brevity now that there are several Mesolithic sites. That site proved to be within *c* 10–20m of the edge of a former bedrock island (Fig 2.2). It is 500m west of the nearest Mesolithic sites reported in the present report, which are on the east side of the same island. Excavation showed that Mesolithic site was on an old land surface developed on Head, it was overlain by estuarine silts, and then peat. Radiocarbon dates showed that the main period of Mesolithic activity dated between 5700 and 5200 cal BC (Bell *et al* 2000; Chapter 4). It produced a lithic assemblage, animal and fish bones, and evidence of the seasonality of Mesolithic coastal activity. There were some waterlogged seeds but unfortunately conditions only became wet enough for pollen preservation some four centuries after the main period of Mesolithic activity. Astrid Caseldine's (2000) detailed pollen study provides an important vegetation record from the later Mesolithic to the Iron Age.

In conducting the project west of Goldcliff island

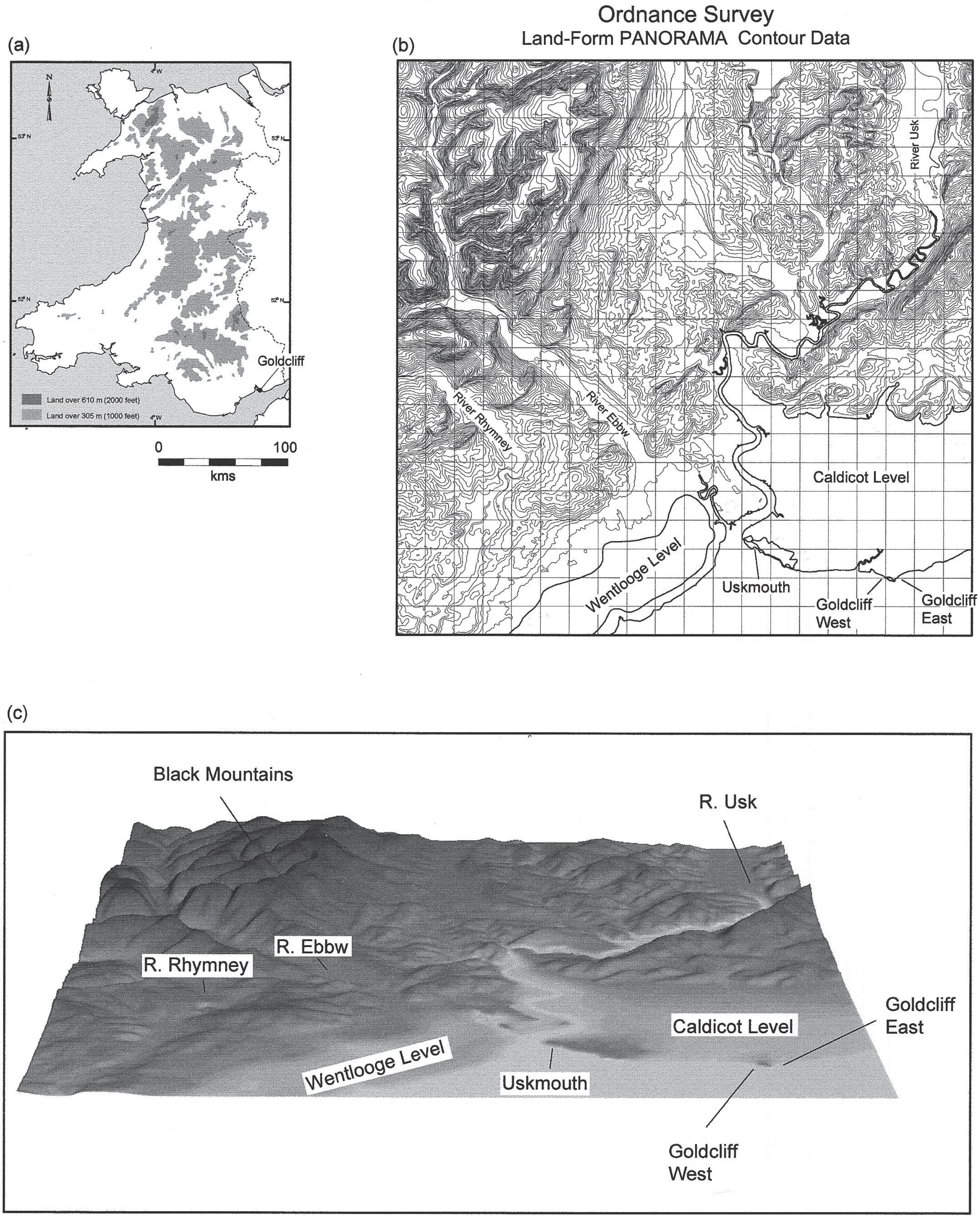


Figure 2.1 The location of Goldcliff East in relation to (a) the map of Wales (b) the coastal levels and contours in the upland to the north (c) isometric topographic plan (b and c reproduced from Ordnance Survey Land-Form PANORAMA Contour Data with permission of the Controller of Her Majesty's Stationery Office, © Crown Copyright; graphic S Buckley)

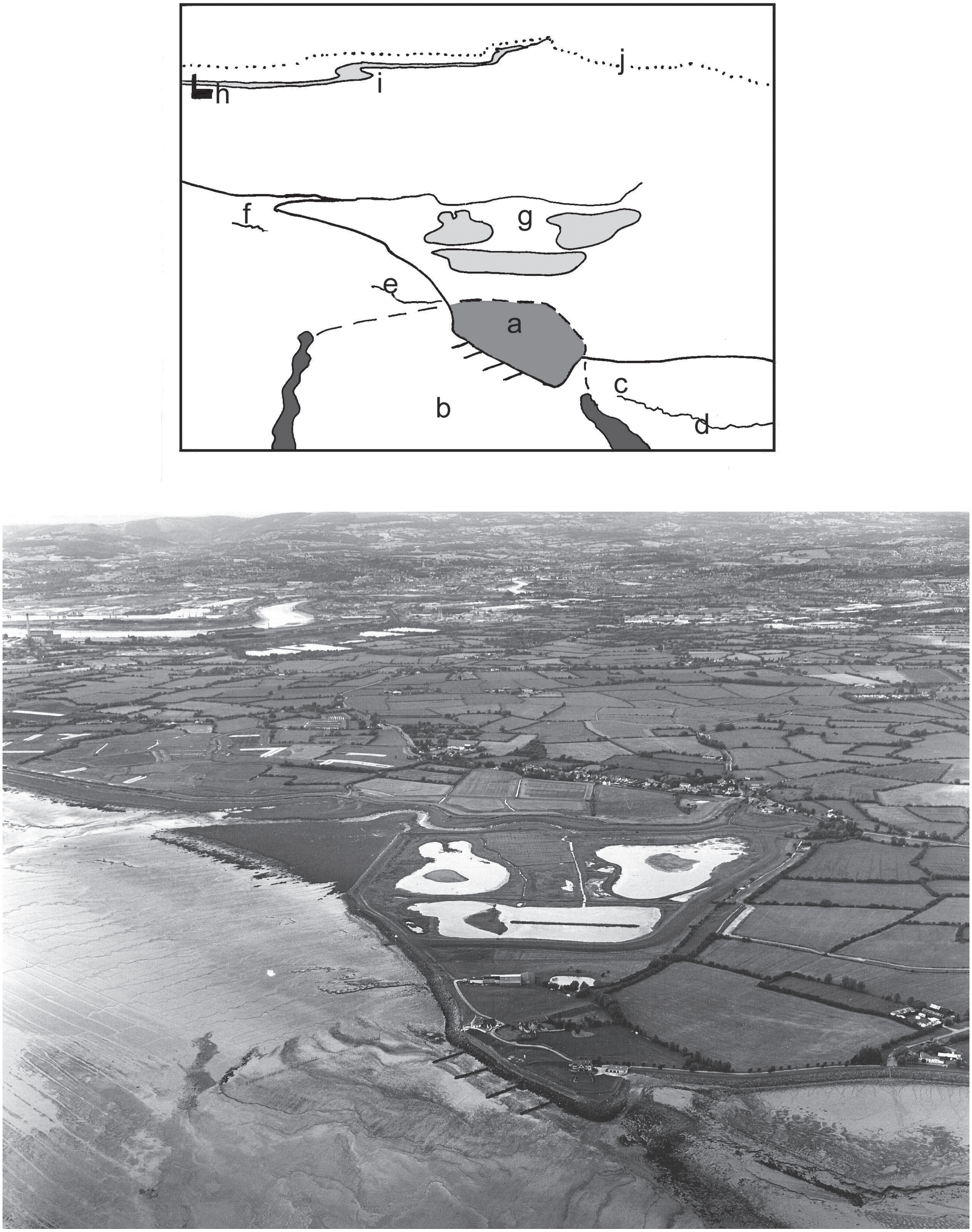


Figure 2.2 Air photograph with interpretative sketch (a) What remains of the former Goldcliff island (b) Former extent of the island, its edges marked by Ipswichian beaches (c) Excavation Site J (d) Excavation Site A (e) Excavation Site W (f) Area of Iron Age buildings 1–4 (g) Gwent Levels Wetland Reserve (h) Uskmouth Power station (i) The River Usk at Newport (j) The former wetland edge (Crown Copyright. Royal Commission on the Ancient and Historical Monuments of Wales)

the writer had become acutely conscious of the importance of the Mesolithic site given the paucity of work on sites with palaeoeconomic and palaeoenvironmental evidence in England and Wales. The problem was that the Mesolithic site received only a small proportion of the project's time and resources. That was inevitable given the huge demands created by the excavation, recording and lifting of Iron Age wood structures, all of them undergoing very active erosion. It was noted in evaluating the results of the project that 'the entire resources available to the project could easily have been allocated doing full justice to the Mesolithic site alone' (Bell *et al* 2000, 348).

By the time the 1990–94 campaign of excavations at Goldcliff was published, it was clear that the Mesolithic period in the Severn Estuary was of such interest that it fully justified a campaign of research specifically focused on that period. That view was reinforced as a result of excavations conducted at Redwick in 1999–2001. These excavations concerned the excavation of a group of four wooden Bronze Age structures (Bell and Neumann 1999; Bell 2001). Linked to that work was a survey of the Holocene sedimentary sequence exposed on the Redwick foreshore enhancing that part of the intertidal survey carried out by Heike Neumann (2000) in 1995–96. At the same time, the area was the subject of a campaign of sedimentary research by Professor Allen (Allen and Bell 1999; Allen and Haslett 2002). These surveys identified an extensive spread of basal submerged forest that a radiocarbon date showed was Mesolithic. Some of the trees examined had evidence of charring. A basal submerged forest had also been surveyed in 1993 just east of the former island at Goldcliff where again there was a charcoal spread. That forest lay beyond the area of palaeoenvironmental investigation and at the time of the original fieldwork was undated. At a late stage in the post-excavation work, a radiocarbon date was obtained by Professor Allen which showed the forest was broadly contemporary with the excavated Mesolithic site west of the island. Since the forest was associated with a thin peat, there was potential to obtain environmental evidence directly associated with the Mesolithic settlement. Unfortunately, there was no time to follow this up in the excavation report (Bell *et al* 2000).

2.1.2 The environmental project

Recognition of the potential of the Severn Estuary sequence as a whole for research on Mesolithic environment and archaeology led to the development in June 2000 of a research project that was submitted as a grant proposal to the Natural Environment Research Council (NERC). Thankfully that proposal was funded and the research project ran from July 2001 to June 2004. The project title was 'Mesolithic to Neolithic Coastal Environmental Change 6500–3500 cal BC: integrating the role and chronology of human agency and natural disturbance factors' (Grant no NER/A/S/2000/00490). The project was led by the writer with co-investigators Dr Petra Dark, Professor John Allen, and Dr (now Professor) Sturt Manning. Other key members of the project team were Nigel Nayling who was responsible for dendrochronology and Dr Shaun Buckley, the project Research Assistant. Four student PhD projects became linked to this project and aspects of their results are included in this monograph: Alex Brown (2005) working on wetland/dryland relationships in the Severn Estuary (Chapter 19); Rachel Scales (2006) working on human and animal footprint-tracks and animal bones (Chapters 12 and 13); Emma Tetlow (formerly Paddock) (2005) working on insects (Chapter 16); and Scott Timpany (2005) working on botanical aspects of submerged forests (Chapter 15). Brown, Scales, and Timpany were based in the Archaeology Department, Reading University under the supervision of various combinations of the investigators; Tetlow was based in the Institute of Archaeology and Antiquity at Birmingham University under the supervision of Dr David Smith. Project members, research students, and various associates met formally for minuted meetings two or three times a year for the duration of the project and also worked together regularly in the field.

This project aimed to evaluate the spectrum of environmental disturbance factors, natural as well as cultural, using a multiple working hypothesis and multi-proxy approach. The objective was that interpretations developed from one source could be compared to those obtained from other sources. Our project aimed to refine the chronology of environmental change in the mid Holocene Severn Estuary in particular by examining the dendrochronological potential of the Mesolithic submerged forests and by a programme of radiocarbon dating. It was also proposed to investigate the timescale of sedimentary increments, for instance testing the idea that some of the minerogenic sediments had evidence of annual banding. The expectation was that more precise timescales of environmental change and comparisons between dated sequences on different sites would enable us to identify changes which were widespread, coeval, and probably of natural cause. The contribution of these to environmental disturbance could then be compared to the generally more localised and specific contributions of human agency. The role of human agency as a disturbance factor was to be evaluated alongside the effects of sea-level change, wind blow, wildfire, and the effects of fauna.

2.1.3 Related environmental research

This project also benefited from a related programme of detailed sedimentary research that was focused on the Goldcliff and Redwick areas and led by Professor John Allen who with collaborators has already published a series of papers on the results. These are of particular importance in this context because they provide a detailed picture of environmental change in the Mesolithic and Neolithic beyond the individual study site reported here including dates for periods of peat formation (Allen 2005). This work also provides evidence of erosive embayments and depositional hiatuses during the period of Wentlooge Formation sediment deposition (Allen and Haslett 2002) and has established that there is annual textual banding within the Mesolithic laminated sediments which contain human and animal footprint-tracks (Allen 2004; Dark and Allen 2005; Allen and Haslett 2006). This detailed sedimentary evidence is only briefly summarised here where it relates to aspects of the archaeological evidence (eg Chapters 4.1 and 17.2) and the papers noted should be consulted for further information.

2.1.4 Fieldwork and the archaeological project

As originally conceived this was a mainly palaeoenvironmental project, although partly designed to build on and complement the archaeological results of the 1992–94 excavations west of Goldcliff island. The first field season of the NERC project in 2001 was mainly focused on the surveying, recording, and sampling of the submerged forest at Redwick, which is 4.8km east of Goldcliff East. This season took place between 11 August and 9 September 2001. That stage of the project was done in tandem with the final season of excavations on the Bronze Age settlement at Redwick (Bell 2001). Work on the Lower Submerged Forest included excavation of trenches across two trees to investigate their stratigraphic context. Tree 40 was a large oak stump, partially charred and surrounded by charcoal. Trees 18 (trunk) and 36 (stump) were sectioned by the same trench. Bell *et al* (2001) provides an interim report on this work at Redwick. No Mesolithic artefactual evidence was found at Redwick and the results will be presented in detail in forthcoming publications on the wider palaeoenvironmental project. Extensive evidence was found for the charring of trees and reeds and it is possible that this relates to the activities of Mesolithic communities maybe from Goldcliff island, or from some other site (Bell *et al* 2003). At the end of the 2001 season a more limited programme of investigation took place on the Lower and Upper Submerged Forests at Goldcliff East. Figure 2.3 is a map of the Goldcliff East embayment showing the location of the main sites mentioned and Table 2.1 outlines the main stratigraphic sequence from the sites discussed below (see 2.1.6).

Within a day or so of fieldwork beginning at Goldcliff it was clear that there was very much more archaeological evidence than the odd flint flakes and charcoal fragments seen at the time of the original survey of this embayment (Bell 1993). Concentrations of lithic artefacts, bone, and charcoal were identified in two areas designated Site A, a buried land surface on the slope of Goldcliff island and Site B associated with the Lower Submerged Forest. At Site B a 6 × 1m trench was excavated which confirmed that artefacts were stratified in the Lower Peat and the Old Land Surface below. At Site A, an area of the Old Land Surface was cleaned, planned and artefacts recorded, a $1m^2$ pit was excavated to investigate the stratigraphic sequence. Even more exciting than the discovery of these new concentrations of Mesolithic artefacts was the finding, in laminated silts postdating the Lower Submerged Forest, of large numbers of human, deer, and bird footprint-tracks. An area of these measuring 12m × 5m was planned (Bell *et al* 2001, fig 6). It is much to the credit of the field teams involved that by extremely hard work it proved possible to accommodate preliminary work on these newly discovered archaeological sites within the existing programmes of work on the submerged forests and the Redwick Bronze Age excavations.

The newly discovered Mesolithic sites, some associated with peat deposits, were clearly of importance given the paucity, noted in Chapter 1, of Mesolithic sites with faunal and environmental evidence. These new sites were under very active erosion. Accordingly, Cadw agreed to fund excavations in 2002 and 2003.

Once Cadw support had been agreed, the NERC and Cadw projects worked in parallel and to mutual benefit: the NERC project was focused on palaeoenvironmental aspects and the Cadw project on the excavation of specific Mesolithic sites and the analysis of the artefactual evidence from them. Fieldwork was a combined operation usually with a team of about 30, of which about a third was focused on the NERC project and the remainder involved in archaeological excavation.

The second season of fieldwork took place between 8 August and 11 September 2002, focused largely on the Goldcliff East embayment. Excavations took place at Sites A and B and recording and excavation of footprints at Sites E, C, and H. Work on sampling and recording the submerged forests continued and detailed plans were made of the forests at Sites J and K. Cleaning of the Submerged Forest at Site J was another pivotal point for the development of the project. In the Old Land Surface immediately under the Submerged Forest there was found charcoal, lithic artefacts, and bones. That was a most important discovery because Site J is much higher in the tidal frame and thus not so difficult to excavate as the lower sites (see 2.1.7 below). Our original expectation that because of its higher position in the tidal frame conditions might be less favourable for the preservation of organic artefacts proved incorrect and this site has produced most of the small collection of waterlogged wooden artefacts. During the 2002 season some limited further recording was done on the Redwick Submerged Forest; however, much of that had by then been covered by shifting sandbanks so it was very fortunate that most of

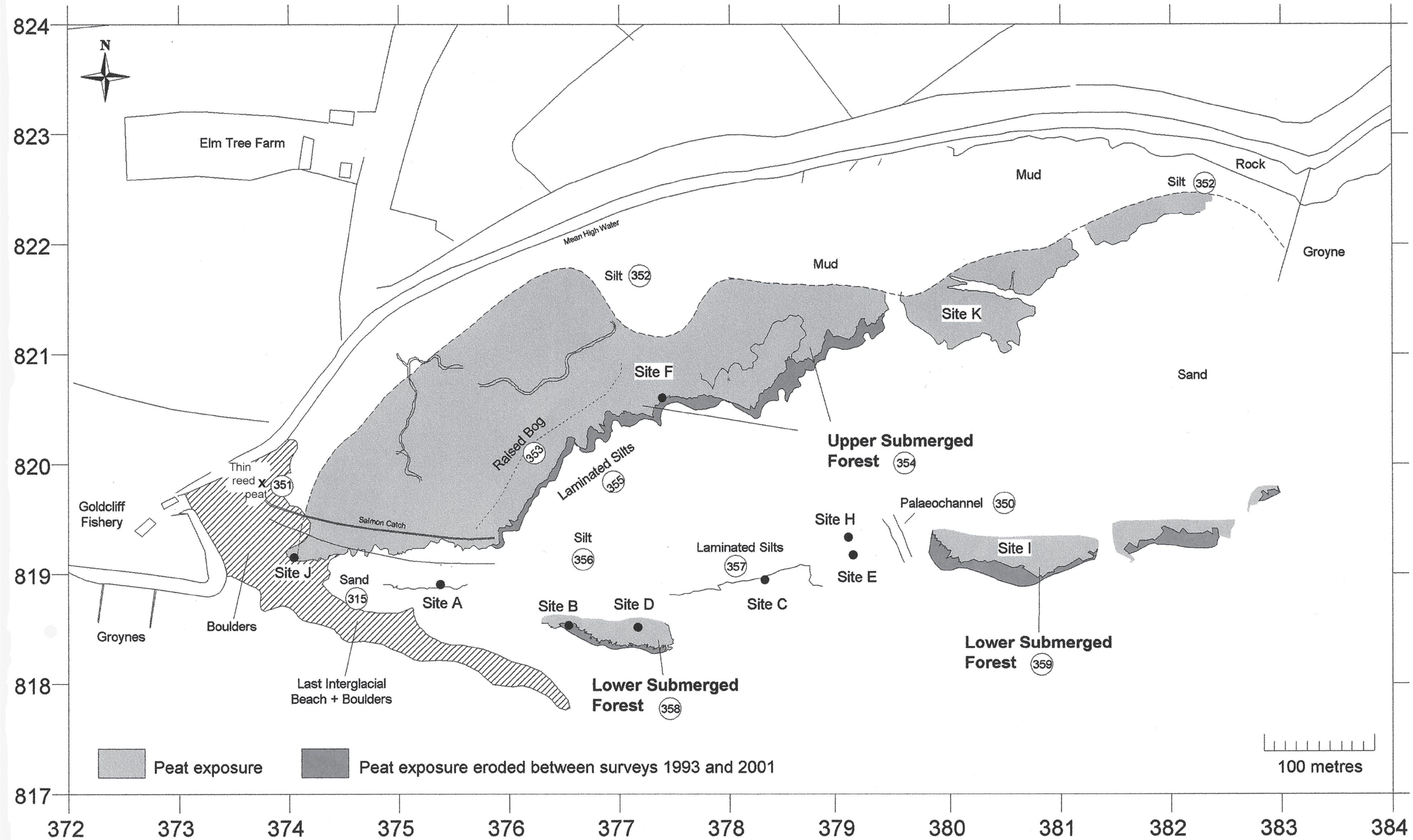


Figure 2.3 Map of Goldcliff East showing the main sites investigated in 2001–03 (graphic S Buckley)

Table 2.1 Outline of the main Pleistocene and Holocene sedimentary units at Goldcliff East, their occurrence on the excavated sites, the presence of archaeological evidence, and the dates available for each unit

Unit	Sediments	Sedimentary formation/ Period	Site	Archaeological evidence	Radiocarbon date	Calibrated range [Based on ^{14}C wiggle-match not allowing for missing wood, sapwood etc]	Chapter
Top							
(x)	Minerogenic estuarine sediments	upper Wentlooge	–	–	–	–	–
(ix)	Thin reed peat	upper Wentlooge	–	–	–	–	–
(viii)	Minerogenic estuarine sediments	upper Wentlooge	–	–	–	–	–
vii (f)	Reed peat	middle Wentlooge	Smith and Morgan Sites 1 and 2	–	3130±70 BP (CAR-644)	1610–1200 cal BC	6 & 7
vii (e)	Raised bog peat	middle Wentlooge	F; Smith and Morgan Sites 1 and 2	–	5020±80 BP (CAR-652) to 3440±70 (CAR-645)	3970–3650 to 1940–1530 cal BC	6 & 7
vii (d)	Reed and sedge peat	middle Wentlooge	F; Smith and Morgan Sites 1 and 2	–	5360±80 BP (CAR-656) to 5020±80 BP (CAR-652)	4350–3990 to 3970-3650 cal BC	6 & 7
vii (c)	Upper Submerged Oak Forest	middle Wentlooge	J, F, Tree 70	Some charred trees (T36 and T70)	from 5850±80 BP (CAR-658) to 5360 ±80 BP (CAR-656)	[4477–4239±7.5 BC]	6 & 7
vii (b)	Alder carr-woodland	middle Wentlooge	J, F, K; Smith and Morgan Sites 1 and 2	Possibly some Mesolithic activity at J			6 & 7
vii (a)	Reed peat	middle Wentlooge	J	Some Mesolithic activity at J	5950±80 BP (CAR-659) to 5850±80 BP (CAR-658)	5050–4610 to 4910–4500 cal BC	6 & 7
vi	Minerogenic estuarine sediment, banded	lower Wentlooge	C; E; G; H; J	Animal and human footprint-tracks at C; E; G; H. Mesolithic activity at J			4 & 6
v	Thin peat containing some trees of Lower Submerged Forest	Mid-Holocene	B; D; I	Mesolithic activity at B and D	6770±70 BP (Beta-60761)	5740–5490 cal BC	3
iv (c)	Thin estuarine sediment	Mid-Holocene	D				3
iv (b)	Lower Submerged Oak Forest	Mid-Holocene	D; I			[6179–5826±4 BC]	3
iv (a)	Old Land Surface	Mid-Holocene	A; B; D; J	Mesolithic activity at A, B, and J	6480±70 BP (CAR-1502)	5490–5330 cal BC	3; 5; 6
iii	Stony Head containing Trias Red Marl	Devensian	J				
ii	Sandy pebbly Head containing Lias limestone	Devensian	J				
i	Sandy and pebbly Ipswichian beach cemented as sandrock locally	Ipswichian	J				
Bottom							

Note: for full details of dating see Chapter 8 our recording and sampling at Redwick had been completed during the first season. During the second season Alex Brown and helpers also conducted environmental sampling and small-scale excavation at Llandevenny on the dryland edge 6km north of Goldcliff, where another Mesolithic site was found. Sampling also took place of peats and submerged forest at Hills Flats (Chapter 19).

The third season of fieldwork took place from 9 August to 15 September 2003. This was again mainly focused on Goldcliff East with the completion of work on the submerged forests, excavation of Sites A, B, D, and J, and recording and excavation of footprint-tracks on Sites C and E. During this season a much larger team provided by the television programme Time Team joined us for a very intensive three days of excavation focused on Site B. During the season some limited further recording was done on the Submerged Forest at Redwick and recording and sampling also took place on the Submerged Forest at Woolaston (Chapter 19).

In addition to the three main field seasons, the project also had some task-specific 'long weekends' with smaller teams of six to ten. Between 27 and 28 March 2002 we concentrated at Goldcliff on examining the lowest peat, recording part of the Upper Submerged Forest and recording footprints. Between 27 and 29 April 2002, in partnership with a team from Exeter University, we recorded exposures of Mesolithic occupation and submerged forest at Westward Ho! following up earlier work in 1983 (Balaam *et al* 1987). That study will form part of a separate publication. Between 27 February and 3 March 2003 a small team investigated the stratigraphic context of trees which formed part of a floating chronology from the Goldcliff Upper Submerged Forest. Work also took place on blocklifting footprint-tracks, Rachel Scales excavated aurochs bones from a palaeochannel at Uskmouth, and there was a preliminary investigation of the Submerged Forest at Woolaston (Chapter 19). The main period of fieldwork and dendrochronological sampling at Woolaston took place between 20 and 22 February 2004 (Brown *et al* 2005). In addition to these defined periods of fieldwork, other visits of one or two days were made; Alex Brown organised a number of such visits to Oldbury (Chapter 19). Since the formal completion of excavations at Goldcliff East, monitoring visits have been made to Goldcliff East when possible and this has led to the discovery of some additional footprints and pieces of waterlogged wood from a Mesolithic palaeochannel. Such discoveries highlight the need for continual vigilance at these intertidal sites where new things are constantly coming to light, particularly after storms.

2.1.5 Geographical and Quaternary context

The Goldcliff East site lies on the north side of the Severn Estuary in Wales (Fig 2.1). It is 8km south-east of the City of Newport and 12km west of the Second Severn Crossing Bridge. To its west lie the Rivers Usk and Ebbw, which join the estuary at Newport, to its east the River Wye, which joins the estuary at Chepstow. These rivers drain the uplands of south-east Wales including the Black Mountains and the Brecon Beacons which both rise to over 750m within 50km of the coast. During the Devensian glaciation the uplands of south Wales were ice-covered; the ice margin ran west to east along the coast of south Wales and then at Newport turned north in the Ebbw Valley and then the Usk Valley (Geological Survey 1977). Thus, the Devensian ice margin was 6.3km west of the Mesolithic sites at Goldcliff East. This is an important point because some of the lithic raw materials (notably glacial tuffs and various quartzites) used by Mesolithic communities are thought to have been glacially transported. At the north edge of the present Levels, Allen (2001) has identified extensive buried deposits of last interglacial beach sands and gravels, which flank the former island at Goldcliff (Allen 2000a). There are also extensive Pleistocene river gravel deposits, which in the Sudbrook area contain Palaeolithic handaxes (Green 1989). The gravels also contain flint nodules, some probably glacially derived, some probably derived fluvially from river systems on the English side to the south-east. These gravels are thought to be the source of flints used by the Mesolithic communities.

Goldcliff lies within the Caldicot Levels, which form the east part of the Gwent Levels coastal lowland (Fig 2.1). The levels are at about 7m OD and form an extensive spread of Holocene estuarine sediments, silts, and peats now reclaimed from the sea and protected by seawalls (Fig 2.2). The levels are at their widest at Goldcliff where the present coast is 5.5km from dryland at Llanwern. The solid geology immediately north of Goldcliff comprises Lower Lias Limestone, with Old Red Sandstone to the north, and Carboniferous Limestone further east, along the edge of the levels. The hills rise to about 60m just inland from the wetland, and then 7.5km inland they rise to 300m at Wentwood. The limestones are probably the original source of some of the chert used as raw materials by Mesolithic communities although they probably obtained them from secondary river gravel contexts (Allen 2000d).

The village of Goldcliff which gives its name to the complex of archaeological sites is 1km inland. The village originally takes its name from the topographic feature on the coast known as Gold Cliff, a promontory which projects slightly into the estuary and marks a bedrock outcrop within the estuarine levels. The solid geology of this feature is Red Marl (Trias) overlain by Tea Green Marl, Rhaetic, and Lower Lias Limestones and shales. Today's bedrock outcrop has been shown by Allen (2000) to be a remnant of a formerly more extensive island which once extended much further out into the estuary. He has demonstrated that the margins of that island are picked out on the foreshore by an eroded expanse of Trias bedrock flanked by exposures of cemented sandrock which represent a fossil beach

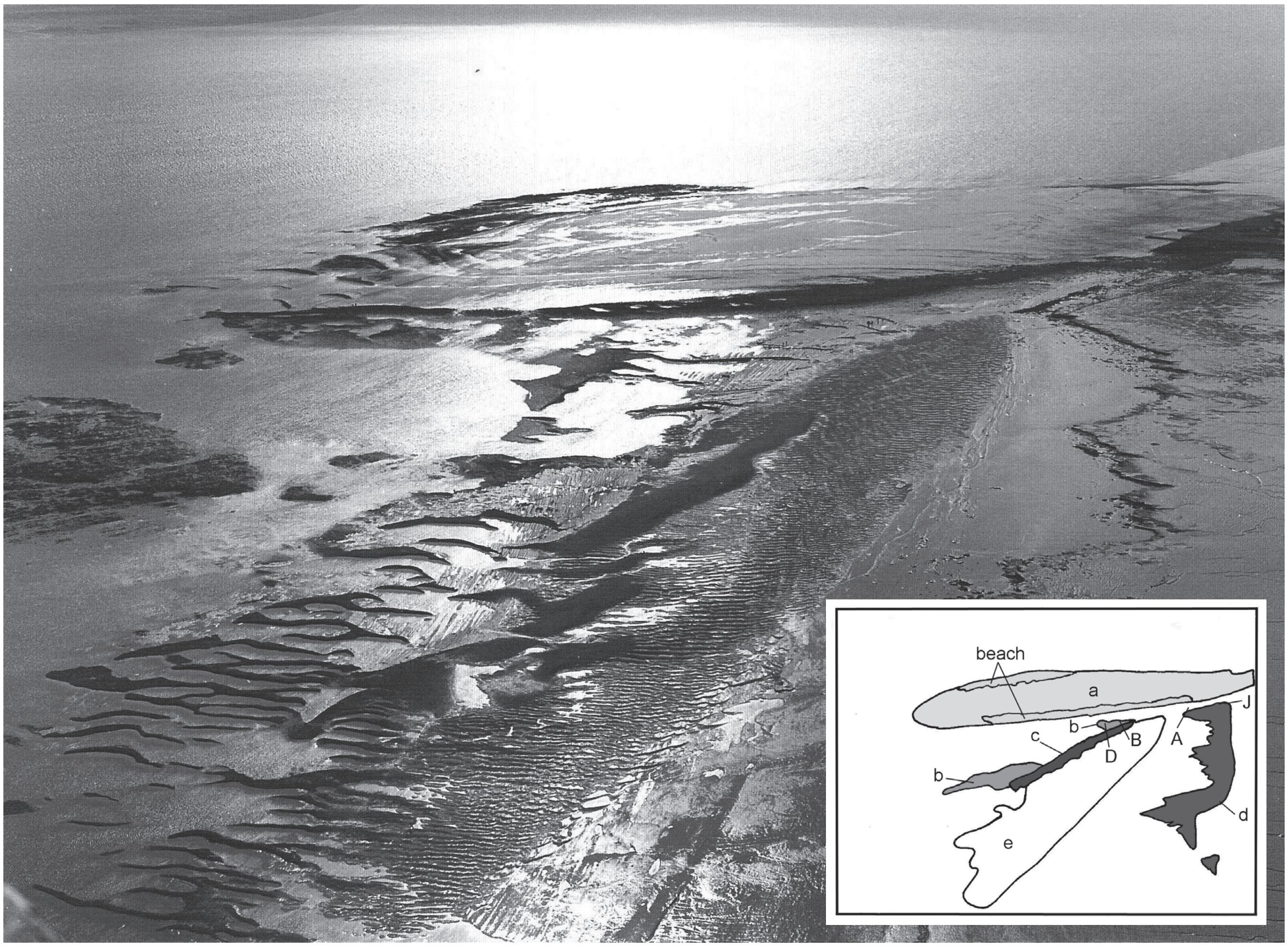


Figure 2.4 Air photograph with interpretative sketch, showing intertidal zone at Goldcliff East (view to the west) (a) oval area delimited by sandrock representing the Ipswichian beach and marking the former extent of Goldcliff Island (b) the Lower Peat and Submerged Forest (c) laminated silts (d) the Upper Peat and Submerged Forest (e) mobile recent sands (Note: the main excavation sites are marked by capital letters) (Crown Copyright. Royal Commission on the Ancient and Historical Monuments of Wales)

of the Ipswichian interglacial (Figs 2.2–2.5; CD 2.1b). The fossil beach shows that the last interglacial island was 1km by 450m. Today what remains is just 350m by 150m. Since the rest of the island has been eroded, we have no precise way of establishing how much remained in the mid-Holocene period considered here. However, the ice margin came no nearer than Newport and although there was clearly extensive periglacial weathering, since the fossil beach is covered in head deposits this seems unlikely to have greatly altered the boundary of the bedrock rise which will also have been spared from major erosion by the low sea levels of the early Holocene. It is thus probably reasonable to infer that the extent of the island as represented by the Ipswichian beach was roughly its extent at the time of the Mesolithic activity reported here. The Mesolithic sites are in a basal Holocene palaeosol, peats, and estuarine sediments which formed around the margins of the former island. The Mesolithic site investigated in 1992–94 was in the intertidal zone on the west of the island (Bell *et al* 2000). Some Mesolithic material was also found in a trench behind the seawall near Hill Farm pond in 1992. The sites reported in this monograph are all in the intertidal zone on the east side of the former island; this is the embayment to which we have given the name Goldcliff East (Fig 2.3).

2.1.6 The sedimentary sequence

The Quaternary and Holocene sedimentary sequence exposed in the intertidal area at Goldcliff East is outlined in Table 2.1. The outcrops of peats are shown in Figures 2.3–2.5 and a section through the sequence in Figure 2.6. The following are the main sedimentary units from the bottom upwards:

Units i–iii (Pleistocene)

Sandy and pebbly sediments of the Ipswichian beach (Unit i) overlie the solid geology round the

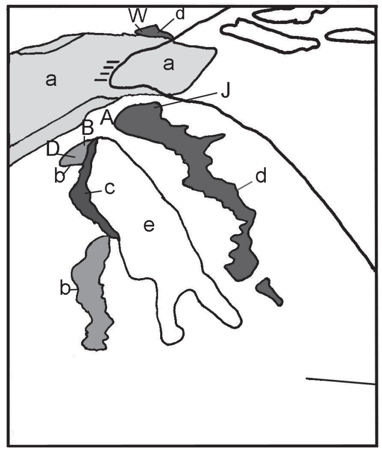


Figure 2.5 Air photographs with interpretative sketch, showing intertidal zone at Goldcliff East (view to the west) (Note: for explanation of letters see Figure 2.4) (© Crown Copyright. Royal Commission on the Ancient and Historical Monuments of Wales)

margins of the former island. This is overlain by sandy and pebbly Head deposits (Units ii–iii) which in places have vertical stones interpreted as Pleistocene involutions (Allen 2000a). Pleistocene Head deposits on the west of the island contain many bovid bones, including bison but Pleistocene vertebrate fauna has not so far been found in the Head deposits to the east of the island.

Unit iv (Holocene)

An Old Land Surface (iva) forms the base of the Holocene sequence, which developed on the Pleistocene Head. It is on this land surface that much of the Mesolithic activity took place and has been subject to excavation on Sites B and D (Chapter 3), A (Chapter 5), and J (Chapter 6). Away from the island, the unit forms a relatively level surface at *c* –4m OD. East of the island, it is cut by a former more deeply incised palaeochannel (Chapter 4). The Old Land Surface rises as the underlying Head rises against the edge of the former island. The highest level at which it is exposed is 1.4m OD on Site J. Because the soil formed on a sloping surface covering a vertical distance of 5.4m, it was buried time transgressively by silts and peats which accumulated against the island edge as a result of the Holocene sea-level rise. The soil was progressively buried between *c* 5400 cal BC and 3700 cal BC; it thus contains evidence of Mesolithic activity extending over a timescale of 1700 years. The Lower Submerged Forest (Unit ivb) which is exposed on Sites D and

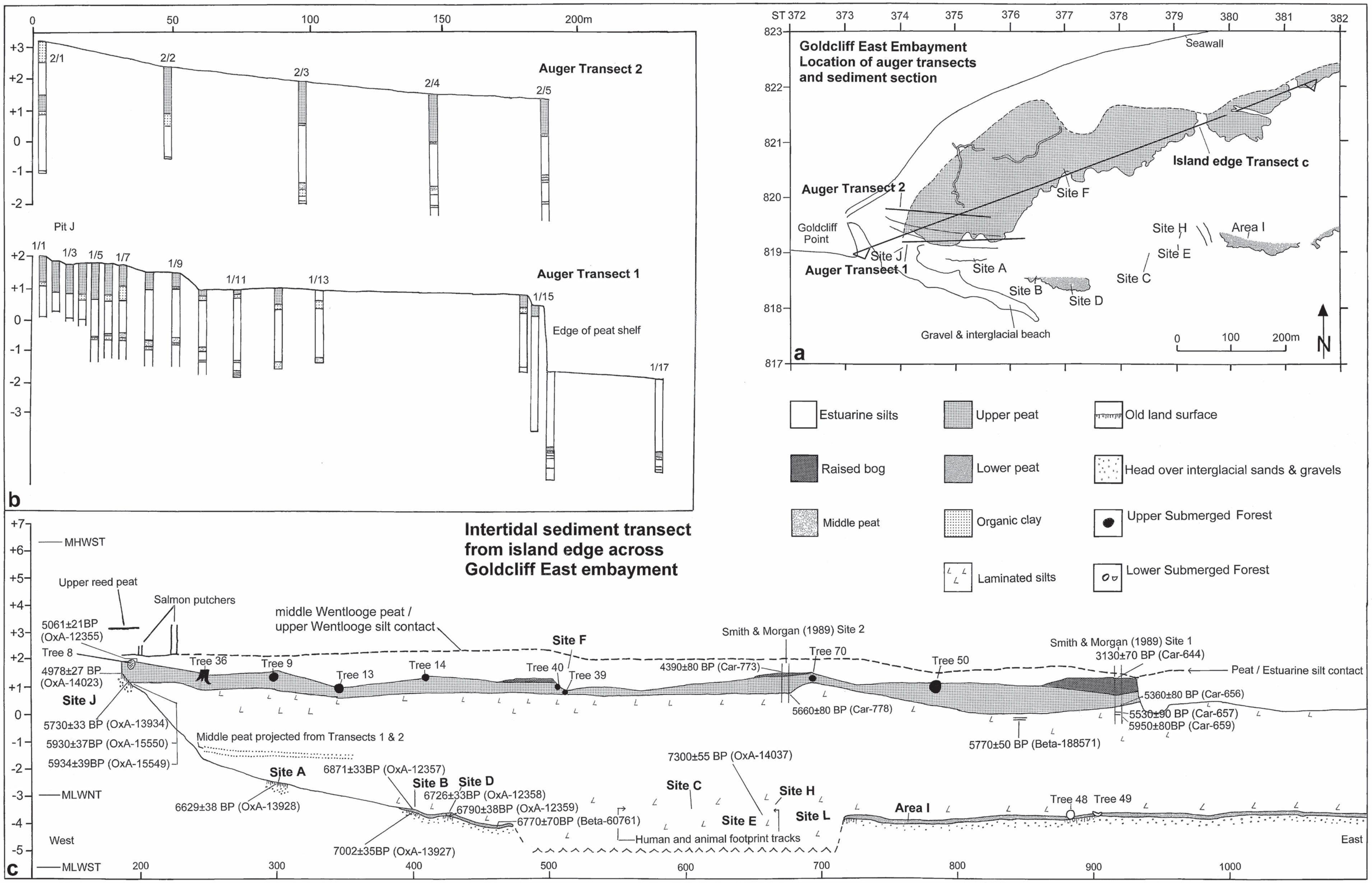


Figure 2.6 Sediment sequence in the Goldcliff embayment a) Location of three transects b) Auger Transects 1 and 2 (by Helena Burg) c) transect through island edge intertidal exposures running north-east from Goldcliff Point, showing the relationship of the archaeological sites and dated horizons to the stratigraphic sequence (drawing M Bell)

I is the last woodland, which grew on the part of this soil at 3.5–4m OD until about 5700 cal BC. On Site D there is evidence for a small increment of estuarine sediment (Unit ivc) on top of the Old Land Surface.

Unit v

A thin (10cm) Lower Peat, this blankets many of the stumps and trunks of the Lower Submerged Forest but some trees (eg T 103 on Site D) are stratified within it. Mesolithic activity on Site B continued into the period when this peat was forming, whilst on Site D there is evidence of a Mesolithic toilet area on the periphery of the focus of activity.

Unit vi

Minerogenic silts (Chapter 4) up to 4m thick covered the peat, formed during a marine transgressive phase. This sediment occurs widely throughout the Severn Estuary and has been named the lower Wentlooge Formation (Allen and Rae 1987). Parts of these silts show marked laminations which show evidence of annual banding (Allen 2004; Dark and Allen 2005). These silts are of particular significance to this study because the eroding surfaces of laminations are covered with the footprint-tracks of people, animals, and birds (Chapter 12). As previously noted (Unit iv) there is evidence of a palaeochannel crossing the foreshore and some of the best-preserved footprint-tracks are along the sides of this channel. The laminated sediments were laid down between 5740–5490 cal BC and 5050–4610 cal BC, thus they are all later Mesolithic. This thick silt buried the sloping sides of the former island, it covered the Lower Peat at Site B at –3.5m OD, and it buried Site A, which was on the side of the island at –2.5m OD. The upper part of the same sediment also covered two-thirds of an occupation area at Site J at between 1m and 1.4m OD which was the highest level reached by this marine transgression. On this site, Mesolithic activity continued at the saltmarsh edge from the time of the Old Land Surface through the period of these estuarine silts (Chapter 6). Where wet patches existed at the saltmarsh edge, some wooden artefacts were preserved.

Unit vii

Peat then developed over the estuarine sediments during a marine regressive phase. This is the thickest peat, which occurs widely within the Severn Estuary and has been named the middle Wentlooge Formation (Allen and Rae 1987). This peat was subject to an earlier palaeobotanical study at Goldcliff East by Smith and Morgan (1989). There is evidence of a sequence of peat-forming communities, successively: reed peat (Unit viia), alder carr-woodland (Unit viib), and oak woodland of the Upper Submerged Forest (Unit viic) which has been the subject of detailed investigation by our project (Chapters 7, 8 and 15) and which dates to 4477–4239±19 cal BC. This was followed by reed and sedge peat (Unit viid) and then by a raised bog peat (Unit viie) which started to form *c* 3970–3650 cal BC and was followed by a short period of reed peat formation (Unit viif) during the initial stages of a subsequent transgression.

During the period when the lower fen woodland (part of this peat unit) formed, there are very few flint artefacts and two trees associated with charcoal, suggesting only small-scale Mesolithic activity. Smith and Morgan (1989) identified a landnam clearance event just after the elm decline, with another clearance episode later in the Neolithic. They reasoned that this activity must have taken place on the bedrock rise of Goldcliff island, because the next nearest known dryland is 6km distant. Our own investigations on the very edge of the island have not found direct evidence of Neolithic activity and the interpretation of the vegetation changes at this time is reconsidered in Chapters 14 and 15.

Unit viii

Estuarine conditions returned in this marine transgressive phase with the deposition of minerogenic silts. This unit occurs widely throughout the Severn Estuary and has been named the upper Wentlooge Formation (Allen and Rae 1987). At Goldcliff East the deposition of this unit takes place from the middle Bronze Age. Within this unit, a thin reed peat (Unit ix) is exposed in small areas on the west side of the embayment.

No evidence is exposed at Goldcliff East of the Iron Age peat which was such a rich source of later prehistoric wood structures west of Goldcliff island (Bell *et al* 2000). Virtually all the archaeological evidence from Goldcliff East is of later Mesolithic date between 5700 and 3700 cal BC. Chapters 3–17 of this monograph are therefore focused on sedimentary Units iv to vi associated with Mesolithic activity and with the succeeding Upper Peat and Submerged Forest of Units vii a–c.

2.1.7 Relationship to the tidal regime

The tidal range in the Severn Estuary, which reaches 14.8m at Avonmouth, is the second highest in the world after the Bay of Fundy in Canada. This regime is central to this study in two respects. Firstly, the rhythmical tidal patterns would have regulated the resources and activities of Mesolithic communities on a daily basis, and in regular patterns reflecting the two-weekly spring tide cycle and other differences in tidal regime through the year. It is acknowledged that the tidal regime of the Mesolithic will not have been exactly the same as that of today, because of the changing geometry of the estuary, global water budgets, temperatures etc. However, by the last two millennia of the Mesolithic, the basic form of the estuary was broadly comparable to that of today and the broad parameters which the tides create for human activity

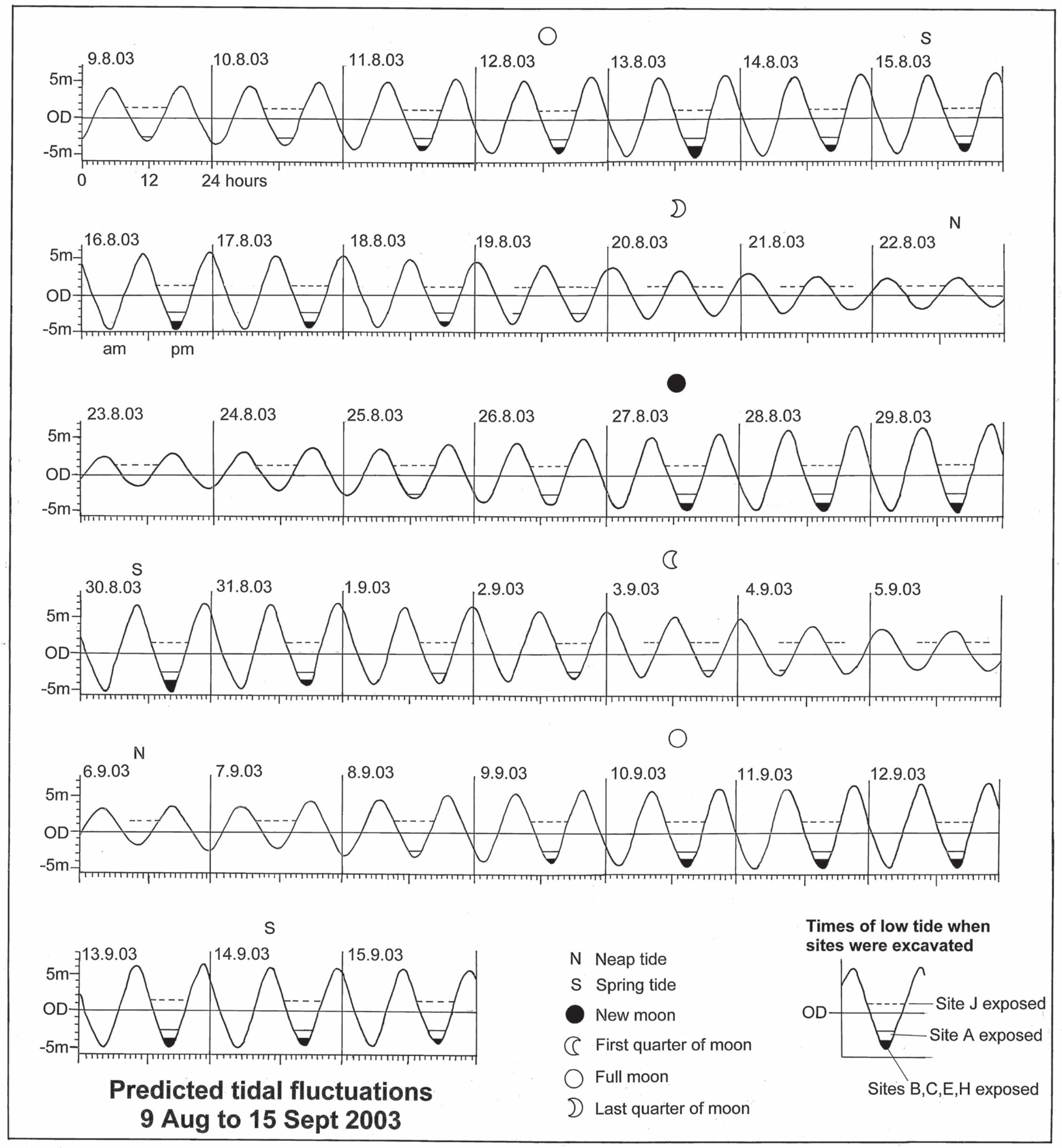


Figure 2.7 The tidal regime in the Severn Estuary as exemplified by the 38-day period of the 2003 field season. The graph shows the exposure time of the main sites investigated (graphic J Foster)

will be essentially applicable. Secondly, the tidal regime has controlled the timing and character of our excavations, determining when and for how long sites on the foreshore are exposed. Spring tides at Newport range between Mean High of +6.29m OD and Mean Low of –5.61m OD. Neap tides range between Mean High of +3.19m OD and Mean Low of –2.91m OD. Figure 2.7 is a plot of the tidal regime over a sample 38-day period comprising the 2003 excavation season. It illustrates the tidal regime in relation to the phases of the moon, OD, and the periods when the excavation sites were exposed. The OD heights of the main sites we have investigated are as follows: Site J, 1.2 to 2m OD; Site A, –2.5m OD; Site B, –3.5m OD; Site D, –4m OD; Sites C, E, and H (footprints), –3.1 to –4.4m OD. Thus, Site J is exposed at every low tide and for an average of six hours. Site A is not exposed at neaps long enough to do anything, and for an average of two and a half hours for about ten days at spring tides. Sites B and D and the footprint sites are only exposed for seven days each spring tide for an average of 1.7 hours. It follows that, taking account of periods of low tide during workable hours of daylight, for the 38-day period of this season, there were 45 tides totalling 264 hours when Site J could be worked, 29 tides totalling 68 hours when Site A could be worked, and 20 tides totalling 34 hours when Sites B, D, and the footprint sites could be worked. These facts and figures make very apparent the limitations which tidal exposure placed on our fieldwork.

2.2 Research questions

The key environmental and archaeological research questions posed by the NERC and Cadw-funded projects were at the outset defined as listed below. At the end of each question we identify the main section in the concluding chapters where these questions are answered or considered.

Archaeological questions

1) Did hunter-gatherers burn woodland or other vegetation in a coastal setting? (Chapters 14, 18.13 and 21.4)
2) Did human activity and economy change as the Holocene transgression progressed from fen woodland to reedswamp and then saltmarsh/ mudflats? (Chapter 18.3.2)
3) What was the nature and economy of Mesolithic activity at Goldcliff East? (Chapter 18)
4) What was the age and gender composition of the Mesolithic human population as evidenced by the footprint-tracks? (Chapters 12 and 18.8)
5) Is there evidence of seasonality of occupation and environmental disturbance? (Chapters 18.13–18.4 and 21.8)
6) What were the main species of animal, bird, and fish present and exploited as indicated by footprint-track and bone evidence? (Chapters 12, 13, and 18.11.1)
7) What fishing techniques were employed in the Mesolithic? (Chapters 13 and 18.11.1)
8) What was the contribution of plant materials to the Mesolithic diet? (Chapter 18.11.2)
9) Do artefact and ecofact distributions point to specific activity areas? What are the implications of this for the duration and nature of settlement? (Chapter 18)
10) Is there evidence for structures, eg shelters and hearths? (Chapter 18.7)
11) Is there evidence for seasonal population movements to other geographical areas inland? (Chapters 18.9–18.10 and 21.6–21.8)
12) Did similar or different forms of disturbance/ human environmental manipulation occur in the later Mesolithic and Nesolithic, and what are the implications for current debates concerning the Mesolithic/Neolithic transition? (Chapters 18.15 and 21.12)

2.3 Methodology

2.3.1 Survey

The archaeological approach to this landscape was based on the research questions, but also had to take account of the tidal regime and the dynamic conditions which led to the exposure and burial of sites. Conditions for finding sites and artefacts vary greatly. Storms can mobilise the mud exposing large tracks of clean Holocene sediment. Such conditions led to major discoveries of Bronze Age and Iron Age sites west of Goldcliff island (Bell *et al* 2000) on two occasions: 31 October 1990 and 30 August 2002. The Goldcliff East embayment has never been closely examined under such favourable conditions. During the three years of fieldwork reported here, conditions have always been more or less muddy. However, the amount of mud is very variable in both time and space. Not only is it less muddy after rough seas and much more muddy when the estuary is calm, but there is significantly less mud at spring tides – when the volume of water entering and leaving the estuary is much greater and the tidal streams are generally about twice the speed of neap tides (Page and Oakley 2002). Notable spatial variability has also been observed within the Goldcliff East embayment. Thus, on any favourable (ie choppy sea) spring tide day the fieldworker stands a reasonable chance of encountering patches of foreshore somewhere which are relatively clean of mud, and others which may have been relatively clean days or weeks before, where mud is now accumulating.

Such dynamic conditions require regular observation and recording. At one time or another it has been possible to examine carefully most exposures of the Old Land Surface and the Lower Peat and Submerged Forest under reasonably favourable conditions, likewise the lower 2m of the laminated Unit vi with its many footprint-tracks. The middle part of the laminated Unit is permanently covered in an extensive band of mobile sandbanks (Figs 2.4–2.5). Some footprint-tracks have been recorded in the upper 50cm of the laminated unit. The Upper Peat Shelf, which is up to 2m high, forms a very prominent feature of the foreshore (Figs 2.4–2.5). The edge of this shelf and the exposures of the Upper Submerged Forest have been carefully examined and areas of the submerged forest cleaned and planned in particular detail at Sites J, F, and K. The inshore 150–200m of the Goldcliff East embayment has been generally mud-covered throughout this project as it is shown on Figures 2.4–2.5. This area was, however, significantly cleaner when it was originally surveyed in 1993 and at that time no prehistoric sites were found (Bell 1993). The sediments exposed in this inner area on the surface of the raised bog and the overlying estuarine sediments are in any case Bronze Age and thus later than the time frame of this project.

2.3.2 Excavation

Intertidal erosion of the Holocene sediment sequence thus exposes a transect (Fig 2.6) across successive former landscapes of later Mesolithic and Neolithic date. The main concentrations of Mesolithic activity identified on those exposures were on Sites J, A, and B. Site D had minimal artefacts but was an important site for palaeoenvironmental investigation just outside the activity area of Site B. When

Figure 2.8 Blocklift excavation technique at Site D in 2003 (photo E Sacre)

a concentration of artefacts was first identified the area was cleaned of mud. This was done on a retreating tide by throwing buckets of water downslope and using farmyard slurry scrapers and T-shaped wooden floor cleaners with a rubber edge to remove the mud, a method first developed by Derek Upton using old floor cleaners found among flotsam on the foreshore. Similar cleaning had to be done on each day of excavation to remove mud that had accumulated from the previous high tide (CD 2.2–2.3). Excavation areas were marked by steel pins and divided into 1m squares by 6-inch nails. Excavation (CD 2.4) was done in 1m^2, which was generally the largest area a person could clean and work in one tide. The objective was to keep adjacent squares on roughly the same level. Excavation of occupation horizons was done using trowels and plastic spatulae. Sediment was usually removed in spits of *c* 4cm depth. Every find made was three-dimensionally recorded: eg lithic artefacts such as worked flints, or heat-fractured stones, bone, charcoal, and worked wood. The field recording methodology employed was essentially that originally developed by the writer for the dating of colluvial sediments forming lynchets and dry valleys (Bell 1983) and subsequently employed in the excavation of the Holocene sediment sequence at Brean Down (Bell 1990) and in the 1992–94 excavation of the Mesolithic site west of Goldcliff island (Bell *et al* 2000, Chapter 4). Each find was placed in a bag with a unique number; that bag contained a plastic garden tag with the same number, which was then placed on the find spot. The easting and northing coordinates on the local grid for that site were measured. At intervals during each low tide, levels were taken on the numbered tags using a dumpy level, the tags were removed and excavation proceeded to the next level. All the excavated sediment from occupation layers was sieved in the sea using a plastic sieve with 1cm mesh. The sediment was too fine-grained to fully disaggregate on the sieve and artefacts were often detected by feel rather than because they were washed clean. One sample of 6 litres was taken from each 1m square of each distinct occupation context and transported to dryland for water-sieving.

Sites low in the tidal frame proved particularly difficult to excavate because the exposure time was so limited, two and a half hours at best, which allowed little time for sieving on site. Consequently, during the 2002 season, the methodology was modified. It was decided not to do any more sieving in the field on Site B but to transport all the sediment from occupation horizons to dryland for wet-sieving. That made much more effective use of the digging time but carrying the sediment to the seawall placed considerable physical demands on the team.

2.3.3 Blocklifting

Accordingly in 2003 a more radical solution was adopted for Sites A, B, and D. Those sites were no longer excavated in the conventional way – instead they were blocklifted. A blocklift methodology had previously been used in the small-scale excavation of the intertidal Mesolithic midden at Westward Ho! (Balaam *et al* 1987a). Implementation of the blocklifting strategy at Goldcliff in 2003 was made possible by the involvement for part of that season of the Time Team television series. They were involved over a three-day period (27 to 29 August 2003) in making a television programme that was

Figure 2.9 Excavation of 0.25m³ blocks within 1m² wood frames from Site B at the field base at Whitson (photo E Sacre)

first screened on 22 February 2004. The decision was made to concentrate work on Site B during that intensive period of activity. The Time Team provided additional excavators, resources, and equipment. After the Time Team departed a more leisurely excavation of Site A proceeded using the same block-lifting strategy.

Blocklifting was done in the following way. Each 1m² was divided into 16 blocks, each 25cm³. Each tin was numbered according to square and its position within the square and a level was taken to relate each block to OD. Each block was cut and loosened, then a metal 4-sided tin, specially made for the purpose, was placed around the block which was then lifted (Fig 2.8; CD 2.5–2.6) and wrapped for transport. The tins were transported using a quad-bike and trailer (CD 2.7) back to our field base at Whitson Community Hall. In all 244 blocks were transported to dryland for micro-excavation and sieving. At the base the blocks were reassembled into a 1m² within a divided wooden frame with sixteen compartments. Excavation of the blocks then proceeded on dryland in the conventional way (Fig 2.9; CD 2.8–2.14). All finds were recorded as before using the three-dimensional coordinates so that the plot of artefact distributions was compatible with those produced for the same sites in previous seasons. Although the effort of lifting and loading blocks was significant, this strategy had major advantages. Excavation could now proceed with much greater care on dryland and without the pressure created by the incoming tide. Artefact recovery was better and it was possible to observe and record micro-stratigraphic detail and footprint-tracks which would not have been visible under muddy field conditions. The new strategy meant that all sediment was transported to dryland, so without additional effort more sediment was available for water-sieving. It is acknowledged that blocklifting may reduce the chances of spotting certain types of small feature such as stakeholes but this is to a degree compensated for by the greater observable micro-stratigraphic detail. It certainly provided a most effective strategy on Site A. The opportunity to sieve more material led to the recovery of many tiny fish bone, tiny microliths, and microlith fragments. The advantages are not so evident on Site B where the area excavated in 2003 had less dense occupation than the parts of the site excavated in previous seasons. Site D proved to have minimal evidence of occupation and was mainly excavated on account of its palaeoenvironmental interest.

2.3.4 Water-sieving

Water-sieving (CD 2.16–2.17) was mainly employed to obtain small macroscopic artefacts (eg microliths) and palaeoeconomic evidence such as fish bones and evidence of utilised plants. The water-sieve was a modified version of the Siraf-type sieve (Williams 1973). Flot was collected on brass sieves of sizes

2mm and 0.5mm. As a general rule one sample was sieved from each occupation horizon in each 1m^2 and as many of the blocklifted samples as possible.

2.3.5 Environmental sampling

Our environmental approach has been to take samples from drawn sections which can be clearly related to the archaeological evidence. We have sampled both sequences including the occupation horizons and from off-site contexts (eg Site D). In relation to the Upper Submerged Forest our investigations lie along a transect from Site J on the dryland edge of Goldcliff island where Mesolithic activity was concentrated, out onto the off-site contexts in the surrounding wetland where we are fortunate in having for comparison the earlier pollen studies of Smith and Morgan (1989). Thus, there is a palaeoenvironmental transect running for 740m from the island edge to the east along the line of the sediment transect shown in Figure 2.6.

Our objective throughout has been to maximise opportunities for a multi-proxy approach, ie an approach based on comparison of the results from various palaeoenvironmental sources. This is important given our objective of contextualising human agency within the broader spectrum of environmental disturbance factors (see 2.2). For this reason particular emphasis was given to the quantification of charcoal occurrence using the same methods in the studies of Dark, Timpany, and Brown (Chapters 14–15 and 19). In order to facilitate comparison, samples for different forms of analysis were taken adjacent to one another. It often proved possible to use the same monolith tin for pollen, plant macrofossils and radiocarbon dating. The larger samples required for beetle study were as far as possible taken immediately adjacent to samples for botanical study. Particular emphasis was also given to mapping the submerged forests and investigation of the associated botanical sequences using pollen and plant macrofossils. Each tree was located and individually recorded on a sample form and photographically (Timpany 2005). Detailed maps were also prepared by Scott Timpany of all the wood in selected sample areas of the Upper Submerged Forest on Sites J, F, and K (Chapter 15).

2.3.6 Dating

Important in understanding the chronology of environmental change was the development of precise chronologies for the Upper and Lower Submerged Forests. To this end all oak trees of appropriate size and age were sampled for dendrochronology by Nigel Nayling and the results are presented in Chapter 8. From the outset we realised that the dendrochronological sequences might not date, because dated tree-ring sequences of this period are few and distant. This proved to be the case, but fortunately through Sturt Manning's involvement the project included a programme of 'wiggle-match' radiocarbon dating, which has proved successful in anchoring our floating tree-ring sequences quite closely in time (Chapter 8). Radiocarbon dates were also obtained from peats, artefacts etc and full details of these are in Table 8.1.

2.4 Structure of the following chapters

This chapter has introduced the stratigraphic sequence at Goldcliff East. The five following chapters cover the main Mesolithic stratigraphic units. These are arranged from the earliest to the latest: the Old Land Surface, Lower Peat, and Submerged Forest (Chapter 3), laminated sediments with footprint-tracks (Chapter 4), Site A (Chapter 5), Site J (Chapter 6), and the Upper Peat and Submerged Forest (Chapter 7). The dating evidence is then presented (Chapter 8) followed by three chapters on the artefactual evidence from stone, wood, and bone (Chapters 9–11). There are then five chapters on the environmental and palaeoeconomic evidence: footprint-tracks, bones, botanical evidence, insects, and sediments (Chapters 12–17), followed by discussion and conclusions relating to Goldcliff East (Chapter 18). The Goldcliff report is then followed by Chapter 19 on related work on other Severn Estuary sites by Alex Brown. There is then another case study of Mesolithic and Neolithic middens at Prestatyn, north Wales (Chapter 20), followed by the conclusions (Chapter 21), which use evidence from the case studies and earlier work in the area to reappraise the later Mesolithic archaeology and the transition to the Neolithic in western Britain.

3 Mesolithic activity at about the time of the Lower Submerged Forest *by Martin Bell*

3.1 Introduction

One of the most evocative sights in the remarkable sediment sequence of the Severn Estuary is the great oak trunks and stumps exposed in the bed of the estuary. Here at low spring tides one has the experience of walking through a lost landscape of around 6000 cal BC. Some of the best exposures of this forest were observed at Redwick in 2001 (Bell *et al* 2001); exposures were also found at Gravel Banks, Goldcliff East, and between Goldcliff and Redwick. The trees of this forest are rooted in an Old Land Surface that developed on Pleistocene sandy gravel Head. The Old Land Surface and the trees are covered with a thin peat and this is buried by a substantial thickness of laminated sandy silts. The discovery in 2001 of flint artefacts, calcined, and uncalcined bone within the thin peat and in the underlying Old Land Surface at Goldcliff East Site B was a key point in the development of this project. It showed, for the first time in the Severn Estuary, that Mesolithic activity occurred in contexts suitable for the preservation of organic and palaeoenvironmental evidence.

3.2 The basal Holocene palaeosol and submerged forest

The Holocene soil below the peat and submerged forest on Sites B and D (Fig 2.3) was developed on Head deposits which were generally sandy with small quartzite pebbles. Its sandy nature indicates its derivation in part from underlying beach deposits

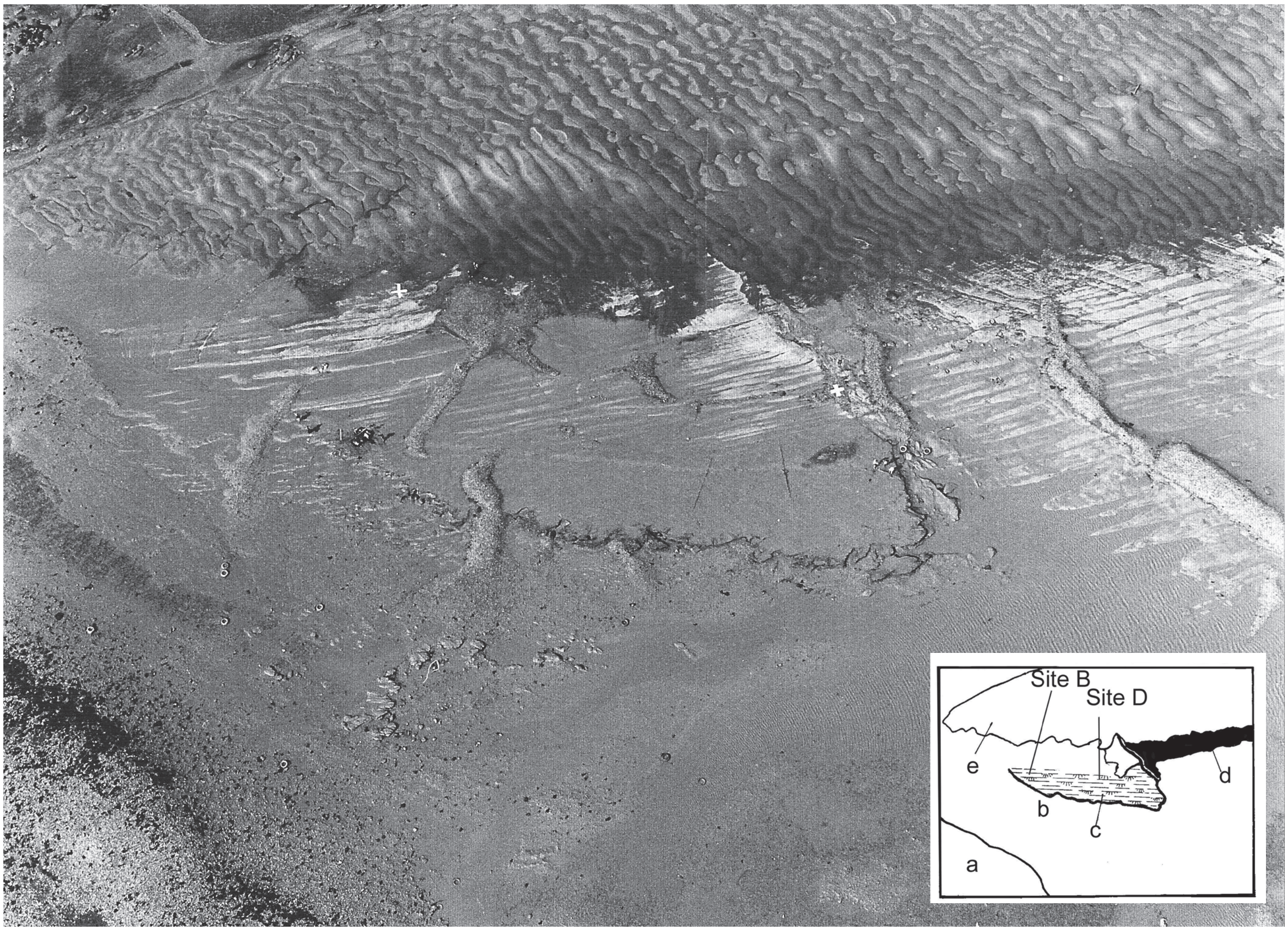


Figure 3.1 The Lower Submerged Forest around Sites B and D with interpretative sketch (a) Ipswichian beach (b) Head (c) Lower Peat is visible with some trees (103 and 102) (d) laminated sediments (e) recent mobile sands (Sites B and D are indicated by letters) (© Crown Copyright. Royal Commission on the Ancient and Historical Monuments of Wales)

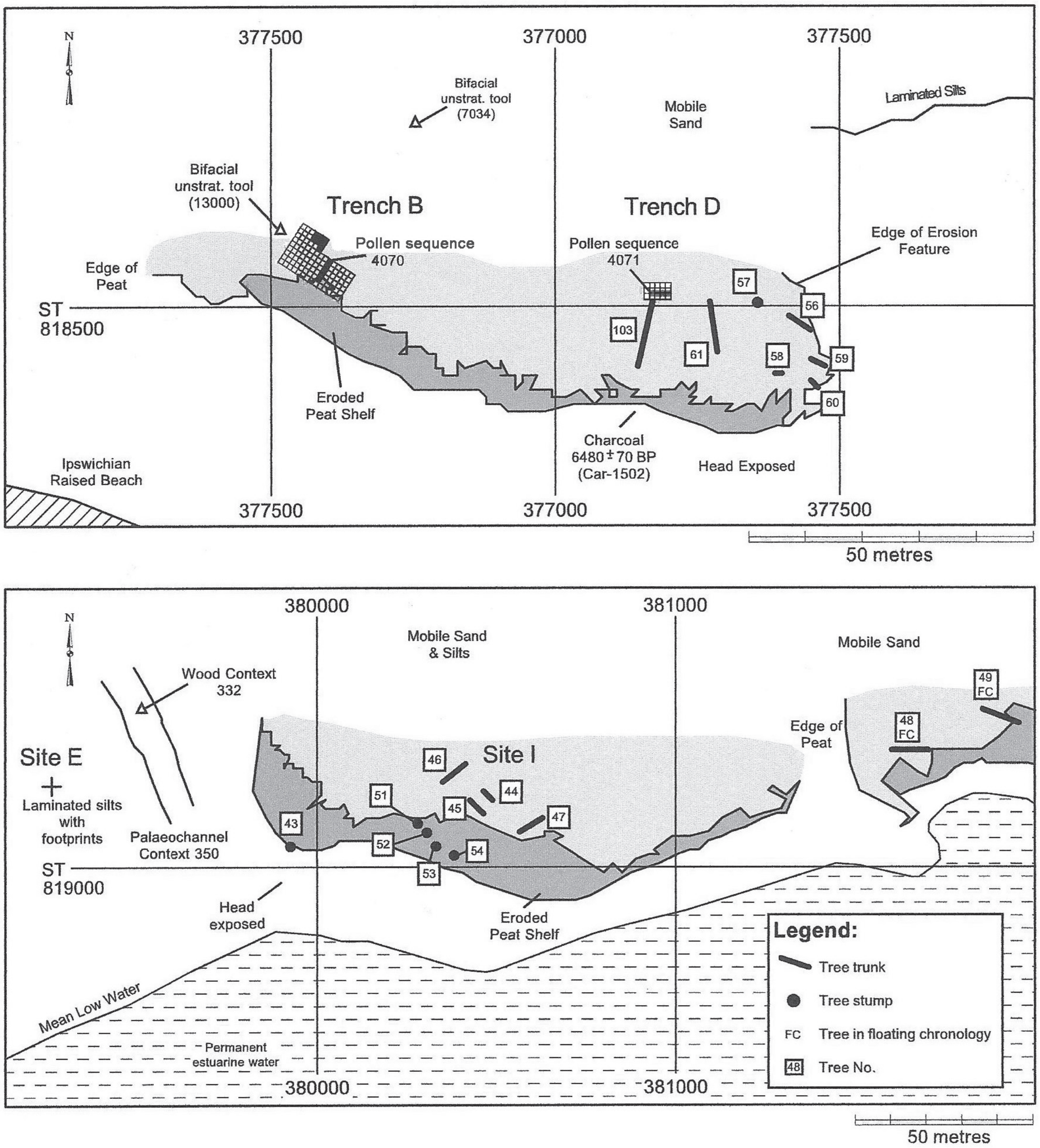


Figure 3.2 Plan of the Lower Submerged Forest around Sites B and D (top) and Sites E and I (below) (graphic S Buckley)

of Ipswichian interglacial date (Allen 2000a). The Holocene soil forms a fairly level surface on Sites B, D, and I at between –3.5 and –4m OD. Evidence of the first Mesolithic activity on Site B was in the minerogenic buried soil and took place under dryland conditions, albeit apparently close to the advancing shore. This surface became subject to increasing waterlogging and a thin peat (*c* 10cm) formed. This comprised mostly reeds but also contains some trees which form part of the Lower Submerged Forest. There are two main exposures of this peat. The westernmost (Figs 3.1–3.2) is at the base of the slope from Goldcliff island in the area of Sites B and D. This roughly level exposure of peat, about 125m by 30m, is delimited to south and east by a low (*c* 25cm) eroding peat edge. It is bounded to the north by overlying estuarine sediments of Unit vi. The western part of this exposure is mainly reed peat with scattered wood fragments and roots. The eastern 35m contains trees forming part of the Lower Submerged Forest. Here six trunks have been recorded. Two are long (*c* 10m) straight trunks: Tree 103 (CD 3.1) and Tree 61, which had grown in high canopy closed woodland. The remaining four pieces are fragments of trunks or branches. There are also three tree stumps including Tree 57 (CD 3.2). All trees are oak and cleaning by Scott Timpany (2005) of a sample area 9m by 10m of this peat surface in the area of Trees 56 to 59 did not reveal any other wood in the peat. Professor J R L Allen (2000a) obtained a radiocarbon date for one of the oaks in this area of 6770±70 BP (Beta-60761; 5740–5490 cal BC). When the initial rapid survey of Goldcliff East was done in 1993 the only find recorded in this area was a single flint flake; charcoal found at the boundary between the minerogenic Old Land Surface and the peat (Bell *et al* 2000, 367) was radiocarbon dated to 6480±70 BP (CAR–1502; 5510–5360 cal BC). Conditions were less muddy when the area was re-examined at the beginning of September 2001 and a scatter of calcined bone, lithics, and bones was found; this became the excavation Site B. Site D was excavated beside Tree 103 to obtain dendrochronological and environmental samples. Flints were found elsewhere on the eroding peat face but predominantly in the western part of the exposure with just one or two on the eastern part; charcoal was found throughout the area of the peat edge.

At the eastern limit of this peat exposure evidence of an erosion feature (Figs 3.1–3.2) was identified by Professor J R L Allen. This takes the form of disrupted bedding within the overlying estuarine silts marking a palaeochannel or embayment which cut the Lower Peat over an area 240m wide between Sites D and I (Fig 2.3). There are hints that this channel or embayment may be incised well into the underlying Head because to seaward there is an area of permanent water that never drains (Fig 2.4). The Lower Peat and Submerged Forest is again preserved east of this feature in the area of peat known as Site I. This easterly exposure of Lower Peat has been planned (Fig 3.2) over an area of 330m x 40m. The peat surface here lies at *c* –3.7m OD. Within this peat five tree stumps and six trunks have been mapped but the cover of mud and sand in this area is variable and other trees have at times been observed, but not mapped.

The edge of the peat exposure at Site I is marked by a low cliff *c* 30cm high which together with sections cut for dendrochronological sampling of trees provides the sequence. The trees in this area grew on the buried soil developed on sandy Head and they are partly covered by a thin layer of peat. When this peat exposure was initially mapped in 1993 charcoal was noted at the base of the peat and one or two flint flakes were recorded. A further flake was seen in 2001. A careful search of the low cliff in March 2002 revealed charcoal at fourteen places all along the most westerly 40m of the exposure. Charcoal was concentrated at the soil-peat interface with some fragments both a few centimetres up into the peat and down into the underlying minerogenic soil. A small burnt root was also observed in the low cliff. No further lithic artefacts were found and it seems that this area was peripheral to the main focus of Mesolithic activity. The only excavations which took place here were small trenches cut to obtain dendrochronological samples of trees. Tree 43 appeared to be the rotted stump of a tree perhaps 1.5m in diameter with surviving peripheral buttresses and roots; parts of the roots were charred and charcoal was scattered around. Tree 49 was a particularly informative and impressive trunk (CD 3.3), 10m long and a maximum of 0.92m in diameter. Its centre was hollow and the section showed that the hollow was filled with peat. Charcoal was present within this peat fill and in the organic sandy silt land surface below the tree. Trees 43 and 49 indicate that some of the trees were partly rotted at the time of their burial and it is possible that they were dead when burning took place. Tree 48 also had charcoal associated with it.

Trees 46, 48, and 49 form part of a floating dendrochronological sequence; this has been dated by radiocarbon wiggle-matching (Chapter 8) showing that these trees grew between *c* 6173 and 5912±4 cal BC, allowing an estimate for missing sapwood (CD 8.26). The three trees cross-match with a number of trees from other exposures of the Lower Submerged Forest east of this area and with the Submerged Forest at Redwick.

3.3 Excavation of Site B

3.3.1 Introduction

It was examination of the western exposure of the Lower Peat in September 2001 which led to the identification of an artefact scatter which had not been visible previously. An area of calcined bone, *c* 0.8m in diameter, and other artefacts were observed on the eroding peat surface. Preliminary investigation in 2001 involved a 6m by 1m trench south to north from the edge of the peat shelf north to the overlying minerogenic silt. Excavation confirmed that calcined bone, bone, flints, and charcoal occurred both within the peat and in the sandy minerogenic soil which underlay it. That preliminary investigation made the case for further work in 2002 when, thanks to the support of Cadw, further excavation was possible. The area is not easy to work in: it is not exposed at all at neap tides and even at the most favourable spring tides it is exposed for no more than 2 hours 45 minutes, usually much less. Accordingly, excavation methodologies had to be adapted to this narrow tidal window.

The first step was to clean the sediment surface and make a plan of the area. Initially in 2002 this was 10m by 6m, extended the following year into an L-shape 14m by 10m (Fig 3.3). The plan was accompanied by a contour survey, which shows that the peat surface here is at *c* –3.5m OD (CD 3.4). Comparison of the plans done in 2001–02 shows that the step which marked the overlying estuarine sediments retreated 2.5m during the intervening winter. Comparison of the 2002 and 2003 contour surveys (CD 3.4) shows that between those two seasons an average of 20cm was eroded vertically from the area west of the trench. Figure 3.3 shows the dissected nature of the peat shelf edge, which is cut by linear erosion gullies running from north-north-east to south-south-west. In the eastern part of the area these gullies have reduced the peat to small islands. Allen (1987c) has described these linear erosion features elsewhere in the estuary as streamwise erosional structures produced by strong currents. The plan (Fig 3.3) also shows the outcrops

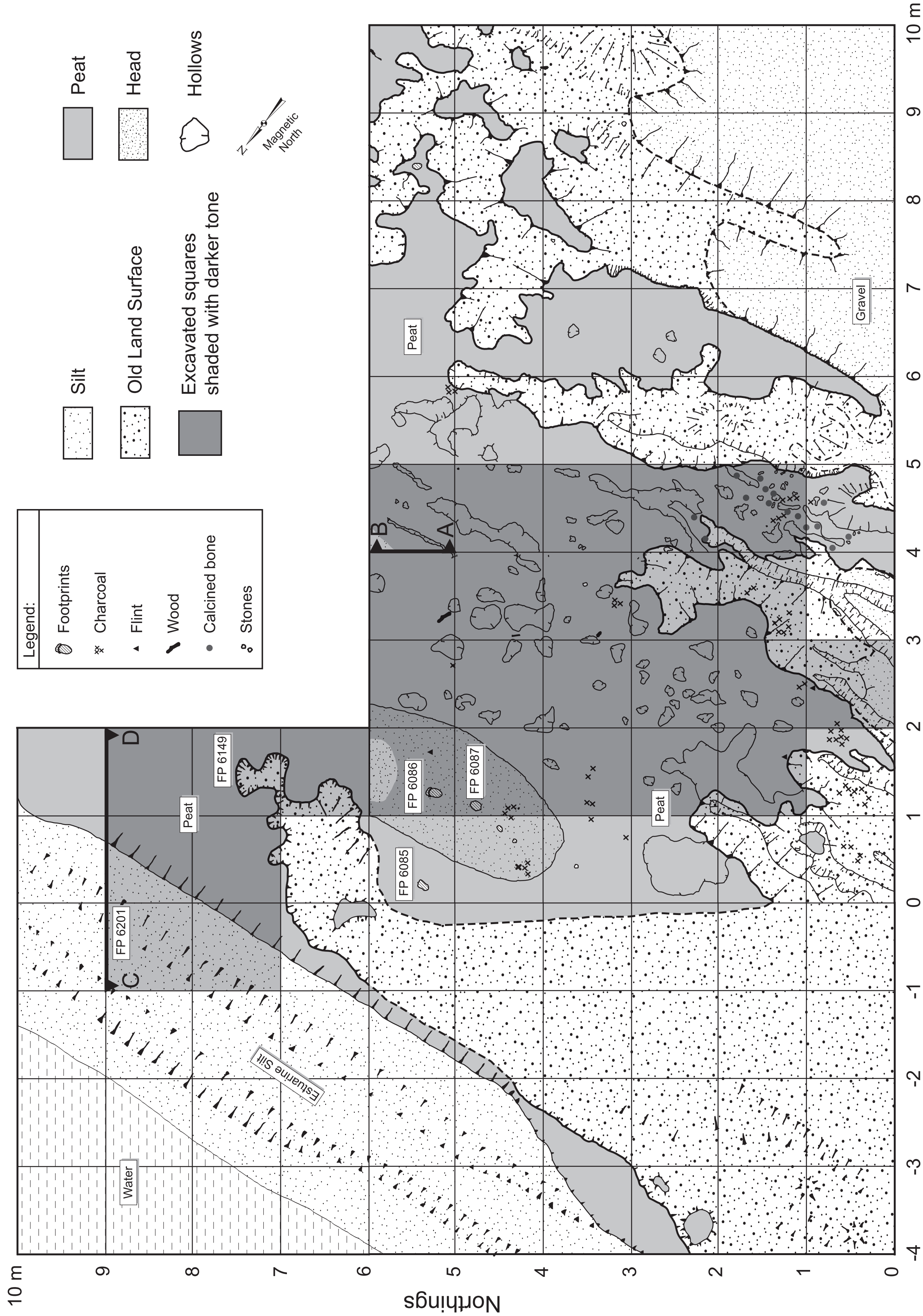


Figure 3.3 Site B, plan of the main sedimentary units showing the positions of the excavations and section drawings (graphic S Buckley)

Figure 3.4 Section of the sediment sequence on Site B: scale – large divisions 10cm (photo E Sacre)

of the successive stratigraphic units from the base: Head, sandy Old Land Surface, peat, and overlying estuarine silts.

In 2002 excavation took place in an area 6m × 4m using conventional techniques outlined in the methodology section (Chapter 2.3.2; CD 3.5): hand excavation, 3-D artefact recording, sieving on site and removal of samples from each $1m^2$ for water sieving on dry land. During the season it became clear that sieving on site occupied too much of the short tidal window. Furthermore, the muddy conditions posed a significant risk that artefacts would be missed. Accordingly, a policy of totally sampling the occupation layers was instituted, with all the sediment taken to dryland for water sieving. The transport of this material across 300m of muddy and rocky foreshore placed great physical demands on the field team. During the 2002 season, $22m^2$ were excavated.

In 2003 the original objective had been to continue the excavation west of the 2002 trench where a level peat surface was overlain by estuarine sediment. However, as already noted, significant erosion of this area took place between the 2002 and 2003 excavation seasons and the peat here was largely eroded. For this reason the 2003 excavation was moved to an area immediately north-west of the 2002 trench (Fig 3.3, north of Northing 6). Here the peat was sealed by estuarine silts. The excavation of Site B in 2003 was largely done over an intensive three-day period and was filmed as part of the Time Team Television programme. This provided the additional resources to help overcome the logistical problems of working on this site, using blocklifting (see Chapter 2.3.3). In all 112 blocks were lifted comprising $7m^2$ of occupation surface, enabling a much more detailed examination of the occupation horizon. Unfortunately, the area investigated in this way did not have such a high concentration of artefacts as the area excavated in 2002. Some viewers of the television programme assumed that the area allocated for excavation in partnership with the Time Team had been deliberately selected as somewhere that was not likely to be very productive. That suggestion betrays a view of television archaeology which is very different from that of the writer. In reality, the area was selected because, at the time, it was considered to have the greatest potential for important discoveries and waterlogged artefacts. The fact that other areas later proved much more productive simply reflects the chance inherent in archaeological excavation.

3.3.2 Stratigraphy

Once the blocks had been removed from the trench it was excavated down to expose a section of the underlying Pleistocene sediments as shown in Figures 3.4–3.5 and CD 3.6. The sediment sequence will be outlined from the bottom upwards. The 2003 trench was excavated to a depth of 1m at its west end. At the base (Context 342) was sand of unknown thickness, probably beach or marine sand of Ipswichian date. This was overlain by Context 322, a weak red (2.5YR4/2) sandy silt with gravel grade pebbles forming a layer 0.25m thick. This is thought to be a thin Pleistocene Head that was the parent on which the Holocene soil (Context 321) developed. The latter was a brown (7.5YR

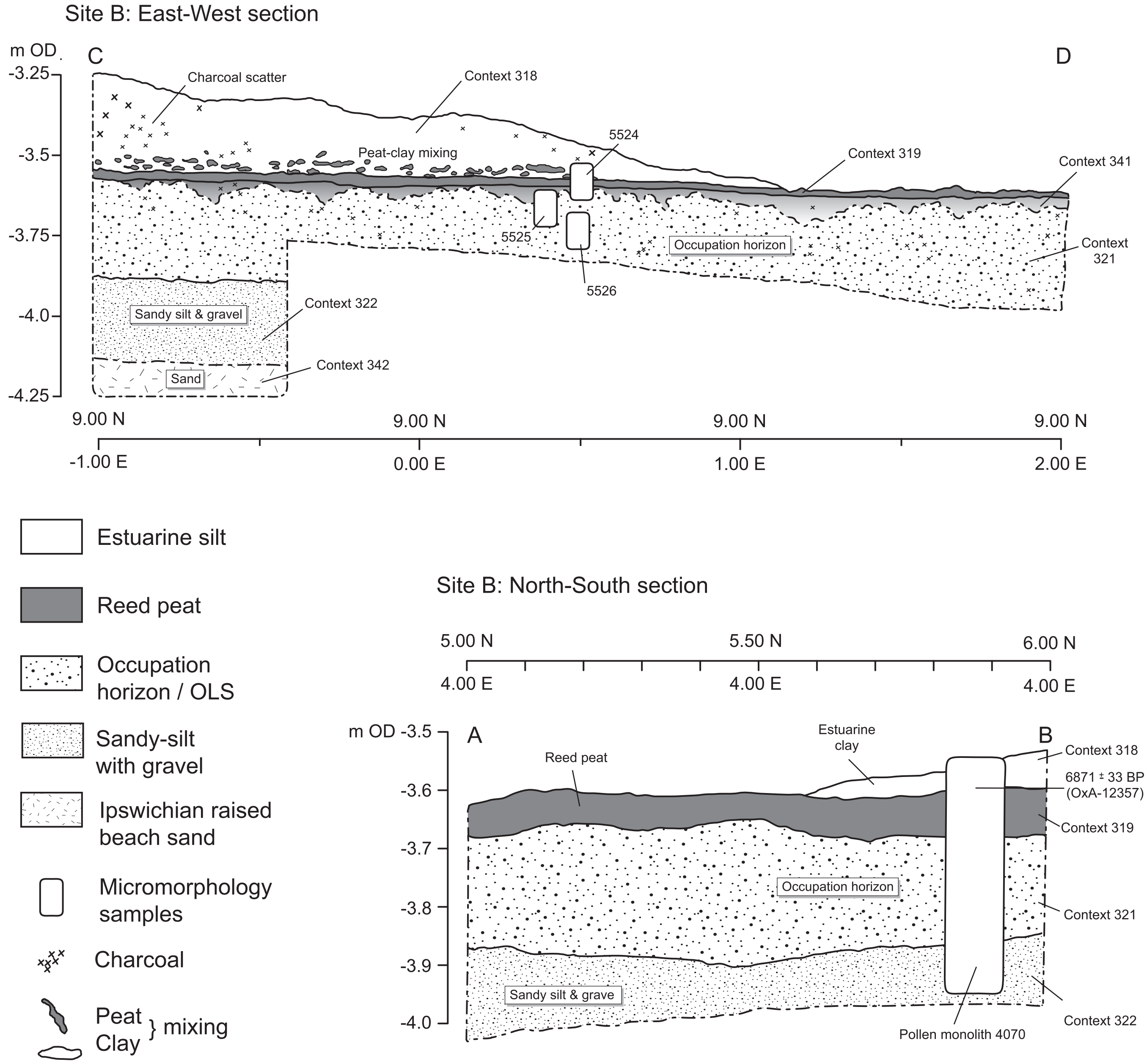


Figure 3.5 Section of the sediment sequence on Site B (graphic S Buckley)

5/3) organic sandy silt 0.33m thick with charcoal and artefacts towards the top of the soil. The top 5cm (Context 341) was a particularly organic dark greenish grey (G1 3/5GY) silt, which had a wavy and irregular basal contact but an abrupt upper contact to true peat. The peat (Context 319) was very dark brown (7.5YR3/2) with laminar clay inclusions 0.5–1mm thick in places. Its surface was at –3.55m OD. It was only 3cm thick in section C–D but up to 10cm in the 2001 trench (Fig 3.5). The peat contained charcoal, bones (many calcined), and lithic artefacts. Excavation revealed many reed stems within the peat and some pieces of wood. No trees were found and the nearest tree was preserved about 30m to the east.

Above the peat was a transition layer 5cm thick of clayey peat (Context 323) with thin laminae 2–10mm thick of estuarine sediment. Three factors seem to have contributed to the formation of this transition layer. First, the initial stages of marine incursion had given rise to interleaving of peat and estuarine sediment. Second, some of the pieces of peat were rounded and pebble-like, so the incursion involved some, probably localised, erosion of the peat. Third, there was some evidence of animal footprint-tracks that had caused mixing at the interface. Overlying silt represented the base of the thick and extensive blanket of lower Wentlooge silts between the Lower and Upper Submerged Forests. In the excavated area only the basal 0.3m of these silts remained. They were a greenish grey (Gley 1 5/1) silty clay. The section (Fig 3.5) shows that some charcoal was present in the basal part of the silts perhaps deriving from erosion of the occupation surface.

When the surface of the peat (Context 319) was first cleaned in 2001 small oval depressions *c* 80mm in diameter were observed in places. One or two of these retained the distinctive form of ungulate footprint-tracks of red deer size. They apparently represent prints made in the peat surface then filled with softer sediment which has subsequently eroded away. Footprint-tracks preserved in this way have been observed on the Iron Age peat surface at Goldcliff West (Bell *et al* 2000) and prehistoric contexts at Rhyl (Chapter 20.14). When in 2002 a larger area of Site B was planned four further red deer footprint-tracks were recorded on the peat surface (6085 and 6088) and two at the very base of the overlying estuarine sediments (6086–7; Fig 3.3). During the excavation of blocklifts in 2003 two further footprint-tracks were recorded: an aurochs in the peat (Context 319) and a red deer at the estuarine sediment/peat interface. Site B was clearly trampled by animals, which together with the effects of peat compaction, explains why many of the bones here were fractured and often had to be lifted in blocks of sediment.

3.3.3 Artefact distributions

The artefacts from Site B were recorded using the same 3-dimensional methods in both the conventional excavation of 2001–02 and the blocklifting strategy in 2003. Figures 3.6–3.7 (and CD 3.7–3.8) illustrate the distributions of artefacts. Lithic artefacts (Fig 3.6) were not numerous on Site B, a total of 45 pieces. A slight concentration of flint flakes and one core was in the 2003 area, where a small amount of knapping may have taken place. In that area the only other lithic artefact was one microlith, with another microlith, and a notched piece on the south edge of the 2003 area. In the area of the 2002 excavation, flakes were more thinly scattered but there was a wider range of other lithic artefacts, and raw materials; tools included a scraper, retouched piece, utilised piece, core, and hammerstone. Flint flakes occur both in the peat (nine flakes from Context 319) and in the underlying minerogenic sediment (eighteen flakes in Context 321). It is, however, notable that every tool comes from the minerogenic soil with the exception of one microlith from the peat. That picture was confirmed by the results of sieving (CD 3.7). In the 2002 area virtually all the small amount of micro-debitage came from the mineral soil (Context 321). Only three pieces of heat-fractured micro-debitage came from the peat. Similarly in 2003, only two pieces of micro-debitage came from the peat, all others were from the mineral soil. Even in the mineral soil, micro-debitage was thinly represented – one square had nine pieces, most between just one and four, and several none. It is notable that in the 2002 area 42% of the micro-debitage was heat-fractured whereas in the 2003 area it was just 8%. We can conclude that no knapping took place during the peat phase and only a small amount in the minerogenic soil phase, mostly in the 2003 area. Activity here seems to have been more to do with the use of tools than their production. Particularly notable finds from the Old Land Surface (Context 321) were a sandstone plaque which had been deliberately shaped and apparently used as a rubber and pounder (3846) and nearby a boulder used as a rubber/hammerstone (3845). Heat-fractured stone (CD 3.8) shows no particular concentration in the 2002 area but there is a cluster in the part of the 2003 area where other artefact types also cluster. In contrast to other lithic artefacts the heat-fractured stone is found both in the peat (Context 317, seven pieces) and Old Land Surface (Context 321, eight pieces). In addition to stratified lithic artefacts from Site B itself, unstratified lithics were also common on the small modern gravel bank immediately west of the site where an axe/adze (13000) was found just 5.7m west of Site B and a rubber/pounder 15m south-west of Site B.

In complete contrast to lithic artefacts, bone (both calcined and non-calcined, Fig 3.7) was more abundant in the peat (Context 319) than the minerogenic soil (Context 321). The peat produced 65 fragments in two main concentrations, one (Context 320) an area *c* 2m in diameter in the south-east corner which had led to the original identification of this site (Fig 3.3, Sq4/1). Another smaller concentration was on the east side of the 2003 area. Other animal bones were less numerous but are found in the same concentrations. Bone from sieving (CD 3.7b) reinforces this pattern. Context 320 has a marked concentration of 270 pieces in the peat and neighbouring squares have lesser concentrations. Four fish bones were found in this area and two others elsewhere. The main concentration of bone fragments in the minerogenic soil was in the same square as the main concentration in the peat, a puzzling coincidence perhaps. More probably it hints at the existence of a cut feature associated with the hearth which was not identified in the difficult and muddy conditions that obtained at the time. The butchery and cooking of red deer seems to have taken place in Context 320 which may have been a short-lived hearth associated with this activity. Nearby were two bone scraping tools (2272, 2273) which may have been used in the scraping of hides. Bone fragments were very few in the sieved samples from the 2003 area.

In the sieve analysis (CD 3.7c) charcoal abundance is quantified on a scale of 1 (low abundance) to 5 (abundant). No square produced an abundance of over 2. Interestingly the main concentration does correspond to that of calcined bone (Context 320) and this applies both in the peat and in the minerogenic soil. Charcoal from sieving only reaches an abundance of 1 in the 2003 area despite the fact that charcoal from excavation was more abundant here. All four of the charred hazelnuts come from the 2003 area. Despite the fact that Site B was waterlogged

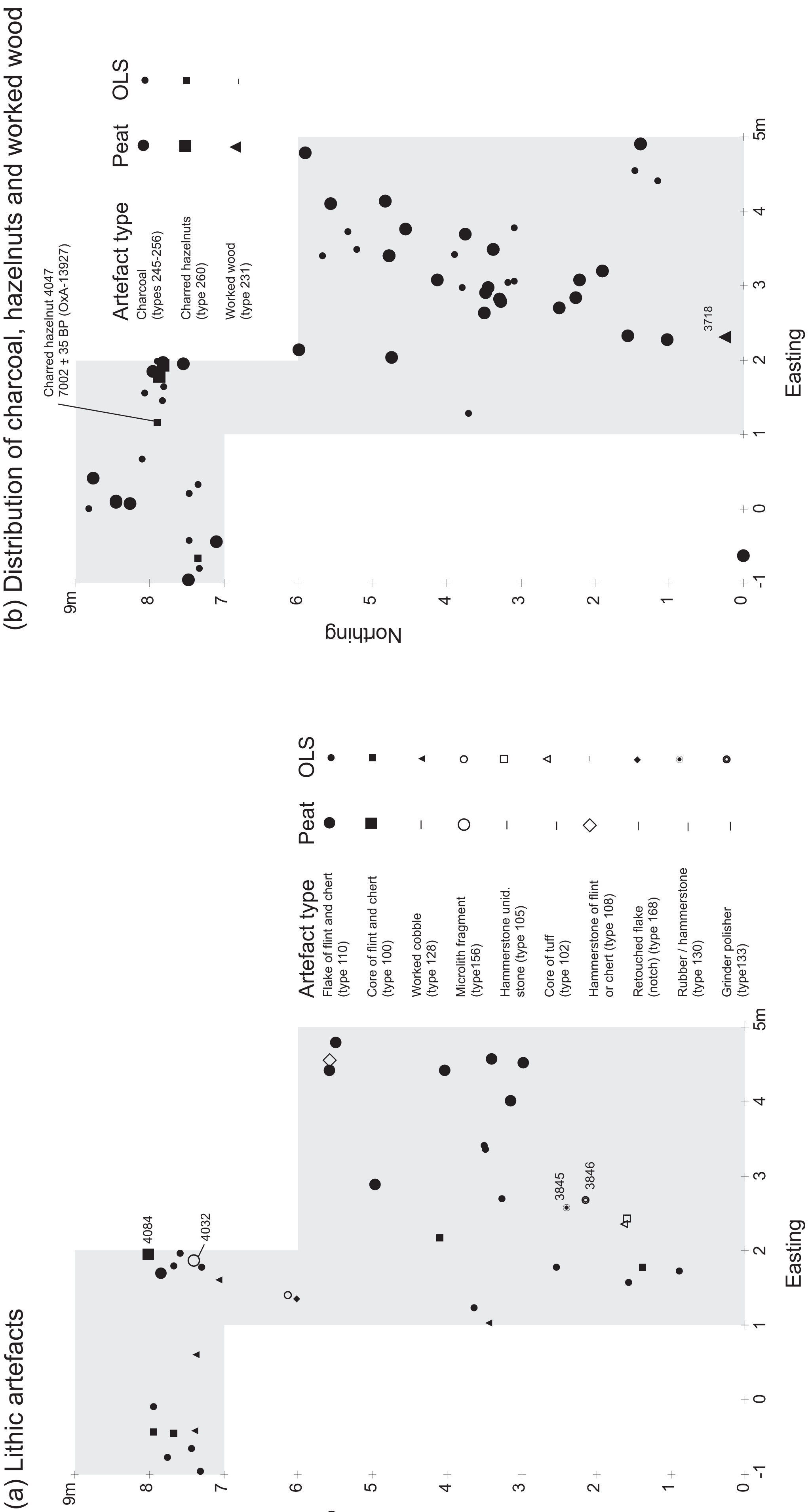


Figure 3.6 Site B, distribution of (a) lithic artefacts (b) charcoal, hazelnuts and worked wood (graphic S Buckley)

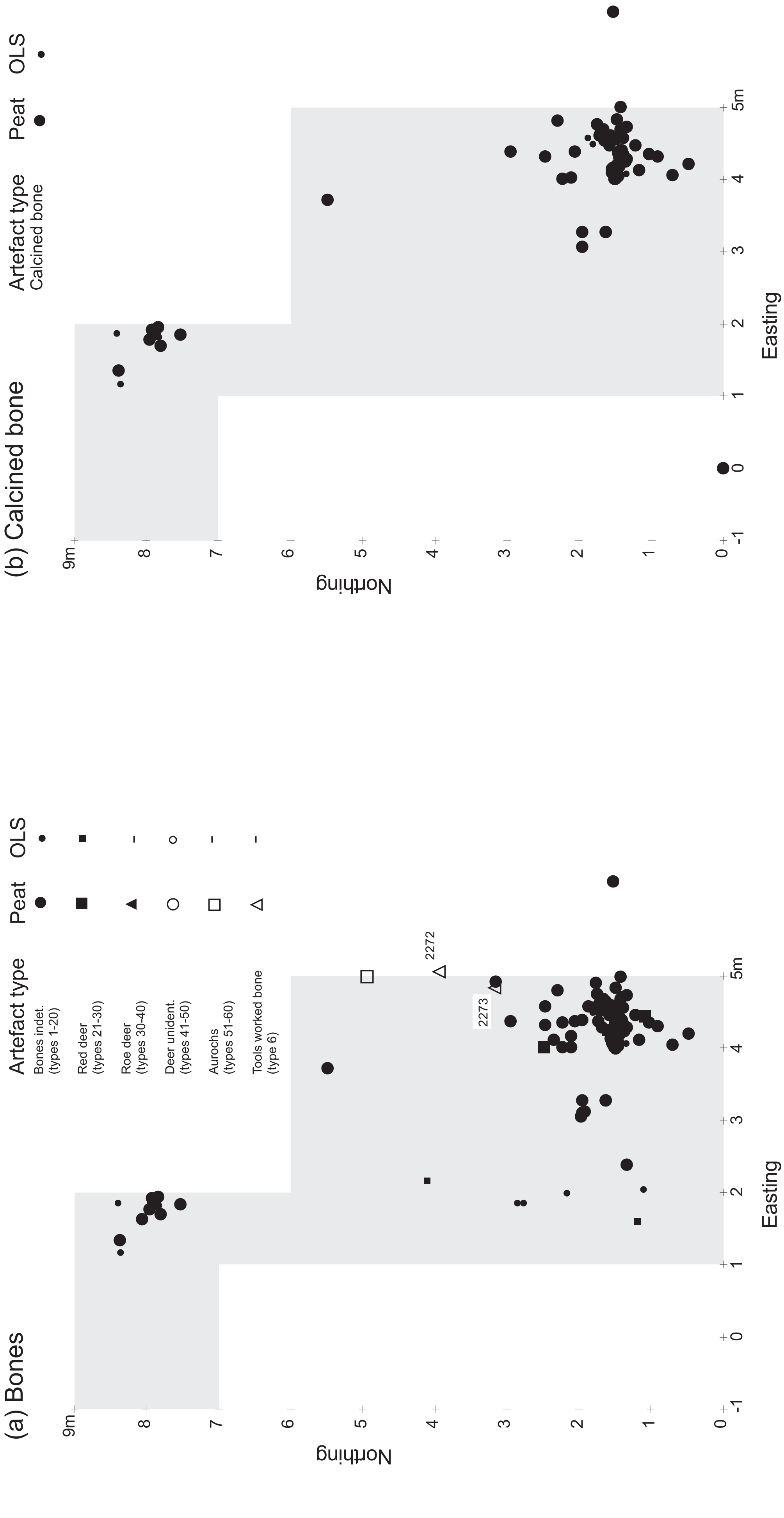


Figure 3.7 Site B, distribution of (a) bone and worked bone (b) calcined bone (graphic S Buckley)

during the later phase of activity associated with the peat (Context 319), it only produced one piece of worked wood, 3718, perhaps the rounded end of a spatula.

The distributions demonstrate two main concentrations of activity on Site B, both of which have pronounced concentrations of calcined bone: Context 320 in the south-east of the 2001–02 area, the other on the east side of the 2003 area. Apart from calcined bone the two areas seem to have been associated with different activities. The mineral soil (Context 321) had a diffuse scatter of artefacts associated with a range of activities – perhaps it lay on the periphery of an activity area. Activity at the time of the peat (Context 319) seems to have been particularly associated with the butchery, cooking, and perhaps hide processing of red deer but very little flint-working. The artefact distributions do not indicate a major focus of activity on Site B. Rather they are suggestive of small-scale activities, probably short-term.

3.3.4 Dating

As regards the date of this activity a charred hazelnut (4047) from the minerogenic soil (Context 321) has been dated 7002±35 BP (OxA-13927; 5990–5790 cal BC). There is also a date for the surface of the peat in the pollen monolith of 6871±33 BP (OxA-12359; 5840–5670 cal BC). Activity on the Old Land Surface may be contemporary with, or slightly later than, the demise of the Lower Submerged Forest and *c* 100–150 years earlier than activity on the peat surface.

3.4 Excavation of Site D

Situated 50m east of Site B this area is part of the same westerly exposure of the Lower Submerged Forest (Fig 3.2). The peat surface here is at –4m OD and, at the most favourable tides, the period of exposure is about 2 hours 20 minutes. Work in this area proved particularly difficult because there was a constant flow of water across the peat surface. Initial investigation took place in 2001 when a trench was cut for dendrochronological sampling of Tree 103. That impressively tall straight trunk was 13.58m long and 12.33m to the first branch (CD 3.1). What survived of the trunk was just 34cm in diameter. Clearly this was a tree which had grown in high canopy forest. A 1m ^{2} pit was dug adjoining the trunk and 0.3m from the base of the tree to record the stratigraphy (Fig 3.8) and take a monolith (4071, CD 3.9) for pollen and plant macrofossils. In excavating this pit, charcoal was recorded but no artefacts. Pollen analysis by Dr Petra Dark (Chapter 14.4.1) showed two distinct peaks of charcoal within the peat and also revealed the presence of human intestinal parasites (Dark 2004a). Given these findings it became important to establish if the Mesolithic settlement area extended as far as Site D. Accordingly in 2003 a further excavation took place. An area 5m by 3m incorporating the former trench was cleaned of mud and sand, planned, and levelled. The peat surface was ridged by parallel shallow gullies of streamwise erosional structures (Allen 1987c) about 0.6m apart. Two square metres were block-lifted in 32 tins (Fig 2.8). The blocks were carefully excavated in the field laboratory on dryland. The trench created by blocklifting was then extended by spade excavation to create a section 5m by 1m crossing Tree 103 (Fig 3.8; CD 3.10–3.12).

At the base of this trench, 30cm below the peat was dark reddish grey (5Y4/2) sandy silt with gravel grade pebbles (Context 348), which is interpreted as Head derived from the Ipswichian interglacial beach exposed to the south. The overlying sediment was a dark reddish brown (5YR3/2) silty sand containing small stones (Context 347), which is interpreted as the basal Holocene soil. In places, the upper *c* 5cm of this layer was a dark grey (7.5YR 4/0) silty clay (Context 346). This may represent a thin estuarine input to low lying areas of the soil surface prior to the onset of peat formation, such was present more extensively below the lower peat at Redwick (Bell *et al* 2001). The distinction between Context 347 and 346 was not apparent in the field but was evident in the laboratory examination of Monolith 4071 (CD 3.9). Within Contexts 347/346 there were irregular and linear organic patches which appear to represent root channels. Charcoal patches occur within these contexts. There was a sharp boundary to the overlying, highly compressed peat which was 5–11cm thick and dark greyish brown (10YR4/2) with abundant *Phragmites* remains. The trunk of the oak Tree 103 had peat below and in places above. The lower 5cm of the peat was entirely organic, the upper 5cm contained fine silty clay laminations representing at least eight separate marine incursions into the peat. In this layer the minerogenic proportion increased upwards reflecting the increased frequency of incursion. There was thus a gradual merging boundary to the overlying bluish grey (5B5/1) silt within which there were traces of laminations (CD 3.9). Within the trench the silt only survived patchily over the peat, but 1m north it was more continuous and the exposed surface showed that the base of the silt was marked by many vertical reed stems showing the continued presence of reeds during the initial stages of this transgression. Within this area of reed stems there were several patches of charcoal flecks, which hints that the practice of reed burning attested during the peat phase continued into the time of the overlying minerogenic sediments. The silts bury the peat to the north and form the lower Wentlooge Formation.

The excavation of 2m^2 of Site D under field laboratory conditions produced just a single flake, a possible flake and one debitage chip, all from the minerogenic sediment below the peat (Context 347). The sieving of sixteen samples totalling 106 litres of sediment produced just two pieces of micro-

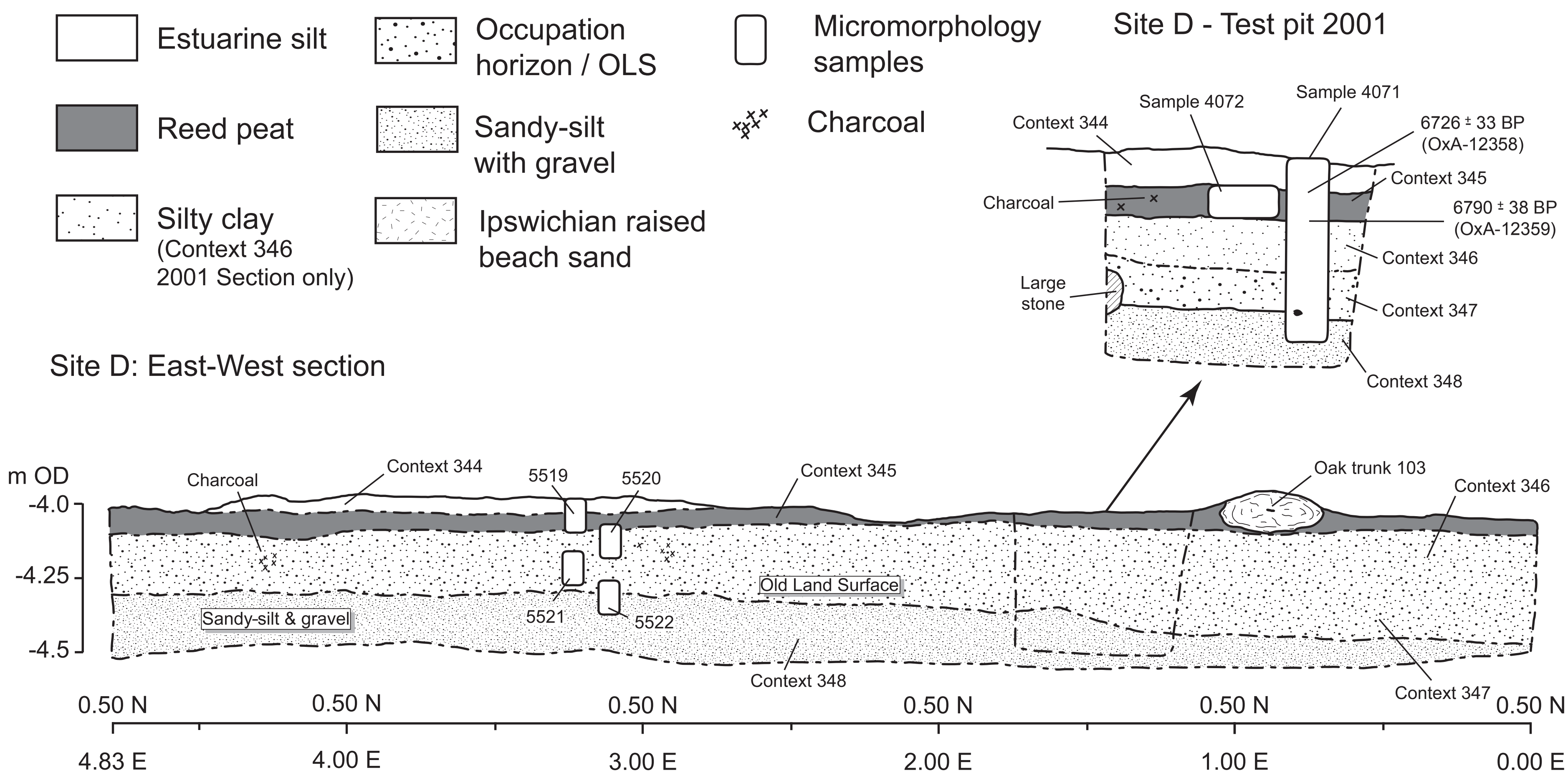


Figure 3.8 Section of the sediment sequence on Site D (graphic S Buckley)

debitage, from Context 347. Hand excavation also produced four fragments of heat-fractured stone from Context 347 and one from the peat (Context 345). One charred hazelnut fragment was found at the transition between the peat and the overlying grey clay (Contexts 344–5). Charcoal was frequent, in the minerogenic sediment (Context 347), peat (Context 345), and overlying silts (Context 344).

The tiny numbers of artefacts on Site D make it clear that it is peripheral to the main areas of settlement activity. Small-scale activities may occasionally have occurred near here. This is suggested by the discovery 17.5m east of Site D of a heat-reddened cobble (13011) used as a hammerstone or rubber and stratified in the peat, and by the finding on two occasions of single flint flakes in the edge of the peat shelf south of Site D. Most of the small artefacts from Site D could, however, have arrived on the feet of people and animals moving from adjoining activity areas. One deer-sized footprint-track was recorded on Site D.

The peat base is dated 6790±38 BP (OxA-12359; 5740–5630 cal BC) and its top to 6726±33 BP (OxA-12358; 5720–5560 cal BC). We know that there were oak trees in the Lower Submerged Forest which were broadly contemporary with the peat at Site D because the peat dates are very close indeed to that obtained by Professor Allen for an oak tree in the same peat exposure 6770±70 BP (Beta-60761; 5800–5540 cal BC). Dates obtained for Trees 48 and 49 in the easterly exposure of the same Lower Submerged Forest extend the span of the floating chronology to within 200 years of the Site D peat dates. Thus, the Lower Submerged Forest at Goldcliff East spans some 400 years.

Site D was investigated mainly to provide an environmental sequence from the Lower Submerged Forest which was outside the activity areas represented on Site B. Botanical analysis shows oak and hazel woodland at the time of the minerogenic soil and invasion by grasses and reeds at the time of the peat when oak and hazel woodland persisted in the area. Two distinct burning episodes are represented, the first involved burning of trees, the second involved reeds. One of the most interesting and unexpected contributions of the environmental study is the discovery of human intestinal parasites at several levels in the peat. Thus, this site which we have seen was peripheral to the main activity areas, was habitually used as an area for defecation.

4 Banded sediments with footprint-tracks
by Martin Bell

4.1 Introduction

One of the aspects which makes the Goldcliff sites of such particular interest is that they occupy the interface between dryland edge occupation and estuarine environments. Thus, we have the association of occupation sites with estuarine sediments preserving large numbers of footprint-tracks of people and animals. The footprints occur extensively in the lower foreshore at Goldcliff East and have been investigated in detail at Sites C, E, and H (Fig 2.3), with individual examples or small groups being recorded in other areas when they happened to be exposed (CD 4.1). Fieldwork at these sites is introduced in this chapter in the context of the overall sediment sequence. A more detailed treatment of the footprints themselves is in Chapter 12. The difficulties which attended investigations on these sites in low foreshore contexts should be noted. The sites are dynamic with areas constantly being eroded or buried by sand and mud. Sites C, E, and H are low in the tidal frame at –3.1m to –4.4m OD (Fig 2.7). They are only exposed around spring tides for about seven days and then only for a maximum of 2 hours 20 minutes. At neap tides they are permanently submerged.

The estuarine sediments preserve footprints well because they are banded. Fine clay and silt laminations are separated by partings of fine sand. The resultant banding is clearly seen in sections in which the differing partical sizes are etched out differentially by wave action (Fig 4.1). Erosion also exposes clay surfaces of individual laminations by removing coarser grained sediments. This results in a series of steps on which the fine grained surfaces within individual bands are separated by little erosion scarps typically 1–4cm high. It is on these smooth surfaces that the footprint-tracks can be most beautifully preserved. Detailed investigation by Allen (2004; Allen and Haslett 2006) of the changing particle size through banded sediments has revealed evidence for rhythmical banding which is interpreted in terms of annual changes in the estuarine sediment regime (Chapter 17). This interpretation is supported by mathematical modelling of the effects of seasonal temperature and turbidity changes on sedimentation and by pollen evidence showing that the amount of pollen and the abundance of types of plant vary in a way which is consistent with the seasonal pattern suggested (Dark and Allen 2005). Identification of annual banding within these sediments is important because it establishes the time of year when some of the best preserved footprints were made and thus contributes to our understanding of the seasonality

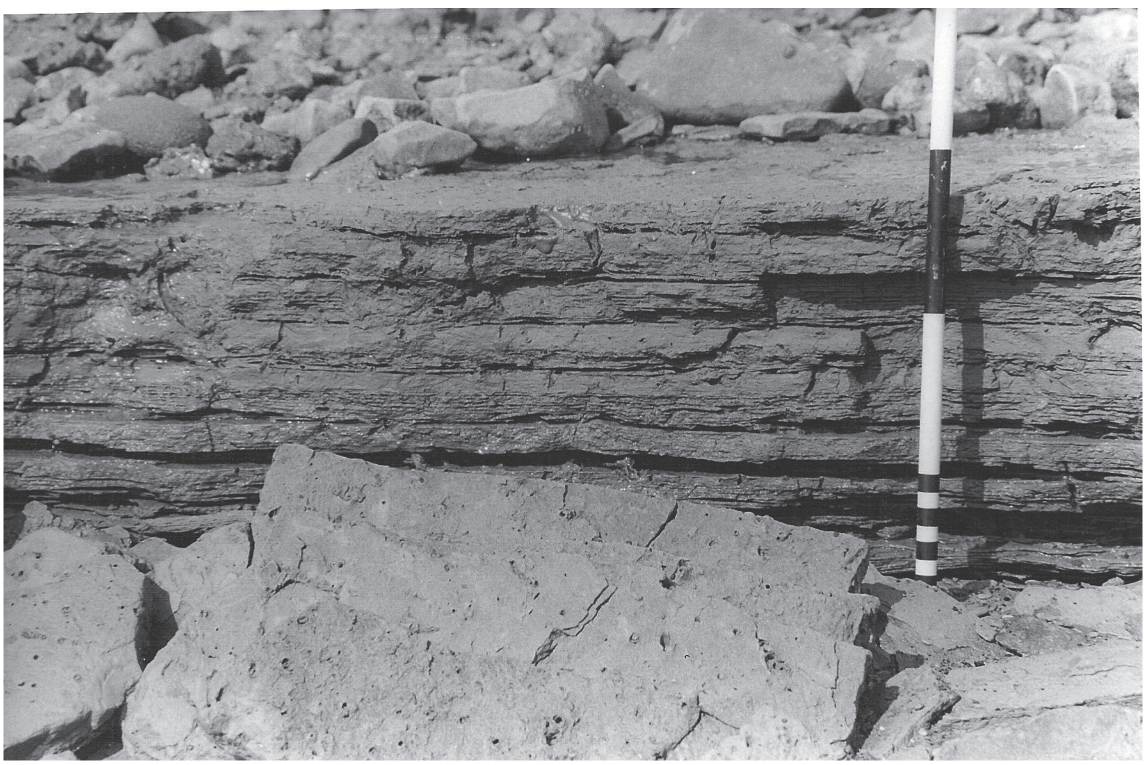


Figure 4.1 Laminated estuarine sediments at Site E: scale – large divisions 10cm (photo E Sacre)

of Mesolithic activity and the time intervals between different activity episodes.

4.2 Sedimentary context

The Lower Peat and Mesolithic occupation surface at Site B, and the Lower Peat at Sites D and I were overlain by estuarine silts comprising the lower Wentlooge Formation (Fig 2.6). The Lower Peat and Submerged Forest was inundated *c* 5650 cal BC. The estuarine sediments were in turn sealed by the Upper Peat and Submerged Forest that started to form *c* 4700 cal BC. Thus, the banded sediments formed over a thousand-year period in the later Mesolithic. Only the lower and upper parts of the estuarine sediment sequence were well exposed. The lower 2m (*c* –3m to –5m OD) was exposed between Sites D and I. Above about –3m OD these sediments were obscured by a sheet of recent estuarine sand dunes, the extent of which was constantly changing. Sometimes the dunes extended to cover areas of estuarine sediments burying the footprint-tracks. Occasionally after storms, the sands were eroded to reveal areas of estuarine sediments covered in footprint-tracks. Landward of the sand the earlier Holocene stratigraphy was also often obscured by modern mud. The top of the estuarine sequence was generally clearer at the base of the Upper Peat shelf. It was on this part of the sediment sequence that the detailed investigations of Dark and Allen (2005) have established the annual banding within these sediments. Some footprint-tracks were recorded in the upper 1m of the estuarine sediments at Sites F/G.

Nowhere was the full thickness of estuarine sediments exposed. The maximum thickness demonstrated by coring on the edge of the island was 2m (Fig 2.6). The total thickness may be calculated by extrapolating from the heights of its contacts with the sediments above and below. The underlying Lower Peat and Submerged Forest forms a fairly level surface at between –3.5 and –4m OD (Chapter 3). The upper contact with the overlying Upper Peat and Submerged Forest occurs at decreasing height away from the edge of the former island: at 1.3m at Site J, at 1m 100m east of Site J, and 0.75–0m in the eastern part of the Goldcliff East embayment cored by Smith and Morgan (1989). That reduction in height of the peat base is the result of greater sediment autocompaction where the sediment thickness is greatest (Allen 2000b). Autocompaction is seen at many sites in the estuary including the peat exposures west of Goldcliff island (Bell *et al* 2000). It follows from these levels that the thickness of estuarine sediments is about 4m.

4.3 Erosion feature between Sites D and I

There are two outcrops of Lower Peat: a western area with Sites B and D and an eastern area Site I. They are separated by a 250m wide stretch with no peat. Professor J R L Allen (pers comm) has identified evidence that this break in the peat is the result of erosion by a palaeochannel or erosion embayment of a once continuous peat surface. The edge of this feature on the west side is marked by the north-north-west to south-south-east trending peat edge near Site D where Trees 56 and 59 are exposed (Fig 3.2). On this face there is a tilted peat block such as marks the edges of palaeochannels elsewhere in the estuary (Allen and Rippon 1997; Allen and Bell 1999). The edge of the erosion can be traced north of the peat edge for 28m through the overlying minerogenic sediments beyond which it is obscured by mud. To the west, the laminated silts are horizontally bedded, while to the east the bands are disrupted, some dip at a steep angle and there is evidence of fallen blocks of sediment and rounded pebbles of eroded silt. East of this edge the silts are not generally disrupted but form a laminated sequence of sediments dipping at 4° to the east. It is within these bands that the best exposures of animal and human footprints occur, at Sites C, E, and H.

There is evidence of a channel marked by steeply pitching laminations and tilted blocks 23m south-west of Site C; this is about 16m wide. At Site H and to its east the sheets of laminated sediments are in places affected by small erosion channels, which contain banded sediments at steeply dipping angles, lenses of finely divided organic matter and rounded pebbles of eroded silt. The evidence for disruption of the silts becomes particularly apparent to the east where there is a larger palaeochannel (Context 350, Site L, Fig 2.2) which contains highly disrupted laminated sediments which at the southern end of the exposed feature forms large fallen blocks of sediment (CD 4.3). This feature is about 12m wide and runs north to south. It marks the eastern edge of the erosion feature and cuts the west side of the Lower Peat exposure at Site I and the underlying Head. About 50m south of the south-western edge of the peat at Site I there is an exposure of estuarine sediments about 1m below the peat demonstrating that the channel cuts significantly into the underlying Head. Estuarine sediments are also exposed at Site E at about –5m OD. The depth of the erosion feature has not been established. Seaward of the erosion feature there is an extensive area of water which even at low tide never drains (Fig 2.4). This is thought to mark the seaward extension of the erosion feature where the less resistant sediments of its fill have been scoured by the strong currents, creating a lower area with permanent water.

The interpretation most consistent with these observations is that the lower part of the lower Wentlooge sediments, the underlying peat, Lower Submerged Forest and the underlying Head are cut by a palaeochannel. The channel edge lies just east of Site D and migrated to the east accounting for the fact that the banded sediments that fill it dip to the east. Its final position is represented by the marked

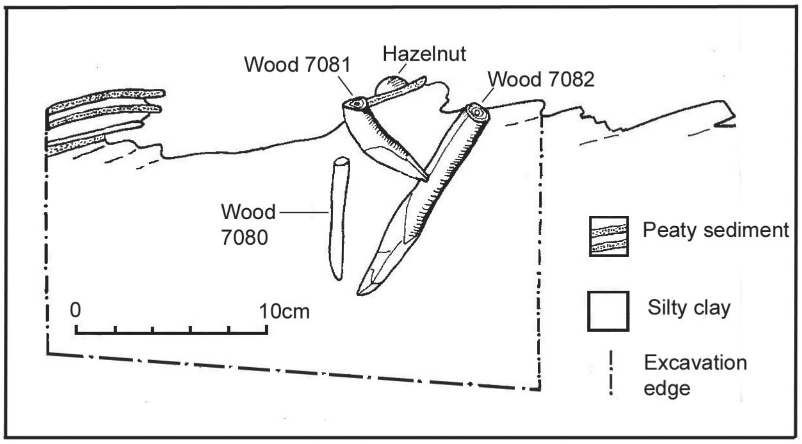


Figure 4.2 Wood structure Context 332 in palaeochannel, Site L

channel feature at Site L. If this interpretation is correct then a channel, perhaps no more than 12m wide at any time, ran north to south immediately east of the former island.

Banded sediments filling the channel outcrop between –3 and –5m OD. On either side of this are Lower Peat exposures at about –4m OD that are cut by the channel. It is uncertain whether the channel existed at the time of Mesolithic activity on the Lower Peat at Site B, but the interleaving of peats and estuarine sediments at nearby Site D (CD 3.12) might hint at a channel nearby. Such interleaving is particularly prevalent in situations where channels provide sources of minerogenic sediment. It is highly likely that the channel existed at the time when Site A was occupied, as this occupation surface occurs only about 0.5m above the highest level at which the channel sediments are exposed. We may hypothesise, therefore, that there was a channel *c* 200m east of Site A.

The existence of this channel is important for several reasons: its sediments contain the best preserved footprint-tracks; it would also have offered resources such as fish and fowl; the footprint-tracks clearly show that it was a spot frequented by people; it may also have been a route for communication by boat. The channel is of further significance still because the more easterly part, including the pronounced channel at Site L, contained a small amount of worked wood (see Chapter 10). These pieces were chance discoveries exposed by tidal scour. The only excavation at Site L involved tiny holes dug to remove particular pieces of wood. Figure 4.2 illustrates one such find, Context 332, exposed on 21 August 2002. Here, tidal scour exposed four pieces of wood. Two were round wood of diameter 14mm, pointed, and at 50° and 70° to the horizontal. The third was 7mm in diameter and near vertical. The wood was associated with laminated silts, in places separated by thin bands of organic silts containing plant fibres, small pieces of wood, seeds, and two hazelnuts. The fourth piece of wood lay between two bands. The bands dipped to the west at 12°. A year later on the 12 August 2003 close to the same point in the channel fill a collection of fourteen smaller pieces of wood was observed (CD 4.4). Most were even-sized, 3mm in diameter; one piece was 12mm. The two longest pieces were *c* 40cm and 50cm long and lay concentrically. No clear-cut ends were observed but given the earlier discovery of Structure 332 in the same area, and the location of these finds in a channel, it seems possible that these fragments are the eroded remains of a basket used in fishing. In the same area a piece of roundwood (14201) which may represent the end of a stake was also found.

Other wood from the laminated silts included 14202, part of a pointed roundwood stake 35cm long by 6cm in diameter, from which two cuts have fashioned a crude point. In one of the tributary channels 20m from the main channel towards Site H another pointed stake 13303 was found; this was 26cm long by 2.6cm in diameter. In addition to these a wood artefact 13302 was found in laminated silts on Site E, 15m east of one of the main excavated areas of human footprint-tracks, on a lamination surface *c* 20cm below the find spot (Fig 4.5). This was a split plank fragment 23.6cm by 5.8cm and 2.2cm thick (Chapter 10). A small woodchip (13300a) was also found in a blocklifted sediment sample about 30cm below the human footprint-tracks on Site E.

It is difficult to interpret this fragmentary worked wood in the channel and associated laminated sediments. Only the group shown in Figure 4.2 appeared to be in an original structural context. The others were stratified in Mesolithic sediments but fragmentary and probably driftwood. They may represent worked wood washed from the settlement at the island edge. At Halsskov Fjord, Denmark, Myrhøj and Willemoes (1997) report a substantial collection of worked Mesolithic wood washed from its original context, probably fishing structures, and accumulated in a sheltered embayment. Some or all of the material from Goldcliff, particularly that shown in Figure 4.2, may represent the eroded remains of fishing structures within the Site L

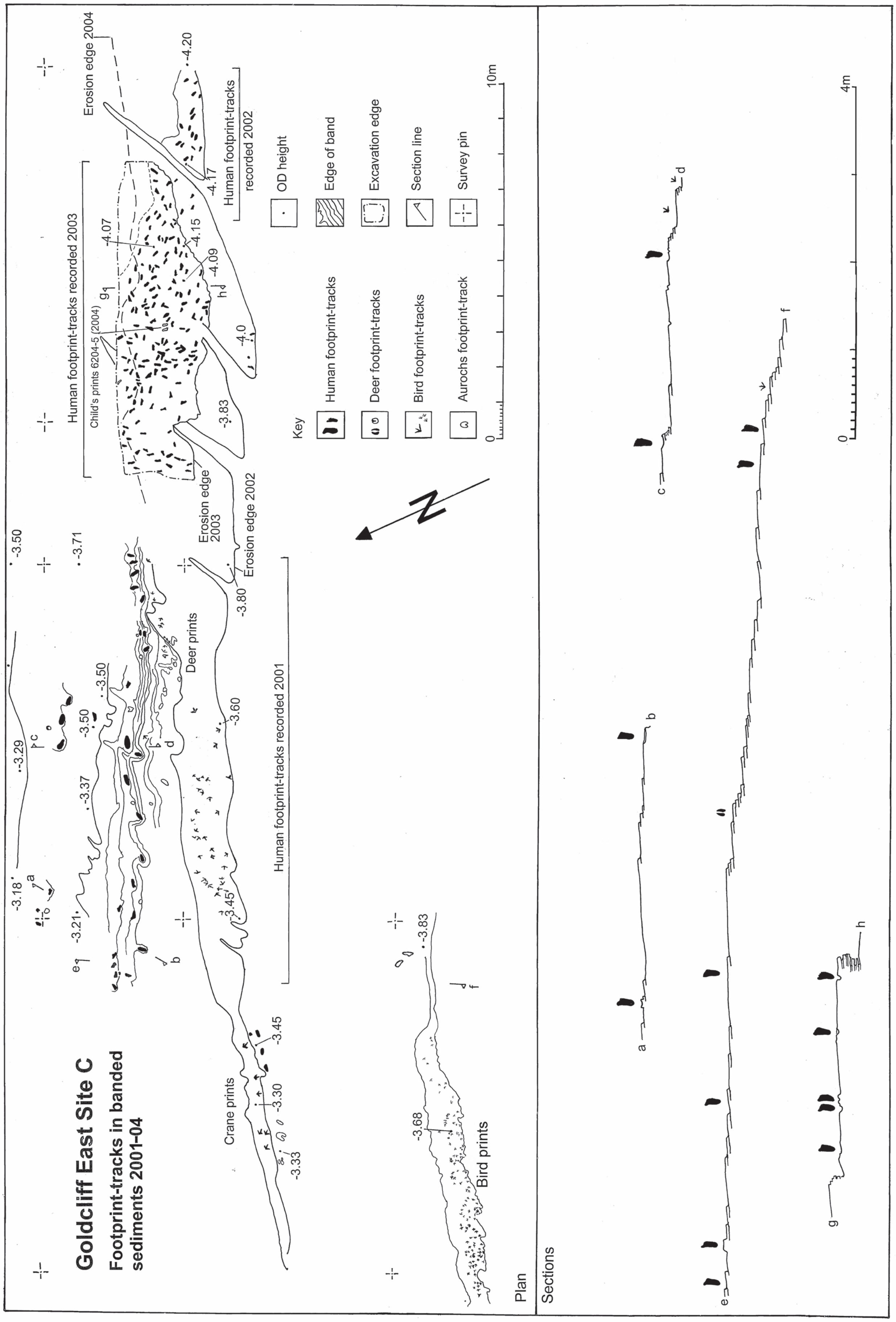


Figure 4.3 Plan of Site C showing the areas of animal and human footprint-tracks exposed by erosion or excavated between 2001 and 2004 (drawing M Bell and R Scales)

palaeochannel itself. Wooden structures associated with fishing are known on many Mesolithic sites in Denmark (Pedersen 1995) and are also found in a channel adjacent to the Hoge Vart site in the Netherlands (Hogestijn and Peeters 2001). Wooden Mesolithic structures associated with fishing have recently been discovered in Dublin Harbour, Ireland (M Mcquade pers comm). Insufficient evidence survived at Goldcliff to be certain whether we were dealing with fishing structures but the hope is that continued vigilant observation of this palaeochannel may one day reveal more clearly defined structures.

4.4 Investigation of footprint-tracks

4.4.1 Site C

Deer prints together with ill-preserved human footprints were noted in the Goldcliff East embayment by Allen (1997b, 503) between Sites A and B (Bell *et al* 2000, 367, map 16). Much more extensive exposures of footprint-tracks were discovered at the end of August 2001 on what was designated Site C. Here a series of low cliffs running north-east to south-west exposed the banded sediments in section. Erosion formed a series of steps in which lamination surfaces formed of fine grained sediments were exposed over an area typically *c* 0.2m wide by 5–10m long. Surfaces were separated by little cliffs, ranging in thickness from one band to many, and in which the laminations were exposed in section (Fig 4.1). Individual bands dip to the east at between 2° and 4°. It is on these laminar surfaces that footprint-tracks can be preserved. The main area in which footprint-tracks have been recorded here is 35m by 11m as illustrated in Figure 4.3. This plan is a palimpsest of accumulated discoveries over three years between 2001 and 2003, with some small additions in 2004 and 2005. At any one time only parts of this area would be exposed below recent sand and exposures in this area were constantly changing. Detail of the footprint-tracks themselves are given in Chapter 12.

The discovery of extensive areas of footprint-tracks on Site C in August 2001 was eleven days before the end of that field season. With some reorganisation of that season's programme it proved possible to make a measured plan of the main area of the exposure, an area 12m by 5m. That plan was complemented by actual sized tracings of six areas totalling 11.6m^2. During that season, 61 footprint-tracks were recorded: 35 human, 18 red deer and 13 bird (Bell *et al* 2001). Only the bird tracks were notably well-preserved, the quality of the human and deer prints was moderate to poor and most were partly eroded. Most of the human footprint-tracks examined during this season were undertraces and overtraces (see Chapter 12 for terminology) and only in a few cases did part of the sediment in actual contact with the foot survive. Investigation in 2001 was restricted to recording what had been exposed by erosion – there was no excavation to reveal better-preserved footprint-tracks, although three of them which were particularly vulnerable to erosion were blocklifted. In the interim report on the 2001 season (Bell *et al* 2001) it was suggested that some particularly large oval prints might represent a shod individual; it is now considered more likely that these are undertraces.

The 2001 footprint-tracks were certainly not coeval and they occurred on several distinct lamination surfaces. This is illustrated by the section drawings in Figure 4.3. These show, for instance, that print 6005 is eight bands (averaging 1cm) thick above Footprint 6009, whilst footprint 6008 is nine bands above 6023, which in turn is five bands above a laminar surface with bird prints, and two bands below these is a lamination with no human prints but many bird and some deer prints. Since some of these are overtraces or undertraces that introduces an element of uncertainty into the chronology but it is probably reasonable to infer that the footprint-tracks planned in 2001 were made over a period of around sixteen years.

By the time of the 2002 field season much of the area planned in 2001 had been covered by sand and gravel, only the more exposed ridges of some steps were exposed. There were, however, some good exposures in the areas to west and south. The most significant area was 6111(a), a lamination surface 10–14m south of the 2001 area at –4.09 to –4.2m OD. Here 24 footprint-tracks of a child and those of a small bird were traced over an area 4m by 1m. They were mostly exposed by erosion but some were uncovered by small-scale excavation. Some 4m north of this site, two other human footprint-tracks were exposed at the edge of a lamination shelf (6128–9). Immediately west of the 2001 area the erosion of a new laminar surface at –3.6m OD revealed 32 footprint-tracks of a large bird, probably a crane (6119), which were traced over a surface 3m by 1.5m. On the same lamination 8m north at 3.3m OD there was a further area of probable crane prints (6124) covering an area 4m × 2m. On a lower lamination surface in the same area there were the tracks of an aurochs (6120) and three footprint-tracks of a child (6125). 5m south of this a narrow exposure of a lamination surface 10m long by a maximum of 1m wide revealed many beautifully preserved footprint-tracks of a small bird (6116). As Figure 4.3 (section e–f) shows there were 33 main laminations below the group of child's footprint-tracks including 6014 recorded in 2001. Three laminations above the bird prints were two human footprint-tracks (6127–8) and one lamination above this a poorly preserved human footprint-track. In addition during 2002 a small area within the 2001 plan was traced, including two human footprint-tracks (6207). Thus, the work of Rachel Scales in 2002 expanded out from the small core area investigated in 2001 and was particularly notable for the discovery of well-

Figure 4.4 The excavation of footprint-tracks at Site E about to be submerged by a rising tide (photo E Sacre)

preserved child's footprint-tracks in Area 6111(a) and three areas of bird prints.

By the 2003 field season there had been further significant encroachment of sand and most of the northern part of the site worked on in 2001–02 was now covered. Fortunately, however, immediately north of the Area of 6111 recorded in 2001, Rachel Scales observed footprint-tracks emerging from below laminations. She made the decision to conduct an excavation using methods developed on Site E in 2002 in order to uncover an area of footprints-tracks. The area excavated over about three weeks was 9m by 2m. The footprint-tracks were on a single lamination surface at between –4m and –4.15m OD. The area contained a remarkable total of 177 footprint-tracks, mostly made by children (Figs 12.2, 12.10; CD 4.5–4.12). Part of this excavation was filmed for the Time Team television programme.

During a visit to the site on 3 August 2004 with a BBC Wales film crew, two exceptionally well-preserved child's footprint-tracks (6204–05) were exposed by erosion below the surface of 6111(b) recorded in 2003, and these were recorded photographically (Fig 12.11) and by a measured sketch. This wonderful fortuitous discovery was filmed and shown on the BBC Coasts series in 2005. A third well-preserved footprint-track (6215) was independently recorded by Edward Sacre during another visit around the same time. A subsequent monitoring visit on 29.9.04 revealed an area of probable crane prints 6m south-east of Area 6111, 27 footprint-tracks were counted and part of this area was recorded photographically.

Immediately west of the small erosion cliff where these footprints are exposed is a small beach of gravel and sand. This beach has produced many unstratified lithic artefacts and an antler mattock-hammer (7065; Chapter 11.2). No flint artefacts have ever been found in the laminated silts themselves so we do not know if the finds derive from here, or whether the sea has swept them to this position from the known sites at the edge of Goldcliff island.

It will be evident from the foregoing that Site C represents a highly dynamic context of which only small areas are generally exposed at any one time. It is a context which is under very active erosion, the rates of which can be calculated from the plans made in successive seasons. Between 2001 and 2002 the erosion sections exposing banded sediments retreated at an average rate of 1.68m (range 1.45–2.2m). Between the 2002 and 2003 field seasons the footprint-track Area 6111 retreated at an average rate of 1.05m (range 1.35–0.8m). Measurements were also taken on 23 July 2005, about two years after the final season, by which time Area 6111 had retreated a further 1.8m (range 1.2–2.4m). That gives an average annual erosion rate of 1.13m calculated over four years. Notwithstanding the depredations of erosion, at the time of the 2005 visit the extensive sand dunes to the north had extended and covered almost all the site. All that was visible were just two crane footprint-tracks on the exposed seaward step edge. How fortunate, therefore, that the recording of this area was done when it was!

4.4.2 Site E

This was 50m east of Site C, where an east/west erosion cliff *c* 1.5m high rises in two or three steps from an area of permanent water to the south.

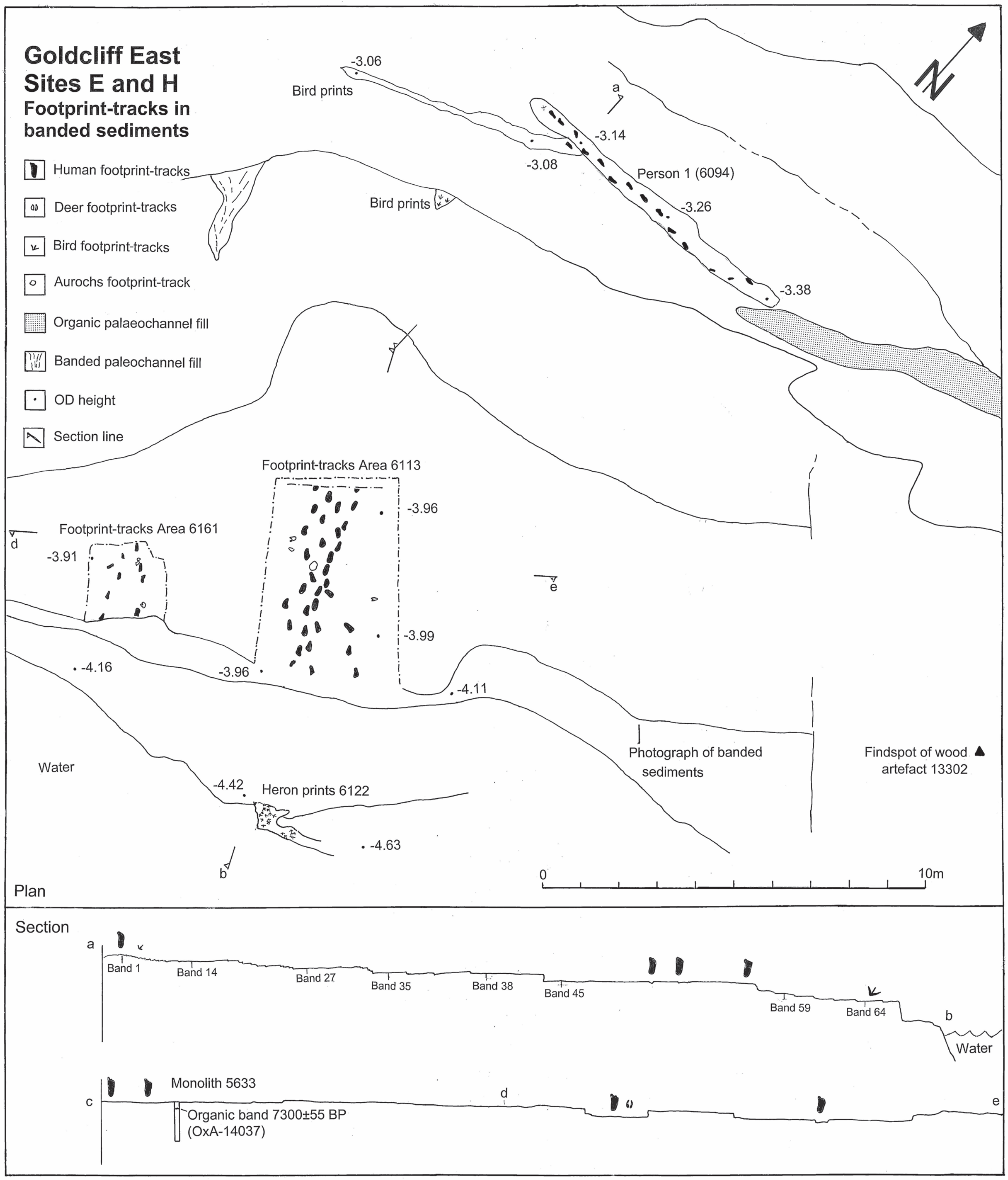


Figure 4.5 Plan of Sites E and H showing the areas of animal and human footprint-tracks exposed by erosion or excavated in 2002 and 2003 (drawing M Bell and R Scales)

This cliff exposes a section through the banded sediments, part of which is shown in Figure 4.1. It was on one of the stepped lamination surfaces here that on 27 March 2002 Rachel Scales discovered some footprint-tracks part exposed but disappearing into the section. There were also some bird prints, including a probable crane (6122) on a lower lamination. Some of the footprint-tracks recorded then were still visible at the beginning of the next field season on 12 August 2002 and Rachel Scales made the decision to uncover a larger area (Figs 4.4–4.5). It was in doing this that she developed the technique of finger-tip excavation following the footprint-tracks below laminations and thereby demonstrating beyond question that the tracks were coeval with the sediments and not produced by recent visitors to the foreshore. During the low tides over about three weeks she excavated an area 6m x 3.5m on a single lamination surface at –3.9m OD. This revealed the tracks of four people, Persons 2–5 (6113) who had walked across the area producing 33 footprint-tracks; there were also four deer prints. Part of this excavation was filmed for the BBC television series 'Meet the Ancestors'. By summer 2003 the area recorded in 2002 was covered in gravel and sand but footprint-tracks were found disappearing into the laminations 2.5m to the west. Rachel Scales followed these by excavating an area 2.5m × 2m, which revealed a lamination surface at –3.91m, with seven footprint-tracks of human and six of red deer (Area 6161). Some 16m east of 6113 the already noted wood artefact 13302 was found within the banded sediments. As in the case of Site C, the sand dunes had encroached further when the site was last visited on 13 July 2005, so much so that sand had spilled over the cliff and filled part of the area of permanent water to its south.

4.4.3 Site H

This was 16m north of Site E where, at a time when this area was particularly clear of mud in August 2002, Rachel Scales found a trail of sixteen human footprint-tracks of Person 1(6094) on a lamination surface between –3.14 and 3.38m OD (Fig 4.5). The trail was 8m long and was traced onto plastic film. The discovery was fortuitous because within three weeks it was eroded away and the area has since been totally buried by sand. Close to this trail there are the already noted small palaeochannels which interrupt the lamination surfaces in places. Figure 4.5 (a–b) shows a profile of the lamination surfaces across Sites H and E. It shows that the trail of Person 1 is 45 bands above the group of four individuals Persons 2–5 (6113). These in turn are nineteen bands above the group of heron prints 6122.

4.4.4 Site G

This area of footprint-tracks is in a very different situation to those previously described. It lies 380m north-east of Site J at the top of the lower Wentlooge laminated sediments, just to the east of one of the sequences of those sediments examined by Dark and Allen (2005) for pollen and sediments which led to the identification of annual banding. The footprint-tracks here are 0.5m below the Upper Peat. The peat here has a good exposure of the Upper Submerged Forest (Site F) which has been planned and was the subject to palaeoecological study by Timpany (Chapter 15; CD 15.1). In this area, erosion had exposed a narrow lamination surface at –0.02m OD, on which Rachel Scales recorded ten deer footprint-tracks (CD 7.11). Some other deer and one poorly preserved human footprint-track were noted in a similar position elsewhere on the same erosion face. Above this level in the overlying peat, a single deer footprint-track (6145) was recorded within the peat.

4.4.5 Other footprint-tracks on the lower foreshore

The main areas of footprint-track recording in laminated sediments have been noted here. They also occurred in peats on Sites B and D, in an Old Land Surface on Site A, and in Old Land Surfaces, estuarine sediments, and peats on Site J, as noted in the relevant chapters on those excavation sites. In addition, individual prints and small groups were exposed elsewhere in the intertidal zone, particularly in the lower Wentlooge banded sediments on the low foreshore between Sites D and C. When time and tide allowed these individual prints were recorded and are included in Chapter 12, as are a few deer prints recorded in a reed peat in the upper part of the middle Wentlooge banded sediments east of Site K. Clearly, footprint-tracks occur within a wide range of stratigraphic contexts and types of sediment at Goldcliff East but it is in the banded sediments of the lower Wentlooge Formation that they are outstandingly abundant and in some cases very well-preserved. Our only regret perhaps is that the ever-changing cover of mud and sand, the brief tidal window and the demands of excavation elsewhere on the site did not enable us to record more of this remarkable evidence.

4.5 Conclusions

The discovery of such an abundance of human and animal footprint-tracks adjoining a complex of excavated sites has provided an entirely new dimension to the study of the Mesolithic. Footprint-tracks have been found previously at Uskmouth and Magor in the Severn Estuary (Aldhouse-Green *et al* 1992) and Formby (Huddart *et al* 1999b) and recent finds at Rhyl are reported in Chapter 20.14. The footprint-track evidence is presented in detail in Chapter 12. Because the Goldcliff footprint-tracks are directly associated with excavated sites this provides the opportunity to compare what they suggest about the age composition and activities with evidence from the settlement areas. Since the footprint-tracks are contained within sediments with evidence for annual banding, they also make an important contribution to our understanding of the seasonality of Mesolithic activity. Another particularly important outcome of the analysis presented in Chapter 12 is the significant role of children in the activities that took place at Mesolithic Goldcliff. The juxtaposition of settlement and footprint-track evidence also provides the opportunity to compare the faunal composition indicated by footprint-tracks with that suggested by the bone assemblages from excavated sites. The main concentrations of footprint-tracks were associated with a palaeochannel, which has been identified east of the excavated settlements and is associated with the extremely fragmentary remains of wood structures which might have been used in fishing.

5 Island edge occupation: Site A *by Martin Bell*

5.1 Introduction

It was here that in August 2001 the first evidence was found for a Mesolithic site at Goldcliff East. The site lies 120m west of Site B but at a higher OD height on the flanks of the former Goldcliff island. Site A is 120m east of the present promontory of Goldcliff but only *c* 80m north of the former extent of the island as marked by the cemented remains of its Ipswichian beach (Fig 2.3). The topographic context of the site today is on the north side of an east–west linear depression, which lies between the raised outcrop of Ipswichian beach and the stepped sequence of Holocene sediments to its north (CD 5.1). Site A lies below a linear arrangement of rocks and posts, some 20m seaward of the edge of the Upper Peat shelf on which stands the more prominent line of posts marking the salmon trap last used in 1991 (Green 1992). Site A itself today exhibits a regular planar surface sloping at 5° to the south. Rough seas periodically remove the mud cover from parts of this surface revealing the stratigraphic sequence. This happened in August 2001 when the outcrop of a charcoal-rich band was observed containing artefacts (CD 5.2). A slurry scraper was used to remove the mud from a 10m exposure of this band leading to the discovery of worked lithics, bones, and charcoal. To investigate the stratigraphic context a 1m^2 pit was excavated and a monolith (209) taken for palaeoenvironmental analysis. Later on 28 March 2002 there was a more extensive exposure of the occupation horizon which showed that the most marked concentration of artefacts was where the 2001 pit had been located, in the centre of a concentration about 20m in diameter overall. The charcoal-rich occupation surface is periodically exposed in places up to *c* 150m west of Site A. It is also exposed about 80m east where a shallow linear depression carries a continuous flow from an intertidal waterfall draining from the Upper Peat shelf. This flow of water means that parts of this area are normally free of mud – allowing visibility of charcoals, worked lithics, and bones (although no excavation has taken place here). Charcoal and artefacts are found wherever this horizon is exposed but not in the same density as on Site A.

A more detailed investigation was carried out in 2001 when an area 15m by 6m around the exposure was, as far as possible, cleaned of mud with slurry scrapers. This was generally done on a retreating tide so that the sea could be used to wash away as much as possible of the mud (CD 5.3). This operation was repeated on a smaller scale on most days when excavation took place here. The northern 40% of the rectangle had deeper mud and could not be cleaned, although that area covers sediments post-dating the known occupation. Once as much mud as possible had been removed a plan showing the outcrops of the main stratigraphic units was made (CD 5.4). A contour survey of the area was also prepared at 0.5m intervals (CD 5.5). This shows that the occupation surface outcrops at between –2.4 and –2.5m OD. This site is exposed for about three hours at the best spring tides. However, at neap tides it is at the bottom of the tidal range, is not fully exposed, and is unworkable. Excavation of the occupation surface was done in a 1m square grid along 15m of the exposure (CD 5.6–5.7). In 2002, 23m^2 were excavated using conventional excavation methods, trowels, and plastic spatulae. Conditions were very muddy here at times. All artefacts were plotted using three-dimensional coordinates and all sediment from the occupation horizon was sieved in the sea using a 1cm mesh. One sample was taken from each 1m^2 for water sieving on dryland, in all 26 samples totalling 156 litres of sediment were water-sieved.

In 2003, a different blocklifting excavation method was employed as described in Chapter 2. The area blocklifted was 6.25m^2, which was lifted in 100 tins. A total of 138 samples were sieved and of these 99 were sorted, comprising 594 litres of sediment. The blocklifting strategy, and the four-fold increase in sieving that went with it proved highly productive of lithics, bones, and many other classes of artefact – particularly because the area excavated that season, although small, proved to be one of especially dense activity.

The stratigraphy on Site A is illustrated in Figure 5.1 (also CD 5.4 and 5.8–5.10). A significant point to emphasise about the stratigraphy is that although the present sloping surface on which the layers outcrop dips to the south at *c* 5°, the Old Land Surface itself dips, also at about 5°, but in the opposite direction to the north-east (Fig 5.1). The explanation for this is that it is dipping away from the edge of the former island that originally lay 80m to the south. Near the base of the linear depression on which Site A lies there are exposures of sandrock of the Ipswichian beach. The base of the excavation stratigraphy on Site A is a sandy pebbly sediment which elsewhere on Sites J and B is seen to overly the beach sand. On Site A, the Head (Context 317) was a greenish grey (Gley 1 5/10Y) sandy sediment with small gravel grade pebbles of flint and quartz; no large stones and no artefacts were present. This is interpreted as a Pleistocene Head derived from the Ipswichian beach and island. Above this, Context 316 is a similar sandy sediment 16cm thick

Figure 5.1 Site A, section C–D of the sediment sequence at the east end of the 2003 blocklift excavation site: scale – large divisions 10cm (photo E Sacre)

also with small gravel grade pebbles. This is distinguished from Context 317 by being more humic and containing some charcoal and a few worked flints; it is accordingly interpreted as the Holocene subsoil. The overlying layer Context 315 is a greenish grey (Gley 25/10/G) sandy sediment grading to a dark grey (Gley 14/N) fine sandy silt upwards. It is 7–10cm thick and contains some gravel-grade flint and quartz pebbles. The dark colour of this layer is to a significant extent due to the high proportion of charcoal that it contains, up to 5%. This was the main occupation horizon and both charcoal and artefacts were very much concentrated in the top of this layer. These observations are consistent with the field interpretation that this represents activity on a soil surface. Within this soil there were some silty lenses indicating some estuarine input to the upper part of the soil. That is also indicated by the irregular boundary with the overlying estuarine sediments which is marked by some small pockets of estuarine sediment in Context 316; one factor which contributed to mixing at this boundary was animal footprint-tracks. An ungulate footprint of deer size was recorded on Site A (Fig 12.12). The tracing of this footprint also showed drying cracks, which were observed in places and must also have contributed to the introduction of some silt into Context 315. The overlying sediment was a bluish grey (Gley 2 5/5b) silty clay. This contained some charcoal, mostly in the lowest 2cm, but almost no other artefacts. It is interpreted as estuarine sediment of the lower Wentlooge Formation, the same stratigraphic unit which at a lower level buried the Lower Peat at Sites B and D. These estuarine sediments are in turn sealed, some 40m to the north, by the Upper Peat and Submerged Forest, which we will see is also of later Mesolithic date.

The occupation surface on Site A is therefore on a sloping surface from the island edge which is discontinuously exposed but is considered to be the same basal Holocene soil revealed by excavation at Sites J, A, B, and D in that order of descent in the tidal range (Fig 2.6). The soil and these sites were buried time transgressively as sea-level rise laid down estuarine sediments and peats at progressively higher levels around the former island. Stratigraphically the burial of Site A postdates that of the Lower Peat shelf which we have seen is *c* 5700 cal BC and predates the Upper Peat which Smith and Morgan (1989) dated to 5950±80 BP (Car-659; 5050–4610 cal BC). The only direct dating evidence for Site A is a charred hazelnut from the occupation surface Context 315 dated 6629±38 BP (OxA-13928; 5630–5480 cal BC). This indicates that activity on Site A is one to three centuries later than the latest activity in the Site B and D areas. Since Site A is 1.05m above Site B it is probable that activity on Site A took place decades, maybe longer, before the eventual burial of the site by estuarine sediments. The inference of this is that it is an essentially dryland site buried by later estuarine incursion. This is consistent with the fact that organic artefacts were lacking and pollen was not adequately preserved for analysis. The only

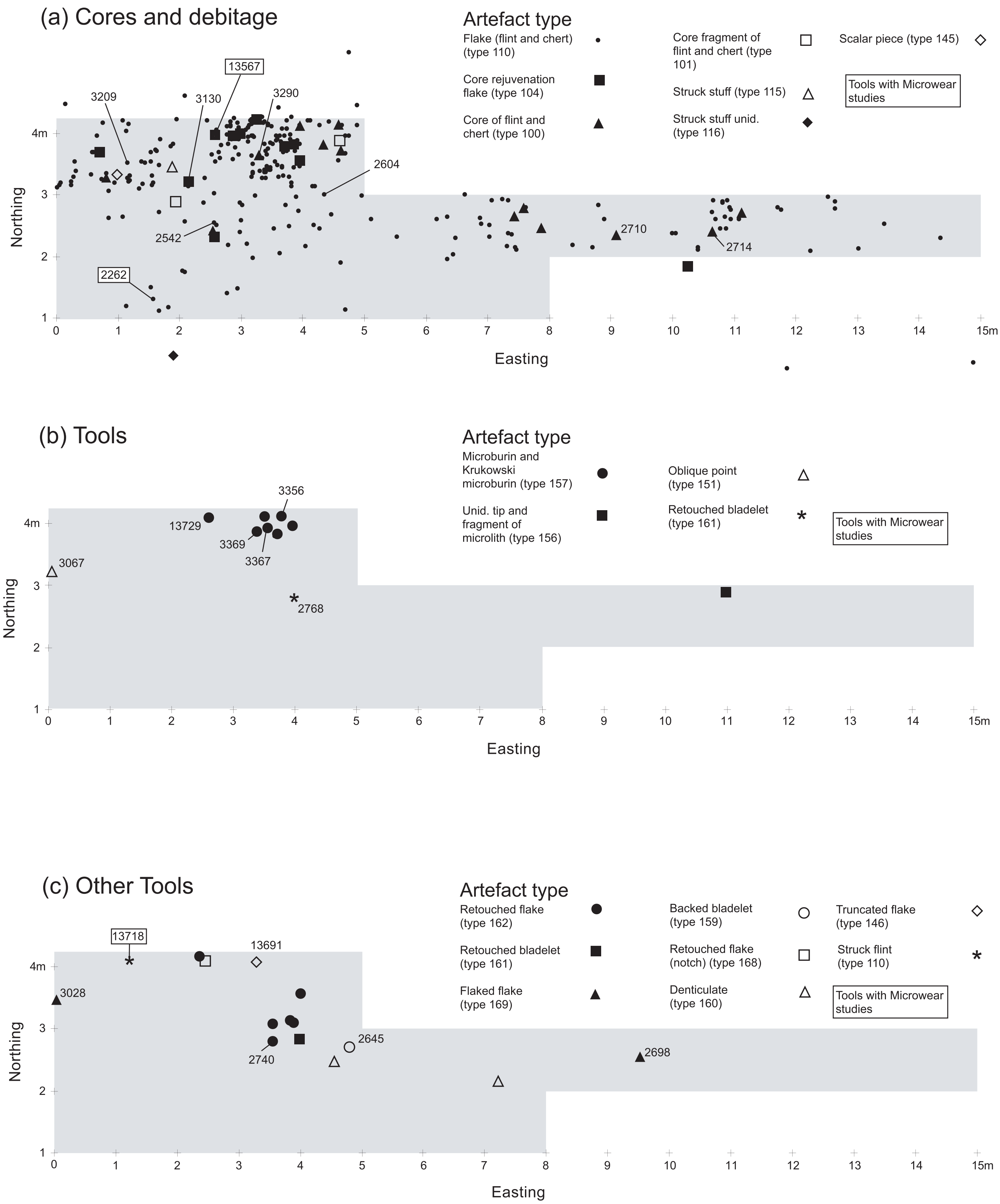


Figure 5.2 Site A, distribution of lithic artefacts (graphic S Buckley)

waterlogged seeds were of elder (*Sambucus nigra*) which are woody and resist decomposition. Preservation conditions on Site A are therefore analogous to Site W, excavated west of Goldcliff island in 1992–94 (Bell *et al* 2000).

5.2 Artefact distributions and activity areas

The distributions of three-dimensionally recorded artefacts from Site A are shown in Figure 5.2 and CD 5.12–5.13 and those from sieving on Figures 5.3–5.4

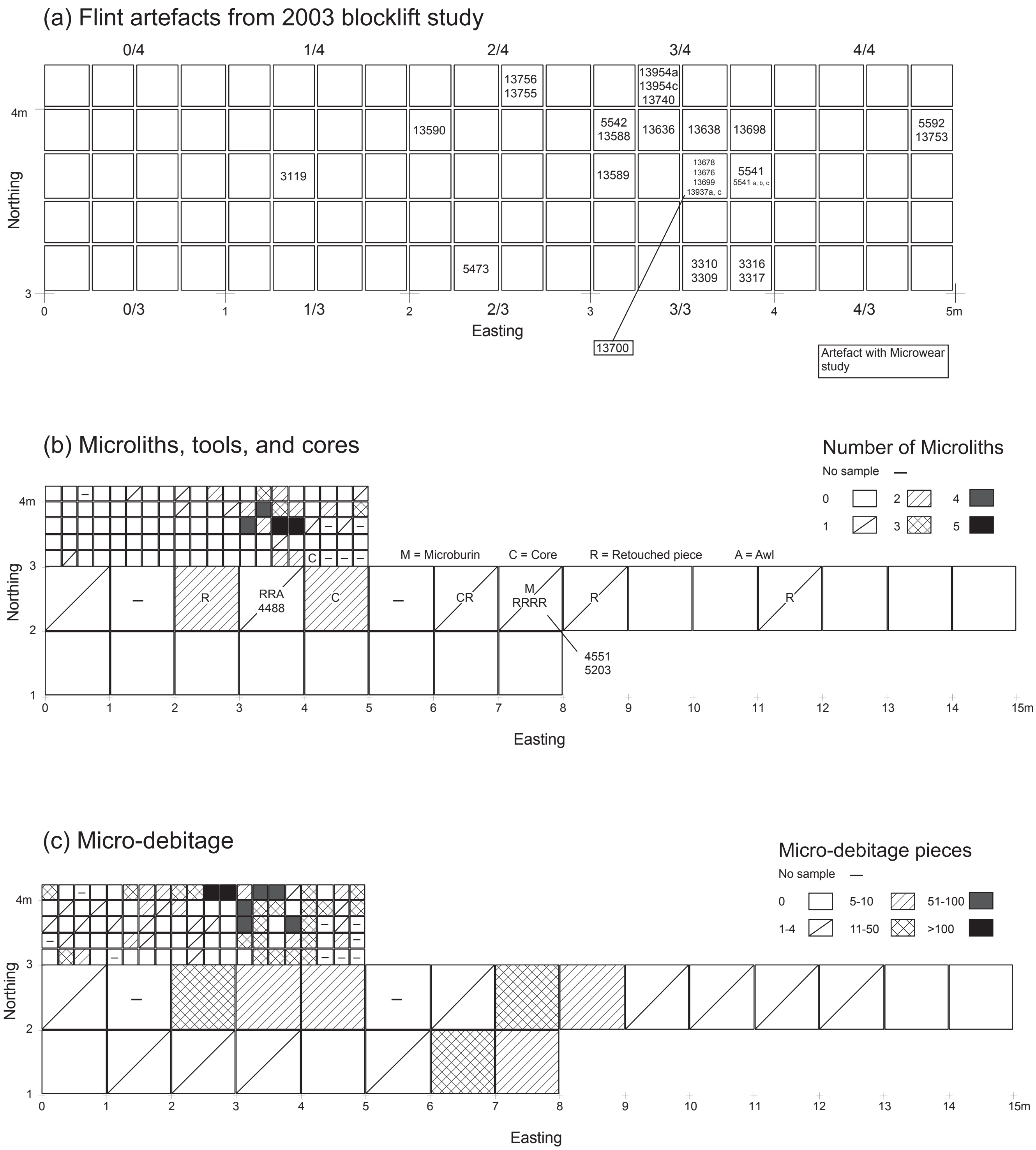


Figure 5.3 Site A, distribution of flint artefacts from sieving (graphic S Buckley)

and CD 5.11. Lithic artefacts occur throughout the excavated area although there are fewer in the south where parts of the surface of the occupation horizon had been eroded before the excavation. The distribution also shows that recovery was better under the blocklifting regime of 2003. There is a marked concentration of lithics in Squares 2/3 and 3/3 of the 2003 area which cannot be explained by better recovery in that year since the limits of the densest concentration are not entirely within the 2003 area. The main concentration comprises mainly struck flints, several cores and a number of retouched pieces. Two much lower concentrations of lithics occur in the 2002 area: Square 7/2 comprising flint/chert flakes, two tuff flakes, and three scrapers; and Square 10/2 made up of a cluster of flakes, two microliths, and one scraper with another nearby. All the scrapers are from these two areas. The pattern produced by three-dimension-

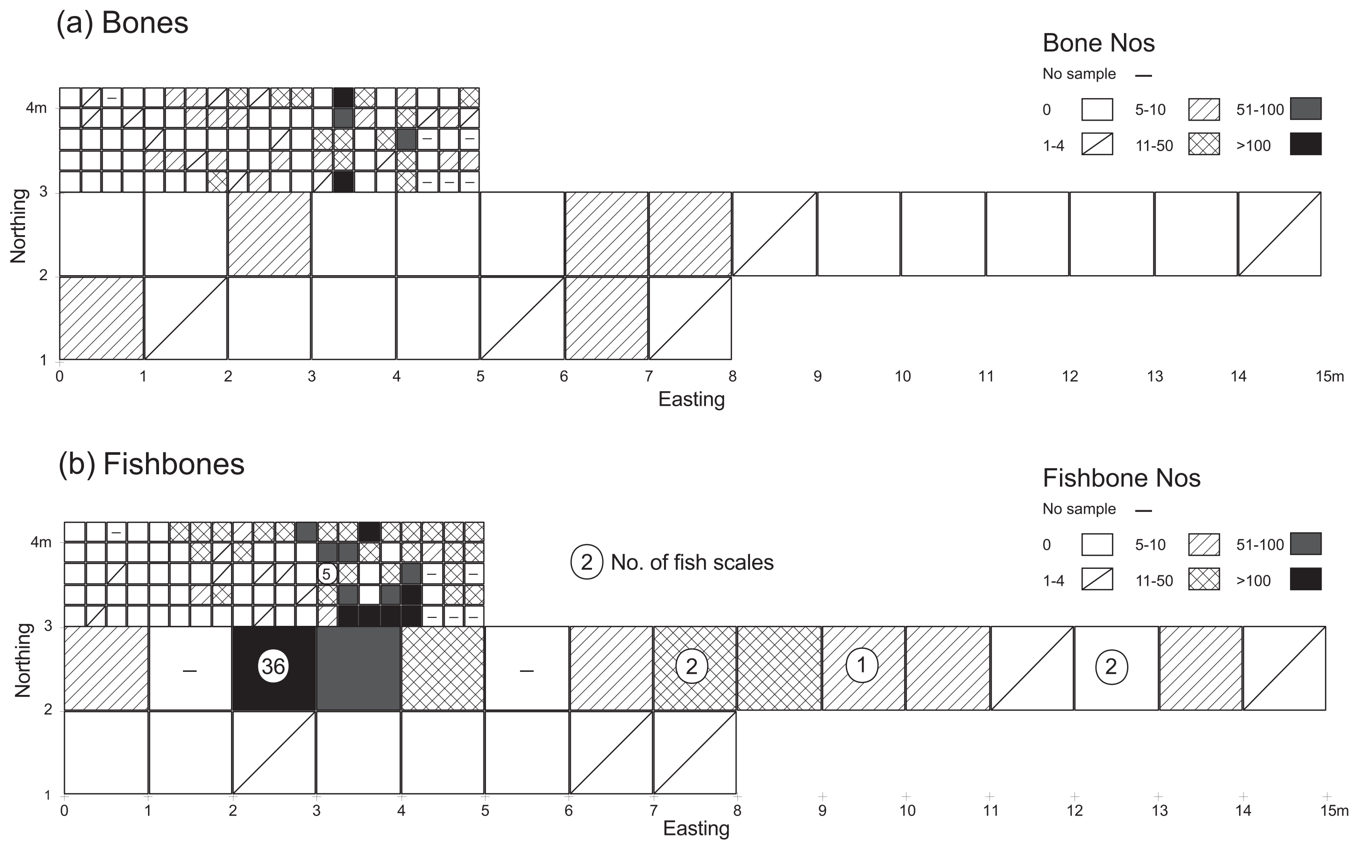


Figure 5.4 Site A, distribution of bone artefacts from sieving (graphic S Buckley)

ally recorded artefacts is significantly strengthened if complemented by distributions from sieving. Figures 5.3a and b show tools from sieving; the densest concentration of microliths corresponds to the main lithic scatter with some blocks producing four or five microliths. Significantly, the concentration of microliths here is not apparent from the results of hand excavation. In all, 70 microliths were found on Site A; only six of these were from hand excavation, the remainder from sieving. More than half of the microliths were broken, possibly the result of knapping accidents or discarded from tool repairs (Chapter 9). The occurrence of four other retouched pieces from sieving reinforces the minor cluster of artefacts already identified in Square 7/2. The distribution of micro-debitage from sieving (Figure 5.3c) demonstrates very clearly that the main concentration of artefacts in Squares 2/3 and 3/3 was associated with flint knapping, over 100 pieces of micro-debitage being found in some blocks. The micro-debitage distribution also emphasises the previously identified subsidiary cluster in Square 7/2, confirming that knapping as well as tool use took place here. Interestingly the other subsidiary cluster in Square 10/2 contains only tiny amounts of micro-debitage suggesting that this area had more to do with tool use than knapping.

The distribution of three-dimensionally recorded (ie larger) bones (CD 5.12) shows a complementary pattern to that described for lithics. The densest area of lithic scatter contained very few bones but the main concentration of larger calcined bones, together with the heat-fractured microliths, could point to a hearth in this area. Many of the bones (mostly deer) are just west of the main lithic concentration. Five pieces of cut-marked bone were found and of these, two lie close to the area of lithic concentration. The distribution of bone fragments from sieving (Fig 5.4) shows the highest concentration in the main area of lithic and calcined bones but there is also a wider concentration over an area about 4m in diameter extending to the west where the larger bones were also found. Once again, the subsidiary concentration of activity around Square 7/2 is apparent.

The distribution of fish bone (Fig 5.4) is particularly striking by comparison with those previously described. It should be noted that this includes small unidentifiable fragments, so the number plotted is significantly greater than the total of identified fish bones from this site. The most marked concentration is in Square 3/3 corresponding to the main concentration of calcined bone and lithics but extending to the south to Squares 2/2 and 3/2. The fish bones are concentrated in an area about 3m in diameter with a striking absence in Square 2/3. The minor concentration seen in other artefact types in Square 7/2 is likewise here apparent. Some fish scales were found in sieving particularly in Square 2/2 and a lesser concentration in Square 3/2.

Two key points emerge from the distribution of charcoal from hand excavation (CD 5.13). The first concerns excavation technique: charcoal was clearly more frequently recorded in the 2003 blocklift excavation than the 2002 field excavation. The second point is that the main concentration of charcoal is not in the main area of calcined bone, fish bone and lithics, but to its west in Squares 0/3 and 1/3. Charred hazelnuts from hand excavation are conversely seen to be more concentrated in the area of fish bone, calcined bone, and lithics. That hint of a pattern was reinforced by the far larger number of charred hazelnut fragments from sieving which were concentrated in Squares 3/3 and 4/3.

The difficulties of intertidal excavation mean that the area excavated at Site A is not large, a total of 29.25m^2. Difficulties of comparison are also created by the employment of contrasting methods in 2002 and 2003. The blocklifting strategy in 2003 provided a much greater 25cm^2 level of spatial resolution for the sieving data than the 1m^2 of 2002 and it is clear that, because there was more sieving, the recovery of microliths in 2003 was much better than 2002. Notwithstanding these problems, some very clear and mutually complementary patterns have emerged. The activities represented in the main concentration included: knapping; cooking; fish processing and drying indicated by the calcined fish bones; and food consumption indicated by the charred hazelnuts. It is possible that these activities were centred on a hearth in Square 3/3. That would be consistent with the distribution of calcined bones and the charcoal from sieving. Given the numbers of heat-fractured stones from Site J (Chapter 6), it is striking there were only eight pieces from Site A, just two were from the main artefact concentrations and four to the east. There was no cut feature or stone boundary defining a hearth and if one existed it must have been superficial. The density of artefacts may be thought to indicate a more significant focus of activity. It is also notable that the dense areas of some distributions such as fish bones, hazel nuts, and micro-debitage have quite sharp edges, that is to say the density falls off abruptly. This hints at some physical barrier to artefact dispersal, perhaps a screen or the walls of a shelter.

One question is whether the areas of greatest artefact density, with their sharp edges, represent the area inside a structure or activities outside. Many living areas found in the archaeological record were kept very clean of artefacts (Schiffer 1987, 60). However, what needs to be appreciated here is that many of the artefacts plotted on these distributions were extremely small – many of the fish bones, hazelnuts fragments, and the micro-debitage would have been invisible to those occupying the surface and easily trodden into the sandy silt of Context 315. Given evidence for cleanliness elsewhere it is notable that some of the largest and most visible artefacts, the larger bones and charcoals, and some retouched tools, were concentrated outside the densest areas of small (ie sieved) artefacts. At Mount Sandel, retouched artefacts, particularly microliths, were concentrated in hut areas (Woodman 1985). It might also be argued that that these concentrations of artefacts do not necessarily represent a domestic focus: might they not be material dumped from the cleaning of a domestic area elsewhere? That explanation is rejected because of the clear complementary patterns that have been identified and are considered mutually consistent with the favoured hypothesis of *in situ* domestic activity represented by the area of dense artefact concentrations.

No physical traces of postholes or stakeholes were found and although blocklifting would have made recognition of structural traces more difficult, the careful excavation methods employed meant that some evidence would have been observed. If a structure existed, it was most likely a tent. The size and exact position is more difficult to determine. The main concentration of several types of artefacts was on the north edge of the excavation, we do not know what lies beyond, so it is probable that the concentrations were larger than the excavated area suggests. Most of the distributions are consistent with a circular wigwam type structure perhaps 2–3m in diameter, maybe larger, centred on Square 3/3, probably with a small hearth feature used for cooking and smoking fish and eels at its centre. Particularly intriguing is the absence of several classes of finds from Square 2/3, eg fish bones, charcoal from sieving, and bone fragments from sieving. Perhaps that area was covered in something that prevented artefacts being incorporated in the soil, an animal skin perhaps providing a dry place to sit, or sleep, near the hearth. Given the prevailing winds from the south-west, the entrance is likely to have been opposite this, to the north-east or east.

A secondary concentration of artefacts has been identified centred on Squares 7/2 and 10/2. These are very slight compared to the concentration previously discussed and may represent specific activity areas, perhaps outside the previously hypothesised structure. That in 7/2 included knapping and tool use, that in 10/2 just tool use. All the scrapers are from these two secondary concentrations.

6 Island edge occupation: Site J *by Martin Bell*

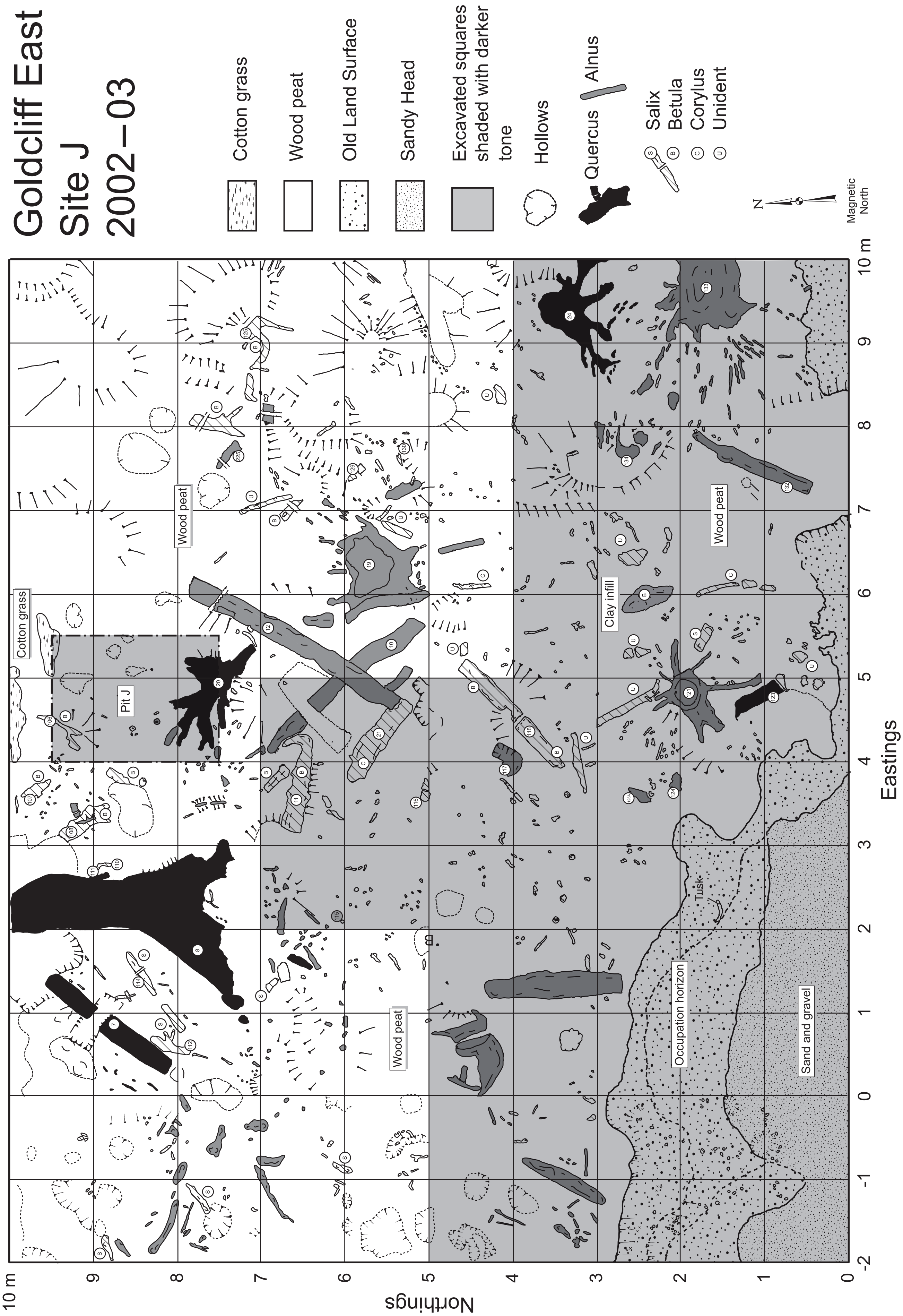
6.1 Introduction

The original investigation of this site took place with palaeoenvironmental objectives. It was selected as an area of the Upper Peat with good exposures of the Upper Submerged Forest. The objective was to make a plan of the forest, take samples to establish the tree types present and pollen samples to establish the vegetation sequence close to the edge of Goldcliff island. When the site was cleaned for planning it was found that the peat overlaid a sandy soil containing charcoal, bones and worked flints (Figs 6.1–6.2; CD 6.1–6.4). This was a most fortunate discovery in terms of the development of the project because, at *c* 1.5m OD, Site J was much higher in the tidal frame than the other excavation sites; this meant that it could be worked on at every low tide, neaps as well as springs, for at least six hours, sometimes longer (Fig 2.7). As the excavation proceeded, it became clear that, during at least the latter part of its occupation, the site lay at the interface between the island edge and the surrounding wetland. The wetland edge topographic situation adds to its archaeological and palaeoenvironmental significance because organic artefacts and environmental evidence are preserved immediately adjacent to dryland occupation sites. Contrary to expectations, organic preservation was better here than at the sites lower in the tidal range. For these reasons, this was the site investigated in greatest detail.

Its intertidal location is 70m east of the Goldcliff headland and 120m west of Site A (Fig 2.3). It is at the western limit of the Upper Peat and Submerged Forest, which stretches east of this point as a pronounced shelf across the embayment of Goldcliff East (Chapter 7). Immediately to its north, Site J is dominated by rows of posts representing the remains of three successive salmon putcher traps (Green 1992). Eight metres north is the earliest, a double line of posts, 3m beyond this a more substantial line, and 10m further a 180m-long double line of tall posts which marked the last traps in use up to 1991. The peat shelf at Site J is overlain by a rocky and sandy beach, which to the south also overlies parts of the Ipswichian interglacial beach. To the north-west this beach runs to a slipway at Goldcliff Fishery.

Initial work on this site in 2001 involved recording a group of trees in the Upper Submerged Forest followed by the excavation of small trenches to establish their stratigraphic relationships and to take samples for dendrochronology. Here there was evidence for successive tree layers, for instance alder overlain by oak. Such relationships were of interest in terms of vegetation history and the area was also of particular interest because it could provide palaeoenvironmental evidence immediately adjacent to the former island. Thus, the decision was made to carry out more detailed survey of the area in 2002 and a 10m by 10m square was laid out with the eroding

Figure 6.1 Site J, cleaning and planning the surface of the submerged forest. Tree 8 is the large buttressed trunk being drawn (photo E Sacre)


Goldcliff East
Site J
2002–03
Cotton grass
Wood peat
Old Land Surface
Sandy Head
Excavated squares shaded with darker tone
Hollows
Quercus
Alnus
S Salix
B Betula
C Corylus
U Unident
N
Magnetic North
Cotton grass
Pit J
Wood peat
Wood peat
Clay infill
Wood peat
Tusk
Occupation horizon
Sand and gravel
Eastings
Northings
10 m

edge of the peat shelf at its south side. The modern cobble and sandy beach was removed from its west side and elsewhere mud and seaweed were removed to expose the peat surface, trees, and wood (Fig 6.1). The surface was then planned (Fig 6.2) and each piece of wood was sampled by Scott Timpany and identified to establish the composition of the former woodland as discussed in Chapter 15.3.1. During the cleaning of this area it was found that in the south-west corner the peat overlay a sandy soil over sandy Head (CD 6.4). The soil contained much charcoal and as cleaning proceeded, worked flints and bones began to appear.

At this stage a contour survey was carried out at 0.5m intervals (Fig 6.3a). This shows that the site lies between 1.2 and 2m OD. The lower area to the south is where the Old Land Surface and underlying Head are exposed. The area between 1.3m and 1.8m OD represents a sloping exposure across successive levels of the Upper Submerged Forest and the higher areas above 1.9m OD are the trunks and stumps of trees on the exposed surface. Figure 6.3 provides comparison between the pre-excavation surface and two of the key stratigraphic horizons subsequently revealed by excavation: the base of the peat and the top of the Old Land Surface.

As part of the original palaeoenvironmental strategy Pit J was opened up centred on Square 4/8, for the purpose of taking samples (Fig 6.2). Once artefacts had been found on the southern side of Site A the original strategy for this site was developed to include a conventional excavation. To start with, a 1m wide by 5m long trench was dug from the peat edge at easting 2m in order to establish the stratigraphic sequence. That done, further $1m^2$ squares on either side were progressively excavated (CD 6.6). During 2002, the total area excavated was $29m^2$. Artefact plotting during the 2002 season indicated that the numbers of artefacts decreased to the east. Accordingly, in 2003, the original 10m by 10m area was extended by 2m to the west, to make an area of $120m^2$. This extension proved a fortunate decision because the densest concentration of some types of artefact occurred in the extended area. In 2003 a further $35m^2$ area was excavated thus making a total excavation area of $64m^2$.

The methods employed in both seasons were the same (Fig 6.4; CD 6.7–6.13): work proceeded stratigraphically in $1m^2$, so far as possible keeping adjacent squares at a similar level. Excavation of occupation horizons was by hand, using trowels, plastic, and wooden spatulas and sponges. Each artefact was individually numbered and three-dimensionally recorded. All the sediment from occupation horizons was sieved by washing in the sea on a 1cm mesh. One

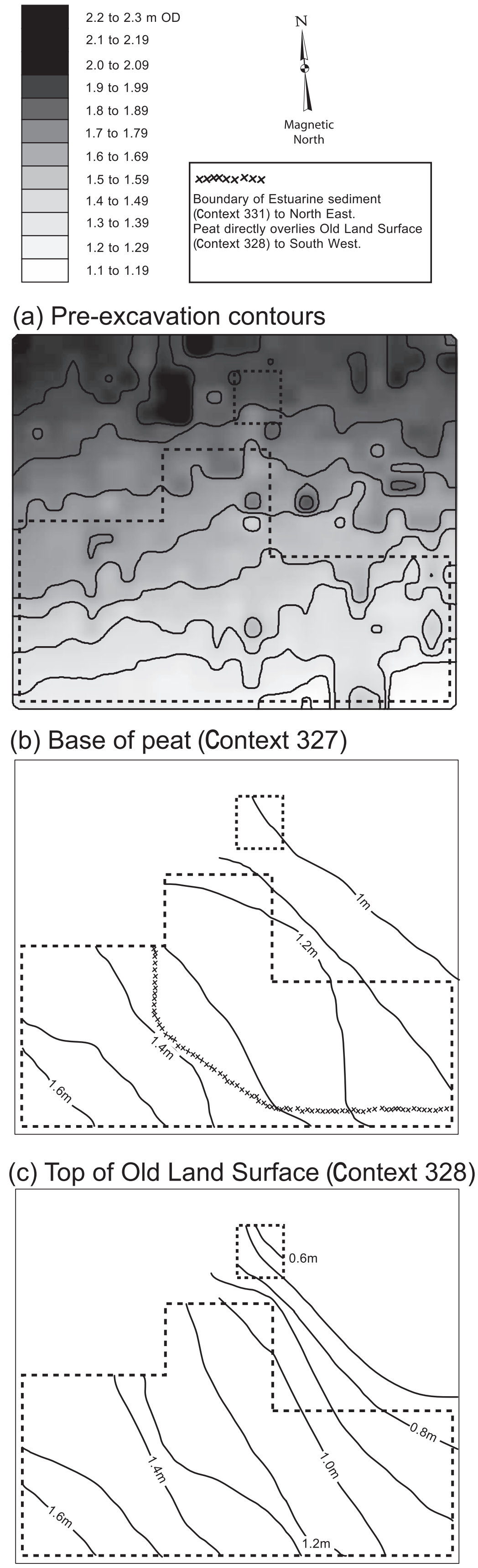


Figure 6.2 (opposite) Site J, plan of the site before excavation showing the identified trees of the submerged forest and the underlying occupation surface (for a colour version see CD 6.5) (graphic J Bezant, S Buckley, and S Timpany)

Figure 6.3 Site J, contour surveys (a) of the site surface before excavation (b) the base of the peat and the limits of estuarine incursion (see key above) (c) the surface of the Mesolithic Old Land Surface, Context 328 (graphic S Buckley)

Figure 6.4 Site J, with excavation in 1m² squares in progress (photo E Sacre)

sample was taken from each 1m² for water-sieving using finer mesh on dryland. In the case of Pit J, all the sediment from occupation horizons was water-sieved. In all 101 samples from Site J were water sieved and sorted, this totalled 431 litres of sediment.

6.2 Stratigraphic sequence

The stratigraphic sequence is illustrated by a number of sections, the locations of which are shown in Figure 6.5; the sections themselves are shown in Figures 6.6–6.11 and CD 6.14–6.19.

6.2.1 Pleistocene sediments

The earliest sediments exposed were in a deep sounding (Fig 6.6; CD 6.14) where excavation went down 0.9m and then a gouge auger was used for a further 2m below this where the underlying Triassic Marl was reached at –1.3m OD. This was overlain by 2.32m of sand (Context 333), at the base dark greyish brown (2.5Y4/2), near the top strong brown (7.5YR5/6). In this sounding, the sand surface was at 1.1m OD. The sand contained small comminuted pieces of shell. The sand was also exposed in the base of the other deep sounding at the base of Pit J (Fig 6.8, C–D) where the sand surface was at 0.3m OD. Its surface therefore dips to the north at about 6°. Examination of forams in this sediment by Dr S Haslett (2002) confirmed that the species present were those found in the Ipswichian beach. In section E–F of Figure 6.6 the sand was overlain by lenses 5–10cm thick of sandy clay containing abundant clasts (Context 360), some lenses were of grey clay with abundant rounded and rotted Lias Limestone clasts, others brown clay with less, or in places no, Lias (Context 361). In total this deposit was 25cm thick. This stony deposit is interpreted as Head derived by solifluction from the former island. This was not present in the Pit J sequence. Similar Head deposits are, however, exposed west of the island where some layers contain Lias and brown sandy clays contain Pleistocene bovid bones (Bell *et al* 2000, 23). Overlying

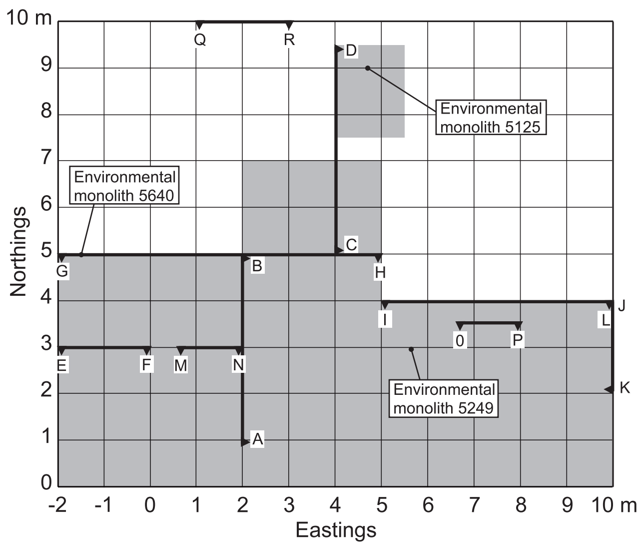


Figure 6.5 Site J, showing the positions of the key stratigraphic sections shown in section drawings and photos and also the position of environmental monoliths (graphic S Buckley)

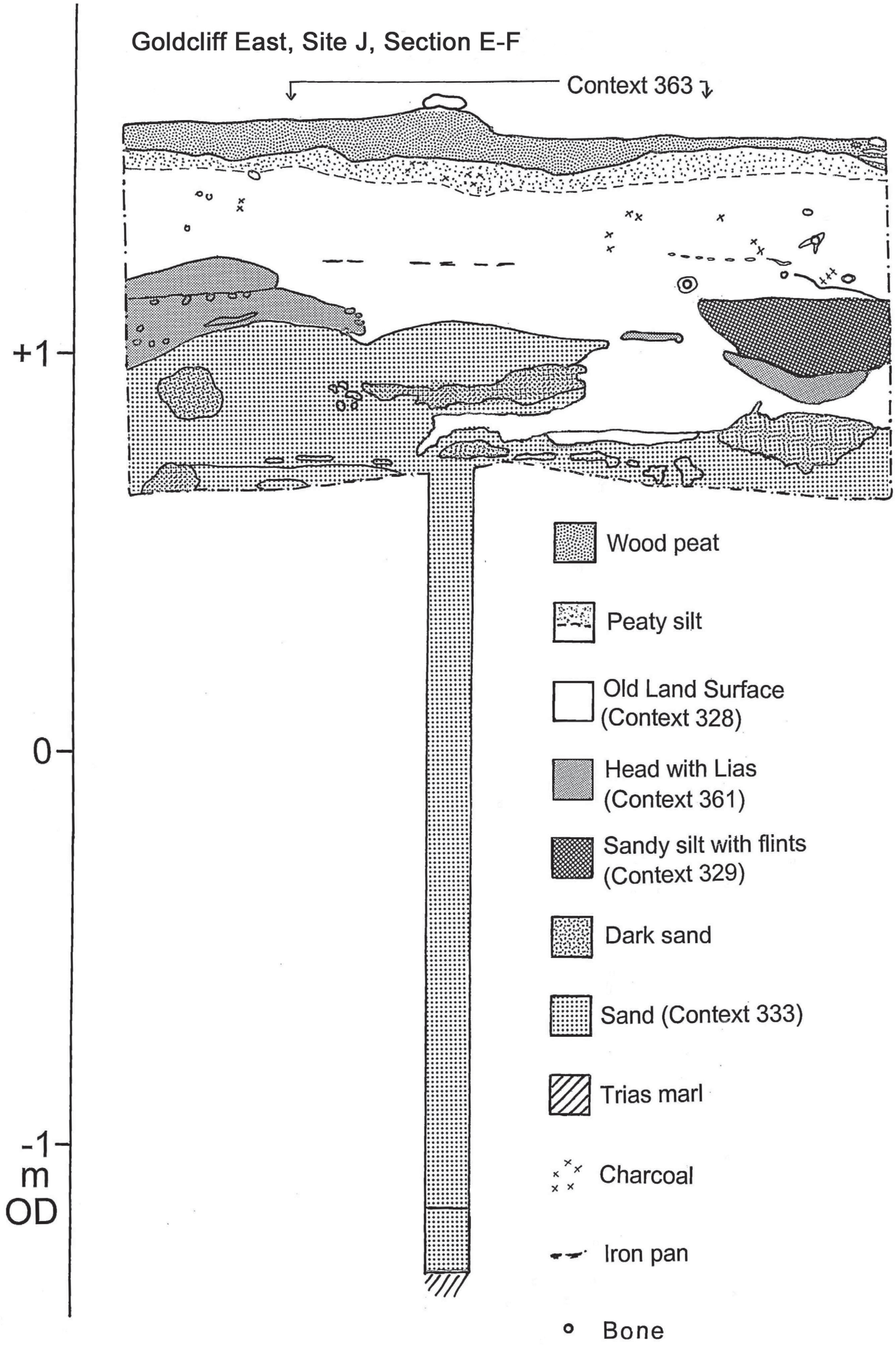


Figure 6.6 Site J, section E–F with auger hole at the base in which Triassic marl is overlain by sands of the Ipswichian beach, then Head with sand, clay, and Lias limestone. A subsoil feature (Context 363) is at the base of the Holocene soil (Context 328) and is overlain by the Upper Peat and Submerged Forest (Context 327) (for a colour photograph of this section see CD 6.14) (drawing J Bezant/M Bell)

Contexts 360/361 was a greenish grey (Gley 1 5/5 GY) sandy clay which contained small gravel-grade rounded flints (Context 329). This was thin and discontinuous in section E–F but up to 0.25m in Pit J. This layer was present at each of the excavated sites and it is thought to be a Head derived mainly from solifluction of the Ipswichian beach.

6.2.2 Holocene Old Land Surface

Throughout the trench the Head was overlain by a dark grey (10YR4/2) sandy silt with gravel-grade pebbles, charcoal and many lithic artefacts, heat-fractured stones and bones (Context 328). Roots, preserved by waterlogging, were abundant in this context, 5–10% in some places, most were 1cm or less in diameter and represent trees growing from the overlying peat. To complicate matters, however, this layer was also found to contain some wood artefacts. In excavating special care was required to distinguish the abundant natural wood and roots from the small number of worked wood artefacts. This was the main occupation surface during the Mesolithic. It is interpreted as the Holocene soil developed on underlying sandy Pleistocene Head. When the site was originally discovered this surface was exposed over about 8m^2 in the south-west corner of the trench, where it outcrops at about 1.6m OD (CD 6.4). The surface of this layer occurred at 0.6m OD in Pit J and this had a dip, inherited from the underlying Pleistocene sediments, of 6° to the north-east.

At the base of this soil in section E–F there was a bowl-shaped feature (Fig 6.6, Context 363) *c* 1–1.5m wide and 0.2–0.3m deep where the underlying Lias Head was absent and it was filled with grey sandy silt. The fill contained worked flints and a concentration of bones of aurochs and deer (Fig 6.13). It might have been a shallow cut feature but its edges showed evidence of undercutting on both sides and its profile is more consistent with the bowl-shaped depression left by the root plate of a tree throw. No trace remained of any wood and it is likely to relate to a period well before a transgression led to the waterlogging of this soil. In the area of this feature artefacts occurred down to *c* 0.4m in the buried soil but generally the artefact rich soil was *c* 0.25cm thick.

Section E–F showed distinct thin (1–2cm) subsoil lenses separated by thin reddish brown (2.5YR4/4) iron pans, sometimes two or three pans occurred. In places the impression was that artefacts occurred on the surface of these pans and it is possible that iron deposition has picked out former land surfaces which were subsequently buried by thin sandy colluvial increments from upslope. In two cases iron pan came away from the soil to reveal casts of marine shells, one a cockle, the other a whelk (Chapter 13.3). This suggests that the occupation horizon originally contained marine molluscs, which have been decalcified and almost disappeared as a result of the acidic conditions on these sandy soils indicated by the evidence for iron movement (Chapter 17.3.5). There were also a few preserved *Littorina* shells in the soil and some of these had iron staining.

6.2.3 Estuarine sediments

In the south-west third of the site where the surface of this soil was above *c* 1.3m OD this soil was sealed directly by the Upper Peat and Submerged Forest (Fig 6.3). On the north-easterly 2/3 of the site, the soil was overlain by greenish grey (Gley 1 5/10Y) silty clay (Context 331; Figs 6.7–6.11; CD 6.15–6.17). This contained some roots from trees growing in the overlying peat below about 1.3m OD. Reed stems were preserved in places. The only clasts present were artefacts of flint, bone and heat-fractured stone. There was also charcoal and some worked wood. Artefacts occurred throughout the layer but increased in its lower part, where it overlay the soil. In places there was evidence of laminations of thickness 1–2cm with partings of fine sand, the surface of these was ripple-marked in places. Sometimes the boundaries were marked by thin, more organic horizons (as shown on CD 6.17), presumably where a surface had become vegetated between depositional increments. This layer thins to nothing along the 1.35m OD line. It thickens to the north-east and its maximum thickness in Pit J is 0.4m. This layer represents the maximum transgression of the lower Wentlooge estuarine silt, which covered two-thirds of the excavated area. Thus the precise limit of the late Mesolithic estuary lay within the excavated trench and what is, in this trench, a relatively thin layer, thickens to the east and north into a silt unit of thickness about 4m (Chapter 4).

Where the Old Land Surface (Context 328) was buried by the estuarine sediments, its surface was increasingly silty upwards. It seems that the soil received silt increments from occasional transgressions during the final stages of pedogenesis. Thus, the boundary between the buried soil and the estuarine sediments was in places not sharply defined during excavation and had a tendency to be gradual and merging. In some sections, however, the surface was clear, particularly because of the darker colour imparted by the inclusion of charcoal (Figs 6.10–6.11). The exposure of surfaces within Context 331 occasionally revealed polygonal patterns of cracks, which at the very edge of the estuary in Square 7/1 were *c* 10cm in diameter. This must have been where the newly deposited mud had dried.

At 10cm below the top of this layer in Pit J there was a thin layer of silty reed peat *c* 2cm thick (Context 262). This represents a short-lived regression followed by a resumption of estuarine sedimentation. Evidence of a similar regression below the main peat is found elsewhere in the Goldcliff East embayment (Chapter 7.2).

6.2.4 Upper Peat and Submerged Forest

In the north-west two thirds of the site the Upper

Figure 6.7 Pit J, the stratigraphic sequence, showing from the base, the Old Land Surface (Context 328), estuarine silts (Context 331), peat containing the Upper Submerged Forest (Context 327): scale – divisions 20cm (photo E Sacre)

Peat and Submerged Forest (Context 327) overlay estuarine sediment (Context 331). In the south-west third of the site, beyond the limits of estuarine sedimentation, the peat directly overlaid the Old Land Surface (Context 328). In places there was a transitional layer between the underlying sediment (Context 334) and the base of the peat. This transitional layer turned out to be something of a geoarchaeological object lesson in the value of detailed consideration of boundaries between stratigraphic units. Here, that evidence contributes to a detailed picture of the environment during the final stage of Mesolithic activity. The transition was about 10cm thick and was a brown (10YR4/3) peaty silt. In places this transitional stage took the form of a reed peat representing a distinct successional stage. Elsewhere, the transition showed evidence of mixing and the intrusion of sediment producing a complex involuted boundary to which a number of different factors can be shown to have contributed (Figs 6.7–6.12; CD 6.15–6.21). The first and most obvious is tree rooting from the overlying peat which has produced vertical, bifurcating, and narrowing humus-filled channels, many containing roots. In Figure 6.10, these demonstrably relate to a single stump in the overlying peat. A second factor is revealed by the presence in places of small (1–2cm) oval pebbles of silt within the transitional zone. That points to some erosion of silt in the transitional phase to peat formation, this appears, however, to have been very localised.

A third, more surprising factor was extensive activity by small mammals. This was demonstrated by pockets in the underlying sediment which were *c* 5cm wide and 5cm deep and contained hazelnuts buried in clusters of one to ten, but mostly between one and three. Figure 6.12 is prepared from actual size tracings of these features made during excavation. Most of the nuts were intact and the hoarder had clearly not returned to collect them. The hollows had been dug in the very early stages of peat formation: they were dug in the estuarine clay (331) or buried soil (328) but were filled with peaty silt. Most of the features were of very uniform shape and size, suggesting that they were mostly the product of hoarding by one species – the size and characteristics being consistent with squirrel (Bang and Dahlstrøm 2001, 138–9). From the stratigraphic evidence these seem to have been burying nuts within the early stages of woodland succession, very close to the woodland/saltmarsh edge. In places, these features were clustered round the root systems of trees, particularly three alder trees on the south side of the trench (Fig 6.2). Significantly there is only one example of a hazel trunk in Site J and that is at a later level: the nuts must have been brought from hazel woodland which existed on dryland at this time

(Chapter 14). However, at least one hoard of three nuts was recorded at the end of a tunnel suggesting that a burrowing small mammal also contributed. Scott Timpany's examination of the traces of animal activity on a sample of hazelnuts from the site as a whole, including those in the overlying peat (not just those in clusters), show that a wide range of animals and birds were exploiting the hazelnut bonanza at the coastal woodland edge.

A fifth factor contributing to the involuted nature of the boundary at the base of the peat was the activities of larger animals, as represented by their footprint-tracks. These were generally recognisable because the animal had trodden peat into the underlying sediment, generally the estuarine silt, sometimes the Old Land Surface, at the very edge of the saltmarsh. All of those sufficiently well-preserved to be identifiable were red deer (CD 12.53). The activities of these deer relates therefore to the period when reeds and woodland were colonising the former saltmarsh.

The transitional zone is also notable as the find spot of two most interesting wooden objects. Object 9199 was a small Y-shaped object found in Square 1/3 about 0.5m horizontally beyond the limits of the estuarine silt transgression. It was below the peat in dark peaty clay resting on the Old Land Surface in the stratigraphic position indicated in CD 6.19. Object 9224 was a 1.14m long pointed, curved, and carefully worked tool – possibly a digging stick or spear. This lay flat in the transitional zone below estuarine sediment and overlying peat (CD 6.22–6.23). The surface on which it lay had a mottled appearance created by deer footprint-tracks. The effect of this trampling, together with subsequent compaction, may account for the fact that this object had eight old breaks. The object lay below and predated an oak, Tree 24 (CD 6.23). Worked flints and other artefacts occurred in direct association with both of these pieces of wood, showing that activity continued until the very point when peat started to form. In fact, it is at this particular stage that we get the best preservation of wooden artefacts.

The peat which overlaid these sediments formed on a surface sloping to the north-east. In the south-west corner of Site J the base of the peat was at 1.5m OD, dropping to 0.97m OD in Pit J and 0.8m OD in a borehole in the north-east corner (Fig 6.3b). Thus the peat base follows the direction of dip of the underlying sediments but the angle of dip has now been reduced to 4° by the deposition of the estuarine sediments of Context 331. As already noted Figure 6.3a shows that the pre-excavation surface of the peat dipped in the opposite direction to the south. This is because the peat to seaward is more eroded, thus on the southern edge of the excavation it was as little as 0.1m thick, whereas in Pit J it was 0.8m thick. This tendency for intertidal peats to be eroded, almost planed off, to seaward is clearly illustrated in Figure 6.8 and seems to be a general feature of intertidal peat exposures. This is an important point to appreciate in palaeoecological and archaeological research because it means that the peat surface exposed is often not of one period but becomes successively younger away from the edge of the peat shelf.

The Upper Peat was woody and forms part of the Upper Submerged Forest, which is considered more broadly in Chapter 7. Observations here are restricted to its exposure within Site J. When freshly exposed the wood peat was a yellowish red (5YR5/6) but it oxidised to a very dark grey (5YR3/1). The peat represents, not so much a single submerged forest, as a sequence of wood layers as the Pit J section shows (Figs 6.7–6.8). At the base there was a band 7cm thick, with small amounts of wood, which in places was a distinct reed peat. Then there was a layer *c* 25cm thick, which was very woody. This was followed by a band about 20cm thick with very little wood; topped by a band 20–30cm thick with small roots in the base and larger pieces of wood above. The final 10–15cm contained little wood. The plan of the wood peat surface (Fig 6.2) represents a diagonal slice across the stratigraphy in which the sequence of layers outcrops as successive bands. In the southern part of the site below about 5m northing is the exposure of the lower wood layer, which is mostly alder, with some oak, birch, and willow. North of this is a band, 2m wide in places, with little wood. North of that the upper wood layer with hazel and alder at the base followed by birch, willow, and oak. As we shall see, the peat contained very little evidence of artefacts above the transitional layer at its base. Excavation produced 1 core, 12 flint flakes, 1 bone, 1 piece of heat-fractured quartzite, 4 heat-fractured flints, 1 wood chip and 2 pieces of worked wood, and 9 pieces of charcoal. The charcoal was sparsely scattered through the peat. An alder trunk 12cm above the base of the peat in Square 1/3 was charred on its surface (CD 6.19), a root 0.6m above the peat base was also charred (Fig 6.8). Some artefacts occurred at the base of the peat. Just a single flake was found 17cm above the peat base. Thus, there is activity at the very beginning of peat formation but very little subsequently.

One feature was located within the peat (Context 335, Fig 6.8; CD 6.18). When originally planned it was D-shaped, 84cm by 43cm, filled with dark greenish grey silt (Gley 1 4/5 GY). Beside this there was a kidney-shaped area 56cm by 64cm that contained peat. The possibility must be considered that this feature relates to human activity but the observations are more consistent with a natural tree-throw feature (Allen 1992; 1998). Thus, the tree would have blown over to the north-east (away from the prevailing wind) tilting by 90° its root bole containing underlying estuarine silt and the top of the Old Land Surface which then weathered off the roots into the hole. The feature contained one worked flint, a piece of hazel charcoal, and two small rounded pebbles such as are common in the Old Land Surface. Larger tree-throw features are common in dryland contexts and often contain artefacts, as indeed did a Neolithic example at Prestatyn Site D (Chapter 20.4.4). At the base of the feature there were roots, some broken but there was no surviving trunk associated with the feature. Two possibilities suggest themselves, one that this

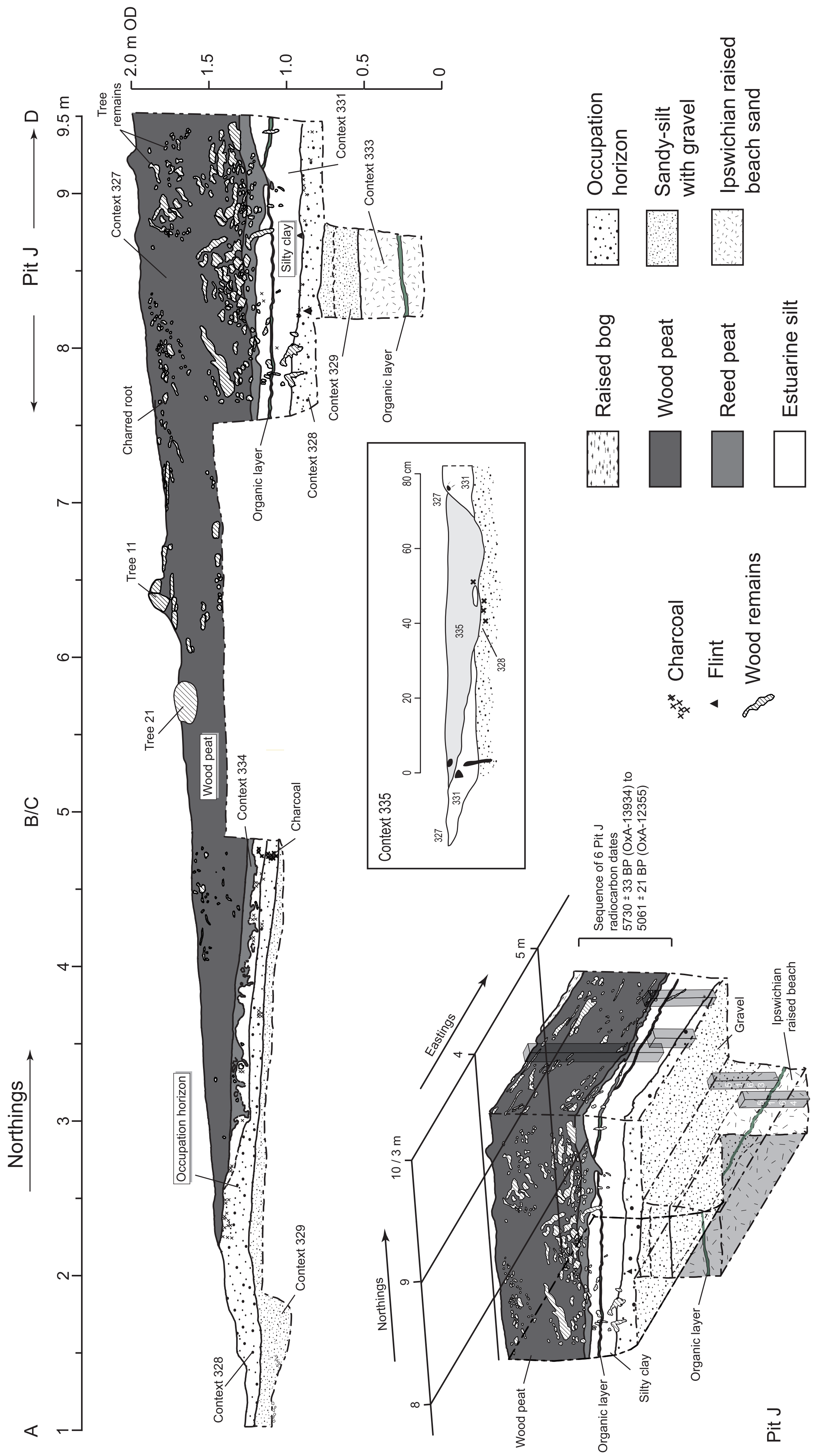


Figure 6.8 Site J, north/south section A–B, C–D (graphic S Buckley)

small blown tree was removed for use by Mesolithic communities, the other that there may be differential preservation of trees even within this peat.

The final successional stage of this woodland was represented by oak trees of which the largest was Tree 8, a trunk 3.8m long and 0.5m in diameter with massive buttress roots such as characterise trees that grow in wetland soils (CD 6.24–6.26). The tree was in the top 0.4m of the wood peat, somewhat disrupting the stratigraphy as a result of subsequent autocompaction. Just above the level of the tree the wood peat was replaced by raised bog peat containing cotton grass. This was yellow red (5YR4/6) when fresh. In 2001, 10cm of this peat remained in places. By the time the area was planned in detail a year later, only two tiny patches of raised bog peat remained on the north side of Pit J (Fig 6.2).

6.3 Environmental sampling

Environmental sampling was concentrated in the deepest peat sequence Pit J, Square 4/8 where monolith tins (Sample 5125) were taken for pollen and plant macrofossil analysis as reported in Chapter 15 and radiocarbon dating as reported in Chapter 8 (Fig 6.8; CD 6.27). A sequence of beetle samples was taken immediately adjacent for comparison and the results are presented in Chapter 16. A monolith (5640) was also taken for pollen, plant macrofossils and radiocarbon dating from the Old Land Surface below the peat in Square –1/5 (Fig 6.9; CD 6.28) and the results are reported in Chapter 14. Samples for sediment micromorphology were taken from two locations on east-west sections (Fig 6.9): one group (5535–6, 5629; CD 6.29) from the western end where the Old Land Surface was directly overlain by peat, the other group (5630–2, CD 6.30) where estuarine sediment occurred between the Old Land Surface and the peat. The results of micromorphological analysis are presented in Chapter 17.3.

6.4 Dating the sequence

The peat sequence sealing both Mesolithic activity in the Old Land Surface (Context 328) and the estuarine sediments is very well dated. Unfortunately, the samples of cut-marked bone which were submitted for radiocarbon dating from the Mesolithic occupation horizon itself failed to date because of loss of collagen. Dating the occupation rests on dates for two wood artefacts 9224 and 9199 with similar radiocarbon dates between 4940–4710 cal BC (Table 8.2).

There is a sequence of six dates from the peat in Pit J and one date for peat inception in Monolith 5640, 7.2m to its south-west. In Chapter 8 these peat dates are compared with the results of wiggle-match radiocarbon dates on two trees from the Upper Submerged Forest, Trees 36 and 8.

At the base of the Pit J date sequence there is the thin reed peat (Context 362) at 0.9m OD, which is only present in Pit J: this is dated 5730±33 BP (OxA-13934; 4690–4490 cal BC). We have noted already that the main peat (Context 327) formed on a sloping surface. There is a 0.41m difference in height between the peat base in Pit J and that in Monolith 5640, 7.2m south-west. In Pit J, the peat base was at 0.99m OD and was dated 5749±23 BP (OxA-12356; 4690–4530 cal BC). Peat inception in Monolith 5640 at 1.4m OD occurred at 4978±27 BP (OxA-14023; 3910–3660 cal BC). It therefore took some 825 calendar years for peat to grow the vertical distance of 0.41cm up this slope. In a coastal context, such as this, peat inception is considered to be a function of Holocene sea-level rise and to have generally taken place at about the height of Mean High Water Spring Tide (Heyworth and Kidson 1982). This in turn suggests a low rate of sea-level rise at the time this peat was developing: around 0.49mm per year in contrast to the preceding rapid rate of rise attested by the underlying laminated estuarine sediments. It follows that for 825 years Site J consisted of two distinct parts: a minerogenic sandy soil which was encroached on by fen woodland at the gradual average horizontal rate of 8mm per year.

The sequence of radiocarbon dates through the Pit J peat sequence (Fig 8.6) shows that formation of the wood peat took place over a period of about 900 years with the latest surviving peat being dated 5061±21 BP (OxA-12355; 3950–3790 cal BC). This date is from 1.77m OD and is just below the level at which raised bog peat occurs. A floating tree ring sequence from the main Upper Submerged Forest has been approximately fixed in time by the wiggle-match dating of Tree 36, which is 80m east of Site J. This showed that the Upper Submerged Forest finally died about 4239±16 cal BC. It is thus coeval with about the middle of the peat sequence at a depth of *c* 0.5m from the top of the peat. None of the oaks in Site J matched the floating chronology but it is a reasonable guess that the two oaks which outcrop in the lower part of the peat (T24 and T123; Fig 6.2) relate to the main submerged oak forest. This suggestion is consistent with their stratigraphic position as shown by comparison of T24 (CD 6.23) with the stratigraphic context of trees in the floating dendrochronological sequence from the Upper Submerged Forest (Figs 7.1–7.2).

The largest tree within Site J, Tree 8, did not match the floating tree ring sequence but was wiggle-match dated because it was in such close proximity to the main environmental sequence in Pit J. The results of wiggle-match dating presented in Chapter 8 show that this tree lived between 4112–3913±6.5 cal BC with allowing for missing wood the latest possible death *c* 3881.5±6.5 cal BC. Comparing the date of this tree with the sequence of dates from Pit J it is clear that the death of this tree relates to a time about 0.2m below the top of the peat. Tree 8 is thus shown to be some 280 years later than the main Upper Submerged Forest floating chronology. The upper layer of oak trees in Site J, including Tree 8, thus represents a colonisation into the fen woodland that may not have extended more than a few tens of

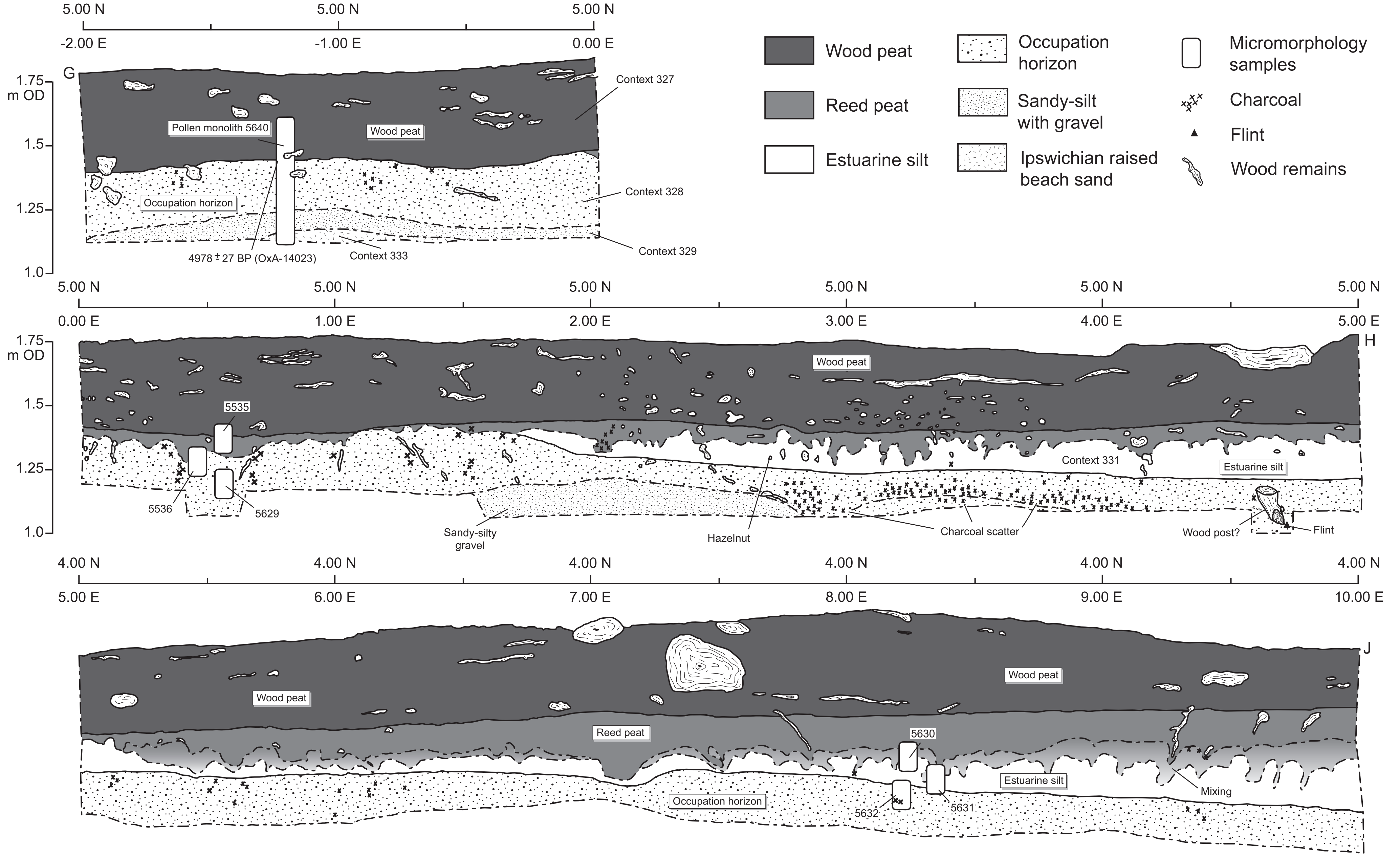


Figure 6.9 Site J, the east/west stratigraphic sequence on the north face of the 2003 excavation (graphic J Bezant and S Buckley)

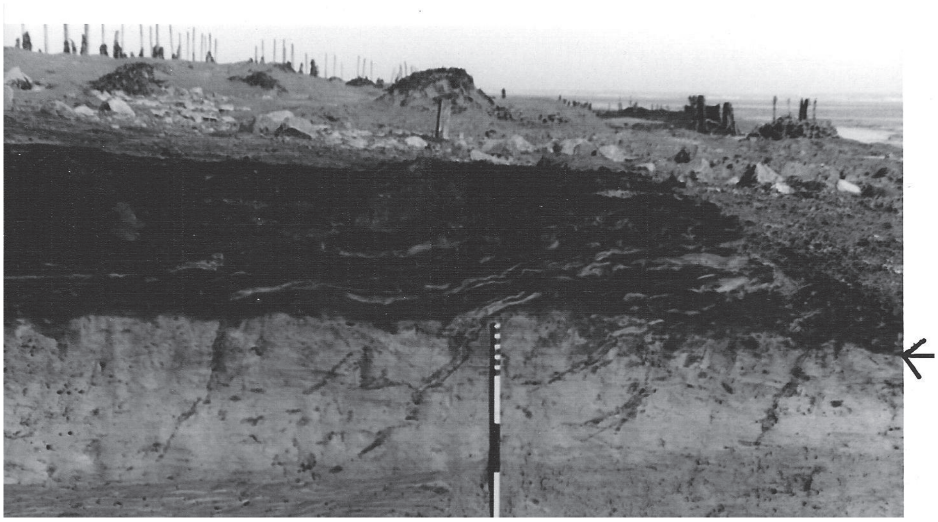


Figure 6.10 Site J, the east face of the 2003 excavation showing (a) the Mesolithic Old Land Surface (Context 328) (b) estuarine silts (Context 331) showing position of wood artefact 9224 arrowed on right margin (c) peat and Upper Submerged Forest (Context 327): scale – large divisions 10cm (photo E Sacre)

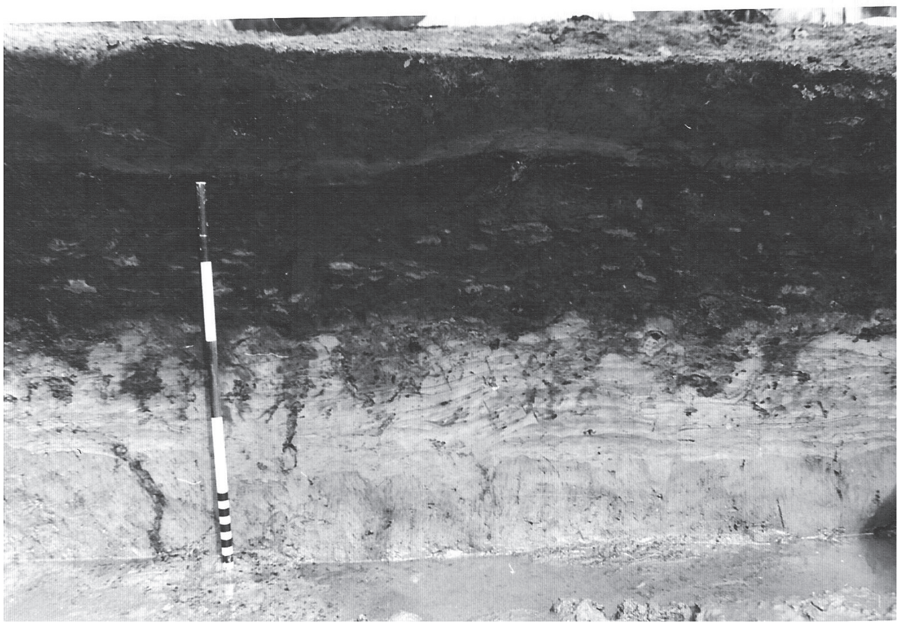


Figure 6.11 Site J, surface of the Old Land Surface (Context 328), overlying estuarine silt (Context 331), the wavy boundary at the base of the peat and Upper Submerged Forest (Context 327): scale – large divisions 10cm (photo E Sacre)

metres from the edge of the former island. Above Tree 8 was peat with little wood which probably reflects wetter conditions preceding raised bog development. The presence of raised bog peat on Site J is notable because comparison of the date of the top of the underlying wood peat in Pit J and the date of peat inception in Monolith 5640, 7.2m away, indicates that soon after 5000 BP raised bog had spread to within about 7m of the edge of the former island. Thus, throughout the Neolithic the island appears to have been surrounded by raised bog.

It follows from the stratigraphic and dating evidence presented that Site J is an exceptionally well-sealed Mesolithic site with activity dated *c* 4900–4710 cal BC. Activity may well have begun earlier and continued later, but on a much smaller scale, until *c* 4000 cal BC. Chapter 9 shows that the lithic artefacts are consistent with a later Mesolithic date. Over roughly the last thousand years of the Mesolithic what began as a dryland, island-edge site was progressively encroached on and buried – first by estuarine sediments representing saltmarsh which was laid down over an unknown period, then by the encroachment of peat over a timescale of 825 years. This progressive burial of the island edge creates the possibility of identifying successive artefact deposition phases and perhaps activity areas using their relative position both in the stratigraphic sequence

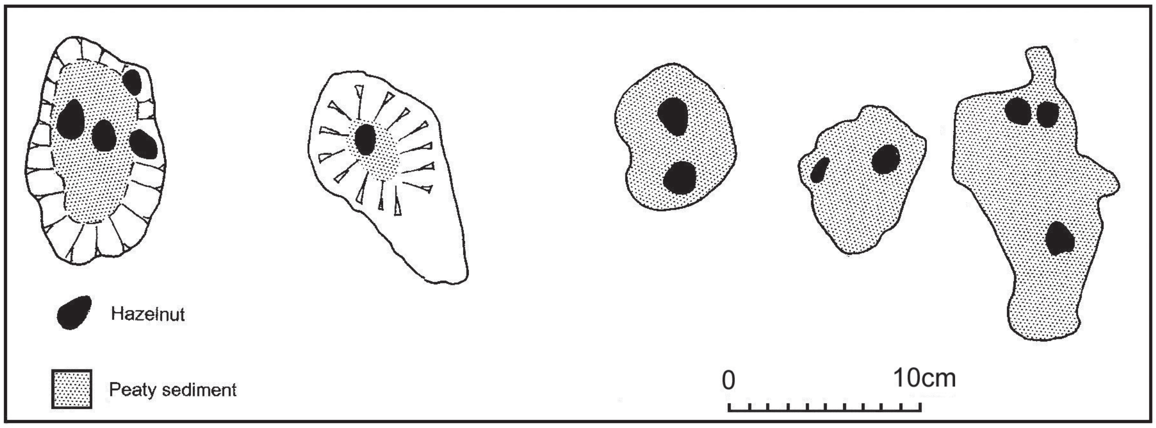


Figure 6.12 Site J: small cup-shaped features at the estuarine silt (Context 331)/peat (Context 327) boundary containing small clusters of hazelnuts; these are believed to be scrapes made by squirrels to bury nuts (drawing M Bell)

(eg horizons within the Old Land Surface and the overlying estuarine sediments) and their horizontal spatial relationships to the progressively buried sloping surface. This represents something of a challenging three-dimensional puzzle, which we will now turn to by considering the distribution of artefacts and their relationship to stratigraphy.

6.5 Artefact distributions and activity areas

The vertical distribution of artefacts in part of the site is shown in Figure 6.13. This is a representative transect across one of the areas of most dense artefact concentration; it also crosses the bowl-shaped sub-soil feature Context 363. The transect is 1m wide and 6m long from easting –2 to +4m and northing +3 to +4m. The section shows evidence of a sequence of artefact types and thus activities in this area. The sub-soil feature is characterised by a particular concentration of aurochs and deer bones. At a higher level in the soil are numerous heat-fractured stones and above this some flakes and tools. The top 10cm of the soil, immediately below the peat, contains fewer artefacts, which suggests an interval, marked perhaps by earthworm sorting or colluviation, between the main period of Mesolithic activity and the burial of the site by peat. At the eastern end of the section, from easting 2m the Old Land Surface is overlain by estuarine silt of Context 331. These saltmarsh sediments which encroached over the buried soil contain artefacts, but in lesser concentration than the Old Land Surface.

In the diagrams which show the horizontal distribution of artefacts (Figs 6.14–6.16; CD 6.31 and 6.35) different symbols distinguish those artefacts from the Old Land Surface (Context 328) from those in the overlying estuarine sediments (Context 331) and those in the overlying peat (Context 327). On Site J as a whole, by far the greatest number of artefacts was in the Old Land Surface, with smaller numbers in the estuarine sediments and few finds in the peat.

Site J shows some distinct clustering of artefacts, which are most evident on the plan of lithic debitage (Fig 6.14b) where each cluster is labelled by a letter A to E round the margin of the site distribution. Particular attention is drawn here to Cluster B, which is centred on grid point 3/2.5 and is roughly circular 3.5m in diameter. This cluster shows a tendency for lithic debris to concentrate around the periphery of the distribution and on that basis it will be suggested that Cluster B might represent the position of some sort of light structure or shelter.

6.5.1 Lithics

The lithic artefacts are discussed in Chapter 9. Figures 6.13–6.15 (and CD 6.31a) show the distribution of lithics, with those illustrated distinguished by their numbers. No significance should be attached to the absence of artefacts in the south-west corner of the trench where the Mesolithic soil had been partly eroded before the excavation (Fig 6.2). The already noted artefact Clusters A–C on the southern side of the site, are each marked by struck flakes with a smaller number of tools and a few cores. Cluster A, on the west edge of the trench, was about 3m in diameter, and comprised flakes with 14 tools, 22 cores and core fragments, and 1 hammerstone. Between Clusters A and B there is a triangular area 2m by 1.5m where flints are absent. This hints at the existence of some barrier to dispersal. Cluster B, near the centre of the trench is a marked concentration *c* 3.5m in diameter which comprises largely flakes. In places these clustered around the periphery of a circular or oval area, suggesting the existence of a barrier to artefact dispersal. This area had 28 cores and core fragments, one hammerstone, one microlith, and nineteen other tools concentrated on the western half of the circular area. Cluster C, on the east side of the trench, is a less dense scatter covering an area 4m by 2m. Within this area there is some tendency for lithics to lie in distinct clusters and for some roughly circular areas c 0.5m in diameter to lack lithics. Within the more

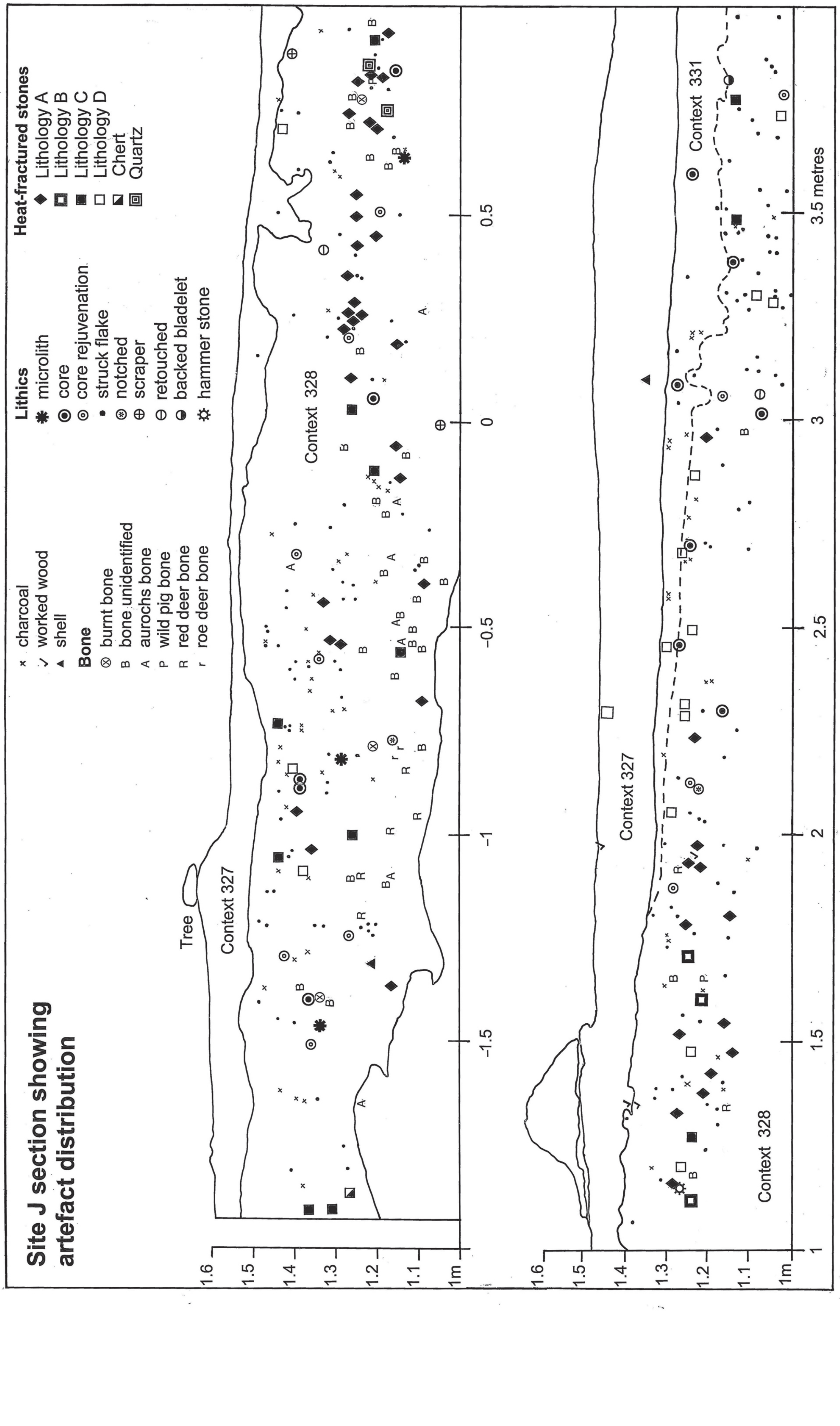


Figure 6.13 Site J, the vertical distribution of artefacts plotted in relation to the stratigraphic section from a 1m wide transect of the excavation from easting −2 to +4 and northing +3 to +4m (graphic J Foster)

Figure 6.14 Site J, distribution of (a) cores and hammerstones (b) debitage. Finds from the Old Land Surface, the estuarine unit, and the peat are distinguished by different symbols. Illustrated artefacts are numbered and artefacts subject to microwear studies have the numbers in a box (graphic S Buckley)

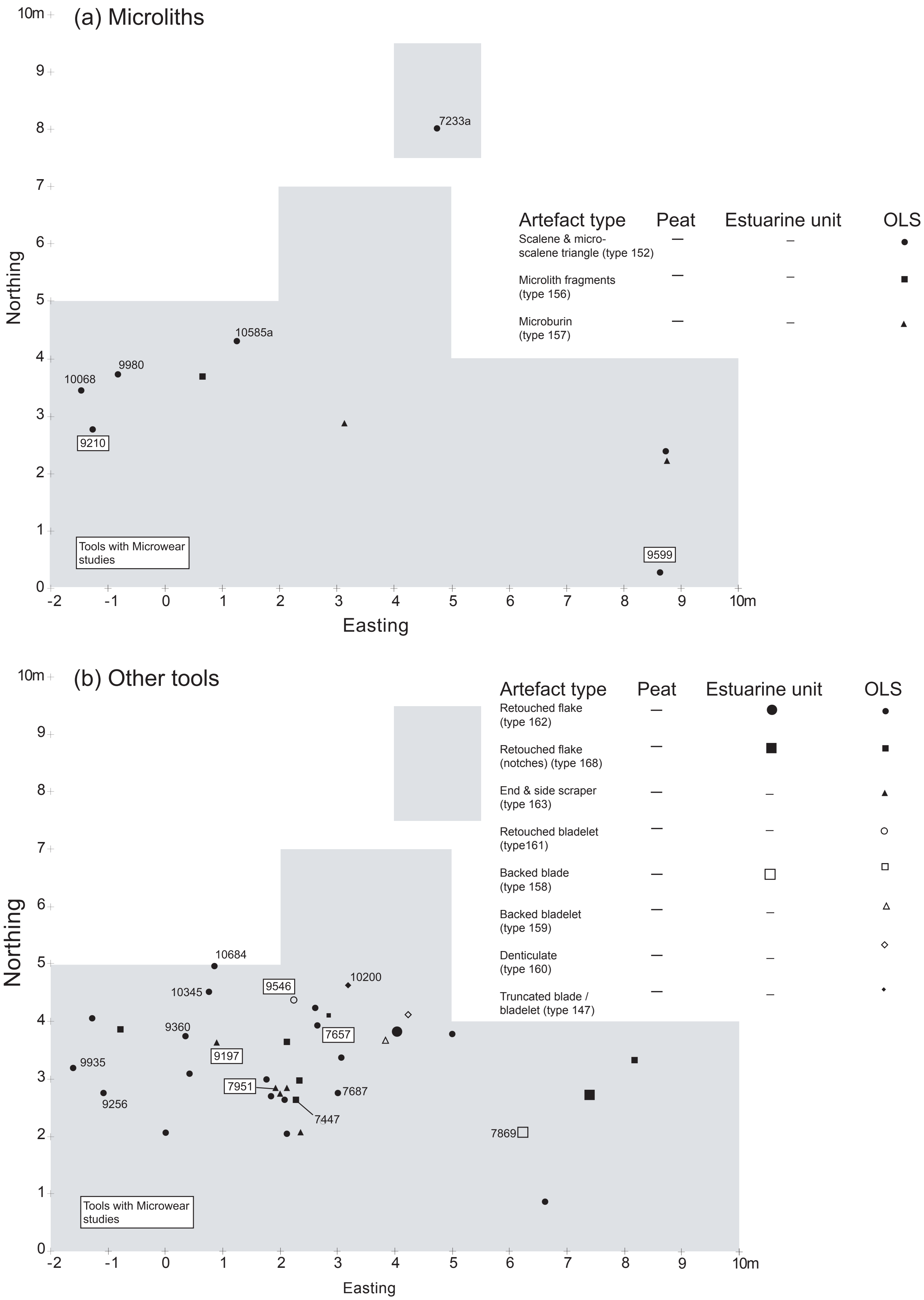


Figure 6.15 Site J, distribution of (a) microliths, (b) other tools. Finds from the Old Land Surface, the estuarine unit, and the peat are distinguished by different symbols. Illustrated artefacts are numbered and artefacts subject to microwear studies have the numbers in a box (graphic S Buckley)

diffuse scatter of lithics seen elsewhere in the trench there are also some lesser concentrations of flakes. Cluster D, on the north edge of the trench is a collection of flakes (2m by 1m). Cluster E, in Pit J, is a diffuse scatter of flakes and cores.

If we compare the distribution of non-microlith tools alone (Fig 6.15b) it is clear that they are particularly concentrated in Cluster B. There is a less pronounced concentration in Cluster A which has more microliths. Clusters C–E show no concentration of tools. Microliths are few on this site by comparison with Site A, only ten from hand excavation and three from sieving, and one microburin shows that some microlith production may have taken place in Cluster A. Comparison of the distribution of artefacts recorded by hand excavation and those from water-sieving reveals some surprising features. Micro-debitage from sieving is not abundant anywhere on Site J (CD 6.31a). What was found comes almost exclusively from the buried soil (Context 328) with only odd fragments from the estuarine sediment (Context 331). The highest concentrations occur not in Clusters A and B with the densest scatters of flint flakes, but in Cluster C. Cluster B is weakly represented on the micro-debitage distribution, but nowhere were there more than ten pieces per sample. Cluster A does not appear at all on the micro-debitage plot, just two squares have five to ten pieces and the central part of the concentration has just one to four. Clusters D and E have only tiny numbers of pieces of micro-debitage. A possible inference from these comparisons may be that the activities on Site J had more to do with tool use; any knapping that took place was small-scale, probably repairs and modifications rather than large-scale tool production.

6.5.2 Heat-fractured stones

Examples of the heat-fractured stones are illustrated in CD 6.32 and their distribution is shown in Figure 6.16a. These were originally from rounded cobbles and boulders of quartzite, which fractured to produce angular, hackled faces. There is one predominant lithology and three less abundant lithologies, and rock types concerned and their origins are discussed by Professor Allen in Chapter 9.4. He concludes that they are the product of heating and then rapid cooling by the application of water. Uses in food preparation, craft activities, and maybe hygiene (eg a sauna) are possible. Heat-fractured stones were abundant on Site J but nowhere else. They mostly come from the Old Land Surface (Context 328) which produced 233 examples. There were only eleven examples from the overlying estuarine sediment and one from the peat. The stones are highly clustered in the westerly lithic concentration (Cluster A). Elsewhere in the trench there is a diffuse scatter bearing no obvious relationship to the clusters identified. There is no obvious distribution pattern to the four lithologies which Allen has identified.

6.5.3 Bones

The animal bone evidence is specifically discussed in Chapter 13 and the worked objects of bone in Chapter 11. There was reasonable preservation of bones in the Old Land Surface (Context 328) and especially in that layer and the overlying estuarine sediments in Pit J. The distribution of bones by main animal taxa is shown in Figure 6.16b. A marked concentration occurs in Cluster A, particularly sub-soil feature 363. Aurochs bones, and a few pig bones, are mostly scattered round the margins of a roughly circular area 2.5m in diameter. Deer bones are more concentrated in the centre. Four of the aurochs bones (10765, 10727, 10726, 10772), and one unidentified bone (9961), showed evidence of use wear, which, it is suggested in Chapter 11, may be a result of preparing skins. It appears that this area was the focus of butchery activity and perhaps skin processing. On most of the rest of the site, bones show no particular clusters and certainly nothing that corresponds to the previously identified clusters of lithics. The exception was around Pit J where the bones were larger and less fragmented than elsewhere (CD 6.34). Finds from the northern part of the site included an aurochs bone with probably evidence of microlith weapon impact (10392), an awl (7595a), and two broken segments of the same rib (7531, 7523) covered in cut marks and possibly used in some productive activity such as the scraping of sinews. A deer scapula (7430a) with wear marks may have been used in a similar way. Bones in the Pit J area were initially interpreted as what Binford (1983) has called a 'toss zone' where bones were thrown onto the saltmarsh edge from the westerly activity area about 6m away. However, subsequent microscope analysis showed at least 4 of the 14 bones had been opportunistically used as tools. That may be rather more suggestive of the deliberate disposal of occupation debris than the concept of a 'toss zone' implies.

A striking find on the south edge of Cluster B was a boar's tusk (CD 6.33). It would be surprising if such an object were just casually discarded, and one may speculate that it may have been deliberately deposited here on the periphery of the cluster. Also within Cluster B were fragments of a tabular bone with a rather complicated pattern of cut marks (3171b) which could represent deliberate decoration.

The distribution of bones from sieving (CD 6.31b) shows only small numbers: there is a group in one square (–1/3) in Cluster A, and another in Square 4/5, which is unrelated to any other artefact cluster. Examples in Pit J suggest that not only large bones were discarded here but also small fragments, although these could have resulted from animal trample. Fish bones are few by comparison with Site A; they were found in just three squares, two of which produced totals of just two and four bones, but the third – Square 7/3 – produced fifteen, and this corresponds to the heart of Cluster C.

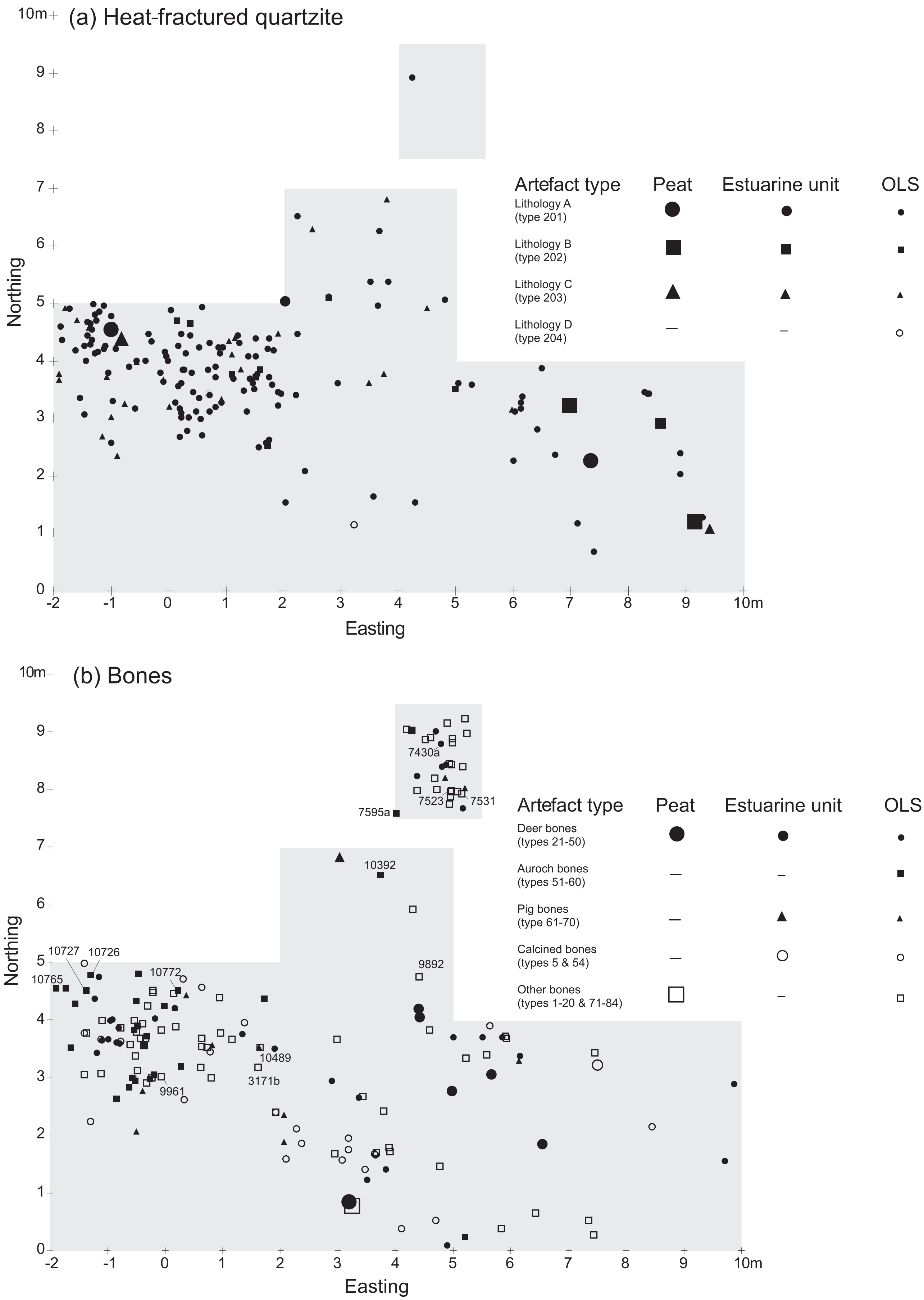


Figure 6.16 Site J, distribution of (a) heat-fractured quartzite of Lithologies A–D, (b) bones. Finds from the Old Land Surface, the estuarine unit, and the peat are distinguished by different symbols. Illustrated artefacts are numbered (graphic S Buckley)

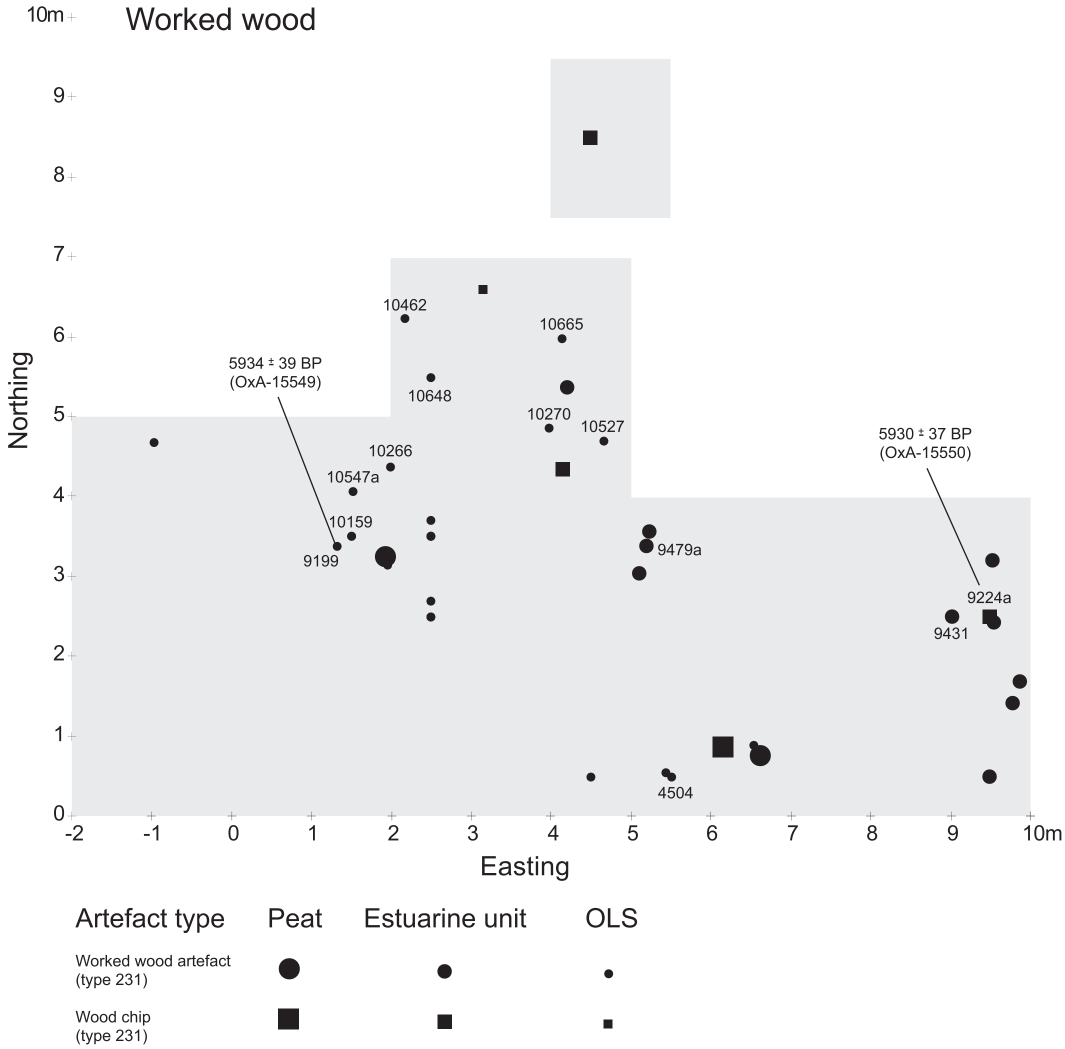


Figure 6.17 Site J, distribution of worked wood with the numbers of illustrated pieces (see wood report), and the radiocarbon dates of wood artefacts. Finds from the Old Land Surface, the estuarine unit, and the peat are distinguished by different symbols. Illustrated artefacts are numbered (graphic S Buckley)

6.5.4 Worked wood

Artefacts of worked wood are individually discussed in Chapter 10. Perhaps the most exciting, and rather unexpected, discovery on Site J was the preservation of wooden artefacts (Fig 6.17). Such discoveries had not originally been though very likely here because the Mesolithic soil sloping to the north-east was seen as a dryland site subsequently buried by peat encroachment and, as we have already noted, there were very few finds from the peat itself. In the event, worked wood was found in all three of the main stratigraphic contexts: the buried soil (Context 328) produced the largest number (20); the estuarine sediment (Context 331) 13 pieces; and the peat (Context 327) 3 pieces. The total number of certainly, and possibly, worked pieces was 38 and the distribution is shown in Figure 6.17. On the edge of Cluster B lay Object 9199, a finely worked Y-shaped piece which lay horizontal on the Old Land Surface just below the peat. Other objects in this area were the tip of a tiny wooden pin (10266), and the point of another wooden artefact (10159). Thus the main concentration of worked wood is in the northern part of Cluster B. A small drum-shaped wooden object (10462), possibly a bead, was on the south edge of Cluster D. Other notable worked pieces of uncertain usage which do not correspond to any of the other artefact scatters identified, included: 10665, 9431, 4504. Worked wood also occurs in the estuarine sediment itself, the largest artefact, 9224, a 1.14m long carefully worked curved pointed stick, perhaps a digging stick or spear. (CD 6.22–6.23 shows it *in situ* on the very surface of the estuarine sediment and the base of the peat.) Three pieces of worked wood came from the peat (Context 327) which, with the very small numbers of lithics, confirms a low level of continuing activity at this time. Just three woodchips were identified from the site: one each from the Old Land Surface, estuarine sediment and peat. Some of the other worked pieces of wood may also represent debris from woodworking but this suggests only small-scale working of wood on the spot, at least during the period from which wood is preserved.

The distribution of charcoal is shown in CD 6.35, this does pick out Clusters A–C, but not in a pronounced way. There is no marked concentration to highlight the position of hearths, nor does the distribution correspond closely to that of heat-fractured stones, which might be expected to represent hearth related activities. Charcoal from sieving was quantified according to the same 5-point scale from 1 (low) to 5 (high), as used at the other sites. This charcoal was concentrated in Cluster B but few squares produced more than the low value of 1 and again there was no distinct concentration. Maybe hearths lay outside the excavated area, or fires were mainly oxidising and produced little charcoal. Uncharred hazelnuts were extremely abundant on Site J and their burial has been attributed mainly to the activities of squirrels (Chapter 6.2.4). It is striking therefore that, by comparison with Site A, few charred hazelnuts were found: only two from hand excavation and a small number of fragments from sieving; the largest number in Square 3/4 occurs in the northern part of Cluster B.

6.6 Footprint-tracks

The base of the peat (Context 327) had a wavy and involuted form which was partly attributed above to trample by animals (Chapter 6.2.4). In section some of the involutions had the distinctive form of ungulate footprint-tracks of deer size (Allen 1997b). When the interface between the peat and the underlying sediment was cleaned, animal footprint-tracks were observed. The most distinct of these occurred where the animal had walked near the base of the peat, treading peat into the underlying estuarine sediment (Context 331) or the surface of the minerogenic soil (Context 328). Footprint-tracks occurred in the peat (2), in the estuarine silts (12) and in the underlying minerogenic soil (8). Most of the footprints were recorded first by tracing in the field on plastic film and, where possible, by blocklifting them and transporting them to dryland where they were micro-excavated by Rachel Scales (Chapter 12.3.6). (CD 12.53 shows the recorded examples, all being red deer.)

6.7 Conclusions

Some marked concentrations of artefacts have been recorded particularly in Clusters A to C (Fig 6.14b). These are not all contemporary. The concentration of aurochs bones was in the base of the soil mostly within the bowl-shaped feature 363. Heat-fractured stones were also in the lower part of the buried soil. That area seems to have been particularly associated with butchery and cooking related activities and, if the interpretation of the bone artefacts is correct (Chapter 11.4), the working of skins. The triangular area between Clusters A and B (Fig 6.14b) with no artefacts could suggest the existence of a wall or barrier or something covering the ground surface preventing the incorporation of artefacts.

Cluster B has more tools, less evidence of heat-related activities, fewer bones, and more worked wood. This suggests activity which was related more to the maintenance of equipment than food preparation. Cluster C has evidence of small-scale knapping and the presence of charcoal and some fish bones indicates food preparation in this area. The concentration of bones in Pit J has already been interpreted in terms of deposition from an activity area on dryland. In considering what is responsible for the distinct clustering of artefacts we are hampered by having no knowledge at all of what lay outside the excavated area, nearer, that is, than the other excavated sites. Clusters A and B are roughly circular and 3m in diameter. Two possible explanations for this form suggest themselves. One is that the clusters simply represent foci where particular activities were concentrated. That does not seem consistent with the rather sharp edges which in places these scatters exhibit (Fig 6.14b). The other possibility is that they represent the sites of small structures. No trace was found here of any postholes. Two stakes (10547 and 10648) were found north of Cluster B, but neither appeared to be in structural position. The most likely type of structure is a tent of tepee type. It may be contended that this is an implausible hypothesis because the interior of structures was often kept clean of artefacts (Binford 1983). However, careful examination of Cluster B (Fig 6.14b) shows very marked peripheral nucleation round the margins of a roughly circular area 3m in diameter with fewer artefacts in the centre. This might be expected with a structure, especially one which was tepee-like with artefacts clustering against an inaccessible wall line and the same confined area possibly being used for storage. The previously mentioned boar's tusk (CD 6.33), which might have been ritually deposited, would lie exactly on the edge of the hypothetical structure. The carefully worked Y-shaped wooden object 9199 is also on the edge of the circle. A break in the peripheral cluster on the east side could mark the position of an entrance. If so, Cluster C might represent activities that took place outside that structure. A tepee of this diameter would have had a total floor area of 5.7m^2, sufficient to provide shelter and storage space for a small family of perhaps four or five people, although this is unlikely to have been for more than short-term occupation. If the artefact clusters are within structures that might explain the lack of micro-debitage, if lithic working took place elsewhere. The tepee explanation seems to work well for Cluster B with its marked peripheral concentration. Such is not evident in Cluster A where the accumulation of larger artefacts including aurochs bones was mainly in the sub-soil feature (Context 363) and heat-fractured stones mainly overlaid this feature. The various classes of artefactual and environmental evidence are reviewed in the following chapters after which we will return to the question of the activities represented on Site J (Chapter 18.4.7) and a review of the possible evidence for structures (Chapter 18.7).

7 The Upper Peat and Submerged Forest *by Martin Bell*

7.1 Introduction

The Upper Peat shelf is the most striking topographic feature of the foreshore at Goldcliff East (Figs 2.3–2.5). Here eroding from the edge of this peat shelf are many large oak trees of the Upper Submerged Forest (Figs 7.1–7.2). The Upper Peat was the first part of the Holocene sequence at Goldcliff to be studied in what, for the Severn Estuary, was a pioneering investigation of vegetation history by Smith and Morgan (1989). This provides a most valuable point of comparison for our own work because it was detailed, accurate, well-supported by radiocarbon dates and extends beyond the Mesolithic period, which is the particular focus of our research. The Upper Peat overlies the Mesolithic sites at Goldcliff East discussed in Chapters 3–6. Investigation of the peat is, therefore, an important part of understanding the environment during the last millennium of the Mesolithic despite the fact that the level of human activity was much reduced during the period of peat formation, as noted in Chapter 6. An additional reason for our particular focus on the Upper Submerged Forest was its relevance to the wider linked research project on Mesolithic to Neolithic Coastal Environmental Change (Chapter 2.1.2). That was designed to investigate the interrelationships between disturbance factors, both natural and cultural, in the coastal zone and it particularly sought to use dendrochrochronology to refine the dating of coastal change and disturbance factors. It was already clear from Smith and Morgan's (1989) work, and our preliminary survey of the Goldcliff East embayment in 1993 (Bell 1993), that the deposits were of appropriate date and had a high potential for this research topic. Our original objective, therefore, in revisiting Goldcliff East was specifically to work on the Lower and Upper Submerged Forests. The discovery of a great deal of Mesolithic archaeology stratified between the two forest layers was an unexpected but extremely welcome bonus.

This chapter introduces the Upper Peat and Submerged Forest and outlines the sequence and the areas where detailed investigations have taken place. Detailed consideration of the dating evidence follows in Chapter 8. The Upper Peat (Unit vii) lies between the middle Wentlooge estuarine silts of Unit vi discussed in Chapter 4 and the upper Wentlooge silts of Unit viii (Fig 2.6; Table 2.1). The peat broadly spans the period 5000 cal BC to 1400 cal BC, the later Mesolithic to middle Bronze Age. Our detailed palaeoenvironmental research covers the first 1500 years of this period from 5000 cal BC to 3500 cal BC, the last 1100 is covered by the earlier work of Smith and Morgan (1989).

The western limit of the Upper Peat shelf is at Site J, some 90m east of the Goldcliff headland. As we have already noted, Site J is the point where the peat abuts onto, and buries, the edge of the former island of Goldcliff. East of J, the peat stretches for 880m forming a very prominent shelf, 1–2 m high (Figs 2.3–2.5), providing good exposures of the Holocene sediments in section. The basal part of this section is formed of grey estuarine silts of Unit vi but south of the shelf these are usually overlain by thick mud and mobile sand which are generally too deep to cross. Landward the top of the peat forms a relatively level surface at between 1–2m OD. At the very edge of the shelf the Upper Submerged Forest is exposed at around 0.5m OD. Between 660m and 750m east of the headland there is a greater exposure of the Upper Submerged Forest up to 50m wide at Site K. About 220m beyond this the peat shelf narrows and is buried below the modern beach at the base of the seawall close to the groyne which marks the east side of the embayment (Fig 2.3). The peat shelf continues to the east but is obscured in places by recent overlying sediments. Its eastward continuation and stratigraphic relationships have been investigated by Allen and Haslett (2006). The peat shelf once again becomes a prominent feature of the foreshore at Redwick where on its surface we have excavated a middle Bronze Age settlement (Bell and Neumann 1999; Bell 2001).

The edge of the peat shelf, and each of the sites we have examined along it, lie on a hypothetical transect between the two promontories at either side of the Goldcliff East embayment. That transect across the embayment is orientated at 70° east of north (Fig 2.6). It has been used as the basis for the section across the embayment shown in Figure 2.6. That transect is also the line of the cores put down by Smith and Morgan (1989) on which their two pollen diagrams lie. CD 7.2 outlines the spatial relationship between the various palaeoenvironmental sites investigated and the former Goldcliff island. Distances given to the present headland are the headland at Goldcliff Fishery. Distances to the island edge are in an east–west direction on the basis that for most of the period when the fen peat formed the island edge was at Site J (Chapter 6.2.3). Other parts of the eroded island to the south would at the time have been rather nearer, as Figure 2.3 shows.

7.2 Stratigraphic sequence

The peat is underlain by minerogenic estuarine sediments of Unit vi. These are silts with clear evidence of banding, the nature and origins of which have been investigated by Dark and Allen (2005) in

Figure 7.1 Tree 1 in the Upper Peat overlying estuarine sediment of Unit vi: scale 1m (for a colour version see CD 7.1) (photo M Bell)

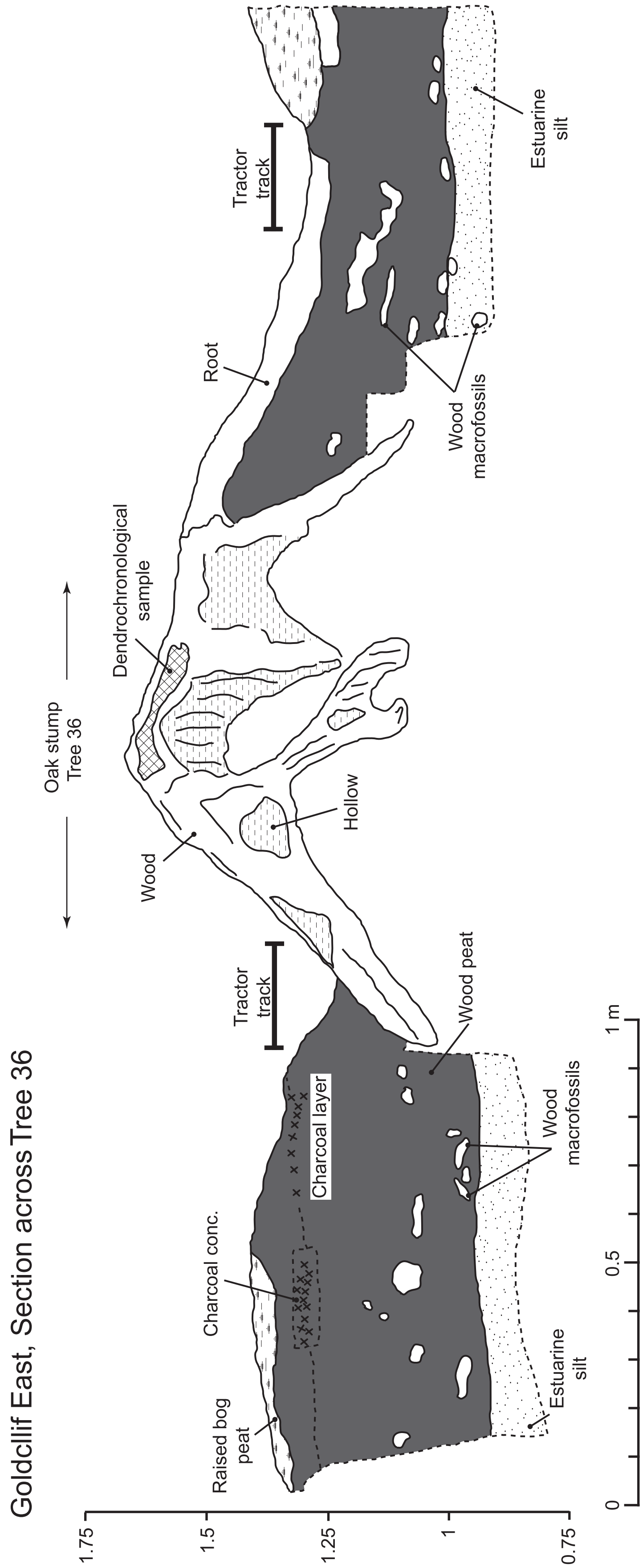


Figure 7.2 Section showing the stratigraphic context of Tree 36 in the Upper Submerged Forest which was used for wiggle-match radiocarbon dating

Figure 7.3 Oak Trees 38–40. Behind them is the raised bog postdating the Upper Submerged Forest; the level in the foreground on which the oaks rest has earlier alder and willow woodland (photo M Bell)

terms of particle size and palynology. Near the top of the estuarine unit a thin silty reed peat is in places exposed. East of Site K it forms a slight ledge and here Rachel Scales has recorded two deer footprints (6164–5) on its surface (CD 12.49.3). Below the main peat shelf there are small ledges, usually under 1m wide, which expose the surfaces of laminations on which footprint-tracks are in places visible.

The inception of the Upper Peat is dated at six places east of Goldcliff island and four places west of the island (CD 7.2–7.3). Peat inception occurs at the same time on either side of the former island. Eight of the dates are between 5000–4400 cal BC and the likely date of peat inception over most of the area is *c* 4800 cal BC. Around this time the entire area was transformed from a high saltmarsh to a peat bog. The two exceptions are later dates for peats at higher OD levels on the edge of the island where peat has grown up the sloping island edge. At Hill Farm Pond on the west edge of the island at 4m OD peat development occurred *c* 3000 cal BC. On the east edge of the island at Site J (Monolith 5640 at 1.43m OD), peat development occurred at *c* 3700 cal BC. The thickest and most continuous peat occurs close to Goldcliff island (Allen and Haslett 2006, fig 1). 600m east of the island, the Upper Peat is divided into two bands separated by estuarine silts. This division was first recorded about half way between Smith and Morgan's (1989, fig 1) Sites 1 and 2 and the continuation of these two distinct peat beds, albeit interrupted *c* 1km east of Goldcliff by erosion, has been documented by Allen and Haslett (2006, fig 1) and Allen (2005), who provide dates for peat inception from other sites to the east and west of Goldcliff.

Comparison of levels across the Goldcliff East embayment shows that the base of the peat on average lies at *c* 0.75m OD and the transition from the peat to the overlying estuarine sediments of Unit viii occurs at about 2.25m OD. Where the peat is fully preserved it is therefore about 1.5m thick, as it was at Smith and Morgan's (1989) Site 1. The full thickness is never, however, exposed at the edge of the peat shelf. As noted above, the edge is subject to greater erosion by waves; because it has been exposed for longer, it will have been subject to greater oxidation when the peat dries out at low tide and also because the peat tends to break off in flake-like slabs from the edge of the shelf (Allen 1999c). As a result of this combination of factors the less resistant upper sedge and raised bog peat tends to have been eroded at the face, exposing the more resistant wood peat and Submerged Forest (Fig 7.3). The minor ledge on which these trees are exposed is mostly about 10m wide and at *c* 1m OD.

Nine stratified trees formed part of a floating dendrochronological sequence and two trees (Trees 36 and 8) were subject to wiggle-match radiocarbon dating (Chapter 8). The stratigraphic context of these trees was investigated in particular detail. Small trenches were cut across the trees in order to take dendrochronological samples and the sections of these were recorded (Figs 7.1–7.3; CD 7.4–7.12). The stratigraphic context of Tree 8 has already been discussed in Chapter 6 since it is part of Site J. The five trees for which the relationship to the underlying estuarine sediments has been clearly established have their mid-points an average of 0.43m above the underlying estuarine silts (range 0.35–0.58m). The average OD height of the tops of the trees is 1.3m OD and the range is 1.65–0.85m OD. The trees themselves were all stratified in wood peat and the exposed peat shelves on Sites F and K produced clear evidence of earlier alder woodland successional stages preceding the oak wood (Chapter 15.3.1).

It was clear from the sections that the stratigraphic context of trees has to be investigated with some care, since initial appearances are sometimes deceptive, especially where a tree projects from the peat shelf. Tree 14 is an example (CD 7.8–7.9): where it was exposed at the peat edge the base of the tree was at 0.73m OD within the underlying estuarine sediments. When a second section was excavated 7m back from the face, it became clear that the true stratigraphic position of the tree was at 1.46m OD, within the peat and 0.58m above the underlying clay. When first recorded this tree was originally over 12m long and projected from the peat shelf. Rising and falling tides resulted in movement of the projecting tree, which excavated a furrow for itself – eventually resulting in the seaward end being over 0.70m lower than the landward end, and apparently within an earlier stratigraphic context.

The stratigraphy presented by Tree 36 (Fig 7.2; CD 7.4–7.5) is likely to be somewhat compressed. This tree lies alongside the salmon putchers and twice a day the fisherman used to drive a tractor out to empty the traps. This resulted in very marked wheel ruts over the surface of the peat hereabouts, there is a rut on either side of Tree 36 and this is likely to have led to compaction of the peat. Of particular note in this section is a charcoal horizon, which must be roughly the surface on which this tree grew. A distinct layer of charcoal was also found corresponding to the mid-point at which the trunk of Tree 70 was lying (CD 7.12). The two trees are 400m apart and given that the dendrochronological evidence shows they are contemporary, it is possible that they were affected by the same fire.

In the case of Trees 14 and 70 the wood peat was thinner and was succeeded by a reed peat (CD 7.6; 7.8). Evidence of reed peat succeeding the woodland phase and preceding raised bog development was found in the pollen sequences of Smith and Morgan (1989). Evidence of the overlying raised bog seldom survives near the edge of the peat shelf where the less resistant peats have generally been eroded. However 5–30m back from the edge a small step marks the edge of the raised bog. The very base of the raised bog survived in one small area in Site J (Fig 6.2) and above Tree 36 (Fig 7.2) and a pronounced raised bog surface overlay the wood peat on Site F just beside and above Trees 38–40 (Fig 7.3).

When the surface of the peat was relatively free of mud, as it was when the original survey of this area was carried out in 1993 (Bell 1993), there was evidence of sinuous palaeochannels *c* 3m wide running across the peat. The channels were silt-filled and presumably represent erosion at an early stage in the subsequent marine transgression. Within one of the channels a red deer antler was found and nearby a cattle skull. The transition from peat to minerogenic silts represents a return to estuarine conditions. This is dated in Smith and Morgan's (1989) Site 1 to 3130 ±70 BP (CAR-644; 1610–1200 cal BC), ie during the middle Bronze Age. The estuarine sediments (Unit viii) are those of the upper Wentlooge Formation. About 1m above the base of these estuarine sediments there is a thin band *c* 10cm of reed peat which is sometimes exposed near the west end of the salmon putchers (Fig 2.3). This is likely to represent a short-lived regression. Estuarine sedimentation then resumed and no sediments later than these are exposed in the Goldcliff East embayment.

7.3 Upper Submerged Forest

When the original survey of Goldcliff East was done in 1993–94 the trees which were visible at the time were surveyed and a number were sampled for dendrochronology (Bell 1993, fig 32). Of these, five proved suitable for measurement, none were dated, but two produced matched tree-ring sequences providing a 223-year master chronology (Hillam 2000). During the survey of 2001–03, a much more intensive investigation of this forest was carried out. So far as shifting mud cover allowed, all trees were examined and those of oak, which appeared to have sufficient rings, were sampled for dendrochronology. Nigel Nayling outlines in Chapter 8 how a floating chronology has been constructed from sixteen trees covering 239 years. Of these sixteen trees, nine were securely stratified in the peat (Trees 9, 13, 14, 36, 38–40, 50, 70), four were lying unstratified in mud below the peat shelf (Trees 41, 42, 63, 68) from which they had clearly been eroded, and three were found east of the surveyed area (71–73). Two of the trees in the Upper Submerged Forest have been wiggle-match radiocarbon dated as outlined by Sturt Manning in Chapter 8. These are: Tree 36 (46m east of Site J; Fig 7.2) which was part of the floating chronology; and Tree 8 (within Site J; Fig 6.1 and CD 6.24–26) which was not part of the floating chronology. This dating programme outlined in Chapter 8 shows that the date of the floating chronology, including Tree 36 is 4477.5–4239.5±7.5 cal BC not allowing for missing sapwood and that Tree 8 died *c* 320 years later, living from 4112 to 3913±6.5 cal BC.

7.4 Palaeoenvironmental transect and sampling

It has been noted above that the exposures of the Upper Peat and Submerged Forest and the various associated environmental sampling contexts lie on a transect which runs east–north-east for *c* 750m from the edge of the former Goldcliff island (Fig 2.3). That transect is the line of the sedimentary section shown in Figure 2.6. The contexts investigated for environmental analysis will be described here in terms of distance along that transect from the island edge as it was in the Mesolithic, ie from Site J. This palaeoenvironmental transect provides a spatial picture of the transition from the island edge to the surrounding wetland. Thus the transect forms a convenient frame of reference for considering spatial aspects of the palaeoenvironment, in particular spatial changes from the edge of Goldcliff island, where Mesolithic activity had been concentrated, out into the surrounding wetland. From a more methodological perspective, palaeoenvironmental studies along this transect also enable us to compare the information derived from a range of palaeoenvironmental sources particularly trees, other plant macrofossils and pollen as outlined in Chapter 15 and insects as outlined in Chapter 16.

0m Site J

At the west end of the transect is Site J, discussed in Chapter 6, where the environmental sequence (Chapter 14.4.4) covers the last episode of intensive Mesolithic activity and continues through the period of subsequent peat development when there is much less evidence for human activity (Chapter 15).

46–210m Trees

Along this stretch of the transect are four trees which all form part of the floating tree-ring sequence. The stratigraphic context of each was investigated (CD 7.4–7.9) and has been outlined above: at 46m, Tree 36 was used for a wiggle-match radiocarbon-dating exercise; at 100m, Tree 9; at 150m, Tree 13; at 210m, Tree 14.

305m Site F

Here Dark and Allen (2005) have investigated the banded sediments below the Upper Peat and Scott Timpany has planned an area of the Upper Submerged Forest 26m by 10m, demonstrating a succession from alder and willow carr to oak woodland. Oak Trees 38–40 form part of the floating tree-ring chronology. A section has been recorded through the sequence (CD 7.10–7.11) and from this investigation, Scott Timpany (Chapter 15) has prepared a pollen diagram spanning the period from the underlying estuarine silts through the carr-woodland phase to the base of the overlying raised bog.

450m Site 2

This marks the west end of the 270m auger transect of Smith and Morgan (1989, fig 1) which conveniently lies roughly along the line of our transect. This was the western of their two pollen diagrams, which runs from the top of the estuarine sediments below the peat, through the wood peat to the base of the raised bog; the upper part had been lost by erosion. This diagram is supported by five radiocarbon dates between 5660±80 BP (CAR-778; 4690–4350 cal BC) and 4390±80 BP (CAR-773; 3340–2880 cal BC).

490m Tree 70

This formed part of the floating tree-ring chronology and a sequence of samples was analysed for beetles beside the tree (Chapter 16.7; CD 7.12).

590m Tree 50

This was one of the trees investigated in 1993 (sample 10372) and reinvestigated as part of the present project. It forms part of the floating tree-ring sequence.

630m Site K

This is an area where the overlying raised bog peat has been eroded away to reveal the most extensive area of Upper Submerged Forest, on a triangular promontory *c* 100m by 40m. Part of this area 34m by 24m was planned in detail by Scott Timpany and the trees and wood identified (Chapter 15.3.1). This demonstrated that it was an area of alder and willow carr with some birch: colonisation by oaks had only extended as far as 50m west of the planned area of Site K. A sequence of samples (CD 15.4) was taken beside Tree 171 for pollen and plant macrofossils (Chapter 15.3.2) and beetles (Chapter 16.8).

720m Site 1

This was the main site investigated by Smith and Morgan (1989) and the only pollen sequence at Goldcliff East to provide a complete sequence through the Upper Peat. The sequence is very well-dated by sixteen radiocarbon dates between 5950±80 BP (CAR-659; 5050–4610 cal BC) and 3130±70 BP (CAR-644; 1610–1200 cal BC).

7.5 Relationship of our study to that of Smith and Morgan

Smith and Morgan's (1989) pollen study is an exceptionally fine, detailed, and well-dated record of the coastal vegetation succession which is shown to be essentially comparable to that of the Somerset Levels. Their work laid the foundation for all subsequent work on the Holocene vegetation history of the Severn Estuary Levels. When they were writing, the existence of extensive Mesolithic and later prehistoric activity at Goldcliff was unknown, although they mention that some prehistoric flints had been found (Smith and Morgan 1989, 162). In their pollen diagrams they identified a landnam event attributed to Neolithic activity or clearance just after the elm decline. The interpretation of this event is further considered in Chapter 14.5.5. There was also a later Neolithic clearance and one during the Bronze Age. Our study was designed to be complementary to theirs. We have focused on Mesolithic activity and its environmental relationships, on the Submerged Forest itself, and its date. Comparison with their evidence that extends beyond ours into the Neolithic and Bronze Age enables us to consider vegetation change and human activity across the Mesolithic/Neolithic transition.

The Smith and Morgan (1989) study particularly emphasises the vegetation succession through fenwood to ombrotrophic bog. Given that emphasis, it is rather surprising that although the existence of oak trees is noted, those around Site 2 being described as 'small oak stools' (Smith and Morgan 1989, 155), the trees of the Submerged Forest are not specifically studied. There is no distinct peak in oak pollen in the sequence from either Sites 1 or 2, so it was unclear to which precise horizon, within the fenwood stage, the oak trees related. The present study enables us to compare the well-dated pollen diagrams from their sites with the wiggle-match radiocarbon dates for the Upper Submerged Forest presented in Chapter 8. This shows that the Upper Submerged Forest dates to about the 1400mm level in the Site 1 pollen diagram at about the level of their date CAR-657 and the 450mm level in Site 2 at about the level of their date CAR-776. In neither diagram does this correspond to a peak in the oak curve despite the prominence of the oak trees in the field and the fact that it is evident from our tree-ring studies that this woodland stage lasted 245 years; evidently the oaks have been masked by high levels of alder pollen. There is no major difference in pollen spectra between Site 2, where our study shows substantial oak trees within 40m, and Site 1 where the nearest identified oak was 130m away. At Site 1 the oak curve only increases after the decline of alder and after the period of the Upper Submerged Forest, although Tree 8 on Site J shows some later growth of oak trees on the wetland edge. This represents something of an object lesson in the limitations of pollen analysis – in this case its ability to detect the trees from the wood. That lesson serves to highlight the value of combining evidence from multiple palaeoenvironmental sources, an approach further developed in Chapters 14–16.

7.6 Archaeological evidence

A notable feature of the Upper Peat is that it overlies a wealth of Mesolithic archaeological evidence in the Goldcliff East embayment, but as noted on Site J there are very few artefacts from within the peat itself. Nowhere else did the survey reveal any finds in the Upper Peat despite the fact that areas of the peat surface were cleaned for recording the Submerged Forest at Sites F and K. It must of course be acknowledged that for most of the time of our fieldwork the peat surface was covered by a layer of mud of variable thickness so it is perfectly possible that some artefacts were missed. Charcoal associated with Trees 36 and 70 seems likely to be associated with human activity, particularly given the earlier evidence for burning noted in Chapter 3. However, the charcoal could be the result of wildfire. In any case, the evidence is consistent with a very substantially reduced level of Mesolithic activity during the period when the Upper Peat and Submerged Forest was forming.

Smith and Morgan's (1989) pollen diagrams produced changes in pollen spectra which they interpreted as evidence of a landnam episode immediately after the elm decline and another later in the Neolithic. They deduced that the inferred clearances must have taken place on Goldcliff island because other dryland, 5–6km away, was too distant. Our extensive fieldwork at Goldcliff east and west of the island has produced no artefactual evidence of Neolithic activity, stratified or unstratified and the strength of evidence for these Neolithic landnams is critically examined in Chapter 14.

It is also notable that no prehistoric structures have been discovered on the surface of the Upper Peat at Goldcliff East. This is in marked contrast to the situation west of Goldcliff island where there was evidence for a Bronze Age wood structure and skull deposition at the island edge and, postdating the main peat, parts of a Bronze Age plank boat (Bell *et al* 2000, Chapters 5 and 6). West of the island there was also a great deal of Iron Age activity represented by rectangular buildings and trackways associated with the peat of a later regression. Thus, at Goldcliff from the end of the Mesolithic wetland activity seems to have shifted west of the island and the area east of the island was apparently little used.

When the original survey of Goldcliff East was done some lines of wood posts were found on the peat shelf (Bell 1993, fig 32). No wood associated with them was actually buried within the peat, as had been the case with the trackways west of the island which produced prehistoric radiocarbon dates. The Goldcliff East lines have not been dated but they are thought to be the remains of fishing structures, no more than a few centuries old.

8 Dating the submerged forests: dendrochronology and radiocarbon 'wiggle-match' dating

by Nigel Nayling and Sturt Manning
with contributions by B Kromer, C Bronk Ramsey, C L Pearson, and S Talamo

8.1 Dendrochronology *by N Nayling*

8.1.1 Introduction

Tree-ring analysis of subfossil trees from the Goldcliff East embayment formed an integral part of a wider research project designed to examine and refine dating of coastal change during the Mesolithic to Neolithic (Chapter 2.1.2). Whilst the dendrochronological potential of Bronze Age and Iron Age timber structures had been extensively exploited during earlier studies focused on the intertidal area west of Goldcliff island, only seven samples from submerged forests (CD 8.1) had previously been examined (Hillam 2000). Much more extensive sampling of trees suitable for dendrochronological study was undertaken by the present project with the aim of providing chronologies for periods when oak formed a significant woodland component in buried landscapes now exposed intertidally. Subfossil trees suitable for cross-matching were encountered in two main horizons east of Goldcliff island. These horizons have been designated the Lower and Upper Submerged Forests (Chapters 3 and 7). In terms of date, preservation, and context, the trees from these horizons form two very distinct groups which may best be considered separately.

The Lower Submerged Forest (Unit ivb) at Goldcliff was rooted in a minerogenic old land surface which produced the earliest evidence of Mesolithic activity at Goldcliff East. This was sealed below a thin basal peat, which at Site B also contained Mesolithic artefacts. The sequence here is reminiscent of that of similar, but more extensive, exposures of submerged forest on the Gwent Levels coast some 6–7km to the east at Redwick (Bell *et al* 2001). This more easterly exposure was sampled comprehensively, as part of the wider linked research project, and a very well replicated tree-ring width chronology constructed. This chronology has not cross-matched against absolutely-dated British, Irish or continental sequences, but has been subjected to wiggle-match dating of sequential decadal blocks from Tree 77 indicating a date range for the rings actually present of 6206–5811±4 cal BC (see Manning *et al* below). This dated chronology covering almost 500 years provided a sequence against which trees from the Lower Submerged Forest at Goldcliff could hopefully be cross-matched. These trees, apparently mostly deposited prior to full waterlogging reflected by the onset of peat formation, were eroded with no survival of sapwood or bark-edge, and often compressed leading to distortion of ring structure. A significant proportion of recorded trees from this horizon also had insufficient rings for dendrochronological analysis.

Above the Lower Submerged Forest are the banded estuarine sediments of Unit vi which contain many footprint-tracks, overlain by the Upper Peat shelf which is described in Chapters 6–7. Comments made here focus on the dating of oak trees making up part of the Upper Submerged Forest. This forest postdates the main phase of Mesolithic activity at Goldcliff although activity may have continued at the island edge where the Mesolithic soil on the highest parts of Site J was only buried by peat at the very end of the Mesolithic (Chapter 6). The palaeoecology of the full flora of the Upper Submerged Forest is considered in Chapter 15. Oak trees were visible close to the eroding edge of the peat shelf, either stratified within the peat, or lying at the base of the shelf having been eroded out of position. Inland of this edge, the peat tended to thicken, covering the submerged forest exposure. During earlier fieldwork, samples had been taken from a number of these trees, five of which had been analysed without producing an absolute date (Hillam 2000, 165). It was hoped that a programme of more extensive sampling might allow construction of a replicated chronology for this horizon. Trees which had been eroded out of the cliff tended to be relatively poorly preserved, with no surviving sapwood or bark. In contrast, stratified trees (see Figs 7.1–7.3) were far better preserved. Although survival of sapwood and bark-edge did occur, often the sapwood had been completely compressed precluding the production of bark edge dates.

8.1.2 Sampling and distribution

The philosophy behind the sampling programme was to accept that visible elements of the submerged forest under study were an eroding resource which should be sampled as comprehensively as possible, subject to the trees appearing suitable for tree-ring analysis. A small field team located individual oak trees, undertook recording on *pro forma* tree record sheets, excavated around the trunk where necessary, and recovered a slice sample for analysis. Initially, sampled trees were mapped using hand-held GPS but were subsequently mapped more accurately using EDM survey. The limited excavations undertaken were often subsequently revisited to carry out more detailed recording of the associated stratigraphy (eg Figs 7.1–7.3; CD 7.5–7.12). Details of the distribution of sampled trees given below should be read in conjunction with the relevant text sections giving more information on the nature of the relevant exposures (Chapters 3 and 7).

The trees sampled from the Lower Submerged Forest derive from three areas (Fig 3.2): the western area around Site D; the eastern area Site I of the Lower Peat shelves; and an area to the east of these, where trees were found but the very patchy exposures of peat were not planned. Of the nine oak trees observed at the westernmost peat exposure, only one had sufficient rings in its sample to merit measurement. This was derived from the longest (13.6m) prostrate trunk (Tree 103) found at Site D (Fig 3.8). Only three of the eleven trees noted on the easterly exposure of peat (Site I) had sufficient rings to allow analysis. These came from Trees 46, 48, and 49 (Fig 3.2; CD 3.3), all prostrate trunks. Eastwards of Site I, although continuation of the basal peat was occasionally visible on particularly low tides, this area was not mapped in detail. Both stratified and unstratified trees were, however, sought for sampling to supplement the limited number of samples recovered *in situ* at Site I and the westernmost basal peat exposure. In a poorly defined area up to 450m east of the mapped extent of Site I, twenty-one oak trees were recorded, of which nineteen were sampled. Whilst many of these were stratified below a thin basal peat as elsewhere, others had been eroded out of position, or were located in difficult situations where the continuous presence of surface water prevented examination of their context. During forays to assess the nature and extent of any intertidal exposures of the Lower Submerged Forest between Goldcliff and Redwick, unstratified oak trunks were encountered, but not sampled, and very few stratified trees were located.

Oak trees from the Upper Submerged Forest were mapped along some 700m of the eroding edge of the Upper Peat shelf. In all, 32 trees were sampled, either stratified within the peat or lying un-stratified immediately seaward of the peat cliff. More details of their stratigraphic position are given in Chapter 7.

8.1.3 Methods

Methods employed in the Lampeter Dendrochronology Laboratory and the project field laboratory (CD 8.4) in general follow those described in English Heritage (1998). Details of the dating methods used are described below.

The complete sequences of growth rings in the samples that were selected for dating purposes were measured to an accuracy of 0.01mm using a micro-computer-based travelling stage (Tyers 2004). Cross-correlation algorithms (Baillie and Pilcher 1973; Munro 1984) were employed to search for positions where the ring sequences were highly correlated. These positions were checked visually using graphs and, where these were satisfactory, new mean sequences were constructed from the synchronised sequences. The *t*-values reported below are derived from the original CROS algorithm (Baillie and Pilcher 1973). A *t*-value of 3.5 or over, is usually indicative of a good match, although this is with the proviso that high *t*-values at the same relative or absolute position must be obtained from a range of independent sequences, and that satisfactory visual matching supports these positions.

All the measured sequences from the two submerged forest exposures were compared with each other and any found to cross-match were combined to form a site master curve. These, and any remaining unmatched ring sequences, were tested against a range of reference chronologies, using the same matching criteria of high *t*-values, replicated values against a range of chronologies at the same position, and satisfactory visual matching. Where such positions are found these provide calendar dates for the ring sequence.

The tree-ring dates produced by this process initially only date the rings present in the timber. The interpretation of these dates relies upon the nature of the final rings in the sequence. If the sample ends in the heartwood of the original tree, a *terminus post quem (tpq)* for the felling of the tree is indicated by the date of the last ring plus the addition of the minimum expected number of sapwood rings which are missing. This *tpq* may be many decades prior to the real date of the tree's demise. Where some of the outer sapwood or the heartwood/sapwood boundary survives on the sample, a date range can be calculated using the maximum and minimum number of sapwood rings likely to have been present. The sapwood estimates applied throughout this report are a minimum of 10 and maximum of 46 annual rings, where these figures indicate the 95% confidence limits of the range. These figures are applicable to oaks from the British Isles (Tyers 2004). Alternatively, if bark-edge survives, then a date of death can be directly utilised from the date of the last surviving ring.

8.1.4 Results

Results from the Lower Submerged Forest are summarised in Figure 8.1 and from the Upper Submerged Forest in Figure 8.3. In these two diagrams the wide white boxes represent measured heartwood, the narrow white boxes represent unmeasured

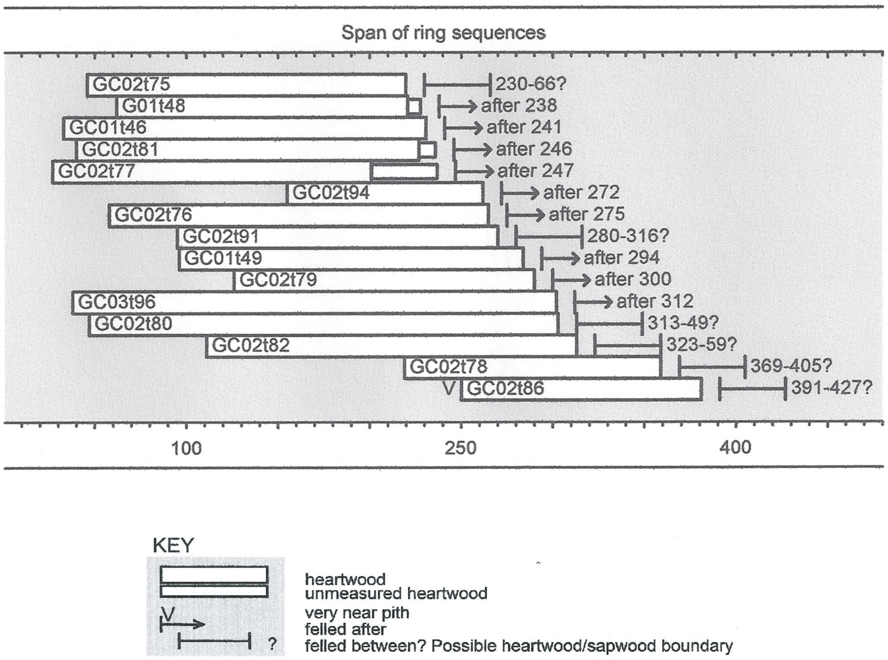


Figure 8.1 Bar diagram showing the chronological positions of the cross-matched trees from the Lower Submerged Forest. Estimated felling periods are shown in relative years (graphic N Nayling)

heartwood, the wide black boxes represent sapwood, the narrow black boxes represent unmeasured sapwood. The space between the box and the bar represents the minimum extra sapwood. Arrows represent trees felled after the date specified and a horizontal line with vertical bars at each end represents a tree felled between the dates specified.

A total of 41 oak trees from the Lower Submerged Forest were recorded. Samples from eighteen of these contained sufficiently well-preserved ring sequences with adequate ring counts to justify measuring their ring widths. Fifteen of these ring width sequences were successfully cross-matched against each other using both *t*-values and visual matching (Fig 8.1; CD 8.5). A 355-year mean of the ring widths from these fifteen correlated sequences was calculated (GClowerT15) and compared with replicated Mesolithic ring width means from Redwick and Gravel Banks in the Severn Estuary, and Bouldnor Cliff off the Isle of Wight coast. Two peat exposures at Gravel Banks, on the English southern shore of the estuary have been the subject of survey, radiocarbon dating, and palaeoenvironmental investigation (Gilbertson *et al* 1990; Riley 1999; Druce 2001; Tetlow 2005). Oak trees, found in both the lower peat and the overlying clay, were sampled for dendrochronology and a resultant chronology matched against the sequences from Lower Submerged Forests at both Redwick and Goldcliff. The Bouldnor Cliff site is now located underwater on the northern coast of the Isle of Wight at approximately –11m OD (Momber 2000). Worked and burnt flint has been recovered from below a basal peat deposit radiocarbon-dated to 8,565–8,345 cal BC (Beta-140104). The peat deposit contained the remains of large oak trees from which dendrochronology samples were taken and a site curve produced. The relative dating positions of these site curves are indicated graphically in Figure 8.2 and the *t*-values between the correlated sequences given in Table 8.1.

Absolute dating of the Goldcliff Lower Submerged Forest sequence is dependent upon correlation with the radiocarbon, wiggle-match dated Mesolithic tree-ring sequence from Redwick (Manning *et al* below), indicating that the tree rings actually present in the Goldcliff Lower Submerged Forest date between 6179–5826±4 cal BC or 5752±4 cal BC taking account of missing sapwood. The only measured sample from the westernmost peat exposure (Tree 103) had only 55 rings and has not cross-matched against any other tree from the Lower Submerged Forest. All three of the measured sequences from the eastern peat exposure (Site I, Trees 46, 48, 49) have cross-matched indicating growth of oak trees at this location during the period 6173–5922±4 cal BC or after 5912 cal BC allowing for missing sapwood. Fourteen of the samples from the less-well defined area of trees to the east of the mapped peat exposures were analysed, of which twelve have cross-matched, both against each other and against the three trees dated at Site I.

Many of the trees from the Upper Submerged Forest contained bands of narrow annual rings which have made the production of reliable tree-ring width series difficult and in some cases impossible. This feature of the trees from this exposure was also noted by Hillam (2000). It has, however, proved possible to cross-match the tree-ring sequences from

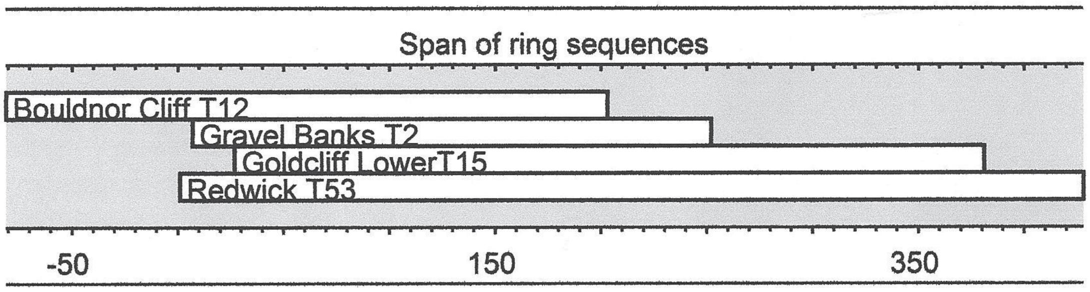


Figure 8.2 Bar diagram showing the relative chronological positions of the cross-matched ring width mean sequences from the Lower Submerged Forests at Redwick, Goldcliff, Gravel Banks (Severn Estuary), and Bouldnor Cliff (Isle of Wight). T is the number of trees in the floating sequence (graphic N Nayling)

16 of the 32 sampled trees. A 239-year mean calculated by combining these correlated ring sequences has been constructed. It has not been possible to match this site mean against previously dated tree-ring chronologies from Britain or Ireland, and the chronological date spans of the cross-matched tree-ring sequences shown graphically in Figure 8.3 are shown in relative years. The degree of agreement between synchronised ring sequences is given in CD 8.6. Wiggle-match radiocarbon dating of decadal blocks of rings from a sample taken from stump 36 indicates a date range of 4432–4245±7 cal BC, or after 4189±7 cal BC allowing for missing sapwood, for this chronology. Wiggle-match dating of Tree 8 shows that at least one oak, just off the edge of the former island at Site J, grew later than the main Upper Submerged Forest continuing into the fourth millennium.

8.1.5 Discussion

Through a combination of dendrochronological analysis and selective radiocarbon dating, the dating of the two main Submerged Forest horizons has been achieved. In the process, additional information, primarily of an ecological nature, has also been accrued providing a relatively rare opportunity to examine the 'history' of the oak trees that formed an element within these two wooded landscapes. In both horizons, oak trees were not the only significant woodland components, as most clearly evidenced by the presence of many non-oak trees in the peats of the Upper Submerged Forest (Chapter 15). Although oaks formed the only highly visible plant material from the Lower Submerged Forest, pollen evidence (Chapter 14) points to the presence of other tree species, possibly present as understorey within an oak dominated forest. Each of the two main forest horizons are examined here with reference to the evidence for the beginning of oak growth, the relative dating of the deaths of these trees, and the evidence for disturbance events in the cross-matched groups.

Wherever possible, samples from the Upper Submerged Forest were recovered which included the pith of the tree so that the relative dates for the start of growth of cross-dated oaks could be considered. During analysis, a note was made of the presence, or estimated proximity of the pith and this is shown in Figure 8.3. Given the uncertainty in some cases about the proximity of the sample to the butt of the tree, the pith may postdate germination of the tree by some years. Nine of the sixteen cross-matched oaks retained the pith (C in Fig 8.3). The earliest Trees 9 and 14 are close to the edge of the island and in general trees further from the island began growth a little later consistent with colonisation from the island (Fig 15.2). However, the most easterly Tree 50 began growing less than 20 years after the earliest trees showing that within twenty years some oaks had spread as far east as Site K. The contribution of faunal agents in tree colonisation are discussed in Chapter 15.

Differential preservation means that the dating resolution for the death of the trees in the relatively dated group from the Upper Submerged Forest is variable (Fig 8.3). Tree 40 is clearly the first tree to

Table 8.1 Cross-matching the 355-year mean sequence (GClowerT15) against floating, but cross-matched Mesolithic sequences from the Severn Estuary and Isle of Wight

Area	Reference chronology	*t*-values
Severn Estuary	Redwick T53 (Nayling unpubl)	29.18
Severn Estuary	Gravel Banks (Nayling unpubl)	11.41
Isle of Wight	Bouldnor Cliff (Nayling unpubl)	7.35

(data provided by N Nayling)

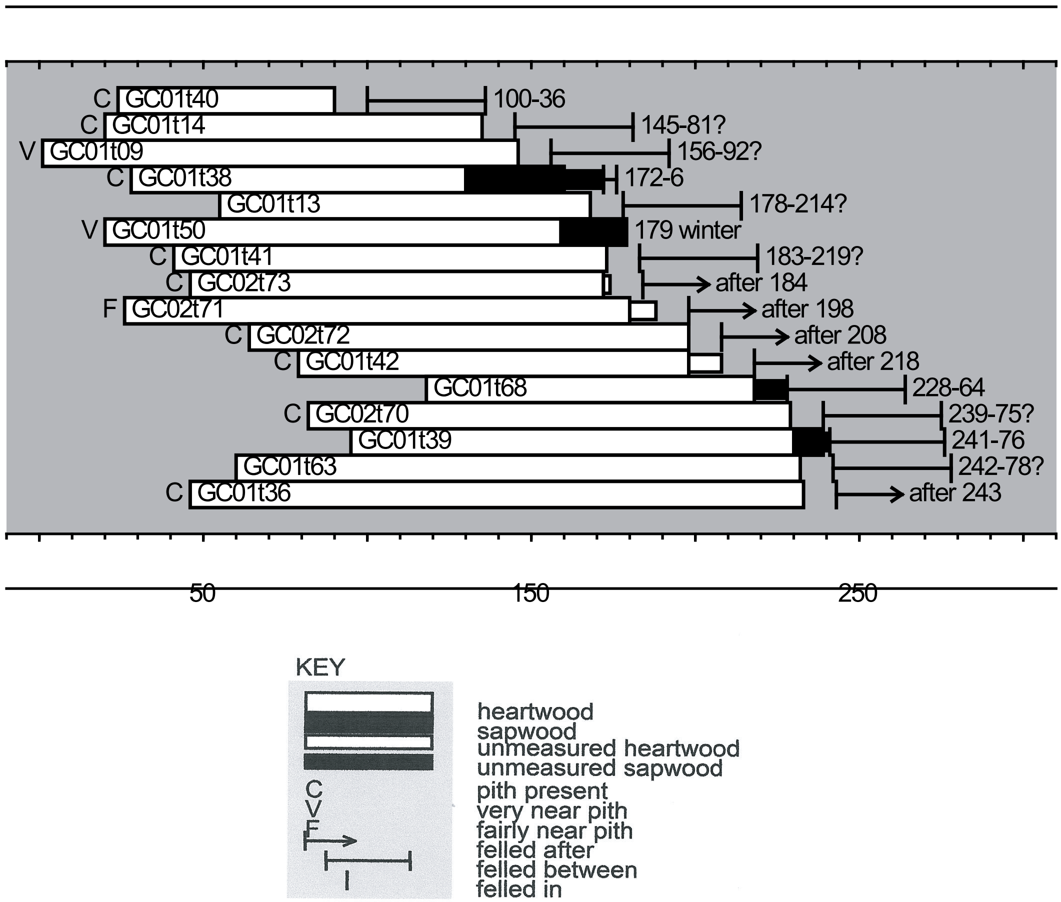


Figure 8.3 Bar diagram showing the chronological positions of the cross-matched trees from the Goldcliff East, Upper Submerged Forest. Estimated felling periods are shown in relative years. The start of each tree-ring width series relative to the pith of the tree is indicated (see key) (graphic N Nayling)

die within the date range of relative years 100–36. Six of the trees may have died between relative years 170–220 including Tree 38 in 172–6, Tree 50 in the winter of 179 and four trees for which possible date ranges can be applied as possible heartwood/sapwood boundaries were present (Trees 14, 09, 13, and 41). Date ranges for the demise of Trees 73, 71, 72, and 42 cannot be given as the trees were too poorly preserved. The death of two trees with partially surviving sapwood (68 and 39) took place between relative years 228–64 and 241–76 respectively. Possible heartwood/sapwood boundaries on samples from two unstratified trees (63 and 70) suggest these also died in the mid-200s.

One of the characteristic features of the growth pattern of subfossil oaks recovered from peat horizons (often termed 'bog oaks') is the presence of periods of suppressed growth. These have most usually been interpreted as reflecting periods of increased wetness through heightened groundwater levels leading to anoxic conditions in the vicinity of the roots (Sass-Klaassen *et al* 2004). In a coastal context, an additional growth constraint may be increased salinity of groundwater.

Marked suppressions in growth in multiple trees within the cross-matched group were noted in relative years 86, 96, 109, and 145. Four trees exhibit suppressed growth after relative year 200, from Tree 70 in the east to Tree 36 in the west, a distance of some 460m; the others were Tree 39 and unstratified Tree 68. As these tree-ring sequences have not been absolutely dated, it is not possible to differentiate here between climatic events which may have affected tree growth, and other disturbance factors such as rising water tables which might relate to storm surges etc. Other variables, such as insect infestations, could also have played a role in restricting tree growth.

In constrast to the Upper Submerged Forest, the trees recorded from the Lower Submerged Forest were in a relatively highly eroded state. This is reflected in the absence of the pith in any of the samples cross-matched to form the floating mean for this exposure (Fig 8.1). This restricts useful comment on the relative date of inception of growth. Examination of the individual tree-ring width series suggests relatively even growth although Trees 46, 77, 80, and 96 do exhibit falling average ring widths in the first few recorded decades suggesting the presence of growth trends. These are amongst the earliest trees recorded and could be seen as a cohort of trees which began growing in relatively open conditions *c* 6206±4 cal BC with growth rates declining as forest developed and the trees matured. The latest tree is clearly 86 which appears to have begun growth shortly before relative year 250 (*c* 5950 BC), suggesting that the germination of new trees continued even after the establishment of oak dominated woodland in the area.

Six of the relatively dated oaks from the Lower Submerged Forest may have surviving heartwood/sapwood boundaries and estimated date ranges for their deaths are given in Figure 8.1. If these date ranges are correct, then clearly no single event led to the deaths of these trees. The latest tree (86) may have been lying within estuarine silts suggesting marine transgression as a cause of death. For earlier trees, the situation is perhaps less clear. Some of these trees must have lain on the forest floor as deadwood for decades, if not centuries, having succumbed to other causes of death such as storms and fungal infection.

8.1.6 Conclusions

The dendrochronological survey of the Lower Submerged Forest proved very successful. A high proportion of the sampled trees (fifteen out of eighteen) cross-matched against each other, usually with relatively high *t*-values, and the resultant mean ring width series for the Lower Submerged Forest has shown high correlation against not only the nearby Redwick mean but also Gravel Banks on the other side of the Severn Estuary. Apparent correlation against the more distant Bouldnor Cliff sequence suggests that eventually teleconnections between quite distant sequences, which at present predate purely dendrochronologically dated oak chronologies for Britain and Ireland, may permit correlation against lengthier continental tree-ring series. In advance of either, continuous extension of existing British oak chronologies back to the earlier 6th millennium BC, or correlation with such distant continental chronologies, dating of the floating Mesolithic oak sequences generated at Goldcliff and elsewhere in the Severn Estuary will require programs of radiocarbon dating of decadal blocks of tree-rings as described below.

Dendrochronological analyses of the apparently better preserved trees within the Upper Submerged Forest proved more problematic. Bands of narrow rings often made reliable measurement of sequences difficult and a lower proportion of the trees were cross-matched against each other, generally with lower *t*-values between trees. Such difficulties will, in part at least, be a reflection of variables such as localised response to changes in hydrology and immediate habitat, and chronological variance within the peat horizons from which the trees came. The results point to the chronological and spatial complexity which exists within submerged forest exposures which are not readily apparent and may only become clear through detailed dendrochronological survey of the type carried out at Goldcliff. The role of relative sea-level rise and disturbance events such as storms on the local hydrology (and hence ring width sequences of the oak trees growing on the coastal margin) is likely to lead to oak chronologies from coastal bogs not correlating against contemporary, absolutely-dated tree-ring chronologies where these exist. Again, the lack of such correlations for the ring width sequence from the Upper Submerged Forest has required wiggle-match radiocarbon dating of decadal blocks of one of the trees (Tree 36) making up the chronology and one of the trees (Tree 8) which did not cross-match.

8.2 Radiocarbon 'wiggle-match' dating the submerged forests *by S Manning, B Kromer, C Bronk Ramsey, C L Pearson, and S Talamo*

8.2.1 Aims and methods

Tree-ring radiocarbon wiggle-matching

The Lower and Upper Submerged Forests were extensively sampled for dendrochronology, and floating tree-ring sequences were established for each as described above by Nigel Nayling. However, it has not (so far) proved possible to link these tree-ring sequences with other absolutely dated tree-ring chronologies from either the British Isles or north-west Europe so as to define calendar dates for the samples and their contexts. Anticipating this problem, a programme of high-precision radiocarbon dating was undertaken at the Heidelberg Radiocarbon Laboratory on samples from three of the trees (Table 8.2; CD 8.7–8.13) investigated in order to obtain relative dendrochronologically defined radiocarbon sequences (time series) from the submerged forests – these relative time series can then be compared with, and placed against, the internationally standard absolutely dated radiocarbon time series available from the northern hemisphere (the radiocarbon calibration curve). This process has come to be called 'wiggle-matching', and it allows a relative dendrochronologically defined radiocarbon time series to be placed within narrow margins into calendar year terms (on wiggle-matching, see eg Pearson 1986; Bronk Ramsey *et al* 2001; Manning *et al* 2001; Galimberti *et al* 2004). See CD 8.14 for an example of how wiggle-matching places a sequence of radiocarbon ages of known relative spacing vis à vis each other against the calibration curve.

Dendrochronologically measured oak samples were marked to annual increments and then dissected with a steel blade under a low-power binocular microscope as precisely as possible into near ten-year samples (dictated by sometimes variable wood quality and other sample specific factors). Oak is sometimes difficult to separate exactly on annual boundaries,

Table 8.2 Goldcliff East radiocarbon dates from archaeological contexts, palaeoenvironmental sequences, and 'wiggle-matched' dated trees. The table also shows dates from Tree 77 at Redwick, which cross-match with the Lower Submerged Forest trees at Goldcliff East

Site	Start/End ring	^{14}C date BP	Lab Code	Cal BC 2σ	Fig no	Monolith	depth cm	Artefact no	Context	Material
Goldcliff A		6629±38	OxA-13928	5630–5480	5.6a			3325	315, Sq 3/3	*Corylus* nut
Goldcliff B		6871±33	OxA-12357	5840–5670	3.9	4070	6-6.5		319	peat/charcoal
Goldcliff B		7002±35	OxA-13927	5990–5790	3.5			4047	321, Sq 5/7	*Corylus* nut
Goldcliff D		6726±33	OxA-12358	5720–5560	3.17	4071	6-6.5		345, top	plant remains
Goldcliff D		6790± 38	OxA-12359	5740–5630	3.17	4071	12.5-13		345 bottom	plant remains
Goldcliff near D		6770±70	Beta-60761	5800–5540	Allen, 2000, 2.1				Lower Submerged Forest in peat	*Quercus* wood
Goldcliff near D		6480±70	CAR-1502	5610-5310	3.2				charcoal below peat	charcoal
Goldcliff E		7300±55	OxA-14037	6340–6030	4.8	5633	13.5-14		357	plant remains
Goldcliff J		5934±39	OxA-15549	4940–4710	6.2, 10.1			9199	328	Wood unid
Goldcliff J		5930±37	OxA-15550	4910–4710	6.21, 6.25, 10.2			9224	331/327	*Quercus* wood
Goldcliff J		4978±27	OxA-14023	3910–3660	6.6, 6.10	5640	26		327	charcoal
Goldcliff J Pit		5061±21	OxA-12355	3950–3790	6.6, 6.9	5125	4		327	peat/wood
		5138±31	OxA-13932	4040–3800	6.6, 6.9	5125	34		327	*Alnus* catkin
		5213±23	OxA-13520	4045–3965	6.6, 6.9	5125	41		327	*Betula* seeds
		5439±22	OxA-13933	4345–4255	6.6, 6.9	5125	50		327	*Rubus* seeds
		5749±23	OxA-12356	4690–4530	6.6, 6.9	5125	82		327	reed peat
		5730±33	OxA-13934	4690–4490	6.6, 6.9	5125	91		362	*Carex*
Goldcliff J Tree 8 Wiggle-match dating	40–50	5292±20	Hd-23728	see text	6.16				327 Upper Peat	*Quercus* wood
	80–90	5230±16	Hd-23725	see text	6.16				327 Upper Peat	*Quercus* wood
	110–120	5245±14	Hd-23722	see text	6.16				327 Upper Peat	*Quercus* wood
	140–150	5183±19	Hd-23726	see text	6.16				327 Upper Peat	*Quercus* wood
	170–180	5073±13	Hd-23719	see text	6.16				327 Upper Peat	*Quercus* wood
Goldcliff Tree 36 Wiggle-match dating	92–101	5515±20	Hd-23257	see text	7.3				Upper Submerged Forest	*Quercus* wood
	112–121	5417±28	Hd-23259	see text	7.3				Upper Submerged Forest	*Quercus* wood
	122–131	5390±22	Hd-23258	see text	7.3				Upper Submerged Forest	*Quercus* wood
	132–141	5399±22	Hd-23222	see text	7.3				Upper Submerged Forest	*Quercus* wood
	142–151	5428±22	Hd-23256	see text	7.3				Upper Submerged Forest	*Quercus* wood
	152–161	5425±24	Hd-23263	see text	7.3				Upper Submerged Forest	*Quercus* wood
	162–171	5506±26	Hd-23264	see text	7.3				Upper Submerged Forest	*Quercus* wood
	172–181	5490±24	Hd-23260	see text	7.3				Upper Submerged Forest	*Quercus* wood
Redwick Tree 77 Wiggle-match dating	241–231	7076±15	Hd-22314	see text	Bell 2000a, fig 3				Lower Submerged Forest	*Quercus* wood
	251–242	7071±18	Hd-22410	see text	Bell 2000a, fig 3				Lower Submerged Forest	*Quercus* wood
	261–254	7130±20	Hd-22411	see text	Bell 2000a, fig 3				Lower Submerged Forest	*Quercus* wood
	270–262	7122±17	Hd-22296	see text	Bell 2000a, fig 3				Lower Submerged Forest	*Quercus* wood
	320–311	7048±15	Hd-22313	see text	Bell 2000a, fig 3				Lower Submerged Forest	*Quercus* wood
	351–342	7011±18	Hd-22295	see text	Bell 2000a, fig 3				Lower Submerged Forest	*Quercus* wood

Note: for other Goldcliff East radiocarbon dates see Smith and Morgan (1989); these dates are also summarised in Bell *et al* 2000, appendix II, which additionally presents a large number of dates from west of Goldcliff island. Dates are calibrated using atmospheric data from Reimer *et al* (2004), and OxCal v3.10 (Bronk Ramsey, 2005) with curve resolution set at 5 (the program default) and round ranges 'on' lacking the distinct physical cleavage properties of coniferous trees for example. However, we believe we achieved close to precise rings. Even so, minimal contamination from, or to, the previous ring cannot be entirely avoided at the beginning and end of each of the ten-year samples taken. Nevertheless, this issue should be relatively insignificant to the present dating exercise based on decadal-scale samples, since such possible dissection error comprises at most a very tiny fraction of the overall approximately decadal timeframe of the samples. Furthermore, any possible variation would effectively be undetectable in terms of the radiocarbon measurements.

Pre-treatment of the samples comprised the modified acid-alkaline-acid (AAA) procedure (80° of 4% NaOH overnight, 30 minutes at 80° of 4% HCl, 1.5 hours at 80° of 4% NaOH, 30 minutes at 80° of 4% HCl). In this process, a full-sized sample (15 to 20g of dry wood) delivers 4g of carbon. The samples were combusted in a 1.8 litre Parr bomb. The original procedure (Dörr *et al* 1989) was modified by adding an additional precipitation step to guarantee highest possible gas purity for large (10 litre) CO_2 gas samples. CO_2 gas obtained by acidifying the precipitate is purified chromatographically over activated charcoal.

The samples were counted for eight to thirteen days in proportional counters in the Heidelberg Laboratory sub-basement counting room. Background and standard are corrected for (minor) fluctuations in atmospheric pressure and gas purity, respectively (Kromer and Münnich 1992). Typical precision is about 1.5‰ at 1σ.

Other radiocarbon dates and sequences

A series of radiocarbon determinations were obtained on samples from the archaeological and palaeoenvironmental research by the project; all these dates are presented in Table 8.2. A sequence of 21 dates for peats at Goldcliff East was published by Smith and Morgan (1989) and these and many dates for archaeological sites west of the former Goldcliff island are published in Bell *et al* (2000, Appendix 2). These earlier publications complement the evidence presented here and together provide a well dated record of environmental change and human activity in the Goldcliff area. The new non-tree-ring dates for this project were run at the Oxford Radiocarbon Accelerator Unit following their standard procedures (see Bronk Ramsey *et al* 2002:1–4 and further refs; Bronk Ramsey *et al* 2004). The aim of analysis here is to consider one set from Pit J at Goldcliff to see whether these data can offer clear and concise dating information relevant to interpretation of stratigraphic relationships.

Analysis and calibration

Bayesian probability analysis and calibration were carried out employing the OxCal software (Bronk Ramsey 1995; 2001 – using v.10 of 2005 – settings: Cubic Interpolation 'on', Resolution set at 1). The appropriate radiocarbon calibration curve for analysis is a more difficult issue. In principle we have used the (as of AD 2005) new internationally recommended IntCal04 dataset (Reimer *et al* 2004). However, as we discuss in the next paragraphs, this project in fact highlights some potential problems in certain circumstances with the naive use of IntCal04 when dealing with fixed sequence dendrochronological wiggle-match radiocarbon dating. This relates to the fact that IntCal04 is a smoothed and interpolated curve of five-year points; thus it may sometimes downplay actual features – wiggles – in the calibration record, and also not always offer the best 'match' for data measured on fixed sequences of 10-year samples (see below). The authors of IntCal04 were aware of some such issues, and the alternative of a full Bayesian analysis incorporating both the fitted data and all the original calibration data was noted (Reimer *et al* 2004, 1037). However, in the absence of undertaking such an analysis here, we have in some cases preferred the dates given from either the previous non-smoothed decadal scale IntCal98 calibration curve (Stuiver *et al* 1998a), or the use of the Belfast Laboratory (UB) data solely on British Isles Oak (on the basis that similar wood from a relatively similar location is being used – UB data extracted from those employed in IntCal04 and referred to below as UB_04). Another occasionally possibly relevant issue can be small regional offsets in contemporary radiocarbon levels and/or inter-laboratory differences, typically at times of steep slopes in the radiocarbon calibration curve (which correspond with major solar minima, ie cooling, episodes: eg Kromer *et al* 2001). Such factors can sometimes help to create ambiguous situations leading to incorrect placements of a set of data from one region or laboratory versus the calibration curve's set of values at times of major 'wiggles' in the calibration curve. An example of this problem is shown in CD 8.15 for the period early in the 3rd millennium BC.

To test and establish the robustness of conclusions reported in this study we considered the wiggle-matches against three datasets (IntCal04, IntCal98, and what we term above UB_04) before then reaching a calendar placement interpretation.

With regard to the tree-ring samples, this project sought to obtain approximately decadal-scale information on the unknown-age samples in order to compare these with the calibration curve constructed from high-precision radiocarbon measurements made at a similar temporal resolution on known-age wood. The process of wiggle-matching, when one attempts to correlate the sequence from the unknown-age sample against the known age calibration curve, is sensitive to the shape and modelling of the calibration curve. The IntCal98 radiocarbon calibration curve was a ragged one comprising ten-year points (made up of an average of the relevant values within the interval). In contrast, the IntCal04 curve is a much more sophisticated statistical artefact and offers five-year data points and overall a much smoother curve – thanks to the

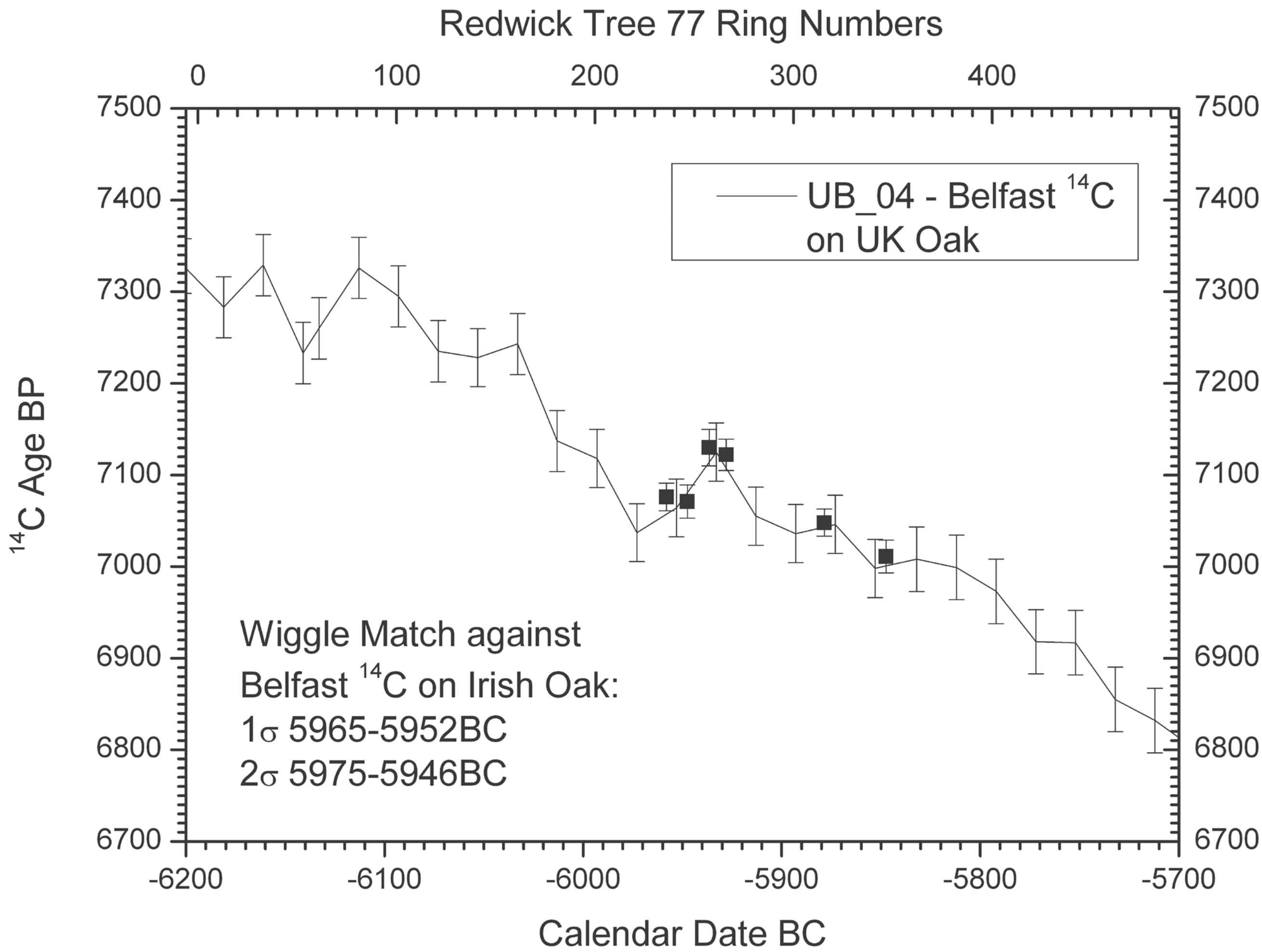


Figure 8.4 Very successful wiggle-match of the Redwick Tree 77 sequence against the Belfast ^{14}C measurements on British Isles Oak. On this best fit ring 236 of Tree 77 is placed at 5958.5 cal BC (graphic S Manning)

curve being conditioned at any point by a moving window of the surrounding data. The logic is impeccable. The trouble is that when we came to try to wiggle-match some of the Severn sequences to the calibration curve it was simply not possible to get a satisfactory outcome with IntCal04 (meaning the data and calibration curve are clearly not describing the same information) – whereas a highly satisfactory fit resulted when IntCal98, or the Belfast British Isles Oak measurements, were employed instead.

CD 8.16 shows the relation of IntCal04 to IntCal98 for the period of main interest here. The main plot shows that, in general, the two curves are very similar. However, as the two insets show, some periods, in detail, exhibit significant variation. For the period 6200–5800 cal BC, for example, the IntCal04 radiocarbon ages are typically slightly more recent than those in IntCal98 (which means calibrated ages will be slightly older), and, most important here, the marked wiggles at 6035 BC and 5935 BC (and the small intervening one at 5995 BC) in IntCal98 are largely lost in IntCal04.

In practice this can lead both to a wiggle-match sequence which offers good agreement with IntCal98 and yet fails an agreement test altogether against IntCal04, and/or to preferred dates some 50 calendar years apart when a tree-ring sequence that seems to lie around a wiggly interval clear in IntCal98 is then dated using IntCal04. Redwick Tree 77, discussed below, illustrates both points. In such circumstances, we have chosen to use the IntCal98 based dating or the Belfast measurements on British Isles Oak as the preferred dates, believing we are more nearly matching like data with like data.

8.2.2 The Lower Submerged Forest, dating Tree 77 at Redwick

Tree 77 is a long-lived oak (CD 8.2–8.3; 8.7–8.9) with 396 rings preserved from an originally older tree (pith not preserved and first 15 surviving heartwood rings compressed and not measured), forming one of the longer elements of the floating Redwick dendrochronology (comprising 53 trees) belonging to the

Lower Submerged Forest described by Nigel Nayling (above). The inner preserved rings of the tree lie at the beginning of the main extant dendrochronological sequence for Redwick (relative year 1), and the outermost preserved rings reach within a few decades of the known end of the Redwick forest group – a 428-year chronology in total (and, estimating missing sapwood to bark-edge, Tree 77 dies around, or just after, relative years 406–42 of the chronology, CD 8.8). This tree thus largely represents the lifetime of the Lower Submerged Forest at Redwick. The Redwick sequence cross-matches with the Lower Submerged Forest at Goldcliff East (Goldcliff sequence starting at Redwick chronology relative year 27 and ending at Redwick chronology relative year 381 = last (heartwood/sapwood boundary?) ring of Tree 86 (which allowing for the possible presence of the heartwood/sapwood boundary might therefore have had a latest possible date of relative year 427, CD 8.8). It also cross-matches with sequences known from Gravel Banks (Severn Estuary) and Bouldnor Cliff (Isle of Wight): see Nayling above.

Six samples from within the Tree 77 sequence (CD 8.9) were dissected and radiocarbon dated in order to determine the approximate calendar age of the tree: see Table 8.2. This sequence was then compared with IntCal04, but does not offer a satisfactory fit. The correlation fails a Chi-Square test at 95% confidence, and no fewer than three of the six samples offer individual agreement levels below the OxCal threshold of 60% – which approximates to a *c* 95% confidence threshold. In contrast, the sequence offers a good fit against either the IntCal98 calibration curve, or especially the Queen's University Belfast calibration dataset (QUB) on British Isles Oak – in particular picking up a significant 'wiggle' feature present in IntCal98 and the UB_04 datasets but much smoothed away in IntCal04 (see Fig 8.4; CD 8.17–8.20; note: any run of such an analysis offers a very slightly different outcome; typical examples shown in CD 8.20).

Taking the IntCal98/QUB_04 dating as the likely correct one, this places the overall 396-year (plus missing wood both to pith and to sapwood) Redwick Tree 77 chronology, and so the majority of the Lower Submerged Forest within (overall maximum) 2σ (95.4%) confidence limits of *c* 6210/6202 cal BC to *c* 5815/5807cal BC. Based on Nayling's analysis (see above) the Lower Submerged Forest thus began an unknown time before about 6210/6202 to 6186/6181 cal BC (in the absence of secure pith dates from any tree in the Redwick chronology) and ends as an entity around or before 5739/5731 to 5715/5710 cal BC (date for ring = relative year 472 as the conjectured last possible sapwood ring of the overall Redwick dendrochronology – the Goldcliff Lower Submerged Forest ends 45 years earlier), and maybe in reality somewhere in the decade before given the pattern of last conjectured dates for several other trees (dates above based on the 2σ ranges). The latest relatively dated tree from the Goldcliff Lower Submerged Forest (Tree 86) probably dies in the date range of relative years 391–427, which suggests the demise of the Goldcliff forest shortly before the death of Redwick Tree 77 (last surviving ring at relative year 396, death probably in years 406–442). Other trees show the forest at Redwick attested even a little later and with missing sapwood the maximum date is probably relative year 472 (dated above). It should be noted that wiggle-match radiocarbon dates on a section of oak from Bouldnor Cliff – which cross-matches dendrochronologically with the Redwick chronology is currently underway and the result will offer a nice test of the proposed dates above, and the suggested resolution of the ambiguity issue noted above.

8.2.3 The Upper Submerged Forest, Tree 36 at Goldcliff East

Tree 36 (Fig 7.2; CD 7.4–7.5) is an oak with 188 preserved rings from the floating Upper Submerged Forest chronology at Goldcliff (see Nayling above). The extant Tree 36 sequence runs from relative years 46 to 233 (with minimum date of tree death after that at relative year 243; CD 8.10) of the Goldcliff East floating chronology. The death of Tree 36 thus lies within six years of the most recent ring of the floating Goldcliff Upper Submerged Forest (from Tree 39) based on samples currently known (see Nayling above) – to which missing sapwood must be added as an estimate of date of tree death (minimum of 10 to a maximum of 46 annual growth rings: see Nayling above).

Eight samples from within the Tree 36 sequence were dissected and radiocarbon dated in order to determine the approximate calendar age of the tree: see Table 8.2. This sequence forms a fairly obvious 'U' shape in graphical terms on the ^{14}C age scale, and therefore must fit somewhere on the radiocarbon calibration curve where there is a compatible feature. At the same time, such a specific pattern across a relatively short period with markedly changing ^{14}C levels will often prove difficult for a precise wiggle-match that meets statistical agreement levels as even a small 'miss' will tend to be exaggerated. In this case comparison of the Goldcliff Tree 36 sequence to the IntCal04, IntCal98, and QUB_04 datasets results in very similar outcomes, but in two cases with unsatisfactory levels of agreement (see CD 8.20). The problem is data which sometimes misses the beginning slope and ending wiggle of the 'U' shape (CD 8.21). Nonetheless, despite these minor problems, it is clear that this sequence can only fit in the approximate area shown for its fit in CD 8.21. We use the fit versus IntCal98 for convenience as the 'best' quality fit and as in the middle range of the fits described for the three calibration datasets employed in CD 8.20. Thus Tree 36 grew from *c* 4440–4425 cal BC to after *c* 4253–4238 cal BC at 2σ (95.4%) confidence. In turn, based on Nayling's analysis (above), this suggests a date around 4485–4470 cal BC for the development of the Upper Submerged Forest (relative year 1 in the extant

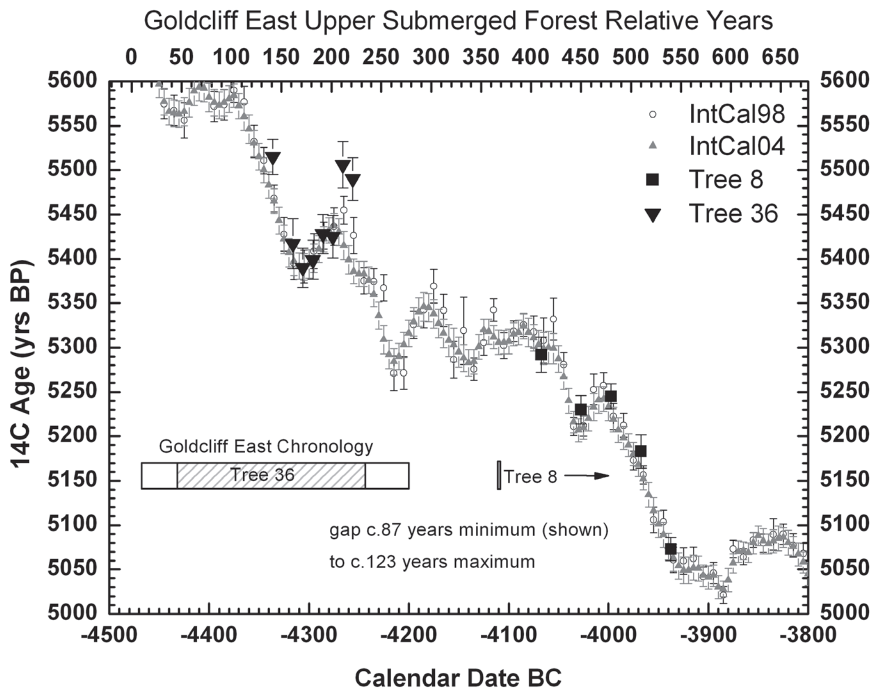


Figure 8.5 Comparison of the wiggle-match placements of Goldcliff Tree 36 (CD 8.20) and Tree 8 (CD 8.21). The calendar scale errors on the wiggle-match placements shown at 2σ (95.4%) confidence are on average less than ±8 years. The apparent calendar time interval between the estimated latest possible end of the Goldcliff East Upper Submerged Forest sequence (relative ring 278) and the record comprising Tree 8 is about 87 years at a minimum (shown above) and 123 years at a maximum (graphic S Manning)

floating Goldcliff East chronology), and a date after 4247–4232 cal BC for its end at 2σ (95.4%) confidence (with a likely latest possible date, based on the maximum sapwood estimate available from Tree 63, of 4208–4193 cal BC).

8.2.4 Site J, Upper Submerged Forest, Tree 8 at Goldcliff East

Tree 8 from Site J, Goldcliff East, is a long-lived oak (CD 6.25–6.26) which has not been successfully linked into the Upper Submerged Forest floating dendrochronology. It was measured from pith (ring 1) out to ring 198 including 14 sapwood rings. Subsequent rings to bark-edge could neither be counted nor measured as they were completely compressed. If we employ the (total) sapwood estimate of 10–46 sapwood rings, it would appear likely that Tree 8 died no later than 32 years after the last measured ring (by relative year 230). The specific interest in dating this tree, apart from trying to elaborate a comparison with the date for the Upper Submerged Forest, exists because Tree 8 is immediately adjacent to the key environmental sequence from Pit J reported in Chapters 15 and 16.

The five data from Goldcliff Tree 8 are the least problematic of the wiggle-match cases: they clearly and comfortably lie down a marked slope in the radiocarbon calibration curve. All three calibration datasets employed in CD 8.20 offer very similar wiggle-match results, with the highest agreement coming from the Belfast data on British Isles Oaks (this places ring 45 of the tree at 4074–4061 cal BC at 2σ (95.4%) confidence level). This best dating is (arbitrarily) thus employed in CD 8.22 to show this wiggle-match. The preserved Goldcliff Tree 8 thus dates around 4118–4105 cal BC to 3920–3907 cal BC at 2σ (95.4%) confidence level. The latest possible date of death is probably 3888–3875 cal BC.

The two wiggle-matched trees from the Upper Submerged forest at Goldcliff together offer the calendar placements and relations shown in Figure 8.5.

8.2.5 Goldcliff Pit J sequence

A sequence of radiocarbon measurements was obtained from Monolith 5125 extracted from Pit J at Goldcliff (Chapters 6 and 15): see Table 8.2. Another sample (OxA-14023) was also obtained from Monolith 5640 some 6m away from where peat started to form later on a sloping surface in this area (Fig 6.8). We considered the relative (intervals variable) sequence of data in Pit J and

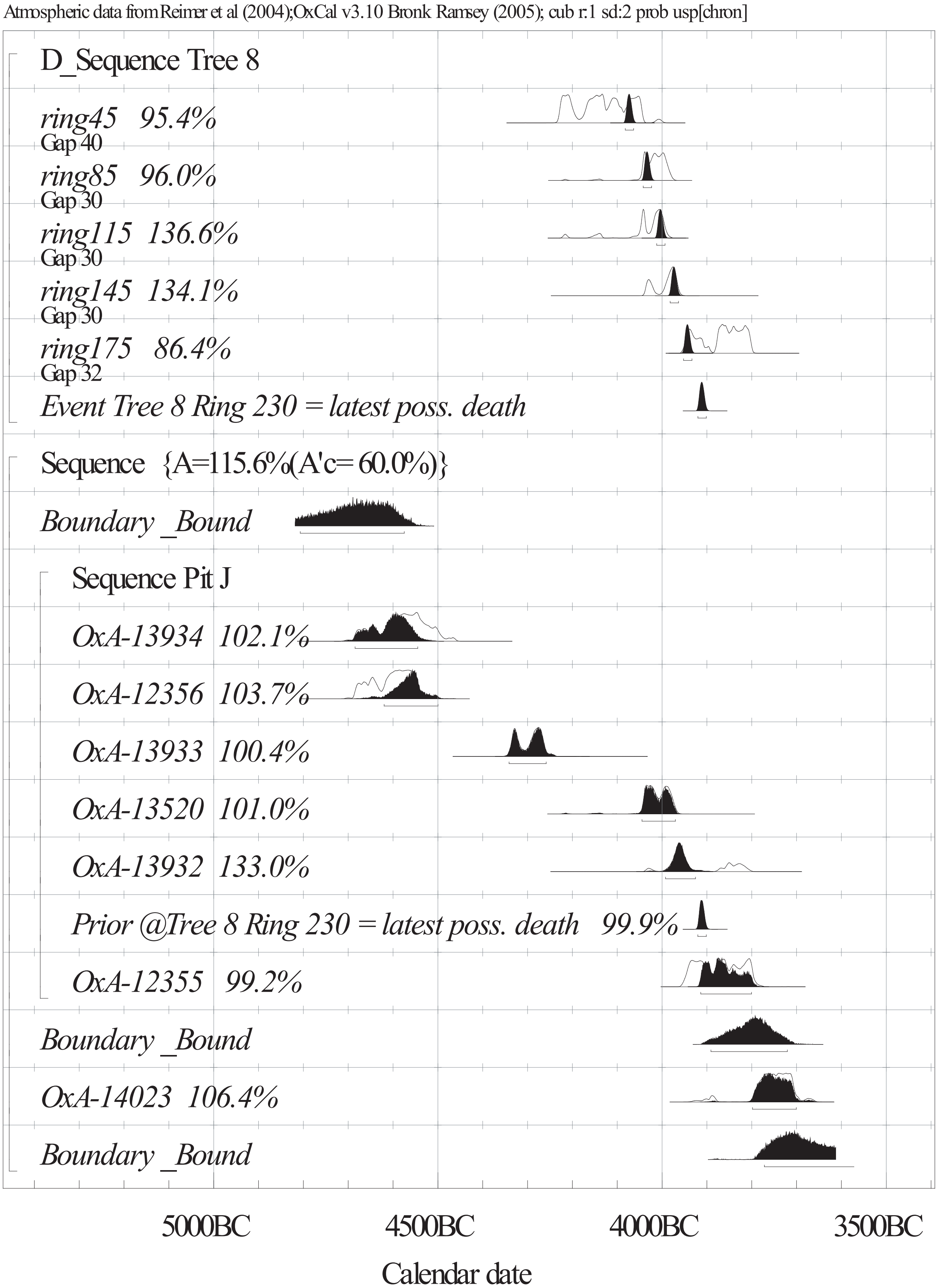


Figure 8.6 Comparison of the wiggle-match placement of Tree 8's latest possible age of death against the Pit J sequence (using IntCal04 for both). Ring 230 fits shortly before, or as contemporary with, the end of the Pit J sequence as represented by OxA-12355. It is assumed to be a prior event in the sequence shown – thus the interval calculated by this model for the time period between OxA-12355 and OxA-14023 should be a minimum value (see text above and CD 8.12–8.13) (graphic S Manning)

quantified the likely interval in calendar time between the end of the Monolith 5125 sequence (represented by OxA-12355) and sample OxA-14023 using the OxCal 'Sequence' and 'Difference' functions as: 80–189 years at 1σ (68.2%) confidence and 34–225 years at 2σ (95.4%) confidence (see Table 8.2 and CD 8.23–8.24). Adding in the likely position of Tree 8's final possible year of life as an additional effective prior element in the Pit J sequence before OxA-12355 (see Fig 8.6), this interval becomes, at a minimum therefore, around 73–158 years at 1σ (68.2%) confidence and around 31–192 years at 2σ (95.4%) confidence (note: each run of such a sequence yields very slightly different outcomes within a range of a couple of years maximum). We can also employ the stratigraphic sequence to refine slightly the dating of the Pit J series as shown in CD 8.25. When we compare the Pit J dates versus the placement of Tree 8 (Fig 8.6) we can observe that Tree 8 grew in the period from before OxA-13520 at 41cm through to around the end of this sequence, with the tree's death most likely shortly before the horizon at 4cm represented by OxA-12355. When we compare with Tree 36, we see that this tree's 188 extant rings lie in the middle of the Pit J sequence, from before, contemporary with, and after sample OxA-13933.

8.2.6 Conclusions

Important but presently floating dendrochronological samples and sequences from the Upper and Lower Submerged Forests have been dated through use of fixed sequence radiocarbon wiggle-matching. Closely defined calendar dates (CD 8.26) have been determined which place and anchor the tree-ring samples and chronologies constructed by Nayling (above). However, this exercise also illustrates some potential complications that may sometimes apply, in particular to relatively short sequences where one particular feature – a 'wiggle' – in the radiocarbon calibration record may, or may not, be crucial to the specific dating.

Notwithstanding the difficulties and the uncertainty involved in the estimation of missing sapwood etc, this exercise has provided close dates for both the Upper and Lower Submerged Forests. The existing dates given here (CD 8.26) may come to be refined a little in the light of a dating exercise on the floating tree-ring sequences from Bouldnor Cliff, Isle of Wight, with which the Goldcliff/Redwick tree-ring sequence cross-matches. The cross-matching of these sites (both associated with Mesolithic activity) highlights the potential of submerged forests to chronological advances in prehistory.

9 Goldcliff lithic artefacts *by R N E Barton with contributions by J R L Allen, A van Gijn, and M Bell*

9.1 The lithic assemblage *by R N E Barton*

9.1.1 Introduction

The lithic artefacts described here are divided into their different constituent site assemblages (A, B, D, and J). The exceptions are a small number of significant stray finds that are treated on an individual basis. Where internal stratigraphic divisions have been recognised, as in Sites J and B, the assemblages are described according to the earliest to youngest contexts in which they were recovered. To facilitate comparisons with other sections of this monograph, the main lithic assemblages are presented in their presumed chronological order (Site B, D, A, and J), according to stratigraphic evidence and radiocarbon dating.

For each site, identification of the artefacts falls into two principal groups of *debitage* and *retouched tools*. Whereas debitage (CD 9.1) consists of all primary products of the flaking process, items that have been modified, either by secondary chipping or deliberate breakage, are classified as retouched tools (CD 9.2). For convenience, the latter also includes examples of the incidental by-products of tool manufacture such as microburins and retouch chips. The artefact descriptions given broadly follow the technological and typological conventions developed for the Mesolithic by Clark (1932) and slightly adapted by the author (Barton 1992; Barton *et al* 1995; Barton 2000).

A selection of lithic artefacts was submitted to Dr Annelou van Gijn for microscopic analysis of use wear, the artefacts in question are noted below and the microwear report follows this contribution.

9.1.2 Raw material

The knapped raw material consists principally of flint and chert with very small amounts of tuff and other stone such as quartzite. The flints and cherts that make up the majority of the flaked artefacts derive from pebbles and small cobbles with characteristically rounded exterior surfaces and displaying varying thicknesses of cortex. The pebbles would appear to be locally derived from marine and fluvial gravels (Allen pers comm). In contrast to their rolled exteriors, the interior flaked surfaces of the flints and cherts are generally sharp and show little obvious signs of post-depositional alteration caused by hydraulic movement or other processes. Most of the lithic artefacts are of a translucent grey-black flint but a substantial component is also made up of chert, which is generally darker and of a coarser nature. A small representative sample of the artefacts was sent to Professor J R L Allen for identification and this provided an invaluable reference collection against which all artefacts were compared by the author of this report. While it was generally possible to separate the pieces into flint and chert, it has to be acknowledged that it was not always possible to distinguish between the two, especially when it came to the identification of minute fragments. In these cases artefacts were simply placed in a third undifferentiated category of flint/chert.

Two supplementary observations may be made here. First, a small amount of Greensand chert was identified in the collections, which could potentially indicate the exploitation of relatively distant sources of raw material from North Somerset or the Avon basin (Barton *et al* 1995). However, given the fact that they were mainly undiagnostic flakes and fragments it would seem more likely that the materials derived from the same local gravels as the rest of the lithics. Second, none of the translucent honey coloured flints reported previously in the nearby Hill Farm assemblage (Bell *et al* 2000, 39) has been identified in this analysis. The source of this material remains unknown.

9.1.3 Site B, Context 321

The excavation and stratigraphic contexts of Site B have been presented in Chapter 3.3.2 and the assemblage is tabulated on CD 9.1–9.3. Context 321 is a minerogenic Old Land Surface (OLS) underlying a peat. The debitage (CD 9.3) includes only eight flakes of which two are of flint, three of chert, and three of an undifferentiated flint/chert. The bladelets are of chert (one) and either flint or chert (two). The main differences lie in the relatively large number of chips recovered. These are mainly of flint (seventeen), with only one chip certainly identified as chert. A potentially significant distinction, however, is that the majority of chips are heavily rolled and do not share the same surface condition as the rest of the artefacts which are relatively sharp and of fresh appearance. This strongly suggests that they were the result of different accumulation processes and it may imply that the chips and the rest of the assemblage are not contemporary. Three single platform cores (two of flint, the other one of uncertain flint/chert type), SITE B

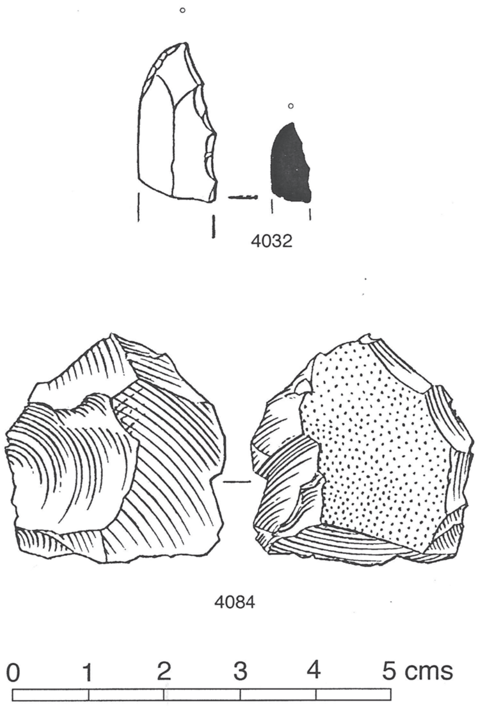


Figure 9.1 Goldcliff East, lithics from Site B (4032 – silhouette represents actual size): scale 1:1 (drawing H Martingell)

an unidentified core fragment and a tested nodule form the remainder of the debitage.

One flint microlith tip is all that was found in this group. It preserves a microburin facet but otherwise does not fall within a classifiable type category. The only other retouched tool is a notch on a chert flake. Of particular interest is the collection of non-flaked stone artefacts from this location. They comprise a hammerstone, a possible rubber and three split elongate cobbles. There is also a sub-rectangular cobble. Although the function of these items is unclear, it seems unlikely that they were connected with flaking activities at this site.

9.1.4 Site B, Context 319

A similarly restricted sample of finds comes from the thin peat deposit that overlies the OLS (CD 9.1–9.3). The peat contains a thin scatter of artefacts consisting almost entirely of debitage. There are only seven flakes, of which four are of flint and the rest of chert. There is a single multiplatform discoidal core, also of chert (Fig 9.1, 4084). No attempt was made to refit the flakes to this core. Only one retouched tool was recovered from this context. It is a broken tip possibly of a small straight-backed bladelet (Fig 9.1, 4032) but is too fragmentary to be certain. The microlith tip is made of flint and, like nearly all the other pieces in this collection, is unburnt. Only one artefact shows traces of burning: a flint chip. There is a possible hammerstone of flint or chert.

9.1.5 Site B: comments on the spatial distribution of lithic artefacts

The distribution of finds from Site B (from a thin peat layer and the underlying Old Land Surface) are presented in Figure 3.6. Except in the north central area, there is little obvious overlap between the two artefact scatters. The spatial distribution of finds shows that the lithics probably derived from separate phases of Mesolithic activity. Both of the scatters seem fairly diffuse and there is no clear focus of either knapping or tool activity, though it should be recalled that only three microliths and no by-products of their manufacture were recovered at this site. The presence of a broken microlith fragment and a retouched flake lying very close to one another on the Old Land Surface might be indicative of related tool-use but in the absence of any other finds this must remain a very tenuous connection. The only core in volcanic tuff recorded from any of the sites comes from the OLS. Its peripheral position to the rest of the scatter may explain why so few other flakes in this material were recovered.

9.1.6 Site D

Site D is described in Chapter 3.4. This assemblage consists of only four chips, a broken pebble, a pebble fragment and a small heavily rolled piece of stone. The only unambiguous evidence of human workmanship are the chips, two of which are of flint and two of undifferentiated flint/chert. None of them is burnt. The pebble fragment is fire cracked but there are no other signs that it was obviously artefactual. It is hard to draw any definite conclusions from such a restricted assemblage.

9.1.7 Site A: lithic technology

Site A is described in Chapter 5 and the lithic assemblage is tabulated on CD 9.1–9.2 and 9.4–9.5.

Flakes

Flakes (length to width ratio of less than 2:1) comprise 351 examples from all stratified contexts in Site A. Length dimensions of the artefacts varied from a maximum of 33mm to the shortest at 14mm (those < 10mm are in the separate category of 'chips' described below). The preferred shape of blank seems to have been an elongate (laminar) flake suitable for transforming into microliths.

A high proportion of flakes have either partly or wholly corticated surfaces (*c* 70%). Analysis of a sub-sample of 222 flakes revealed a surprisingly high percentage of complete specimens (51%). Of the remainder of broken pieces, there is a slightly greater representation of proximal to distal ends (45:35) with the rest consisting of mesial fragments. The presence of flexional breaks amongst the broken pieces is consistent with knapping fracture accidents

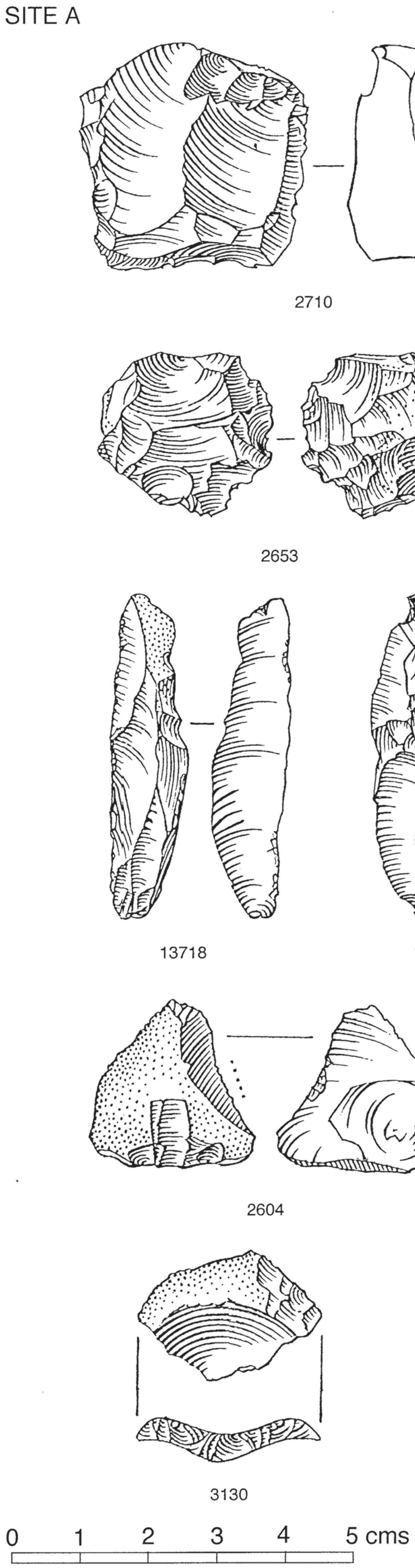


Figure 9.2 Goldcliff East, lithics from Site A: scale 1:1 (drawing H Martingell)

and together with the cortical flakes provides confirmation that primary reduction took place on site.

Analysis of the raw material suggests that 54% of flakes were of flint and 39% of chert. That the two materials could be used completely interchangeably (and thus there was little to choose between them) is suggested by the similarity in the dimension of flakes in both materials. Only a single tuff flake was recorded in the assemblage (3196). It has a curved profile with multi-directional scars on its dorsal surface and resembles a biface thinning flake. The colour and texture of the flake is very similar to an unstratified adze-like tool (Fig 9.7, 13000). Unfortunately, it was not possible to demonstrate an interconnecting refit.

Comparatively few burnt flakes (16%) were recorded in the assemblage and this is also reflected amongst the other major categories of artefact including microliths (see below).

Although most of the flakes can be seen as waste products or as unused blanks, 8 examples exhibited edge wear patterns that are consistent with use. The macroscopic wear, which ranges in type from tiny nicks and notches to continuous flake scars (Fig 9.2, 2604), was usually limited to one of the margins or the distal end. A unilaterally crested flake (13567) and a blade (3209) displayed similar damage patterns to those present on the flakes. Two of the artefacts, a flake (2262) and the crested example (Fig 9.2, 13567) were in fresh enough condition to be submitted for use-wear analyses (see below).

Blades/bladelets

Blades are artefacts that are twice as long as they are broad and normally display parallel dorsal scars. Bladelets are a sub-category of this group with width dimensions of 12mm or less. Of 32 blanks in this category, only one can be regarded as a true blade. A similar scarcity of blades and bladelets has been noted in the other Goldcliff assemblages (Barton 2000) and is a widely recognised phenomenon in Later Mesolithic assemblages across southern Britain (Pitts and Jacobi 1979). As mentioned above, preferences were shown for the production of laminar flakes, which may have been partly due to the constraints imposed by the small size of pebbles available as raw material.

Chips

Defined as tiny flakes <10mm long, these items are amongst the most common by-products of knapping activity and they form a major component of material described as micro-debitage. There are 1467 chips in the assemblage but this does not include 114 pieces of undifferentiated micro-debitage. Their presence provides some of the best evidence for manufacturing activities at the site. Of the classifiable examples, roughly 51% were of flint and 46% were of chert, though even these minor differences may be a little deceptive because of the difficulty in separating the raw material. Of perhaps greater significant are the tiny proportion of chips (~1%) with obvious signs of burning (calcined and with a crazed or cracked surface). However, it is possible that this underestimates pieces that were only lightly burnt.

Shatter

This category describes small chunks or fragments of struck material and includes burnt products that do not conform to either flakes, bladelets, or chips. Out of the 82 pieces of this type categorised 57% are burnt. There is not much difference in the representation of flint (28%) or chert (32%) but it was impossible to classify about two thirds of the material.

Cores and related forms

There are a total of nineteen artefacts in this category (CD 9.4) including a core fragment and a tested nodule with a single flake removal. All of the cores are on small water-worn pebbles with varying amounts of cortex. The cortex ranges in thickness from a thin skin to chalky rind of about 1–2mm. A majority are made on flint (11) with only six of chert. In terms of lithic sources all display varying degrees of surface rolling that typify pebbles of the local gravels, though it is conceivable that those with thicker chalk cortex have a different origin. There are no other major signs of surface alteration. The only two burnt examples are a core fragment and a multiplatform type.

Of the three main core types, the most common category is of the one platform type (Fig 9.2, 2710, 2542). The majority have flake removals that extend around at least half of the perimeter of one of the ends. There are only two examples with cortical backing. There is little sign of any platform preparation prior to detaching of flakes, as in abrasion of the core edge. The second most common type is the multiplatform core, which includes a few discoidal forms (Fig 9.2, 2653, 2714).

An unusual form in this assemblage is the scalar piece or *pièce esquillé*. Although only one example has been noted here, similar types have been recorded in the Mesolithic assemblage from Context 1202 on Site W on the west side of Goldcliff island (Barton 2000, Fig 4.7). In the latter example they were interpreted as small bipolar cores made using the anvil technique.

Core rejuvenation flakes include core tablets (Fig 9.2, 3130), crested forms (Fig 9.2, 13718) and *flancs de nucléus*. The latter may be described as 'a flake that removes all or part of the core's flaking face' (Barton 1992, 267). Such a flake can be the unintended consequence of delivering the percussive blow too far back from the edge, but it may also be a useful method for refreshing a flaking face affected by hinge fractures. At Site A the majority of rejuvenation flakes are of flint. The exceptions are a bidirectionally crested blade of chert and two *flancs de nucléus* for which only an undifferentiated flint/chert could be identified. The disproportionately low presence of chert is slightly surprising given the numbers of cores in chert. This cannot be attributed to differences in technique alone as both raw materials occur in all of the core categories. It should be noted, however, that the overall representation of rejuvenation pieces is rather low given the number of cores (eg two core tablets for 16 cores). It demonstrates that several different reduction techniques were used by the same group of knappers.

9.1.8 Site A: retouched tools

Microliths

Microliths are the single largest category of retouched tools recorded in Site A (Fig 9.3; tabulated on CD 9.5). They comprise a variety of mainly geometric shapes that can all be classified typologically as later Mesolithic (Clark 1936; Jacobi 1984). Numerically, the most common forms are crescents followed by small scalene triangles (also known as micro-scalene forms). Only one of the classified microliths (a scalene) is burnt. In terms of raw material, out of 31 microliths identified by type, 23 are of flint and 7 of chert with one an undifferentiated flint/chert. Although some of the smallest examples are made of flint, this is not exclusively the case as shown by two out of three micro-isosceles triangles that are made of chert. Over half of the microliths in the sample are broken (56%) and thus are hard to 'type' with any degree of certainty. The breakages are unlikely to have been thermally induced as only one case of burning was noted. Most of the breaks are simple flexional snaps and it is possible that the microliths were discards from slotted antler or wooden shafts that were being repaired on site. On the other hand, none displayed typical 'impact fractures' (Barton and Bergman 1982) so it would be hard to infer that they had been parts of composite arrowheads, though use in other equipment such as harvesting knives cannot be discounted. A more likely explanation is that many of the breakages were the result of simple knapping accidents that occurred during the final stages of retouch.

Backed bladelet

The only example (Fig 9.3, 2645) measures 31mm × 9mm × 3mm. It is made of coarse chert but since many of the microliths are also in this material it seems unlikely that the raw material type is of significance. It was found within the main artefact concentration (Fig 5.2) so there can be little reason to doubt the stratigraphic integrity of the find. The artefact is abruptly retouched on both of its lateral edges and terminates in a break at the distal end. It is conceivable that it is a broken processing tool such as an awl or borer.

Denticulates and notches

There are two denticulates and one notch. The denticulates (2648, 2812) are on chert and flint respectively. Both are on flakes and reveal large contiguous notches along one edge. Neither is burnt. A large chert flake (13722), with distal and proximal breaks, shows a single notch. Like the other two examples, it is unburnt.

Truncated flake

Only one truncated flake (Fig 9.2, 13691) was recorded. Made of flint, it is modified distally with a straight truncation. The piece is non-cortical and unburnt and is otherwise morphologically indistinguishable from other flakes in the assemblage.

Retouched flakes and bladelets

There are thirteen artefacts with continuous abrupt to semi-abrupt retouch. The retouch is usually along one of the lateral edges but a notable exception is an example with invasive retouch that resembles an awl (Fig 9.2, 2740). Eleven of the artefacts are on flakes, the remaining two are on bladelets. As with the other major tool categories there is a slight predominance of flint over chert. The flakes include seven of flint, three of chert and one undifferentiated flint/chert. There is no obvious selectivity in the types of flakes used. Of the flakes recorded five display unidirectional dorsal flake scars, while five out of eleven had some degree of cortex present on their dorsal surfaces. Lengths were not systematically registered but where measured fell within the 10–25mm size range. Only two of the flakes are burnt. In contrast to the retouched flakes, the two bladelets in this category may have been specially made for use since bladelets are exceedingly rare in the assemblage. Neither of the examples is cortical. The one in flint is 25mm long and the chert example is 27mm long, placing them near the upper end of size category in this assemblage. No signs of burning have been detected on either artefact.

Miscellaneous tools

Amongst other sundry artefacts with secondary modification are two flaked flakes (Fig 9.2, 2698, 3028). These are described as artefacts from which single flakes have been removed and are similar in technique to those reported in much earlier lithic technologies (Ashton *et al* 1992, 146). They can be interpreted as either cores or tools in their own right. In this context they are simply placed within the tool category for convenience.

Microlith debitage

This group consists of 36 microburins (Fig 9.3: 3356, 3367, 3369, 13729, 13937c), microburin miss-hits (Fig 9.3, 13954) and Krukowski types. The microburins are dominated by distal examples (18), exclusively with the notch on the left hand side. There are eight proximal microburins with a notch on the right hand side. In both of these cases, the retouch indicates manufacture of microliths modified by direct retouch on the left-hand side. The single exception is distal microburin with an inversely retouched notch. It may relate to an inversely retouched microlith fragment also in the collection. Miss-hits are defined as microlith debitage in which there is a transverse, straight snap instead of an oblique break as in typical microburins (Barton 1992, 269). There are three proximal examples and one distal example in the collection. Krukowski microburins, or broken tips with a microburin facet present (Barton 1992, 269), are

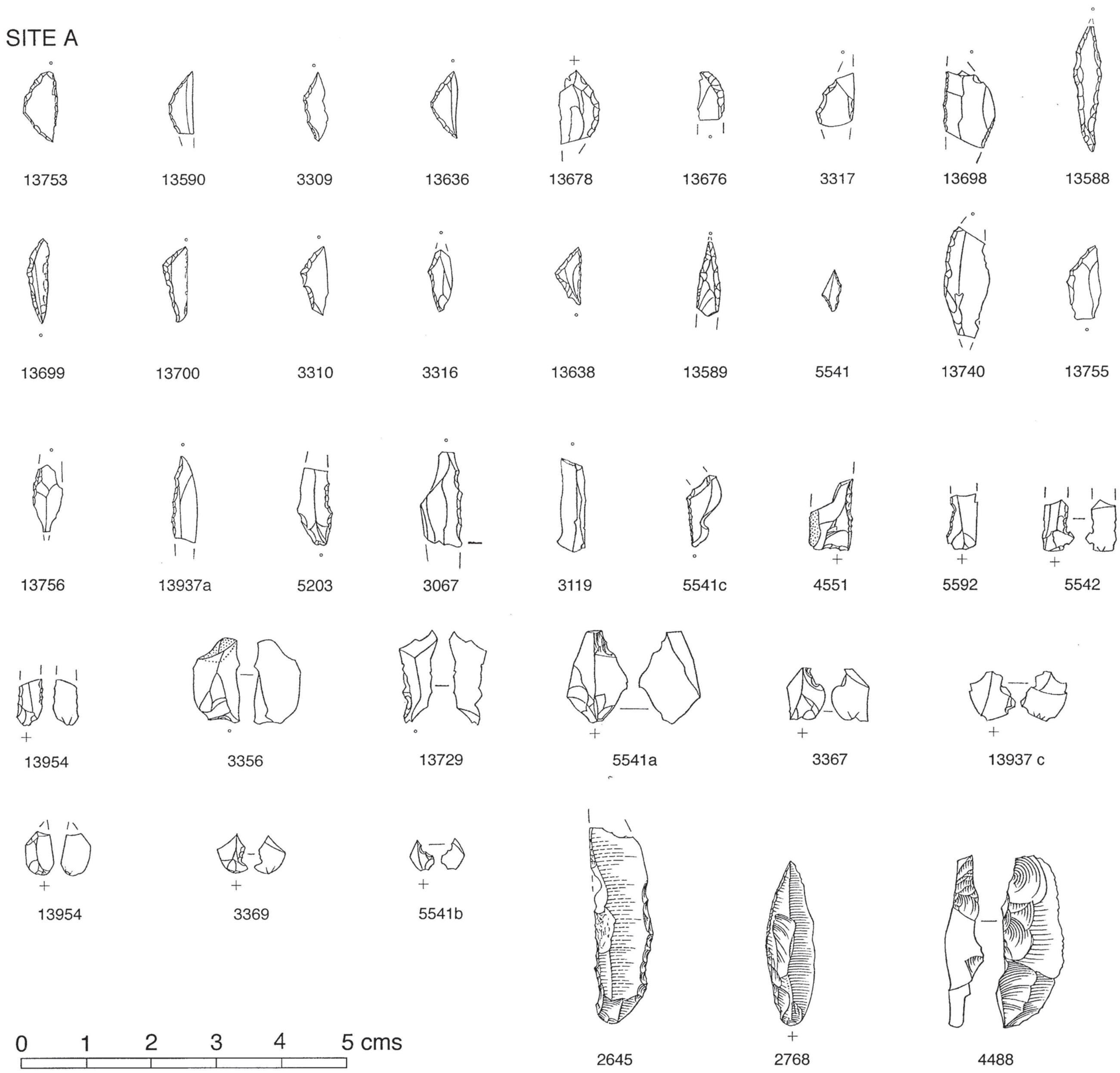


Figure 9.3 Goldcliff East, lithics from Site A: scale 1:1 (drawing H Martingell)

represented by six examples. Together with the other microburin classes, these examples provide unambiguous evidence for the manufacture of microliths. None of the microlith debitage shows any traces of burning. An analysis of raw material type indicates a virtually exclusive use of flint (33 of 34 examples recorded). An interesting exception is a distal microburin on what appears to be Greensand Chert. In the absence of microliths in the same material, it raises intriguing questions of how this piece came to be at the site and whether it reflects the activities of more than one knapper. No refits with the chert tools from Site J could be demonstrated (see below).

Retouch chips

There are six retouch chips, four of which are tiny and could be from the manufacture of microliths. All of the latter are of flint, while the larger examples are small curved pieces in both flint and chert and could belong to any one of the bigger tools. None of the retouch chips is burnt.

9.1.9 Site A: Comments on the spatial distribution of lithic artefacts

The greatest concentration of lithic finds occurs in the northern half of the trench (Figs 5.2–5.3). Although knapping seems to have taken place at two or more loci (based on the distribution of cores and core rejuvenation flakes), it is clear from the spread of microlith debitage that the manufacture of these tools was probably focused in only one area. A fairly tight cluster of retouched artefacts is also discernible on the southern perimeter of the debitage. Apart from a broken microlith tip and flaked flake (which could be debitage rather than a tool), all of the tool activity seems to have been restricted to the western half of the site.

9.1.10 Site J, Context 328 (including 328/9 and 329): lithic technology

Site J is described in Chapter 6. By far the largest collection of artefacts was recovered from the Old Land Surface (328) and immediately beneath this at the interface (328/9) with underlying Head deposits (329). The Site J lithic assemblage is tabulated on CD 9.1–9.2 and 9.6–9.7.

Flakes

There are 443 flakes in the assemblage. A majority are complete (61%) and vary in length from 40mm to 10mm, although one exceptionally large flake 75mm long was also recorded. The overall dimensions of the flakes are broadly comparable to those from Site A and many can be described as being elongate and of laminar appearance. Of the broken examples, 54% are proximal fragments, 31% are distal and the rest are mesial portions of flakes. It is clear that primary knapping activity occurred on site, as many of the flakes reveal partly or wholly corticated surfaces (68%). As at Site A, flint is slightly more prevalent than chert (approximately 55% as opposed to 35%, not including pieces of uncertain flint/chert type). Interestingly, there are five tuff flakes and one flake of an unidentified stone in the collection. None of the tuff flakes is particularly diagnostic but the existence of a small chip and a tested pebble in tuff (see below) implies that perhaps some flaking of this material took place on site. A low percentage of burnt flakes (12%) was recorded in the assemblage and this compares with all of the other artefact categories including microliths. In addition to the observations above, seventeen flakes exhibited macroscopic edge damage in the form of very small isolated notches, or continuous flake scars, usually located along one margin or at the distal end. A limited number were submitted for microwear analysis. Four bladelets and two of the unidirectionally crested blade(let)s (Fig 9.4, 9256) display similar damage, of which only a bladelet (Fig 9.5, 9038) appeared to be suitable for microscopic wear analysis.

Blades/bladelets

There are 48 blades and bladelets in the assemblage (Fig 9.4, 4866, 10327, 10380; Fig 9.5, 7546). As a proportion of the flaked debitage, the blade(let) to flake ratio is more or less the same as in Site A. Both flint and chert examples are represented in about equal proportion (21/19). The scarcity of bladelets is something already alluded to as a particular characteristic of the later Mesolithic in southern Britain (Pitts and Jacobi 1979).

Chips

This category includes 262 examples and probably represents the clearest evidence of manufacturing activity. Unlike the other debitage classes, the majority of chips are of flint (66%), while chert (19%), and undifferentiated flint/chert make up the rest of the total. The higher representation of flint amongst the chips, if not simply a product of limited recognition, might be attributable to the presence of flint tools such as scrapers. It is otherwise difficult to explain the predominance of this raw material. The existence of a single chip of volcanic tuff might be linked to a tested nodule of the same material found on site (see below). The evidence for burning reflects a similar pattern to that seen on the flakes, with 12% of the chips recorded as burnt.

Shatter

Out of the 88 pieces of shatter only five pieces were recognisably burnt, demonstrating that all resulted directly from the knapping process. As with other artefacts from Site A the raw material is dominated by flint (60%) followed by chert (34%).

Cores and related forms

Of the three main categories of core (CD 9.7), the most common examples are of the one platform type (Fig 9.4, 9975, 7484, 9944, 10366). The next most numerous category are multiplatform cores (Fig 9.4, 10719) followed by two platform types (Fig 9.4, 9724, 9459). There is no distinction according to raw material. Flint is the most often present in 25 examples with chert in sixteen and undifferentiated flint/chert in six examples. The material is exclusively on small water worn cobbles and pebbles. Negative scars visible on the cores indicate the production of laminar flakes. There is little sign of platform abrasion and in many cases the flaking extends around the perimeter of one end of the nodule, except in two pyramidal single platform types that exhibit cortex on the back of the core. As in the Site A assemblage, at maximum reduction many cores assume a multiplatform discoidal shape. Very few of the cores (five) are burnt, but this includes a tested nodule.

Little further information can be added from the core fragments, most of which (four) are of flint. Of the two pebbles with single flake removals (tested nodules) the only point of interest is that one is of volcanic tuff. A chip in this material may originate from this pebble but the same cannot be said for five tuff flakes, which could not be refitted and in any case far exceed the single removal observed on the nodule.

Out of the 22 identifiable core rejuvenation products attention is drawn to seven crested pieces that indicate the technique of preparing and refreshing the core face. That only very sparing use was made of this technique may be explained by the small size of the pebble raw material. The only unusual item is a unidirectionally crested blade that is much bigger than the rest (Fig 9.4, 9256). It measures 70mm × 18mm × 6mm and must have been imported to the site since none of the cores would have been large enough to have produced such a blade. From

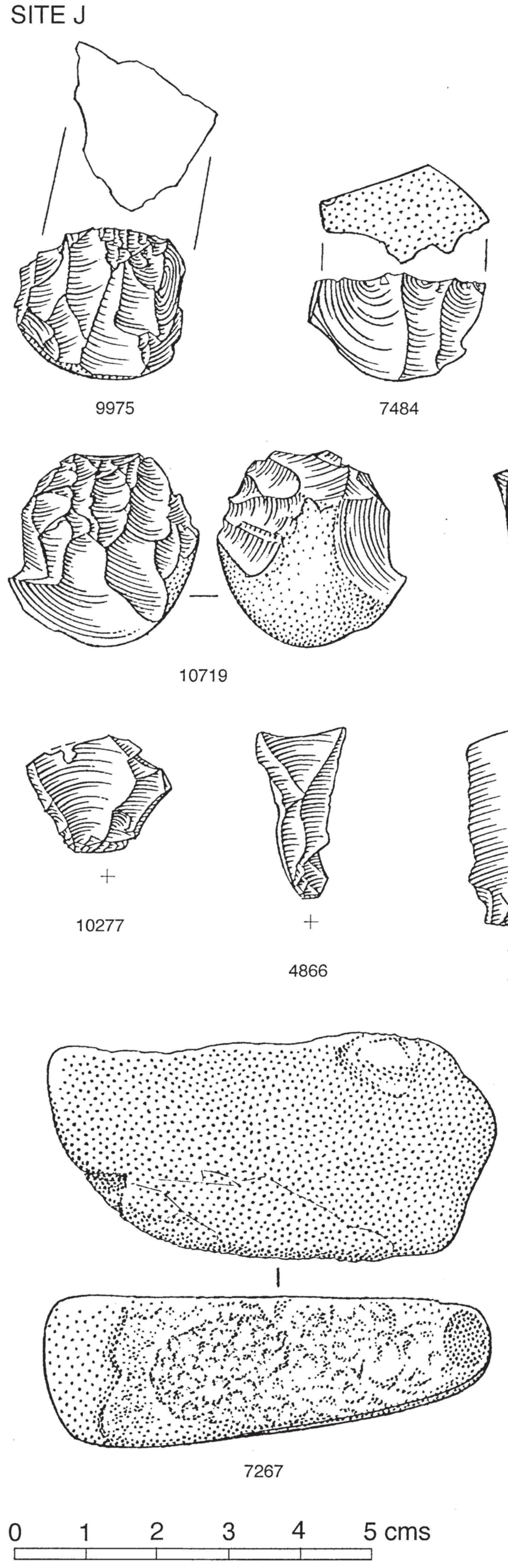


Figure 9.4 Goldcliff East, lithics from Site J: scale 1:1 (drawing H Martingell)

a technological viewpoint it is not particularly diagnostic of period but it is certainly bigger than one might expect for the later Mesolithic. It may have been collected by the site occupants purely for its curiosity value.

9.1.11 Site J, Context 328: retouched tools

Microliths

The most representative forms amongst the thirteen microliths recovered are six scalene micro-triangles

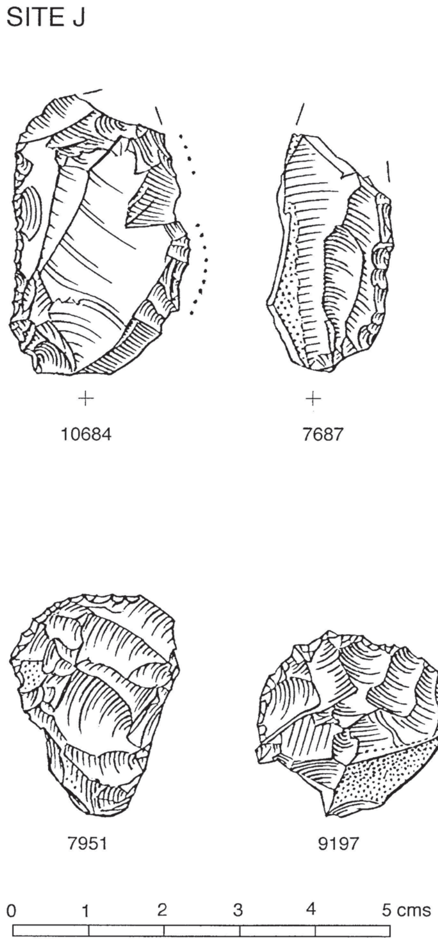


Figure 9.5 Goldcliff East, lithics from Site J: scale 1:1 (drawing H Martingell)

(Fig 9.6, 9210, 9980, 9599, 10068, 10585a, 7233a). Because of their minute size it is very likely that they were used as tiny inserts for composite tools. The rest of the microliths consist of two oblique points (Fig 9.6, 13837) and a crescent (Fig 9.6, 4527), with the remainder being made up of unidentified fragments (three) and a single broken tip. Only two of the microliths are burnt (both micro-scalenes). As with the other categories, flint was predominantly used (nine) with only one chert artefact noted, though three of the microliths could only be characterised as undifferentiated chert/flint.

Backed blade and bladelet

A chert backed blade was recovered from within the scatter, which, had it not been securely stratified, might have been suspected as being of late Upper Palaeolithic origin (Fig 9.6, 7869). It is approximately 45mm long and 12mm wide and made on a thick cortical support. It displays abrupt direct retouch along both lateral edges, which extends from the proximal end roughly half way up the length of the tool. A second backed piece, in this case with bladelet dimensions, was also recorded (Fig 9.6, 7326). It is a complete flint tool measuring 26mm × 9mm × 4mm. The abrupt backing is on the right edge and runs down the whole length of the piece. Neither implement is burnt.

End-scrapers and side-scrapers

There are three end-scrapers and two side-scrapers. The scraper edges are morphologically very similar being characterised by semi-abrupt retouch. Two of the scrapers have a slightly denticulated appearance (Fig 9.5, 9197, 7951). Apart from one example in chert, the other four are all of flint. It should be noted too that one of the scrapers (a flint side-scraper) comes from Context 328/329 interface. None of the scrapers is burnt.

Denticulates and notches

There is one denticulate and three notches. The denticulate is on a large chert flake characterised by a series of contiguous notches along both lateral edges (Fig 9.4, 10200). The other tools consist of single notches on one lateral edge of two flint flakes and one of chert. None of the tools in either of these categories is burnt.

Truncated bladelet

Only one truncated tool was identified. It is an unburnt flint bladelet with a distal concave truncation.

Retouched flakes and bladelets There are nineteen tools with miscellaneous retouch, of which only two are on bladelets (one of flint, the

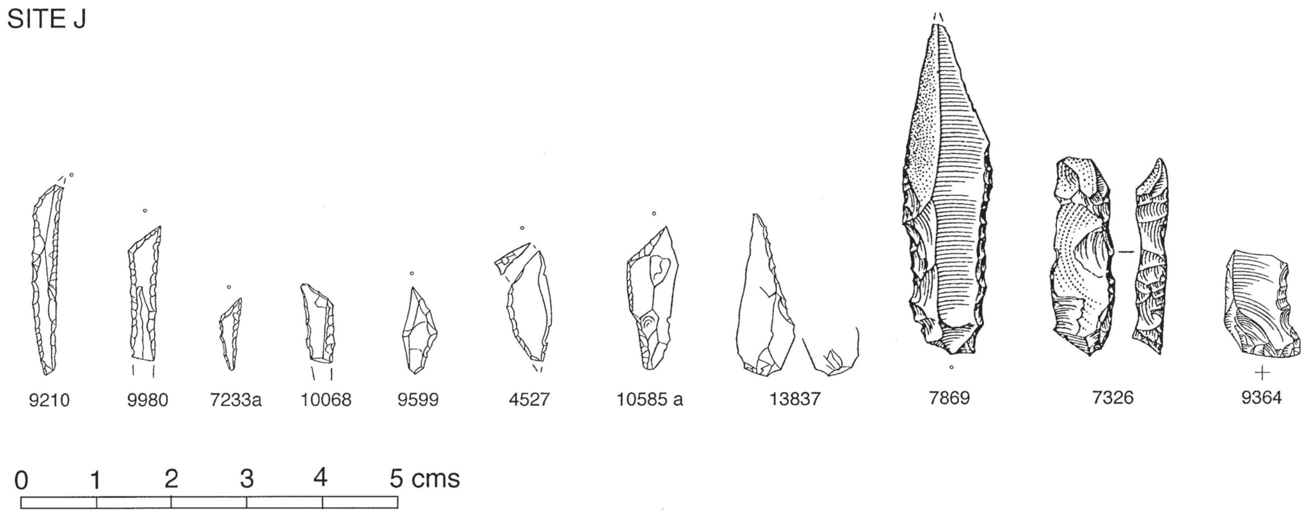


Figure 9.6 Goldcliff East, lithics from Site J: scale 1:1 (drawing H Martingell)

other of chert/flint undifferentiated). Interestingly, the retouched flakes are mostly of chert (seventeen) with only five in flint. In the majority of cases, the retouch is partial and modifies only one edge of the artefact. However, exceptions are provided by two examples (Fig 9.5, 10684, 7447), which are retouched on all or part of both edges. Two flakes display retouch at their distal ends, while two reveal invasive scalar retouch along one margin and one has inverse retouch. None of the tools in this category is burnt.

Microlith debitage

There are only three artefacts in this category but given the relatively small quantity of microliths recovered this is hardly surprising. The tool debitage comprises one distal microburin (notch left), one proximal microburin miss-hit, and one Krukowski microburin. The miss-hit is in chert, the other two are of flint. None of them is burnt.

9.1.12 Site J, Context 331

Artefacts were also found in the estuarine silts (331) which covered the north-east two thirds of Site J (overlying Context 328) (Fig 6.3; CD 9.6). Amongst the debitage recorded in this context were 63 flakes, with slightly more chert (51%) than flint (46%). Apart from five bladelets and seventeen chips, the only other significant category were cores, which included one single platform type and two examples each of two platform and multiplatform types. The sole remarkable feature of this group is a single platform core, which can truly be described as a bladelet core. Interestingly, the cores were all of flint leaving open the question of what had happened to the chert example(s) from which the majority of flakes had been detached. It can be argued that knapping had taken place *in situ*, or nearby, due to the presence of chips (including four of chert) and core rejuvenation forms (three *flancs de nucléus*; four core tablets and one bidirectionally crested blade). Apart from three core tablets in chert, the rest were in flint. Only fourteen burnt artefacts were recovered from the site, all debitage products. The three retouched tools from this context comprise one backed bladelet and two retouched flakes. The backed bladelet is a complete example of chert while the two retouched flakes are of flint.

9.1.13 Site J, Context 327

Only fifteen artefacts were recorded from the peat at the top of the sequence (CD 9.6). Except for three items in chert (two bladelets and one multiplatform core), the rest were of flint. It is possible that the bladelets originated from the core of the same material but no refitting was attempted to confirm this. The only other noteworthy feature of this tiny assemblage is that three of the artefacts are burnt (a flake, a bladelet, and a chip).

9.1.14 Site J, Contexts 327/328; 327/331; 328/331; and 328/334

This small group of artefacts comes from various interfaces between contexts. The most notable feature amongst the few flakes recovered is that two from Context 328/331 are of volcanic tuff. One of the examples (10470) exhibits minor edge damage and implies that it might have been used as a tool. Amongst the formal retouched tools is a microscalene in flint, a notch and retouched flake from Context 327/8. The only other tool is a retouched flake from Context 328/331.

9.1.15 Site J: comments on the spatial distribution of lithic artefacts

The majority of finds are in the Old Land Surface (OLS – Context 328) with smaller numbers in the estuarine silt (Context 331) and a few in the peat (Context 327). The artefact distributions are shown in Figures 6.13–6.15. Overall, the cores and core rejuvenation flakes in the OLS seem to form two concentrations, near the southern margin of the scatter and a slightly more isolated pocket in the north-eastern squares. The refitting of cores and their by-products would prove added confirmation of the *in situ* nature of finds in these two areas. There may also be a close relationship between cores and rejuvenation flakes in the eastern area of the estuarine unit (Context 331).

The distribution of tools in the OLS shows a significant concentration of micro-scalene triangles in the western half of the scatter. This is an interesting observation and might reflect either the outcome of a manufacturing episode or alternatively be related to activity employing the use of these typologically related forms. The close proximity of a scalene microlith and a microburin in the eastern end of the trench could indicate a toolmaking episode but this would need verification via refitting as well as raw material analysis. Amongst the other retouched tools, there is a circumstantial link in the distribution of the end and side scrapers, with three very closely associated examples and with two others lying slightly further apart.

9.1.16 Unstratified finds of significance

Bifacial Tools

Within the surface assemblage are two bifacial implements both of which are of tuff (Fig 9.7, 13000; Fig 9.8, 7034). These both come from unstratified modern beach gravels in the area of Sites B and D and their findspots are shown in Figure 3.2. Morphologically, they are roughly D-shaped in cross-section, thus fulfilling the generally accepted criteria for adzes (Berridge and Roberts 1986, 19). However, in one case this shape is accentuated by the existence of a naturally flat cleavage plane in the rock, whilst in the other a substantial area of the original outer surface of the cobble is preserved, thus leaving open the possibility that it had only been partly finished. The same tool tapers at one end into a trihedral point and so could equally meet the description of a pick (*sensu* Palmer 1977, 25–6). Neither of the tools was recovered in association with the lithic scatters mentioned above. The only tangible connection with any of the excavated assemblages would be the few tuff flakes in Site J and a single example from Site A. The most likely by-product of a bifacial tool was a potential thinning flake from A but attempts to refit it to either of the large core tools proved unsuccessful.

In detail, the larger of the two axes/adzes (Fig 9.7, 13000) was recovered unstratified on the surface of recent beach gravels, 7m south-west of Site B. The tool is greenish-grey in colour and has maximum length, width and thickness measurements of 136mm × 59mm × 50mm. The artefact is fresh condition, its edges are relatively sharp and there is little visible evidence of abrasion except in one area where the natural cleavage plane of the rock meets a slightly fresher negative flake surface. Here the edge is distinctly smooth and somewhat rounded but it is difficult to know whether this was the result of deliberate utilisation or was the natural state of the block before it was worked. Very slight rounding of some of the flake arrêtes at either end of the artefact could suggest a degree of tool-use, perhaps caused by rubbing or abrading. Both ends of the implement are somewhat curved and blunted making it unlikely that it had been used as a cutting tool. Certainly there are no signs of any transverse re-sharpening removals characteristic of tranchet axes (Wymer 1977).

The second implement is somewhat smaller than the first (Fig 9.8, 7034). It was found by Derek Upton, unstratified on the surface of the recent beach gravel, a little north of Site B. The artefact has maximum measurements of 110mm × 49mm × 39mm. It is matt black in colour and is in a slightly finer grained tuff than the first tool. Like the other implement it has been bifacially flaked, though part of the original outer surface of the rounded cobble is still preserved. The flaked surfaces, on the whole, have a fresh appearance, though it is interesting to note that localised areas of rounding, possibly caused by scraping, rubbing, or polishing, are visible down one of the longer sides. Similar traces are visible along one of the arrêtes at the pointed end and on a small portion of the blunter end, while heavy battering can be seen along the second of the longer lateral edges. If not due to repeated attempts to remove flakes, this may also be indicative of tool use. It is difficult to determine any function of this tool without more detailed analysis but clearly not all of the wear was focused at the pointed end, as might be expected in the case of a pick. Equally, it would seem from the irregular shape of the tool that it could not have been easily hafted. From the nature and distribution of the abrasion it is possible that the tool was used for scraping a moderately hard material such as wood or bone. A similar degree of rounding has been noted on the edges of tools employed to scrape bone (Bordes 1965; Newcomer 1974).

Unifacial leaf point

A retouched tool of unambiguous early Upper Palaeolithic type was recovered from modern gravels between Sites B and A, about 50m west of the former (Fig 9.9, 7000). It comprises the proximal portion of a unifacial leaf point. The artefact is made on a large patinated flint blade, with a distal break, and has maximum dimensions of 80mm × 38mm × 16mm. The blade is triangular in cross-section and has parallel flake scars coming from the same direction as the blade itself. The butt is plain and fairly large (12mm × 5mm). The retouch scars are all on the ventral surface as is typical in such tools. The scars are flat and invasive and have resulted in the partial removal of the blade's bulb of percus-

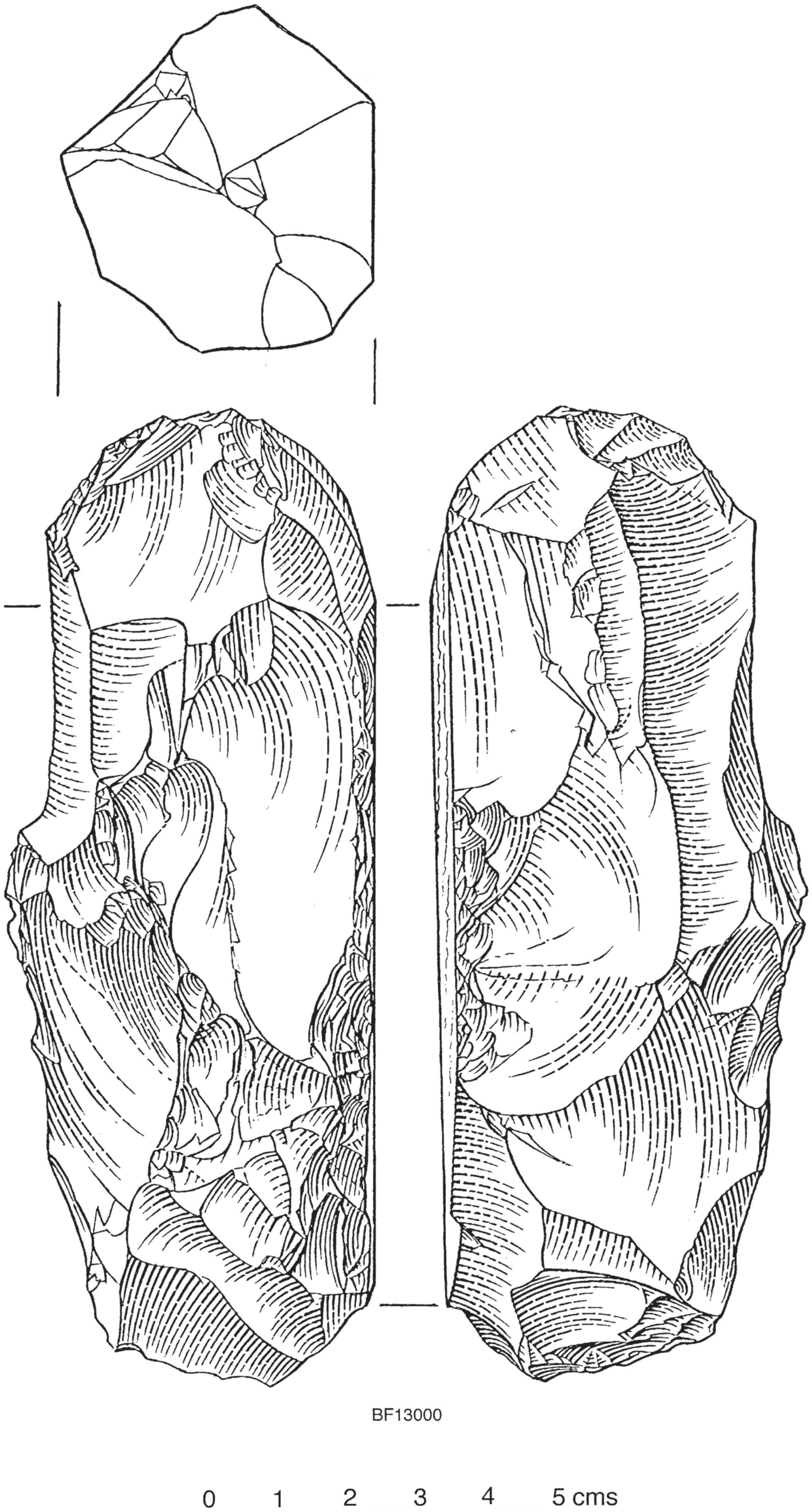


Figure 9.7 Goldcliff East, tuff adze/axe 13000, unstratified: scale 1:1 (drawing H Martingell)

sion. This is a feature often seen on such points and appears to have served both to thin the blank and to give it a more regular profile, by reducing any natural curvature of the blade. The flexional snap at the distal end is the kind of breakage that can result from impact, though equally, it is impossible to rule out accidental fracture during retouch. The artefact exhibits slight nicking down its lateral

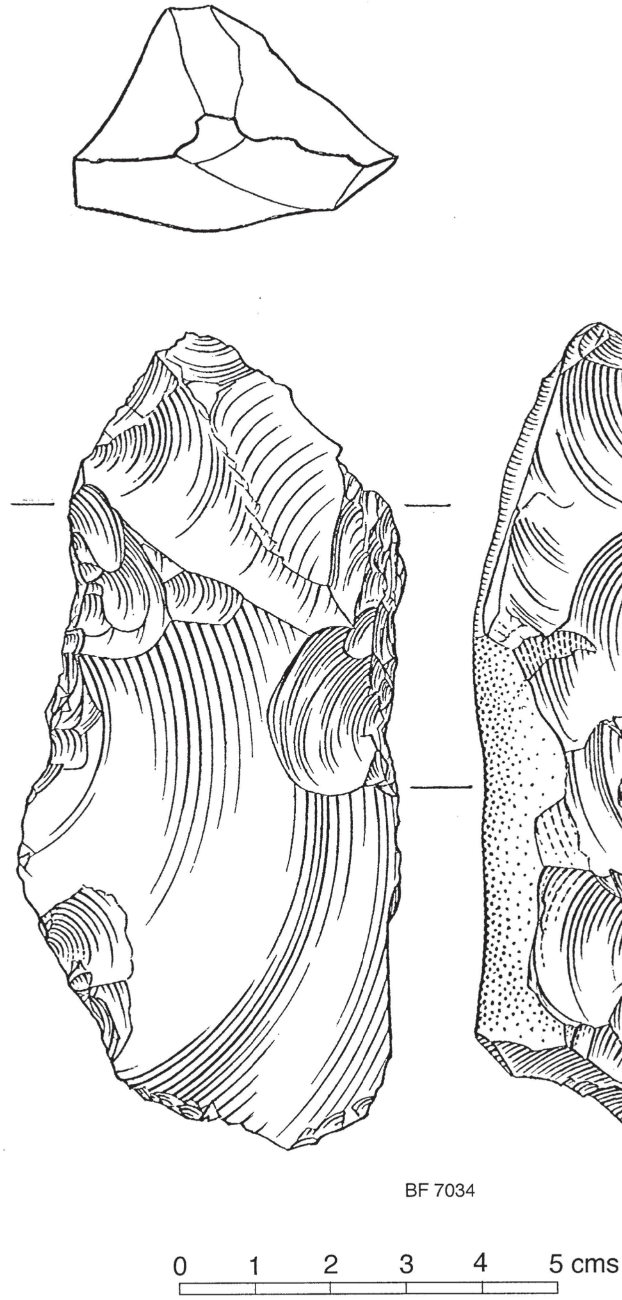


Figure 9.8 Goldcliff East, tuff adze/axe 7034, unstratified: scale 1:1 (drawing H Martingell)

edges but is otherwise in sharp condition. There is now a growing list of findspots for these kinds of leaf points in Britain (Jacobi 1990, fig 2). The nearest known location to Goldcliff, as the crow flies, is Uphill Quarry Cave in Somerset, though further examples have been recovered along the Welsh coast at Paviland Cave in the Gower Peninsula. Dating of these artefacts has proved problematic but AMS determinations of associated bone using the latest ultrafiltration techniques suggest that they should be no younger than about 36,000 years BP (Higham pers comm). Confirmation of this age also comes from sites in Central Europe where parallels for these artefacts can be found in the early Upper Palaeolithic of Poland and The Czech Republic. An interesting suggestion is that these industries may represent the activities of some of the last surviving Neanderthal populations in northern Europe. The presence of such a find in isolation at Goldcliff could be explained as a hunting loss.

9.1.17 Comparisons with other Mesolithic assemblages in western Britain

The retouched tools from Sites B, A, and J are representative of those that occur in narrow blade Later Mesolithic assemblages in England and Wales (Barton and Roberts 2004; David and Walker 2004). One of the defining features of this grouping is small

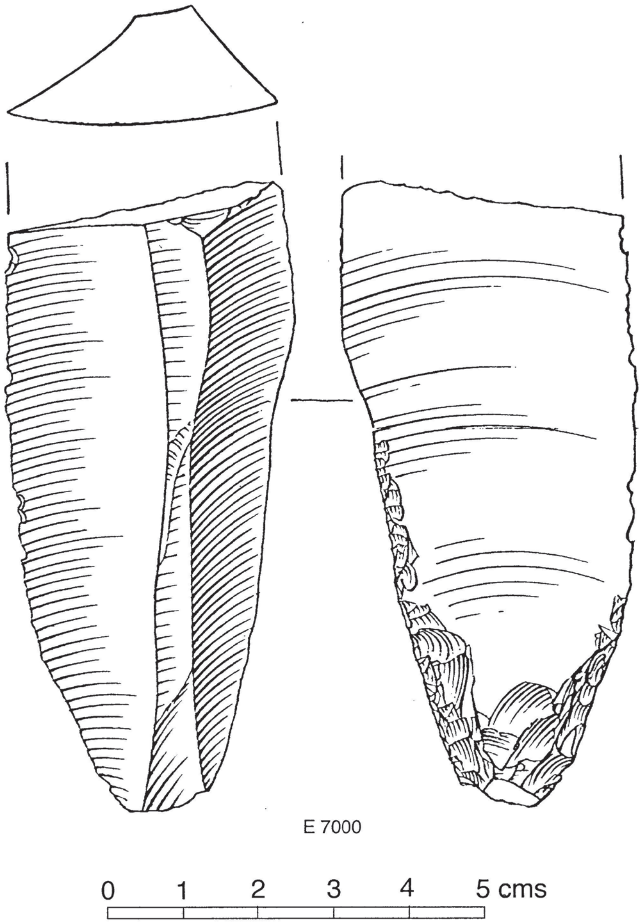


Figure 9.9 Goldcliff East, Early Upper Palaeolithic unifacial leaf point 7000: scale 1:1 (drawing H Martingell)

geometric microlith shapes such as narrow micro-scalene triangles, curve-backed pieces (including microlunates), straight-backed and small oblique points. The examples from Goldcliff all come from well-sealed cultural horizons and there can be no doubt of their contextual and stratigraphic integrity. A similar case can be made for Site W, the later Mesolithic site west of the island (Bell *et al* 2000). Other tools in the assemblages described here include end-scrapers, denticulates, notches, and truncations, but there is a notable absence of burins or any of the idiosyncratic bevelled pebbles (tools on elongate beach pebbles with bevelled ends) that have been recorded at other later Mesolithic coastal findspots in Wales (David and Walker 2004).

Chronologically, the items of most diagnostic value are the micro-scalene triangles, which, in association with narrow straight-backed pieces with bilateral retouch (or 'rods', Jacobi 1984) and other tiny forms seem to become very much more common in England and Wales after about 7000 BP (Barton and Roberts 2004). There are few sites as well dated as Goldcliff, but other examples with reliably dated microlithic types include Madawg Rockshelter in the Wye Valley, where the younger of two age determinations on burnt hazelnut charcoal (OxA-6082; 6655±65 BP) provides an age for a hearth deposit containing a burnt micro-scalene triangle (Barton 1997). Broadly comparable determinations have also been obtained from Misbourne, Wiltshire for bovid remains associated with a micro-scalene component (OxA-601; 6190±90 BP; OxA-619; 6100±120 BP; OxA-618; 5970±100 BP) (Gowlett *et al* 1986).

At Goldcliff, the micro-scalenes include a variety of sub-types ranging from very narrow elongate forms at Site J to tiny examples less than 12mm long at Site A. Despite these differences both would fulfil the definition of scalene micro-triangles (David and Walker 2004). In terms of comparative examples, identical elongate forms have been recorded in the Black Mountain uplands at Waun Fignen Felen (Powys), in scatters WFF/1 and WFF/9 (Barton *et al* 1995, fig 16), while more diminutive examples are present in scatter WFF/10. This separation of sub-types is not always so clearly defined. For example, both the elongate and the diminutive forms occur side by side in Site J, as they do in the assemblages at Bryn Newydd, Prestatyn in north Wales and Cwm Bach, Pembrokeshire (David and Walker 2004, figs 17.13 and 17.14). This suggests that there is little or no chronological significance in the individual occurrence of these shapes. On the other hand, there can be little doubt that their design was wholly intentional. An interesting indication of this comes from Waun Fignen Felen, where the scatters consisted *only* of microliths and were divided according to micro-scalene sub-type. In these instances, it seems highly probable that the microliths were the remnants of slotted equipment that had long since perished. One intriguing speculation is that the separate microlith groups were components of functionally distinctive tools eg harvesting knives and/or different kinds of composite arrowheads. If correctly interpreted, it implies that composite tools of more than one sort were being manufactured at Goldcliff Site J.

While typological affinities are identifiable in the microlith assemblages, some interesting distinctions can be made in the non-microlithic tools from Goldcliff and various other assemblages in coastal west Wales. Two of the key elements missing at Goldcliff have already been alluded to above. First, the total absence of burins is a noteworthy feature that can most probably be attributed to functional differences between sites. If this interpretation is correct then it may also be of relevance that where such tools do exist, as at Cwm Bach, they are found in association with perforators (David and Walker 2004, fig 17.4), tools that are likewise missing from the Goldcliff lithic inventories. A second characteristic is the absence of bevelled pebbles but unlike the burins this may have a more straight-forward explanation. As has previously been documented the occurrence of bevelled tools seems to be strongly influenced by factors of local topography and geology (Jacobi 1980), so for example, they are generally not found along 'soft' shorelines of the types that occur near Goldcliff. However, the question arises whether, in the absence of appropriate rock-forms, different materials were selected for functionally equivalent tools. This may have been the case in some Scottish Mesolithic sites where bone and antler objects with damaged bevelled ends have been recorded (Saville 2004, fig 10.9). It is notable that at Goldcliff bone artefacts utilised for scraping are present (Chapter 11.4).

A striking feature of the Goldcliff collections is the conspicuous number of picks or adzes that have now been recovered from areas immediately adjacent to the Mesolithic sites. Linking these core tools to the individual scatters has so far proved difficult but there is circumstantial evidence of a relationship with Sites J and A where flakes have been found in the same distinctive volcanic tuff as the core tools. Tuff flakes have also been recovered from the Site W on the west of the island (Barton 2000). Based on the small quantity of flakes preserved it is doubtful that primary production took place at these sites. Instead, it seems more likely that core tools were transported to Goldcliff either partially prepared or as ready made implements. The presence of isolated flakes at Sites J and A can be interpreted in terms of reshaping or resharpening events, though we feel that most of the activities associated with the use of these tools would have occurred nearer to the place of discard (ie away from the main artefact scatters). The existence of core tools is well documented in the later Mesolithic. Particularly prolific examples are known from Culverwell in Dorset (Palmer 1999). Various pecked and ground stone axes have also recovered in west Wales and in Ireland from late Mesolithic contexts (David and Walker 2004). The function of these tools has never been satisfactorily explained. At Goldcliff, the processing of plants has been deduced from microwear polishes on flint artefacts (see below) and this would be consistent with our supposition that the adzes or picks were sometimes used for grubbing up plants and roots (Bell *et al* 2000).

In conclusion, one way of looking at the Goldcliff sites is to conceive of them as denser patches of activity across this later Mesolithic landscape. At locations like Sites A and J a relatively broad range of functionally different tool forms have been uncovered which would fit the description of short-term residential locations. Rather more specialised activities seem to be represented at other nearby locations (Sites B and D) and by individual findspots of adzes or picks. Considered as a whole, it seems implicit that the total density of sites on and around Goldcliff island is a direct consequence of the wealth and concentration of resources available in the coastal zone, which would have made them particularly attractive habitats for hunter-gatherer groups (Mellars 2004). Similar levels of later Mesolithic activity can be detected on the coastal promontories of south Wales (Fig 1.6). One of the special merits of Goldcliff is that because of the high quality of preservation, individual patches of activity survive as intact and discrete archaeological units. This can be juxtaposed with the less well-differentiated and thicker palimpsests of artefacts that typify the headland localities.

9.2 A functional analysis of some lithic implements from Sites A and J *by A van Gijn*

9.2.1 Sampling and methods

Until the mid-1970s the function of stone implements could only be inferred from their shape, using ethnographic and ethno-historic analogies. We now know that using an implement causes the development of wear traces. These features include edge removals (frequently called use retouch), edge rounding, polish, and striations – and they can be studied microscopically. Experimental research has demonstrated that the configuration and appearance of these traces varies according to contact material and motion (eg Keeley 1980; van Gijn 1990; and Odell 1977 for an outline of the method of studying these traces). It must be stressed, however, that it is not always possible to distinguish the traces from different activities because they display an overlap in diagnostic attributes (van den Dries and van Gijn 1997). Along the same vein, it is not always possible to interpret all archaeological wear traces because we have no parallels in our experimental reference collection.

In addition to the wear traces, residue can be preserved on the surface of the tools as well. This may include bitumen or tar from hafting arrangements, as well as remnants of the worked material such as starch grains, blood-stains, and so forth. Frequently, however, such remains are absent.

A total of 50 artefacts was submitted to analysis in order to ascertain the suitability of this material for microwear analysis. This entire sample was cursorily examined in order to determine the extent of post-depositional modifications. A total of nineteen implements were subsequently examined for traces of use.

Routinely, the implements were first scanned for traces of residue by stereo-microscope. An overview of the wear traces was obtained by stereo-microscope with oblique or incident light, under magnifications ranging between times 10 and times 50. Subsequently, the implements were studied by an incident light microscope, fitted with Nomarski DIC interference and polarizing options, magnifications ranging from times 150 for scanning to times 560 for detailed observation. Edge removals were mainly studied by stereo-microscope with either oblique or incident light, polish, and striations by incident light microscope with bright field illumination. Chemical cleaning was not necessary, nor did we make use of an ultrasonic cleaning tank to remove adhering dirt. All implements were regularly wiped with alcohol during microscopic analysis to remove finger grease.

The experimental reference collection used for the analysis includes many experiments related to the exploitation of the wetlands during Mesolithic and Neolithic times, especially as this pertains in the Rhine/Meuse delta in the western part of the Netherlands. This collection encompasses more than 1400 experiments.

9.2.2 Preservation

Part of the material turned out to be very well-preserved. This concerned the dark coloured fine-grained flint. Incidentally, some abrasion may have occurred, causing a slight gloss across the surface, particularly affecting ridges and edges, rounding them slightly. Still, wear traces from most contact materials would have been visible on this material with the possible exception of polish from softer materials like fresh hide or meat. These materials hardly cause edge removals and can therefore only be inferred from the presence of polish.

Some of the tools were made on a coarser grained chert-like material of a bluish colour. This material is less suitable for microwear analysis as traces are not so easily visible and also develop more slowly. Polish from softer contact materials are therefore more easily missed. Still, it is not the minor post-depositional surface modifications that makes the analysis of this type of material difficult, but the character of the raw material itself.

All in all, the pilot study of the material indicates that use wear analysis is very promising indeed. Traces from working bone, antler, silicious plants and hide should be interpretable on the material from Goldcliff Site J (and possibly A). This may not be the case with traces from softer contact materials. The results can therefore not be taken as directly representative of the activities carried out at the site (van den Dries and van Gijn 1997). It is, however, very rare that flint and chert are so well preserved that we can be reasonably confident that we find the total spectrum of uses. The Goldcliff material is comparatively well preserved and the expectation is that, especially the fine-grained black flint, should provide very suitable material for a more extensive use wear analysis.

9.2.3 Inferring activities

Apart from the 50 implements that were scanned in order to determine the level of preservation and the suitability of the material for a microwear analysis, a sample of nineteen artefacts was taken to do a regular use wear analysis. Part of the sample was selected by Professor R N E Barton. Those artefacts were selected that were most likely to have been used, such as microliths and scrapers. Additionally, some larger blade-like struck flakes were included, even though these did not display any traces of modification. Many of the artefacts which exhibited use wear are illustrated in Figure 9.10 showing the location on the artefact and type of wear observed. Stereo-microscope photographs of the use wear itself are shown in Figure 9.11 and in higher definition colour images on CD 9.8–9.13. Three artefacts from Site J did not display any traces of use (7684, 7986, and 9085). Again, this does not mean these tools were not used in the past, as some activities only produce very minimal edge damage and polish even after a considerable period of use (see van den Dries and van Gijn 1997 for a quantitative approach to this issue). A total of four implements from Site J (4733, 7662, 9197; and 9599) showed very minimal traces, the attributes of which being insufficiently characteristic to allow a functional interpretation. These four implements were interpreted as probably used. It concerned two struck flakes (4733 and 7662), an end/side scraper (9197; Fig 9.10) and a scalene microlith (9599). Areas of use are indicated on Figure 9.10.

One implement from Site A (2262), an unmodified struck flake with an elongated, blade-like shape, displayed traces indicative of butchering. It has a rough polish believed to have resulted from contact with hide, as well as some small patches of what is commonly considered to be bone polish. Further along the right lateral edge, along the concave part, a different polish is visible, orientated in a perpendicular direction with respect to the edge and interpreted as what has been designated in previous studies as 'polish 10' (Fig 9.11 a and b). It is unknown what kind of contact material is responsible for the occurrence of this type of polish (see Schreurs 1992; van Gijn 1998). 'Polish 10' resembles in some ways regular hide polish but also displays features more suggestive of plant working. The material responsible must be highly abrasive in order to inflict the regularly rounded edge and the striations, but not very hard as edge removals do not occur.

Another implement from Site A (13718; Fig 9.10), again an unmodified struck flake, also displayed traces interpreted as resulting from cutting hide (Fig 9.11c). It concerns a rough polish with a clear directionality indicative of a cutting motion. There is considerable edge damage so the hide must have been quite resistant or dirty. This implement also shows some tiny patches of black residue, interpreted as wood tar, used in hafting arrangements. This residue is located on the edge opposite the one with the use wear traces.

Three artefacts used for cutting up soft animal material (hide or meat) were encountered amongst the sample from Site J (7546, Fig 9.10; 7631 and 9210). In all three cases it concerned traces from hide or meat that were not totally typical. One was a scalene microlith (9210) displaying small patches of black residue that may be related to wood tar, and hence to the hafting arrangement (Fig 9.11d). This tool was most probably used to cut meat, indicating it may have been part of a composite tool

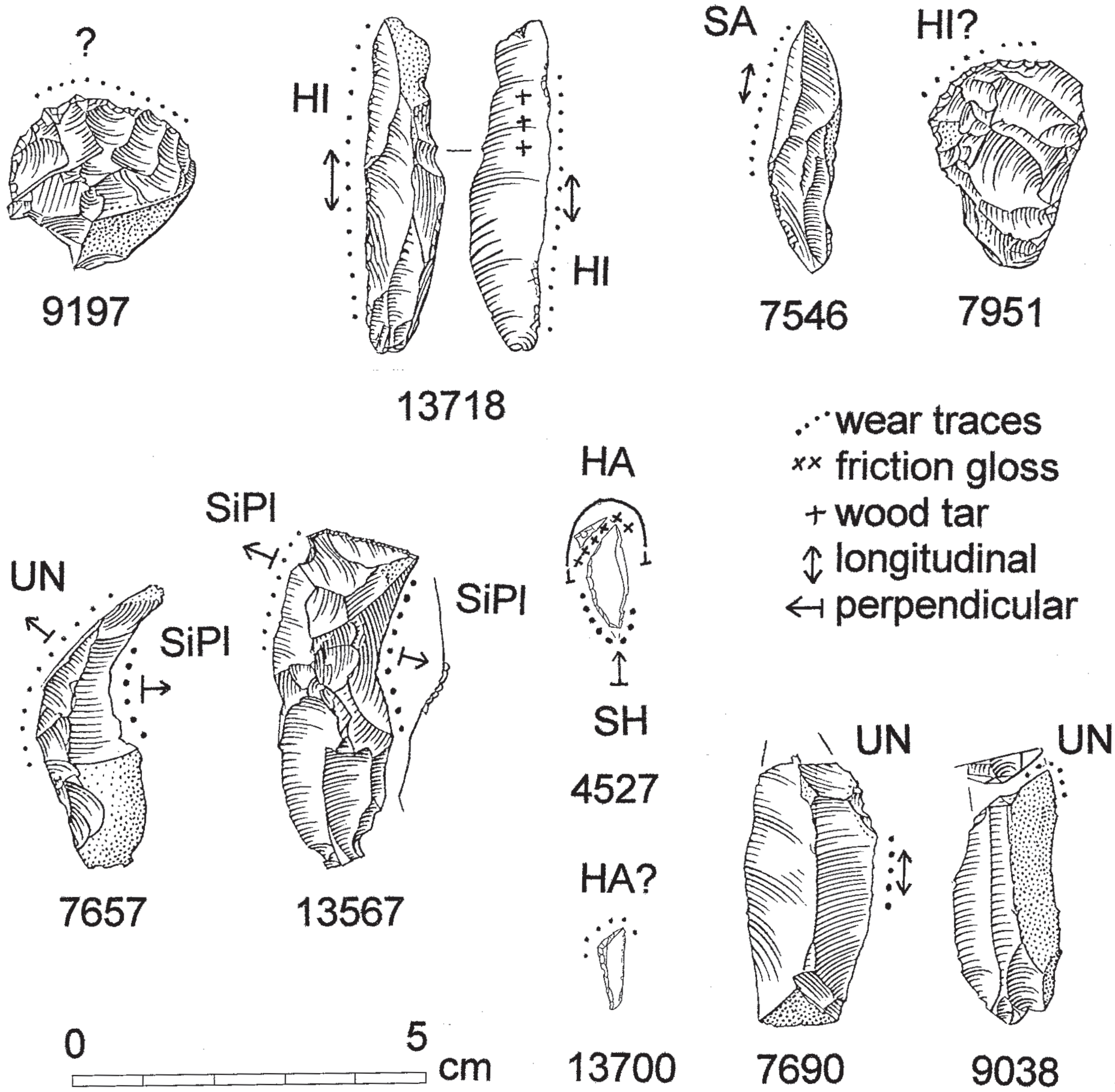


Figure 9.10 Goldcliff East, use wear traces on flint and chert implements. UN = unknown, HI = hide, HA = hafting, SH = shooting, SA = soft animal, SiPl = silicious plant (graphic H Martingell and J Foster)

used for butchering. Hides were not only cut, but also incidentally scraped, as indicated by the end/side scraper with possible hide working traces (7951: Fig 9.10). This tool has a rounded distal end with a rough and matt polish without a clear directionality.

Two elongated flakes with concave edges were used to scrape or plane silicious plants (7657 from Site J and 13567 from Site A: both Fig 9.10). Artefact 13567, a core rejuvenation flake, displays a very bright, smooth polish with perpendicularly-orientated striations (Fig 9.11e). The polish is mostly concentrated on the ventral surface, indicating that this is the contact surface. This implement has also been used on its convex edge, albeit for a shorter period of time than the opposite edge. Artefact 7657, a struck flake, displays the same kind of polish. Here, the polish was present both on the ventral and the dorsal surface. The opposite lateral edge also has traces of wear. In this case the contact material must have been soft and abrasive. These traces may have something to do with a hafting arrangement or with handling like a piece of leather to facilitate holding the piece.

Two microliths display possible hafting traces (4527 from Site J – a crescent; and 13700 from Site A – a scalene, Fig 9.10). Both had rounding and friction gloss on one end, suggestive of being due to a hafting arrangement (Fig 9.11f). One (4527) also showed impact traces on the opposite tip, pointing to use as a projectile.

Last, some implements have traces that are most probably associated with use but that could not be further specified because they do not exhibit sufficient

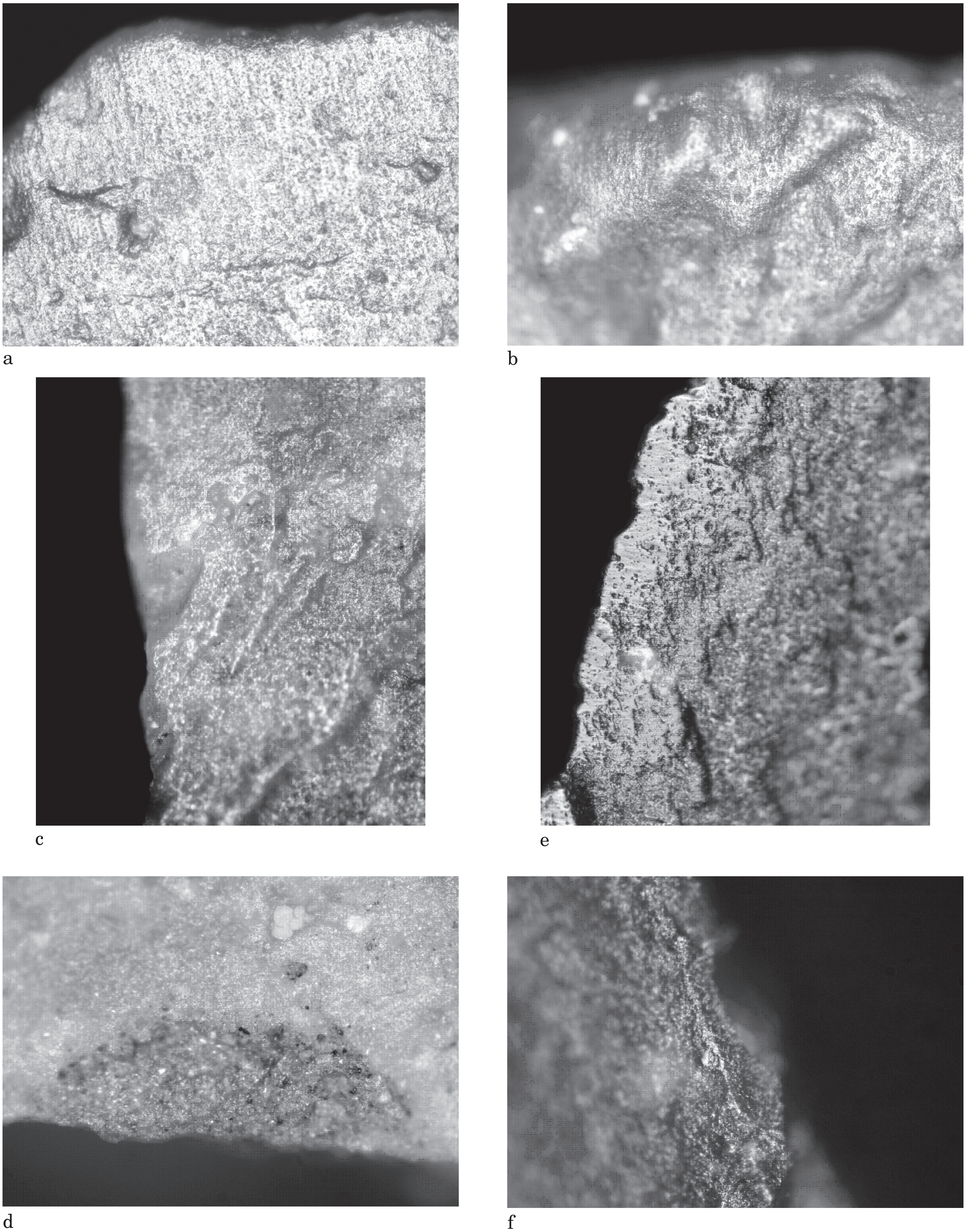


Figure 9.11 Goldcliff East, stereo-microscopic pictures of wear, all at original magnification ×300 (a / b) 2262, rounding and striated polish, referred to as 'polish 10' (c) 13718, rough polish and striations (d) 9210, brown / black residue interpreted as a piece of wood tar associated with a hafting arrangement (e) 13567, bright, smooth polish and perpendicularly orientated striations, interpreted as having been used to plane or scrape silicious plants (f) 4527, patch of friction gloss, probably associated with hafting (For colour versions see CD 9.8–9.13) (photos A van Gijn)

similarities to experimentally used tools (7690 and 9038; Fig 9.10).

9.2.4 Conclusion

The pilot study of a sample from Goldcliff East Sites A and J has shown that most of the material is very suitable for a microwear analysis. This pertains especially to the fine-grained black flint. On the coarser-grained chert traces develop much more slowly and it is therefore difficult to arrive at a functional inference. Post-depositional surface modifications are limited to some slight abrasion, causing some occasional rounding of the ridges. Generally speaking, however, the wear traces from most contact materials should be visible.

The more detailed functional study of a small sample of the material, concerns too small a sample to allow far-reaching conclusions about activities and thus about possible functional differentiation between the sites. Still it was possible to infer a few activities that took place; the tools were used for butchering, hide working, processing of silicious plants and, very tentatively, as projectile. The use of three tools from Site J for butchering and hide working is in agreement with the proposal that aurochs were butchered on Site J. Hide working and butchering tools were, however, also encountered at Site A, a site believed to have more of a residential function. The latter interpretation may be supported by the presence of a tool with 'polish 10', a type of polish that is tentatively associated with craft and not subsistence activities (van Gijn 1998). The presence of tools used to plane silicious plants at both Site A and J may be explained in different ways. This type of trace is very common on blades from late Mesolithic and early Neolithic contexts in the Netherlands, and seems to disappear here before the beginning of the middle Neolithic. The polish bears enough similarity to experiments with scraping *Phragmites* or *Typha* to make them pliable enough for making baskets or mats. However, the presence of a large number of striations indicates contact with gritty particles. It is therefore also possible that the tools were used to process the rhizomes of *Phragmites*, or other water plants. Experiments done so far with the latter activity had too short a duration for use wear traces to develop but more long-term experiments are currently underway.

The use wear analysis of a small sample of tools has also made clear once more that apparently unmodified artefacts, without retouch or even use retouch, have been selected as tools. This has been observed at many sites where a microwear analysis has been carried out (eg Juel Jensen 1986; van Gijn 1990). This should not be surprising as many activities simply require a suitable cutting edge that does not get damaged if a proper edge is selected for the task at hand. Most general archaeologists are still separating the artefacts with (use) retouch, referred to as tools, from the non-retouched implements, referred to as waste. This dichotomy is a construct of archaeologists, and bears no relationship to the prehistoric situation where for many activities prehistoric people have just selected a stone tool close at hand, with a suitable edge, that only occasionally needed some modification.

9.3 Object of stone *by M Bell*

A rounded pebble (3846, Fig 9.12; CD 9.14–17) came from Site B, Context 321/ 322 (Fig 3.6). It has been identified by Allen as a coarse-grained orthoquartzite of Lithology A (see below), possibly of Upper Carboniferous Millstone Grit origin. Diameter 100.5mm, thickness 29mm. One surface is flat, apparently as a result of grinding, the other is curved. On part of the edge a protuberance has been broken off. On either side of this wear is particularly marked producing angled facets. Other less pronounced facets occur round the edge of the object; they are regular in shape, *c* 40m by 15mm. The face to which they are angled alternates round the periphery. Originally there were seven facets, one has been almost totally removed and others partly damaged by later battering on part of the edge and the curved face. The object as a whole fits the hand well and the most pronounced facets on either side of the protuberance provide a suitable place for the thumbs. The flat face is thought to have been used as a grinder, perhaps for the preparation of plant foods, the battering probably reflects later use as a maul or hammerstone.

This artefact represents the use of groundstone technology, which is seen in the late Mesolithic in the form of polished axes and pebbles with bevelled ends. Both occur at Nab Head (David 1990) and at several sites in Ireland, eg at Ferriter's Cove where there is a multi-faced dished grindstone perhaps for axe polishing (Woodman *et al* 1999). There is a possible quern from Rhuddlan (Quinell and Blockley 1994, fig 11.3). Pebble polishing stones, rubbers and axes are found at Newferry (Woodman 1977, plate l3). Stones used for grinding and polishing seem not infrequently to also show evidence for subsequent use as hammers as at Ferriter's Cove and Newferry, and Hoge Vaart, Netherlands (Hogestijn and Peeters 2001, fascl 9, afbl 1.2). The types of grindstone and rubber which we find in the Mesolithic of the British Isles are comparable to those used in the grinding of seeds by aboriginal Australian communities (M A Smith 1986). There is some similarity between the general shape of this piece and two of the most enigmatic artefacts from Mesolithic Wales. The first is the so-called figurine from Nab Head (David and Walker 2004); this has a protuberance for the head/phallus and hints of a geometric body shape with five sides. The second is one of a series of natural pebbles from Rhuddlan,

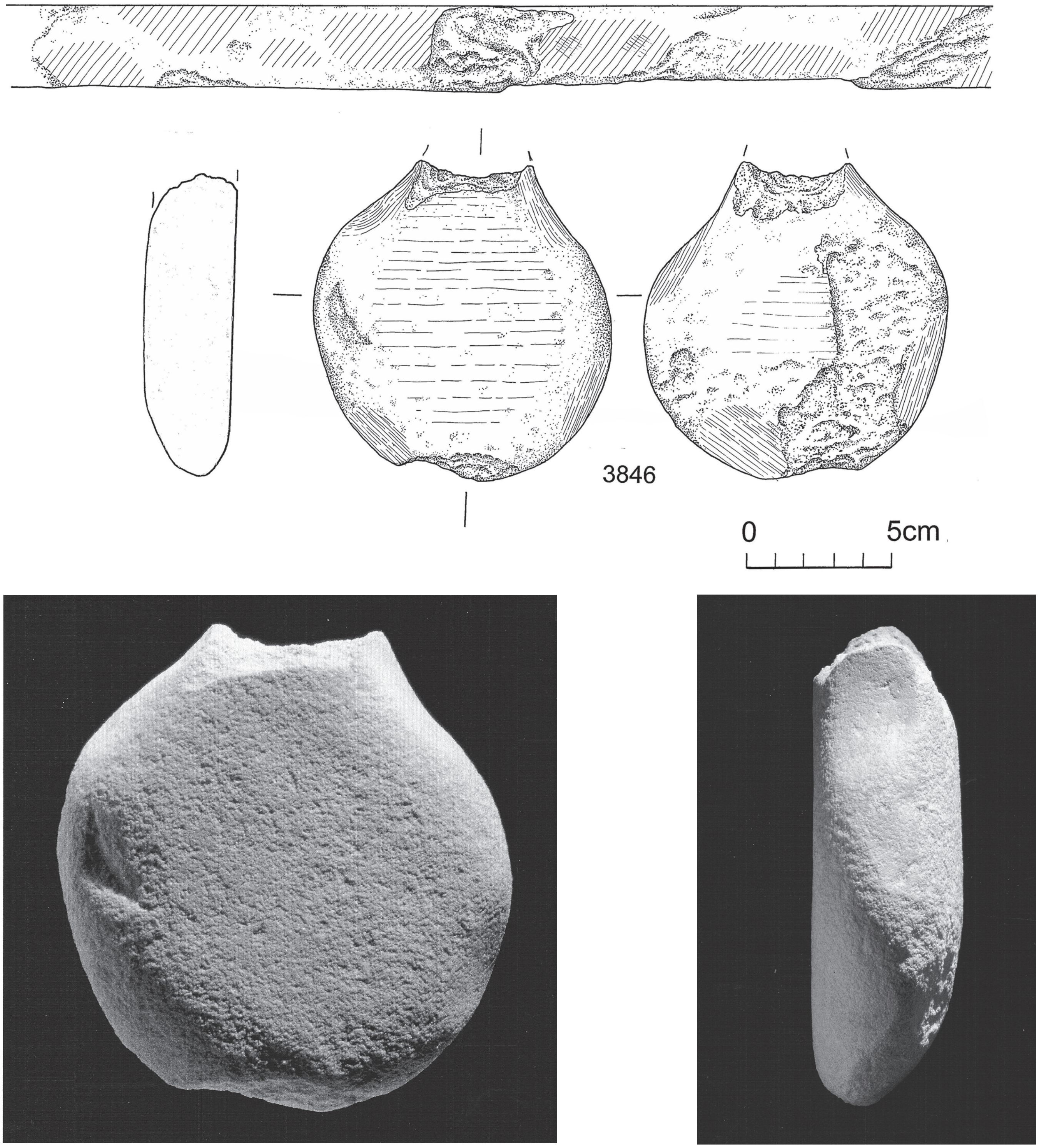


Figure 9.12 Goldcliff East, Site B, stone rubber 3846: scale 1:2 (drawing J Foster; photos © copyright National Museum of Wales)

which are decorated by incised lines (Berridge and Roberts 1994, fig 11.1; CD 20.58); this is elongated with a broken protuberance; this, and others, were broken after decoration. A flat circular pebble with finely incised lines has also been found at Llandegai (Lynch and Musson 2001). The distinctive features exhibited by these enigmatic objects may suggest that they had a symbolic significance. This may not be incompatible with interpretation of the Goldcliff example as a grinder. A good stone is likely to have been particularly valued, as it was by Aboriginal Australians who passed them on from mother to daughter (Horton 1994). The role played by such artefacts in transforming food might have led to the attribution of symbolic significance.

9.4 The geology of utilised and heat-fractured stones *by J R L Allen*

9.4.1 Lithological description

The heat-fractured stones from Goldcliff East (CD 6.32) are made up of the following lithological categories:

Lithology A predominates. It is a pale grey, unfossiliferous, well-sorted, fine to very coarse grained orthoquartzite, commonly with granules and occasionally with small pebbles of vein-quartz. The rock is lightly to moderately cemented with secondary quartz and has a marked porosity.

Lithology B is similar to Lithology A except that variable amounts of flakes of mica (≤1mm) are present and, in occasional specimens, carbonaceous flecks. The rock is moderately porous.

Lithology C is an unfossiliferous, well-sorted, medium to very coarse grained, slightly to moderately feldspathic-lithic quartzite with small but variable amounts of mica (flakes ≤1mm) similar to lithology B. The porosity is moderate to low.

Lithology D is made up of assorted, medium to very coarse grained orthoquartzites. The rocks are hard and compact, with no significant porosity.

The presence of these lithologies on the various sites and contexts is outlined on CD 9.18. Other lithologies used for heat-fractured stones were flint, sharp, angular, sometimes finely fractured pieces of burnt flint and chert, sharp, angular finely fractured pieces of burnt chert, some definitely of Lower Carboniferous age judging by facies/fossils. Tuff, which was used for tools, was only used twice as a heated stone. The tuff is hard, black, siliceous, very fine grained and faintly laminated.

9.4.2 Provenance of the main lithologies

The assemblage is of a very narrow range of rock types, of which the three most numerous (Lithology A–C) above are considered to be geologically closely related. The ultimate source of the clasts is a separate issue from their immediate provenance.

The mature orthoquartzites of Lithology A invite comparison with the sandstones of the Millstone Grit (lowermost Upper Carboniferous) of the south Wales Coalfield (Kelling 1974), especially the commonly very coarse and pebbly basal measures of the north and east crops (Squirrell and Downing 1969, 84; Barclay *et al* 1988, 13; Barclay 1989, 66). Orthoquartzites are, however, present in the overlying Lower and Middle Coal Measures, but they are accompanied by somewhat less mature sandstones (Kelling 1974, 212), perhaps the sources of Lithologies B and C. A Carboniferous provenance is supported by the flecks of coaly matter seen in occasional samples of Lithology B. Nothing in the collections resembles the mid-dark grey, immature sandstones of the Pennant Measures of the highest Coal Measures (Kelling 1974, 214). There is little that is distinctive about Lithology D, but the degree of induration suggests a pre-Carboniferous and probably pre-Devonian provenance.

That the fragments are clearly from water-worn pebbles and cobbles indicates that their immediate source is in the gravel deposits of the area (Welch and Trotter 1961, 133; Squirrell and Downing 1969, 1, IX; Barclay 1989, 110). To the north and especially the west, these are (1) a range of glacial deposits contained largely in valleys, (2) river terrace deposits, and (3) alluvium of the Taff, Rhymney, Ebbw, Usk, and Severn, partly derived from (1) and (2). Typically, these gravels contain clasts from a wide range of sources, but are known to include sandstones of Carboniferous origin. Pleistocene sandy gravels underlie the sub-Holocene land-surface exposed near the Redwick site, but in terms of the composition and size of the clasts are considered unlikely to have been the immediate source.

9.4.3 Comparison with other prehistoric sites

Earlier accounts of clast assemblages on the Severn Estuary Levels with which comparisons can be made come from: Site W, west of Gold Cliff Island (name given to the cliff exposure on the former island within Goldcliff parish; Allen 2000d, 38); the Mesolithic-Neolithic occupation deposit at Oldbury Flats (Allen 1998, 105); Bronze Age/Iron Age sites at Rumney Great Wharf (Allen 1996a, 4, 9); Redwick (Bell in preparation); and the Romano-British settlement also on Rumney Great Wharf (Fulford *et al* 1994, 196). There is a strong similarity of lithology and use between the assemblages from these sites and the collection from Goldcliff East – thermally fractured, pure/comparatively pure quartzites of moderate-high porosity tend to predominate. Given the much more varied composition of the putative parent gravels, it is concluded that quartzite clasts were deliberately selected for properties that favoured their use at these archaeological sites in processes that involved severe thermal shock. The clasts were probably used to heat water at Gold Cliff, Redwick, Oldbury Flats, and Rhymney Great Wharf (Bronze Age/Iron Age).

9.4.4 Heat-fractured stone from Goldcliff East

The lithologies collected appear to represent a deliberate selection; clearly the various quartzite lithologies (Lithology A–D) were chosen most, especially Lithology A (242 fragments), then Lithology C (32), while Lithology B (16) and Lithology D (6) were less used. The distribution of the lithologies is interesting (CD 9.18); most of the heat-fractured stones came from Site J, Context 328 (324 fragments, for distribution see Fig 6.16a). Site A had few heat-fractured stones, but most were of flint (13). Very few stones came from Site B (11). Chert was also used occasionally (31), and mainly comes from Site J, Context 328. Vein-quartz appear to have been very occasionally exploited; the only examples come from Site J and these are probably all from the same clast (see below). A few pieces of Lithology A suggest that the rock was occasionally used in other ways. The very little tuff is, with two exceptions, not thermally shocked but appears to be working debris.

The fragments from the different lithologies were spread out and checked for joins. Only one join was found, between 10354 and 10436 (Lithology A from Site J, Context 328). However, when the fragments were divided visually into groups based on size of inclusions, it was possible to distinguish seven groups which probably came from the same cobbles (CD 9.19); all were from Site J, Context 328. Six were of Lithology A, the other group were of vein-quartz, probably from three cobbles from the same clast. The fact that very few of the fragments join suggest that they accumulated over a long period of time and the pieces excavated were a few scattered remains of the original discarded pieces.

10 Mesolithic worked wood *by Richard Brunning*

10.1 Introduction

The evidence of wetland sites in Denmark, the Netherlands, and Germany has demonstrated the important role that worked wood, tools and structures played in the Mesolithic period. By contrast, our knowledge of Mesolithic woodworking in the UK is appallingly slight – limited to evidence from seven sites, of which four merely represent individual chance finds. The controlled excavation of Mesolithic worked wood in a coastal sedimentary sequence at Goldcliff East is therefore an exciting find that has more than doubled the number of finds of worked Mesolithic wood from the UK, and may provide an indication of the types of site where greater effort should be concentrated in future if we are to enhance our knowledge of this once ubiquitous, but now incredibly rare, component of material culture.

10.2 Methodology

Wooden remains were recovered during excavation and from bulk sieving during the 2002 and 2003 seasons. The method of retrieval and species identification for each piece were not known when the woodworking evidence was studied. Wood identifications, where known, were provided by Scott Timpany; some pieces have not been identified because it would have resulted in too much damage.

The sampling and recording was undertaken according to the latest professional guidelines (Coles 1990; Brunning 1997). For the sake of brevity the common English names are used for the wood species. After cleaning, the dimensions, morphology, and woodworking information were recorded on wood recording sheets. Cross sections were sketched of all the converted timbers and woodworking debris. The converted material was described according to the method of splitting, such as radial, tangential, half, or quarter split. The knottiness of the wood was assessed on a scale of 1–5 with 5 being very straight grained and 1 very knotty.

The recording methodology followed that used in the Somerset Levels and other prehistoric sites in Britain and Ireland (Coles and Orme 1983; Coles and Orme 1985; Brunning and O'Sullivan 1997; O'Sullivan 1997). The worked points of timbers were classified according to the number of sides they had been worked on to produce 'pencil', 'wedge', or 'chisel' shaped ends. The number, length, width, and cross-sectional shape of the tool facets were noted.

The woodworking analysis of the material from the 2002 fieldwork consisted of a rapid visual check with measurement of the dimensions of significant pieces. The numerous pieces of bark and miniscule fragments collected from bulk sieving were not measured. Due to the small nature of some of the material, an individual woodworking sheet was not filled in for each piece. Instead the relevant information was recorded in tabular form.

10.3 Artefacts

Site J

For discussion of worked wood on Site J see Chapter 6.5.4 and for their distribution see Figure 6.17.

Digging stick or spear-like object 9224 *(Fig 10.1)*
This artefact was recovered from the interface between the peat (Context 327) and the estuarine sediment (Context 331). It is shown *in situ* in CD 6.22–6.23. It has been radiocarbon dated 5930±37 BP (OxA-15550; 4910–4710 cal BC). It was made from oak roundwood. It was 1160mm long, and 45mm by 30mm at its widest point, and was broken into seven pieces, with at least one small additional piece missing. The breakage was at least partly the result of trampling by deer, evidenced by footprint-tracks. It had a slight (natural) bend 390mm from its thicker end. Its thicker end was broken and several side branches had been torn off. Several cut faces produced a roughly square cross section at the thicker end. It was cut on several sides over the last *c* 800mm towards the tip, which ended in a distinct point, although it was poorly preserved.

Y-shaped tool 9199 *(Fig 10.2–10.3; CD 10.1–10.3)*
This was recovered from the Old Land Surface (Context 328). It has been radiocarbon dated 5934±39 BP (OxA-15549). It is a 169mm-long forked branch carefully fashioned over its surviving length to create a 'Y'-shaped tool. The main stem was 20mm in diameter and had been cut on several sides to form a gradually tapering pencil point. One of the prongs had broken off close to the stem but the other survived to a length of 40mm and had been cut on several sides to form a rounded point. This clearly represents a carefully worked artefact although its purpose is unknown. Its size may suggest a hand-held tool.

Charred bead-like object 10462 *(Fig 10.3)*
This was recovered from the interface between the Old Land Surface (Context 328) and the estuarine sediment (Context 331). It is a worked piece of

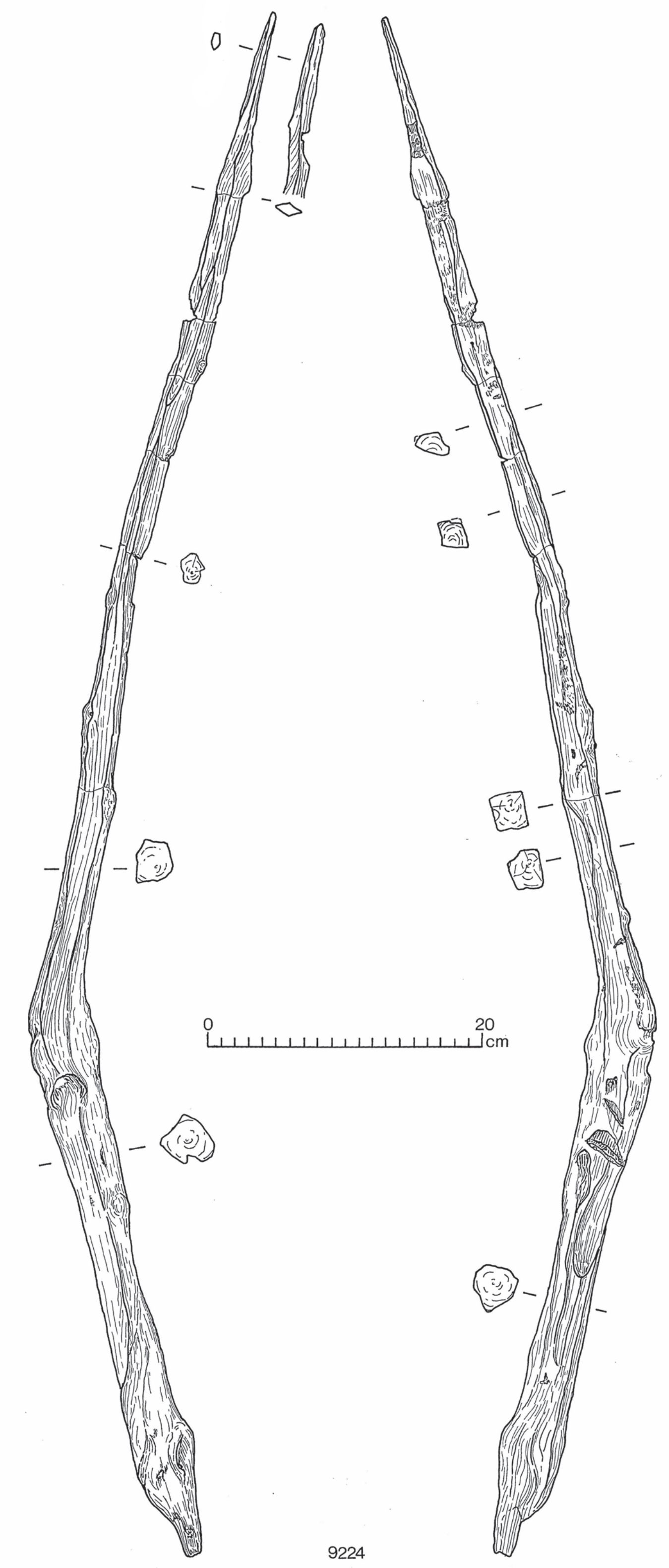


Figure 10.1 Goldcliff East, worked wood artefact 9224 from Site J (drawing J Foster)

Figure 10.2 Goldcliff East, worked wooden artefact 9199 from Site J: scale in cm (photo M Bell)

roundwood 15mm long and 16mm in diameter, apparently charred over its entire surface, although it is too heavy to be charred throughout. No bark is present but the pith is central and the outside of the item may represent the bark edge, especially as the slightly oval shape mirrors the ring pattern. Roughly seven annual growth rings are visible. Both ends have slightly bevelled edges and one end face is very smooth, possibly due to wear. The other end displays several lateral cut marks towards one edge and a concave dished area in the middle with a smooth polished surface. No wear is visible on the other face. At each end is a tiny vaguely central indentation (*c* 1mm x 1mm) caused by several slight cut marks. These appear to have been made after the ends had been polished (by wear?). It is not possible to be conclusive about the function of the item but it appears to have been an object held in the fingers with the ends used to rub against something.

V-shaped tool 4504 *(Fig 10.3)*
This was recovered from the Old Land Surface (Context 328). This potentially complete artefact formed a flattened 'V'-shape with two roughly symmetrical arms, *c* 50mm long that tapered towards the ends. The object appeared to have been carefully cut on both its inside and outside faces. It was thickest in the middle where it was 14mm by 14mm and tapered to both ends where it was 8mm or 9mm by 4mm. The object has several grooves on one side and on the inside face of the 'V' that may have been caused by wear from a fine string during its active life or by post-depositional damage. One arm represents a side branch while the other is formed from the main stem, considerably reduced in width and thickness. This shows that some effort was expended to obtain a roughly symmetrical piece of these dimensions. The size suggests that it may have functioned as some sort of hand tool.

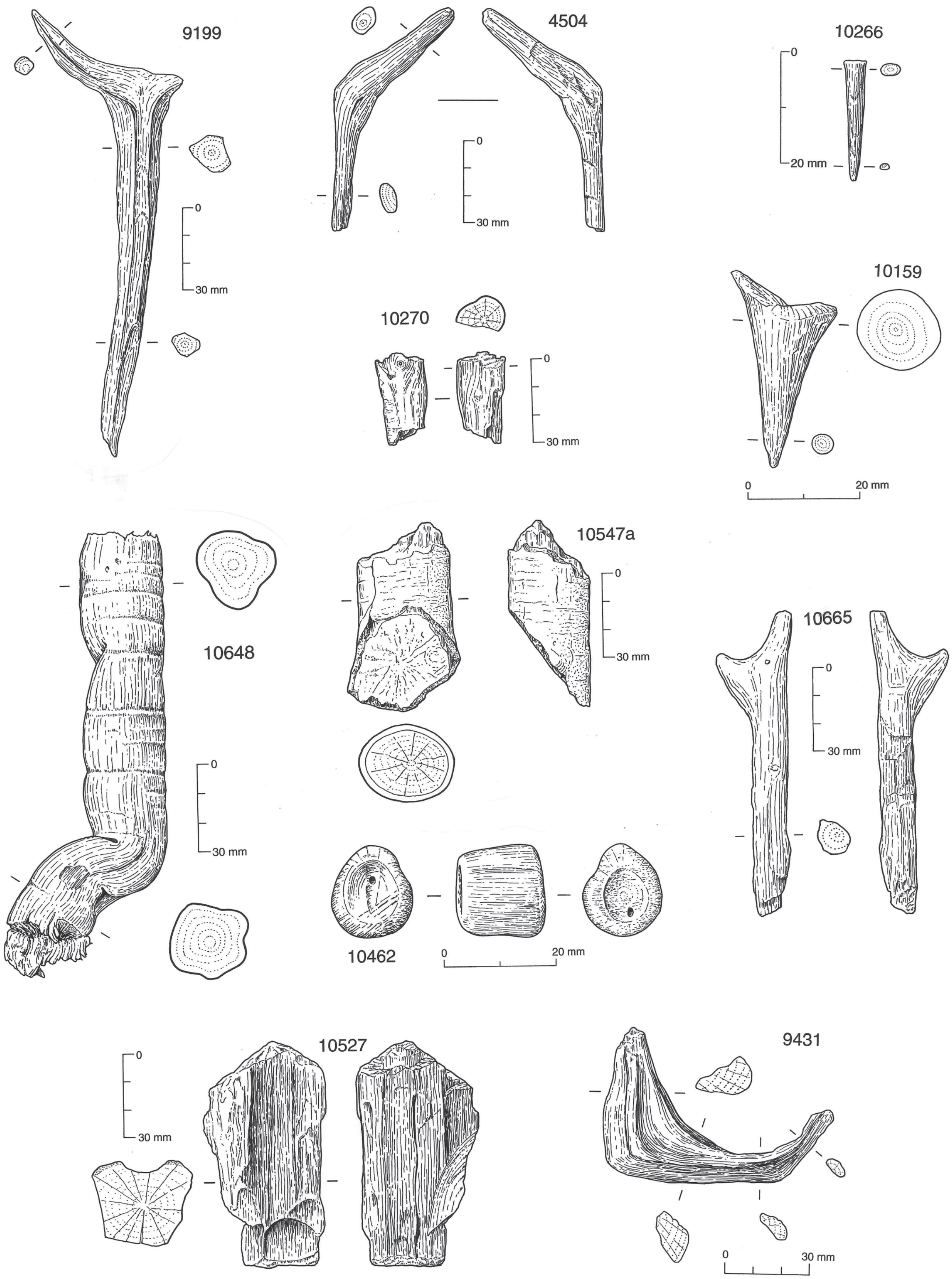


Figure 10.3 Goldcliff East, worked wood (drawing L Collett)

Pointed tool tip or pin 10266 *(Fig 10.3)*
This was recovered from the Old Land Surface (Context 328). It is a small piece of wood, only 21mm long and 4mm in diameter that had been carefully worked on all sides to form a point. Its wider end was broken so its total length is unknown but it may represent a fine pointed tool of some sort.

Pronged object 9431 *(Fig 10.3)*
This was recovered from the estuarine sediments (Context 331). It is a naturally curving piece that seems to have utilised a side branch and part of a larger stem to form a small tool. One prong is broken off but the object seems to have been made to be symmetrical with two prongs forming a curving 'U' shape. The object is widest in its middle where it is diamond shaped in cross section, 31mm wide and 16mm thick. The surviving prong tapers to a width of 6mm and a thickness of just 4mm. Careful work has gone into the creation of the object with its slender prongs and the finished shape has been very deliberately achieved. Its purpose is uncertain but the size suggests a hand tool. It has not been identified to species.

Possible stake 10648 *(Fig 10.3)*
This alder roundwood, 28mm in diameter, was probably a stake. Both its ends were broken but it was buckled in several places, a characteristic very frequently observed on prehistoric waterlogged sites where stakes have been driven into a hard deposit while still 'green' (eg Coles *et al* 1978; Brunning and O'Sullivan 1997).

Cut piece 10270 *(Fig 10.3)*
Hazel roundwood, 31mm long and 17mm in diameter. Both ends are broken but there are cut facets on two sides that form a chisel variant point at one end, the very tip of the point being broken off.

Cut piece 10159 *(Fig 10.3)*
Hazel roundwood, 35mm long and 20mm in diameter. One end is broken and the other forms a pencil point with no distinct facets, possibly due to erosion.

Other worked wood from Site J

In addition to the more distinctively worked and illustrated pieces described above there is a larger number of pieces of wood from Site J which show evidence of probable, possible, or rather doubtful working. These are described on CD 10.4. This includes 25 pieces from the Old Land Surface (Context 328). Four of these, in addition to 10648 described above, may be classified as stakes, four may be classified as split pieces; two, in addition to 10270 and 10159 described above, may be classified as cut pieces; and there are a further nine pieces which were generally rather decayed, compacted, or eroded – showing possible, but less clear, evidence of working. From the estuarine sediment (Context 331) there were six pieces classified as cut; three pieces which are woodchips, showing that some woodworking took place nearby; and one small hazel fragment which had been pressed against another piece of wood and might be a fragment of basketry, however, the compression could equally have occurred naturally.

Site B

'Spatula' 3718 *(Fig 10.4)*
This was recovered from the peat surface (Context 319). It consists of a small (11mm by 4mm) radially split piece of oak that had been carefully cut into a curve at one end, the other end being broken. It only survived to a length of 13mm but represents the tip of a carefully fashioned tool such as a spatula or stirrer.

Site E

Two pieces were recovered from buried estuarine sediments on this site during the examination of human footprints as described in Chapter 4.3.

13300
A hazel woodchip 24mm by 8mm by 1mm.

13302 *(Fig 10.4)*
The findspot is marked on Figure 4.5. A piece of worked hazel, 238mm long, tangentially split, cut on one narrow side so that it began to taper, possibly towards a point, although that end was broken. The other end was also broken but towards the middle of the break was a deliberately carved curving edge suggesting that it may have broken across a perforation in the timber. Any such perforation would have created a weak spot in the timber, making a fracture there more likely.

Palaeochannel east of Site E

Five pieces of pointed roundwood were recovered from the minerogenic sediments in this context, all of which may originally have functioned as stakes. In addition, one eroded piece of alder roundwood (7082) may have been cut at one end. The first three (7080–7082) are from Context 332 and are shown *in situ* in Figure 4.2. In Chapter 4.3 it is speculated that these may be the eroded remains of a fishing structure.

7080 *(Fig 10.4)*
Alder roundwood, 63mm long and 13mm diameter, cut on two to three sides over its surviving length to form a pencil point.

7081 *(Fig 10.4)*
Alder roundwood, 55mm long and 16mm diameter, possibly cut to a point although erosion of the surface makes it hard to identify worked faces.

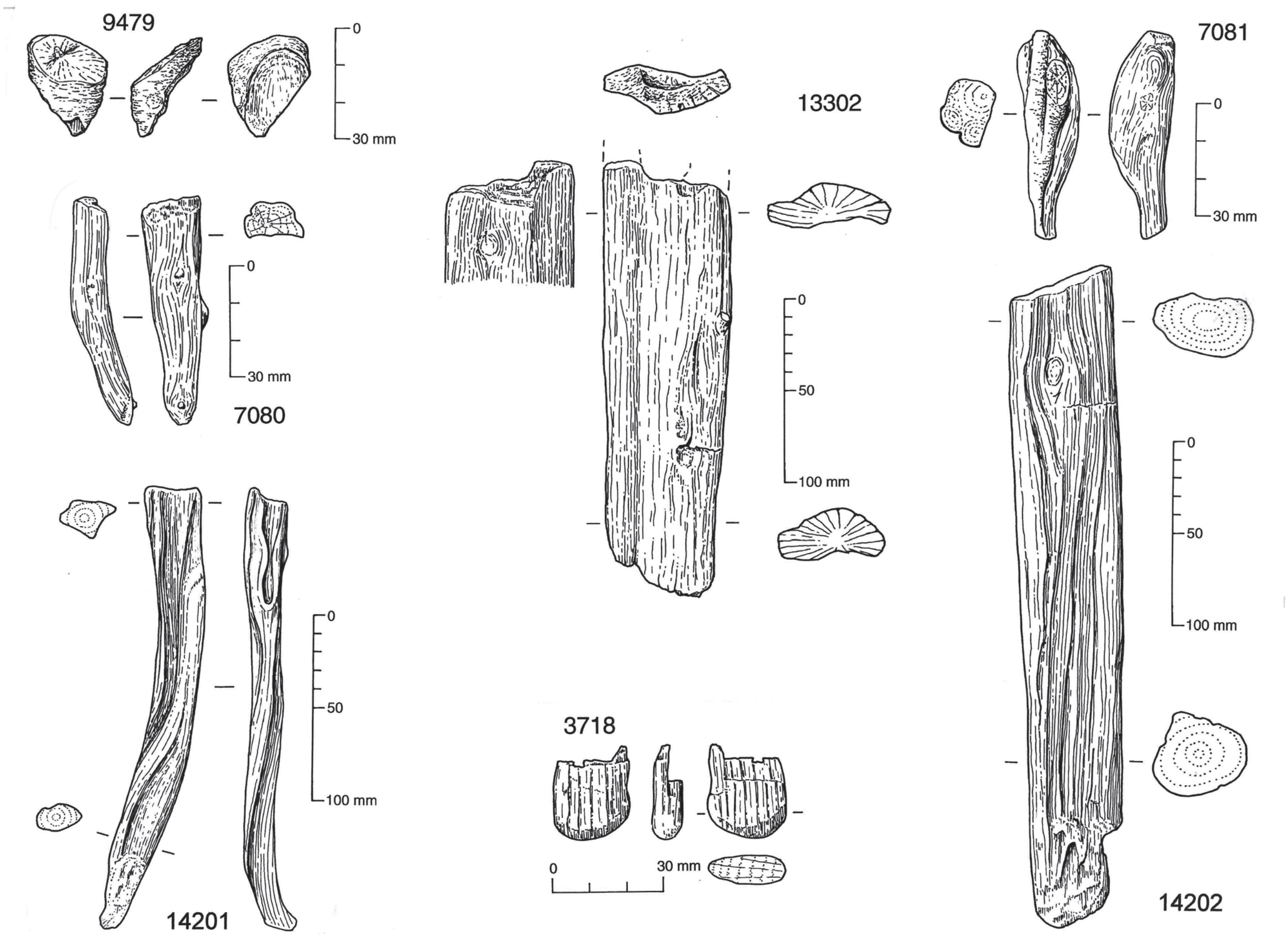


Figure 10.4 Goldcliff East: worked wood (drawing L Collett)

7082
Roundwood, 110mm long and 70mm in diameter, with possible working to a pencil point.

14202 *(Fig 10.4)*
A large piece of hazel roundwood, 358mm long and 56mm in diameter that was cut on two sides to form a possible point. It had broken towards the tip so the theorised point was absent.

14201 *(Fig 10.4)*
This was a very slightly curving piece of roundwood, 254mm long and 29mm by 22mm at its widest point. It was eroded over its entire surface, most notably towards one end. It appears to have been cut over most of its surviving length, with several distinct facets where small side branches had been removed and towards one end that does not come to a sharp point but instead exhibits an eroded, rounded end. This may represent a small stake that worked loose and was subsequently eroded in the channel.

10.4 Discussion

The wood assemblages from the six sites studied have produced varying evidence for worked wood. Sites A and D produced no evidence of worked wood. Site B produced only one worked piece, but Sites E and J both produced several pieces. Both the pieces from Site E had been worked and five of the six items from the palaeochannel to the east had been worked. From Site J, 45 out of 110 items examined had been worked in some form. This proportion underestimates the extent of human influence as many of the broken pieces of wood and bark could have been created by natural or human activity.

The worked assemblage consists of roundwood cut on the side or at the end, woodchips, some probable stake fragments, and a number of small tools and other artefacts. In addition there is one dubious piece of possible basketry. Some of the worked roundwood is charred and there is some roundwood that is charred but shows no signs of working.

The cut roundwood is small, mainly 30mm or less in diameter and there is no evidence that the simple cut ends were intended to turn them into small stakes. The woodchips are mainly from small diameter roundwood and the species identifications suggest that hazel and alder predominated as they did for the roundwood. There is evidence from the Old Land Surface at Site J that stakes did exist because of the buckling seen on two items. Neither of these were functioning as vertical stakes in the context in which they were found. The four cut pieces of roundwood all had carefully fashioned points and may represent stakes that were eroded into the channel.

There are the remains of seven probable tools, one from Site B (3718) and six from Site J (4504, 9199, 9431, 9224, 10462, and 10266). All these appear to represent carefully made hand tools but their purpose is uncertain, although 9224 may represent a digging stick or spear-like object and 3718 a spatula or stirrer. Objects 9224 and 9199 have been directly radiocarbon dated as noted above and produced closely similar dates in the later Mesolithic, which provides a date for human activity at Site J. Some further parallels for the wood tools and some more speculative suggestions as to their functions are outlined in Chapter 18.4.7.

The wooden assemblage is not in a very good condition. Some of it has been slightly damaged by its retrieval, especially those pieces recovered from sieving bulk samples on site. It has also been compressed by overlying sediments, is heavily fragmented, and appears to have suffered from surface erosion and some decay. This supports the possibility that some of this material may represent wood deposited by water action, possibly along a strandline. Its recovery along with bone and lithic assemblages suggests that the material has not moved very far.

Mesolithic wooden remains are extremely rare in the UK. A survey of waterlogged prehistoric wood from Britain and Ireland in 1978 identified only three find spots of Mesolithic wood (Coles *et al* 1978). A more recent survey of prehistoric wood in England (Brunning 2003) has increased this total to six sites for England, Scotland and Wales. Of these six sites, the most famous is the possible timber platform at Star Carr (Clark 1954) that produced two published tools, a birch paddle and a birch mattock handle and more recently planks (Mellars and Dark 1988). The other five consist of the Round Hill site in Humberside that has recently been reinterpreted as a hunting platform (R A Smith 1911; van de Noort and Ellis 1995); an 'axe haft or bow' from Brettenham, Norfolk (Norfolk SMR 5967); a Scots Pine stake from under 4m of peat at Lordenshaw hillfort, Northumberland (Northumberland SMR pers comm); a possible canoe found in 1923 on Thurlstone Sands, Bigbury Bay, Devon (Devon SMR 2812 and 37509); and another canoe from Friarton, Tayside (Geikie 1880), the date of which, based on apparent sedimentary context, 'must be regarded as suspect' (Mowat 1996, 132). Although the small assemblage from Goldcliff East is not in the best condition it is significant because it gives us a glimpse of the woodworking techniques from this period and evidence of part of the material culture that normally does not survive.

The best comparisons for the assemblage probably come from Denmark from strand deposits and fish trap remains in the Storebaelt. On the south side of Halsskov Island the remains of a disintegrated fish trap dating to *c* 5400 cal BC were discovered (Pedersen *et al* 1997, 136–51). It comprised hazel withies of 13mm to 47mm diameter and mainly between 20mm and 40mm. This size and species composition compares with the material from Site J. In addition there were 'clusters of thin branches and twigs by the shoreline . . . the branches nearest the shoreline may be part of some construction that bounded the trap at the shoreline' (Pedersen *et al* 1997, 136). In a similar area at Margrethes Ness substantial wood 'wreckage' dating to *c* 5,000 cal BC was excavated along a strand line. This comprised posts of 50–80mm in diameter, hazel stakes of 20–40mm, and thinner hazel wands that had been used as withies for panels (Pedersen *et al* 1997, 163). The description of these two sites have similarities to the Goldcliff East material and suggest one possible origin for the material may be from the damaged remains of broken-up fish traps mixed with other cultural material.

11 Bone and antler tools *by Martin Bell with contributions by Rachel Scales*

11.1 Introduction

The Goldcliff excavations produced a small collection of antler and bone tools; such finds are rare on Mesolithic sites in the southern half of the British Isles. Site A produced one worked bone, Site B, two examples, and Site J, eight examples. In addition Site J produced one bone with probable weapon impact marks, and three bones with cut marks and wear traces indicating utilisation. There was also an unstratified antler mattock or hammer from Site C. Other bones exhibited cut marks clearly relating to butchery and they are noted in Chapter 13.1.6. A few of the bones seemed to have been carefully fashioned artefacts, but most seem to have been subjected to short-term opportunistic use producing wear-traces. Simple experiments carried out as part of a Mesolithic experimental weekend at Butser Experimental Farm have contributed to our understanding of how some of these pieces may have been used and this is noted where relevant in the following sections.

11.2 Antler artefacts

Antler mattock-hammer 7065 *(Fig 11.1)* An unstratified find made by Derek Upton on a gravel beach close to one of the main areas of footprints at Site C. The artefact shows some rounding and erosion from coastal processes and the pedicle is partly fractured, probably by recent boulder impact. It nonetheless preserves clear evidence of both working and utilisation. It is 'T'-shaped, 213mm by 164mm. The red deer antler pedicle (diameter 54mm) appears to have been humanly modified, is smoothed and apparently battered, possibly through use as a hammer. Although battered the pedicle is rounded with no evidence of chopping or sawing; thus it was naturally shed. The main beam (length 80mm) has been modified, about half the circumference of the beam remaining, tapering to a quarter. The internal spongy tissue is absent creating a socket of 'C'-shaped section. The end, and part of the side, of this socket is smoothed and polished by use. At the base of the beam there is a pronounced groove within which the surface is polished. There is also a slight notch half way along the socket, also polished. Both groove and notch are likely to relate to some form of skin or plant binding which has held something in the socket forming a composite tool. The bez tine (length 140mm) is broken. At its mid-point, and to a lesser extent at the end, the surface is polished; this may relate to its use as a handle. The interior of the socket, the groove, and much of the top of the 'T' are blackened and appear to show evidence of burning, the position of which indicates that it involved the organic binding and maybe something combustible held in the socket.

The artefact has similarities to the perforated mattock-hammers which are widespread in Britain and Europe – most, but not all, being dated to the Mesolithic (C A Smith 1990). All the Welsh examples are from similar intertidal contexts: those from nearby Uskmouth (Aldhouse Green *et al* 1992) and Splash Point, Rhyl (Chapter 20.14) are radiocarbon dated to the later Mesolithic, while another perforated antler implement comes from Ynys-las/Borth, close to the submerged forest (Houlder 1994). Many perforated and unperforated antler implements have sockets formed, then rounded by wear similar to this artefact, for instance at Oronsay, other Scottish 'Obanian' sites (Clark 1956; Mellars 1987, 123), and Hardinxveld-Giessendam, the Netherlands (Louwe Kooijmans 2001 a and b). The pedicles of some antler implements at the latter site and at Hoge Vaart, the Netherlands also show evidence of use as hammers (Hogesytijn and Peeters 2001). There is also some similarity to the unperforated axes, in this case of reindeer antler, of so-called 'Lyngby-type' from Scandinavia and Britain (Cook and Jacobi 1994) – although these date to the late Glacial. They too have tines modified as a mattock-like implement. Two Danish antler artefacts from Kallerup Bog and Samso have grooves and associated polish produced by cord lashings (Mathiassen 1938). Some early Mesolithic antler artefacts from Star Carr also show evidence for the removal of soft tissue to make sockets (Clark 1954, 156, AM2). The socket in the Goldcliff example might have held a lithic artefact such as a small axe/adze or possibly a wood point, in view of the apparent evidence for charring within the socket. Experiments at Lejre, Denmark show that the perforated antler mattocks make effective woodworking tools (Jensen 1996). The associations of Mesolithic mattocks are particularly with coastal and riverine contexts (as with the Welsh examples) and it has been argued that one of their principal uses was for digging up plant foods (Zvelebil 1994). This example showed no evidence of striations expected in digging coarse-textured or stoney sediments – fine-grained estuarine silts seem more likely. The possibility that it acted as a hilt for a stone tool perhaps makes the working of wood more likely. A replica of this artefact was produced with a very crude small flint pick in the socket: it proved to be a most effective tool in pointing small pieces of hazel roundwood (Fig 18.5).

2273 Split antler *(Fig 11.2) (Site B, Context 319)* A strip of cut-marked antler, calcined, 189mm by 13mm. It is split from the original bone and fashioned

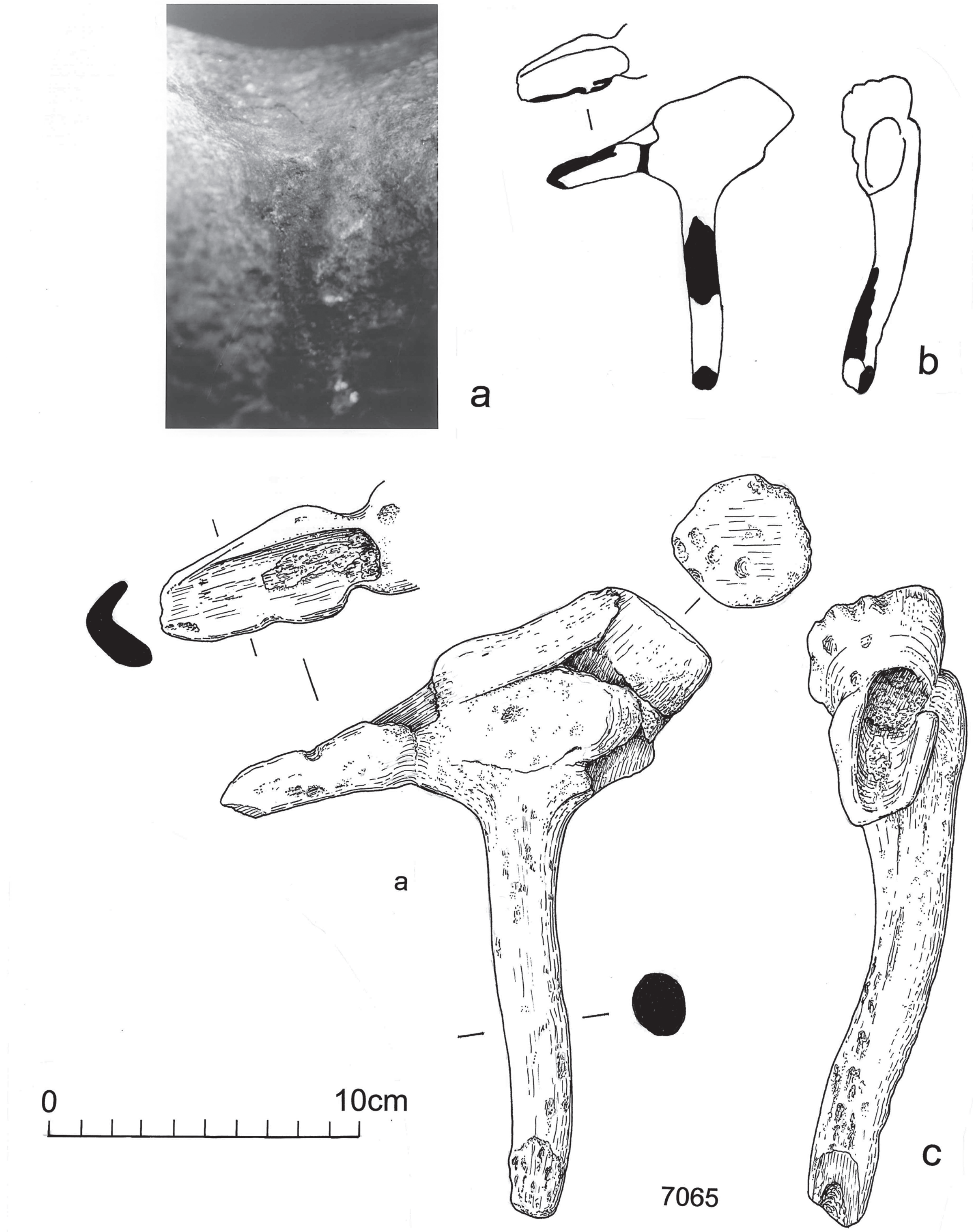


Figure 11.1 Goldcliff East, antler mattock-hammer 7065 (unstratified foreshore) (a) photomicrograph of polish on 7065 at point marked by a on c (b) sketch of areas of polish on 7065: scale 1:4 (c) antler mattock-hammer 7065: scale 1:2 (drawing J Foster; photo M Bell)

by chipping along one edge but there is no evidence of the use of groove and splinter technique as seen at Star Carr (Clark 1954). One end is smoothed and rounded and has a high polish on the inside (Fig 11.2) and a less intense polish on the outside. At this end the external surface also shows abrasion along the long axis of the piece. At the same end there are also cut marks or abrasion marks underlying the foregoing at right angles to the axis of the piece. There are fifteen fine, pronounced cut marks (Fig 11.2c) on one 15.7cm long edge regularly spaced at an average interval of 1cm (range 0.5–3.5). At the rounded end these cut marks are at 24° to the axis of the piece, steepening to 50° in the middle of the long side and 62° at the opposite end. Although strikingly numerous and regular, the cut marks seem too fine

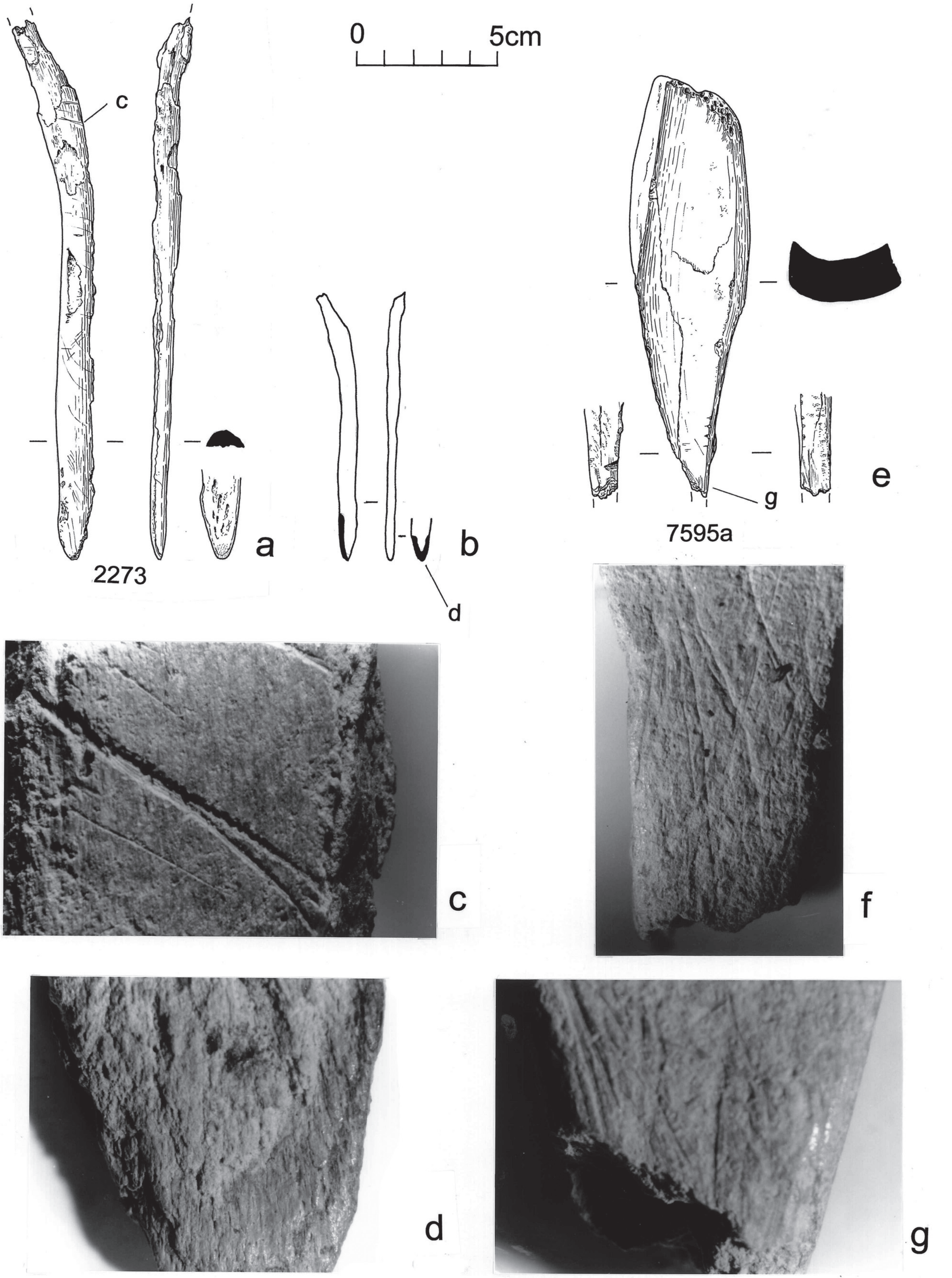


Figure 11.2 Goldcliff East, bone and antler objects (a) object 2273 (Site B); scale 1:2 (b) sketch of areas of polish on 2273; scale 1:4 (c) cut marks on 2273 at point marked by arrow on 'a' (d) polish on 2273 at point marked by arrow on 'b' (e) bone object 7595a (Site J); scale 1:2 (f) cut marks on back of object 7595a (not drawn) (g) striations and polish on 7595a at point marked by arrow on 'e' (drawing J Foster; photo M Bell)

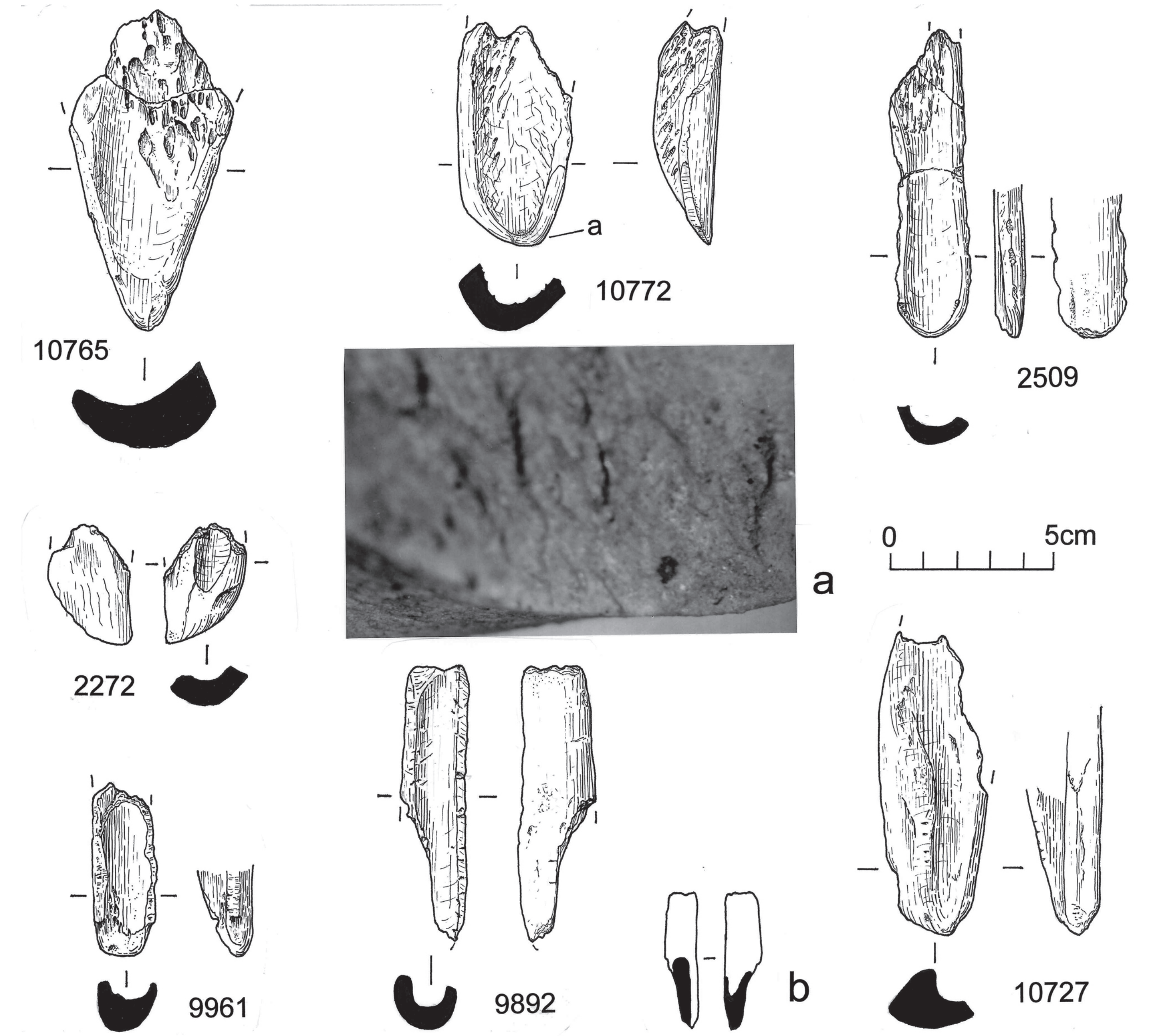


Figure 11.3 Goldcliff East, bone scrapers: 10765 (Site J), 10772 (Site J), 2509 (Site A), 2272 (Site B), 9961 (Site J), 9892 (Site J), 10727 (Site J). (a) polish on 10772 at point marked by arrow (b) sketch of areas of polish on 9892: scale 1:2 except 1:4 for 'b' (drawing J Foster; photo M Bell)

to have represented a form of deliberate decoration – some are only visible under the microscope. There are slight abrasion marks (similar to 7430) on the ridge of the piece, which also shows slight polish.

11.3 Bone artefacts

7595a Awl *(Fig 11.2) (Site J, Context 328)*
Fragment of aurochs humerus, 143mm by 41mm. A flake of bone has been removed from each side forming a point, which is slightly rounded and shows pronounced polish. There are abrasion marks along the axis of the piece near the tip (Fig 11.2g). The tip has been broken after formation of the polish. The polish might be consistent with use as an awl, eg to perforate skins, but the abrasion also suggests use on something harder. Bone awls are present on Obanian sites in Scotland (Lacaille 1954) and Mesolithic contexts in the Hardinxveld-Goessendam sites in the Netherlands (Louwe Kooijmans 2001a and b).

11.4 Bone scrapers

The largest group of bone artefacts are split long bone shafts with curved 'U'-shaped ends showing polish (Fig 11.3). Several show evidence of breakage after the polish, suggesting use involving some force. Artefacts of this type are frequently found when bone is preserved on Mesolithic sites. Examples occur at Star Carr (Clark 1954, 161), Morton (Coles 1971, fig 15), Oronsay (Mellars 1987), and other Scottish sites classed as 'Obanian' (Lacaille 1954). There are also examples from Nanna's Cave, Caldey (Lacaille and Grimes 1955, fig 17). The general view seems to be that these artefacts were used for working skins. The Goldcliff examples are not well worked or as strongly polished as those from some other sites. The impression is of bones crudely modified, used for a specific task resulting in polish, then discarded. It is notable that six of the bone scrapers came from the concentration of smashed aurochs and deer bones in the north-west corner of Site J (Fig 6.16b). Our original hypothesis was that these artefacts were used to scape marrow. However, experiments showed that such tools are not really as effective as heating for the purpose of marrow extraction. A more probable function for these tools was skin processing and the scraping of deer skins produced traces of similar wear.

10765 *(Fig 11.3) (Site J, Sq –1/4, Context 328)*
Fragment (96mm by 49mm) of aurochs radius, worked end 'v'-shaped rounded, and trace of polish on slightly raised area of bone 15mm from end both inside and outside. End appears to have been broken in use.

10772 *(Fig 11.3) (Site J, Context 328)*
Fragment of an aurochs humerus, of 'U'-shaped section, 65mm by 34mm. At one end there is a regular curved smooth edge with marked polish on the outer surface extending in places to the other end which appears to be broken. There is some polish on the interior but the break itself has only slight polish.

2509 *(Fig 11.3) (Site A)*
Fragment of red deer humerus, split (91mm by 24mm), slightly rounded and smoothed on one long side where there is also a bright patch of polish. There is slight polish on the smoothed end and inside the bone. One side of the object appears to have been broken ? in use.

2272 *(Fig 11.3) (Site B, Context 319)*
Fragment of an unidentifiable large mammal long bone (39mm by 24mm) with a cracked and eroded surface, probably also burnt, but apparently worked to a spatulate end with a marked polish at the pointed end and on the inside.

9961 *(Fig 11.3) (Site J, Context 328)*
Fragment of large to medium mammal bone, split (52mm by 21mm), rather eroded, one end is rounded and smoothed and probably originally worked, the other is broken. There is evidence of abrasion at right angles to the axis. There are traces of polish on the inside and outside, breakage has taken place after use.

9892 *(Fig 11.3) (Site J, Context 328)*
Fragment of red deer humerus, split, 'U'-shaped section (82mm by 22mm). The more pointed end has some polish on the exterior and interior surface. A break postdates the polish and its original form may have been more spatulate. It appears to have been used for scraping.

10727 *(Fig 11.3) (Site J, Context 328)*
Fragment of aurochs long bone, very rounded and eroded (92mm by 35mm). There is patchy polish on the external surface and traces of polish on the interior at the more pointed end, broken after polish. There are slight fine cut marks which may relate to butchery. Four distinct cut-mark notches on one broken edge may not be explicable in terms of butchery.

10726 *(not illustrated) (Site J, Sq –1/4, Context 328)*
Fragment of aurochs long bone, split (102mm by 30mm). There are three clear cut marks at *c* 45°. Some patchy polish at broken and pointed end. Not a worked tool but possibly utilised.

10489 *(not illustrated) (Site J, Sq 1/3, Context 328)*
Fragment of red deer radius (75mm by 19mm). Rounded at one end with traces of polish in places on external surface and side.

11.5 Bone with evidence of possible weapon impact

10392 *(Fig 11.4, CD 11.1) (Site J, Context 328)*
Distal end of aurochs radius, (78mm by 82mm). Part of the tabular surface of the bone has been split away exposing the spongy interior. The surface is marked by six deep angular stab marks in rough alignment over a distance of 45mm. There is no sign of fresh fracturing which would be the case if these were the result of excavation damage. Two of the impressions are markedly triangular, they range in size from 8mm x 3mm to 3.5mm x 1.5mm. The depth of these marks is 5mm furthest from the articulation decreasing to 3mm. Close to the articulation there are two marks at right angles and a shallower groove continuing one of these on the main alignment of stab marks. The most likely explanation for these marks seems to be impact by one or more microlith-armed weapon(s) – subsequently withdrawn, perhaps splitting off the tabular bone surface. There is no trace of flint fragments in the marks, such as has been found in weapon impact marks elsewhere (Noe-Nygaard 1974). An alternative possibility is that these represent separate stabbings with a fine weapon or tool, either before death, or during dismemberment, possibly the early stages of perforation to achieve an axial split of the long bone. However, that seems less consistent with the evidence than the impact of a composite weapon. This bone also has fine cut marks on the opposite face.

11.6 Bones with cut marks and wear traces

Some of the following have cut marks sharply defined and clearly made with lithic blades during butchery.

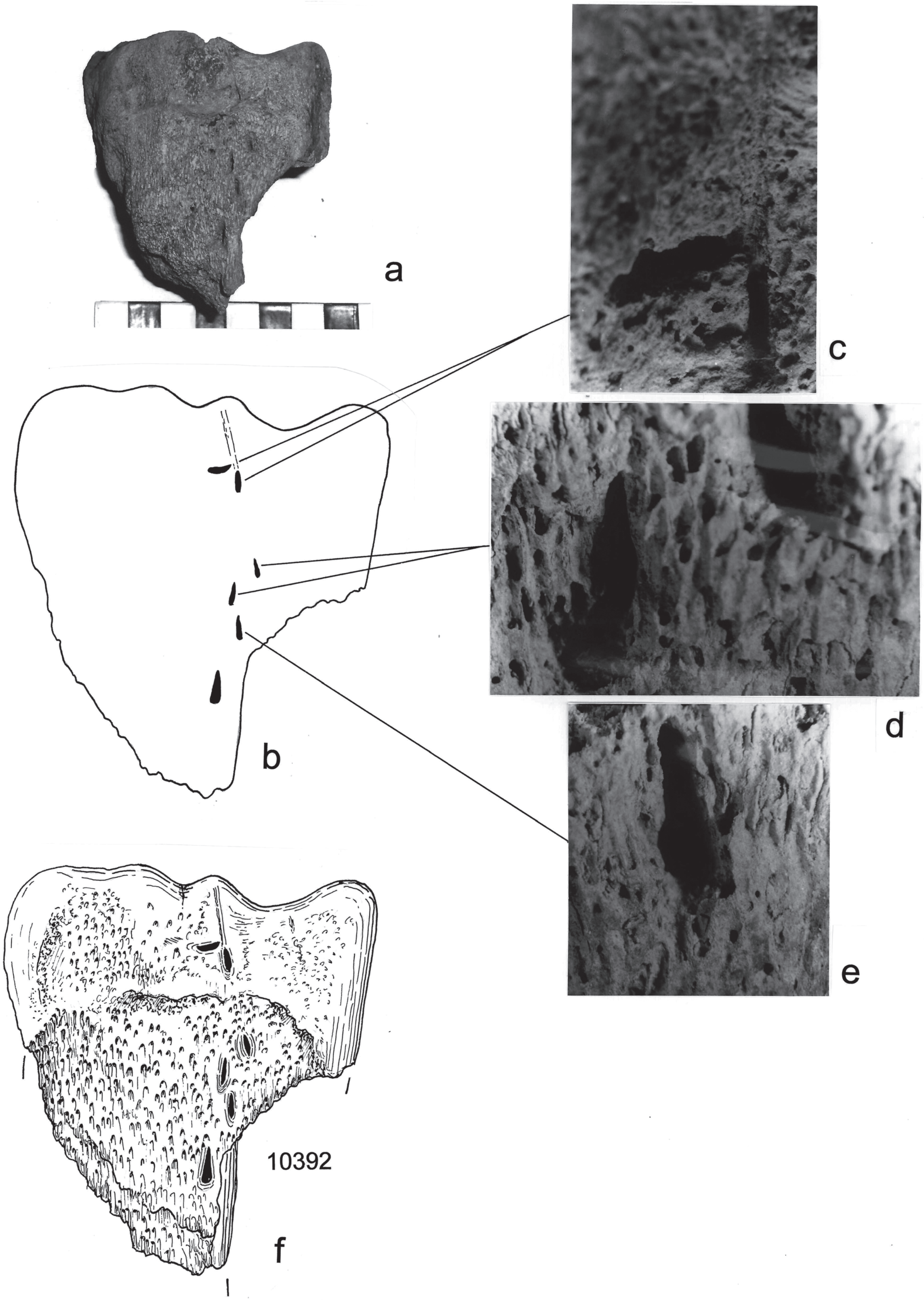


Figure 11.4 Goldcliff East, bone object 10392 (Site J) (a) photo of 10392 showing stab marks; scale in cm (b) sketch of 10392 indicating position of photos 'c–e': scale 1:2 (c–e) photos of stab marks on 10392 (f) drawing of 10392: scale 1:1 (For colour illustration see CD 11.1) (drawing J Foster; photo M Bell)

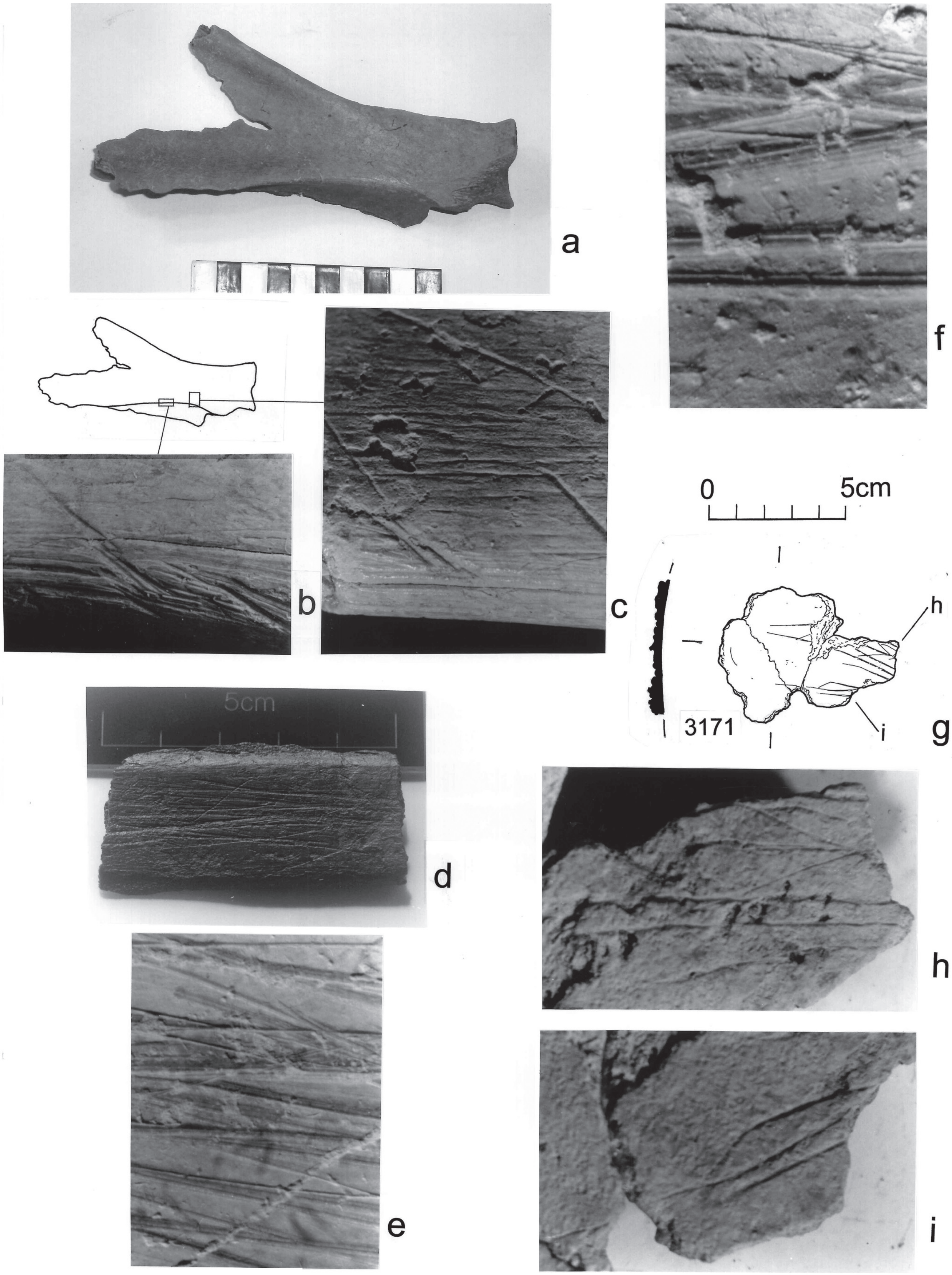


Figure 11.5 Goldcliff East, cut-marked bone. (a) 7430 showing cut marks: scale in cm (b–c) photomicrographs of 7430, lower edge showing cut marks (d) 7531, cut and abrasion marks: scale in cm (e) photomicrograph of 7531, cut marks (f) photomicrograph of 7523, cut marks (g) drawing of 3171: scale 1:2 (h–i) photomicrographs of 3171, cut marks (for colour illustration see CD 11.2) (drawing J Foster; photo M Bell)

Some also show evidence of abrasion to the bone surface, which might be a result of scraping during butchery or subsequent utilisation of the bone.

7430a *(Fig 11.5a–c; CD 11.2) (Site J, Context 328)*
Red deer scapula with cut marks at *c* 30° to the axis and pronounced linear abrasion: the abraded area shows a pronounced polish. The cut marks, abrasion, and polish are concentrated on the distal end on the caudal edge of the infraspinous fossa, between the scapula neck and caudal angle. Numerous similar cut marks on an elk scapula at Star Carr were interpreted as a result of meat removal (Legge and Rowley-Conwy 1988, fig 42). Wear is not sufficiently extensive, or concentrated on the distal edge for this to have functioned as a digging tool. It seems more probable that the abrasion and polish results from the use of the curved edge of the scapula in some processing activity, such perhaps as the scraping and cutting of animal sinew.

7531 *(Fig 11.5d–e) (Site J, Context 328)*
A segment of medium-sized rib (deer or boar-sized), the tabular surface of which shows cut and abrasion marks along the axis of the piece and traces of polish. (Fig 11.5d–e). Possibly the same bone as 7523, which has similar marks.

7523 *(Fig 11.5f) (Site J, Context 328)*
Two small fragments of medium-sized rib (deer or boar-sized), from among ten fragments from same find, with multiple cut and abrasion marks along rib axis, some possible polish on surface. The microscope photographs show that some individual cut marks are made up of multiple furrows, the product perhaps of a lithic blade with nicks in its edge. One mark (Fig 11.5f, top) on 7523 shows trifurcation. These traces might be the result of these rib pieces being used in a processing activity such as scraping and cutting of animal sinew.

3171 *(Fig 11.5) (Site A, Context 314)*
Three joining tabular fragments of roe deer scapula, on the surface of which are twelve fine cut marks, some linear, some curvilinear, and others at an angle (Fig. 11.5g–i). Two other associated, but not joining fragments of bone both have two cut marks. These might be a result of butchery or skinning. The possibility should also be considered that these incisions represent deliberate doodles or decoration, as seen on pebbles from Rhuddlan, north Wales (Berridge and Roberts 1994). Geometric patterns of incised lines have also recently been noticed on the walls of caves, at Aveline's Hole, apparently sealed since the Mesolithic, and Long Hole, Cheddar Gorge, and interpreted as possible Mesolithic art (Mullard and Wilson 2005 a, b).

11.7 Bone and antler artefacts: conclusions

Apart from the generally isolated finds of antler mattocks, bone artefacts are very rare in Mesolithic Britain. The main assemblages are from early Mesolithic Star Carr and later Mesolithic Scottish 'Obanian' sites and as the references indicate there are similarities with the bone artefacts from these and later Mesolithic assemblages from the Netherlands. Some pieces of bone were worked to make specific tools (eg 7065, 2273, 7595a, 10765). However, much of this bone seems to represent debris from butchery and the smashing of bone for marrow extraction, which was opportunistically used, perhaps as part of the same suite of related activities. The possibility must be considered that some of the slighter polish might result from estuarine processes such as abrasion by sediment. However, in general this is thought unlikely. Much of this bone was buried in the basal soil some in overlying silt. There is a marked regularity in the edges showing the most marked polish, particularly the split bone scrapers. The activities represented on the west side of Site J are likely to have included the scraping of skins and maybe the scraping and cutting of sinew. The relatively slight traces of polish on some bones emphasises the importance of microscopic examination of bone.

12 Footprint-tracks of people and animals
by Rachel Scales

12.1 Introduction

12.1.1 Footprint-tracks

Footprint-tracks of humans and animals have been found in a wide variety of geological and archaeological deposits (Allen *et al* 2003, 56). In the Severn Estuary, Mesolithic human footprint-tracks have previously been found at Uskmouth and Magor (Aldhouse-Green *et al* 1992). Animal footprint-tracks have been recorded widely in the estuary by Allen (1997b) and in association with prehistoric archaeological sites at Oldbury (Allen *at al* 2003, fig 1), Redwick (Bell 2001) and Iron Age sites west of Goldcliff island (Bell *et al* 2000, fig 8.13). Goldcliff East is an exceptional site in terms of footprint-track preservation. Erosion exposes footprint-tracks in banded sediments and it has proved possible to uncover larger areas by excavation. Investigation of these sediments have been introduced in Chapter 4. The areas of banded minerogenic sediment (Fig 4.1) containing footprint-tracks outcrop on the lower foreshore between the Lower Submerged Forest peat dated *c* 5600 cal BC and the Upper Peat *c* 4800 cal BC. Dark and Allen (2005) have demonstrated evidence of annual banding in the upper part of this sedimentary unit. The finer-grained laminations correspond to the spring and summer months, while the coarser-grained sandy bands formed during the autumn and winter months (Chapter 17.2). The main investigations of footprint-tracks took place on the low foreshore on Sites C, E, and H (Fig 2.3). Footprint-tracks were not restricted to these sites; they occur widely within the banded silts and small groups, or individual examples, have been recorded elsewhere in other sedimentary contexts. They were also recorded within excavation trenches, particularly on Site J with small numbers on Sites A, B, and D. Some footprint-track recording also took place in the upper part of the laminated sediments on Site F/G just below the Upper Peat. This chapter summarises research that has been presented in greater detail and in comparison with other sites in Scales (2006).

12.1.2 Terminology

Terminology (Fig 12.1) in this chapter follows Allen (1997b), Allen *et al* (2003), and Scales (2006). Individual prints made by a human or animal are *footprint-tracks*. A series of footprint-tracks made by an animal as it moves is a *trail*. *Stride* length is the complete cycle of limb movements, ie the distance between the left heel and left heel, or right

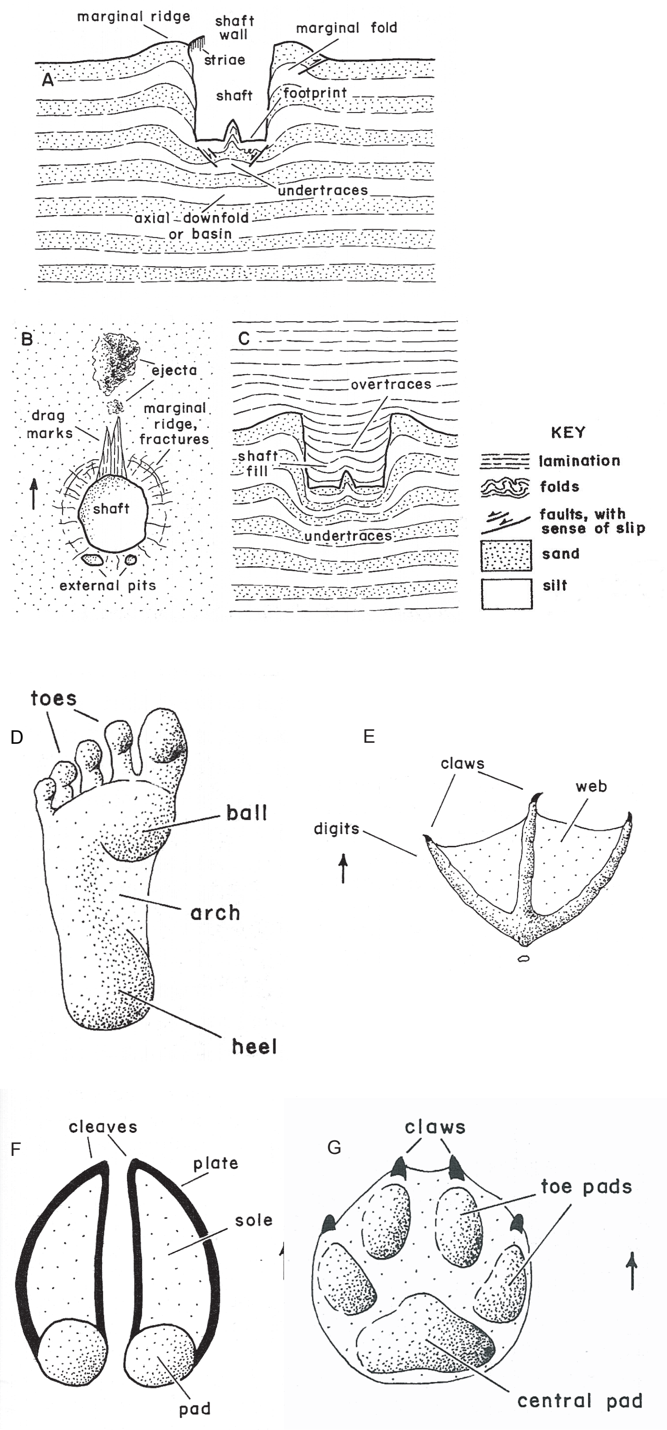


Figure 12.1 Terminology used in the description of human and animal footprint-tracks (A and B) vertical section (C) surface view (D) human (E) bird (F) generalised cloven hoof (G) dog (drawing J R L Allen)

heel and right heel. *Cadence* is the rate of walking. The *footprint* is the surface in contact with the underside of the foot when the limb is withdrawn. In banded sediments the footprint will be pushed into, and distort, the underlying layers, leaving *undertraces*. The footprint becomes filled with laminated sediment creating *overtraces* above the footprint. Other features that may be recorded are *marginal ridges* (sediment deformed around the footprint), *marginal folds* under the foot, *drag marks* and *pits* from the toes. There may be *interdigital ridges* between the toes or hoof sections.

12.1.3 Methodology: excavation and recording

As the footprint-tracks lie on the lowermost foreshore, and are not exposed for more than 2 hours 40 minutes even at the most favourable spring tides (Fig 2.7), appropriate excavation and recording methods had to be developed for the conditions (Scales 2006). Exposed footprint-tracks were recorded as soon as possible by tracing using large clear plastic sheets (builder's covering plastic) and waterproof pens. The resulting 1:1 plan was later digitised. Trails of footprint-tracks disappeared below clifflets formed of overlying laminations. Some such areas were excavated (Fig 12.2) by peeling back the laminations by finger tip only and the fine layers of sand within the laminations eased away. The sediment was too fragile to use anything as harsh as a trowel or plastic spatula. Once a layer of sand had been removed, water was gently poured over the silt so that the surface was washed clean and any features could be observed. It was generally found that the best method was to excavate a couple of footprint-tracks at a time and allow the next tide to clean them further. Some very well-preserved footprint-tracks were blocklifted by enclosing them in specially constructed metal tins. In the laboratory micro-excavation took place, using a scalpel, a few millimetres at a time, tracings being made at every stage. In this way the footprint, its dimensions, any overtraces and undertraces could be excavated and recorded. Excavation made it possible to study footprint-tracks as they were freshly exposed and to reveal a much larger area of tracks than would have been exposed naturally. During excavation the footprint-tracks were generally left at the level at which they first became visible in the silts, namely at the level of the overtraces. Examination at this level means that dimensions are exaggerated and some of the detail is unclear. Accordingly, examples were blocklifted and micro-excavated down to the footprint level providing more accurate measurements and more detailed features.

The excavation of footprint-tracks has shown beyond doubt that they were securely stratified within the banded sediments and had not been produced by recent visitors to the foreshore. Furthermore the banded sediments are semi-consolidated as a result of compaction. Thus, whilst they can be somewhat deformed by the pressure of somebody walking or kneeling today, the result does not resemble the more fluid deformation and contortions created at the time the footprints were originally made.

Figure 12.2 Excavation of footprint-tracks at Site C in 2003, being filmed for the Time Team television series (photo E Sacre) (for a colour version see CD 12.1)

Casts of footprint-tracks were made in two ways. The first was Plaster of Paris which takes about twenty minutes to dry before it can be lifted, but this is often too long when working in intertidal areas. A second method of casting using dental alginate (supplier: A Tiranti Ltd) is much quicker, with a setting time of two minutes. However, it can only be stored for about three months before deterioration, so permanent plaster casts of the alginate casts were made shortly after the originals were taken. In some cases, it is possible to compare footprint measurements, often of overtraces, with those based on casts of the actual footprint. This shows that the tracings of overtraces can sometimes overestimate true size by up to 20% (*c* 6cm). In relation to the trails of individuals described below, some estimate is made of the probable margins of error based on comparisons of this kind.

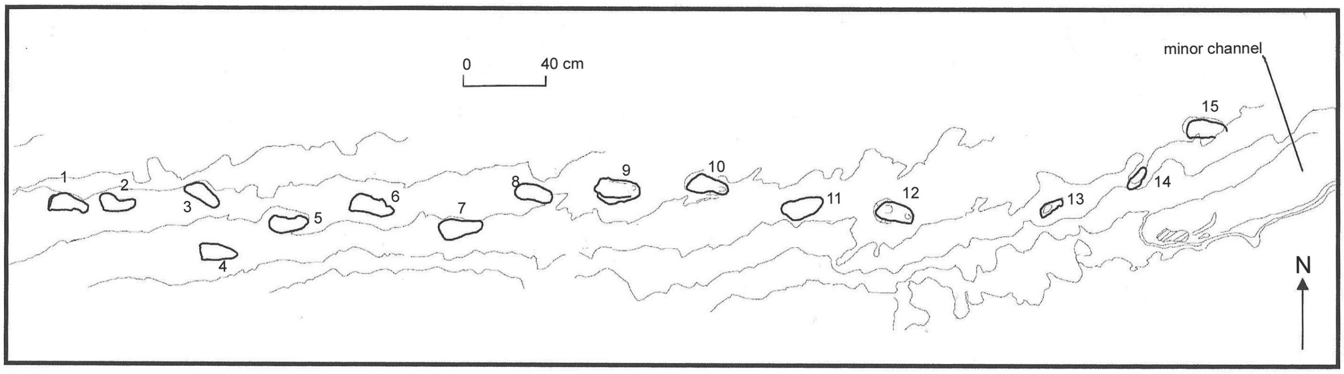


Figure 12.3 Plan of trail made by Person 1, Site H, showing the outcrops of laminations and a minor channel (graphic R Scales)

12.1.4 Methodology: estimation of age, height, and speed of walk

Various methods can be employed to estimate the type of person that made each footprint-track, particularly their age, height, and speed of walk. Age can be estimated from footprint-outline length accurately for children, less so for adolescents and adults. The Clarks (1990) survey and data of children from Spalding Primary School aged 4–11 (Scales 2006, fig 3.2) provide data for children aged 3–16 years of age. Over the age of 14 only an estimate of age can be given.

The estimation of height from footprint length has been the subject of discussion since the 19th century when the physical anthropologist Topinard (1877) suggested a simple ratio of foot length to stature, foot length being 15% of height; a ratio adopted by Robbins (1986). Giles and Vallandigham (1991), argued, however, that there should be different calculations for the sexes. That is not practical for prehistoric evidence for which determination of sex is problematic, especially in the case of children. Previous height estimation research has focused on adults (eg Robbins 1986). The study of children from Spalding Primary School (Scales 2006 tables 13.2–13.4; figs 13.3–13.5) showed that a better estimate for children is a ratio of foot length to stature of 15.6%. Both sexes produced the same figure, indicating different calculations for males and females are not necessary. Thus adult height calculations employ the ratio of 15% and for children 15.6%.

Little research has been carried out into the weight estimation of an individual from their footprints; however, Robbins (1986) suggests that there may be a ratio between foot width and weight of 66.6 % for male individuals over 14 years of age and 70.6 % for females. She has no ratio for children. There was a correlation between the weight and footprint-outline ball widths of the Spalding children, using a ratio of 28% (Scales 2006, fig 3.6), again there was little variation between sexes. The Giles and Vallandigham (1991) regression equations are not suitable for use with children but provide more accurate results for adults. However, to use these equations it is necessary to know the sex of an individual.

Once foot and stride length have been measured from a trail it is possible to estimate relative stride length and speed of walk. Published data on this estimation are based on a small number of biomechanical experiments (Grieve and Gear 1966); non-linear equations were used to estimate relative stride length. One problem is that it is not easy to take into account size variations between men, women, and children. Alexander (1984) addressed this by examining men, women and children separately. Speed of walk for the Goldcliff East data set has been calculated using the formulae and values described in CD 12.2. In this chapter the human footprint-tracks are presented in greater detail, because of their exceptional archaeological interest: there is less detail on the animal footprint-tracks. Where possible human footprint-tracks have been assigned to particular individuals, eg Person 1. Footprint-tracks in the trail created by Person 1 are numbered 1/1 etc. Details of the individual persons represented are given in Table 12.1.

12.2 Human footprint-tracks

12.2.1 Site H

Person 1 (Trail 6094)

This trail was discovered in a bed of finely banded silts (details of the investigation were introduced in Chapter 4.4.3). The newly exposed trail was rapidly subjected to the erosional processes of the tide and within three days after completion of recording it had been completely eroded away. A tidal window of just 1½ hours was available for recording. The trail (Fig 12.3; CD 12.3) consisted of sixteen human footprint-tracks exposed at the undertraces level. Two were well-preserved (1/2 and 1/6); the rest were less so. The pattern of footprints, left, right in sequence and in a straight line 8m long, shows that they were all made by one individual. The person walked from the east, heading west towards Goldcliff island. Part of the trail was alongside a gully in the salt marsh and

Table 12.1 Summary of data obtained from human footprint-tracks for Goldcliff East individuals

Person	Age category	♂/♀	Age (years)	Height (m)	Height (ft/in)	Wgt(kg)	Foot size (cm)	British Shoe size (Clarks)	Walk speed	No of footprints	Site	Season of activity
Person 1	Sub-adult	♂	10½ -11	1.47	4ft 10	38	22.1	3½	101	16	H	Spring/ summer
		♀	11-12	1.42	4ft 8				107			
Person 2	Sub-adult	♂	12½	1.6	5ft 3	58	24	5½	97	9		Spring/ summer
		♀	14+	1.62	5ft 3½	61			114			
Person 3	Sub-adult	♂	13½ - 14½	1.69	5ft 6½	80	25	7+	93	7		Spring/ summer
		♀	14+	1.67	5ft 5½	85			113			
Person 4	Sub-adult	♂	12½ -13½	1.65	5 ft 5½	65	24.8	7+	103	8	E	Spring/ summer
		♀	14+			69			124			
Person 5	Adult	♂	16+	1.75	5ft 9	72	26.8	9 ♂	92	9		Spring/ summer
		♀	14+	1.72	5 ft 8	76			107			
Person 6	Child	♂	8½	1.34	4ft 5	30	20.9	2		4		Spring/ summer
		♀	9									
Person 7	Adult	♂	14½ +	1.73	5 ft 8	61	26.3	9+ ♂	86	4		Autumn/ winter
		♀	14 +	1.7	5ft 7	65			110			
Person 8	Young child	♂	6	1.16	3 ft 10	28				3		Autumn/ winter
		♀	6½									
Person 9	Child	♂	7½	1.31	4ft 4	33				1		Autumn/ winter
		♀	8									
Person 10	Young child	♂	3	0.98	3ft 2½	20				2		Autumn/ winter
		♀	3-4									
Person 11 = 18	Young child	♂	4	1.03	3ft 5	21	16.1	Child size 10		108±10		Spring/ summer
		♀	5								C	
Person 12	Sub-adult	♂	10½	1.4	4ft 7	19	21.9	3		57±10		Spring/ summer
		♀	11									
Person 13	Sub-adult	♂	10½ -11	1.43	4ft 8	23	*22.4	* 4		2		Spring/ summer
		♀	11-12	1.49	4ft 10½							
Person 14	Young child	♂	6	1.15	3ft 9	20	*18	*Child size 11½		1		Spring/ summer
		♀	6½									
Person 15	Sub-adult	♂	13½	1.65	5ft 5	76	24.8	7+		4	H	
		♀	14+			72						
Person 16	Young child	♂	5	1.08	3ft 6½					2	E /C	
		♀	5½									
Person 17	Young child	♂	9 ½	1.38	4ft 6		21.6	2		3	C	
		♀	10									
Person 19	Young child	♂	4-5	1.1	3ft 7					4		
		♀									C	
Person 20	Adult	♂	14+	1.8	5ft 10			11 ♂		2		
		♀										
Person 21	Adult	♂	14+	?	?					2		
		♀										

Adult (14+) Sub-adult (age 11–14) Child (age 7–11) Young child (age 3–6)
*Estimate based on overtrace only. Walk speed in steps per minute
(data provided by R Scales)

Figure 12.4 Trails of Persons 2–5 beginning to appear at the start of excavation on Site E (Area 6113). The front two footprint-tracks had been exposed by the tides, the rear two by hand excavation: scale 0.5m (photo E Sacre)

the silt around many of the footprint-tracks was marked by the small circular holes of reed stems. One footprint-track is missing from this trail, a left footprint-track obscured by overlying laminations between 1/12 and 1/13. Person 1 was walking in bare feet. Most of the footprint-tracks have marginal ridges around the front part of the foot, with weight being put on the toes and the ball of the foot. The tracks also had splayed toes, so the individual was probably moving in fairly soft sediment; a few footprint-tracks show that the person slid in the mud (1/8, 1/11). The person appears to have hesitated at footprint-track 1/3, as this print is side by side with 1/4. Further details of individual footprint-tracks of Person 1 is given in CD 12.3–12.9.

An age estimation for Person 1 is made using measurements taken from plaster casts of 1/6 and 1/8 and information based on the Clarks' (1990) survey of age and foot size (Scales 2006, fig 3.2). The two plaster casts show clear footprint outlines, distinctly curved heels and big toe impressions. The maximum right foot length is 22.1±0.5cm so the individual could be a girl aged 11–12+, or a boy aged 10½ –11+. Since age estimation suggests that the individual could have been older than 11 years of age, stature has been estimated using a mean percentage of 15% (Scales 2006, chapter 3). Therefore, stature (in cm) = foot length (in m) / 0.15 = 0.221/0.15. Person 1's height is 1.47m if a boy, or 1.42m if a girl (4ft 10in or 4ft 8in). Speed of walk (cadence) has been estimated using a non-linear equation used for predicting relative speed from relative stride (Scales, 2006, chapter 3). Using values for relative speed obtained from Alexander (1984, fig 1; based on Grieve and Gear 1966), a cadence of 101 steps per minute can be estimated. Person 1 was walking briskly parallel to the shoreline towards Goldcliff island.

Given the size and shape of the footprint-tracks, Person 1 is likely to have been an older male child, or an adolescent female. The marginal ridges and shallow heel impressions of the footprint-tracks suggest that the individual moved with the emphasis of their weight on the balls of the feet and was not carrying any excess weight. The individual was moving at a steady pace until they halted near to the end of the recorded trail (1/3 and 1/4), where the person may have stopped to pick up, gather, or observe something before continuing on their way.

12.2.2 Site E

This site, the investigation of which was introduced in Chapter 4.4.2, is just 10m south-west of the Site H trail made by Person 1 (Fig 4.5). Here there is an east-west cliff of eroding banded sediments with permanent water to seaward. The bedding planes exposed by erosion often reveal footprints including those formed by Persons 2–10.

Persons 2–5 (Area 6113)

This trail was discovered on 27 April 2002 (Fig 12.4) when footprints were observed on a lamination surface projecting from a low cliff of banded sediments. CD 12.10–12.17 is a sequence of photographs showing these footprints from the time of their initial discovery through their progressive excavation in August 2002. It was on this site that the technique of hand excavation of the footprint-tracks was developed. Two footprint-tracks were revealed by peeling back the laminations behind two of the visible examples (Fig 12.4). The method having proved successful, the decision was made to carry out an excavation of this trail and a 5m trail of 33 footprint-tracks, all overtraces, was revealed (Fig 12.5–12.6; CD 12.18). These headed in a south-easterly direction towards the estuary. It was possible to make out the four distinctive trails of Persons 2–5. In the same laminations running across the trail three red deer footprint-tracks headed in a westerly direction along the shore.

Trail 6113 differs in a number of ways from Trail 6094. It was exposed by hand rather than erosion and the footprint-tracks are at the level of the over-

Figure 12.5 Trails of Persons 2–5 on Site E (Area 6113). The excellently preserved footprint of Person 6 (6160a) is at the left-hand end of the 0.5m scale (photo E Sacre)

traces, several centimetres above the true footprint. The overtraces are large, and although it is possible in most cases to identify direction and whether they were made by the left or right foot, more detailed features such as the heel, ball and medial arch of the foot are not present. Overall they give a more imprecise indication of the true footprint than those of Trail 6094. Several block-lifts were taken for micro-excavation. The sediments were extremely fragile and some blocks crumbled: of the surviving blocklifts, one was from Person 2, two from Person 4, and two from Person 5; none from Person 3 survived.

Person 2

Nine footprint-tracks at the overtrace level, another (a right foot between 2/6 and 2/7) was lost due to erosion before a tracing could be made. Person 2 was the most readily identified of the four trails because it did not follow a straight path. The first three steps, as with Person 3, are orientated in a south-easterly direction. However, at 2/4 the trail starts to veer east, but the individual appears to have straightened course again by 2/8 to continue in a south-easterly direction towards the estuary. The undertraces and marginal ridges (CD 12.3) show Person 2 was moving with particular emphasis on the ball of the foot at a brisk pace. Six out of the nine footprint-tracks had marginal ridges and the ridges appear to be somewhat random in their placement, along the left-hand side of the foot for 2/2, 2/3, and 2/5 and the right-hand side of the foot for 2/1 and 2/6. The presence of a number of marginal ridges indicates that the sediment through which Person 2 was moving was harder than that of the other individuals. The large overtraces of this trail along with the marginal ridges shifting from left to right in no particular pattern may also indicate that the individual was moving with a certain degree of hesitancy through the area rather than at a steady pace. The stride measurement for Person 2 was 1.26m (CD 12.19) and 1.21m at the point where Person 2 altered direction, decreasing stride length. This suggests a pause for observation and reorientation. Once the individual has altered direction the stride length once again increased. Details of the micro-excavation of blocklifted footprint 2/4 are given in CD 12.20.

There were significant differences in both the breadth and length of Person 2's footprints at the overtrace level (CD 12.3). However, estimates of age and stature can be based on the plaster cast of micro-excavated footprint 2/4. The maximum left foot length was 24±0.5cm and the age, if male was 12½+, if female 14+. Estimated stature was 1.6±0.03m (5ft

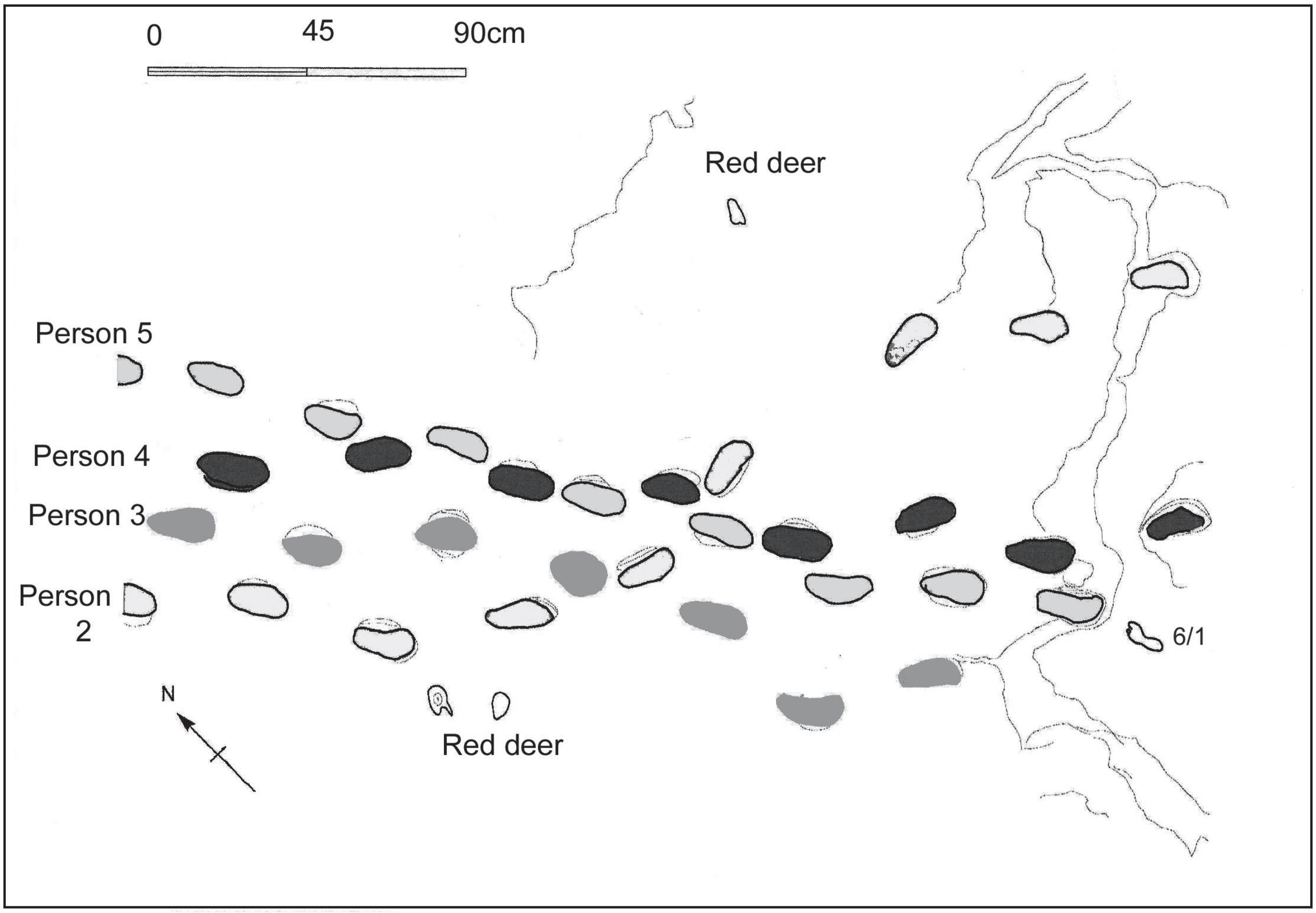


Figure 12.6 Plan of the trails of Persons 2–5 on Site E, shaded to indicate the individuals. This also shows the footprint of Person 6 (6/1; see Fig 12.7) on a lower lamination (for colour version see CD 12.18) (graphic R Scales)

3in) and cadence 93–7 steps per minute if male, or 114–16 steps if female.

Person 3

Seven footprint-tracks run in a south-easterly direction. The trail starts to the left of Person 2 and right of Persons 4 and 5. The last footprint-track in the trail was eroded out by the tide before the final area tracing was taken. Person 3 maintains a straight course, although 3/6 bears slightly more to the south-west than the others, but there is no pronounced change in direction. 3/4 was walked in by a deer crossing the trail. Person 3 walked alongside Persons 4 and 5 and part of the trail of Person 2 but at no point is there any evidence of overlapping footprint-tracks, suggesting that the four people were walking side by side at the same time.

Ridges were noted for five out of seven footprint-tracks (CD 12.3), at first along the left-hand side of the foot and then along the trail they shift to the right side and around the toe area. It is possible the presence of Person 2 may have influenced Person 3 to lean to the left and then once Person 2 changed direction Person 3 was able to bear to the right and increase the distance between themselves and Persons 4 and 5. The length of stride for Person 3 is 1.2m until the end of the trail where it decreases to 1m (CD 12.19). This shortened stride is likely to have been caused by the south-westerly movement of the right foot 3/6. It is interesting to note that at exactly the same point, Person 2 is almost mirroring Person 3's movements and the stride pattern is similarly reduced.

Person 2 has shown that the length and breadth of the footprint is significantly greater at the overtrace level (CD 12.3). In this case of Person 3, however, we have no more exact measurement from micro-excavation because the lifted block crumbled. All we can do is estimate that these overtraces are about 20% larger (*c* 6cm) than the actual footprint. The maximum overtrace length (CD 12.3) ranges from 31.1cm to 28.4cm (a difference of ±2.7cm) for the left foot and 31.4 cm to 26.7 cm (a difference of ±4.7cm) for the right. The average length for the left footprint-track is 30cm, whilst for the right it is 28.5cm (a difference of 1.5cm). A rough estimate for foot length for this individual is therefore *c* 25cm (3/1). This would suggest that the trail was made either by a male aged between 13½/14½ years and adult, or a female aged between 14 years and adult,

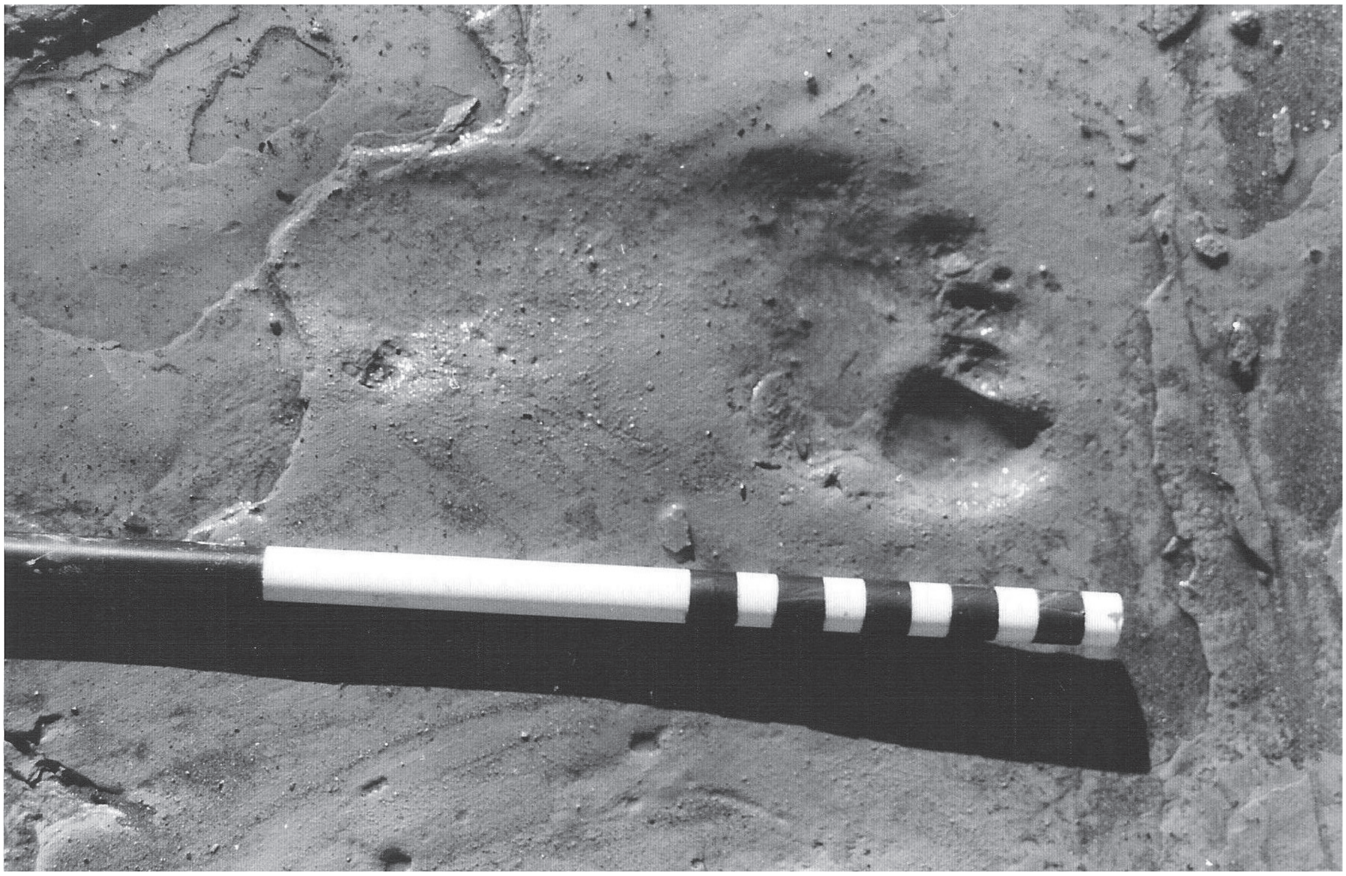


Figure 12.7 Footprint-track of Person 6 (6/1, 6160a), Site E: scale – small units 1cm (photo E Sacre)

with a stature of 1.69±0.03m (5ft 6in). Person 3 was probably moving between 93 to 113 steps per minute.

Person 4

Eight footprint-tracks at the overtrace level heading in a south-easterly direction, to the immediate north-east of Person 2. Person 4 walked very close to Person 5, although their trails never actually overlap. Marginal ridges (CD 12.3) were noted on seven out of eight footprint-tracks on both the left- and right-hand sides, with no obvious pattern: on the last two they occur on both sides. For the first few strides (CD 12.19) the length is 1.30–1.33m, subsequent strides decrease by *c* 20 cm. This decrease occurs at the same point in the trails of Persons 2 and 3. It is also at this point that the footprint-tracks of Person 4 appear to separate slightly from those of Person 5. The blocklift excavation of footprint-track 4/7 is described in CD 12.21 and illustrated with plans and sections of the blocklift on CD 12.22. The foot length measurement from the micro-excavated footprint-track is 24.8±0.5cm, suggesting that the trail was made by either a male aged 12½ to 13½, or a female aged 14 years to adult. As the individual was older than 11 years of age, stature has been estimated using a mean percentage of 15 %, at 1.65±0.03m (5ft 5in). The relative speed of the trail is 100–03 steps per minute if male, or 124–8 steps if female.

Person 5

This person is represented by nine footprint-tracks running in a south-easterly direction, very close to Person 4. A tenth footprint-track was lost due to tidal erosion before the final tracing was made. Five of the nine footprint-tracks had marginal ridges (CD 12.3), they were on both the left- and right-hand sides of the feet; they do not follow a particular pattern. The stride measurements (CD 12.19) display a larger degree of variation in comparison with the other three trails, possibly because Person 5 was trying to walk in between the footprint-tracks of Person 4, which caused a slightly more erratic pace. The excavation of blocklifts of footprint-tracks 5/4 and 5/9 are described in CD 12.23. Once again the overtraces show significant variation in footprint-track size (CD 12.3). However, the blocklift shows a footprint length of 26.8cm, suggesting that the trail was made by either a male aged 16 or over, or a female aged over 14 years or over, with a stature of 1.75m or 1.72m (5ft 8–9in), and a relative speed of 85–92 steps per minute for a male and 100–07 for a female. A person of this height is likely to be adult.

Persons 2–5, conclusions

The length, width, and stride measurements for each of the four trails are very similar. They were either made by four very similarly aged and built individuals, or the same individual. While there are

Figure 12.8 Footprint-track of Person 6 (6/2, 6160b), Site E: scale 10cm (photo E Sacre)

slight differences in the information gained for each trail, given the margins of error, it cannot be ruled out that they are one individual. However, the way in which the trails run alongside one another, do not overlap, pause and in some cases change direction for reorientation, suggests that there were four individuals walking in the same direction at the same time. The fact that they pause at the same point strongly suggests a common purpose. A pause for observation might be consistent with stalking or fowling, less so perhaps with the gathering of plant resources. Persons 2–5 walked on the same pronounced layer of clay overlain by a distinctively sandy layer. Dark and Allen's work (2005) on similar banded sediments has shown that fine portions of the bands were laid down in summer and coarser, more sandy parts in winter (Chapter 17.2). This suggests these footprints were made in spring/summer and covered by a winter sandy layer.

***Person 6* (Trail 6160)**

At the end of the 2002 field season, overnight erosion in Site E removed an area of silt some 25cm in depth from the edge of the area where the trails of Persons 2–5 were being examined. This revealed the best-preserved human footprint-track (6/1) so far recorded in the Severn Estuary (Fig 12.7; CD 12.24–12.25), exposed at the footprint level in a particularly fine set of laminations with a series of cracks running across the bedding plane. Because this exceptional find occurred at the end of the field season, and was followed by a period of unfavourable tides, there was no opportunity to excavate the area further. During the 2003 field season, due to a shifting of the sands and mud overlying Site E three further footprint-tracks were exposed in the same fine lamination of silt with its drying cracks. The footprint-tracks themselves were particularly well-preserved and it was possible to recognise that they had been made by the same individual as 6/1. The footprint-track of a right foot (6/2, Fig 12.8; CD 12.26–12.29) was orientated in a northerly direction. A right footprint-track (6/3) heading west was located 47cm to the west of 6/2. There was a fourth right footprint-track (6/4) 12.5cm from 6/3, exposed at the overtrace level, facing north-east. The tracks here were within an area of *c* 1m^2 and appeared to have been made by the same individual, they were not consecutive tracks within a trail, because all three were made by the right foot and orientated in different directions.

The best-preserved footprint-track**,** 6/1, is the only left footprint-track in the group (Fig 12.7). It is headed inland, orientated in a north-north-westerly direction. The medial arch is clearly visible suggesting that the individual was probably eight years of age or older, which is when this feature typically forms (Scales 2006). The impression of the heel, while visible, was faint and noticeably shallow. The ball impression on the other hand was clearly formed and much deeper, indicating that the weight of the individual had been focused towards the ball and toes. This perhaps indicates that the individual was in motion, probably walking, rather than running, as a heel impression is present and there are no marginal ridges around the footprint. The toe impressions on this footprint-track are the clearest seen on a prehistoric human footprint-track. All five toes are clearly distinguishable, and it is possible to see the shape of the toe pads, particularly that of the big toe. What is also conspicuous is that the toe impressions are pointed, probably indicating that this particular individual had long toenails. A natural drying crack was noted in the sediment running horizontally 5cm in front of the footprint. This footprint-track was blocklifted and the micro-excavation of the blocklift is described in CD 12.30. The toe impressions were clear in the other three footprint-tracks, with the toe nails showing in 6/3. A distinct medial arch could also be seen in all three.

The quality of footprint-tracks in this group was exceptionally fine (Figs 12.7–12.8). This is probably due to a number of factors that occurred both prior to, and after, the footprint-tracks were made. The fine silt bedding surface in which the tracks of Person 6 were made, suggests that the footprint-tracks were made during the warmer spring/summer months of the year (Dark and Allen 2005). A series of drying cracks that have been preserved across the bedding surface also indicate that after they were made the weather was warm causing drying and crack formation (Allen 1987a). This suggests a high saltmarsh environment. The mud may have been drying prior to the walk because there are no particularly large marginal ridges, nor is there any sign of spiking, where cohesive mud in the base of the footprint may have lifted up as the foot was removed. The texture of the sediment allowed for clear impressions of the sole of the foot to be made. The sediment then appears to have continued drying because cracks formed across 6/2. This process would have allowed the clearly defined shape to be maintained. The footprint-tracks then seem to have been covered over by a fine layer of sand. The exceptionally well-preserved footprint 6/1 had a maximum length of 20.9±0.05cm and a maximum width of 8.4cm (CD 12.31). This would suggest that the trail was made either by a boy aged around 8½ years, or a girl aged around 9 years. Stature is estimated as 1.34±0.03m (4ft 5in). As there is not a complete trail in this area, it is not possible to work out cadence for this particular individual. The footprint-tracks were made by the same individual, but do not suggest purposeful movement, perhaps the child was engaged in some activity, or playing.

Persons 7–10 (Trail 6161)

At the end of the 2003 summer season, part of a large human footprint-track (7/1) was noted at the edge of a lamination shelf *c* 2m to the south-west of Area 6113 (Fig 4.5; CD 12.32). A particularly large animal footprint-track (6161/E), possibly a juvenile aurochs, was located immediately behind it and just over a metre to the west was another human footprint-track. Two days of hand excavation were carried out on the area to see if these footprint-tracks belonged to trails. This revealed six more human footprint-tracks at the overtrace level, two red deer footprint-tracks (6161/F), and two indistinct overtraces that could belong to either deer or human children. At least two separate human trails are present within the area, as well as two further apparently unrelated footprint-tracks which appear to represent four individuals. There were no marginal ridges associated with any of the footprint-tracks in this area, suggesting that the sediment may have been particularly firm. Footprint-track 7/1 lay in the edge of the lamination shelf allowing the footprint-track to be cleaned and observed in section (CD 12.33). It was filled with a coarse clay layer of a maximum 1 cm deep. A layer of sand lay beneath that on top of a fine layer of silt. This suggests that the footprint may have been made in the spring/summer months and was then covered by a layer of sand and clay. Footprint-track 7/2 was blocklifted and micro-excavated using water down to a fine lamination of silt and sand that was felt to be the footprint. This was an unusual example, although it was possible to see the clear outline of the foot there were no detailed impressions of the sole of the foot. This almost featureless footprint was large, 26.3cm in length and 9.5cm in width. The featureless appearance of the footprint may have been a result of a firm substrate, or possibly due the wearing of some kind or footwear, although no evidence of a material imprint was left.

Person 7

The micro-excavated footprint of 7/2 is 26.3±0.5cm, suggesting that the trail was made by a boy aged 14½ years or more, or an adult female. The person had the equivalent of a modern size 8 foot: an individual with this size feet is more likely to have been an adult, and probably male. Stature has been estimated as 1.70–1.73m (5ft 7–8in). It was possible to obtain one stride measurement of 1.23m between 7/1 and 7/3 and a cadence of 86–110 steps per minute can be estimated. Person 7 was walking in a northerly direction away from the estuary.

Person 8

Three footprint-tracks (8/1–8/3) orientated in a southerly direction towards the estuary, 1m to the east of Person 7. The footprint-tracks are at the overtrace level and do not exhibit any marginal ridges. The track is of a girl of 6½ years or a boy of 6 years, about 1.16m (3ft 10in) tall.

Person 9

9/1 is a left footprint-track at the overtrace level which is orientated in a northerly direction. It does not have any features, such as marginal ridges, of particular note. The person was a child aged 7½–8, about 1.31m (4ft 4in) tall.

Person 10

The overtraces of a footprint-track lie a few centimetres from 8/3. They are particularly featureless but have the general oval character of human overtraces. The foot dimensions are very small, probably a child aged about 3, with a height of 0.98m (3ft 2½ in).

12.2.3 Site C

This site is 80m west of Site E (Fig 2.3). The investigation of this area was introduced in Chapter 4.4.1. Here an eroding scarp of banded sediments runs roughly north-west to south-east exposing bedding planes on which footprint-tracks are often exposed (Fig 4.3). This is where the first human footprints were discovered in 2001 (Bell *et al* 2001).

Persons 11–12 (Area 6111)

In 2002 footprint-tracks were exposed at varying levels (CD 12. 34–12.35), some still had overtraces remaining, a few were at the footprint level and many appeared to be undertraces, or the footprint-track fill had been removed by the tide creating deep, hollow outlines of the footprints. Twenty-four footprint-tracks were recorded. In 2003 parts of this trail were still visible. The decision was made to excavate the area further and it became the largest expanse of footprint-tracks excavated (Figs 12.9–12.10). CD 12.36–12.40 show a sequence of photographs taken as this area of footprint-tracks was progressively exposed by excavation of the banded sediments within which they lay. The south-west part of the trail was on the edge of the lamination shelf which was subject to tidal erosion. It was clear that a number of footprint-tracks had been eroded away over the course of the year and were continuing to do so. In all 165 footprint-tracks were recorded, many of a poor quality, made by at least two individuals, Person 11 (6111A), a small child, and Person 12, an older child (6111B). Footprint-tracks belonging to Persons 11 and 12 are orientated in walks generally running in north and south directions, with some running east and west. Both individuals have clearly been moving across the area repeatedly.

Person 11

The varied angles of orientation for Person 11 suggest that this individual did not move in a straight line. The most significant footprint-track of the trail was recorded during 2002 before a tracing could be made, a right footprint-track orientated in an easterly direction (CD 12.35). It was exposed partially at the footprint level with some overtraces remaining over the lower half of the impression. All five toe impressions were visible, but the big toe was dominant. It splayed out (sometimes referred to as 'toeing out') distinctly. It gave the impression of being rather flat-footed although the medial arch region was covered by overtraces. What was significant, however, was its size. It was particularly small and narrow, if not delicate, suggesting that this was made by a very small child. There were no marginal ridges around it, which seemed to be typical of this individual's footprints within the trail. A further characteristic of Person 11's footprints was that they crossed several other footprint-tracks of Person 12 (CD 12.43). The varied angles of orientation, could suggest that this young child may have been playing or 'mud larking' in this area. Measurements based on the plaster replica of the footprint-track show the foot was 16.1cm long and the ball width 5.8cm suggesting that the footprint was made by a girl aged 4–5, or a boy of 3–4. Since age estimation suggests that the individual was a young child, stature has been estimated using a mean percentage of 15.6%. The child was probably 1.03±0.03m (3ft 5in) high.

Person 12

There were unfortunately no footprint-tracks at the footprint level exposed belonging to this individual. A particularly interesting feature, a marginal ridge concentrated around the heel, was noted on several of their footprint-tracks (CD 12.41). This has not been observed on any of the other recorded footprint-tracks at Goldcliff and it suggests that the individual may have been carrying a load causing extra pressure to be put on the heel, possibly even Person 11. Many of the footprint-tracks in the area are very narrow and deep, some up to 7cm (CD 12.42–12.43). This could have been caused in a number of ways. The sediment traversed may have been deep in places and, when the foot was removed from the mud, the walls of the footprint-track would be subjected to suction, narrowing them. An alternative is that the individual was walking in an unusual fashion: the occurrence of the marginal ridges around Person 12's heel suggests unusual movement patterns. However, a micro-excavated blocklifted right footprint-track (12/19) also suggests Person 12 was moving with emphasis on the side of the foot. Micro-excavation revealed a narrow footprint with a maximum width of 5.2cm and length of 21.9cm. The toe area bore what appeared to be a big toe impression, but the other four toes were not clearly represented. The toe area reached a depth of 5cm while the heel had a depth of 2cm. What appears to have happened is that the individual's foot has entered the sediment at an angle, and weight has been placed on the medial side of the foot, but not the lateral. This has caused an unusually elongated and narrow looking footprint-track. The length suggests that the footprint was made by a boy aged about 10½ years, or a girl of 11 years. This individual was about 1.40±0.03m (4ft 7in) in height.

Persons 11–12: summary

The features of these footprint-tracks suggest that at times both individuals may have been struggling with their balance. These children may have been out gathering plant resources, fishing, or fowling. Site C was an area with abundant bird prints, which

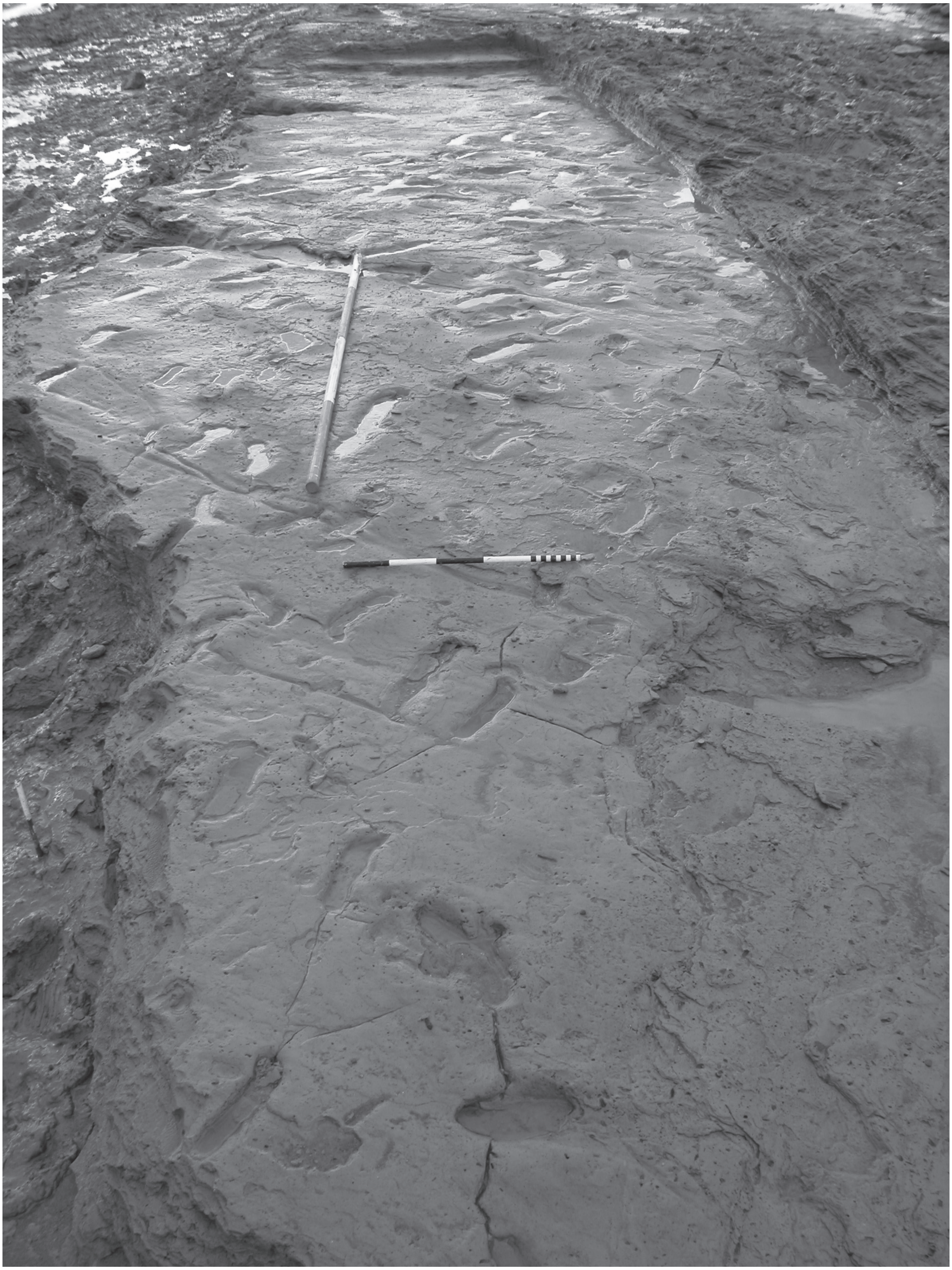


Figure 12.9 Excavation in 2003 of the trails of Persons 11–12 (Area 6111), Site C: small scale 0.5m (photo E Sacre)

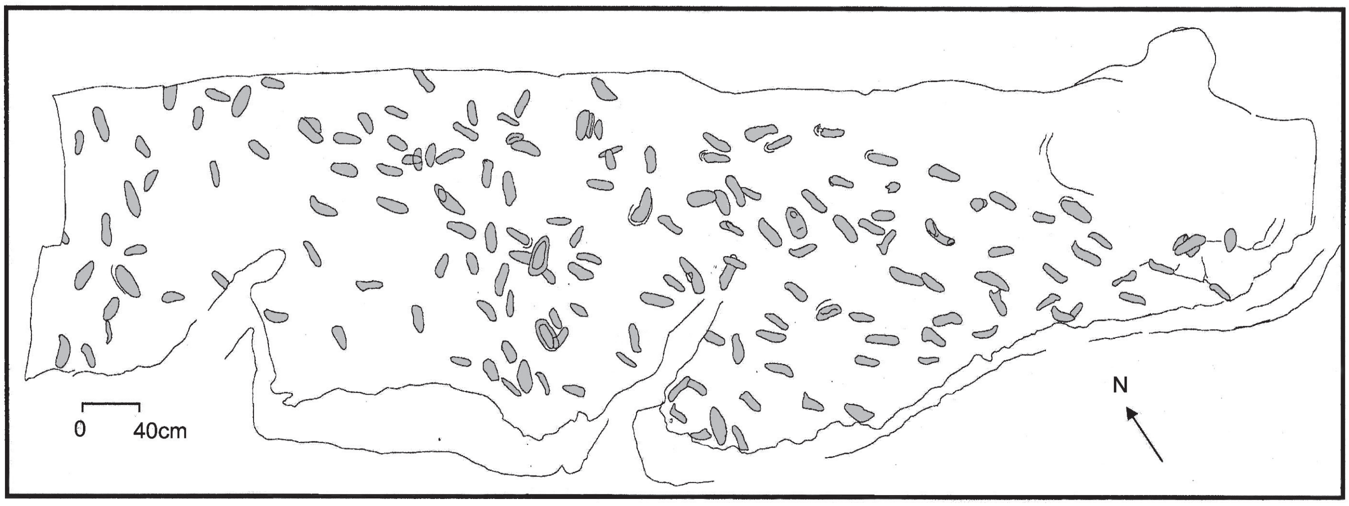


Figure 12.10 Plan of the trails of Persons 11–12 (Area 6111), Site C, excavated in 2003 (graphic R Scales)

could have been the source of their interest. The footprints of these two individuals, however, suggest that whatever the purpose of their excursion, they were not moving in a direct fashion and it is possible that they were playing.

Persons 13 and 14: footprint-tracks 6204, 6205, 6215

When the laminations in Area 6111 eroded in summer 2004, a year after the completion of the main project, three footprint-tracks were exposed: 6204, 6205, and 6215 (Fig 12.11; CD 12.44–12.47). These are all left footprint-tracks. 6204 and 6215 are almost certainly the same individual (Person 13). This was a girl aged 11–12 years, or a boy aged 10½ –11 years, probably 1.43–1.49m in height (4ft 8–10½ in). 6205, who was heading in the opposite direction, was a much smaller individual (Person 14). This was a girl of 6½ years or a boy of 6 years, probably 1.15m in height (3ft 9in).

Person 15

In 2002 a right footprint-track exposed at the under-trace level (6095), orientated in a southerly direction, was recorded at the edge of laminations just above the trail belonging to Person 1 on Site H. Footprint-track outline measurements for length and ball width were 24.8cm and 11.2cm respectively. Age can be estimated at 13½ years for a male, and 14 years to adult for a female (Clarks 1990). Using the 15% ratio of foot length to height, stature is estimated to be 1.65m (5ft 5in) for a man or a woman. Weight estimations for Person 15 using Robbins's (1986) ratios for persons over 14 years of age, suggest a male weight of 76kg and a female weight of 72kg.

Person 16

Two footprint-tracks (6109, 6110) of a child were recorded to the north-east of an area of bird footprint-tracks (6116) between Sites E and C. Both were at the overtrace level and showed signs of small circular reed holes similar to those found with Person 1. A footprint-track outline length of 20.6cm suggests a footprint-outline length of 16.9cm. The age estimate is 5 years for a boy and 5½ years for a girl, with height estimated at 1.08m (3ft 6½ in).

Person 17 (6207)

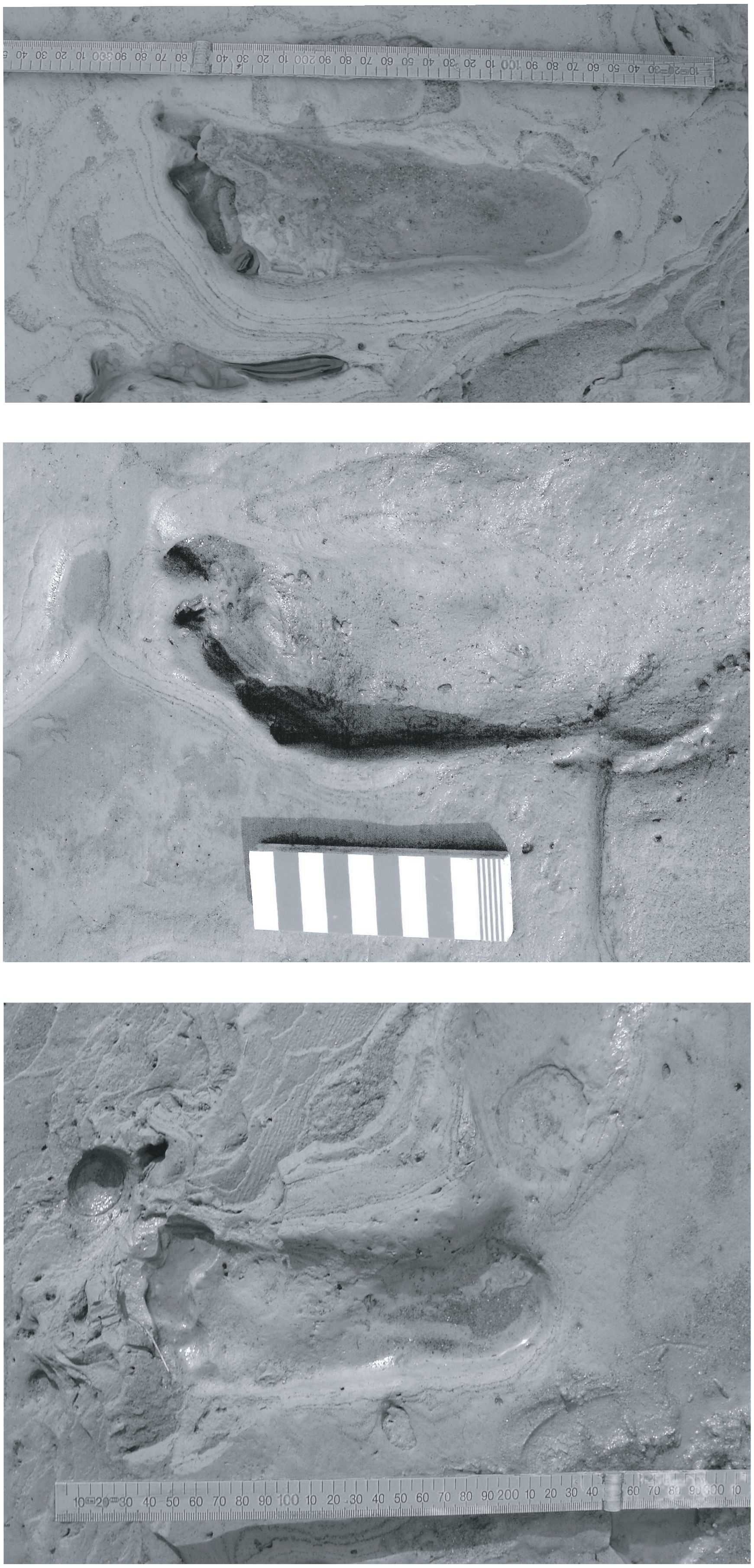
At the north-west end of Site C a right footprint-track at the overtrace level, orientated in a north-easterly direction, was recorded in 2003, on laminations above those where the footprint-tracks of Persons 11–12 were exposed. The footprint-track had marginal ridges down the lateral and medial sides of the foot. It was blocklifted and the fill was micro-excavated out in the laboratory. The ball region had a depth of 6cm and the heel had a shallower depth of 3cm. The footprint-outline was particularly featureless, although measurements were taken of 21.6cm for footprint-outline length and 7.5cm for ball width. Person 17 is estimated to have been either a boy aged 9½ years of age or a female aged 10. Using the 15.6% ratio, height is estimated to be 1.38m and weight 27kg.

Person 18

In 2002, six footprint-tracks belonging to a single person (Person 18) were recorded at the north-west end of Site C. The measurements were identical to those for Person 11, and were probably made by this person.

Persons 19–21

In 2001 a group of 27 footprint-tracks was recorded on Site C (Bell *et al* 2001, 34–40) from sixteen different bands of laminated sediment. There were 24 adult footprints, five child prints, and six other indistinct human footprint-tracks. Three human footprint trails were identified. Person 19 (6011–14) was a child aged 4–5 years old, about 1.1m tall; the pace length was 307mm. Person 20 (6034–5) was an adult male, shoe size 11, stature 1.8m, with a pace



a

b

c

Figure 12.11 Footprint-tracks of Persons 13 (a) 6204 and (b) 6215 and 14 (c) 6205 from Site C, 2004 (for colour version see CD 12.44–12.47) (photos: 6204 and 6205 M Bell; 6215 E Sacre) length of 630mm. Person 21 (6006–7) was an adult, possibly male, walking south, pace length 385mm. Nearby is a print (6008) going in the opposite direction, possibly the same person coming back. Originally it was thought that some of the large footprint-tracks, eg of Person 21 and 6021, 6023–4, may have been shod (Bell *et al* 2001). However, it is now considered more likely that these large oval footprint-tracks are high overtraces. Some of the other footprint-tracks are those of children aged 7–9; sixteen out of the 27 in the Site C 2001 area are those of individuals aged under 14 years old.

12.2.4 Human footprint-tracks: conclusions

The Mesolithic population

Hundreds of human footprints have been recorded from Goldcliff East and over 270 of these have been assigned to 21 individuals (Table 12.1). All the human footprints were in laminated silts from Sites C, E, and H. Of the assigned footprints, 17 (6%) were made by four adults aged over 14 years; 69 (25%) were made by seven sub-adults aged 11–14; six (2%) by children aged 7–11 years; and 186 (67%) were made by seven young children aged 3–6. The majority of human footprint-tracks appear to have been made during the spring/summer months. Person 7, however, may have been active during the autumn/winter months. Both adults and children were moving through this environment, perhaps foraging for food, gathering raw materials, hunting, or fishing. The two children from Site C may have been enjoying the mud! The best-preserved footprints show the toes clearly and these people were obviously bare-footed, with the slight possibility that Person 7 was shod. The earliest shoes known from Europe were found with the 'ice man' from the Alps and date to *c* 3200 BC (Spindler 1994); they were made of leather stuffed with grass. If basic shoes were worn in the Mesolithic, they would be made of organic materials such as rawhide or plant materials and would not survive prolonged wetting. It would be more sensible, therefore, to walk on the foreshore without shoes, and being bare footed would have probably given the people a firmer grip and made walking in the soft sediment easier.

Some of the older individuals at Goldcliff East (Persons 2–5 and 7) are associated with deer footprint-tracks. Persons 2–5 in particular may have been a small hunting party of adolescent males. Convincing evidence has been presented from the pauses and turning points of their trails that the four acted together with a common purpose. A higher prevalence of male footprint-tracks in close association with deer footprint-tracks has also been noted at Formby Point, Merseyside (Huddart *et al* 1999).

As regards stature, the Goldcliff individuals that are likely to have been adult females or sub-adult to adult males have statures ranging from 1.60–1.75m (5ft 3in–5ft 9in). The data may be compared with stature estimates of the footprint trails at Uskmouth where adults were 1.73–1.80m tall (5ft 8–11in), and at Magor Pill, where an adult was 2m tall (6ft 7in, Aldhouse-Green *et al* 1992). A skeleton from Aveline's Hole, Mendip has a stature estimate of 1.43–1.59m (4ft 8in–5ft 1in; Schulting and Wysocki 2002). The stature for Neolithic individuals from Formby Point, based on footprint-track data, shows the mean male height to be 1.60m (5ft 3in) and the female height 1.45m (4ft 9in) (Huddart *et* al 1999). Wider comparisons with estimates of stature from other Mesolithic and later prehistoric populations in Europe (Scales 2006, Table 9.3), show average adult stature to be between 1.55–1.76m, which is consistent with the Goldcliff evidence.

The later Mesolithic Goldcliff population represented by footprints can be compared to the early Mesolithic burials from Aveline's Hole, Mendip (Schulting and Wysocki 2002; Schulting 2005). Between 50 and 100 individuals were originally reported from the 18th- and 19th-century excavations in this cave. Remains of only 21 individuals have survived: adult men and women, sub-adults and infants. None of the adults had reached the fifth decade of their life, or beyond. Of the juvenile skeletons, three children aged 2½–4½, 3½–6½ and 5–7 years of age were recorded. Two infants were also present, one aged 6–18 months and one at, or near, term. Clearly, the young children were not buried separately, or treated any differently from the adults and may have been seen as of equal importance, as indeed the association of men, women, and children in the Mesolithic cemeteries of Denmark suggests (Ahlström 2003; Radovanović 1996). A number of the individuals from Aveline's Hole had signs of enamel hypoplasia indicating repeated stress in childhood, which may have been nutritional in origin. Two individuals also exhibited *cribra orbitalia*, which has been interpreted as evidence for iron deficiency anaemia. Causes for such a condition include inadequate diet, or a high parasite load. Interestingly, Dark (Chapter 14.2.3; 2004) has noted the presence of the intestinal parasite *Trichuris* at Goldcliff East, so the Goldcliff foragers are likely to have suffered from similar ailments.

The invisible people: the role of children in the Mesolithic

The archaeological record generally presents a static picture of the lives of men and women captured at a single moment in the past, usually in the prime of their life (Gilchrist 2000). It is much harder to ascertain a sense of demographic diversity, particularly for the British Mesolithic, where few skeletal assemblages survive. Gilchrist (2000) argues that archaeologists suffer from an intellectual bias where there is a lack of consideration of age diversity. It is all too easy to imagine 'man the hunter' when considering Mesolithic sites whose artefact assemblages are habitually dominated by lithics. Evidence of population composition from footprint-tracks is particularly valuable in this respect and provides fresh insights into the individual movements of people using the wetland, in terms of their height, age, and actions. While the age estimations for the Goldcliff individuals are often imprecise (Table 12.1) there is no doubt that many of the footprint-tracks belong to children and adolescents.

The notion of the wetland environment being predominantly exploited by children is perhaps difficult to accept on first consideration. Children are frequently invisible in the archaeological record, particularly in the case of early prehistoric contexts where it is hard to determine age diversity, let alone how a child experienced daily life, and developed knowledge and cultural perspectives. The need to take children into consideration has been increasingly recognised within the archaeological community in recent years, particularly in Scandinavia, but also in Britain with the growing emphasis on feminist and gender archaeology over the last decade (Gilchrist 1999; Lillehammer 2000, 2005).

Anthropological and ethnographic evidence helps to put the footprint-track evidence into a broader perspective. More than 40% of most hunter-gatherer populations are children (Hewlett and Lamb 2005). Ethnographic studies are increasingly providing examples of hunter-gatherer children actively engaged in foraging (Bird-David 2005). Hawkes *et al's* (1995) observations show that Hadza children were active foragers close to camp, and accompanied adults to distant resource patches, up to 10–15 km away. Younger children remained closer to camp, while older children spent little time close to home, preferring to travel further to earn significant nutrient returns. At Goldcliff there are patterns possibly similar to the Hadza. The youngest children are represented at Site C, with the exception of Trail 6160, while those aged ten years or older are primarily focused further away from the main activity camps at Site E.

Site C had a trail of a child (Person 11) aged as young as three or four years old, with an older sibling or peer (Person 12) aged between ten and eleven years of age. The question is why was such a young child brought onto the marshes? It may be difficult for us to understand that the young may have willingly been involved in foraging or fowling activities, because of the western world's predisposition to over-protect the young. The haphazard nature of the Mesolithic footprint-tracks at Goldcliff East in Trail-complex 6111 could be interpreted as a child playing. Equally, the Goldcliff child may have been engaged in foraging or hunting activities with a sibling or peer. Kamei (2005) has produced the first systematic anthropological study of play by foragers. At Baka in Cameroon children aged four or five formed groups with older children, spending most of their day with peers. Sometimes they stayed within the camp, sometimes they ventured out into the forest. Adults seldom interfered with their activities. Baka children engaged in very little physical play. Instead play offered a forum for learning how to interact socially with other children. Interestingly it did not focus on the practising of adult activities or roles.

Zeller (1989) looked into the activities of children from thirteen different cultures with hunter-gathering and limited horticultural bases. He showed that children as young as 3–5 were involved in a very wide range of activities including child care, carrying, catching, gathering, and tool use. Given this ethnographic data, it is perfectly possible that the youngest Goldcliff child (Person 11) was involved in subsistence activities and may have even been enjoying him/herself! It has already been noted that children were present, so far as we can tell, on equal terms with adults, in the Aveline's Hole early Mesolithic burial assemblage (Schulting and Wysocki 2002). As at Goldcliff East, so also at Formby, children predominate in the footprint-tracks (Huddart *et al* 1999) and children are also present at Uskmouth and Magor Pill. Clearly, children were active widely within the estuary, including the last two sites, which were much further from dryland than the Goldcliff examples. This serves to underline the significant, and geographically quite wide-ranging, role that children played in the lifeways of the Mesolithic world.

12.3 Animal footprint-tracks

Many of the areas with human footprints also had animal footprint-tracks, particularly those of red deer. Animal footprint-tracks were also found within the occupation areas on the excavation Sites J, A, B, and D and elsewhere on the foreshore. More detailed descriptions of the animal footprint-tracks are given in CD 12.48 with tabular details and measurements of individual footprints on CD 12.49. The evidence is also discussed in more detail by Scales (2006).

12.3.1 Site B

This was an excavation area associated with Mesolithic occupation on the Lower Peat (Chapter 3). Four red deer footprint-tracks (6085–8) were recorded during excavation of Site B (Fig 3.3). They were made on the estuarine silts (318) overlying the peat and had been trodden into the surface of the peat (319). On Site B a possible aurochs footprint-track (6149) was noted in excavating a blocklift, micro-excavation demonstrated the presence of two toes. The maximum length of the footprint-track was 11.8+cm and its width 11cm, just slightly larger than a modern cattle footprint that has a length between 10–12cm and a width of 9–10cm (Bang and Dahlstrøm, 2001, 83). Although this is small compared to aurochs footprint-tracks (Huddart *et al* 1999, fig 4; Bell and Brown 2005), this seems more likely to be a juvenile aurochs rather than a large red deer stag.

12.3.2 Site E

Group 3 (Trail 6113)

In association with the already described human trails of Persons 2–5 and 7–10 on Site E there were also red deer footprint-tracks in the same laminations. The tracks of Persons 2–5 were crossed at right angles by those of a red deer, which had been walking away from Goldcliff island in a south-easterly direction (Fig 12.6). The two footprint-tracks were side by side, probably because the animal was jumping. Both also showed splayed toes and dew claws.

Group 4 (Trail 6161)
This group was in the same lamination as the human footprint-tracks of Persons 7–10 (CD 12.32). There were two red deer footprint-tracks (F1–2). One other footprint-track (6161/E; CD 12.50), had a maximum length of 13.2cm and a width of 10cm. The rounded shape of the track and the broadness of the cleaves, approximately 3–4cm larger than a modern red deer stag (Bang and Dahlstrøm 2001, 74), suggests that this is an aurochs. Its size is comparable to that of a large modern cattle footprint. An adult aurochs would be expected to be much larger than domestic cattle and it is probable that this is a juvenile, or possibly a female.

12.3.3 Site C

Group 11 (6020, 6022, 6025–7, 6029–32, 6038, 6040, 6047–50, 6052–3)
When this site was first investigated in 2001, seventeen adult and one juvenile (6038) red deer footprint-tracks were recorded on Site C in the same area as the tracks of Persons 19–21 (Bell *et al* 2002, 34–40).

Group 2 (Trail 6112)
During 2002, seventeen red deer foot-print tracks were recorded from exposed silt laminations 40m west of Site C (CD 12.51).The footprint-tracks were traced on large plastic sheeting and plaster casts made of the nine best preserved examples. The length of footprint-tracks varied from 13.1 to 6.3cm and the width 9.5–5cm. All were of red deer except 6112E which was very small (6cm long and 5cm wide) and could have been a roe deer or juvenile red deer.

Wolf footprint-tracks Group 5 (6147 and 6150)
Two footprint-tracks (6147 and 6150) west of Site C were discovered next to each other at the end of a tidal window as the water was just starting to cover them. A tracing of 6147 was taken immediately, but no more could be done until the following day. Overnight the tide did erode the features slightly, but the footprint-track was blocklifted and a plaster cast taken from the blocklift. 6147 in particular was remarkably well preserved with all four digits and claws clearly visible (CD 12.52). It measured 5.9cm long by 6.4cm wide. It was exposed at the footprint level allowing the features to be clearly observed when it was first discovered. The track was relatively shallow with a maximum depth of 0.7cm. What is particularly interesting about this track is the absence of the central pad, especially given the level of preservation of the toe pads. The animal may have been running on its toes when the track was made leaving no central pad impression. The footprint-track outline is almost identical in size to that of a modern wolf. It is possible that these footprint-tracks were made by a dog. *Canis familiaris* is the domesticated wolf. The earliest dogs in Britain comes from the early Mesolithic site of Star Carr (Clark 1954) where there is also considerable evidence for dog gnawing on animal bones. The evidence for carnivore gnawing on the material from Goldcliff is restricted to four bones (Chapter 13.1.7), insufficient to suggest that dogs were present on the site, given that no dog bones occur. The few Mesolithic specimens of dogs that have been found in Britain suggest that they were of a moderate size with a shoulder height of about 60cm, the size of a Scottish Collie (Yalden 1999, 99).

12.3.4 Site A

Group 6 (6163)
One red deer footprint-track, length 7.4cm, width 7.5cm, was found during excavation of Site A (Fig 12.12). It was located in the estuarine clay horizon (315) and was surrounded by infilled mud cracks and flecks of charcoal. Tracings made at stages of excavation show widely splayed toes (3.8cm) of a red deer with the characteristic toe pads and curved cleaves were present.

12.3.5 Sites G and F

Footprint-tracks were also recorded in the upper 0.7m of the laminated silts just below the Upper Peat some 370m north-east of Site J (Fig 2.3). On Site G, below the Upper Peat, there were 29 red deer footprints and one aurochs print with a maximum length of 17cm and a width of 14.5cm (CD 7.11). One cervid footprint-track was recorded on a surface within the Upper Peat on Site F, and two red deer footprint-tracks were also recorded in the upper laminated silts east of Site K.

12.3.6 Site J

Group 1 (6132–59)
The 21 cervid footprint-tracks from Site J (CD 12.53–12.54) were peat-filled (Context 327) trodden into the estuarine clay (Context 331, 6132–7) or into the Old Land Surface (Context 328, 6138–59). This suggests that the footprint-tracks were made during the initial stage of reed peat formation. This reed-covered area at the island edge was soft enough for an animal walking over it to sink into the sediments below. There was clearly a wet area here, as shown by the preservation of wooden artefacts

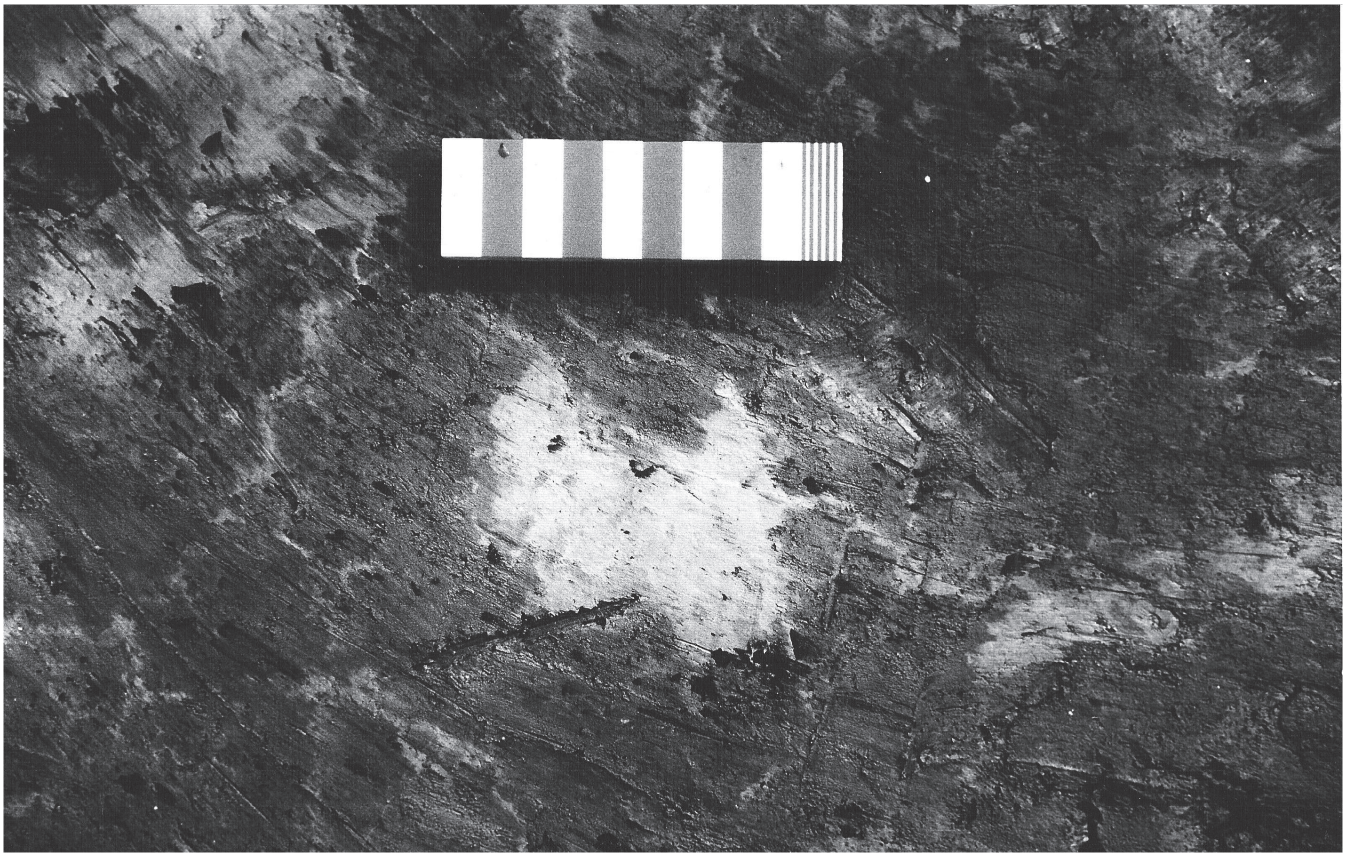


Figure 12.12 Footprint-track 6163 of a red deer, Site A (note the presence of drying cracks): scale 10cm (photo E Sacre)

in areas marked by animal footprint-tracks (CD 6.22–6.23). 6148 (Fig 12.13) is a particularly fine deer footprint-track which illustrates the peaty fill of the footprint itself, this was one of the examples blocklifted for micro-excavation and the photograph shows what was revealed when 2.5cm had been removed. There were eleven red deer prints, three roe deer with two other possible roe deer, and three prints which were probably cervid. The red deer prints have rounded pads at the rear of the toes and the outer edges of the cleaves curve towards the tip (see no 6132). Seven of the red deer footprint-tracks were probably female (6–8cm in length and 4.7–6cm wide). Three footprint-tracks (6132, 6136, and 6137) are larger (8–10cm long, 5–6.5cm wide), and are likely to be red deer stag tracks, probably made by the same animal. The splayed toes of 6132 suggest that it may have been galloping or jumping (Scales 2006, chapter 4, fig 11). 6136 is probably the right forefoot and 6137 the right hind foot of the animal, 6137 being just in front of 6136. 6136 had an awkward shape, with the right toe 3.5cm longer than the left. Several footprint-tracks are smaller: 6134, 6135, and 6151 are likely to be prints of a roe deer, on the basis of size (5–7cm long and 3.5–4.4cm wide) (Bang and Dahlstrøm 2001, 77) and the fact that the toes are narrow and pointed at the tip. 6134 has a very long (7cm) print, but is only 3.5cm wide, the length probably being caused by the foot being dragged from the sediment. Two other tracks (6138 and 6141) may also be roe deer on size, though they could be juvenile red deer. 6152 is small (4.4cm long and 6cm wide) but the rounded toes and width suggest a juvenile red deer rather than roe deer.

12.3.7 Conclusions: animal footprint-tracks

Goldcliff East has provided 149 recorded mammal footprint-tracks which are identifiable: 83 red deer, 5 roe deer (though 3 of these could be juvenile red deer), 37 indeterminate deer, 6 aurochs, and 2 wolf. There are no wild boar prints. What has become evident from recording the footprint-tracks is that this is a three-dimensional form of evidence. Unlike bone that essentially keeps the same morphology, footprint-tracks change shape from one footprint-track to the next. This is influenced both by the type of sediments an animal is walking on and by how fast the animal is moving.

CD 12.55 plots all the red deer footprints for Group 1 (Site J), Group 2 (Trail 6112), Site F (6145) and the Upper Silts (Site G). These measurements vary greatly in size even though they are from the same species. This is partly due to the type of sediment in which they were formed, as can be seen with the data from Site J. The majority of the points

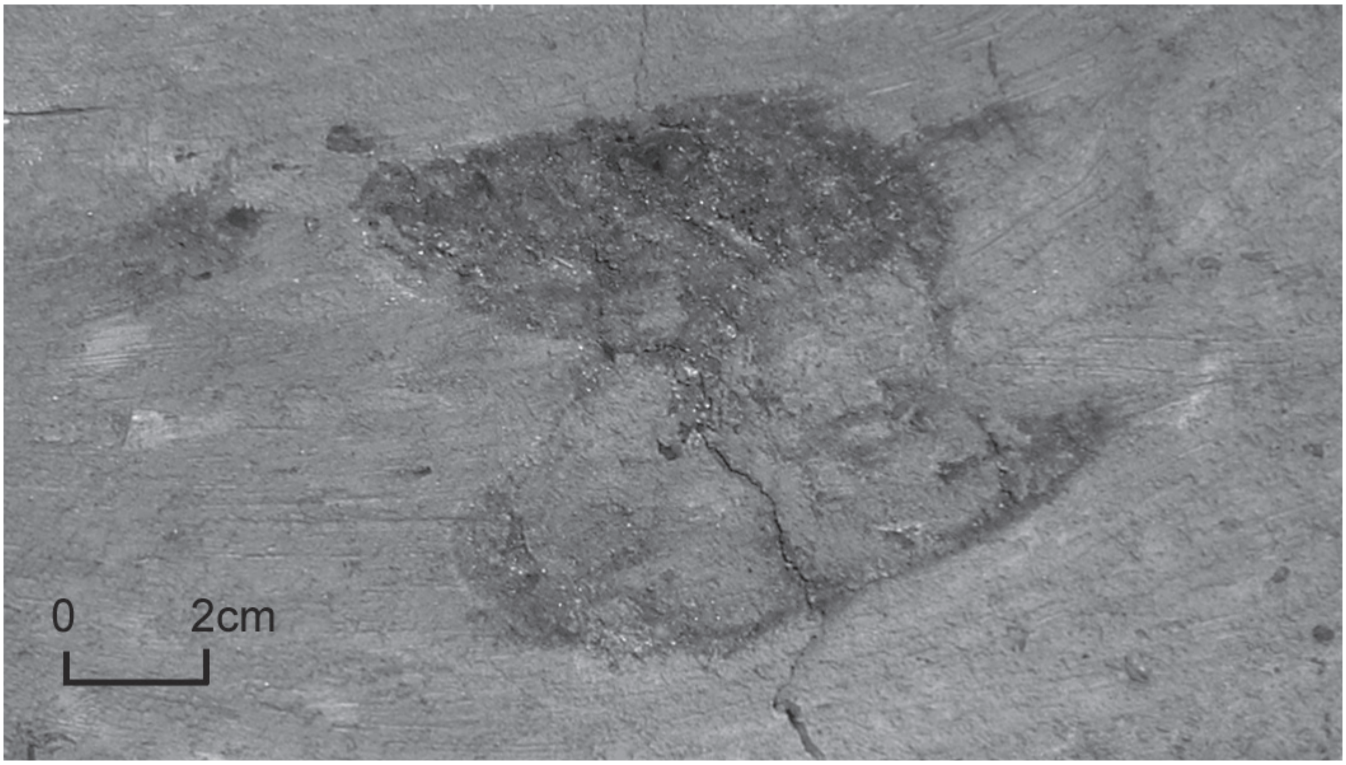


Figure 12.13 Red deer footprint-track 6148, Site J (photo M Bell)

are clustered to the left of the graph suggesting that footprint-tracks made in peat may give an underestimate of the size if the footprint as compared to those in the silts. The data from the silts suggests that a number of the footprint-track outlines give an over estimate for the size of the footprint. This plot shows therefore that it is dangerous to try to think of measurements from deer footprints as a straight indication of the size of the footprint. It is vital to consider each footprint-track individually and understand the factors that have contributed to its formation, such as the angle at which the foot has entered the sediments, whether the sediment was particularly soft, and the speed at which an animal was moving.

The humans and animals shared the same landscape at the same time, as evidenced by the human and deer footprints from Site E, Area 6113. The footprint-tracks allow us to see what animals were moving in close proximity to the Mesolithic activity areas. Small groups of red deer and roe deer were grazing the salt marshes. The small number of aurochs footprints suggest that they were not moving in groups in this area: aurochs are woodland animals and being large may have avoided the soft areas of the foreshore. The bone evidence (Chapter 13.1.4) shows that aurochs were in the area, and that wild boar and red and roe deer were hunted. The fact that there are no wild boar footprint-tracks suggests that they may have avoided the saltmarshes. However, evidence from the Tigris-Euphrates swamps (Thesiger 1964) suggests that boars flourish in *Phragmites* swamps, which were clearly extensive at times at Goldcliff between the island and the mainland.

12.4 Bird prints

The lower foreshore on Sites C, E and surrounding areas preserves a wide range of bird footprint-tracks (CD 12.56). The footprint-tracks of crane (*Grus grus*), and grey heron (*Ardea cinerea*) are particularly plentiful, while tracks of oyster catcher (*Haematopus ostralegus*), black headed gull (*Larus redibundus)*, common gull (*Larus canus*) and terns (Sterninae) were also found. Of these, cranes and terns are summer visitors; the others are likely to have been present year-round (Sharrock 1976; Bruun 1978). There are large areas of exposed bedding surfaces that have been extensively walked across by birds. Whilst the mammal footprint-tracks on the lower foreshore indicate that the sediment was typically quite soft, birds, being light, did not sink in. All the bird footprint-tracks observed have been on very fine silt laminations deposited during the spring and summer months. Even claw marks may be preserved (Figs 12.14–12.15).

Site C (Fig 4.3) was particularly rich in bird footprint-tracks, many were made by cranes (CD 12.57–12.61). One footprint-track of a crane (6119) was blocklifted and micro-excavated. It appeared to be at the footprint level to start with. The three toes were clearly visible and claw marks were also observed. The track had a maximum length of 10.8cm and a width of 14.5cm. It was micro-

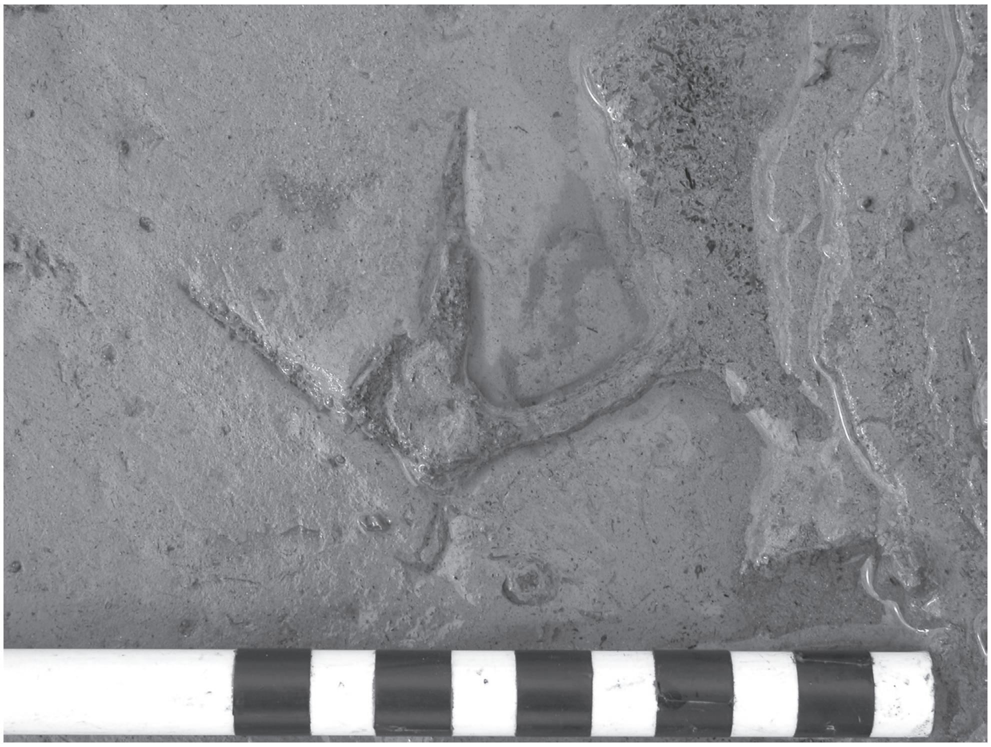


Figure 12.14 Footprint-track of a three-toed wading bird, possibly an oyster-catcher, from Site C: scale 1cm divisions (photo E Sacre)

Figure 12.15 Individual webbed footprint track from Site C, possibly that of a tern: scale 10cm (photo E Sacre)

excavated at 3mm increments to a depth of 1.8cm. The footprint-track retained its distinctive shape to a depth of 1.2cm and then began to fade out and get smaller until it had nearly disappeared at a depth of 1.8cm. The presence of crane at Goldcliff is particularly interesting as it is a species no longer resident in the UK. Cranes now migrate to warmer climates during the winter months suggesting that the bedding surfaces with crane footprint-tracks on them may relate to the warmer spring/summer months. This suggestion is further supported by work of Dark and Allen (2005) which shows that the bird footprint-tracks are all on fine-grained spring-summer sediments. A modern crane middle toe is on average 6–7cm long (Bang and Dhalstrøm 2001), whilst the Goldcliff examples are 9–10cm long suggesting this species was larger during the Mesolithic.

Heron footprint-tracks were also common: groups being represented on Site E (CD 12.62) and Site C (CD 12.63–12.64). On the west of Site C (Fig 4.3) an exposed lamination surface 8m long by 0.5m wide was covered with about 119 small bird prints (CD 12.65). They were mostly of similar size and form and those sufficiently well-preserved for identification appeared to be oyster-catchers or similar sized waders (CD 12.66–12.68). In the area around Site C there were also the tracks of gulls, their size indicates they were made by black-headed and common gulls. A number were rather smaller with webbing that only extended about halfway down each toe, these are probably terns (CD 12.69).

Due to the difficulties of working in the intertidal zone, and particular archaeological significance of the human footprint tracks, those of the birds have not so far been investigated in the level of detail which this unusual form of evidence merits. As the illustrations in Figures 12.14–12.15 and CD 12.57–12.69 show, the level of preservation and the way in which the individual prints have been picked out and affected by post-depositional formation processes and erosion vary considerably. This means that interpretation is difficult and some identifications can only be tentatively made. It is to be hoped that future research will focus more specifically on the bird prints, and the formation processes relating to this evidence. In that way a much longer species list could certainly be obtained. Meanwhile the clear evidence of crane and the other species identified make a most valuable contribution to our understanding of the past natural history of the Severn Estuary Levels. Today the estuary is a Ramsar site and European Union designated Special Area of Conservation. The extensive Gwent Levels Wetland Reserve (Fig 2.2), which runs west of the former Goldcliff island to the River Usk, provides an important wetland and over-wintering site for birds.

13 Mammal and fish bones *by Rachel Scales and Claire Ingrem (with a note on molluscs by Martin Bell)*

13.1 Animal bones *by R Scales*

13.1.1 Introduction

There are very few Mesolithic faunal assemblages from well-stratified deposits in Wales and western Britain (David and Walker 2004). Some small assemblages are known from cave sites in Caldey, Pembrokeshire and Gower (Lacaille and Grimes 1955; Caseldine 1990). However, some of these cave deposits are not securely stratified or directly related to archaeological horizons. Small assemblages are found in caves in the Wye Valley (Taylor 1927; Barton 1994), the Mendips (Everton and Everton 1972) and Torbryan, Devon (Roberts 1996). Some securely stratified material has been found in submerged forests in Pembrokeshire (CD 1.2). Of these the most significant is the Lydstep pig found with microliths seemingly from the weapon used to kill it (Jacobi 1980). Aurochs and other mammals have been found in the submerged forests, although many were not in direct association with archaeological artefacts (Lewis 1992). The limited number, and small size, of later Mesolithic bone assemblages restricts the comparisons that can be made. The bone assemblage from Site W west of Goldcliff island is the most important comparison. Beyond this is the small assemblage from the intertidal midden site at Westward Ho!, Devon (Levitan and Locker 1987). Most of the bones that have survived at Goldcliff East are from large mammals, even though there was a good level of recovery on the site and much of the sediment was sieved. The material discussed here is all from stratified contexts. Table 13.1 gives a breakdown of the identified bone assemblage by species and site and additional information is contained in CD 13.1–13.3.

13.1.2 The sites

Site J
Over 90% of the bone material recorded came from the Old Land Surface (Context 328). A very small number of bones were found in the interfaces between the Old Land Surface and the overlying estuarine silts (Context 331; CD 6.34). There were just five identifiable bones in the estuarine silt (Context 331). The total identifiable bones were 74, of which: 32 were red deer (43%), 25 aurochs (34%), 11 wild boar (15%), and 6 roe deer (8%).

Site A
The majority of bones were from the Old Land Surface (Context 315). A small number of bones were recorded from the estuarine silt (Context 314) overlying the Old Land Surface. The total identifiable bones were 25, of which: 13 were red deer, 3 aurochs, 6 wild boar, and 3 roe deer.

Site B
Over 80% of the bone fragments found at Site B were situated in the peat (Context 319). The remaining bone fragments came from the Old Land Surface (Context 321). Total identifiable bones 15, of which: 7 were red deer, 1 aurochs, 6 wild boar, and 1 roe deer.

13.1.3 Methodology

The condition of much of the bone, while good for bone of Mesolithic date, was fragmented and fragile. Chemical dissolution of the bone surface had occurred in places with parts of the bone surface being eroded whilst other parts were well-preserved and exhibited evidence of cut-marks and utilisation (Chapter 11). Overall 446 stratified bone fragments were recorded, with 108 identifiable to species level. Numbers of fragments given are the basic fragment count unless stated otherwise. Where a bone had clearly fragmented during excavation and the pieces could be joined, it was given a fragment count of one. Table 13.1 gives the number of identifiable fragments of each of the main mammal species and the minimum number of individuals (MNI) three-dimensionally recorded from each context. In addition, there were 338 unidentifiable bones three-dimensionally recorded and 710 unidentifiable bone fragments were recorded from the sieved samples (CD 13.1).

13.1.4 Animal species

Red deer (*Cervus elaphus*)
Red deer is the most frequent mammal in the assemblage. The distribution of the different elements recorded can be seen in CD 13.2. Most of the red deer bones were from the Site J Old Land Surface (Context 328) with just one from the overlying estuarine sediment (Context 331) and a few from Sites A and B. Teeth were the most common element, accounting for 25% of the red deer fragments found. However, all body parts were present – the more weighty meat cuts (such as scapula, humerus, and pelvis), as well as the metapodials and phalanges even though these provide little or no meat. The presence of almost all body parts shows that complete carcasses were being processed on site, unsurprisingly perhaps given the footprint-tracks which show red deer were moving on and close to the sites (Chapter 12.3). Deer foot-

Table 13.1 Number of identifiable bones, Minimum Number of Individuals, and percentage for each species, from stratified contexts for Sites A, B, and J at Goldcliff East

Species	Site	Context	No of bones	MNI	Total no of bones from Sites A, B, and J			Total no of bones from Goldcliff East	
					Species	No	%	No	% of bones
Red deer (*Cervus elaphus*)	J	328/ 329	28	3					
	J	331	4	1	Total red deer J	32	30		
	A	314	1	1					
	A	315	12	1	Total red deer A	13	12		
	B	319	4	1					
	B	321	3	1	Total red deer B	7	6		
Total red deer								52	48
Aurochs (*Bos primigenius*)	J	328/ 329	24	3					
	J	331	1	1	Total aurochs J	25	23		
	A	315	3	1	Total aurochs A	3	3		
	B	319	1	1	Total aurochs B	1	1		
Total aurochs								29	27
Wild boar (*Sus scrofa*)	J	328	11	2	Total boar J	11	10		
	A	315	6	1	Total boar A	6	6		
Total boar								17	16
Roe deer	J	328	6	1	Total roe deer J	6	6		
(*Capreolus capreolus*)	A	314	1	1					
		315	2	1	Total roe deer A	3	3		
	B	319	1	1	Total roe deer B	1	1		
Total roe deer								10	9
TOTAL identifiable bones								108	100

(data provided by R Scales)

prints were found on Sites J, A, and B themselves. It would have made it easy to return to camp with the entire carcass, rather than removing selected joints. Bone and antler artefacts (Chapter 11) show that the people from Goldcliff East made use of the whole deer carcass, and it may have meant as much to them in raw material worth as meat. The absence of stratified antler at Goldcliff East may be due to several factors such as the importance of its use as a tool, poor preservation, or perhaps the season of site use.

Aurochs (**Bos primigenius*****, *wild cattle)***

This was the second most frequent species represented at Goldcliff East, making up 21% of the identifiable fragments (Table 13.1). Aurochs-sized ribs and vertebrae were also recorded. Most of the aurochs bones were from the Old Land Surface (Context 328) on Site J with single bones from the Site J estuarine sediments (Context 331) and Site B, and three bones from Site A. 51% of the identifiable aurochs fragments were non-meat-bearing teeth and mandibular fragments. Most of the remaining bones present were from meat-bearing bones such as humerus and pelvis. Only one foot bone was found. With a small number of fragments it is not easy to be certain whether the absence of certain body parts is distinctive of a particular hunting or butchery practice, or whether it is simply a problem of preservation. The density of aurochs bones, however, suggests that they may have been more likely to survive than say the smaller more porous bones of wild boar. The complete absence of identifiable aurochs metapodial fragments and the presence of only one phalange could indicate that these bones were utilised in some way, eg as tools such as pounders, as at Star Carr (Legge and Rowley-Conwy 1988, 47). Another possibility for the apparent absence of metapodials is that they may have had the bone marrow extracted and been fragmented in the process. A number of teeth were recorded but there was little evidence for horn cores or cranial fragments. Grigson (1983) noted the same pattern at Cherhill and it is unclear for both sites whether their absence is due to taphonomic factors, or whether the skulls may have had some kind of ritual significance and were transported elsewhere. Aurochs skulls have been found among grave goods from burials associated with the Iron Gates Mesolithic in Europe along with other items of cultural importance such as red deer antler and boar tusks (Radovanović 1996). The considerable size of aurochs and the presence of a range of body parts suggest that at Goldcliff the carcasses were butchered on, or close to, site. There is very scant footprint-track evidence for the movement of aurochs on the saltmarshes (Chapter 12.3.7).

Wild boar (*Sus scrofa*)

There are very few wild boar bones from Goldcliff East (Table 13.1). These came from the Old Land Surface on Site J (Context 328) and the Old Land Surface on Site A (Context 315). Teeth are dominant for this species, perhaps because they are hard and preserve well in comparison to the more porous post-cranial elements. However, what is particularly noticeable is that all the identifiable fragments are from the head and feet which bear little or no meat. The lack of meat bones may be significant despite the low fragment count. A possible explanation is that pig bones are generally quite porous and may not have survived well. However, a similar pattern in body part representation was noted in the contemporary assemblage from Site W (Coard 2000). It may, therefore, be more likely that this is the reflection of a butchery practice with the animals being slaughtered on site and then the main meat-bearing joints from the upper and lower limbs taken elsewhere for cooking.

Roe deer (*Capreolus capreolus*)

The small number of fragments (Table 13.1) are mostly from the Site J Old Land Surface (Context 328). There seems to be a higher prevalence of radii than any other element. No teeth or toes were found in the material, which suggests that the animals may not have been butchered on site; it may have been more likely that selected cuts of meat were taken from the carcass and brought to camp but the number of bones is limited.

Otter (*Lutra lutra*)

Present only on Site W west of the island (Coard 2000).

Bird bone

Three small fragments of bird bone, which could not be identified to species, were found in Context 315 from Site A. One was part of a coracoid, and the other two pieces were long bone fragments.

13.1.5 Age and seasonality

Red deer

For those fragments where it was possible to observe epiphysial fusion, they were all found to have fused. Seven identifiable tooth fragments were recorded; 1 P4, 4 M1/M2s, and 2 M3s, however only four were complete enough to give an indication of enamel wear. A P4, M1/M2, and an M3 all showed signs of some wear, but none were completely in wear. The third cusp of the M3 showed that it was just coming into wear while the fourth tooth, an M1/M2 was unworn. Such tentative data might hint that the age of the animals at death ranged from immature to young adult. No stratified antler was found on site. The antler tool (no 7065) found unstratified close to Site C (Chapter 11.2) was made from a cast red deer antler. Red deer cast their antlers between mid-March and mid-May (de Nahlik 1974) but there is no evidence to suggest that the antler was shed during a period of activity at Goldcliff East. An antler axe handle is likely to have been a valued item that would have been curated and carried from site to site until it was no longer of practical use.

Aurochs

Only three of the aurochs fragments (first phalange, radius, and tibia) were sufficiently complete to show evidence of epiphysial fusion; all were fused. Eight identifiable aurochs teeth were recorded; 4 M1/M2s and 4 M3s. All four M1/M2s appeared to be in a similar state of wear where the whole crown was in wear. Only two of the M3s were complete enough for wear to be examined. One was unworn suggesting the animal was young, while the other was in wear, including the third cusp, indicating that this particular beast had reached dental maturity.

Wild boar

Most of the pig fragments are teeth. Three of the five bone fragments found were complete enough to indicate that they were fused (first and second phalange, metapodial). Of the teeth there was one M3 that was just coming into wear and one M1/M2 that was in wear. Two moderately large pieces of boar's tusk were also recorded on Site J (CD 6.33). This would suggest that there were animals nearing dental maturity being utilized. Much of the other evidence, however, points to the presence of very young and neo-natal pigs at Goldcliff East. There were three unworn dP4s, plus two very small canines and an incisor. In Poland (Haber 1961), wild boar piglets are usually born between mid-March and mid-April. In Denmark, Mohl (1978) notes most are born in April, with some in March or May. The presence of very young piglets at Goldcliff East would suggest that Sites A and J were being used during the spring months.

Roe deer

Roe deer accounts for only a small number of the identifiable fragments. There are no teeth from the site, nor has any antler been recovered. Two neonatal bones (tibia and radius) have been recorded from Site J. Roe deer in Britain tend to be born in May (McDiarmid 1978) although in Denmark fawns are produced between mid-May and mid-June (Strandgaard 1972). So this would suggest a period of use for Site J in spring to early summer, which would support the suggestion of spring usage from the evidence for wild boar piglets.

13.1.6 Butchery, burnt bone, and fragmentation

The number and frequency of butchery marks recorded can be seen in CD 13.3. Cut marks were found on red deer, aurochs, boar, and roe deer bones indicating that the bones of these species are likely to be from butchery and food refuse. Chop marks in general tend to signify the dismemberment of a carcase and cut marks its filleting. Only four bones in the assemblage had chop marks, and all were aurochs. Larger bones, such as those of wild cattle, would perhaps have needed more forceful butchery and that is possibly why there are none for the smaller species in the assemblage. The cut marks made on bones by lithic blades are described in Chapter 11.6 and illustrated in Figure 11.5. The bones with cut marks are: red deer proximal humerus (CD 13.6), roe deer scapula (Fig 11.5), and segments of medium-sized rib (Fig 11.5).

From the bone fragments found at Goldcliff East, 43% were burnt, most of them calcined (CD 13.3). Some may have been burnt in cooking, more perhaps if refuse was thrown back into the fire after it had been consumed. A red deer phalange and two teeth were amongst the burnt deer elements. These are not meat-bearing bones so perhaps some secondary burning of waste products occurred. 21% of red deer bones were burnt in comparison to only 4% of aurochs bones, possibly because the latter were used in making tools. Another activity may have been extraction of marrow to produce fat. The calorific value of fat is much higher than carbohydrate or protein and so it is quite likely that it would have played an important role in food. The fat can also be used in many activities such as waterproofing of animal skins, eg for making houses or boats.

A clear distinction in the distribution of burnt bone can be seen (Scales 2006, table 6.10). On Sites J and A, *c* 20% of the fragments found were burnt. However, at Site B, 93% from Context 319 and 70% of Context 321 were burnt. Site B appears to have been used for a specific activity such as cooking or the burning of waste material. It also explains why only 8% of the bone fragments found at Site B could be identified.

13.1.7 Conclusions

The size of the bone fragments has been analysed in 1cm intervals (Scales 2006, table 6.11). 56% of the fragments found at Goldcliff East were smaller than 2cm and 86% were smaller than 5cm. It is clear from these figures that this is a highly fragmented assemblage which is why there are low numbers of identifications to species level. Fragmentation was the result of a combination of factors including poor preservation. There is evidence of red deer trampling over the Mesolithic Old Land surface at Sites J, A, and B (Chapter 12.3). Burnt bone is also more susceptible to fragmentation. The influence of dogs on the assemblage (Payne and Munson 1985; Davis 1987) is probably low given that only 1% of bones were gnawed. There was evidence for the smashing of bones probably for marrow extraction. A number of the broken bones, particularly those of aurochs on Site J, were turned into tools (Chapter 11).

The total number of pieces of bone three-dimensionally recorded was 446 and the total identifiable to species was 108, thus 24% of the three-dimensionally recorded pieces were identifiable to species. This does not include the bone from sieving, none of which was identifiable to species; there were 402 fragments of bone and 307 pieces of burnt bone. So there is a total of 709 bones (excluding fish) from sieving, plus 446 three-dimensionally recorded pieces, making an overall total of 1156 pieces of bone. Of this 9% was identifiable to species. This can be compared to the Site W (Coard 2000) where 139 three-dimensionally recorded pieces could be identified to species from a total of 1000 pieces (ie 14%). The proportion of bone fragments recovered from sieving in the sites reported here was 61% as compared to 32% on Site W. Thus the difference between the proportions of identifiable pieces on the east and west sides of the island is not great (5%) and are almost certainly accounted for by the more substantial sieving programme during the 2001–03 excavations rather than by greater bone fragmentation among the assemblages from east of the island.

Table 13.2 lists the species present within the environs of Goldcliff island based on both footprint-track and animal bone data. Footprint-tracks and bones are not equivalent data sets and they are subject to very different taphonomic and preservation conditions; however, some interesting points emerge from their comparison as well as from comparison of sites east and west of the island (Fig 13.1). The Goldcliff East economy seems to have been focused significantly on red deer, which makes up nearly half of the bone assemblage. Interestingly this dominance of deer is mirrored by Site W where red deer accounts for over two-thirds of the assemblage. Red deer is present at most British Mesolithic sites and has for a number of years been considered a staple Mesolithic food along with hazelnuts. This is a stereotype Goldcliff reinforces both from bone data and footprint-tracks. A similar preference for red deer has been documented for Mesolithic groups across Europe, such as the Iron Gates Mesolithic (Radovanović 1996) and the Kongemosian culture in southern Scandinavia (Ahlström 2003). However, Goldcliff does have a wider range of animal, fish, and plant resources than most southern British Mesolithic sites.

Most body parts are represented in the assemblage at Goldcliff East and Site W, suggesting that the animals were hunted, processed, and consumed at the site. A number of bone tools thought to be associated with activities involving hide working have been recovered from the site so the Mesolithic

Table 13.2 Species present within the environs of Goldcliff island based on both footprint-track and animal bone data

Species present in environs of Goldcliff island	Goldcliff East bone assemblage	Goldcliff West bone assemblage (Site W)	Goldcliff East footprint-track assemblage
Red deer (*Cervus elaphus*)	Sites A, B, & J	Present (1202).	Sites A, B, C, E, F, G, and J
Roe deer (*Capreolus capreolus*)	Sites A, B, & J	Present (1202)	Possible presence at Sites C & J
Aurochs (*Bos primigenius*)	Sites A, B, & J	Absent	Sites B and E
Wild boar (*Sus scrofa*)	Sites A & B	Present (1202)	Absent
Otter (*Lutra lutra*)	Absent	Present (1202)	Absent
Wolf (*Canis lupus*)	Absent	Present (1202)	Near Site C
Crane (*Grus grus*)	Absent	Absent	Sites E & C
Heron (*Ardea cinerea*)	Absent	Absent	Sites E & C
Oyster catcher (*Haematopus ostralegus*)	Absent	Absent	Sites E & C
Mallard (*Anas platyrhynchos*)	Absent	Present (1202)	Absent
Tern (*Sterna* sp.)	Absent	Absent	Sites E & C
Common gull (*Larus canus*)	Absent	Absent	Sites E & C
Black-headed gull (*Larus redibundus*)	Absent	Absent	Sites E & C
Bird indet.	Site A	Present (1202)	Sites E & C

community were using this resource for meat, tools and other secondary products.

Aurochs bones make up a quarter of the Goldcliff East assemblage. Most body parts are represented suggesting that the animals were butchered on, or close to, the site. Aurochs have been noted at many Mesolithic sites in Britain both early and late in the period but none was found at Site W. Aurochs were clearly present in the wider area, so the reason for their absence could perhaps be due to a difference in seasonal occupation of the two sites. Alternatively, it may mean that the sites represent the focus of different activities including hide processing at Goldcliff East for which these large animals are likely to have been important.

Roe deer are represented in most early and late Mesolithic bone assemblages in the Britain but only in small percentages as at Goldcliff. Roe tend to prefer more enclosed woodland whilst red deer frequent the forest fringes and more marginal zones. Clear examples of roe footprint-tracks are uncommon at Goldcliff. This again may reflect habitat preference; the marginal salt marsh environment does not seem to have been preferred by roe deer. The anatomical parts present suggest that the animals may have been killed and butchered off-site, bones from the head or feet being few.

Wild boar makes up 15% of the Goldcliff East bone assemblage. The surviving body parts are from the head and feet regions, implying that animals may have been slaughtered and processed on site while the main meat-bearing cuts may have been carried off for consumption elsewhere. A similar pattern of utilisation was noted at Site W where the majority of identified elements belonged to the head and feet.

What is particularly interesting is that although wild boar is represented in the bone assemblages both east and west of Goldcliff island, no footprint-tracks have been found. A misidentification of footprint-tracks is unlikely as wild boar tracks are particularly recognisable with both the front toes and dew claws visible within the impression (Bang and Dahlstrøm 2001). Their absence in the record may be due to wild boar preferring a deciduous woodland habitat.

Wild boar is a common component in Mesolithic bone assemblages, although its numbers appear to fluctuate. It has been noted at the early Mesolithic sites of Star Carr, Thatcham, and Wawcott. At Thatcham, *Sus scrofa* accounts for nearly half of the main meat-bearing mammals (Wymer 1962), while at Wawcott it represents nearly a third (Carter 1975). At Star Carr on the other hand wild boar makes up only 2% of the meat-bearing mammals (Legge and Rowley-Conwy 1988) with red deer and elk playing a more significant role. For the later Mesolithic, the extent to which boar was exploited also varies. A small stratified Mesolithic bone assemblage from Westward Ho! (Levitan and Locker 1987) contained only one pig bone, as did the assemblage from Morton, Fife (Coles 1971). However, Ferriter's Cove in Ireland displays an economy almost entirely based on pig with some evidence for early domestic sheep and cattle (Woodman *et al* 1999). Cherhill, Wiltshire is one of the largest late Mesolithic assemblages in Britain and is pig dominated (Grigson 1983).

Two wolf footprint-tracks were found on the lower foreshore at Goldcliff East (CD 12.52). There are no skeletal remains belonging to wolf or dog east of the island but there were a small number of bones with carnivore gnawing (CD 13.3). Coard (2000) did find 3% of the bones tentatively identified as wolf at Site W (Fig 13.1), again with a little carnivore gnawing.

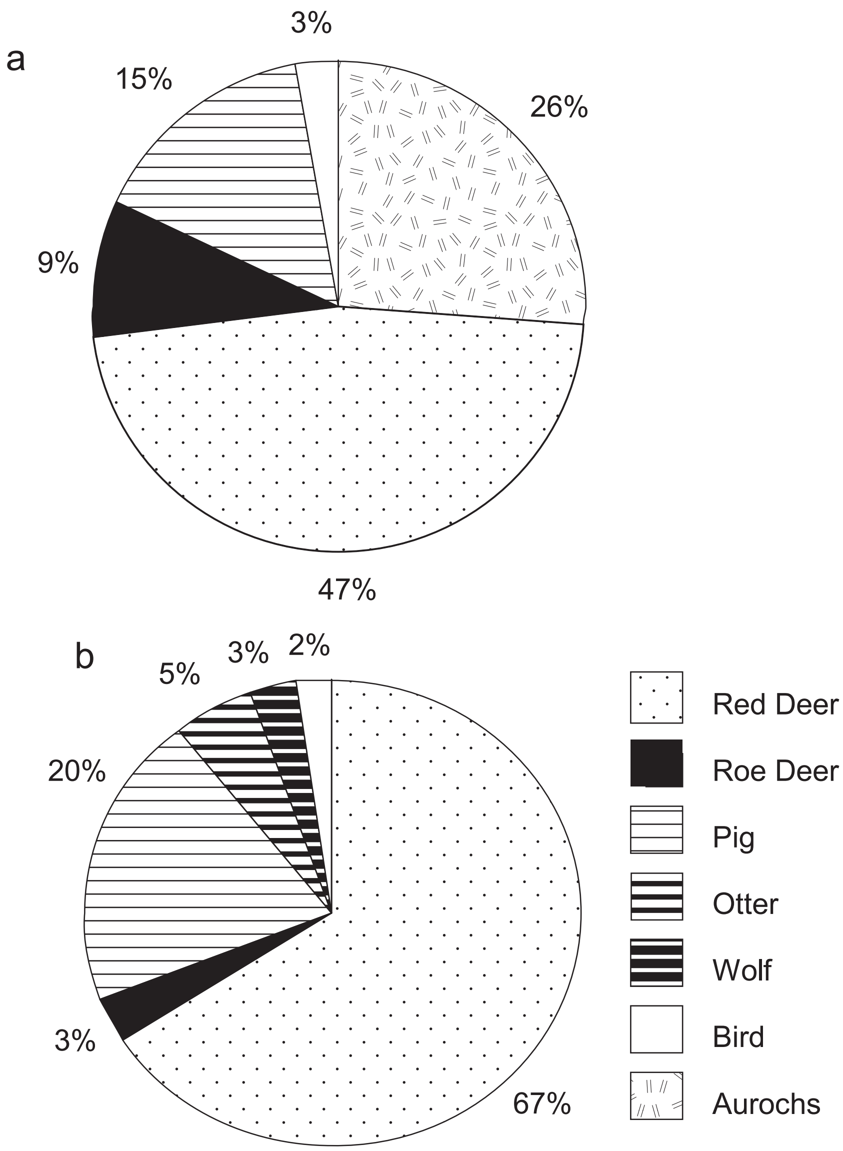


Figure 13.1 The number of identified bones from (a) Sites J, A, and B by species, compared to (b) the number from the 1992–94 excavations on Site W (graphic R Scales)

However, we do not know whether this occurred whilst the site was in use or after abandonment. Dog and wolf are notoriously hard to distinguish (Degerbol 1961; Benecke 1987). The earliest example of dog found on a British archaeological site is at Star Carr (Degerbol 1961; Legge and Rowley-Conwy 1988). Both dog and wolf bones have been recorded at the early Mesolithic site of Thatcham, Berkshire (King 1962), but stratified examples from late Mesolithic assemblages are few, just Cherhill (Grigson 1983) and Caldey (Lacaille and Grimes 1955).

The estuarine environment would have provided a good opportunity to catch wildfowl. The footprint-tracks of tern, heron, crane, oyster catcher, common and black-headed gulls have been recorded (Chapter 12.4). The concentrations of crane footprint-tracks and the presence of the human footprints of Persons 11 and 12 (Chapter 12.2.3) around Site C could suggest that children may have been wildfowling in the area. Two bird bones thought to have been Mallard (*Anas platyrhynchos*) were recorded from the Mesolithic bone assemblage from Site W. No mallard footprint-tracks have been positively identified at Goldcliff East, but duck provided another resource.

The bone assemblage from Goldcliff is small but it is still one of the largest assemblages from western Britain. The faunal data suggests an economy focused on terrestrial game with fishing and foraging activities. It is interesting that, although the site is geographically coastal, its exploitation focus was not all that strongly marine-focused by comparison for instance with the island midden sites on Oronsay (Grigson and Mellars 1987; Mellars 1987). The contrast may reflect the extensive saltmarsh and wetland environments at Goldcliff providing an abundance of terrestrial fauna, as the footprints show, as does evidence for significant use of plant resources in the following chapter.

13.2 Fish bones *by C Ingrem*

13.2.1 Introduction to the sites

A significant quantity of fish bones was recovered by wet-sieving. Site A produced the majority of the identifiable fish remains: 4432 fragments were identified in initial sorting, 4056 from Context 315 and 236 from Context 316; many of them were calcined. They were particularly concentrated in a 2m square on Site A (Fig 5.4), which also corresponds to the concentrations of debitage, micro-debitage and other bones (Chapter 5). Figure 5.4 shows all fragments of fish bones, not just identifiable fragments. A small number of fish bones came from the Old Land Surface at Site J (Context 328). A few fish bones were recovered from Site B (1 from Context 319 and 5 from Context 321) but none are identifiable to species. About 12% of the fish bones were identifiable to taxa. The wider project aimed at investigating the ecology of coastal environments and human interactions with the natural environment; consequently the primary objectives of this report are to investigate seasonality, fish exploitation, fishing techniques, and consumption practices.

13.2.2 Methodology

The fish bones were identified and recorded at the Centre for Applied Archaeological Analyses (CAAA), University of Southampton with the aid of the comparative collection housed in the LAZOR (Laboratory for Zooarchaeological Research) using a low power (x10) binocular microscope. All fragments were recorded to species and anatomical element where possible (with the exception of ribs and fin spines) to produce a basic fragment count of the Number of Identified Specimens (NISP).

The proportion of an element represented by each fragment was recorded as < 25%, 25–50%, 50–75% and >75% according to completeness. Where possible, elements were sided. The state of preservation was recorded as good, medium and poor. Evidence of damage caused by gnawing, and burning was recorded. Few cranial or appendicular elements were present and none of these were sufficiently complete to allow measurements to be taken, therefore size was visually categorised with the aid of the reference specimens following the categories used by Cerón-Carrasco (1999) as follows: very small (<150mm), small (150–300mm), medium (300–600mm), large (600–1200mm), and very large (1200–c 2000mm).

13.2.3 Fish species

A total of 513 identifiable fragments of fish were recovered including nine fragments belonging to shellfish, probably crab claws (Table 13.3). Excluding the shellfish, six taxa are represented – salmon *(Salmonidae)*, eel *(Anguilla anguilla)*, bib *(Trisopterus luscus)*, bass *(Dicentrarchus labrax)*, mullet *(Muglidae)*, and flatfish. In addition, single specimens most probably belonging to cyprinid *(Cyprinidae)* and sand eel *(Ammodytidae)* are also present. Only two identifiable bones were recovered from Site J and both are vertebrae of eel.

Site A produced 502 identifiable fish bones of which the majority (83%) belong to eel. A wide range of taxa is represented but bass is the only other species present in significant numbers (9%). Anatomical representation of eel is shown in CD 13.4 and it is immediately apparent that vertebrae from both the abdominal and caudal regions of the body dominate the assemblage. Cranial and appendicular elements are scarce. Similarly, bass are represented solely by vertebrae although again both abdominal and caudal regions are represented (CD13.4). Approximately three-fifths of the identifiable assemblage (79%) displays evidence of burning and almost half of these are calcined with the remainder burnt black or brown. Burning has affected all taxa (Table 13.3). Four vertebrae belonging to eel have been crushed in a manner suggestive of chewing. The size of the fish represented was estimated by comparison with reference specimens of known length (Table 13.3). The majority (60%) were classified as small (150–300mm), almost a quarter fell into the medium category (300–600mm), and the remainder were classified as very small (<150mm).

13.2.4 Interpretation and discussion

The anthropogenic nature of the deposits from which the fish remains were excavated and the evidence for burning on the bones leaves little doubt that they represent food remains. The remains of eel dominate the assemblage; this is not surprising as they were the most frequent species at Site W, although there they comprised a smaller proportion of the assemblage (Ingrem 2000). In other respects the assemblages differ, the main characteristic of the earlier assemblage was the very small size of the fish being exploited and the narrow range of taxa represented with goby *(Gobiidae)* comprising 29%, and smelt *(Osmeridae)* and three-spined stickleback *(Gasterosteus aculeatus)* making up 8% and 6% respectively. At Goldcliff East, bass are the only other species found in significant numbers.

At both sites, all of the species present can be found in estuarine and brackish water providing evidence that the inhabitants were exploiting the immediate environment. Eel are catadromous, migrating from freshwater to the oceans to spawn and as a result are common in rivers and estuaries especially where there are intertidal pools (Wheeler 1969). In general those found in the sea and estuaries are small, with elvers inhabiting the littoral zone or taking to the rivers when they have reached a length of 70mm; on the western French and Irish coasts this occurs in January and in the Channel and Irish Sea, in

Table 13.3 Goldcliff East fish representation according to NISP and percentage NISP, Sites A and J; incidence of burning (NISP), Site A; and estimated size of specimens identified to taxa, Site A

Species		Species representation					Incidence of burning according to species (NISP), Site A					Estimated size of species identified to taxa, Site A			
		Site A	Site J	?	Total N	Total %	Calcined	Charred	Brown	Total burnt	Total % burnt	600=300mm	300–150mm	<150mm	Total
Salmonidae	salmon	2			2	‹1	2			2	100				
cf. Cyprinidae	cyprinid	1			1	‹1								2	2
Anguilla anguilla	eel	415	2	8	425	83	155	100	78	333	78	112	273	30	415
cf. *Anguilla anguilla*		6			6	1	5		1	6	100				
Sm. Gadidae		10			10	2							5	5	10
Trisopterus luscus	bib	1			1	‹1	1			1	100			1	1
Dicentrarchus labrax	bass	44			44	9	23	7	12	42	95				
cf. *Dicentrarchus labrax*		6			6	1	3	1	1	5	83		10	34	44
cf. Ammodytidae	sand eel	1			1	‹1	1			1	100				
Muglidae	mullet	3			3	1	2		1	3	100			3	3
Flatfish		4		1	5	1	2		1	3	60		1	3	4
Shellfish (?crab)		9			9	2		8		8	89				
TOTAL		502	2	9	513	100	194	116	94	404	79	112	289	78	479
%												23	60	16	100

(data provided by C Ingrem)

February. Eels spend several years in freshwater, feeding and growing and begin migrating to the sea to spawn having attained a length of at least 410mm, consequently these adult eels are abundant at river mouths in September/October when large numbers are caught in traps (Wheeler 1969). The estimation of fish size, purely by visible comparison with specimens of known length, is far from ideal especially in an assemblage where most of the bones are vertebrae because the size of these elements is extremely variable depending on their location in the spine. The exact proportions of fish in each size category should therefore be treated with caution, however a quarter of the eel bones recovered from Site A are estimated as belonging to fish between 300mm and 600mm and these are likely to represent the remains of eels caught during the autumn migration. The remainder of the eel bones belong to individuals below 300mm in length, which falls between the sizes reached by elvers arriving at, and eels departing from, estuaries and so they must derive from individuals that had inhabited the estuary for much of their life cycle and could therefore have been caught throughout the year. This is a similar pattern to that seen in the previously excavated assemblage from Goldcliff Site W where most of the eel bones belong to small and very small fish (Ingrem 2000).

Although the sample of bass is small, all derive from small or very small fish. In spring, bass migrate inshore when, according to Wheeler (1969) young school fish arrive off the coast from March to May, followed a month later by larger individuals. First and second year bass (below approximately 190mm) are also common in estuaries during the autumn. As bass migrate offshore in winter, the very small size of the majority of bass represented at Goldcliff East suggests that the site was occupied some time between spring and the onset of the winter migration.

Eel clearly dominate the assemblage and, whilst frequency cannot be directly used as a measure of importance (because of the variation in the number of bones possessed by species and the chances of survival in the soil as a result of fat content and density), their overwhelming predominance suggests that they were deliberately targeted. There is plenty of archaeological and documentary evidence for the popularity of eel as a source of food throughout history, from the Saxon period until more recent times (Schweid 2002; Locker 2003). They can be caught using traps, nets, lines, or spears (CD 13.5). Today, traps are used (Wheeler 1969) to take advantage of the large numbers of adult eels migrating from rivers to the oceans in the autumn and also at other times when they are growing (Burgess, nd). Pronged spears can be used to catch eels that have burrowed into mud for the winter hibernation (*ibid*), however this method is unlikely to be employed on very small fish. The frequency of eel and the generally small size of the fish recovered from Ertebølle suggested to Enghoff (1986) that fishing took place with fish traps located in shallow water. The size and wide range of fish present at Goldcliff suggests that here too traps or nets were used with taxa other than eel and bass probably representing incidental catches.

The overwhelming predominance of vertebrae is likely to reflect variations in bone density rather than the elements originally present, in general axial bones are denser and more robust than cranial and appendicular elements. Eel are the only species that comprise a sample of sufficient size to allow consideration of body part representation. The presence of a few cranial and appendicular elements is evidence that whole fish were originally present, unsurprising in light of their small size and the close proximity of the site to the estuary. Cranial elements are virtually absent for other species but this is most likely a reflection of the small samples.

The small number of crushed vertebrae may provide an indication that the bones were not removed prior to consumption. It may be no coincidence that much of the material had been burnt, as burning often increases rates of survival. The charred and calcined condition of many of the bones indicate that they had been exposed to open fire temperatures in excess of 400° C (Gilchrist and Mytum 1986). Burning is unlikely to have resulted during the cooking process as the surrounding flesh would have acted as a protective barrier, it is most likely that fish was cooked and eaten by an open fire onto which the resulting waste was thrown. It is not possible to determine whether eels were eaten fresh, or in a preserved form, although historically eels are known to have been cured by smoking (Schweid 2002, 116) and it is therefore quite possible that at least some of the catch was prepared in such a way, for consumption at times when other resources were scarce.

Evidence for the exploitation of fish and shellfish particularly, during the Mesolithic period is relatively common in other parts of the world and often attests to the seasonal use of resources. Mesolithic sites in Britain that have produced fish remains are scarce although sites on Oronsay, Inner Hebrides, produced evidence for seasonality suggesting that saithe *(Pollachius virens)* were caught at several different times of the year (Mellars and Wilkinson 1980). The Danish evidence is more plentiful and at many sites, both coastal and inland, one or two taxa dominate the assemblages, for example at Praestelyngen (Noe-Nygaard 1983) 78% of the remains belong to pike (*Esox lucius),* at Ertebølle (Enghoff 1986) cyprinids constitute 67% and eel 17% of the assemblage, whilst at Maglemosegård (Aaris-Sørenson 1980) the remains of cod *(Gadus morhua)* comprised 83% of the fish bone. The predominance of a single species is often interpreted as reflecting a seasonal procurement strategy and at Praestelyngen, fish were killed during the summer season. The evidence from Ertebølle, however, suggests that, although eel were caught during the autumn, marine fishing was carried out on a smaller scale during the summer. At Site A, Goldcliff, the predominance of eel, a considerable proportion of which are of a size suggesting that they were migrating seaward, also suggests the deliberate targeting of fish during the autumn. The young bass, being common in estuaries during the autumn may have been caught incidentally, although this is by no means certain and they may equally have been caught earlier in the season. Similarly, the smaller eels would have been available throughout the year although their size suggests that they were unlikely to have been speared during the winter hibernation.

13.2.5 Fish remains: conclusion

Goldcliff East is the second site to produce evidence for the exploitation of estuarine fish, in particular eel, during the Mesolithic period in Britain. Fishing practices that focus on the exploitation of one or two fish species have previously been documented at sites in Denmark and Scotland where there is evidence that fish exploitation took place both on a seasonal basis and throughout the year. The characteristics of the assemblage from Goldcliff East suggest that fishing took place during the autumn, and possibly between the spring and autumn although the evidence is tentative and it is therefore important that it be considered alongside the other indicators of seasonality that have been recovered from the site (Chapter 18.14).

13.3 Molluscs *by M Bell*

A very small collection of marine molluscs was found, mostly on Site J in the Old Land Surface (Context 328) and the overlying estuarine silts (Context 331). This evidence is more fully described and illustrated on CD 13.7–13.11. It includes two casts of decalcified shells: one cockle (*Cerastoderma edule),* the other whelk *(Buccinum undatum)*. There were also some tiny periwinkles: *Littorina obtusata* (4), *Littorina* 'saxatalis type' (1) and *Littorina littoralis* (1). The '*L saxatalis* type' had a broken spire and could have been strung on a necklace. These shells are identified as Mesolithic because sediment in their aperture matched the context in which they were found, because of adhering charcoal or because of their condition and iron staining. Some (eg from Context 331) could have been washed into the site naturally, or been collected with driftwood or seaweed. They might suggest that marine molluscs made a very minor contribution to the diet but the muddy estuary hereabouts is not a rich environment for edible molluscs.

14 Plant communities and human activity in the Lower Submerged Forest and on Mesolithic occupation sites *by Petra Dark with a report on charcoals by Rowena Gale*

14.1 Introduction

This chapter is concerned primarily with the plant communities associated with the main Mesolithic occupation sites at Goldcliff East. This evidence derives from the Lower Peat and Submerged Forest at Sites B and D, and the Mesolithic Old Land Surface and base of the overlying Upper Peat at Site J. The plant communities associated with the Upper Peat and Upper Submerged Forest are discussed by Scott Timpany in the following chapter.

Pollen-analytical research at Goldcliff began in the 1980s, with the publication of a pollen sequence from the Upper Peat, spanning the period from *c* 5000 to 1500 cal BC (Smith and Morgan 1989). Subsequently, excavations of later Mesolithic to Iron Age sites west of the former Goldcliff island (Bell *et al* 2000) provided a context for analysis of pollen and other floral and faunal evidence (Caseldine 2000), giving valuable insights into environment change and human resource use in a prehistoric estuarine setting.

Further research at Goldcliff East was prompted by the discovery in 2001 of new Mesolithic sites associated with earlier peat deposits. This area became a principal focus for the NERC–funded 'Mesolithic to Neolithic coastal environmental change' project, which encompassed several different aspects of the archaeological and palaeoecological record from Goldcliff East, and other sites in the Bristol Channel (Bell *et al* 2001; 2002; 2003). This presented the opportunity to examine a series of Mesolithic sites in the coastal zone, progressively inundated by the sea, allowing reconstruction of the response of human groups to spatial and temporal fluctuation in their resource base. The aim of this chapter is to present primarily botanical evidence (pollen, charcoal, and macroscopic plant remains) for interactions between later Mesolithic human activity and environmental change at Goldcliff, particularly involving the use of fire. The sedimentary sequence has been introduced in Chapter 2 and accounts of the excavations and stratigraphy at the sites discussed here are in Chapters 3–7.

14.2 Methods and results

14.2.1 Field sampling

For pollen and charcoal analysis

At each site an intact block of sediment was removed from one of the excavated sections in a 50cm monolith tin for high resolution palaeoecological analyses of the Mesolithic soil and overlying deposits. At Sites B (Monolith 4070) and D (Monolith 4071), the entire thickness of the Lower Peat, and part of the overlying estuarine silts, were included in the sample. The location of the Site B monolith is shown in Figure 3.5 and the Site D monolith in Figure 3.8, and a photograph of the Site D monolith in CD 3.9. At Site J, where the Mesolithic soil was directly overlain by the Upper Peat, only the lowermost part of this peat was included in the sample (Monolith 5640), the location of which is shown in Figure 6.9. CD 6.28 is a photograph of the monolith. Preliminary analysis of samples from the occupation horizon at Site A, where peat was lacking, showed that very little pollen was present, so no pollen or associated charcoal sequence has been produced from this site. The samples were wrapped in clingfilm and transported to the laboratory. Sediment stratification was recorded from the cleaned surface of the monolith, and samples taken for analysis of pollen and microscopic charcoal, macroscopic charcoal, and radiocarbon dating. The monoliths were then wrapped in foil and thick plastic and stored in a freezer.

For macroscopic plant remains

The excavated areas were divided into 1m grid squares and samples of approximately 4 litres taken from each square covering the occupation horizon. These were flotation sieved (mesh sizes 2mm and 0.5mm) using a modified version of the Siraf-type flotation tank (Williams 1973). Some larger plant remains, especially hazelnuts, were also collected during hand excavation.

14.2.2 Pollen and microscopic charcoal particle analysis

For high-resolution pollen and microscopic charcoal particle ('micro-charcoal') analyses from Sites B and D contiguous samples 1cm^3 in volume and 0.5cm thick were removed from the peat and top of the underlying minerogenic horizon, with a 5cm interval for the remaining minerogenic deposits (in which the pollen was poorly preserved and too sparse to count). At Site J, where the monolith included the base of the Upper Peat, contiguous samples were taken from the basal 6cm of peat and upper 5cm of the mineral occupation horizon, with samples at 2cm intervals for the lower part of this horizon.

Chemical sample preparation followed standard procedures (Berglund and Ralska-Jasiewiczowa 1986), including sieving with a 100μm mesh to remove coarse particles, micro-sieving with a 10μm mesh to remove the finest particles, and addition of *Lycopodium* tablets (Stockmarr 1971) for calculation of charcoal concentrations. Pollen samples were mounted in glycerine jelly.

Pollen was counted using a Leica DMLB microscope at a magnification of ×400, with a magnification of ×1000 for critical determinations. Wherever possible a minimum sum of 300 identifiable pollen grains and Pteridophyte (fern) spores was reached, but for a few samples from the minerogenic horizons counts were lower. Pollen and spores were identified using the key of Moore *et al* (1991) and by comparison with the reference collection in the Department of Archaeology, University of Reading. Vascular plant nomenclature follows Stace (1991) and pollen and spore nomenclature follows Bennett *et al* (1994). *Corylus avellana*-type pollen is assumed to represent hazel in view of the abundance of charred and waterlogged hazelnuts in the deposits. Unidentifiable deteriorated pollen grains and spores were classified according to the categories of Cushing (1967).

Poaceae pollen grains with a maximum diameter >40μm are classed as 'cereal type', although this group includes some wild grasses, such as *Glyceria* (Andersen 1979; Tweddle *et al* 2005). The maximum measurable grain diameter and annulus diameter of all cereal-type grains (which occurred only at Site D) were measured and are listed in CD 14.1. Mean grain sizes could not be determined in most cases because of folding of the grains. Glycerine jelly causes swelling of pollen grains, so that their dimensions are not directly comparable to those mounted in silicone oil, which was the mounting medium used by Andersen in his identification key (1979). To correct for this, Andersen (1979) recommends comparison of the size of hazel pollen grains in the same samples against a standardised hazel grain size in silicone oil of 24.5μm. Measurement of hazel grains in the Goldcliff samples indicated an increase in grain size of approximately 1.5 times compared to their expected dimensions in silicone oil. A correction factor was calculated for each sample and applied to the cereal grains to allow comparison with samples mounted in silicone oil. Four out of five of the cereal-type grains had corrected sizes >40μm. Andersen (1979) found that it was unnecessary to correct annulus sizes.

Pollen percentage calculations are based on a sum including all identifiable pollen grains and Pteridophyte spores, excluding obligate aquatics. Calculations for the different categories of unidentifiable pollen grains are based on the main sum plus the sum of unidentifiable grains. The data sets have been zoned and preliminary pollen diagrams produced using the ANSI C program psimpoll (Bennett 2000). Pollen percentage diagrams for all taxa occurring at ≥1% of the pollen sum are shown in Figures 14.1, 14.3, and 14.5. Brief descriptions of the key characteristics of each zone are given in CD 14.2–14.4. Charcoal area in the same samples as those used for pollen analysis was estimated by point counting (Clark 1982). Some of the micro-charcoal could be identified as 'grass type' by the presence of stomata and epidermal cells characteristic of the grass and sedge families (Poaceae and Cyperaceae) (Fig 14.7). A smaller proportion showed anatomical features indicating a woody origin, but wood charcoal of the sizes considered here (mostly <100μm) rarely shows distinctive anatomy. Micro-charcoal with insufficient diagnostic anatomical detail to enable identification of the plants represented is classed as 'charcoal undifferentiated', and includes both woody and herbaceous species. Micro-charcoal is shown in relation to the pollen assemblage zones in Figures 14.2, 14.4, and 14.6. At all sites micro-charcoal values were negligible in the deposits predating the pollen sequence.

14.2.3 Parasite eggs

During pollen analysis of samples from Sites B and D the presence of several parasite eggs of the genus *Trichuris* (whipworm) was noted (see Dark 2004a for a preliminary report of these findings, after which additional eggs were discovered at Site B). The eggs are approximately lemon-shaped, with a thick smooth wall and brown in colour (Fig 14.8). Most are well-preserved but lack their polar plugs. Given the importance of size criteria in specific identification of whipworm eggs, the length and width of all eggs were measured (CD 14.5). The eggs range in length from 42.0μm to 49.5μm, and in width from 20.0μm to 25.0μm. The mean length is 45.0μm and width is 22.5μm.

This size range can be compared with measurements of modern eggs of whipworm species infecting humans and other mammals. For example, Beer (1976) states that eggs of the human whipworm, *T. trichiura*, have a mean length without polar plugs of 49.8μm (range 45.3–56.0μm), and width of 25.5μm (range 23.1–28.7μm), while eggs of the whipworm of pigs, *T. suis*, have a mean length of 51.5μm (range 35.1–62.8μm) and width of 30.1μm (range 26.8–34.5μm). Thus, *T. trichiura* eggs are, on average, slightly smaller than those of *T. suis,* but the size ranges overlap. The eggs of *Trichuris* species of other domesticated and wild mammals are generally larger than those of *T. trichiura* and *T. suis*. For example, Thienpoint *et al* (1979) give size ranges of 70–80μm length (with polar plugs) and 30–42μm width for *T. ovis* (which affects ruminants), and 70–90μm length and 32–41μm width for *T. vulpis* (of dogs).

Consideration of the size of the eggs from Goldcliff must take account of the fact that they were found in peat samples that had been treated chemically for pollen analysis and mounted in glycerine jelly. These procedures are known to cause some shrinkage of *Trichuris* eggs. Working on samples from Viking

Age York, Hall *et al* (1983) found that *T. trichiura* eggs untreated and mounted in water had a mean length without polar plugs of 55.3µm (range 48.1–61.6µm) and width of 26.6µm (range 23.1–30.8µm), while those subjected to chemical pollen preparation procedures and mounted in glycerine jelly had a mean length of 41.2µm (range 34.7–47.0µm) and width of 22.1µm (range 17.7–30.0µm). The Goldcliff eggs are similar in size to the treated *T. trichiura* eggs and, even allowing for shrinkage, would seem to be too small to derive from whipworms of dogs or ruminants. These eggs are most likely to come from whipworm of humans, given that they occur on sites with archaeological evidence for human activity, and are directly associated with peaks of charcoal. The possibility that they derive from wild pigs cannot be totally eliminated, given the overlap in size ranges of *T. trichiura* and *T. suis* eggs, and discovery of bones of wild pig at Goldcliff, but it is notable that no pig footprints were found in the banded sediments at Goldcliff East (Chapter 12.3.7).

14.2.4 Macroscopic charcoal

Following removal of samples for pollen and micro-charcoal analysis, parallel series of samples were taken from the monoliths from Sites D, B, and J for analysis of macroscopic charcoal (>250µm). Comparison of the results with the micro-charcoal sequences (Figures 14.2, 14.4, and 14.6) helps to shed light on sources of charcoal reaching the deposits.

The samples were 0.5cm thick and *c* 5cm^3 in volume. After determination of precise sample volume by water displacement, samples were sieved on nested sieves of mesh size 1mm, 500µm and 250µm. The number of charcoal particles in each size class (ie 250–500µm, 500µm–1mm, and >1mm) was counted and expressed as number per unit volume.

During charcoal counting a few fruits and seeds were noted (mainly orache, *Atriplex* sp., seeds from the estuarine silts overlying the peat), but the sample size was too small to provide meaningful quantification of their presence. Bulk samples from the occupation horizon at each site were analysed separately (see below) to provide additional insights into *in situ* vegetation and potentially plant use and seasonality.

14.2.5 Macroscopic plant remains from bulk samples

Samples were water-sieved in the field (Chapter 2.3.4; CD 2.16–2.17). Initial sorting of the sieved residues was undertaken by Deborah Tills, and plant remains other than wood charcoal (which was given to Rowena Gale, below) and hazelnuts passed to the author for identification. Seeds and other identifiable plant remains were picked from the samples and identified using a Leica MZ12 stereomicroscope at a magnification of ×8 to ×100. Identification was aided by reference to Berggren (1969; 1981), Anderberg (1994) and Schoch *et al* (1988) and modern reference material. The occurrence of macroscopic plant remains at each site by context is summarised in CD 14.6. There were also large numbers of fungal sclerotia but these are not listed.

14.2.6 Radiocarbon dating

Samples for radiocarbon dating from the monolith sequences comprised thin slices of peat, or remains of reed (*Phragmites australis*) or charcoal picked from the peat from selected horizons from each sequence. In addition, samples of charred hazelnuts retrieved during excavation were analysed from the occupation horizons at Sites A and B. Samples were dated by the Oxford University Radiocarbon Accelerator Unit, and the results are fully reported in Table 8.2.

14.3 Factors involved in interpretation of the sequences

14.3.1 Sedimentary context

The sequences comprise a series of sedimentary contexts, beginning with a mineral soil (the original Mesolithic land surface), overlain by estuarine silts and then peat (Site D), or directly by peat (Sites B, J), overlain in turn (at sites low in the tidal frame) by estuarine silts. The mineral soil formed in oxidising conditions, explaining the scarcity and poor preservation of pollen throughout most of its depth. At Sites B and J pollen abundance increases in the upper part of the mineral soil/occupation horizon, presumably as a result of the rising water table that eventually led to peat formation. At neither site is there evidence for a significant break in accumulation of pollen between the upper part of the mineral soil and the base of the peat. At Site D there seems to have been a phase of estuarine sediment deposition on the surface of the mineral soil before peat formation began. Pollen is sparse in all but the uppermost part of these silts, suggesting that there may have been a period in which they dried out before the water table rose again and peat formation began.

Differential pollen preservation can be a problem in analysis of minerogenic deposits where a substantial proportion of the assemblage shows signs of deterioration, as in the lower horizons of the Mesolithic soil here. Pollen counts are not presented from these horizons due to the likelihood of bias towards more resistant pollen grains, such as pine (*Pinus*), and fern spores. The estuarine silts also contain a relatively high proportion of deteriorated and therefore unidentifiable grains, reaching a maximum of *c* 15% at Site D. Pollen in estuarine silts comes from a wide variety of sources, and a substantial proportion of the pollen in the water

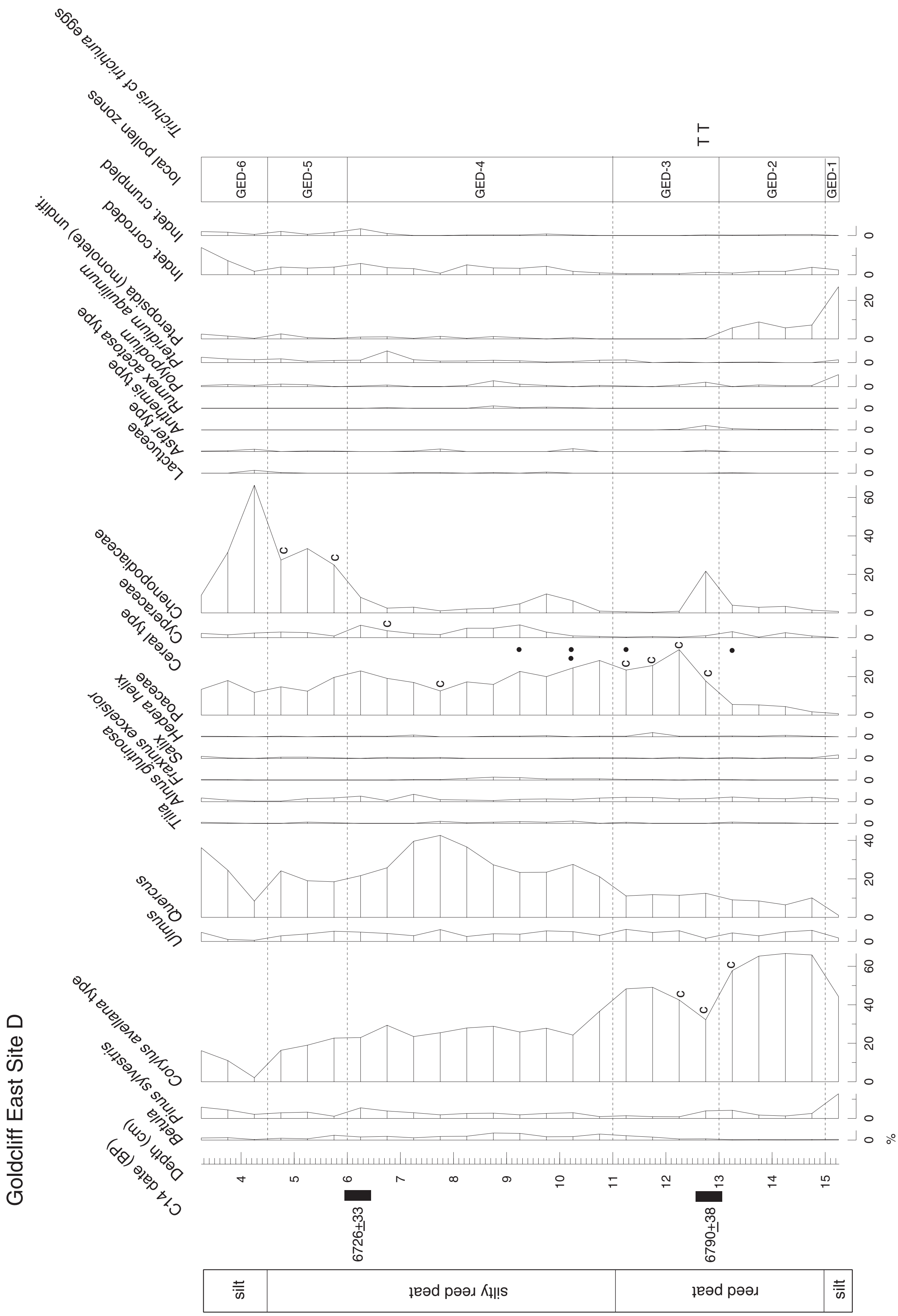


Figure 14.1 Goldcliff East, Site D (Monolith 4071): pollen percentage diagram showing all taxa comprising ≥1% of the pollen sum (see text) *and* Trichuris *eggs. C = pollen clump* (*graphic P Dark*)

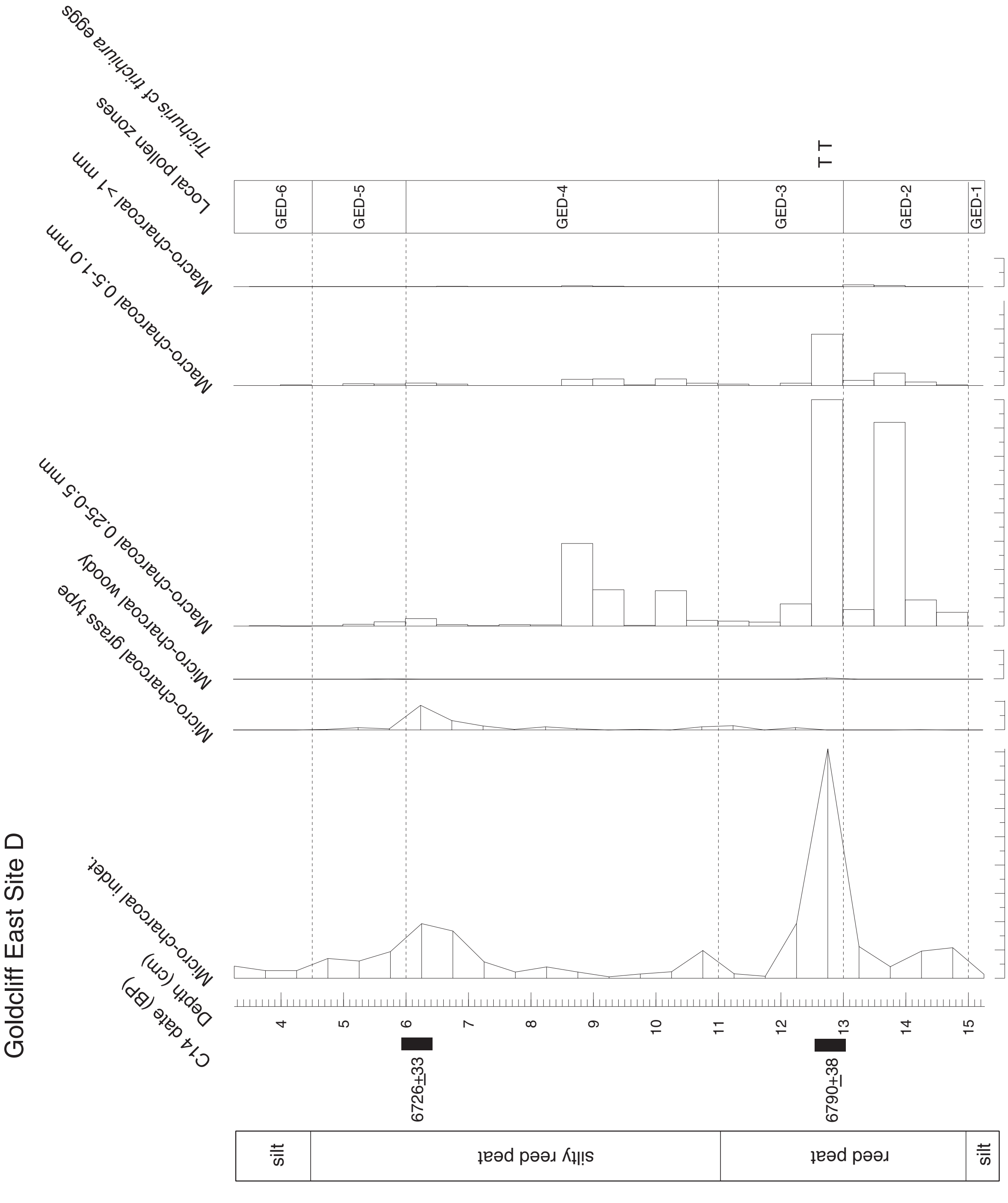


Figure 14.2 Goldcliff East, Site D (Monolith 4071): charcoal diagram (graphic P Dark)

body may have remained there in suspension for many years, or have been reworked from earlier deposits, before deposition (Dark and Allen 2005). At Sites B and D, thin laminae of silt appear in the upper part of the Lower Peat, indicating episodes of marine flooding prior to inundation of the sites. Furthermore, the consistent presence of Foraminifera test linings in all pollen samples analysed from Sites B and D suggests that both sites were at least occasionally inundated before deposition of visible silt laminae began. This flooding will have introduced pollen from the estuarine water body onto the site, and probably explains the increased proportion of corroded pollen as the silt content of the peat increased at Site D.

14.3.2 Temporal resolution

The thin basal peat seems to have accumulated over a short period of time, perhaps a century on the basis of radiocarbon dates from Site D, but the limited number of radiocarbon dates means that estimates of the temporal resolution of the sequences can only be very approximate. The Site D pollen sequence, comprising contiguous samples 0.5cm thick, probably has a resolution of approximately two samples/decade, ie each sample represents approximately five years, with a similar resolution at Site B. At Site J, establishing a chronology is more problematic because much of the sequence is from the former soil, dated by two wooden artefacts with closely similar dates between 4940–4710 cal BC (Table 8.2). In the nearby Pit J sequence (Chapter 15), peat formation began some 700 years earlier than at Site J, so the radiocarbon-dated pollen sequence from Pit J overlaps with the Mesolithic soil analysed here. Unfortunately, however, it is not possible to use the Pit J sequence to estimate a chronology for the Mesolithic soil sequence because the radiocarbon dates from Pit J suggest a very variable accumulation rate for the wood peat. Also, the pollen assemblages during the alder carr phase are so dominated by local pollen deposition that the more regional pollen signal that might otherwise be used to compare the sequences is obscured.

14.3.3 Pollen source areas

The predominant sources of pollen to the deposits will have varied as the depositional context changed, but at all stages *in situ* vegetation probably contributed much of the pollen to the assemblages. Evidence for the taxa involved occurs in the form of pollen clumps (of 2–25 grains), which are likely to have fallen directly from the parent plant. At Site D, three consecutive samples in the Lower Peat contain small clumps of hazel pollen, suggesting that the tree grew close to the site. Several samples from the reed peat also contain clumps of Poaceae pollen, presumably derived from the wetland grasses. Wetland grasses are also the likely source of the cereal-type pollen at Site D. These pollen grains first appear in the upper part of the reed peat, dating from *c* 5750 cal BC, and continue after the site becomes subject to periodic marine inundation. Notwithstanding this early date, the absence of cereal-type pollen from Sites B and J, closer to the dry land where any cereal cultivation must surely have taken place, strongly implies that this pollen is from wetland grasses.

The marked rise of the Chenopodiaceae curve towards the top of the Site D sequence is accompanied not only by pollen clumps, but also orache nutlets, again attesting to the local origin of the pollen from encroaching saltmarsh. Similarly, at Site B, the presence of clumps of Chenopodiaceae pollen coincides with substantial peaks in pollen abundance indicating local saltmarsh. The retreat of the woodland edge at Sites B and D as wetland communities spread in response to rising sea levels would have created a more open environment around the sampling sites, increasing the proportion of pollen reaching the sites from vegetation on higher ground.

At Site J clumps of up to 25 alder (*Alnus glutinosa*) pollen grains occur in several samples from the Upper Peat, which is rich in woody remains of alder (Fig 6.2) and clearly reflects *in situ* alder carr. As noted above, once alder colonises the sampling site it completely dominates the pollen signal to the extent that other plant communities, even within a few metres of the carr edge, are scarcely represented.

14.3.4 Charcoal source areas

As with pollen, micro-charcoal source areas vary depending on the depositional context. Charcoal occurs in variable quantities in the Mesolithic soil and Lower Peat, and could reflect local vegetation and surface plant litter fires (Scott *et al* 2000), hearths, or particles blown in from elsewhere. The smaller quantities of charcoal in the estuarine silts might have blown in from fires on adjacent areas of dry land, or represent material reworked from earlier deposits or held in suspension in the estuarine water body (Dark and Allen 2005). Analysis of micro- and macro-charcoal from parallel sets of samples provides the opportunity to attempt to distinguish between the different sources, based on the assumption that macro-charcoal is most likely to represent *in situ* burning (especially given the crisp appearance of most fragments, suggesting that it has not been reworked).

The micro- and macro-charcoal curves from Sites D, B, and J are compared in Figures 14.2, 14.4, and 14.6 respectively. At Site B there is a fairly close correspondence between micro- and macro-charcoal peaks. At Site J the overall distributions of micro- and macro-charcoal through the sequence are similar, although micro-charcoal continues into the base of the wood peat, which contains virtually no

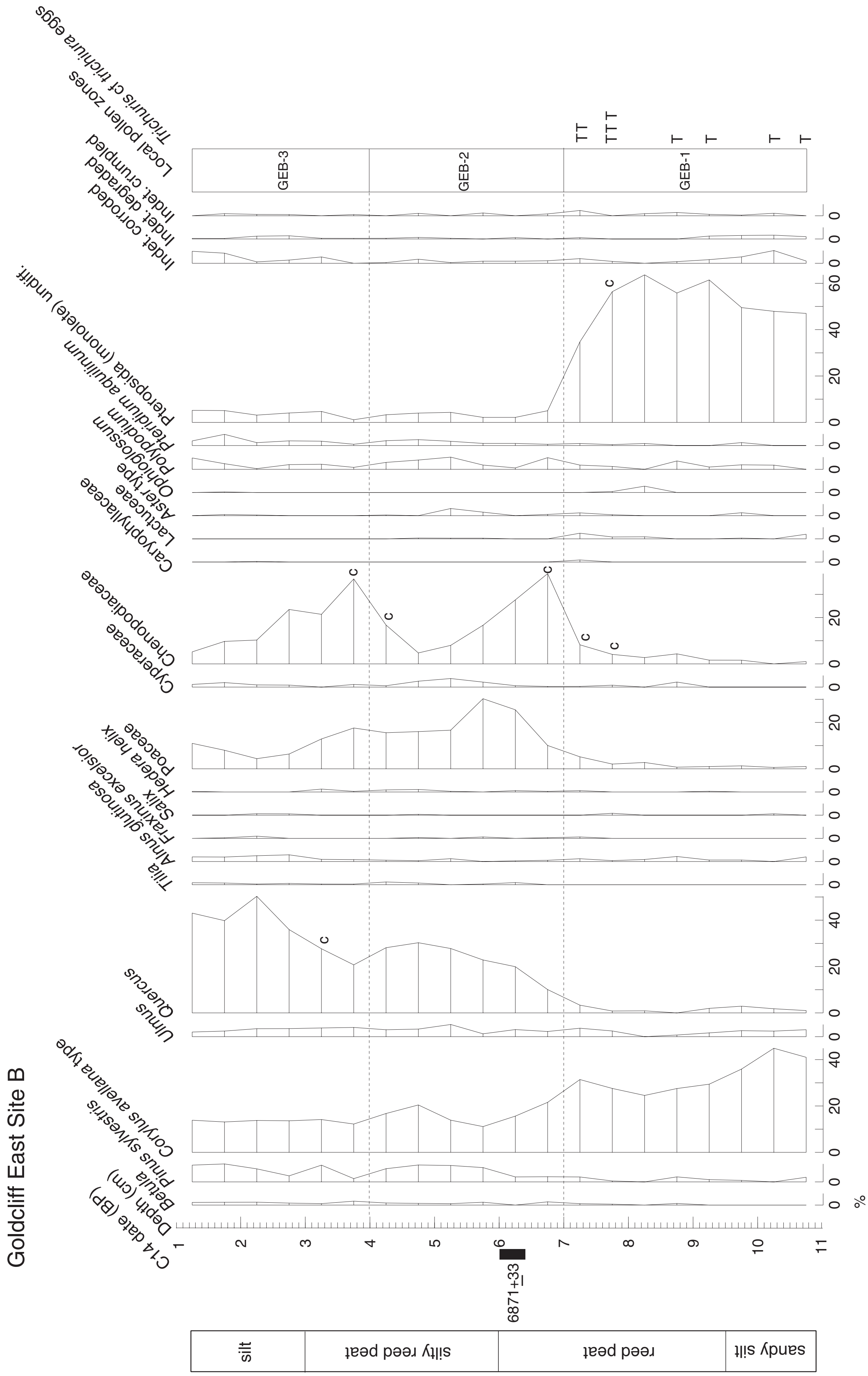


Figure 14.3 Goldcliff East, Site B (Monolith 4070): pollen percentage diagram showing all taxa comprising ≥1% of the pollen sum (see text) and Trichuris *eggs. C = pollen clump (graphic P Dark)*

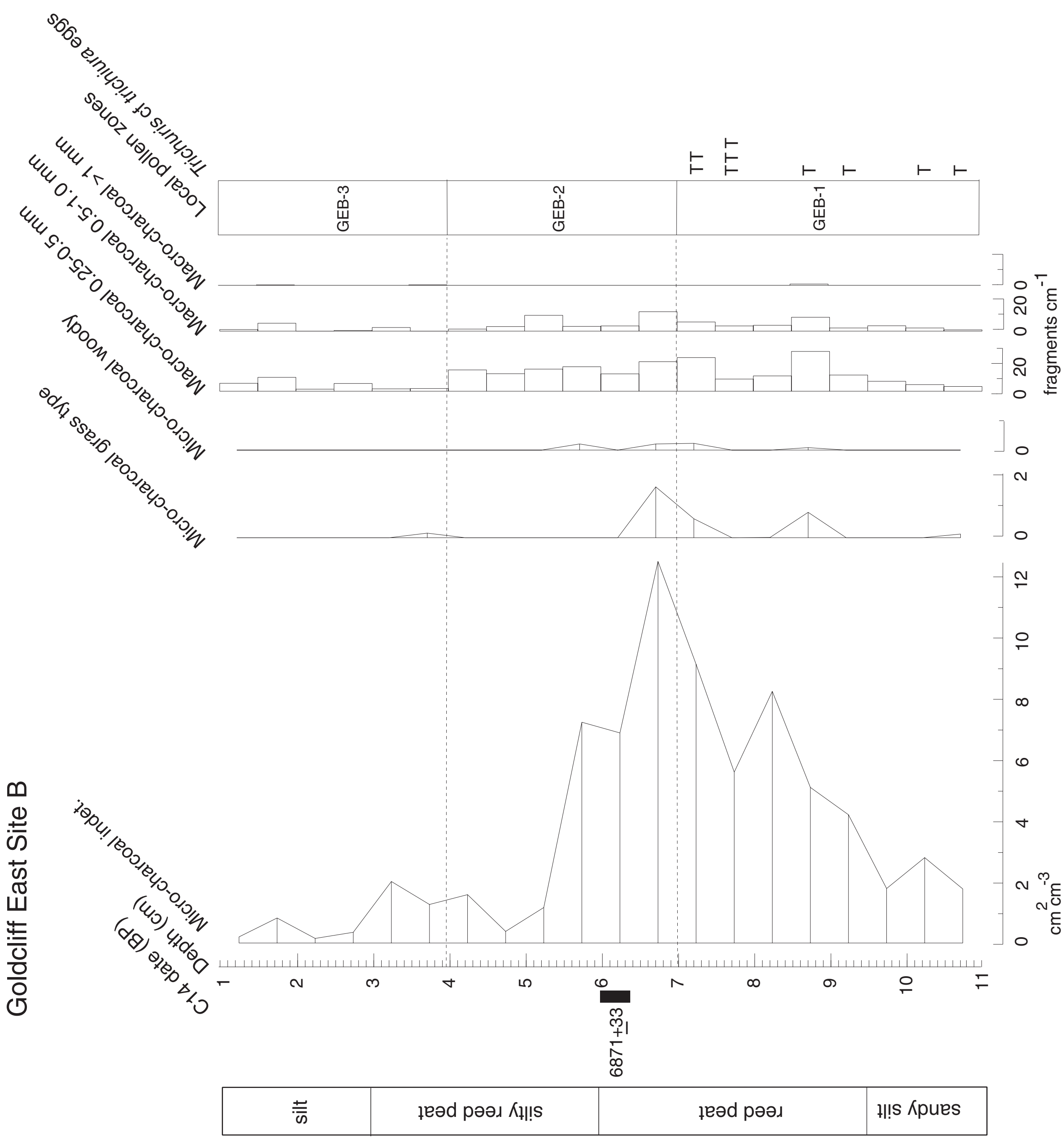


Figure 14.4 Goldcliff East, Site B (Monolith 4070): charcoal diagram (graphic P Dark)

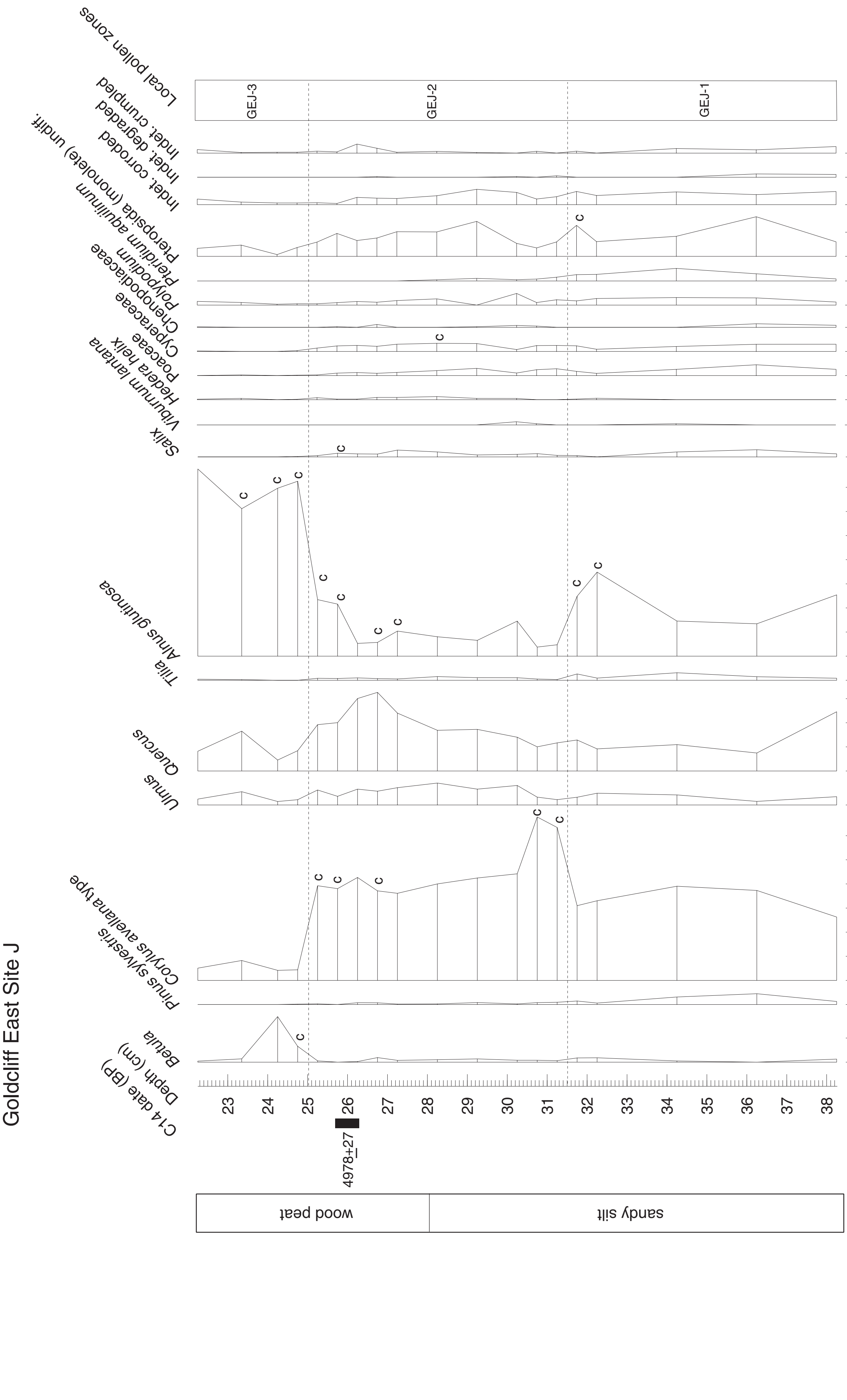


Figure 14.5 Goldcliff East, Site J (Monolith 5640): pollen percentage diagram showing all taxa comprising ≥1% of the pollen sum (see text) and Trichuris *eggs. C = pollen clump (graphic P Dark)*

macro-charcoal. At Site D the main micro-charcoal peak corresponds with the largest macro-charcoal peak, but there is an earlier macro-charcoal peak that lacks a corresponding peak of micro-charcoal. A period of relatively high macro-charcoal values in the middle of the sequence also lacks a corresponding micro-charcoal peak. These differences may reflect the fact that while smaller particles are likely to distribute evenly as a charcoal 'rain' across the peat surface, larger particles will fall with a more patchy distribution. Furthermore, different plants tend to produce charcoal of different size ranges: for example, wood charcoal fragments will cover a wider range of sizes than those from reeds, so *in situ* fires may produce varying charcoal 'signals' depending on the vegetation composition. As all of the micro-charcoal peaks at all three sites correspond with the presence of macro-charcoal, it is likely that much of the micro-charcoal in these sequences reflects local burning, of standing vegetation, plant litter, or hearths (cf Dark 1998).

There are considerable differences in overall charcoal abundance between the three sites, as well as between different types of deposit at each site. Starting with the earliest deposits, the Mesolithic soil contains virtually no charcoal at Site D but moderate quantities of micro- and macro-charcoal at Sites B and J. This is in accordance with the artefactual evidence for human activity on the Old Land Surface at the latter two sites but not at Site D. The greatest abundance of charcoal, however, occurs in the Lower Peat, with the highest values for micro-charcoal at Site B but the greatest peaks of macro-charcoal at Site D. The abundance of charcoal seems surprising given that artefacts were rare in the Lower Peat, suggesting that vegetation may have been burned at these sites by people whose principal foci of activity were on higher ground. This possibility is considered further later in the light of changes in the pollen curves.

In the Upper Peat at Site J macro-charcoal was virtually absent and micro-charcoal confined to the basal 3cm, prior to the local expansion of alder carr. This suggests an absence of local fires during formation of the Upper Peat, but more distant burning is possible, at least initially.

14.3.5 Sources of macroscopic plant remains

Macroscopic plant remains from the occupation horizons are particularly valuable in providing possible evidence for human plant collection and use, although not all concentrations of seeds/fruits need be anthropogenic. At Site J small caches of uncharred hazelnuts were a frequent find, probably left by squirrels, and some hazelnuts showed signs of gnawing by small mammals such as voles (Chapter 15.4.1). At Site A, however, hazelnuts were represented mainly by charred shell fragments. These almost certainly reflect human consumption of the kernels and discard of the shells into hearths. Charred fruit stones, such as sloe (*Prunus spinosa*), probably also indicate human consumption.

Elder (*Sambucus nigra*) seeds were also abundant at Site A, but very few were charred. These could similarly reflect food remains (purposeful discard of the seeds into a fire perhaps being less likely as their small size means they would not add significant fuel). Alternatively they may reflect natural accumulations fallen from trees growing at the woodland edge, given the great profusion of berries produced by a single elder tree, or deposited by birds.

Other fruits/seeds in the occupation horizons, especially those of wetland plants such as sedges (Cyperaceae), may reflect direct deposition from *in situ* vegetation, wind transport, plant material collected as fuel, or for some other purpose. In some instances, such as the nutlets of orache and fruits of goosegrass (*Galium* cf *aparine*), it is unclear whether the propagules were collected deliberately. Orache would have formed a component of the local saltmarsh communities, and could well have reached Site B (the only occupation horizon in which it is recorded) naturally, but the seeds and leaves also provide a potential food source. The hooked fruits of goosegrass (mostly from Site A) could have been transported to the site attached to animal hides and removed during hide working, or the plant may have had a culinary or medicinal use (see later). Charring is not itself proof of human use, as the plant may have been charred during natural or anthropogenic vegetation fires.

14.4 Interpretation

14.4.1 Site D

The pollen sequence at Site D (Fig 14.1) begins in the top of the silts overlying the Mesolithic soil. Below this level pollen was sparse and poorly preserved, macroscopic plant remains were confined to a few orache nutlets, and charcoal was barely present. The lack of significant quantities of charcoal, combined with scant artefactual evidence, suggests that there was little human activity at this site prior to the period of peat formation.

On the basis of the radiocarbon date of 6790±38 BP (OxA-12359; 5740–5630 cal BC) from 2cm above the base of the peat, peat formation is estimated to have begun *c* 5800 cal BC. The remains of oaks in the peat, including one immediately next to the pollen monolith, suggest that the Mesolithic soil supported oak woodland prior to the phase of marine inundation that led to deposition of the silts. This inundation presumably killed the oaks and led to local growth of saltmarsh, which was replaced by open reedswamp (attested also by insect remains: see Chapter 16.4) as the frequency of inundation declined. At least sporadic marine flooding throughout the sequence is suggested by the consistent presence of Foraminifera test linings in every pollen sample.

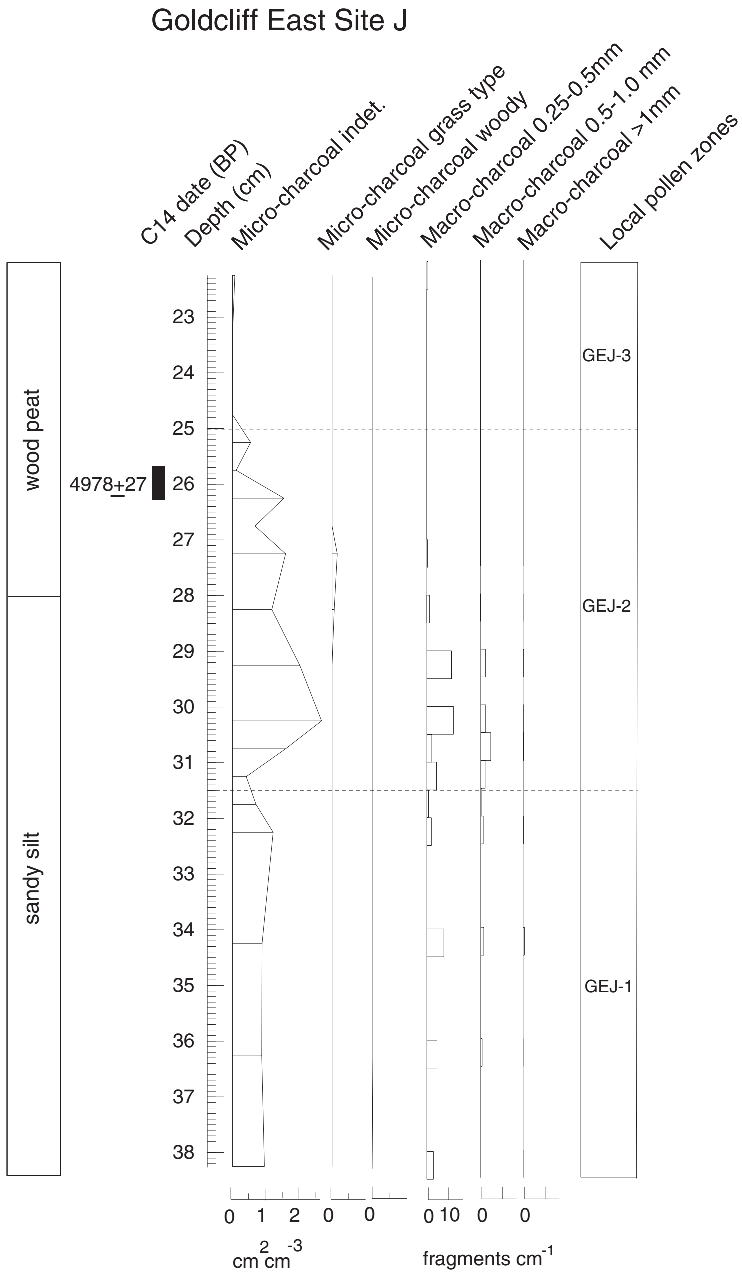


Figure 14.6 Goldcliff East, Site J (Monolith 5640): charcoal diagram (graphic P Dark)

During the reedswamp phase the adjacent dry land supported hazel woodland with a ground layer of ferns, and also some oak and elm (*Ulmus*). The abundant charcoal in this part of the sequence might represent burning of the local wetland vegetation, adjacent woodland, and/or a hearth, but the small size of the macro-charcoal (almost all <1mm) makes a hearth unlikely. A large peak of both micro- and macro-charcoal at 12.75cm (5740–5630 cal BC) coincides with a substantial decline of hazel, raising the possibility of burning of the local woodland edge.

A notable feature of the pollen sequence from the basal part of the peat is that it contains surprisingly little Poaceae pollen, given that the deposits comprise the remains of reeds (which produce abundant wind-dispersed pollen). This period of low Poaceae values coincides with the part of the sequence with the most abundant charcoal, but is followed by a five-fold increase of Poaceae values as charcoal drops after its 12.75cm peak. A possible explanation for this pattern is that the local reeds were consistently burned before flowering (in August–September), and that the increase of Poaceae pollen reflects a return to flowering once this practice ceased. Reeds may have been burned accidentally as a by-product of firing of the woodland edge, or as a deliberate

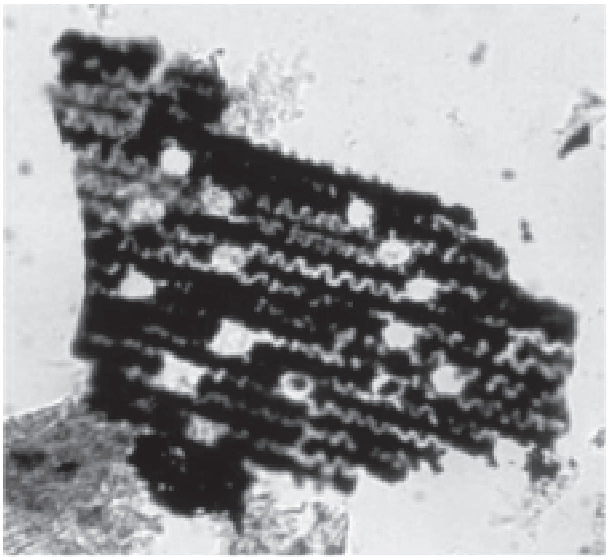


*Figure 14.7 Micro-charcoal particle from Goldcliff East Site D (6.25cm), photographed at a magnification of ×400. Several epidermal cells are present with sinuous outlines resembling those of the reed (*Phragmites australis*) (photo P Dark)*

management strategy similar to that which appears to have been employed at the early Mesolithic site of Star Carr (Mellars and Dark 1998). At this point in the sequence two whipworm eggs occur, providing further indications that the site received at least brief human visits.

Hazel recovers after this phase of burning, but declines again coinciding with the next, smaller, charcoal peak (10.75cm), and appearance of silt laminae reflecting increased marine flooding. At this point oak pollen percentages increase, perhaps reflecting encroachment of oak woodland onto areas of dry land formerly dominated by hazel. Tree remains of this date are absent from the Lower Submerged Forest, however, raising the possibility that the increase in oak pollen is an artefact of the replacement of areas of local hazel woodland by reedswamp and saltmarsh communities as the water table rose. The more open conditions would allow an increased proportion of pollen to reach the site from oak woodland growing on dry land, which was some 100m to the west and perhaps *c* 80m distance to the south at this time.

A peak of macro-charcoal at 8.75cm coincides with a minor decline of grass pollen, while a later peak of micro-charcoal at 6.25–6.75cm (with a significant component of grass type – Fig 14.7) coincides with an increase of grasses and decline of oak. It is difficult to ascertain whether changes in vegetation at this point are reflecting responses to burning or increased frequency of marine inundation.

At 6726±33 BP (OxA-12358, 5720–5560 cal BC) saltmarsh began to encroach across the site, indicated by a dramatic increase in Chenopodiaceae pollen and the presence of orache nutlets. Shortly after this peat formation ceased and accumulation of pure silts began, reflecting marine transgression.

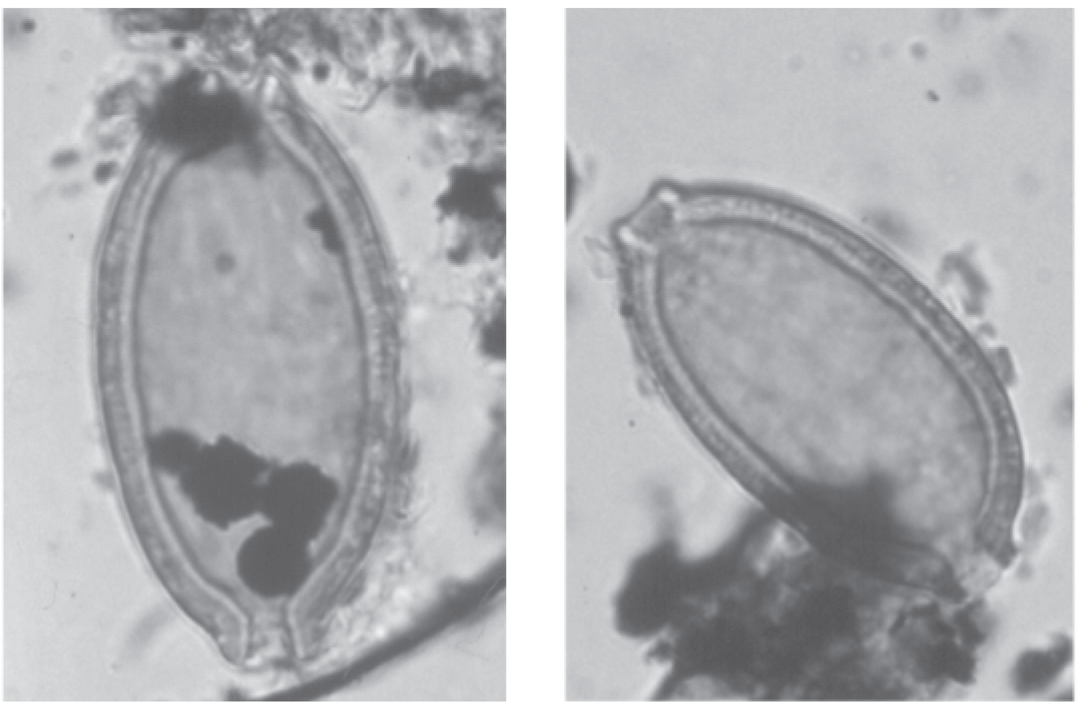


*Figure 14.8 Whipworm (*Trichuris cf trichiura*) eggs from Goldcliff East, Site D: lengths (left) 47.5µm and (right) 42.0µm. Black particles are pyrite formed in association with bacterial activity in the presence of organic material under reducing conditions (photo P Dark)*

14.4.2 Site B

At Site B the pollen sequence begins in the upper 1.5cm of the Mesolithic soil. Below this pollen was sparse and poorly preserved, and micro-charcoal rare. The Mesolithic soil did contain a few charred hazelnuts, one of which was dated to 7002±35 BP (OxA-13927; 5990–5790 cal BC), a few other seeds, most probably from local wetland vegetation, and some wood charcoal (see below section 14.8). The Mesolithic soil supported hazel woodland with a ground layer of ferns, remaining the dominant woodland nearby as the water table rose and peat formation began. As at Site D, occasional flooding of the site throughout the sequence is suggested by the presence of Foraminifera test linings in every pollen sample analysed.

Despite the spread of reedswamp across the site, local human activity is suggested by the abundance of charcoal, which is especially high in the basal peat. Human activity is also indicated by the presence of whipworm eggs in the soil surface and basal peat. This corresponds with the excavated evidence that artefacts extended from the mineral soil into the peat (Chapter 3.3). The charcoal comprises a mixture of woody and grass-type fragments, and could originate from a nearby hearth, as there is a concentration of calcined animal bone 3.5m from the sampling site (Fig 3.3). As at Site D, however, there is a similar relationship between the presence of reed peat and low Poaceae pollen values during the phase of high micro-charcoal values, followed by an increase of Poaceae as charcoal declines. Burning of reedswamp again seems likely, perhaps accompanied by burning of hazel at the woodland edge, probably representing the same phase of burning as at Site D.

Shortly before 6871±33 BP (OxA-12357; 5840–5670 cal BC) hazel declines and there is an increase of Poaceae and Chenopodiaceae, followed by the appearance of silt laminae in the peat. These changes reflect an increased frequency of marine inundation of the site, leading to the retreat of local hazel woodland and its replacement by wetland communities. As at Site D, the increase of oak pollen may result from the creation of more open conditions locally allowing oak pollen from woodland on dryland to reach the sampling site. Evidence for burning declines in this phase, and whipworm eggs are absent, suggesting that people made less use of the immediate area.

14.4.3 Site A

The lack of peat formation and poor pollen preservation at this site suggests a relatively low water table compared to the other sites prior to marine inundation. The abundant elder seeds (which are highly resistant to decay) and charred and uncharred hazelnuts in the occupation horizon probably reflect a combination of deliberate collection and natural accumulation from trees growing close to the site. The date of 6629±38 BP (OxA-13928; 5622–5482 cal BC) for a charred hazelnut suggests survival of hazel woodland in the area after its retreat from Sites B and D, although the nuts need not necessarily have been collected in the immediate surroundings of the site.

14.4.4 Site J

At Site J the soil surface is overlain by the Upper Peat, which at the site of Monolith 5640 (1.43m OD) began to accumulate shortly before 3800 cal BC, but in the base of Pit J (0.99m OD), just 7.2m to the north-east, began to form from *c* 4500 cal BC following a period of estuarine silt deposition (Chapter 15). Elsewhere at Goldcliff the base of the Upper Peat has been dated from *c* 5000 cal BC (CD 7.3; Smith and Morgan 1989; Caseldine 2000).

At Site J pollen is preserved through a greater depth of the minerogenic occupation horizon than at the other sites, but again concentrations decrease substantially down the profile. The unusually good level of preservation in the Mesolithic Old Land Surface at this site is also attested by the presence of leaves of deciduous trees (CD 14.11) and waterlogged wooden artefacts (Chapter 10) revealed during excavation. An example of the latter is Object 9199, at a similar OD height 3m from the sample monolith, which shows that conditions suitable for organic preservation may have obtained since the date of this object, 5934±39 BP (OxA-15549; 4940–4710 cal BC).

The macroscopic plant remains from the soil horizon comprise a mixture of charred and uncharred hazelnuts, a few elder seeds, and a single whole charred elderberry. These again probably reflect a combination of food debris and natural accumulations. Most of the remaining seeds are of wetland plants. In contrast to Sites B and D, Foraminifera test linings are absent from pollen samples from this site, suggesting that the sampling site was above the maximum reach of marine inundation (as comparison of Figs 6.3 and 6.5 confirms).

The basal half of the minerogenic horizon corresponds with a period in which alder carr occurred on adjacent wetland areas, including the site of Pit J (Chapter 15), with hazel woodland on the site itself. Towards the top of the soil the extent of alder woodland declined, perhaps as former waterlogged areas nearby dried out and were colonised by hazel. Oak then began to increase and continued to do so after *in situ* peat formation began, declining only when the site became colonised by dense stands of alder. The switch to alder carr occurred remarkably rapidly, beginning at 4978±27 BP (OxA-14023; 3910–3660 cal BC) and producing a dense canopy beneath which herbs and even ferns were sparse.

The question arises as to whether the Neolithic elm decline can be recognised in the sequence.

Elm does decline shortly after the horizon dated 4978±27 BP (OxA-14023; 3910–3660 cal BC), as alder becomes dominant locally. Unfortunately it is impossible to say whether this represents a general decline of elm on dry land because of the extent to which alder dominates the local pollen signal, and the likely effect of the dense alder carr in filtering out pollen from more distant sources. There is no accompanying evidence for human activity from the pollen record – neither cereal-type pollen nor ribwort plantain (*Plantago lanceolata*) are present – and charcoal declines at this point. This problem is apparent also in Pit J, where a very similar decline of elm accompanies the first major expansion of alder at *c* 4500 cal BC, a date too early to represent the Neolithic elm decline. The later decline of elm at 5213±23 BP (OxA-13520; 4045–3965 cal BC) in Pit J might represent the classic elm decline, but it also coincides with a substantial increase of alder and is earlier that the date of the elm decline at other sites at Goldcliff.

Smith and Morgan (1989) identified the end of the elm decline as occurring at 5020±80 BP (CAR-652; 3970–3650 cal BC) in their Site 1 sequence (730m north-east of Site J), immediately preceding the onset of raised bog growth. This is consistent with Caseldine's identification of the elm decline shortly before 4900±60 BP (CAR-1500; 3910–3520 cal BC) in her Pit 15 monolith, west of Goldcliff island (Caseldine 2000), where it again coincides with the switch to raised bog conditions. The greater clarity of the elm decline at these sites, where it occurs after the replacement of alder carr by open mire conditions, is presumably attributable to the major expansion of the pollen source area brought about by this change (discussed further later).

Micro- and macro-charcoal are less abundant in the Site J sequence than at Site B. The highest values occur in the upper part of the Mesolithic soil, immediately after the large hazel peak, and may reflect burning of local hazel woodland. Use of hazel wood as fuel is another possibility, however, as the assemblage of wood charcoal from the site is dominated by hazel (below, section 14.8), and the presence of heat-fractured quartzite and burnt aurochs bones at the site may represent a hearth (Chapter 6). Charcoal virtually disappears once the site becomes dominated by alder carr, suggesting that people abandoned the site at this time, as the near absence of artefacts in the peat confirms (Chapters 6 and 7).

14.5 Discussion

14.5.1 Environmental context of later Mesolithic human activity and plant food availability

The palaeoecological sequences examined here provide relatively brief 'snapshots' of coastal environments occupied by later Mesolithic peoples from *c* 5800 to 5600 cal BC and for perhaps a few centuries prior to 3800 cal BC, and can provide insights into why these localities may have been visited. The pollen evidence relates most closely to the wetland edge environment, with development of extensive reedbeds fringed by hazel and/or alder woodland, with a densely wooded landscape of oak, elm, and lime (*Tilia*) inland.

Less evident from the pollen assemblages, but clearly attested from the macroscopic plant remains, is the abundance of potential food plants within this environment. Hazelnuts appear to have been a significant food source, as at many Mesolithic sites in Europe (eg Kubiak-Martens 1999; Mithen *et al* 2001, and see reviews by Zvelebil 1994 and McComb and Simpson 1995). Elder (*Sambucus nigra*) probably grew in abundance at the woodland edge and provided a major source of berries. Other soft fruits from shrubs growing at the woodland edge probably included raspberries (*Rubus idaeus*), sloes (*Prunus spinosa*), and dogwood (*Cornus sanguinea*).

Wetland plants may have provided additional sources of food, especially the local reedbeds. Clark (1972) and Kubiak-Martens (1999) have discussed the use of reed (*Phragmites australis*) rhizomes and stems as a source of starch (see also the review of potential uses of reed by Law 1998), and the presence of numerous charred reed stem fragments at the late Mesolithic/Ertebølle settlement at Tybrind Vig, Denmark, has been suggested as possibly indicative of gathering of reeds for some purpose (Kubiak-Martens 1999). The charred and uncharred nutlets of orache (*Atriplex* sp) from Goldcliff Site B may reflect use of this plant as a food resource also. The seeds are themselves edible, and a frequent find on late Mesolithic coastal sites in Europe (eg Kubiak-Martens 1999; Robinson and Harild 2002), but the leafy parts also provide a source of greens.

The charred fruits of goosegrass (*Galium* cf *aparine*) are more enigmatic, as they would seem unlikely to reflect use of the plant, which is covered in small prickles, for food. However, boiling removes the prickles and the plant can then be eaten (Mabey 1972; Duke 1992). Consumption as a vegetable would be most likely before the seeds mature and the plant dries out, but the seeds themselves can apparently be roasted and used like coffee. Medicinal use is also a possibility, as the plant apparently has diuretic properties. Charred goosegrass fruits were also among the commonest macroscopic plant remains from the late Mesolithic/Ertebølle site at Halsskov on Zealand, Denmark (Robinson and Harild 2002), suggesting deliberate collection.

In addition to the variety and abundance of plant foods, the attraction of the woodland edge and wetland setting to animals would have provided an additional reason for humans to congregate here, and perhaps to attempt to manipulate the environment.

14.5.2 Use of fire

Charcoal is abundant in the Lower Peat at Goldcliff, much of it apparently attributable to burning of local vegetation. Comparison of the pollen and charcoal data suggests that burning of reedswamp and hazel woodland may have occurred. Whether these fires represent accidental spread from hearths or a deliberate strategy is difficult to say. Apparently deliberate burning of reedbeds has previously been identified at the early Mesolithic site of Star Carr, in an inland lake-side context (Mellars and Dark 1998), where it may have been used to improve the quality of reed growth at specific points around the lake to attract animals and so aid hunting (Mellars 1976). A similar explanation is possible at Goldcliff, especially in view of the evidence from footprints that large herbivores such as red deer and occasional aurochsen frequented the area.

The apparent burning of hazel woodland may reflect accidental firing of trees at the edge of the reedswamp, or again a deliberate strategy. It has long been argued that fire may have played a role in the abundance of hazel in the Mesolithic, perhaps being used to increase the production of hazelnuts as a source of food (A G Smith 1970). However, comparison of 'off-site' pollen sequences and micro-charcoal data has often failed to demonstrate a link (eg Clark *et al* 1989; Bennett *et al* 1990; Day 1996; Simmons 1996, 140), suggesting that large-scale burning of hazel woodland is unlikely. This does not, however, eliminate the possibility that fire was used on a more local scale to manage stands of hazel woodland close to foci of Mesolithic human activity. Simmons (1996, 139) suggests that a suitable place to seek such activity would be ecotones, and the sites at Goldcliff occur in just such a situation, at the transition from woodland to wetland communities.

14.5.3 Seasonality

The preservation by charring of a wide range of plant remains at Goldcliff presents the opportunity to examine the question of whether the sites were visited at particular times of year. If reed burning at Sites D and B has been correctly interpreted as preventing flowering, then it must have occurred shortly before or during the flowering season in late summer/early autumn (August–September). Other indications of seasonality are provided from the fruits and seeds brought to the sites and/or clearly utilised by people (but only securely if they are unlikely to have been stored), or plant remains accidentally charred by anthropogenic fire (Dark 2004b). The charred remains of hazelnuts from Sites A, B, and J probably represent food collected in early autumn (September–October), but their potential for storage means that they need not have been eaten at this time.

Charred remains of soft fruits are more useful seasonality indicators, as they are likely to have been eaten fresh soon after collection. The most abundant remains of soft fruits were of elder (*Sambucus nigra*) (which fruits August–September), comprising several hundred uncharred seeds, four charred seeds and a charred whole berry. Other charred soft fruit remains present (Site A) were a sloe (*Prunus spinosa*) stone, available at the same time of year, and two stones resembling dogwood (*Cornus sanguinea*), which fruits in September.

Nutlets of the Chenopodiaceae family (*Atriplex* and *Chenopodium*) are produced from August to October and may have been accidentally charred during burning of wetland vegetation, or collected as a food source. The fruits of sedges (including *Cladium mariscus* and *Carex* spp.) and alder (*Alnus glutinosa*) were almost certainly charred during vegetation fires or in hearths, and again point to activity in summer/early autumn. Goosegrass (*Galium aparine*) fruits ripen from June to August, so could have been charred earlier in the summer than most of the other plant remains.

Other evidence from Goldcliff East points to summer activity, including the occurrence of human footprints in fine-grained parts of the banded silts (Chapter 12), shown by textural and pollen analyses to have been deposited in summer (Allen 2004; Dark and Allen 2005). At Goldcliff West the Mesolithic site produced a range of waterlogged plant materials (Caseldine 2000, CD 13.24) but fewer charred seeds: a fragment of hazelnut, a seed of greater plantain (*Plantago major*), two species of rush (*Juncus* sp. and *Bolboschoenus maritimus*), and two grass (Poaceae) caryopses (Caseldine 2000). These again suggest at least some burning in late summer, although the faunal evidence from the site pointed towards activity in winter (Barton and Bell 2000).

14.5.4 Spatial variability in human activity

The botanical and associated analyses provide some insights into spatial variation in later Mesolithic human activity at Goldcliff, in relation to different environments at the wetland-dryland interface. Sites J and A, highest in the tidal frame, were clearly foci for human activity, the litter of charred hazelnut fragments and remains of other probable food plants in the Old Land Surface at both sites suggesting periods of activity long enough to involve use of a hearth and food consumption. Conversely, human activity at Sites B and D was more sporadic in character, and appears largely to have involved use of fire to manipulate the reedswamp and woodland edge plant communities. The occurrence of whipworm eggs at both of these sites suggests that the local area was also used as a defecation area, in contrast to Site J, where whipworm eggs are lacking (poor preservation at Site A prevents an assessment of the occurrence of parasite eggs at this site). Given that Sites B and D both seem to have been subject to occasional marine flooding (on the basis of continuous presence of Foraminifera test linings) during the periods of burning, the lack of more prolonged visits is unsurprising.

14.5.5 Human activity in the early Neolithic period?

At Site J the pollen sequence extends into the early Neolithic period, providing the opportunity to assess whether there was continuity of human activity from the later Mesolithic period. Archaeological evidence for local Neolithic human activity is lacking, but Smith and Morgan (1989) and Caseldine (2000) have argued for woodland clearance at the time of the elm decline on the basis of their pollen sequences east and west of Goldcliff island respectively. Given that the nearest area of dry land other than the island was some 6km away, this raises questions about the apparent discrepancy between the archaeological and palaeoecological evidence for human activity at this time.

At Smith and Morgan's Site 1, the end of the elm decline is dated 5020±80 BP (CAR-652; 3970–3650 cal BC), and occurs immediately before the shift from reed peat to *Sphagnum* peat. Smith and Morgan argue that the elm decline represents the first of a series of phases representing a clearance episode lasting *c* 250 years, followed by woodland regeneration, comparable to examples from the Irish Neolithic (Pilcher *et al* 1971). The identification and characterisation of these phases can be questioned on several grounds, however. In terms of chronology, Smith and Morgan's timescale is based on four radiocarbon dates from the relevant part of the sequence (a fifth is rejected as it is out of sequence with the others). Following their assumption of a constant accumulation rate during the clearance episode (which is unlikely as it spans the transition from reedswamp to raised bog), the pollen samples would be at intervals of approximately 30 years. 'Sub-phase A1', representing the elm decline, comprises a single pollen sample and is assigned a duration of approximately 30 years. 'Sub-phase A2', with just two pollen samples, is assigned a duration of approximately 60 years. Unfortunately, however, the relatively poor resolution of the pollen sequence means that it is impossible to assign meaningful durations to fluctuations in the pollen curves represented by only one or two samples. While the overall duration of the 'clearance' episode may well span a period in excess of two centuries, a closer sampling interval and greater number of radiocarbon dates would be needed to characterise and date stages within it.

With regard to the interpretation of the pollen record as representing clearance, 'Sub-phase A1', the elm decline, is accompanied by an increase in grass pollen (previously present in the reed peat) and small peaks of bracken (*Pteridium aquilinum*), dock (*Rumex acetosa*) and other herbs. 'Sub-phase A2' shows a decrease of oak, an increase of hazel and heather (*Calluna vulgaris*), and a peak of grasses, but a decline of most of the herbs that had peaked in A1. Together these phases are interpreted as a possible period of pastoral farming, or the maintenance of open conditions by wild herbivores. Cereal-type pollen does not appear until 'Phase B', assigned a duration of *c* 170 years, during which hazel continues to increase, grasses decline, and ribwort plantain (*Plantago lanceolata*) is consistently present, accompanied by sporadic occurrence of other herbs. In 'Phase C' cereal-type pollen disappears, plantain declines, and there are slight increases of oak and elm. Phase B is interpreted as agricultural, followed by woodland recovery in Phase C. The grounds for identifying Phase B as agricultural are the cereal-type pollen, ribwort plantain, and presence of other taxa 'generally regarded as associated with prehistoric agriculture such as *Artemisia*, Chenopodiaceae and *Urtica*' (Smith and Morgan 1989, 160). Smith and Morgan do not state their criteria for identifying their 'cereal type', the first example of which occurs well before the elm decline at 5850±80 BP (CAR-658; 4910–4500 cal BC). As discussed above in relation to Site D, the virtually certain origin for the pre-elm decline cereal-type grains in the wetland grass flora must cast doubt on those in later deposits (cf Tweddle *et al* 2005). *Artemisia* and Chenopodiaceae pollen could also have originated from wetland (saltmarsh) communities, as both occur earlier in the sequence.

Caseldine (2000) suggests that a similar clearance occurred in her Pit 15 sequence, lasting for around 400 years following the elm decline. Here again the apparent clearance coincides with the onset of raised bog formation, which at this site replaced fen carr-woodland, dramatically enlarging the pollen source area. The appearance of ribwort plantain at the elm decline suggests that there were areas of short grassland communities or other disturbed ground nearby, but these need not have been anthropogenic in origin. Here cereal-type pollen is not present at the elm decline, but does occur earlier in the sequence (first just before 5920±80 BP: CAR-1501; 5000–4580 cal BC and again just before the elm decline), and perhaps a couple of centuries after the decline. The criteria for identification of cereal-type pollen are not stated, but an origin in the wetland grass flora seems likely here, as at the other Goldcliff sites.

In attempting to interpret events at the time of the elm decline at Goldcliff it is important to view the pollen record in the light of the major changes in the local wetland environment that occurred at the same time. The elm decline was immediately followed by the onset of raised bog growth at the sites examined by Smith and Morgan and Caseldine. Furthermore, an unstable water table at Smith and Morgan's Site 1 is suggested by fluctuations in the relative abundance of heather and *Sphagnum*, the former indicative of relatively dry bog surface conditions. Such instability may itself have encouraged the slight increase in diversity of herbs of open and disturbed ground in their pollen sequence. At Site J the elm decline coincides with a period when the *in situ* vegetation became more closed rather than open, as alder carr came to dominate the site. Here there is no evidence that might be interpreted as indicative of human activity, either from the pollen or charcoal records. Instead, this period seems to mark abandonment of the area, as micro-charcoal disappears totally from the deposits, having been present continuously in the earlier part of the sequence.

Consideration of all of the pollen sequences spanning the elm decline at Goldcliff indicates that this was a period of changing hydrological conditions, the vegetational response to which varied spatially. There is no evidence from the pollen record that cannot be explained in terms of changes in pollen source areas and creation of new and perhaps unstable habitats in response to hydrological change. In the light of the absence of archaeological evidence for Neolithic human activity on the island, it seems reasonable to infer that the area was abandoned at the end of the Mesolithic period. This may be explicable in terms of the major change in resource availability as saltmarsh and reedbeds were replaced by a vast raised bog.

14.6 Conclusions

Palaeoecological analyses from Goldcliff East reveal interactions between human activity and environment change from *c* 5800 cal BC to 3800 cal BC. During this period fluctuating sea level triggered changes in the extent and character of vegetation communities including saltmarsh, reedswamp, hazel woodland, oak woodland, and alder carr. Late Mesolithic human activity appears to have been focused in the reedswamp and hazel woodland communities, and may have included management of such communities to increase their productivity using fire. Human groups seem to have avoided the alder woodland, perhaps because it was denser, presenting fewer hunting opportunities, and also offered fewer potential plant foods. At all sites there is positive botanical evidence for activity in summer and autumn, but this does not exclude the possibility of a human presence during the rest of the year.

The Goldcliff area seems to have been abandoned at the end of the Mesolithic period, in the face of a major expansion of raised bog communities. Changes in pollen deposition at the time of the elm decline are largely attributable to local vegetational responses to hydrological change, which dramatically altered pollen sources areas. Cereal-type pollen is recorded at Goldcliff from as early as *c* 5750 cal BC at Site D, almost certainly originating from local wetland grasses, urging caution in interpretation of early cereal-type pollen records from other coastal wetlands (see, for example, recent discussion by Innes *et al* 2003).

14.7 Acknowledgements

This work forms part of the NERC-funded project 'Mesolithic to Neolithic coastal environmental change *c* 6500–3500 cal BC' (Grant NER/A/S/2000/00490). The monolith and bulk samples were collected by Professor Martin Bell and the excavation team, and the bulk samples were flotation sieved by Dr Shaun Buckley, Deni Vorst, Shaun Keating, and helpers. I thank Dr Shaun Buckley for preparation of the pollen samples, Deborah Tills for preliminary sorting of macroscopic plant remains from the bulk samples, and Dr Alex Brown for quantifying the macroscopic charcoal from Sites B and J.

14.8 Charcoals from the Mesolithic Sites A, B, D and J *by Rowena Gale*

14.8.1 Introduction

The full charcoal report can be found in CD 14.7–14.10. Charcoal samples were collected from Sites A, B, D, and J. A total of 329 samples (599 fragments of charcoal) were examined. Site A: 92 samples, Site B: 62 samples, Site D: 35 samples, Site J: 140 samples. Classification follows that of *Flora Europaea* (Tutin and Heywood 1964–80). Group names are given when anatomical differences between related genera are too slight to allow secure identification to genus level. The anatomical structure of the charcoal was consistent with the following:

Araliaceae. *Hedera helix* L. (ivy)
Betulaceae. *Alnus glutinosa* (L.) Gaertner (alder)
Caprifoliaceae. *Sambucus nigra* L. (elder)
Corylaceae. *Corylus avellana* L. (hazel)
Fagaceae. *Quercus* sp. (oak)
Oleaceae. *Fraxinus excelsior* L. (ash)
Rosaceae:
Pomoideae, which includes *Crataegus* sp. (hawthorn); *Malus* sp. (apple);
Pyrus sp. (pear); *Sorbus* spp. (rowan, service tree, and whitebeam)
Prunoideae. *Prunus spinosa* L. (blackthorn)
Rosoideae. *Rosa* sp., briar, or *Rubus* sp. (bramble)
Salicaceae. *Salix* sp., willow, or *Populus* sp. (poplar)
Ulmaceae. *Ulmus* sp. (elm)

Site J

Charcoal was particularly frequent in Context 328 (Old Land Surface), and consisted mainly of hazel, although oak, elm, and the hawthorn/*Sorbus* group were also well-represented, with smaller amounts of ash, blackthorn, elder, and ivy. Only two pieces came from Context 335, hazel and *cf* hazel: the structure of the latter was slightly atypical for stem material but may have been part of a root. Charcoal was fairly abundant in Context 331; the hawthorn/*Sorbus* group formed the dominant taxon here, although hazel, oak, elm, and blackthorn were also recorded. Scant charcoal of hazel, ivy, and elm was available from Context 327. With such a limited amount of charcoal available it is not possible to comment on the economic preference of wood species, other than to note the apparent absence of wetland species. Charcoal from the burnt wood 7950, from 6/2, in which beetle tunnels were recorded was identified as ivy (*Hedera helix*). The wood structure was slightly knotty.

Site A

Taxa identified from Context 316 included hazel, oak, ivy, and the hawthorn/*Sorbus* group. In contrast, Context 315 was conspicuously rich in charcoal and identified as predominantly hazel and oak, although elm, the hawthorn/*Sorbus* group, willow or poplar, ivy, and bramble or briar were also present. Although the function of the charcoal is unknown, it seems likely to have been the by-product of a heat-based activity at the site, perhaps cooking or smoking/drying of fish. A small amount of charcoal from Context 314 comprised of oak and elm heartwood, the hawthorn/*Sorbus* group, and roundwood from hazel.

Site B

The charcoal from Context 321 may relate to domestic cooking fuel. This consisted mainly of oak heartwood and hazel but also included alder and the hawthorn/*Sorbus* group. Charcoal from Context 319 included oak, hazel, the hawthorn/*Sorbus* group, blackthorn, and ivy. A small scatter of oak charcoal was recorded in Context 318 and a few fragments of hazel and oak charcoal from the interface of these horizons (Context 318/319).

Site D

Small quantities of charcoal were present in Context 347 and Context 345. Oak was common to both contexts; blackthorn and hazel were present in Context 345. Charcoal was more abundant in Context 344, and composed predominantly of oak heartwood but also included elm, hazel, the hawthorn/*Sorbus* group, and blackthorn.

14.8.2 Discussion

Charcoal deposits recovered from Sites J, A, and B could be interpreted as fuel residues from domestic or similar activities. Charcoal from Site D may have accrued from the deliberate destruction of the woodland by burning. Fuel gathering was likely to have been biased towards species that provided high-energy firewood, eg oak, ash, and hazel, although difficulties of felling and transporting large wood and timber probably encouraged the use of more conveniently acquired (combustible) material. Whenever possible, hearths were probably sited close to the source of fuel. The charcoal analysis indicates that firewood was gathered predominantly from oak and hazel, although the use of the hawthorn/*Sorbus* group was also frequent at Site J. The use of oak heartwood (probably from large wood) endorses evidence from samples collected for dendrochronology, which demonstrated that the area supported mature oaks. On the furthest fringes of habitation, towards the edge of the foreshore, some use may have been made of driftwood and fallen trees.

Species less well-represented in the fuel deposits include alder, ash, ivy, blackthorn, elm, elder, willow or poplar, and bramble or briar. Differences in the ratio of species dominance in the contexts examined – eg the apparent abundance of the hawthorn/*Sorbus* group at Site J (Contexts 328 and 331) and the absence of elm at Site B – may relate either to species availability or distribution in a given area or, for the former, to the gross fragmentation of a single piece of charcoal in a given sample. It is worth noting that hawthorn scrub readily colonises cleared areas and the frequency of the hawthorn group in some contexts on Site J may indicate the onset and subsequent felling of scrubby growth. Interestingly, given the estuarine character of these sites, there appears to have been little use of fuel from wetland species, such as alder and willow. This may be due to their poor performance as firewood (although similar parameters apply to elm which was fairly frequent in the charcoal deposits) or their inaccessibility on the wetland, but more probably reflects the proliferation of oak woodland in the environment at this time.

Evidence from the pollen record (above) is indicative of a densely wooded environment during the Late Mesolithic period, dominated by hazel, oak, and elm. The charcoal analysis correlates closely with these results. The widest range of species was identified from Site J, which, in addition included ash, hawthorn/*Sorbus* group, bramble/briar, and elder. Ivy was recorded from Sites A, B, and J; this seems more likely to have been incidental, perhaps gathered on host species collected as firewood. A survey of the Upper Submerged Forest verified that oak had replaced the dominant alder woodland of the lower part of the Upper Peat (Chapter 15.3.1).

The charcoal analysis makes an important contribution to the arboreal database for this period and also testifies to the exploitation of a range of local woodland species at Goldcliff East for domestic purposes. A slightly narrower range of species was named from contexts on Site D. The overall results appear to correspond fairly accurately to the provisional data obtained from the forest survey and the pollen record.

15 Plant communities of the Upper Submerged Forest *by Scott Timpany*

15.1 Introduction

Investigations of the Upper Peat and Submerged Forest have been introduced in Chapter 7 and the dating evidence outlined in Chapter 8. This chapter is concerned with the palaeobotanical study of these deposits, which forms part of the wider research, which is presented in full detail in Timpany (2005). Previous studies of the vegetation sequence have been made by Smith and Morgan (1989) on the Upper Peat at Goldcliff East, the present study complements their research in focusing particularly on macrofossil evidence for the composition of the Upper Submerged Forest, which they only considered to a limited extent. There has also been a previous study of peats of Mesolithic to Iron Age date from west of Goldcliff by Caseldine (2000). The pollen sequence from the Mesolithic occupation on Site J, immediately underlying the Upper Peat, has been presented by Dr Dark in Chapter 14.4.4.

All the sites examined in this, and earlier studies, lie along a hypothetical west to east transect across the former Goldcliff island (Fig 15.1; CD 7.2). East of the island they are:

(1) Site J Monolith 5640 from the Mesolithic occupation surface and base of peat (Chapter 14), which was on the very edge of the island at the time;
(2) Site J Pit (this chapter), which was *c* 6m from the island edge;
(3) Site F (this chapter), which was about 305m from the island edge;
(4) Smith and Morgan's (1989) Site 2, which was 450m from the island edge;
(5) Site K (this chapter), which was 630m from the island edge;
(6) Smith and Morgan's (1989) Site 1, which is the most distant easterly at 720m from the island edge.

This sequence of sites, at varying distances from the former island, makes it possible to consider spatial aspects of prehistoric vegetation change. Insect evidence from some of the sites along the same transect is presented in Chapter 16.

15.2 Methods

For pollen analysis and sieved plant macrofossils the methods employed were those outlined in Chapter 14.2. However, in this chapter there is a particular emphasis on wood identification as evidence of the composition of the submerged forest and for comparison with the pollen record. Thus, a multi-proxy approach to palaeoecology was employed; this involved recording individual trees and planning areas of Submerged Forest at Sites J, F, and K, together with the collection of samples for pollen and non-pollen microfossil analysis (fungal spores), plant macrofossil analysis, wood analysis and dendrochronological analysis directly associated with the planned sites. Further details of the analytical methods can be found in Timpany (2005).

Areas of submerged forest were planned at all sites, leading to the production of some of the most detailed plans produced of a submerged forest. The method employed was first to establish a grid in each area and then remove surface water and mud using a mud scraper or sponges (and buckets). The peat was then cleaned back further using trowels, carefully exposing the wood on the peat surface. Once pieces of wood had been exposed, they were planned and pieces larger than 10cm were numbered and sampled for wood identification. Once recorded, trees and wood samples were surveyed for position and OD height data through levelling and/or using an EDM. The larger tree remains were sampled for dendrochronological analysis and additionally recorded using tree record sheets (Timpany 2005, appendix II).

At Site J a pit was excavated to a depth of *c* 2.5m and a 1m monolith (S5125) from the top of the pit incorporating the Upper Submerged Forest was taken (Fig 6.8; CD 6.27) and sub-sampled for pollen and plant macrofossil analysis. Plant macrofossil, bulk samples were also taken at 35–45cm and 70–80cm. Beetle samples were also taken from this pit face by Emma Tetlow (Chapter 16.6).

15.3 Results and interpretation

Results presented here particularly focus on Pit J, where the Upper Submerged Forest overlay the excavated Mesolithic site. For ease of discussion, the results and interpretation have been divided into two parts: the first, wood identifications and dendrochronology, the second, pollen, non-pollen microfossils, and plant macrofossils. The results are integrated in the discussion section.

15.3.1 Wood identification and dendrochronological analysis

The wood plan for Site J (Fig 6.2) shows *Alnus* (alder) to be the dominant taxon growing at the site, seconded by *Betula* (birch), and *Quercus* (oak),

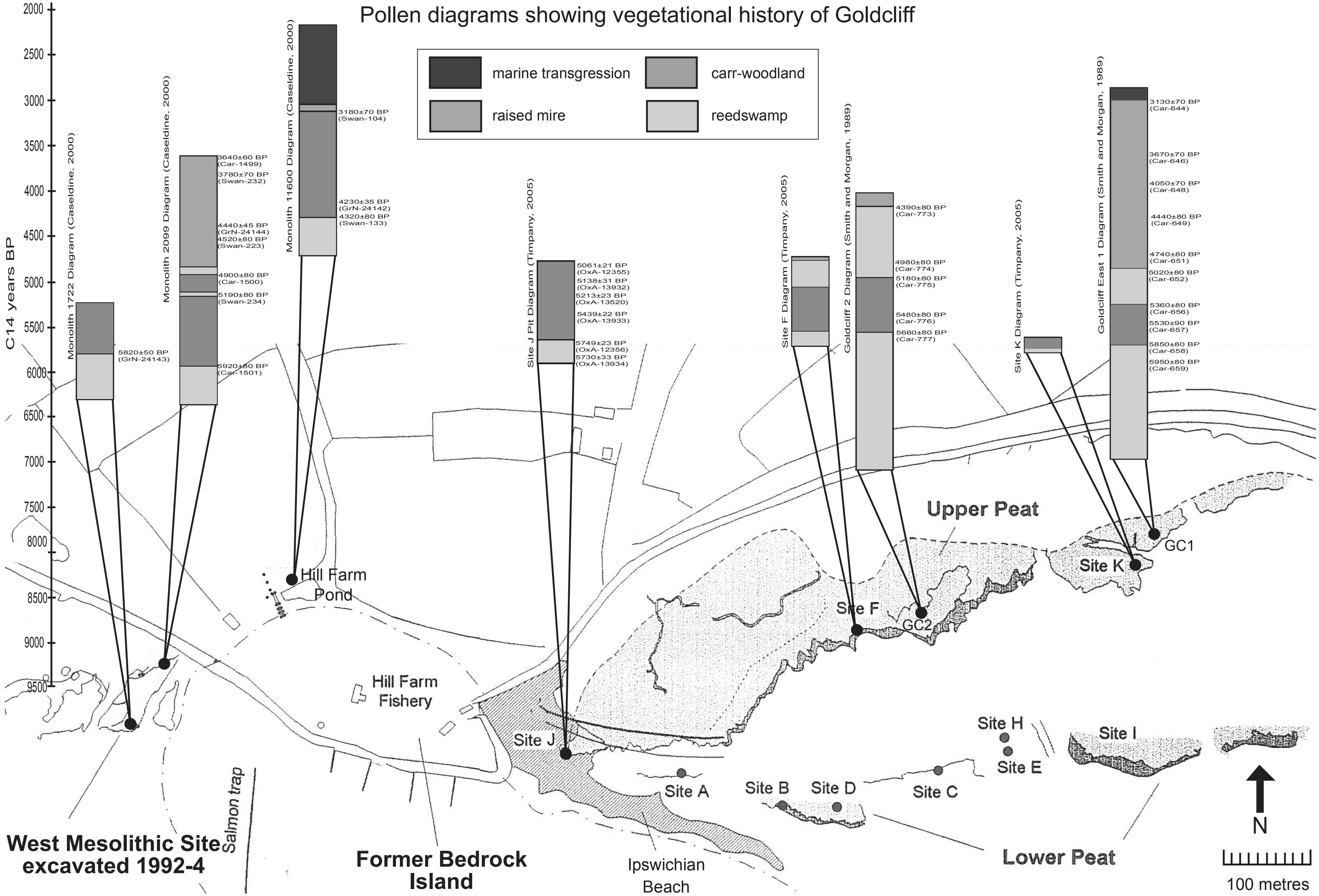


Figure 15.1 The location of pollen investigations in a transect on either side of Goldcliff island, showing the dates at which key environmental and vegetation changes took place at each site (graphic S Timpany)

with more sporadic remains of *Salix* (willow) and *Corylus* (hazel). Remains of *Eriophorum* (cotton grass) are also present on the peat surface towards the northern edge of Site J.

Measured OD heights from wood identification samples chart the *in situ* vegetational succession at the site. The peat surface (shown in Fig 6.2) slopes from north to south (Figs 6.3a and 6.8) a difference in height of *c* 1m. Therefore, the wood plan shows a sequence of woodland succession from south to north.

The wood identification and OD height data from Site J show the first trees to invade the wetland at the island edge were largely *Alnus*, with *Betula*, *Quercus,* and *Salix*. This data ties in with the recovered worked Mesolithic wood from the estuarine silt/peat interface, which suggested wood derived from an early carr-woodland developed at Site J dominated by *Alnus* (Chapter 10). Figure 6.2 shows this initial carr-woodland was succeeded by *Betula*, *Alnus*, *Salix,* and *Corylus* carr-woodland and was later invaded by *Quercus*, which represents the final stage of woodland succession at Site J. These two phases of carr-woodland development can be seen in Figure 6.7, in the concentrations of wood remains towards the basal and upper layers of the peat. A band between *c* 55cm to 75cm, containing fewer wood remains (Fig 6.2 between northings 4 to 6).

Dendrochronological analyses of non-*Quercus* trees (*Alnus* and *Betula*) from Site J shows that some of these trees lived beyond the age of maturity (*c* 35 years) (McVean 1956) and grew to substantial sizes, as shown from *Alnus* tree remains at Site J and across the Upper Peat shelf (Timpany 2005). For example Tree 10, a fallen *Alnus* trunk, lived for *c* 85 years and has a maximum diameter of 400mm, however, only around half the tree had survived, the pith being at the edge of the tree, suggesting the tree originally had a diameter of approximately 0.8–1m.

This *Alnus* carr-woodland at Site J was growing during a period of *Quercus* woodland development across the Upper Peat shelf at Goldcliff East. However, none of these *Quercus* trees have been successfully matched to the Upper Submerged Forest floating chronology. Wiggle-match dating of Tree 36 has successfully dated the period of *Quercus* woodland in the floating chronology, built by Nigel Nayling to *c* 4477–4239±7 cal BC (Chapter 8). The nearest *Quercus* tree from this floating sequence to Site J, is Tree 36, approximately 46m east of Site J, which lived from *c* 4432 cal BC to 4245±7 cal BC, almost the whole time-span of the chronology. The earliest dated tree in the floating chronology, Tree 9 (Fig 8.3), although *c* 200m south-east of Site J, was approximately 55m to the east of the edge of Goldcliff island at that time. This indicates the earliest *Quercus* trees in the Upper Submerged Forest invaded the wetland close to the island. Worked wood, charcoal, and pollen evidence from the Old Land Surface at Site J suggest *Quercus* was growing on Goldcliff island during this period, and this is the likely source for the *Quercus* trees invading the wetland at Goldcliff (Chapter 14).

High-precision radiocarbon wiggle-match dating was also carried out on Tree 8, a large *Quercus* trunk within Site J (Chapters 7 and 8), dating the tree to *c* 4111–3910±6.5 cal BC. This tree therefore represents a later period of *Quercus* tree growth *c* 120 years after the death of the main *Quercus* forest. Tree 8 lies at the highest OD heights at Site J, at *c* 2.3m OD, with the trunk descending into the peat between 1.34–1.74m OD (CD 6.24). The evidence suggests this to be the last phase of woodland succession at the site, occurring prior to the development of raised mire at Site J. Remains of the mire can be seen from the presence of *Eriophorum* at the northern limit of the site (Fig 6.2).

The Upper Submerged Forest investigated at Sites F and K both share similarities to some stages in the succession at Site J. At Site F, wood identifications reveal carr-woodland dominated by *Alnus*, including ten stumps and one trunk, with smaller amounts of *Salix*; together with three *Quercus* trunks (Fig 7.3; CD 15.1). These *Quercus* trees are part of the floating chronology for the Upper Submerged Forest and together span almost its duration (Fig 8.3). That Tree 40 overlies Tree 41, which died before this tree, suggests it was left standing after death for a period of *c* 60 years. Standing dead trees would have been vulnerable to strong winds, and therefore susceptible to windthrow (Allen 1992; 1996b). The fallen trunks visible at Site F may have been felled in this way and subsequently buried by the developing reed peat. The presence of fungal spore Reading-Type 1 within an *Alnus* stump, suggests the stump stood rotting for a period after death, before being buried by the accumulating raised mire (Timpany 2005, app v).

The wood identifications combined with the OD height data (CD 15.1) provide a picture of successional change at Site F. Tree remains at the lowest OD heights (*c* 0.6–0. 7m OD) show that the earliest trees to invade the site were *Alnus* and *Salix*, suggesting the initial colonization of these taxa led to *Alnus-Salix* carr-woodland. With increasing OD height the wood remains show that this carr-woodland was replaced by *Alnus* dominated carr-woodland, and finally by *Quercus-Alnus* woodland. Tree 310 lived for 71 years, showing *Alnus* trees grew to maturity. The *Alnus* trait of growing in clumps is also seen in the wood plan with the bunching of *Alnus* stumps (CD 15.1).

Wood identifications at Site K show a predominantly *Alnus* carr-woodland, with *Salix*, *Betula*, and *Corylus* also present; unlike Sites J and F, no *Quercus* remains are present (CD 15.2–15.4). The wood identifications indicate that the carr-woodland present at Site K was at an earlier stage of succession than Sites J and F. Large remains of *Salix* and *Betula* trees at the site suggest they formed a significant part of the woodland composition; less so for *Corylus* with only a small number of small pieces

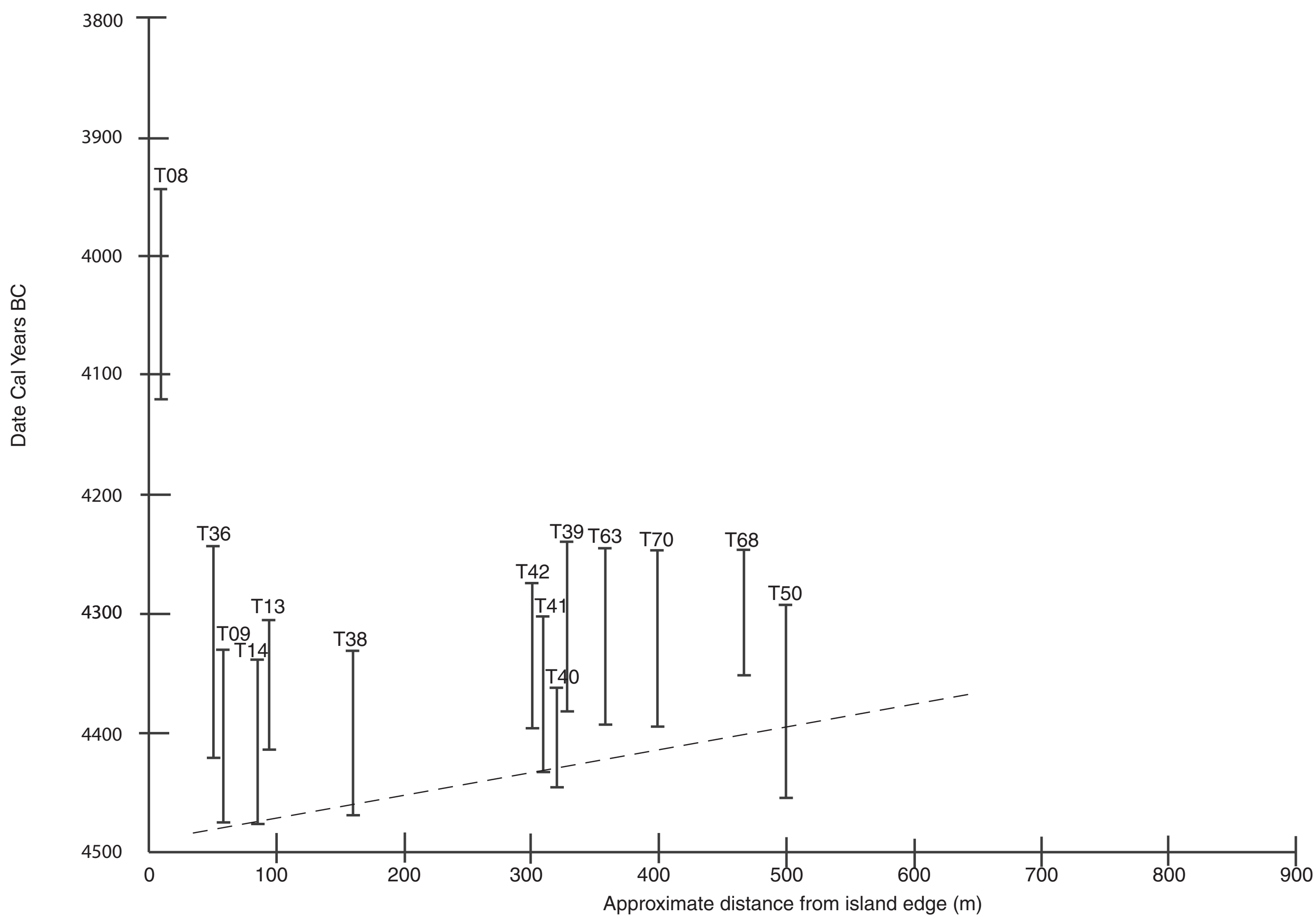


Figure 15.2 Graph showing period of tree growth in the Upper Submerged Forest compared to distance from Goldcliff island (graphic S Timpany)

present. The *in situ* stumps at the site indicate that, as at Site F, trees grew in clumps within the woodland, suggesting a patchy canopy.

Dendrochronological analysis of four *Alnus* trees (163, 170, 172, and 174) indicates trees were able to reach mature ages, with little evidence of environmental stress. The tree-ring data indicates that Tree 172 was able to grow to a large size fairly quickly at the site, being *c* 36 years old at time of death and having a maximum diameter of 0.52m; compared to Tree 163 which lived for *c* 71 years and had a maximum diameter of 0.3m. This data suggests that local conditions (probable water table height) varied at the site, allowing for some *Alnus* trees to grow more rapidly than others.

Again OD height data can be used to chart succession; the sequence shows initial development of *Salix-Alnus* carr-woodland to gradual dominance of *Alnus* at the site, with then limited colonisation of *Corylus* and *Betula*. Although no *Quercus* trees are present at Site K, *Quercus* tree remains are present some 20m to the west where Tree 50 is part of the floating chronology (Chapter 8.1.5).

The *Quercus* trees which form the Upper Submerged Forest show a broad trend of the earliest trees close to Goldcliff island and later trees at increasing distance from the island (Fig 15.2). This data combined with the evidence gathered at Sites J and F suggests a trend of tree spread from Goldcliff island across the peat shelf towards Site K of: *Salix – Betula – Alnus – Corylus – Quercus*. To the east of Site K, all tree remains present on the Upper Peat shelf have been identified as *Salix* (Timpany 2005). This suggests *Alnus* trees present at Site K may be the eastern limit of spread from Goldcliff island.

15.3.2 Pollen, non-pollen microfossil, and plant macrofossil analysis

Throughout the period of vegetational succession on the wetland of Goldcliff East, pollen evidence shows there was *Quercus-Corylus* mixed deciduous woodland present on Goldcliff island (Smith and Morgan 1989; Caseldine 2000; Timpany 2005). The existence of this woodland on the island, together with the nature of wetland communities (having floristic similarities to other communities, eg ruderal communities) means that care is needed in the interpretation of pollen sequences. The use of plant macrofossil and non-pollen microfossils, such as fungal spores, will aid the interpretation of local vegetational communities and local conditions (eg pooling) on the wetland.

Saltmarsh-reedswamp phase c 5730±33 BP (OxA-13934; 4690–4490 cal BC) to c 5650 BP (4520–4450 cal BC)

After a period of rapid sea-level rise, which deposited the estuarine silts of the lower Wentlooge Formation, sea-level rise slowed allowing the accumulation of plant litter from first saltmarsh, then reedswamp communities on the wetland around Goldcliff island forming the Upper Peat of the middle Wentlooge Formation (Fig 15.1). Phases of marine inundation occurred during this period of peat growth and can be seen in the stratigraphic record as lenses of clay intercalated with peat layers. This has led to over five peat layers being counted at some locations such as Redwick, to the east, on the Gwent Levels (Allen 2001).

Evidence of such clay lenses between horizons of peat formation is shown within Monolith S5125 at Pit J, where a 1cm reed peat layer (at 91cm, Fig 6.8) is overlain by estuarine silts, reflecting a period of marine inundation. This peat band has been radiocarbon dated to 5730±33 BP (OxA-13934; 4690–4490 cal BC). The base of the main peat layer has been radiocarbon dated to 5749±23 BP (OxA-12356; 4690–4530 cal BC).

Pollen and plant macrofossil evidence for this period (Figs 15.3–15.5; CD 15.5–6) shows the presence of reedswamp and upper saltmarsh communities at Sites J, F, and K. Large values of Poaceae pollen are likely to reflect largely the local growth of reeds across the wetland; this is supported by the small size of grains (<25μm) and the presence of *Phragmites australis* (common reed) macrofossils within the reed peat layer (Moore *et al* 1994). This reedswamp community shares similarities with modern S4 *Phragmites australis* reedswamp (Rodwell 1995), which commonly develops in open water transitions within estuaries today. Saltmarsh is indicated by the presence of maritime plants such as Chenopodiaceae (goosefoot) and *Aster*-type (Michaelmas daisies), which often represent saltmarsh environments in estuarine pollen diagrams (Scaife 1994; Caseldine 2000).

Some grading of reedswamp to tall-herb fen is shown in the floral assemblages with Cyperaceae pollen and *Carex* sp. nutlets showing the presence of sedges, together with *Eupatorium cannabinum* (hemp agrimony) seeds, *Urtica dioica* (common nettle) pollen and seeds, and *Lychnis*-type (catchflies) and *Lotus*-type (bird's foot trefoils), all of which grow in this community (Rodwell 1995). Ferns, such as *Osmunda regalis* (royal fern) and *Thelypteris palustris* (marsh fern) may also have been growing within these communities (Clapham *et al* 1964; Rodwell 1995). Pooling of water is also indicated by aquatic pollen types such as *Potamogeton* (pond weed), fungal spore Type 8, Type 72 (zoological remain of *Alona rustica*), and Type 62 (*Mougeotia* cf *gracillima*) (Clapham *et al* 1964; van Geel 1986).

Fungal Type 55 a/b (*Sordaria* spp.) during this vegetation period may indicate the presence of dung near the site from grazing animals such as deer, which have been shown to have been present from footprint evidence (Chapter 12). However, it has also been linked to the presence of decaying wood, notably *Betula* sp. (van Geel *et al* 1981). Microscopic charcoal values are high during this period, suggesting burning of the vegetation. The presence of identifiable grass microscopic charcoal, suggests it is the reedswamp being burned. It is probable that people were still exploiting resources on Goldcliff island and the wetland, although less intensively than previously (Chapter 7.6).

The purpose of such burning could have been to manage the height of reeds, prevent encroachment of the woodland onto the wetland or encourage particular wetland plant resources: such activities continue today (Law 1998). Burning of the reeds may also have been to spot wading birds or grazing animals (ie deer) for hunting purposes, similar to methods attributed to Mesolithic peoples at upland sites (Simmons 1996; Simmons and Innes 1996). Similar evidence for reed burning has been recorded at Star Carr, North Yorkshire (Mellars and Dark 1998).

Carr-woodland period c 5650 BP (4520–4450 cal BC) to c 5061±21 BP (OxA-12355; 3950–3790 cal BC)

A successional change takes place at *c* 5650 BP (4520–4450 cal BC) at Site J, with reedswamp and saltmarsh indicator taxa (eg Chenopodiaceae and Poaceae pollen) declining as carr-woodland develops, shown, in particular, by a rapid increase in *Alnus glutinosa* (in AJ Zone 2). The pollen and plant macrofossil evidence at Site J suggests a sequence of carr-woodland taxa invasion of the wetland, from Goldcliff island, initially *Salix* sp. and *Betula* sp., followed by *Alnus glutinosa* (Fig 15.3; CD15.5). The local presence of *Salix* and *Betula* is shown in the plant macrofossil assemblage through the presence of seeds, buds, bud scales and, for *Salix*, wood fragments (CD 15.5). This early carr-woodland may have had similarities to the W2 *Salix cinerea-Betula pubescens-Phragmites australis* woodland (Rodwell 1991a), which is often present in primary hydrarch successions, forming primary woodland cover by directly invading herbaceous fen.

The presence of *Corylus avellana* nuts close to the base of the wood peat suggests *C. avellana* was also present within the early stages of carr-woodland development. Wood identifications from Site J indicate *Quercus* trees were also present in the early carr-woodland, although this is difficult to see in the pollen record (Fig 15.3), with the strong signal from *Quercus* trees present on the island and the absence of any *Quercus* sp. macrofossils in the assemblage in the initial carr-woodland stage (AJ Zone 2).

This successional change from a reedswamp/tall-herb fen environment to carr-woodland takes place across the wetland to the east of Goldcliff island and Site J, at *c* 5700 BP (*c* 4550–4495 cal BC). Smith and Morgan (1989) date this succession at 5850±80 BP (CAR–658; 4910–4500 cal BC) and 5660±80 BP (CAR–778; 4690–4350 cal BC) from their GC1 and GC2 sites respectively. A similar sequence of succession is seen with an initial carr-woodland cover of *Salix* sp. with *Betula* sp. and *Alnus glutinosa* at Sites F and K in the pollen and plant macrofossil assemblages (see Figs 15.4–15.5), together with the Smith and Morgan (1989) sites. The assemblages suggest *Betula* was a lesser component in these woodlands than those close to the island edge. This is shown in the wood identifications from Site F, where *Betula* is absent. However, large remains of *Betula* trees are present at Site K despite little representation in the floral assemblages (Fig 15.5). Caseldine (2000) also found *Betula* pollen values were higher close to the western edge of Goldcliff island and diminished with distance across the wetland to the west.

Following this initial *Salix-Betula* carr-woodland development there is a rapid local increase in *Alnus glutinosa* at Site J (AJ Zone 2 into AJ Zone 3). This is shown in the pollen diagram from the site with values of over 80% TLP and the presence of buds, seeds, female catkins, and wood fragments in the plant macrofossil diagram (Fig 15.3; CD 15.5). This rise in the prominence of *A. glutinosa* at Site J marks another successional change in carr-woodland development, to *Alnus* carr-woodland. The dominance of *A. glutinosa* at Site J in the floral assemblages is mirrored by the wood identifications, where stumps and trunks of *Alnus* are prevalent (Fig 6.2). This *Alnus* carr-woodland is suggested to share similarities with the modern day W5 *Alnus glutinosa-Carex paniculata* woodland (Rodwell, 1991a). This carr-woodland type is characteristic of lowland fen peats today, and is known to succeed *Salix-Betula* carr-woodland.

The succession to *Alnus* carr-woodland is seen across the wetland at Goldcliff East, at Sites F and K (Figs 15.3–15.5) and in Smith and Morgan's (1989) GC1 and GC2 pollen diagrams. At Goldcliff West, Caseldine (2000) also records the development of *Alnus* dominated carr-woodland. The dominance of *Alnus* within the carr-woodland is evident from all environmental sources used; however, other arboreal taxa were present. Pollen and plant macrofossil evidence show *Salix*, *Betula pubescens*, and *Corylus avellana* continued to grow at Site J, during this period of *Alnus* dominance. Similar carr-woodland is also indicated from the assemblages at Sites F and K (Figs 15.4–15.5). Buds of *Crataegus* sp. (hawthorn) indicate this taxon grew locally at Site J, despite being poorly represented in the pollen record and absent in the wood identifications. A taxon not shown on the wood identification plan, but which has been found from a wood identification below the surface layer (shown in Fig 6.2), is *Rosa canina* (dog rose). The discovery of this species again highlights the benefits of using a multi-proxy approach, as Rosaceae pollen was not found in the fossil pollen record.

Quercus has also been shown from the Upper Submerged Forest floating chronology and wood identifications to have been part of this carr-woodland, particularly around the edge of Goldcliff island. The local growth of *Quercus* is also evidenced by the presence of *Quercus* buds in the plant macrofossil assemblage (CD 15.5).

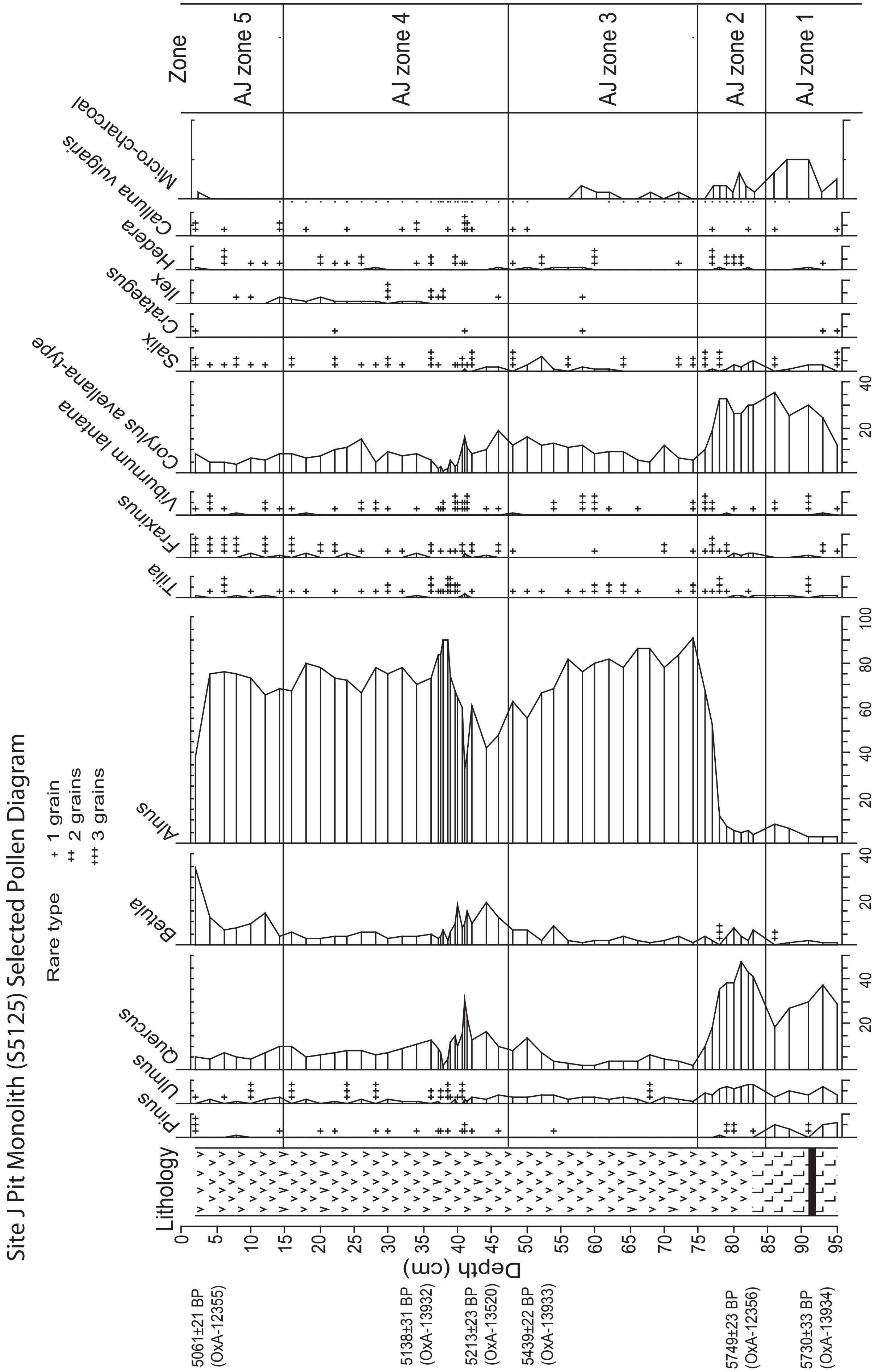
At *c* 41cm in the Pit J pollen diagram, a disturbance event takes place affecting the carr-woodland (Fig 15.3). This disturbance has been radiocarbon dated to 5213±23 BP (OxA-13520; 4045–3965 cal BC) and is shown by a sharp decline in *Alnus* pollen and rises in other arboreal taxa such as *Betula*, *Corylus*, and *Quercus*. This suggests a reduction in *Alnus* allowing for a stronger signal from the woodland on Goldcliff island and creation of gaps in the carr-woodland exploited by other carr-woodland taxa such as *Betula*. The plant macrofossil assemblage shows a local increase in *Betula pubescens* following the disturbance, which is suggested in the pollen record. However, this disturbance appears to have been short-lived with *Alnus* pollen values rising sharply at 40.5cm. This is also suggested in the plant macrofossil assemblage with a large increase in *Alnus glutinosa* seeds soon after that of *Betula* seeds. Local growth of *Rubus idaeus* (raspberry) shown in the plant macrofossil assemblage and increases of *R. idaeus* seeds around 40cm may reflect its preference for disturbed ground (Stace 1997).

A decline in *Ulmus* (elm) pollen values at *c* 41cm, where the *Ulmus* pollen curve declines to rare taxa (1–3 grains only), also appears to be linked to the disturbance event and is suggested to represent a mid-Holocene *Ulmus* decline. This decline and the cause of the disturbance event are further discussed below.

The pollen evidence, and to some extent the plant macrofossil evidence, at Pit J, indicates the continued presence of tall-herb fen at the site, which is likely to have formed the field layer of the *Alnus* carr-woodland (Rodwell 1991a). The presence of a suite of herbaceous taxa within the assemblages including: *Carex* sp. (nutlets); *Filipendula* (meadowsweet); *Galium*-type (bedstraw); *Utricularia*-type (bladder wort); *Succisa pratensis* (devil's bit scabious); and *Lychnis*-type and *Lythrum*-type (purple loosestrifes) all indicate the local presence of tall-herb fen. This tall-herb community is likely to have resembled that of the S25 *Phragmites australis-Eupatorium cannabinum* tall-herb fen (Rodwell 1995): many of the herbaceous taxa present appear within modern day examples of this environment. This community also appears to have been present during the carr-woodland period at Sites F and K (Figs 15.4–15.5).

Some *Calluna vulgaris* (heather) pollen is also present sporadically through the assemblages suggesting there may have been some formation of raised mire nuclei near Site J during this carr-woodland stage. The occurrence of Type 10 fungal spores, which has been related to *C. vulgaris* (appearing to form on the roots), also suggests local growth (van Geel 1986; van Geel *et al* 1986).

Ferns grew within the damp, wet areas of the carr-woodlands, such as *Thelypteris* and *Osmunda regalis*.



Site J Pit Monolith (S5125) Selected Pollen Diagram
Rare type
+ 1 grain
++ 2 grains
+++ 3 grains
Lithology
Pinus
Ulmus
Quercus
Betula
Alnus
Tilia
Fraxinus
Viburnum lantana
Corylus avellana-type
Salix
Crataegus
Ilex
Hedera
Calluna vulgaris
Micro-charcoal
Zone
AJ zone 5
AJ zone 4
AJ zone 3
AJ zone 2
AJ zone 1
Depth (cm)
5061±21 BP (OxA-12355)
5138±31 BP (OxA-13932)
5213±23 BP (OxA-13520)
5439±22 BP (OxA-13933)
5749±23 BP (OxA-12356)
5730±33 BP (OxA-13934)

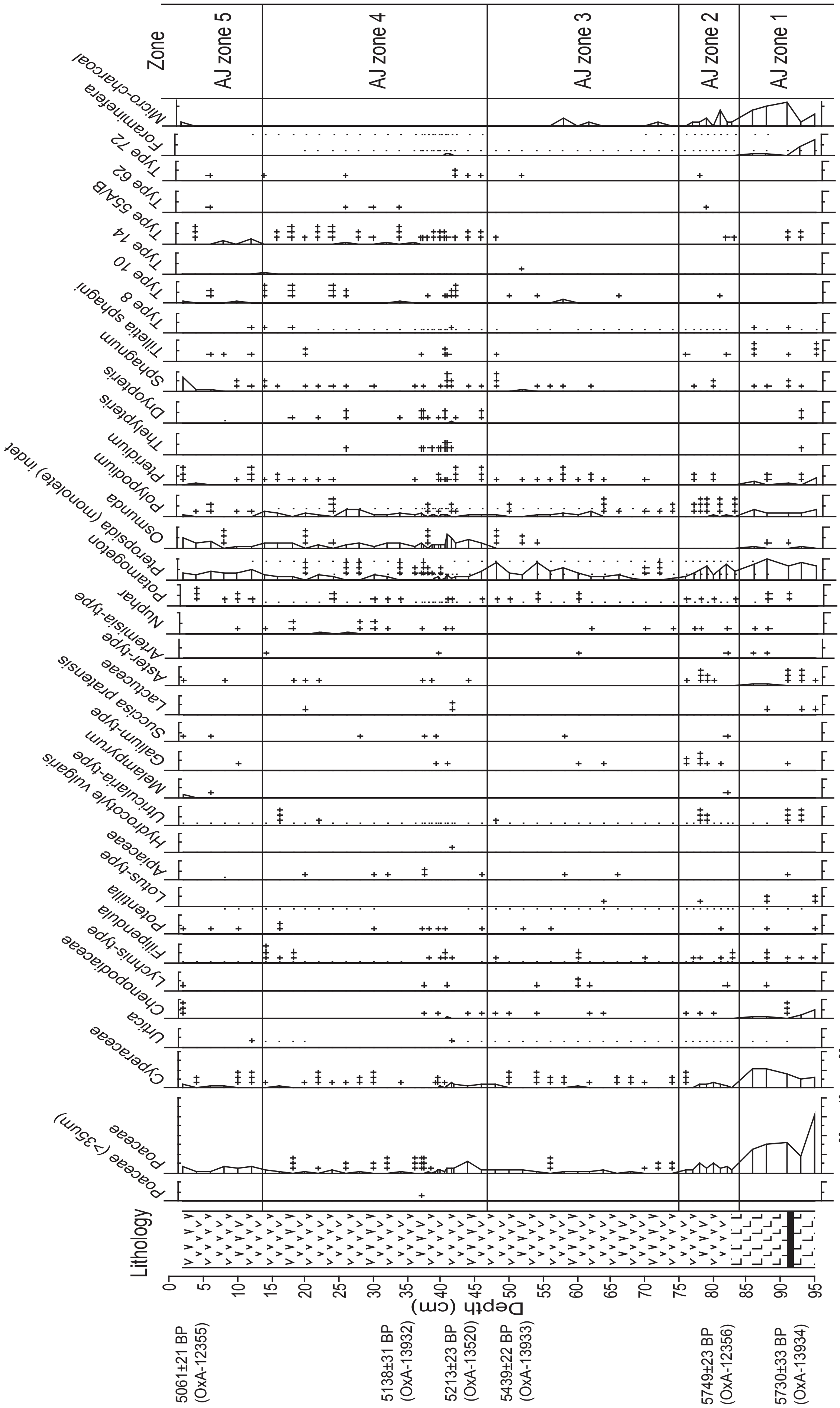


Figure 15.3 Goldcliff East, Site J pit (Monolith S5125): pollen diagram (graphic S Timpany)

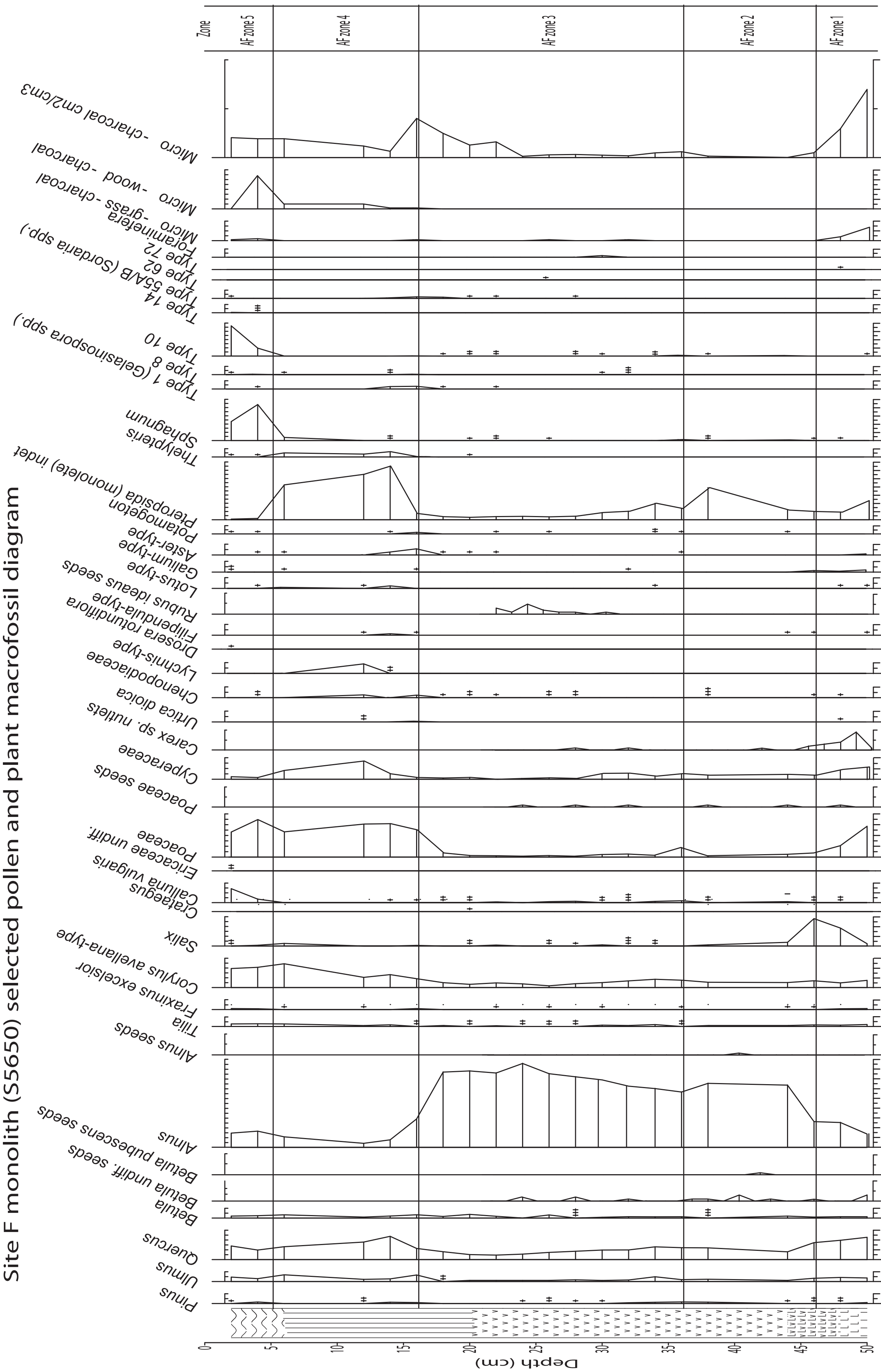


Figure 15.4 Goldcliff East, Site F (Monolith S5650): selected pollen and plant macrofossil diagram (graphic S Timpany)

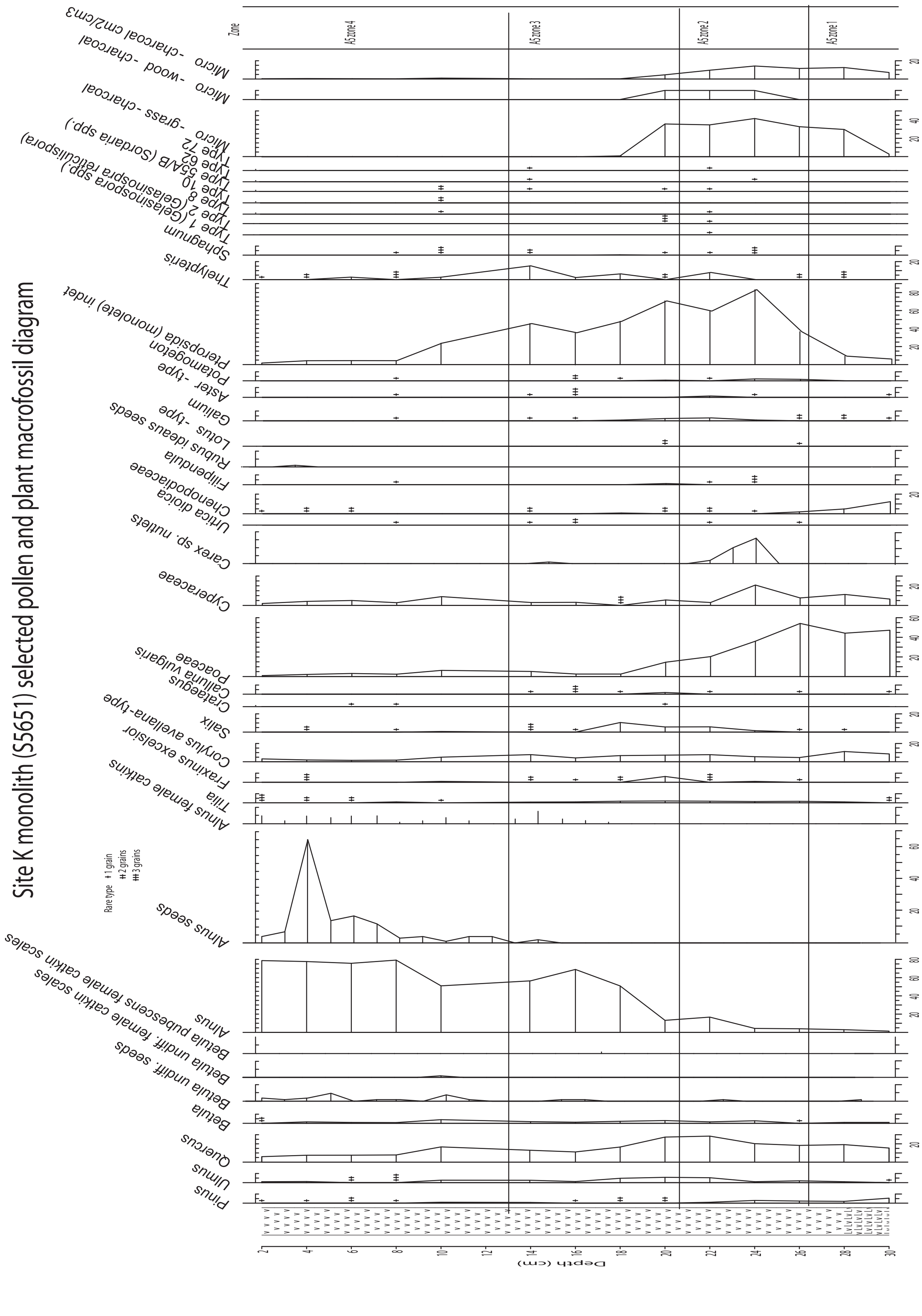


Figure 15.5 Goldcliff East, Site K (Monolith S5651): selected pollen and plant macrofossil diagram (graphic S Timpany)

Shallow pooling of water on the carr-woodland floor is shown by the presence of Types 62 and 72 (van Geel 1986) and *Nuphar* (water lily) pollen, (thought to be *N. lutea* (yellow lily) due to the preference of *N. pumila* (least water lily) to highland areas), together with *Potamogeton* pollen (Clapham *et al* 1964). Microscopic charcoal values are low throughout the period of *Alnus* carr-woodland across the sites, suggesting little burning was taking place locally.

At Site J, the beginning of the end of the *Alnus* carr-woodland period can be seen at the top of the pollen diagram (AJ Zone 5, 2cm), when the *Alnus* pollen curve starts to decline (Fig 15.3). This level has been radiocarbon dated to 5061±21 BP (OxA-12355; 3950–3790 cal BC). This date is in broad agreement with the Smith and Morgan (1989) study, which dated the end of the carr-woodland period to 5020±80 BP (CAR–652; 3970–3650 cal BC) from their GC1 site. Caseldine (2000) at Goldcliff West also has a date of 4900±60 BP (CAR–1500; 3910–3520 cal BC) for the end of the carr-woodland period. These dates suggest the death of this woodland took place across the wetland of Goldcliff East and West at *c* 5000 BP. The decline of *Alnus* on the wetland can be seen most clearly at Site F (AF Zone 4), where locally, less erosion of the peat has taken place and a later peat survives, with evidence of raised mire taxa at the top (Fig 15.4).

The death of the *Alnus* carr-woodland occurred at *c* 5000 BP and was caused by sea-level rise at Goldcliff East, evidenced more widely by sea-level curves for the Severn Estuary/Bristol Channel (eg Scaife and Long 1995; Jennings *et al* 1998). This rise caused the coastline to move further inland, therefore causing a rise in the water table across the wetland at Goldcliff, which effectively drowned the trees where they stood. That not all trees died at the same time across the wetland is shown in the pollen diagram for Sites J and K (Figs 15.3 and 15.5), which suggest trees such as *Betula* and *Quercus* trees survived for some time after the death of many of the *Alnus* trees. This would have created a landscape of live trees standing amongst dead trees, which would have been subject to the wind (eg windthrow, windprune), leaving fallen and tilted trunks and branches, amid *in situ* stumps, which we now see as submerged forest.

Reedswamp to raised mire period c 5000 BP (c 3800–3755 cal BC) to 3130±70 BP (CAR-644; 1610–1200 cal BC)

Following the rise in sea level and demise of the *Alnus* carr-woodland a retrogressive successional change occurs at Goldcliff East, back to reedswamp. This change is not shown within the Pit J assemblages, or that of Site K, which ends during the carr-woodland period. However, it can be seen in the Site F assemblage (AF Zone 4, Fig 15.4). This succession is noted in the stratigraphic record with the development of a reed peat, containing plant remains of *Phragmites australis*. The dominance of reeds is suggested by the increase in Poaceae pollen; rises also in the pollen of *Aster*-type and Chenopodiaceae suggest some high saltmarsh on the wetland. Tall-herb fen taxa are also present amongst the reeds, such as *Lychnis*-type, *Galium*-type, *Filipendula*, and *Lotus*-type (Rodwell 1995). Wetter conditions are also noted by the increase in ferns shown by a rise in *Thelypteris*. Microscopic charcoal values rise following this change to reedswamp, which may again indicate the burning of reeds at Goldcliff (see below).

This change to a reedswamp on the wetland is also recorded by Smith and Morgan (1989) at both their GC1 and GC2 sites and by Caseldine (2000) at the GC2099 monolith site, Goldcliff West. The reedswamp phase lasts for around 300–600 years at the GC1 and GC2 sites, until *c* 4740±80 BP (CAR–651; 3660–3360 cal BC) and 4390±80 BP (CAR–773; 3340–2880 cal BC) respectively, and for approximately 500 years at Goldcliff West, until *c* 4520±80 BP (Swan–223; 3500–2900 cal BC) (Smith and Morgan 1989; Caseldine 2000).

The end of the reedswamp period is succeeded by a change to raised mire at Goldcliff East. The beginning of this successional change can be seen in the Site F diagram (AF Zone 5), with rises in the curves of *Calluna vulgaris*, *Sphagnum* and fungal Type 10, which is associated with fungi that grows on the root nodules of *C. vulgaris* (van Geel 1986), showing it was growing locally, together with the stratigraphic change to raised mire. The appearance of *Drosera rotundiflora* (round-leaved sundew) pollen is also indicative of raised mire communities (Clapham *et al* 1964; Rodwell 1991b). A slight rise in Poaceae pollen may be due to the presence of *Molinia caerulea* (purple moor grass) communities, which can be found in the hollows of raised mire environments (Clapham *et al* 1964; Rodwell 1991b).

There is a slight rise in the microscopic charcoal curve, which is probably due to the change to raised mire *Calluna* dominated vegetation being more prone to natural burning (Rodwell 1991b; Simmons 1996). The presence of microscopic charcoal which has enough surviving structure to be identified as wood microscopic charcoal (see Fig 15.4), suggests it is dead wood or trees being burned close to Site F. The occurrence of *Gelasinospora* sp. (Type 1) also suggests some burning may have been occurring locally (van Geel 1986). The presence of fungal Type 55 a/b may also indicate dead wood on the ground (such as that being burnt), and/or animal dung, suggesting animals may have been grazing on the raised mire.

The period of raised mire continued until an increase in sea level, which submerged the wetland of Goldcliff East, depositing a layer of estuarine silts, the upper Wentlooge Formation (Chapter 2). Smith and Morgan (1989) date this marine incursion from their GC1 site to 3130±70 BP (CAR–644; 1610–1200 cal BC). At Goldcliff West, Building 2, Caseldine (2000) has dated it to 2580±70 BP (CAR–1438; 900–410 cal BC), from her GC1221 monolith site. These dates suggest the sea-level rise occurred gradually across the south-east Wales coastline, Goldcliff East becoming submerged some 600 years before parts of Goldcliff west of the island.

15.4 Discussion

15.4.1 Vegetational succession and tree spread on the wetland, Goldcliff East

The palaeoecological data from the sites across the wetland at Goldcliff East shows a successional sequence (Fig 15.1) similar to that described by Walker (1970) for the post-glacial hydroseral succession in the British Isles, the exception being of a retrogressive successional stage (return to reedswamp), following the carr-woodland period. This vegetational sequence of saltmarsh – reedswamp – carr-woodland – reedswamp – raised mire has also been found to varying degrees at other sites along the south-east Wales coastline (eg Caldicot Pill, Scaife and Long 1995; Barland's Farm and Vurlong Reen, Walker *et al* 1998; Redwick, Timpany 2005).

At Goldcliff East the presence of a known, local source of arboreal taxa, Goldcliff island, allows the spread of these taxa across the wetland during the carr-woodland period to be commented upon. The wood identification and dendrochronological studies have shown a general pattern of spread from the island of carr-woodland taxa followed by *Quercus* (see above). However, the picture is not all that simple, the floating chronology for the Upper Submerged Forest shows that *Quercus* trees spread across the wetland at varying distances and times from Goldcliff island. For example, Tree 9, which is possibly only *c* 55m from the island edge at the time is followed some twenty years later by Tree 50, *c* 20m to the west of Site K, and *c* 680m east of Tree 9. This distance of *Quercus* tree spread in such a short period may be evidence of the spread of trees by fauna, eg acorns dropped by birds, such as the jay, onto the wetland (Vera 2000).

Further evidence of tree spread through faunal agents has been found at Site J, Goldcliff East, through the study of large numbers of *Corylus* nuts recovered (Timpany 2005). Upon excavation *Corylus* nuts were discovered to lie in small scoops (2 to 3 nuts per scoop; Fig 6.12), suggesting their burial by animals, such as squirrels. *Corylus* nuts were retrieved from three contexts: 328 (the Old Land Surface), 331 (estuarine silts), and 327 (wood peat layer); the greatest number of *Corylus* nuts coming from Context 327 (for stratigraphy see Chapter 6.2).

Examination of predation marks on the nuts, as identified in Bang and Dahlstrøm (2001), revealed that a thriving community of small mammals and birds lived within the carr-woodland, including: red squirrel (*Sciurus vulgaris* L.); wood mice (*Apodemus sylvaticus*); bank voles (*Clethrionomys glareolus*); water voles (*Arvicola amphibia*); great tit (*Parus major*); and magpie (*Pica pica*). The collection and burial of *Corylus* nuts by such fauna would have aided the spread of *Corylus* at the woodland/wetland edge and thus have contributed to the extension of *Corylus* woodland, which was a valuable resource for Mesolithic communities, as the numbers of charred *Corylus* nuts shows (Chapter 14.3.5). Faunal agencies are also likely to have contributed to the spread of *Quercus* across the wetland, although no acorns were found preserved within any of the contexts to examine. This method of distribution may help to explain why *Corylus* wood remains are scarcer at a further distance from Goldcliff island (the source of *Corylus* trees). This is shown in the wood identification data with *Corylus* tree remains frequent at Site J, absent at Site F, and then present in smaller amounts at Site K (CD 6.5, 15.1–15.3).

15.4.2 Carr-woodland disturbance episode, *Ulmus* decline, and the role of human agency

At *c* 41cm in the pollen assemblage for Site J (Fig 15.3) a disturbance event occurs, which causes a decline in *Alnus* trees on the wetland. A possible mid-Holocene *Ulmus* decline also takes place in the woodland community on Goldcliff island. This disturbance has been dated to occurring at approximately 5213±23 BP (OxA-13520; 4045–3965 cal BC). This *Ulmus* decline occurs some 300 years prior to that recorded by Smith and Morgan (1989), which dates to *c* 4900 BP (*c* 3800–3600 cal BC). The date is just outside of the mean range for the decline in the British Isles given by Parker *et al* (2002), of 6347–5281 BP. However, the actual cause of this disturbance event, and decline in *Ulmus*, is difficult to ascertain. Storminess may have led to the felling of trees on the island and surrounding wetland. Although absent in the stratigraphic record at Site J, estuarine silts have been recorded by Caseldine (2000) within the stratigraphy of Monolith GC2099 and have been radiocarbon dated to 5190±80 BP (Swan–234; 4240–3790 cal BC). Smith and Morgan (1989) record some evidence of a marine transgression at *c* 5360±80 BP (CAR-656; 4350–3990 cal BC) from the presence of clay particles within the peat layer, at their GC1 site, indicating this may be the same event. The presence of Foraminifera at this level at Site J and an increase in saltmarsh taxa, including a large Poaceae grain (>35μm) thought to represent *Festuca*-type (likely *F. arenaria,* rush leaved fescue), a coastal grass (Fig 15.3), also suggest some marine incursion took place. There is also evidence in the beetle record for marine conditions around this time, with the presence of saltmarsh taxa such as *Limnoxenus niger* and *Elaphrus tessellatus* (Chapter 16.6).

Another possible cause for the decline in *Ulmus* could be Dutch Elm Disease, since Tetlow (2005) recorded the presence of the disease carrier *Scolytus scolytus* beetles earlier in the history of Site J, between depths of 93–83cm. Although present earlier, this find indicates the possibility that these taxa may have persisted at the site through to this period, some 500 years later, and so spread the disease. No later findings of *S. scolytus* were made during the disturbance phase at Site J and so its presence during this *Ulmus* decline cannot be proven beyond doubt. However, the presence of *S. scolytus* in sediments below the horizon of the *Ulmus* decline has been used at other sites in the British Isles to argue for the possibility of Dutch Elm Disease as the causal factor, for example at Hampstead Heath, London (Girling and Greig 1985). It is also possible that people contributed to the vegetation disturbance but it is some thousand years later than the latest dated Mesolithic activity on Site J (Chapter 6.4) and by this time the archaeological evidence suggests a greatly decreased level of human activity.

The fact that *Ulmus* has been recognised as a favoured food for browsing animals is also relevant in the light of evidence for faunal activity at this time. An increase in *Potentilla*-type, a possible indicator of grazing, together with possible dung indicators such as Type 55a/b (*Sordaria*-type), suggest the presence of grazing animals during this period (Fig 15.3). No beetles present are specific to dung; however, there are species relating to foul and rotting material such as *Oxytelus rugosus* (Chapter 16.6; Tetlow 2005). Footprint evidence at Site J also shows deer were present from the reedswamp period through to the carr-woodland stage. Therefore, it is possible that herbivores may have aided the decline in *Ulmus* through the consumption of saplings and foliage. Rackham (2003) observes that young shoots of trees are often favoured by browsing animals, such as deer, and if they were consuming those of *Ulmus*, it would make regeneration difficult. The role of animals in vegetation disturbance is relevant in light of the ongoing debate of the role of herbivorous animals within the woodlands of the early to mid-Holocene (eg Vera 2000).

It is uncertain which of these possible causes were responsible for the disturbance seen in the Site J pollen assemblage at 41cm. It may have been one or a combination of these disturbance mechanisms – for example, storm damage could have led to gaps within the woodland canopy being exploited by people, animals, and insects, which then prevented subsequent regeneration of the woodland. The pollen and plant macrofossil evidence shows taxa such as *Betula* were also able to exploit gaps in the canopy, although *Alnus* recovered quickly at Site J. The *Ulmus* population on Goldcliff island, however, was probably not very large, being part of an island community, and therefore any event causing the death of part of the population would have had a significant impact on the *Ulmus* population as a whole. The pollen evidence suggests it was unable to recover fully from this period of disturbance.

These points are made in order to emphasise that there is no one simple explanation for the quite limited vegetation disturbance at the time of the Upper Submerged Forest. In fact there are pieces of evidence which support a number of alternative explanations. We cannot therefore simply attribute changes observed to human agency. Contrary to our expectations at the beginning of this project that we would find significant evidence of early Neolithic activity, given Smith and Morgan's (1989) identification of a landnam event, it has turned out there is very little evidence for activity during the period of the Upper Submerged Forest. Charcoal records from the site suggest that the main periods of burning preceded the development of the carr-woodland on the wetland when microscopic charcoal evidence suggests it is reeds rather than woodland being burnt (Chapter 14). However, the presence of charred trees (36 and 70; Chapter 7.6) from the carr-woodland phase suggests burning did take place during this period. The question of the extent of human activity in the period of Upper Peat formation is returned to in Chapter 18.15.

16 Insect assemblages from the Lower and Upper Peats *by Emma Tetlow*

16.1 Introduction

The value of insect remains as a tool for palaeoenvironmental reconstruction in the Severn Estuary was demonstrated by earlier work at Goldcliff by D N Smith *et al* (1997; 2000). The present project provided the opportunity for further palaeoentomological work and allowed direct comparison between assemblages east and west of the former Goldcliff island. Insect assemblages were examined from three locations between 500 and 1200m to the east of the earlier study. This forms part of a wider study of late Mesolithic palaeoenvironments and insect assemblages in the Severn Estuary and Bristol Channel (Tetlow 2005). This work encompassed sites on both shores of the estuary – at Redwick (also on the Gwent Levels), at Gravel Banks, and Westward Ho! in England.

16.2 Sampling strategy

Sampling was undertaken on Sites B and D from the Lower Peat. Pit J provided a complete sequence through the 1.2m of the Upper Peat and Submerged Forest. Insect assemblages from the Upper Peat were also investigated beside a large, fallen oak trunk (Tree 70) on the edge of the peat shelf and next to the exposed remains of a fallen alder trunk in Site K. These Upper Submerged Forest sites form a transect from the island edge at Site J to Tree 70, 490m to the east, and Site K 630m from the island edge. Each trench was comprehensively sampled, context by context, producing a complete picture of the palaeoenvironmental change in each area. The exception was Site B, where work was very limited.

16.3 Methods

The samples were processed using the standard method of paraffin flotation as outlined in Kenward *et al* (1980). The insect remains were then sorted from the paraffin flot and identified under a low power binocular microscope. Where possible, the insect remains were identified by comparison with specimens in the Gorham and Girling collections housed at the University of Birmingham. The taxonomy used for the Coleoptera (beetles) follows that of Lucht (1987).

16.4 The Lower Peat at Site D

Excavation of this site was introduced in Chapter 3.4 and the section sampled is shown in Fig 3.8. For a full list of the beetle assemblage see CD 16.1. The assemblage recovered from the reed peat (from a depth of 11–15cm) within Site D was small, well-preserved, and readily interpretable. The majority of insect species recorded indicated that this was an area of marshland, or reedswamp, interspersed with muddy, leaf-filled pools, or slow-moving channels, subject to occasional influxes of brackish or saline water. The peat development postdates the woodland, hence the lack of lignacious and saproxylic taxa from Mesolithic contexts at Goldcliff East, Redwick, and Gravel Banks (Paddock 2001, 2003; Tetlow 2004, 2005).

The carabidae, *Dromius longiceps*, *Odacantha melanura* and *Agonum thoreyi* are all commonly found together and live amongst the stems of bulrushes (*Typha latifolia)* and the common reed (*Phragmites australis*) (Lindroth 1974; 1986). Further carabids, *Elaphrus cupreus*, *Trichocellus placidus*, and *Bembidion assimile*, are found under leaves and detritus in swampy, damp woodlands and on the muddy banks of reed-filled pools and ditches (Lindroth 1974; 1985; 1986). *Bembidion assimile* and *Dromius longiceps* are commonly found at the coast (Lindroth 1974; 1985; 1986), and the latter is often found in reedswamps and fenland subject to incursions of brackish water (Hyman 1992).

The environments suggested by these assemblages were the zone of transition from freshwater reedswamp to high saltmarsh. Saltmarsh zonation or haloseral succession is controlled by the position at which the saltmarsh lies in the tidal frame (Ranwell 1972; Long and Mason 1983; Packham and Willis 1997). The transitional zone from high saltmarsh to reedswamp lies above Mean High Water Spring Tide (MHWST); this zone experiences inundation during the highest equinoctial tides, the highest of the year, for as little as two to three hours.

Pollen evidence from Site D supports this hypothesis (CD 16.2). The site was initially colonised by sedges (*Carex* spp.) and grasses. These were replaced, within the top 6cm of the monolith, by a dramatic increase in the pollen of Chenopodiaceae (oraches), a family which includes a variety of halotolerant species such as glassworts (*Salicornia*), sea blites (*Sueada* spp.), and oraches (*Atriplex* spp.) (Chapter 14.4.1). These taxa are all commonly used by palynologists as indicators of saltmarsh.

At Gravel Banks, located 1.5km from the modern English shoreline of the Severn Estuary, reedswamp development was contemporaneous with that at Goldcliff East (Tetlow 2005; Tetlow and Smith, in prep). Formation of the basal peat at Goldcliff East was relatively short-lived. Radiocarbon dates, from the top and bottom of the peat lens in Site D suggest peat formation began *c* 6790±38 BP (OxA-12359; 5731–5627 cal BC) and ceased *c* 6726±33 BP (OxA-12358; 5720–5560 cal BC). Peat formation at Gravel Banks was equally short-lived occurring between 6620±70 BP (Wk 5826, 5620–5420 cal BC) and 6460±70 BP (Wk 5829; 5530–5260 cal BC; Druce 2001).

16.5 The Lower Peat at Site B

Two samples of the peat (Context 319) were examined but the few insects present (CD 16.1) were poorly preserved and fragmentary, which precluded interpretation.

16.6 Upper Peat and Upper Submerged Forest at Pit J

As the rise in relative sea levels slowed and sedimentation in the estuary reached equilibrium, peat formation at Goldcliff East resumed *c* 5749±23 BP (OxA-12356; 4690–4500 cal BC). Despite the widespread submerged forest which grew at Redwick and Goldcliff during the Mesolithic and Neolithic, entomological evidence of this forest from the associated peat deposits has been significantly absent. Similarly, only limited woodland taxa have been recovered from contexts associated with the Neolithic mixed birch and willow woodland at Redwick (Paddock 2003; Tetlow 2005). In contrast, samples from the Upper Peat at Goldcliff East have produced a sequence of well-preserved and diverse faunas, including two comprehensive and unequivocal woodland assemblages, directly comparable to those found to the west at Goldcliff (D N Smith *et al* 1997; 2000).

Samples were recovered from Pit J, situated at 1.49m OD, approximately 2m deep and cut between 5 and 7m from the Mesolithic edge of the Goldcliff East island. At both Redwick and Gravel Banks the Pleistocene sands and Head and the estuarine silts and clays which underlie the Upper Peats had produced no interpretable palaeoentomological material; hence no samples from these deposits were recovered from Pit J (Tetlow 2005). The first sample was from a discontinuous band of fragmentary reed peat, 5 to 10cm thick (Context 334). Subsequent samples were recovered from the substantial band of Upper Peat up to 85cm thick, which contained two distinct woody layers (Figs 6.7–6.8). For a list of the insect species present on this site see CD 16. 3 and for a tabular comparison of the insect and botanical evidence from Pit J see CD 16.4.

Pit J (119–93cm)

Both samples from the lower contexts of Pit J indicated similar environments. The aquatic species, the dytiscids, *Hydroporus scalesianus*, *Hydroporus tristis*, and the hydraenid, *Hydrochus brevis*, are all associated with small bog pools and leaf-filled woodland water bodies (Hansen 1987; Nilsson and Holmen 1995). Waterside species include the Carabidae, *Bembidion doris* and *Agonum thoreyi,* which are commonly found in swamps and marshes, with the latter more closely associated with tall reedswamp and fen (Lindroth 1974, 1986). The orthoperid, *Corylophus cassidoides*, and the pselaphid, *Bryaxis bulbifer*, are both found in damp tussocky grassland (Pearce 1957; Koch 1989a, 1989b). A single specimen of the curculionid, *Rhyncaenus sparsus*, was recovered, which lives at the margins of oak-dominated woodlands (Koch 1992).

Both assemblages were composed of aquatic and waterside species suggestive of some form of wet, tussocky grassland interspersed with boggy, leaf-filled, and possibly slightly acidic pools. It is likely that these biomes represented the 'sedge tussock' of Walker (1970), as any indicators of saltmarsh and brackish waters, or unequivocal indicators of reedswamp, were absent. Pollen from similar depths (100–110cm, pollen zone GC3) indicated that reedswamp was present at Goldcliff East (Smith and Morgan 1989). Pollen zone GC3 was interrupted by a fine band of sedge peat with vegetation composed of great fen sedge (*Cladium* spp.), grasses, and herbaceous plants – which included species such as catchflies (*Silene* spp.), ragged robin (*Lychnis flos-cuculi*) and pennyworts (*Hydrocotyle* spp.), all species of damp, boggy meadows. Smith and Morgan (1989) also suggest that these pollen assemblages indicate fen meadow or fen grassland.

Pit J (93–83cm)

Subsequently, conditions appear to have become notably drier. The abundance and diversity of aquatic species decreased significantly and these were replaced by species associated with swamps and bogs – living on vegetation composed of sedges and tussocky grassland with tall reeds, with mixed woodland across Goldcliff island (Fig 16.1). A distinct woodland fauna was found, although insect evidence suggests this woodland had not yet encroached upon the site. The most significant species was the renowned scolytid, *Scolytus scolytus* (the elm bark beetle). The wych elm (*Ulmus glabra*) will withstand periods of waterlogging and flooding better than the majority of deciduous trees and is common amongst floodplain vegetation (Nicholson and Clapham 1975). Pollen samples from between 93cm and 80cm also produced the highest values for elm in this monolith (AJ zone 1, Chapter 15). Equally, the nearby mixed woodland of Goldcliff island would have provided a source for obligate saproxylic and lignacious beetle species within easy flying distance. At Goldcliff, D N Smith *et al* (2000) suggested that these species of drier woodlands, many of which are ready fliers, may have flown or crawled in from the woodland on Goldcliff island itself, which is 5–7m from Pit J.

Other woodland indicators included the scaphidiid, *Scaphisoma agarcininum,* which is found in deciduous woodland amongst rotting, mouldy wood and fungi (Koch 1989a). More ambiguously associated with fen woodland were the Carabidae

Pterostichus minor and *Agonum livens*. These species are both found in damp woodland, but are more commonly found in swamps and bogs, the latter particularly associated with alder and willow carr (Lindroth 1974; 1986).

In comparison, the pollen diagram suggested nearby woodland dominated by oak and hazel (*Corylus* spp.), with lime (*Tilia* spp.), alder (*Alnus* spp.), ash (*Fraxinus* spp.), and birch (*Betula* spp.). Higher values for grasses, sedges, *Aster* spp., and the Chenopodiaceae are also found in this zone suggesting that saltmarsh and/or reedswamp conditions persisted nearby (Chapter 15). It seems likely that during this stage of development, the area around Pit J was sedge tussock (Walker 1970), little changed from that seen in the previous sample and at the margin of a mixed woodland, which was slowly encroaching upon the site. Reedswamp and saltmarsh were still within close proximity and suggest the waters of the estuary were static, or that relative sea-level rise had slowed.

Pit J (70–83cm)

Aquatic and waterside taxa continued to decrease and were replaced at this depth by woodland taxa and species associated with damp, decaying organic material. The Hydrophilidae, *Cercyon convexisculus* and *Cercyon sternalis* are found in damp, rotting organic material. A further hydrophilid, such as the Carabidae *Cercyon analis*, and the scarabaeid, *Oxyomus silvestris*, are found amongst fouler, rotting material; the latter is also found in dung, rotting manure and fungi in all types of countryside (Hansen 1987; Koch 1989b). The woodland assemblage was also characterised by species associated with rotting or mouldy wood: the colydiid, *Cerylon impressum*, is a saproxylic species, which is found under bark and infected wood and fungi (Hyman 1992); the anobiid, *Grynobius planus,* and finally, the aspidiphorid, *Aspidiphorus orbiculatus,* are found amongst old rotting timber and puffball fungi in, and at the margins of, woodland (Koch 1989a).

The peat from which this fauna was recovered was notably woody. The coleopteran fauna provided only limited evidence for the composition of this woodland. Many of the taxa recovered will live on the rotting wood of a variety of deciduous trees including alder, birch, beech, oak, and maple. However, identification of woody remains from across Site J, from peat at corresponding depths clarifies this issue; small amounts of oak, birch, and willow were found with a larger quantity of alder (Fig 6.2). The definition of alder woodland in the palaeoenvironmental record using entomological methods is problematic (see below Site K) and is related to the paucity of species which feed upon alder (*Alnus* spp.) (Bullock 1993).

Pit J (70–60cm)

Sclerites recovered from this depth were poorly preserved and highly fragmentary. The poor standard of preservation and limited assemblage allows only tenuous inferences to be made about the immediate environment at this time. Fen woodland, probably alder carr, persisted with an understorey of damp, tussocky grassland interspersed by shallow peaty pools: this interpretation is supported by the pollen evidence (Chapter 15).

The insect assemblage was extremely restricted and whilst a woodland element was still evident, there was a distinct absence of the lignacious and saproxylic species observed within the previous samples. Indicators of fen woodland, such as *Pterostichus minor* and *Pterostichus strennus*, decreased in abundance although *Agonum livens* reappeared (Lindroth 1974; 1986). A single specimen of the liodiid, *Agathidum marginatum*, was recorded and is found in rotting vegetation, fungi, and generally foul material in woodlands and other habitats (Koch 1989a). Species associated with tussocky grassland all but disappeared; many of the aquatic species which remained, such as the dytiscid, *Hydroporus melanarius*, are associated with ephemeral, peaty pools (Nilsson and Holmen 1995).

Plant macrofossils recovered from this depth displayed a similar decline in numbers and were totally absent at a depth of approximately 66cm, reappearing at 62cm (Chapter 15). It is unlikely that this paucity was a result of taphonomic factors such as compaction or drying of the peat after deposition. Well-preserved and relatively diverse coleopteran and waterlogged plant assemblages were obtained from the samples directly above and below this horizon. The most plausible explanation for this poor preservation is that there were drier conditions at the time of deposition; hence the preservation of the insect and waterlogged plant remains was compromised.

Pit J (60–35cm)

The samples from these contexts produced the most comprehensive woodland assemblage derived from any of the four sites explored for this research (Tetlow 2005). The assemblages suggest a complex mosaic composed of trees in all stages of growth and decay from saplings to the rotting remains of their ancestors. A rich understorey of shrubs, interwoven with honeysuckle (*Lonicera* spp.) and ivy (*Hedera* spp.), surrounding forest glades and clearings containing pools and boggy areas were also recorded (Fig 16.1). This complex woodland biome is reminiscent of the prehistoric 'Wildwood' (Rackham 1976).

Lignacious and saproxylic insect species suggested a heterogeneous canopy of mature deciduous trees: the curculionid, *Curculio venosus*, the scolytid, *Leprisinus varius*, and the colydiids, *Cerylon fagi* and *Cerylon histeroides*, are primarily associated with oak (Hyman 1992; Koch 1992). The rhizophagid, *Rhizophagus perforatus*, is found with rotting oak, elm (*Ulmus* spp.), and willow (*Salix* spp.) (Koch 1989b), and the tenebrionid, *Hypophloeus unicolor*, is found on rotting oak, birch (*Betula* spp.), and willow (Hyman 1992). The Curculionidae, *Acalles ptinoides* and *Rhyncaenus lonicerae*, scolytid, *Scolytus mali,* and scarabaeid, *Gnormius nobilis*, suggested a varied shrub layer of species compris-

Figure 16.1 Mixed deciduous woodland, fen carr, transitional reedswamp, and sedge tussock at Ynys Hir, Ceredigion. This mosaic is strongly reminiscent of vegetation at the island edge at Goldcliff East during the late Mesolithic (photo E Tetlow)

ing hawthorn (*Crataegus* spp.), hazel, dog rose (*Rosa canina*), honeysuckle, and various fruit trees such as apple (*Malus* spp.), pear (*Pyrus* spp.), and blackthorn (*Prunus spinosa*). Evidence of hawthorn and bramble (*Rubus*) were also recovered from the waterlogged plant remains (Chapter 15).

Aquatic and waterside species increased once more. The Curculionidae, *Thryogenes festucae* and *Thryogenes scirrhosus*, suggested the woodland floor was colonised by grasses and sedges interspersed with leaf-filled pools colonised by lush, emergent, aquatic vegetation such as club-rush (*Schoenoplectus lacustris*) and bur reed (*Sparganium* spp.) (Koch 1992). The aquatic species are characteristic of very slow-moving, or standing, water such as the Hydrophilidae, *Cymbiodyta marginella* and *Hydrobius fuscipes*, and the curculionid, *Tanysphyrus lemnae*, which feeds on duckweed (*Lemna* spp.) (Hansen 1987; Koch 1992). Drier areas also existed on the woodland floor – as indicated by the nitidulid, *Brachypterus urticae*, a monophagous species which feeds on nettle (*Urtica* spp.) (Bullock 1993), and by the curculionid, *Apion laevigatum*, which is found on disturbed ground, with mayweed (*Matricaria* spp.) and chamomile (*Anthemis* spp.) (Hyman 1992).

Pollen and waterlogged plant remains from comparable depths indicated that initially, birch was the dominant taxa at the site, but was rapidly replaced by alder. Wood identification from across Site J (Fig 6.2) indicates a mixed deciduous woodland composed of oak, alder, and birch, with some hazel and willow (Chapter 15). Insect evidence suggesting oak-dominated woodland with some limited evidence for birch and willow, conflicts with wood identification, as well as waterlogged plant and pollen evidence from corresponding depths. At Goldcliff East, the most plausible explanation for this disparity is the limited number of beetle species associated with alder carr and the large number of species associated with oak (Bullock 1993), an issue already highlighted. Pit J lies in close proximity to the remains of what would have been a large, mature oak Tree 8 (Fig 6.2). Oak trees support a vast diversity of invertebrate species, greater than any other habitat in Europe; more monophagous species are associated with oak than any other plant, and many oak-dwelling

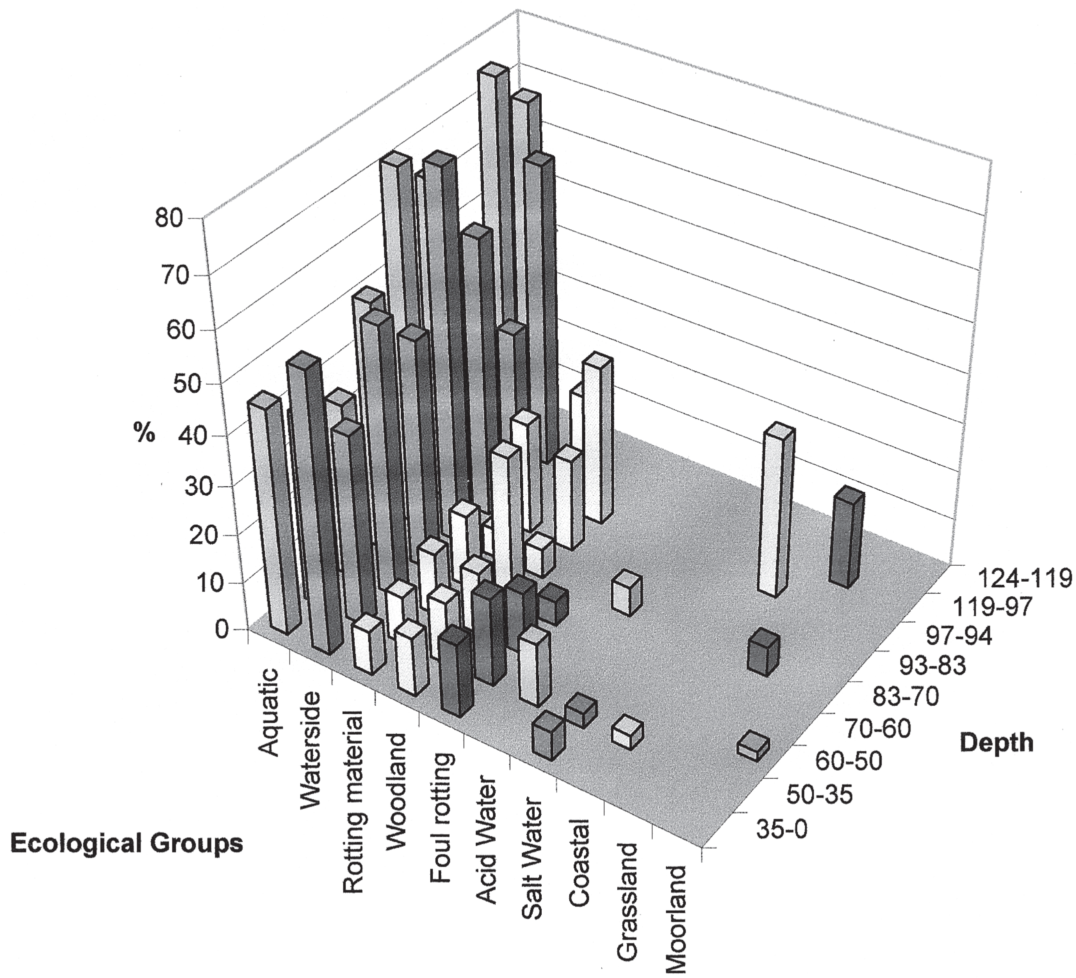


Figure 16.2 The main ecological groups of beetles in the sequence from Site J (for allocation to ecological groups and sources see CD 16.3) (graphic E Tetlow)

Coleoptera are dependant on rotting and decaying wood (Lewington and Streeter 1993). During the later Mesolithic, the area occupied by Pit J would have lain directly beneath the extensive canopy of this tree, which represented a highly productive and diverse environment. Hence, any beetle assemblage recovered from deposits forming beneath this dense canopy would produce a bias towards oak-dwelling species.

Other factors also affect this picture, including the large difference in pollen production by alder compared to oak (Erdtman 1969; Lowe and Walker 1984). Moreover acorns do not preserve well in the archaeological record. Whilst wood identification clarifies this issue, other botanical and entomological proxy indicators remain at significant odds and highlight the importance of multi-proxy study. This dense woodland stretched across much of what is now the modern, coastal embayment at Goldcliff East.

Pit J (35–0cm)

In the final sample from Site J the woodland fauna was still evident, but had begun to decline. It is replaced by aquatic and waterside species, suggesting that the area was becoming increasingly wet. Woodland indicators continued to suggest live oak trees, although the composition of the woodland appeared to be changing subtly, perhaps suggesting the opening of the canopy. Two species indicated pine (*Pinus* spp.) and other conifers: the rhizophagid, *Rhizophagus ferrugineus*, is commonly found in mixed and coniferous woodland and pine heaths (Koch 1989b), the curculionid, *Rhyncolus chloropus*, is associated with rotting pinewood and other conifers (Koch 1992; Bullock 1993). However, it is not impossible that both species migrated from the woodland on the nearby island since the dryland edge was located only 5m to 7m away.

Indicators of this regressive succession and woodland demise were the growing numbers of reed swamp and waterside species. The Dytiscidae, *Graptodytes granularis*, *Agabus bipustulatus*, and the carabid, *Elaphrus cupreus*, suggested silty pools with lush emergent vegetation (Lindroth 1974, 1985; Nilsson and Holmen 1995). This was also reflected in the pollen diagram, by grasses, sedges, and a series of herbs associated with wet grassland such as meadowsweets (*Filipendula* spp.). Aquatic taxa increased significantly in diversity and abundance in pollen zones AJ4 and AJ5 (Chapter 15). Many suggested muddy, slow moving or standing leaf-filled water. A small coastal/brackish component was also recorded, the hydrophilid, *Limnoxenus niger*, and the Dytiscidae, *Hydroporus tessellatus*, are found in pools and slow moving streams on salt marshes (Nilsson and Holmen 1995). Several saltmarsh Coleoptera were also recovered from the upper samples of the Site K and Tree 70 trenches.

This episode of succession at Goldcliff East was the most intriguing. The spatial variation of vegetation in a relatively small area suggested the complex interaction of both primary and secondary influences at work. The coastal component found within the Tree 70 trench and to a lesser extent Site J, suggested a short-lived acceleration in relative sea-level rise affecting the area. This persistent wetness would readily explain the demise of deciduous woodland, such as oak, unable to tolerate constant waterlogging and increasing levels of salinity.

The evidence for the expansion of coniferous trees such as pine was also significant: pines are a particularly light demanding tree and would not become successfully established in densely canopied or damp woodland (Nicholson and Clapham 1975). The presence of two species of Coleoptera which are both unequivocal indicators of pine do suggest that this taxa grew either at, or in very close proximity, to Site J. Extrapolating the proximity of pine to an individual site using pollen data is notoriously difficult (Caseldine 2000). Pine pollen will travel long distances and is more buoyant than the majority of species and was over-represented in several monoliths at Goldcliff, west of the island. The palaeoenvironmental investigations at these sites produced comparable results to those at Goldcliff East. Pine-dwelling Coleoptera were also found, but there was limited pine pollen in corresponding monoliths (D N Smith *et al* 1997, 2000; Caseldine 2000). Nonetheless, the insects suggest that pine had become established on Goldcliff island.

In the damper woodland surrounding Goldcliff island, succession appears to have progressed towards the development of ombrotrophic bog. With the demise of species unable to tolerate constant waterlogging, an expansion of alder and reedswamp vegetation occurs. The mixed alder/reedswamp at Goldcliff East was likely to have been the 'lag fen' found at the edges of an ombrotrophic bog, where nutrient-rich run-off created a more diverse environment (Caseldine 2000), prior to increased acidification and encroaching raised bog vegetation such as *Sphagnum*, cotton grasses and heather. At Redwick, raised bog began to develop over a similar temporal scale; a full record of the development of this raised bog may still be found in the Upper Peat shelf (Tetlow 2005; Tetlow and Smith in preparation). Many of the Coleoptera which recorded the early stages of bog development at Redwick were found in the assemblage from the Tree 70 trench (Paddock 2003; Tetlow 2005; Tetlow and Smith in preparation). Similar successional patterns during the Mesolithic/Neolithic transition have been found in peat deposits in the Dyfi Estuary (Tetlow *et al* in press).

16.7 Goldcliff East Tree 70

Across the Upper Peat shelf, 490m east of Site J, samples were recovered from around Tree 70, a large prone oak trunk (CD 7.6; 7.12), which lived for approximately 239–75 years, around 4200 cal BC (Chapter 8). For a table of the insect species present see CD 16.6. The environment around the fallen oak trunk, Tree 70, was subtly different to that at Site J and suggests damper woodland than that found closer to the island edge; lignacious and saproxylic insect taxa persist throughout. Clear evidence of burning was found around Tree 70; this is not reflected in the composition of the coleopteran assemblages. None of the species associated with burnt woodland by Whitehouse (2000; forthcoming) or Professor Russell Coope (pers comm) was present.

Tree 70 (43–34cm)

The early stages of vegetation development at the site were characterised by species suggestive of shallow, clear, acidic pools, damp woodland, and leaf litter. This environment persisted in the subsequent sample which suggested slow moving, or standing, water surrounded by abundant leaf litter and, again, the presence of deciduous woodland.

A degree of ambiguity was associated with the woodland species in these two samples, such as the carabid, *Pterostichus strennus,* which is found amongst leaf litter in damp woodlands but also in other wet habitats (Lindroth 1974). A more distinct indicator of woodland was the cisid, *Cis* spp., which are commonly associated with bracket fungi on both coniferous and deciduous trees in all types of woodland (Koch 1989b). Notable by their absence from these two samples were any indicators of either estuarine or saltmarsh conditions, or reedswamp. Pollen and waterlogged plant remains from Site F, 185m to the west of this area, did suggest the close proximity of saltmarsh or reedswamp and carr-woodland colonised by willow, alder, and oak (Chapter 15).

Tree 70 (34–23cm)

The subsequent samples were dominated by species directly associated with lighter woodland or woodland margins with a muddy substrate colonised by rushes and reeds.

Many of the woodland species were associated with damp and rotting wood: *Rhizophagus bipustulatus* is generally found on oak and beech (*Fagus* spp.), but also found were more cosmopolitan species such as the anobiid, *Grynobius planus* (Koch 1989b;1992). Fen woodland species were also present; the carabid, *Agonum livens*, is found in willow and alder carr, whilst many of the aquatic species such as the dytiscid, *Hydroporus tristis*, are common in leaf woodland pools (Nilsson and Holmen 1995), the hydraenid, *Hydrochus brevis*, is also found in woodland pools and reed litter (Koch 1989a).

A larger component of this assemblage in relation to parallel woodland contexts from Site J, were species of waterside vegetation such as sedge tussock and tall reedswamp (Walker 1970). The Staphylinidae, *Olophrum fuscum* and *Lesteva heeri* (Koch 1989a), are indicative of muddy substrates with vegetation composed of reeds, sedges, and rushes (*Juncus* spp.) as is the orthoperid, *Corylophus cassidoides* (Koch 1989a). Some evidence of taller reeds was found in the presence of the monophagous reed dwelling chrysomelid, *Plateumaris braccata*, and the curculionid, *Thryogenes schirrosus*, found amongst bur reed (*Sparganium* spp.) and club-rush (*Scirpus* spp.) (Koch 1992).

Pollen and waterlogged plant evidence from corresponding samples also indicated damp woodland with an understorey of sedges and interspersed by shallow pools, fringed by tall, emergent vegetation. Initially, alder dominated the aboreal pollen, however, the waterlogged plant remains suggested the woodland was predominantly composed of birch (Chapter 15). It is possible that this disparity between pollen and waterlogged plant remains was a result of the large amounts of pollen produced by alder in relation to other arboreal species (Erdtman 1969; Lowe and Walker 1984). Whilst any conclusive evidence of alder carr was absent from the insect assemblage, the presence of alder woodland, or fen carr, was supported by wood identification and further pollen analysis from Site F (Chapter 15). Wood identifications indicated an extensive area of alder carr with limited amounts of willow and two significant fallen oak trunks (Tree 39 and Tree 40). Pollen evidence also suggested that alder, with some willow, dominated this woodland.

Tree 70 (23–0cm)

The final sample from this sequence suggests that the progressive trend towards 'climax' deciduous woodland was checked and a hiatus in vegetative succession occurred. The site was colonised by a complex mosaic of ecotones that included reedswamp, damp woodland, raised bog, and saltmarsh. Evidence of a short-lived sea-level oscillation was found at Site J, Site K, and Site F. Foraminifera were found at corresponding depths in Site F (305m to the east of Site J) and in Pit J: their presence was probably the result of a storm surge or exceptionally high tides (Chapter 15). Evidence from Tree 70 suggests that estuarine influence may have persisted for slightly longer in this area; saltmarsh taxa from the uppermost sample of the Tree 70 trench were considerably more abundant. The pselaphid, *Brachygluta simplex*, and the carabid, *Tachys scutellaris*, are both restricted to saltmarshes and coastal locations (Lindroth 1974; Pearce 1957). Two further carabids, *Bembidion varium* and *Bembidion assimile*, are found on sparsely vegetated, muddy substrates and are both halophilous taxa (Lindroth 1974, 1985). Evidence across Goldcliff East suggested the close proximity of saltmarsh habitats and positive sea-level tendencies during this period of peat formation. This transgression was also recorded by Smith and Morgan (1989), but was not found in the corresponding insect or pollen assemblages west of the island at Goldcliff (D N Smith *et al* 1997, 2000; Caseldine 2000).

A second significant component of the assemblage from Tree 70 was the appearance of the curculionid, *Micrelus ericae,* a phytophagous taxa associated with heather (*Calluna* spp.), and potentially implied the early stages of a raised bog formation. Raised mire developed at Goldcliff East between 5020±80 BP (CAR-652; 3970–3650 cal BC) and 3130±70 BP (CAR-644; 1530–1210 cal BC) (Smith and Morgan 1989). Evidence of damp habitats with heather was found in assemblages from both Redwick and Goldcliff; at both sites conclusive entomological evidence of mature raised bog was recorded (D N Smith *et al* 1997, 2000; Paddock 2001; Tetlow 2005). However, at Goldcliff East, the Upper Peat shelf has been severely truncated by erosion and evidence of the well-developed raised bog which covered Goldcliff East is virtually absent from the sites which have been investigated, with the exception of Site F. Evidence was limited to preserved cotton grass (*Eriophorum* spp.) on the current surface of the peat in places on Site J (Fig 6.2). Further site-specific evidence came from a small trench, which was opened in 2001 to remove a dendrochronological sample from the prone oak trunk of Tree 8 in Site J (CD 6.1–6.2). The uppermost sample was rapidly assessed by the author and produced an assemblage restricted to Coleoptera found in wet moorland and raised bogs.

16.8 Goldcliff East Site K

Site K (27–18cm)

This is an area of the Upper Submerged Forest, 630m east of the former island. The wood here was subject to detailed planning and botanical investigation. The location selection for pollen, plant macrofossil and insect studies is illustrated in CD 15.2 and 15.4. For a table of the insect species present see CD 16.6. The assemblages from the pit at Site K varied little throughout peat formation and were predominantly composed of taxa which live amongst damp tussock grassland or sedge-dominated fen and tall reed swamp. No significant or definitive woodland assemblage was found.

The carabid, *Dyschirius globosus*, is found on all types of moist open ground, further species of the pselaphid family are all found on tussocky grassland and with mosses and sedges in freshwater locations (Lindroth 1974; Pearce 1957). Many species suggested damp, rotting material including the hydrophilid, *Cercyon sternalis*, and the staphylinid, *Micropeplus porcatus* (Hansen 1987; Koch 1989b). One of the most significant species is the anthicid, *Anthicus gracilis,* which is found with the rotting debris of the common reed and sedges (Koch 1989b). Today, this species is extinct in the British Isles and its current ecological range is central and south-eastern Europe (Duff 1993). A single indicator of brackish influence was found: the pselaphid, *Brachygluta simplex*, lives amongst rotting tidal debris and the roots of grasses and is exclusive to coastal locations and saltmarshes (Pearce 1957). At this stage, the pollen from this area did not demonstrate any great disparity with the insect fauna, as pollen recovered from between 26cm and 20cm suggested a similar environment to that of the insects: grasses and sedges with a small woodland component predominantly composed of oak (Chapter 15).

Site K (18–0cm)

Species associated with damp, tussocky grassland persisted, but overall, this assemblage strongly suggested a transition from this type of vegetation to tall reedswamp with strong evidence for some form of deciduous woodland. Two species of Carabidae, *Agonum viduum* and *Agonum thoreyi*, were both suggestive of tall reedswamp, the latter species commonly associated with the common reed and bulrushes (Lindroth 1974; 1986). Also increasing sharply were the incidence and abundance of species associated with 'fen litter' and the decaying remains of reeds and sedge. These included the hydrophilids, *Cercyon sternalis* and *Cercyon convexiusculus* (Hansen 1987), and also the staphylinid, *Lesteva heeri* (Koch 1989a).

Whilst demonstrating an overall decrease, the aquatic species continued to suggest slow moving or standing waters. A third hydrophilid found within this sample, *Hydrobius fuscipes*, is particularly characteristic of standing water and may be found amongst rich vegetation in the shallows (Hansen 1987). A single halobiontic species was recovered form this sample, the carabid, *Bembidion normannum* – a species found exclusively in coastal locations on clay substrates (Lindroth 1974).

The woodland component was represented by the anobiid, *Grynobius planus*, found amongst the dry, dead branches of a wide variety of deciduous trees including oak (*Quercus* L.), beech (*Fagus* L.), birch (*Betula* L.), and alder (*Alnus* Mill.) (Koch 1989b). Other, more ambiguous indicators included the Carabidae, *Pterostichus diligens* and *Pterostichus minor,* which are commonly found in damp deciduous woodlands, swamps, and bogs (Lindroth 1974; 1986).

The insect assemblage suggested that Site K was at the margins of the woodland, or within a substantial clearing. The biomes represented by the insect assemblages from Site K correspond with the 'sedge tussock' and 'grass-dominated fen' phases of hydroseral succession (Walker 1970). In contrast, pollen evidence suggested the area was colonised by alder carr; wood identification also indicated mixed woodland, composed mainly of alder and willow with some birch and hazel (Chapter 15). In the final sample, alder pollen increased dramatically, and continued to do so throughout the final samples, other taxa including grasses, sedges, and other arboreal taxa demonstrating a corresponding decrease. The explanation for this paucity of alder-dwelling Coleopteran taxa is relatively simple: definition of alder carr from the palaeoentomological record is notoriously difficult. This topic has been addressed by D N Smith and Whitehouse (2005), D N Smith *et al* (2000), Robinson (1993), and Girling (1985). The vast majority of deciduous trees support a relatively large population of beetles (Girling 1985). Alder is the exception to this rule: whilst 93 species feed upon oak, only 14 feed upon alder (Bullock 1993). A similar lack of evidence was found in alder-related contexts at Goldcliff by D N Smith *et al* (2000) and at Site J. Analysis is hampered further by a void in current entomological knowledge of insect dynamics in modern alder carr, a rare and rapidly declining biome (Rodwell 1991a).

16.9 Conclusions

The insect assemblages from Pit J at Goldcliff East have produced a clear picture of vegetative succession at the site during the late Mesolithic. The assemblages from Site D and Pit J represent the following discrete phases of succession:

Lower Peat (Site D)

- Transitional reedswamp on site, with estuarine and saltmarsh biomes seaward;
- Saltmarsh covers site.

Estuarine Sediments

The Upper Peat and Submerged Forest

- Reedswamp re-established, vegetation change driven by succession;
- In Site J, sedge tussock and tall reedswamp persisted. Mixed alder and willow carr became established. Mixed deciduous woodland composed of oak, hazel, and birch covered Goldcliff island (Caseldine 2000; Chapter 15);
- Drier conditions at the site compromised the preservation of proxy evidence. Pollen evidence indicated alder-dominated woodland (Caseldine 2000; Chapter 15);
- Mixed deciduous woodland covered the site. Mature deciduous trees with a shrubby understorey were interspersed by damp pools and channels filled with emergent aquatic vegetation;
- During the late Mesolithic to early Neolithic, the vegetation was a mosaic of mixed woodland, tall reedswamp, saltmarsh and raised bog. Parallels may be drawn with environments at Goldcliff, west of the island, during the late Iron Age *c* 300 cal BC (Bell *et al* 2000). The woodland canopy was opened by increased waterlogging in the

former wetlands surrounding Goldcliff island giving rise to 'lag fen' vegetation. A short-lived rise in sea level established an area of saltmarsh close by;
- Raised ombrotrophic mire became established at Goldcliff East.

The insect evidence is important in complementing the environmental picture derived from botanical sources outlined in Chapters 14 and 15. In particular the beetles show that the peat on Site D postdates the period of the Lower Submerged Forest and relates to reedswamp subject to, at first occasional, and later progressive, marine inundation. This also accords with the sedimentary evidence from Sites D and B presented in Chapter 7.3. Thus, pollen evidence for hazel and oak woodland at this stage derives from the nearby island. The beetles and botanical evidence between them provide an environmental transect from the island at Site J to Site K in the wetland to the east. In the Upper Submerged Forest on Site J at the island edge we have evidence for a old woodland beetle assemblage (Fig 16.2), which is less well attested away from the island at Site K where conditions were more open despite the existence of the Submerged Forest. The Upper Submerged Forest was subject to episodic water-table rises and some evidence of marine incursion. Other disturbance factors such as the elm decline which might be related to the effects of disease or minor reductions of woodland could relate to natural disturbance factors (such as storms or grazing animals) or small-scale human activity. The beetle evidence does not provide direct evidence of human activity at the time of the Upper Submerged Forest. As woodland became established at Site J, it may have formed a dense, impenetrable barrier of fallen trees, vines and boggy, leaf-filled pools, which would have presented communities with an extremely challenging environment to exploit. Notably absent from the Pit J assemblage were any species of the family Scarabaeidae, commonly known as 'dung beetles', which would suggest large grazing animals. This may be a significant observation given Smith and Morgan's (1989) interpretation of a pastoral clearance event just after the elm decline and Dr Dark's contention (Chapter 14) that the vegetation changes at this time might be artefacts of changes in pollen recruitment at the transition from fen swamp to raised bog. Neither the pollen studies reported here nor the archaeological fieldwork have found any certain evidence of Neolithic activity. Likewise, the insect evidence points to a low level of human activity in the closing centuries of the Mesolithic and later.

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17 Sediments and soils *by J R L Allen and Virgil Yendell*

17.1 Introduction

The overall sedimentary sequence at Goldcliff East has been outlined in Chapter 2 (Fig 2.6). The Goldcliff area has been the subject of extensive sedimentary research. Allen (2000a) presented the evidence for the former Goldcliff island and its encircling Pleistocene raised beaches. Bell *et al* (2000) investigated the Holocene sediment sequence and associated archaeological finds west of the former island. Allen (2001) has used borehole evidence to investigate the buried palaeotopography and sediments of the Gwent Levels more widely. Subsequently there has been a campaign of research in parallel with the archaeological investigations reported here and focused on the mid-Holocene sediments between the River Usk and Magor Pill, which includes the Goldcliff area. This research has been led by Professor J R L Allen and collaborators and has been important in placing the investigations at Goldcliff in a wider context. This research has particularly concerned the identification of erosion episodes and embayments within the Wentlooge Formation (Allen and Haslett 2002) and evidence for annual banding in the laminated lower Wentlooge Formation sediments (Allen 2004; Dark and Allen 2005; Allen and Haslett 2006). Section 17.2 summarises the evidence for annual banding which is of particular archaeological significance. This is followed by Virgil Yendell's contribution on the micromorphological investigation of soils and sediments from excavations at Sites D, B, A, and J.

17.2 Annually banded sediments *by J R L Allen*

The silts of Unit vi between the Upper and Lower Peat, which yield such a rich assemblage of human and bird footprint-tracks near low-water mark at Goldcliff East, exemplify a facies of Holocene high mudflat-saltmarsh silts increasingly recognised throughout the Severn Estuary Levels. They have a number of archaeological implications as well as being significant for an understanding of the sedimentology and evolution of this and other Holocene estuarine sequences.

This significant facies is characterised by the presence of a textural banding that ranges from visible to the unaided eye to cryptic and demonstrable only by high-resolution granulometry (Allen 1990a, 2004; Allen and Haslett 2002, 2006). Typically, the bands, however resolved, range between several millimetres and several centimetres in thickness, but examples measuring up to a few decimetres are known locally. It is only in the coarser silts that banding is visible to the unaided eye. Each band consists of a set of fine-grained tidal laminae that grades up into a set of coarse-grained laminae. The laminae take a sub-millimetre–millimetre thickness, and each consists of a sharp-based lower part of clean silt/very fine sand, often with detrital plant fragments, grading up into a clay-rich upper portion. It is sometimes possible among the laminae present in the thickest bands to detect, in terms of lamina scale, a range of tidal periodicities (eg Plater *et al* 2002; Stupples 2002). The coarser laminae are the least resistant to erosion by wave and tidal currents and consequently tend to be recessed in outcrops of the silts. The banding present in the finer grained silts is cryptic and can only be resolved by measuring the grain size of contiguous slices of sediment that are much thinner than the banding itself (eg Allen 2004; Allen and Haslett 2006). In thin section these silts vary from completely structureless to faintly laminated on a sub-millimetre scale. Irrespective of the overall texture, however, the finest part of a band can have as little as half the grain-size of the coarsest (Allen 2004; Allen and Haslett 2006).

It is becoming clear that the textural signature in these banded sediments is paralleled by a botanical one. In a so far unique representation of the facies on the Caldicot Level, the coarsest part of each band is associated with a thin layer (≤ 3mm) crowded with prostrate, subparallel plant stems (Allen and Haslett 2006). The plants appear to be a grass or small rush, and were evidently decayed when they were laid flat by the current that gave each assemblage its preferred orientation. An occurrence with many similarities has been described from the modern marshes of a British Columbian estuary (Gibson and Hickin 1997). More likely to be encountered are the subtle patterns in the concentration and percentages of pollen and spores recently described by Dark and Allen (2005). Banded silts from just below the main peat as developed at Goldcliff East have in the fine-grained parts a higher proportion of pollen from late spring- to summer-flowering plants than in the coarse-grained ones. The total concentration of pollen is also highest where the silt is finest.

An annual origin can be assigned to the banding (Allen 2004; Dark and Allen 2005). It is accounted for in terms of two linked models, that for texture resting on seasonal changes in the climate and hydraulics of the modern estuary, and that for the palynology on the observed patterns of flowering and sporulation, albeit involving a plant population modified by human activities. Winter in the Severn Estuary is characterised by low sea temperatures (high water viscosity) and frequent storms (enhanced turbulence), whereas during summer, storms are rare and water temperatures are high. Under these conditions, mudflats and saltmarshes are expected to accumulate significantly coarser silts during winter than summer, the difference in grain size increasing with the general severity of the year in terms of storminess and temperature. The pollen and spore content of the coarser deposits are consistent with deposition from the buffering 'reservoir' of suspended grains in the estuarine water-body and from rivers, when there is little pollen in the 'winter' air. During the season of flowering and sporulation, however, a fresh supply of grains is expected to be added to these 'background' sources, enhancing the levels available for incorporation into the fine-grained 'summer' sediments. Currents are likely to be able to flatten and orient plant tissues only after the autumn die-back when, in a link with the physical model, the coarsest silts are expected to be deposited.

Two stratigraphical contexts for the occurrence of annually banded silts are particularly important (Allen 2003). One being investigated in the Gwent Levels is the product of continuous, unbroken deposition over the course of a relative sea-level fluctuation. A highest intertidal-supratidal peat is seen to grade upward without a break into a saltmarsh silt, as demonstrated by Foraminifera, in turn grading up into another peat. Banding in this case is confined to the middle levels of the silt and is found to decline in thickness upward and downward from there. The implication is that the rate of relative sea-level rise at first increases and then decreases. The second context involves a mudflat-saltmarsh silt also contained between two peats. In this case, however, the top of the Lower Peat, or a horizon low in the silt, is a visible to cryptic depositional break, normally marked by a jump in grain size, from fine to coarse, and in Foraminiferal facies, from high marsh to mudflat/low marsh. Visible breaks are marked by some or all of an uneven surface, concentrations of sand and/or shells, and lumps of peat. The annual banding in the silts above shows only an upward decline in thickness, pointing to the initially rapid and then more gradual filling up of accommodation space permitted by a change of regime from an eroding to an accreting coast. Together with a second bed of a similar character, one such mid-Holocene occurrence detected on the shores of the Caldicot Level (Allen and Haslett 2002) has now been traced over an outcrop of 15km (Allen and Haslett 2006). Other examples are provided by the post-medieval Rumney, Awre, and Northwick Formations, recorded throughout the Severn Estuary (Allen and Rae 1987; Allen 1990a, 2004).

Annual banding in estuarine silts has three main implications of archaeological interest (Allen 2004; Dark and Allen 2005). First, it has the potential to provide short chronologies at high resolution, changing from floating to absolute where high-precision radiocarbon dating becomes possible. Second, it provides evidence of seasonality. For example, footprint-tracks made in the fine-grained part of a band, perhaps rendered stiff but still impressionable by a degree of drying, can be interpreted as registering 'summer' activity. The third implication is climatic. According to the physical model, the difference in grain-size between the coarse and fine parts of bands should become more marked as 'winter' and 'summer' conditions of storminess and temperature increasingly differ. According to recent high-resolution textural work (Allen and Haslett 2006), a laterally extensive unit of banded silts deposited on the Caldicot Level *c* 5000 cal BC was formed under climatic conditions on the whole significantly milder than today, a conclusion supported by independent evidence.

17.3 Thin section examination of Mesolithic Old Land Surfaces and occupation horizons *by V Yendell*

17.3.1 Introduction

Research focused on the Old Land Surface (OLS) at four sites (J, A, B and D) on the margins of the former Goldcliff island. The OLS slopes south-east from the island with the more easterly sites at successively lower OD heights. Thus, the Old Land Surfaces do not represent a single chronological phase but a surface progressively inundated by estuarine peats and silts of the Wentlooge Formation (Fig 2.6). This chapter provides summary micromorphological descriptions and identifies evidence for the nature of the sedimentary and landscape change. The research reported here is presented in greater detail by Yendell (2004), where the research aims were to characterise the formation and evolution of the identified Old Land Surfaces at successive tidal frames and stages of inundation, to establish whether any of the land surfaces represented soils and to identify any evidence of human activity which they contained. The research reported here follows previous soil micromorphological research on Site W, west of Goldcliff island by Macphail and Cruise (2000). For a glossary of micromorphological terms see CD 17.11.

The methods used are outlined in greater detail in Yendell (2004). These include: micromorphological analysis of multiple soil-sediment profiles (described according to the methods of Bullock *et al* 1985); particle size analysis; X-ray diffraction of the clay component; total phosphate analysis; and smear slide investigation of sponge spicules.

17.3.2 Site D

The excavation on this site was outlined in Chapter 3.4, the stratigraphic relationship of the samples is shown in Fig 3.8 and CD 3.12. Scanned images of the thin sections of the sediments at Site D are shown in CD 17.1, positioned on a close-up view of the section drawing of Site D in order to show them in their sedimentary context. Slide 5522 is the lowest in the section and contains Context 348 as the basal sediment. Particle size data shows Context 348 is a sandy silt. However, in thin section it is indistinguishable from the overlying sediment (Context 347). The particle size data shows that the OLS (Context 346/347) has a smaller coarse fraction than the underlying sediments. The resulting description of a silty fine sand plus the micromorphological description of sandy clay loam support the in-field interpretation of an OLS. A peat (Context 345) seals Context 346/347, which is in turn sealed by an estuarine silty clay (Context 344). Summary micromorphological descriptions from this sequence are presented in CD 17.2.

Overall, the loss of structure and lack of voids in the Old Land Surfaces across the sites is typical of drowned palaeosols (Macphail and Cruise 2000, 56). Lithologically the OLS is similar to that investigated at Site W, but lacks the high frequency of charred roots and bone (*ibid*). The absence of any appreciable difference between the phosphate levels of this context (Context 346/347) and two background samples demonstrates a lack of significant human input at this site, although the presence of human intestinal parasites suggests otherwise (Chapter 14.5.4).

Overlying the minerogenic sediment is a peat (Context 345), the boundary representing a sharp intrusion with only slight root disturbance. Thin section 5519 shows the peat for most of its depth as intercalated with millimetre thick layers of silty clay (Context 344). The intercalated peat is shown in a plane polarised light close up in Photo 1 on CD 17.1. The incidence of sponge spicules and the very fine particle size of this silty clay confirm the apparent marine origin. This pattern suggests peat formation and then successive but intermittent marine sedimentation.

The site has been interpreted as a possible defecation area due the discovery of evidence for intestinal parasites (Chapter 14.5.4; Dark 2004a). The higher phosphate reading for the peat at Site D (2.75 to 5.38ppm), compared to Site B (0.62 to 2.58ppm), points towards activity while the site was waterlogged. Occupation is unlikely due to the waterlogged conditions and because such activity would be associated with biological mixing of the upper portion of the profile (Macphail and Cruise 2000, 56). Mixing is clearly not evident in the boundary between the peat (Context 345) and the underlying Old Land Surface (Context 346/347).

17.3.3 Site B

The excavation of this site was outlined in Chapter 3.3, the stratigraphic relationships of the samples are shown in Fig 3.5. Presented in Figure 17.1 (in colour on CD 17.3) are images of thin sections spatially distributed at their sample depths within the section face of Site B. The lowermost sediment present in thin section, Slides 5626 and 5525, is Context 321 and is the occupation horizon. Particle size data gives this sediment as a slightly sandy silt, but it is apparent more as a sandy clay loam in thin section. Context 321 is very similar in lithology to the underlying sediment (Context 322) but its higher gravel content distinguishes it. According to field descriptions, Context 341 overlies Context 322, although no additional context is apparent in thin section. Intercalated with the upper section of the occupation horizon is a peat (Context 319, Slide 5524). Sealing the site is Context 318, present in slide 5524. In thin section this sediment has a predominantly clayey matrix but particle size analysis indicates a sandy silt. Summary micromorphological descriptions from this sequence are presented in CD 17.4.

The small amount of gypsum and pyrite (Photo 1, Figure 17.1) in the OLS indicates a change from a reduction to an oxidation chemical environment. Pyrite framboids form in association with decaying organic matter, within acid sulphate soils in marine sediments (Bullock *et al* 1985, 67; Dent 1986, 75). The presence of pyrite is an indication of chemical reduction, which may be a result of marine inundation. Additionally, the leached conditions indicated by pale grey colouring of all of the possible Old Land Surfaces was also highlighted at Site W and is indicative of drowned palaeosols (Macphail 2000, 56). Pyrite is readily weathered into gypsum in an oxidation environment (Bullock *et al* 1985, 70). The incidence of these minerals in the OLS and intercalated peats and silts indicates short-term marine transgressive-regressive phases (Grim 1968; Bullock *et al* 1985; Dent 1986, 75). The lack of pyrite and iron formation in the upper bounds of the OLS, along with the lightness of colour, signifies possible leaching in the profile. No glauconite was recorded until nearing the upper boundary though. The presence of glauconite is an indication of chemical reduction, which may be a result of marine inundation. Glauconite is indicative of marine diagenesis under bacterial action and is also connected to high levels of organic matter. Glauconite is also associated with slow sedimentation rates, due to the ease with which it is altered into limonite and geothite (Grim 1968, 541; Gribble and Hall 1992). A particle of glauconite is shown in cross-polarised light (Fig 17.1, Photo 2) and plane polarised light (Photo 3). The glauconite present could be related to the waterlogging indicated by the overlying peats (Context 319), or inundation related to the estuarine silts (Context 318), but due to its nature will only have formed near the surface of the sediment at the time. The boundary between the OLS (Context 321) and the peat (Context 319) is prominent but diffuse, and bioturbation is evident in both. The

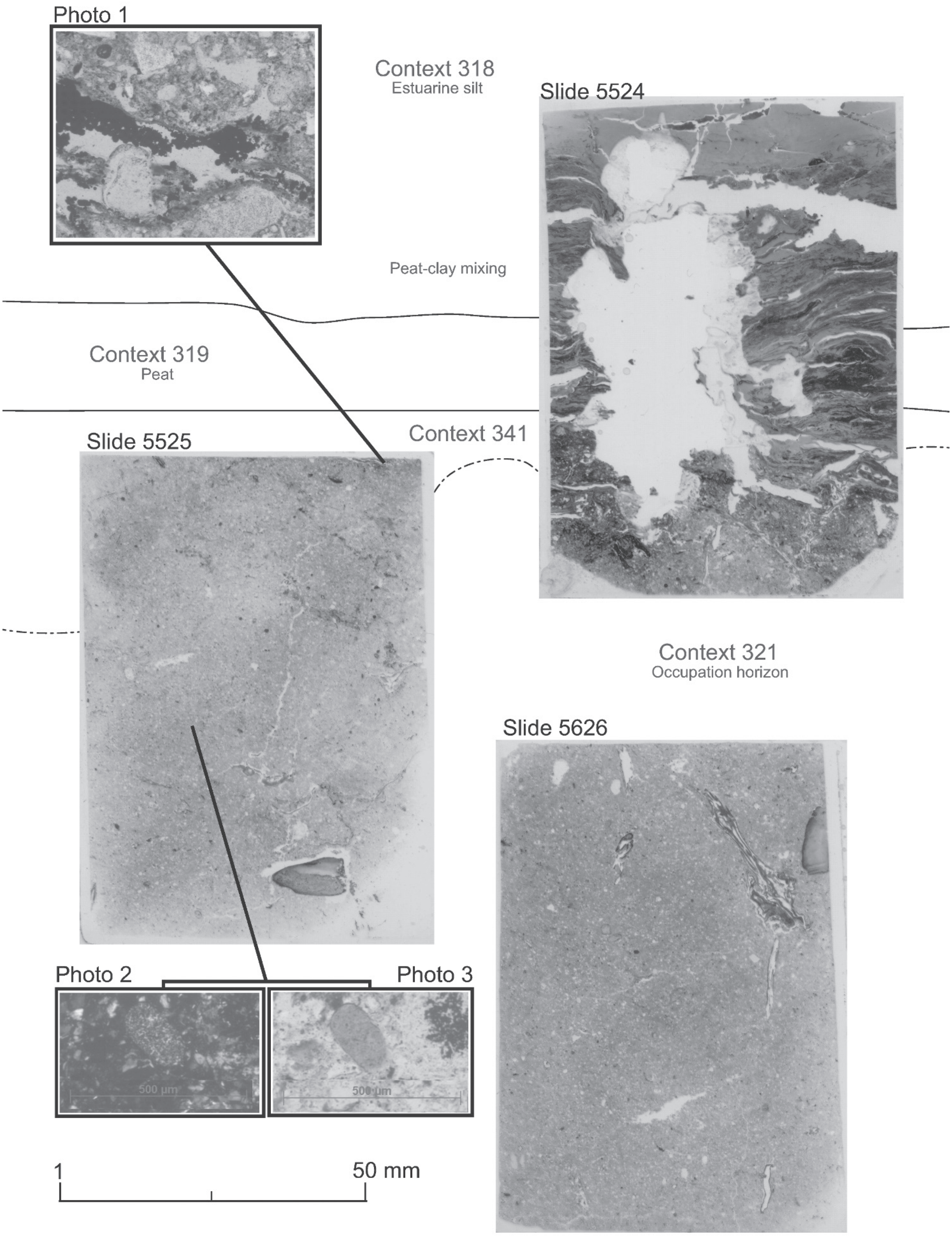


Figure 17.1 Goldcliff East, Site B: flatbed scans of thin sections at their sample positions on the relevant section drawing (for colour version see CD 17.3) (photo V Yendell)

peat is not continuous and is intercalated with thin silty layers (Slide 5524).

The phosphate levels for the OLS (Context 321), at 0.21 to 0.43ppm, are noticeably different to its overlying sediments (Contexts 319 and 318), between 0.62 to 2.78ppm, but not the background readings (0.21 to 1.35ppm). Although the high readings near the surface of Context 321 (0.62 to 0.65ppm) may be related to the higher P content of the overlying peat (Context 319), from 0.62 to 2.58ppm, the micromorphological descriptions suggest an increase in charred organic matter over this section, visible as dark particles in the lowest unit of Slide 5524 (Fig 17.1). Higher phosphate readings could suggest some human input but the levels are not statistically significant. A lack of coarse charcoal does allow for the distribution to be a result of biological mixing or marine inundation (Macphail and Cruise 2000, 56). The incidence of glauconite as a possible indicator of the rapidity and strength of inundation may with more investigation help resolve this.

17.3.4 Site A

The excavation of this site was introduced in Chapter 5 and the location of the sediment micromorphology samples is shown on CD 5.10. Scanned images of the samples are presented in CD 17.5. The images are spatially distributed on a close up of the east/west section. Context 316 overlies the Head, a silty sand (Context 317). Context 316 is less coarse than the Head with particle size data indicating a sandy silt and micromorphological description suggesting a sandy clay loam (Slide 5517, CD 17.5). Context 316 has a similar lithology to its overlying sediment (Context 315), as they are both sandy silts. The site is sealed by an estuarine sediment with a silty clay particle size. Summary micromorphological descriptions from this sequence are presented in CD 17.6.

Pyrite framboids are present in these sediments but could also form as a result of the later Holocene marine transgression that continues today. A degree of gypsum present in the upper section of the occupation horizon (Context 315) indicates oxidation conditions at the time of its formation. All of the pyrite may have been altered to gypsum. This further suggests that the upper layer was under a different chemical environment to that below (Grim 1968; Bullock *et al* 1985; Dent 1986, 75).

The Old Land Surface is separated into two contexts due to the extremely high charred component of the upper part (Context 315), visible in Photo 2, CD 17.5. Contexts 315 and 316 are lithologically the same. The occurrence of possible sponge spicules in Context 315 indicates some marine input. An absence of sponge spicules from the overlying marine sediment (Context 314) may be the result of chemical and mechanical action. The nature and distribution of the coarse charcoal and bone remains is similar to that found at Site W, suggesting a lack of disturbance and gentle sedimentation. Localised fireplaces may have been broken by any post-occupation biological activity or gentle inundation (Macphail and Cruise 2000, 56).

The diffuse concentration of bone and large charred matter in a banded distribution suggests some concentrated activity on a temporal scale (Slide 5516, CD 17.5). Photo 3 is a close up of a possible fish tooth in thin section; fish remains were abundant on Site A (Chapter 13.2). The presence of bone in the lower parts of the estuarine silt could be due to bioturbation and sedimentary mixing. Human activity on Site A is accompanied by significantly (0.0 at <0.05) higher phosphate levels, up to 9.56ppm, than were recorded from Sites D, B, and J – with a highest of 1.07ppm.

The mineral results show that the OLS (Contexts 316 and 315) includes expandable and illite clays. There is a high incidence of void fillings in Context 315, some with laminated layers (CD 17.5, Photo 1), also showing different stages and forms of illuviation in this possible B-horizon. The micro-laminations in the fillings within voids are a result of the influence of Na^{++} ions on a fine-grained soil and not to clay translocation typical in forest soils (Macphail and Cruise 2000, 56).

17.3.5 Site J

The excavation of this site was introduced in Chapter 6 and the location of the two sequences of samples examined for sediment micromorphology are shown on Fig 6.9 and on photographs on CD 6.29–6.30. The eastern sequence of samples was taken where the Old Land Surface (Context 328) was overlain by estuarine sediments (Context 331) and the western sequence where it was overlain directly by peat (Context 327).

Site J (east)

Flatbed scans of the prepared thin sections are presented at their sample positions on the relevant section drawing (CD 17.7). The basal sediment included in the thin sections is the occupation horizon (Context 328), a sandy clay loam. Particle size analysis records Context 328 as a sandy silt or sandy clay. Its basic lithology is similar to field descriptions of the underlying sediment, sandy silt with gravel, but it is significantly finer. Sealing the OLS is Context 331 (Slide 5631). A small degree of sand is evident in thin section, in this sediment's lower portion. However, the particle size analysis records only clay and silt. Overlying Context 331 is first a reed peat (Context 327), only visible in thin section at the very top of Slide 5630. Summary micromorphological descriptions from this sequence are presented in CD 17.8.

Slides 5632 and 5631 (CD 17.7) show a diffuse boundary between the OLS (Context 328) and the overlying clay silt (Context 331). A reduction environment is evident for the lower sections of Context 328, indicated by the presence of pyrite. It appears more likely that these sediments were not exposed to constant inundation or slow sedimentation rates necessary for glauconite formation (Grim 1968; Bullock *et al* 1985; Dent 1986, 75). Mixing could be due to marine incursion or floral and faunal factors.

Sponge spicules were absent from the lower sediment (Context 328) but were found in the overlying clay silt (Context 331). This estuarine silt (Context 331) is an allogenic sediment and would have accumulated at a high rate. The boundary with the OLS ranges from clear to diffuse with channels or lenses of clay visible suggesting intermittent inundation and significant mixing of the sediments (Slides 5632 and 5631, CD 17.7). Long-term and continuous waterlogging from the thin deposits of peat formed directly on the OLS.

The iron formation is predominantly pseudomorphic and no horizons are formed. The frequency of void fillings suggests pedogenesis. The complexity of the illuviation is distorted by bioturbation in both this (Context 328) and the overlying sediment (Context 331). Bioturbation is evident from the frequency of excremental void fillings present (CD 17.7, Photo 1). The relevance of some of the upper boundary void fillings to pedogenesis is questionable considering the clear to diffuse nature of the boundary. The character of the irregular boundary, iron formation, and excremental void fillings is very similar to that found at Site W and is typical of marine-inundated Old Land Surfaces (Macphail and Cruise 2000, 56).

No significant phosphate readings are located in this J Sequence. The charred matter present in examples of the buried soil (Context 328) and the overlying marine sediment (Context 331) is somewhat greater near the OLS upper boundary but only by a small degree.

Site J (west)

Spatially distributed scans of the thin sections are presented in Figure 17.2 (and in colour on CD 17.9). The images are on a close up of the west/east section. The lowest sediment present in thin section is Context 328. Proposed as an OLS, it is apparent as a sandy clay loam in thin section: this is confirmed by the sandy silt/clay results of the particle size analysis. Again, the similarity to the underlying sediment, a sandy silt with gravel, supports an *in situ* formation. Differing from the eastern section of Site J, there is no estuarine sediment sealing the OLS. Instead, a reed peat (Context 327) has formed directly on Context 328. Summary micromorphological descriptions from this sequence are presented in CD 17.10.

Pyrite formation is not recorded in the lowest depths of the Holocene soil (Context 328), but is present in the upper sections of Context 328 and in the overlying peat (Context 327). The occurrence of gypsum may be from the initial oxidation environment of the land surface's formation, with the pyrite in the sediments above being a result of the present environment. However, a lack of clustered formations does not discount redeposition or reworking, as evident from the excremental pedofeatures. The peat (Context 327), an autogenic sediment, forms directly on this context which would have required waterlogging but no direct inundation of this section, offering the possibility that the long-term conditions required for glauconite formation were not present (Grim 1968; Bullock *et al* 1985; Dent 1986, 75).

The laminated void fillings (Fig 17.2, Photo 3) contained within the OLS (Context 328) are particularly complex in this sequence. Instances of iron nodule formation plus illuviated clays can give some order to possible pedogenic processes but no time frame between occurrences can be proposed (Theocharopoulos 1982). A detailed image of iron nodules in oblique incident light is presented (Figure 17.2, Photo 2).

No significant phosphate levels for the OLS are evident, coinciding with low frequencies of charcoal and bone recorded in thin section. This is surprising given the quantity of heat-fractured stone and aurochs bones in this area (Fig 6.16). A large quartzite sandstone is present in this sequence but shows no sign of heat-fracture or human use (cross polarised light image in Figure 17.2, Photo 1). This may suggest that the activity associated with the heat-fractured stone and bone remains was very localised, although the location of a large quartzite sandstone in conjunction with significant excremental pedofeatures suggests post-depositional disturbance that would conceivably have distributed the archaeology. Such disturbance of flint artefacts, as well as the breaking up of the remains of fireplaces by biological activity, was proposed at Site W under similar circumstances (Macphail and Cruise 2000, 56).

17.3.6 Conclusions

Analysing sequences from multiple locations has provided the opportunity to understand the development of the Old Land Surface and subsequent sediments at both the spatial and temporal scale. The archaeological evidence from the sequence of occupation surfaces provides a rare opportunity to examine the activities and impact of hunter-gatherer communities on the landscape at the micro-scale. The presence of pyrite, glauconite, and gypsum, as evidence of marine diagenesis and mineral alteration, has been used to interpret the sedimentary environment. Short-term marine transgression-regression is evident above the Old Land Surface at Sites D and B. This supports the botanical and insect evidence in Chapters 14 and 16 and together with the artefactual evidence demonstrates continued human activity following the site's waterlogging and episodic marine incursions.

Thin sections give evidence for burning in the peat at Site B and phosphate levels support a higher human input in the peat at Site D, which is proposed as a defecation area (Chapter 18.4.2). The low frequency of finds in the marine silt at Site A is a result of rapid inundation and sedimentary inter-

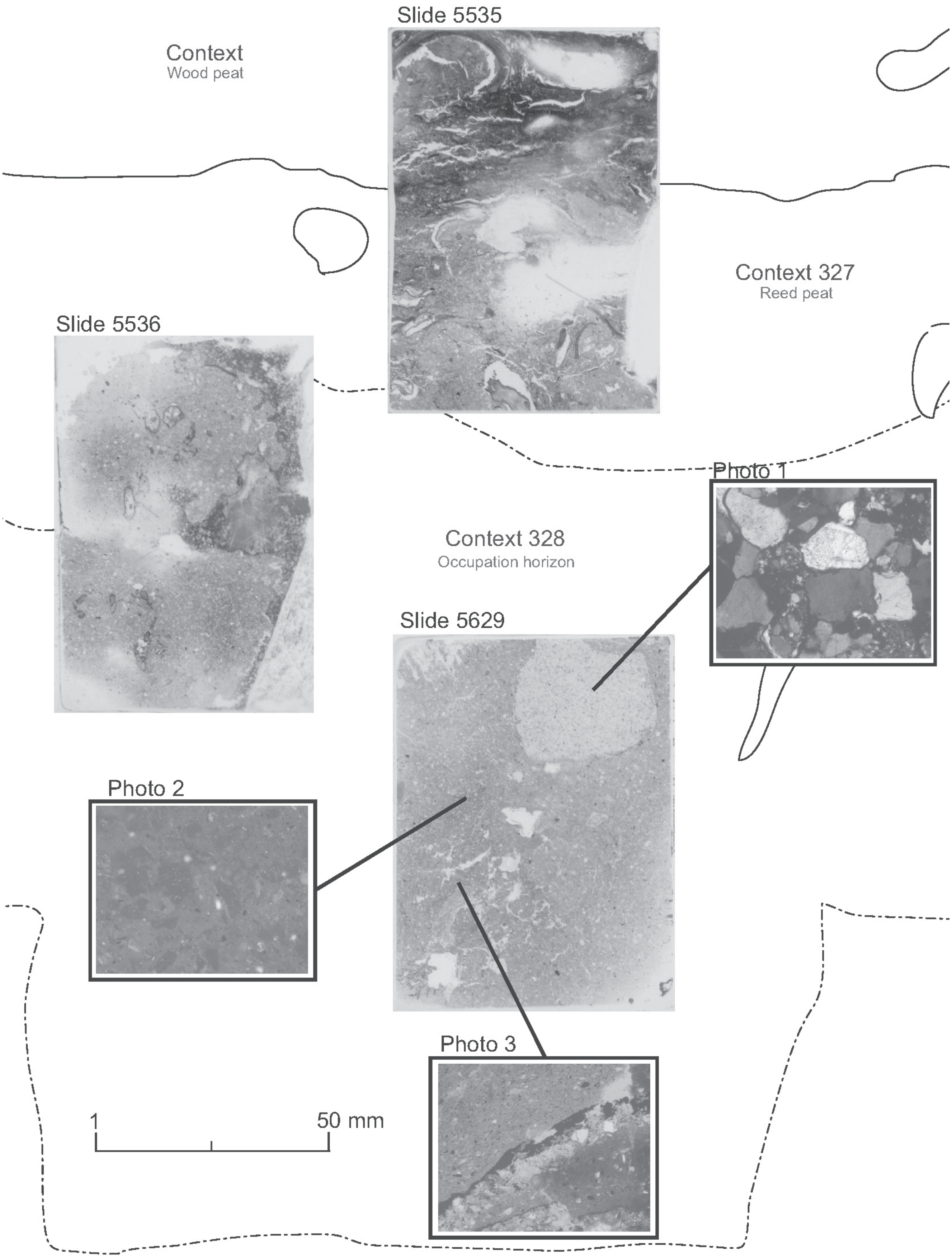


Figure 17.2 Goldcliff East, Site J, west series: flatbed scans of thin sections at their sample positions on the relevant section drawing (for colour version see CD 17.9) (photo V Yendell)

mixing. Wood and reed or grass burning associated with fish bones is a distinct phase of activity. The diffuse but banded distribution ceases sharply after marine inundation. A similar sedimentary intermixing as at Site A is evident at the eastern end of Site J; even so, the greater number of finds here shows human activity extended onto the saltmarsh edge. The western series of samples from Site J provide evidence of the dryland soil not subject to marine transgression; here there is evidence for iron deposition and the incorporation in the profile of rock fragments of non-local origin. No evidence for continuing human activity was recorded in thin section once the main Upper Peat formed.

18 Mesolithic communities at Goldcliff: conclusions *by Martin Bell*

18.1 Introduction

This chapter aims to provide a synthesis of Mesolithic activity at Goldcliff in terms of its environmental setting, the activities which took place, evidence for seasonality and sedentism etc. Beyond this, it attempts a more speculative approach by suggesting additional resources that, for various reasons, might not have survived. The justification for this speculative approach is the belief that despite the impoverished nature of the available British Mesolithic record we do not have to continue to take such a limited view of the resources that were used. For the writer, this interpretation has been strongly reinforced by the opportunity to see at first hand hunter-gatherer sites in the American North-West with its rich ethnohistorical record. Equally, a comparative European approach has offered insights from the much richer Mesolithic sites in Denmark and the Netherlands. Furthermore, it might be argued, from the evidence at Goldcliff and less studied coastal sites (Chapters 1 and 21), that our restricted view of the British Mesolithic is not so much a reflection of what actually survives, but rather a consequence of limited excavation in England and Wales, as well as an unimaginative approach to the selection of sites for investigation.

Mesolithic sites have been excavated at Goldcliff to the east of the former island as reported in this volume. This account also draws on evidence from earlier excavations of 1992–94, west of the island, called here for brevity Site W and reported by Bell *et al* 2000. The W label was not used in the original report, which simply referred to 'the Mesolithic site' but is employed here for clarity now that there are several Mesolithic sites.

18.2 Topographic setting and sea-level change

The excavated Mesolithic sites at Goldcliff East are buried by, and stratified within, sediments laid down during the final stages of rapid sea-level rise in the first half of the Holocene. Curves showing sea-level rise in the wider region of south-west England and Wales have been prepared by Heyworth and Kidson (1982) and subsequently more detailed studies at Porlock (Jennings *et al* 1998) and the Axe valley (Haslett *et al* 1998). The previous campaign at Goldcliff also involved the production of a revised sea-level curve with four dated points from peats on the edge of Goldcliff island (Bell *et al* 2000, fig 17.2). The Goldcliff dated points suggested sea level 1m or so above the previous Heyworth and Kidson curve and this was attributed to the fact that earlier sea-level curves had included points subject to autocompaction which Allen (2000a) has demonstrated is a significant factor with intertidal peats where they overlie significant thicknesses of Holocene sediment. The autocompaction problem makes Goldcliff a particularly ideal site for sea-level studies because peat formation here was time transgressive, it occurred up the edge of the former island. Peat lies directly on sandy soils developed on Head rather than soft Holocene sediments subject

Table 18.1 Sea-level index points around the edges of Goldcliff Island. Mean sea level has been calculated by subtracting the MHWST at Newport, +6.3m OD, from the OD height of the sample

Site	Fig Ref/ source	^{14}C date	Lab Code	Cal range	Mid-point	OD height	Mean sea level (m)
Goldcliff J 5640	6.10	4978±27 BP	OxA-14023	3910–3660	3745±125	+1.43m OD	–4.87
Goldcliff J 5125 91cm	6.6, 6.9	5730±33 BP	OxA-13934	4690–4490	4590±100	+1.16m OD	–5.14
Goldcliff B 4070 6–6.5cm	3.9	6871±33 BP	OxA-12357	5840–5670	5755±85	–3.635 OD	–9.935
Goldcliff D 4071 12.5–13cm	3.17	6790±38 BP	OxA-12359	5740–5630	5685±55	–4.10m OD	–10.4
Goldcliff Pit 15 base	Bell *et al* 2000 fig 5.3	5920±80 BP	CAR-1501	5000–4580	4790±210	+0.68m OD	–5.62
Site W 1722	Bell *et al* 2000 fig 4.4	5820±50 BP	GrN-24143	4790–4540	4665±125	+0.71m OD	–5.59
Hill Farm Pond	Bell *et al* 2000 fig 3.7	4320±80 BP	SWAN-133	3350–2650	3000±350	+3.7m OD	–2.6

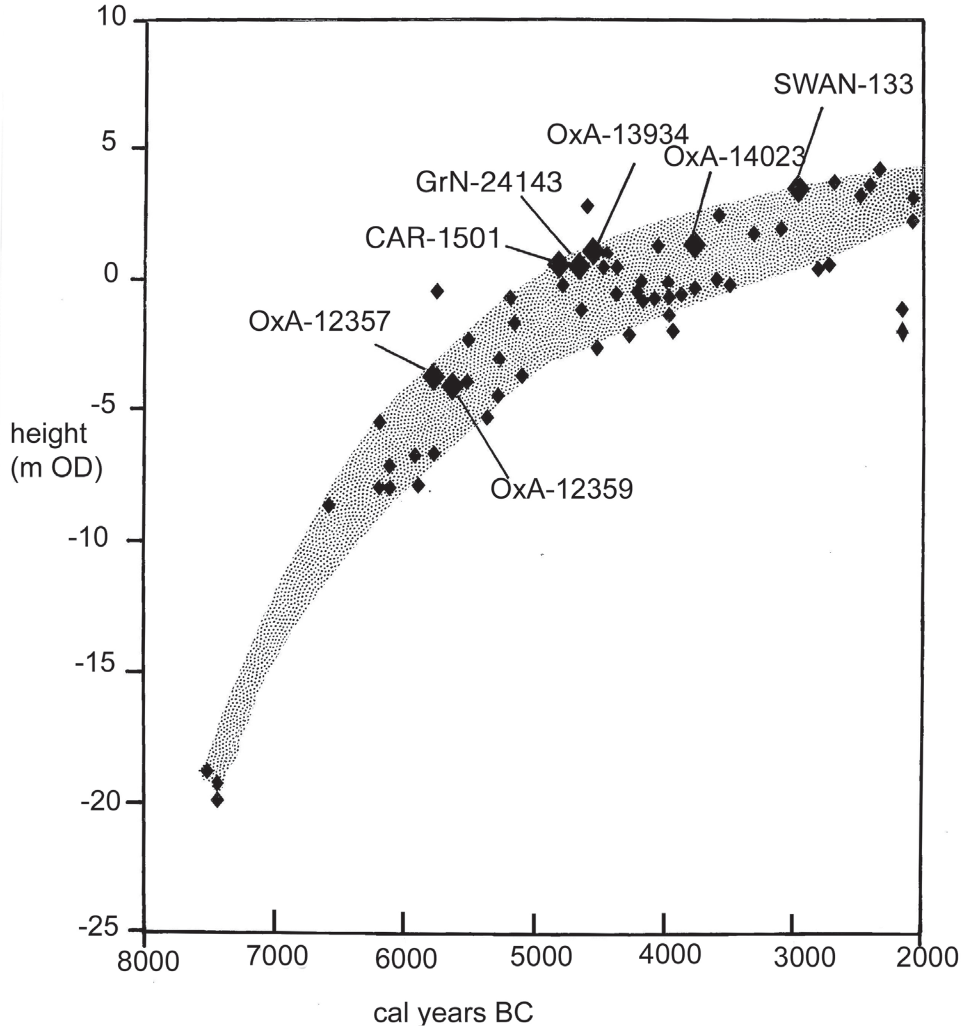


Figure 18.1 Sea-level curve for the Severn Estuary 7500–2000 cal BC. Small diamonds = points after Allen 2005, fig 1; shaded area highlights main distribution of dated points (omitting possible outliers); large diamonds = sea-level index points around Goldcliff island as listed in Table 18.1

to compaction. The current campaign of research at Goldcliff has increased the number of dated points on the island edge to seven, as listed in Table 18.1 and plotted as a revised curve in Figure 18.1. This curve has been prepared on the assumption that peat inception occurred approximately at Mean High Water Spring Tide (MHWST). Mean sea level is calculated by subtracting the present MHWST at Newport which is +6.3m OD from the OD height of the sample. The earlier Heyworth and Kidson curve provides some indication of the rate of sea-level rise (*c* 8mm per annum) before it reached the point where peat started to form around Goldcliff island. The Goldcliff data provides a record of sea-level change covering the period from *c* 5700–2650 cal BC.

We can use this curve to reconstruct the changing palaeotopography and environment around Goldcliff before and during the periods of Mesolithic activity (Figs 18.2–18.3). Reconstructions draw on the following local information concerning the nature and height of the pre-inundation sediments from intertidal exposures: the limited coring programme at Goldcliff East summarised in Figure 2.6; the more extensive coring programme previously conducted west of Goldcliff island (Bell *et al* 2000, chapter 3); and the wider synthesis of borehole and Quaternary stratigraphy on the Gwent Levels as a whole (Allen 2001). There is good evidence for the height of the Holocene basement to the north-east of Goldcliff island as a result of boreholes for the Gwent Levels Wetland Reserve and from the foreshore to the east and west of the island. We have no direct evidence behind the present seawall to the north-east of the island and reconstructions to seaward of the Holocene exposures discussed here are hypothetical since we do not know the height of the Holocene basement where it has been eroded away or buried. Reconstruction to seaward is based on the submarine contours of Admiralty Chart 1176 but these must be used with caution because we cannot quantify the extent to which the Holocene basement may have been eroded, or the thickness of post-inundation sediment with which it may now

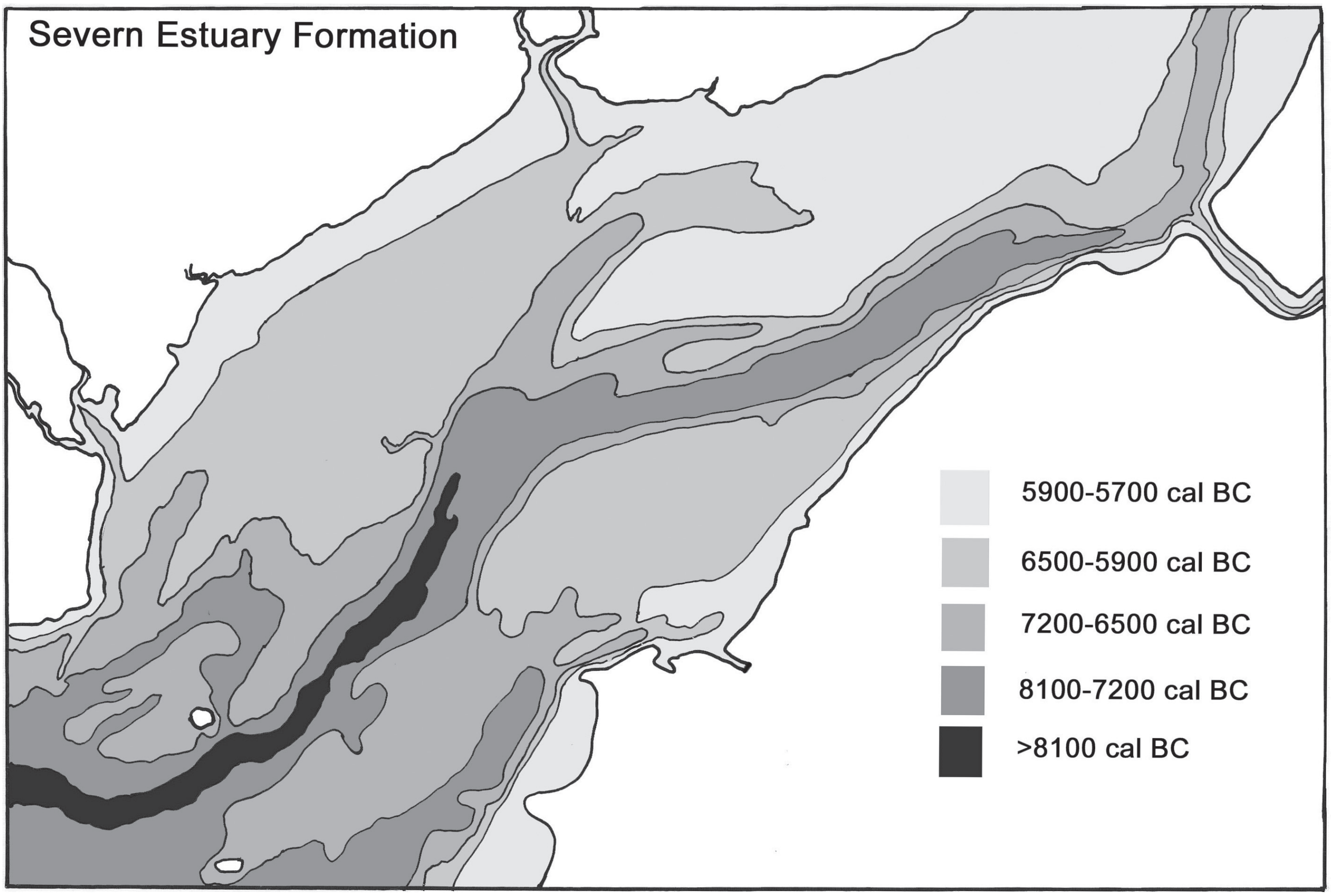


Figure 18.2 The Holocene transgression in the Severn Estuary showing the approximate dates at which spring tides reached areas of the estuary (graphic J Foster)

be covered. An attempt has been made, however, to suggest the possible seaward course of channels evidenced by boreholes to landward although the exact position of these channels is hypothetical.

In the centre of the Severn Estuary there is a deep channel about 1.5km wide which at the estuary mouth between Steep Holm and Flat Holm has its base at –32m, at which height spring tidal influence would first have been felt *c* 8420 cal BC (Fig 18.2). The channel runs to the north-east to *c* 10km south of the mouth of the Usk at Newport, and spring tidal influence would have reached here *c* 7200 cal BC. At that point, the main deep channel swings close to the English shore. By 7200 cal BC when sea level was at about –10m OD, spring tidal influence would have extended up this channel at least as far as Avonmouth and up the tributary channel of the Usk as far as Newport, where boreholes show the Holocene base at *c* –12m OD (Allen 2001, fig 6). At that time, the hill at Goldcliff would have looked out over a relatively level plain towards the tidal mouth of the River Usk 4.5km away to the west and the tidal channel of the Severn 6km to the south. However, we have no evidence of human activity at this stage, or any of the previously described Holocene stages.

West of Goldcliff, borehole evidence indicates a possible channel or embayment picked out by the top of the Pleistocene stratigraphy running towards the site of Goldcliff Pill, but not a proto-Pill (Allen 2001, fig 12). This might represent a small tributary channel draining south-west to the Usk. Here, at –8m OD, spring tidal influence may have reached around the present mouth of Goldcliff Pill *c* 1km west of Goldcliff at *c* 6170 cal BC. Coincidentally, that date is roughly when the oldest trees in the Lower Submerged Forest commenced growth. This forest covers the period until c 5774 cal BC; the surviving trees were oak but the pollen and charcoal evidence for Sites B and D indicate that hazel was a component of the woodland. The oaks were tall and straight examples, 10m and 13.5m to the first branch being recorded, and they had clearly grown up within a closed forest environment.

By 5900 cal BC, spring tidal influence had reached –6m OD within 1km south of Goldcliff (Fig 18.3). East of the island, Allen (2001, fig 3) records the existence of a buried channel which cuts down to rockhead at –10m OD. Unfortunately, we do not know what thickness of Pleistocene, or earlier Holocene riverine sediment, is in this channel. All we can say is that the estuarine basement lies somewhere between –5 and –10m OD. It is probable that spring tidal influence was extending up this channel to the north

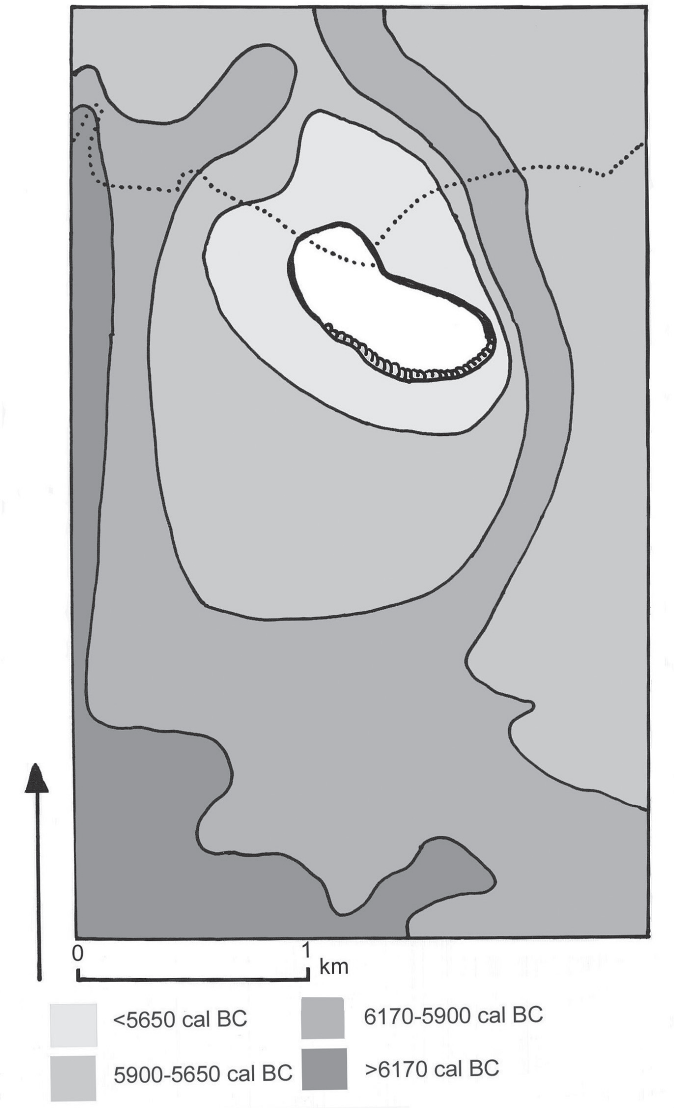


Figure 18.3 Reconstruction of coastal and environmental change at later Mesolithic Goldcliff shows areas inundated between the dates indicated (a) before 6170 cal BC (b) 6170–5900 cal BC (c) 5900–5650 cal BC (d) c 5500 cal BC (graphic S Bell)

of Goldcliff by at least 5900 cal BC, when sea level stood at about –6m OD, and probably rather earlier. As a consequence of marine influence extending up this channel to the east and the extending marine influence up the channel or embayment in the area of Goldcliff Pill, Goldcliff would, at about 5900 cal BC, have become an island at high spring tides. This was at about the time when the last trees of the Lower Submerged Forest were killed by a rising water table and perhaps burning. At that stage the island was about $1km^2$, thus around three times the area of dryland that existed at the time of Site J. The earliest Mesolithic artefact evidence from Goldcliff dates from around 5800 cal BC, indicating that human activity dates to the period when the site became truly coastal, and when estuarine saltmarsh had encircled it. At this point there was still a relatively flat surface at about –4m OD to the north of the island and also the other side of the channel to the east. The island itself rose to at least 20m above the surrounding saltmarsh. It may well have had cliffs on its west and south sides inherited from the Ipswichian shore (Allen 2004), although these would have been partly degraded by erosion and solifluction in the Devensian. The island would have been a prominent landmark in the estuary, the more so after the inundation of trees in the surrounding lowland. To the west there are likely to have been more extensive saltmarshes where the base of the Holocene stratigraphy is rather lower between Goldcliff Pill and the mouth of the Usk (Allen 2001, fig 6).

In the report on Mesolithic Site W (Bell *et al* 2000) it was suggested that Mesolithic activity took place during a regression period represented by the Lower Peat and Submerged Forest. Now that much more detailed work has been done that interpretation must be revised on two counts. Firstly, it is clear that Mesolithic activity was not confined to one episode but continued over a far longer period and through a number of significant environmental changes. Secondly, the evidence from the area of Lower Peat reported here cannot now be interpreted as a regression phase but rather as a transgressive peat formed as sea level rose. The original interpretation was based on the observation that in places there is a thin layer of estuarine sediment above the sandy Old Land Surface and below the basal peat. That observation has been confirmed by the work reported here at Goldcliff East (Chapters 14 and 17). Similar observations have been made below submerged forests at Westward Ho! and some of the Pembrokeshire sites. These stratigraphies were originally interpreted as indicating the onset of estuarine conditions followed by a regression. It is now thought much more likely that, in this area of very high tidal range, some deposition of estuarine sediments will take place above MHWST prior to the water table rising to the point where peat forms. Another possibility is that the silts represent tidal drainage trapped between rockhead and slightly elevated peatmarsh to seaward (J R L Allen pers comm).

The trees of the Lower Submerged Forest had by 5650 cal BC given way to reedswamp attested on Sites B and D. The peat was occasionally subject to marine inundation but this became more frequent as the silt laminations (CD 3.9), forams, pollen (Chapter 14), beetles, and sediment micromorphology (Chapter 17) all show. Some human activity continued on Site B through the reedswamp phase. Hazel pollen clumps show the trees grew close by, but the beetles indicate that by this stage the trees were growing on the neighbouring dry ground rather than the wetland. This was hazel woodland with some oak and elm and a ground layer of ferns. The reedswamp at –4m OD was obliterated by sea-level rise *c* 5650 cal BC after which the bedrock island was surrounded by saltmarsh and mudflats at the time when the laminated silts containing human and animal footprint-tracks were laid down. The period of the laminated silts is the period of most intensive activity at the island edge. The island margins were buried by saltmarsh and the dryland area had shrunk to between one third and half of its size at the time of earliest Mesolithic activity (Fig 18.3). The banded sediments which are *c* 4m thick were laid down over a period of 1100 years between 5700 and 4600 cal BC. Over this period sea level rose by 5.26m, or 4.8mm per year. Investigation of the banded sediments within this sequence indicates rapid sediment deposition; up to 19mm per year is recorded further to the east between Redwick and Magor (Allen and Haslett 2002).

This period of banded sediment deposition was also the period when the most intensive Mesolithic activity is attested at Goldclifff. The sea-level curve suggests that marine influence would have reached Site A at –2.5m OD by about 5500 cal BC. This is the date of activity on Site A and the micromorphological evidence confirms that occupation occurred more or less at the limit of tidal influence (Chapter 17). Site W at *c* 0 OD would have been inundated *c* 4800 cal BC. However, most activity on that site is some 400 years earlier, suggesting that the site stood somewhat above tidal influence some metres back from the contemporary shore.

Tidal influence reached Site J at *c* 4700 cal BC and that is the date of wood artefacts from that site. Many of the lithic, bone, and other artefacts are at lower stratigraphic horizons in the Old Land Surface and are likely to be somewhat earlier. Site J was originally the dry island edge onto which wetland encroached. The dryland originally supported oak and hazel woodland. It was between 4500–4800 cal BC that the next major environmental change took place. The rapid rate of sedimentation attested in the underlying banded sediments gave way to peat growth up the sloping island edge at Site J, between 4590 and 3745 cal BC by just 0.27m, a rise of 0.31mm per year. This major marine regressive phase led to the development of peat both east and west of the island. A detailed picture has been developed of the succession stages of this wetland and of spatial variation along the transect represented in Figure 2.6 from the island edge to the east. This picture has been developed by planning the trees, plant macrofossil analysis, pollen, and beetles (Chapters 14–16). Reedswamp colonised first, then carr-woodland of willow and birch, then alder carr, then the development of oak woodland in the Upper Submerged Forest which lived between *c* 4477–4239±7.5 cal BC, not allowing for missing sapwood. It is notable that this oak woodland did not appear as such a distinct ecological episode in the earlier pollen study of Smith and Morgan (1989), emphasising the value of the multi-proxy approach adopted here. One oak (Tree 8) in the wetland on the island edge grew significantly later, between 4112–3913±6.5 cal BC, not allowing for missing sapwood. The main Upper Submerged Forest was followed by evidence of a temporary marine transgression, rising water tables, the death of the trees, and the development of reed/sedge swamp prior to the development of raised bog, which existed from *c* 3800–1700 cal BC. What is particularly notable is that the period of Upper Peat growth around the island sees a very marked reduction of human activity to minimal levels, probably from soon after 4700 cal BC. Micro-charcoal levels are quite high in the reedswamp phase at the base of the peat but rapidly decline as alder colonises. Thereafter there are just a few flints and some macro-charcoal fragments stratified in peat – both on Site J and west of the island, but notably low concentrations of micro-charcoal confirming the impression of limited and probably not very frequent activity. It seems that the dense alder woodland of this period was much less favoured than the preceding saltmarsh. However, some of the trees in the Upper Submerged Forest were also burnt, which may indicate some continuing human activity.

Soon after Goldcliff first became an island, at the time of Sites B and D (*c* 5600 cal BC), it probably occupied an oval area of about 1km^2 or 100ha. By the time of Site J (*c* 4800 cal BC) the burial of the island edges by estuarine sediments had reduced the size of the dryland area to roughly the size of the last interglacial island, a kidney-shaped area about 1km by 0.4km or 32ha. Today the marine erosion of the island has removed most of the island leaving just 12% or 3.75ha and making it difficult to conceptualise the size and nature of the topographic feature that provided the setting for this Mesolithic activity (Figs 2.2–2.4). Today the Severn Estuary has two prominent islands at its mouth, which provide points of comparison: Steep Holm, 770m by 280m, which rises to 80m (three times the height of Goldcliff), and Flat Holm 550m by 475m, which rises to 10m or so above Goldcliff island. There is also the tiny Denny Island, which may be the almost entirely eroded remnant of a former island. Thus Goldcliff was a topographic feature slightly larger in area but less prominent in height than the Holms. The difference is that in the period in question the two Holms were permanent islands whereas Goldcliff would always have been connected to dryland at low tide by saltmarsh, reedswamp, fen woodland, or raised bog. We can envisage, however, that the ease of access to the island would have varied through time depending on wetness, vegetation, erosion cycles, and the dissection by palaeochannels of the wetland.

18.3 The date of activity and evidence for cultural change through time at Goldcliff

18.3.1 Palaeolithic

The earliest evidence long predates the sea-level and environmental changes outlined in the preceding section, and one artefact provides evidence of activity in the Pleistocene. The artefact in question is the unstratified unifacial leaf point that Professor Barton (Chapter 9) attributes to the early Upper Palaeolithic around 36,000 BP. He notes this may be a casual hunting loss but it does serve to highlight the archaeological potential of the Pleistocene part of the Severn Estuary sequence. At Goldcliff, this comprises beach and inshore sediments which Allen (2000a; 2001) has shown are of Ipswichian interglacial date, overlain by Head which, on the west side of the island, contains abundant bones including those of bison. Examination of that bone bed has not so far produced any evidence of human activity. However, lithic artefacts have been found in gravels in the bed of the estuary at Sudbrook and Sedbury (Green 1989; Aldhouse-Green 1993). These and the leaf point highlight the need for vigilant examination of Pleistocene sediments whenever they are swept clear of mud. The Pleistocene is almost certainly the part of the Severn sequence with the greatest unexplored archaeological potential.

18.3.2 Mesolithic

The earliest possible evidence for Mesolithic activity at Goldcliff is from banded sediments associated with human footprints on Site E, which is dated 7300±65 BP (OxA-14037; 6340–6030 cal BC). However, we need to be rather cautious of this date because it is rather earlier than expected given its OD height and the fact that it is from sediments in a channel which appears to cut a later peat. It is possible that the finely divided plant material dated includes some reworked material. Other possible evidence of early human activity is the charred trees in the Lower Submerged Forest, which are dated 6179–5826±4 cal BC, not allowing for missing sapwood. Here we cannot exclude the possibility that charring resulted from wildfire rather than human agency. There is, however, clear artefactual evidence for human activity within 100–300 years of the foregoing dates. The earliest horizon with artefacts is the palaeosol on Site B 7002±35 BP (OxA-13927; 5985–5784 cal BC). The overlying peats which also contain artefacts are only slightly later, as is the evidence for human intestinal parasites on Sites B and D. Activity on those sites extended to perhaps 5600 cal BC when the basal peat was buried by estuarine banded silts.

Site A, at –2.4m OD, has only one date, 6629±38 BP (OxA-13928; 5622–5482 cal BC), which suggests activity one or two centuries later than Site B. Activity at Site J is dated by AMS dates on the two wooden artefacts with similar dates between 4940–4710 cal BC. Thus, the dated activity at Site J is around 900 years later than Site A and 1000–1100 years later than Site B. However, there is more than one phase of activity at Site J and the earlier phases of activity might be decades, or centuries, earlier than the dated wooden artefacts. A further factor with Site J is its location on a surface sloping to the north-east which was progressively buried by peat over an extended timescale. The lowest part of the site was buried 5730±33 BP (OxA-13934; 4690–4490 cal BC), the highest part by 4978±27 BP (OxA-14023; 3910–3660 cal BC). It is notable therefore that the upper part of the site was not buried until *c* 800 years later than the date of the wooden artefacts. The peat which started to form on the lower part of the site contained very few worked flints and some charred wood, but very low levels of micro-charcoal (Chapter 15). There is some evidence of vegetation changes which could relate to small-scale anthropogenic activity but might equally reflect coastal change. The most economical interpretation of this evidence is that for the last millennium of the Mesolithic, when wood peat was forming around the bedrock island, there was a much lower level of human activity.

As regards the date of the human footprint-tracks, we have the equivocal date noted above which could suggest some are as early as 6300 cal BC. Stratigraphically, they lie above the basal peat, which was both cut into and covered by banded sediments containing footprints *c* 5500 cal BC. The banded sediments are postdated by the Upper Peat and Submerged Forest; there are several dates for the base of this (CD 7.2–7.3) and they indicate it started to form *c* 4650 cal BC. The main concentration of footprint-tracks is in the basal 2m of the banded sediment sequence between 4–5.5m thick (Fig 2.6). Thus, it is reasonable to suggest that the investigated footprint-tracks on Sites C, E, and H probably formed in the first 300 years of banded sediment formation, ie *c* 5500–5200 cal BC, at about the time when Site A was occupied. One or two very poorly preserved human footprint-tracks have been observed in banded sediments immediately below the Upper Peat. Although none of these has been recorded, they do show activity just before 4650 cal BC.

Site W dates between 5600–5200 cal BC (Bell *et al* 2000, fig 4.13) and is roughly contemporary with Site A and the main period of footprint-tracks east of the island. Site W also confirms a much lower level of subsequent human activity – just one or two flints, some charcoal, and a dated charred hazelnut are later.

From this dating evidence we can conclude that Mesolithic activity at Goldcliff certainly began by 5900 cal BC, perhaps *c* 300 years earlier. Activity continued for at least 1100 years until 4800 cal BC. As Professor Barton notes in the lithics report (Chapter 9), the dating evidence is entirely consistent with the dominance of narrow blades in the later Mesolithic assemblage. The small geometric microliths, particularly scalene micro-triangles, are characteristic of the end of the Mesolithic, and their abundance on Site A suggests they characterise at least the last 1500 years of the period. Evidence for a significantly reduced level of activity in the last *c* 800–1000 years of the Mesolithic might be explained in terms of settlement pattern changes in the later Mesolithic or even a precocious Neolithic (see below). However, it coincides with the regression during which peat started to form round the island, so perhaps people no longer visited these sites because there was not such ready access to important saltmarsh and woodland edge environments. Activity might simply have shifted seaward to the southern, now eroded edge, of the island – or elsewhere. The low level of activity attested by just a few flints and some charcoal is not inconsistent with a continuing focus of activity elsewhere on the island.

By virtue of its good chronological and stratigraphic resolution, Goldcliff stands apart from the majority of known Mesolithic sites in Britain, which are unstratified lithic scatters (Wymer 1977; Locock 2000). Through the sequence of occupation sites there is no clear typological separation of artefact types over time (which would suggest chronological development), although the assemblage from the earliest Site B is very small. There are, however, typological issues in the later Mesolithic for which this evidence is particularly relevant; these include the role of core axes/adzes, groundstone technology, and the use of microliths. It has been argued that the use of axes/adzes was abandoned in the later Mesolithic (Burrow 2003). There are now three examples made from volcanic tuff from the Goldcliff East embayment and another from 1km to the east at Porton. None of these was stratified, but tuff flakes, some of which may derive from making such implements, have been stratified on Sites A, J, and west of the island. Groundstone axes do occur with Mesolithic assemblages at the Nab Head and there are other examples from less secure contexts in west Wales (David and Walker 2004). Such axes are common in the Irish Mesolithic and in continental Europe, but there is no evidence for them at Goldcliff. Also notably absent are the bevelled pebbles which form one of the most characteristic artefacts of coastal Mesolithic sites in Pembrokeshire (David and Walker 2004) and south-west England (Jacobi 1979). Their distribution supports Jacobi's view that they were associated with some activity specific to the rocky shores of the south-west; many are found close to seal rookeries and they could be specialist tools for processing seal skins (Jacobi 1979). Notwithstanding the absence of evidence for groundstone axes or bevelled pebbles there is the faceted sandstone disc from Site B (Fig 9.12), the manufacture of which seems entirely compatible with the groundstone axes, perforated disc, and figure from the Nab Head (David and Walker 2004).

As the latest Mesolithic site in Wales with a significant artefact assemblage, Goldcliff is particularly relevant to the question of technological change in the later Mesolithic. In some parts of Britain, such as Scotland, there is evidence that Mesolithic technology was in decline in the late Mesolithic (Burrow 2003). Some argue this makes the late Mesolithic typologically invisible, and helps to explain the absence of late Mesolithic sites. The Goldcliff evidence does not really support this proposition, although it must be acknowledged that activity was on a much reduced scale in the last 800–1000 years of the period. Even so, there are many microliths on Site A and smaller numbers on Site J. Other sites in southern Britain clearly demonstrate that microlith use continued to the very end of the Mesolithic, as shown by a group of microliths from the Fir Tree Shaft in Dorset (Allen and Green 1998) and those in the weapon apparently associated with the Lydstep pig (Jacobi 1980; Lewis 1992; David and Walker 2003). Although there are quite marked differences in the types of artefact found in successive occupation sites at Goldcliff, none of these appears to relate to chronological changes in material culture and they are more likely to be explained in terms of contrasting patterns of activity, as Professor Barton agrees.

18.4 Material culture and activity areas

Even on sites such as at Goldcliff East, with a well-preserved range of artefact types, the interpretation of activities from material culture is by no means straightforward. Levels of confidence with which activities may be identified vary according to artefact type and the nature of the available evidence. At one end of the spectrum are the artefacts that have clearly been worked but do not have a distinctive typological form or any functional attributes. Others are of recognisable types for which functions have been suggested on other sites or by the ethnohistorical record. In some of these cases we can be more confident if the inferred activities are independently attested by other sources of evidence, eg the bone record. Finally, there are artefacts with wear traces which can be replicated experimentally as produced by particular activities. Annelou van Gijn's use-wear analysis (Chapter 9) of a small sample of lithic artefacts demonstrates that a significant proportion of the utilised pieces for which a function can be suggested are not recognisable retouched tool types, but rather debitage which proved suitable for use. We also have some more tentative evidence for use-wear on bone artefacts and small-scale experiments that make some contribution to establishing the activities involved. The individual sites which have been identified in this report each represent discrete concentrations of activity observed in eroding intertidal sections. The sites defined are bounded by areas with fewer artefacts but there are unknown dimensions: what happened to seaward where the sediments and sites have been eroded away, or to landward where they are buried? The picture developed here is based therefore on an intertidal transect across the former island. CD 18.3 summarises aspects of the archaeological record from each site and suggests some of the activities which they may represent, and these are discussed below from earliest to latest.

18.4.1 Site B

Activity was associated with two distinct stratigraphic contexts: the Old Land Surface and overlying peat. In both layers the artefact scatter was diffuse with only very limited evidence for knapping: just two pieces of debitage and 0.12 lithic tools per square metre. Tools were present in both layers but in very low numbers; they included two microliths and a retouched flake in the OLS and one microlith in the peat. A spatula of split antler (2273) seems most likely to have been used in processing skins. The single wooden artefact (3718) might be part of a spatula or handle. The sandstone plaque (3846) is enigmatic; it has been argued that it was perhaps used in plant processing and later as a pounder, but its groundstone form has also been interpreted as of possible symbolic significance. Bone was mostly calcined and concentrated in one small area *c* 1.5m in diameter in the peat, probably a hearth, with another small concentration 5m away. The main concentration had no associated lithic artefacts, or heat-fractured stones. There was a small concentration of both in the secondary cluster and a scatter of a few heat-fractured stones elsewhere, probably used in cooking (Chapter 18.4.7). The main animals represented were red deer with some aurochs and roe deer, and a few fish bones, but none identifiable. The overall impression is that this site lay on the periphery of a settlement area, a suggestion which is supported by the presence of human intestinal parasites showing that it also served as a defecation area. The sandstone plaque and antler spatula might reflect the occasional use of this area for skin and plant processing. A less prosaic interpretation might see them as potent artefacts deliberately placed at the edge of the settlement, a suggestion consistent perhaps with the possible later battering and breakage on the sandstone plaque, and observations below about defecation practice. Judging by the numbers of unstratified artefacts found nearby it seems likely that the focus of this activity area has been eroded away to the south where the ground originally rose on the edge of the former island.

18.4.2 Site D and defecation practice

The only artefacts here were four flint chips, a broken pebble, and a heat-fractured stone, just two artefacts and no tools per square metre. The presence of human intestinal parasites (Chapter 14) suggests that this was a defecation area rather more peripheral to the focus associated with Site B. Together, Sites B and D cast new light on defecation practice in prehistory, a topic which is largely unconsidered, at least in a north-west European context. In later prehistory, in an Iron Age context at Glastonbury Lake Village, Coles and Minnitt (1995, 201) suggest that defecation took place outside the settlement entrance. In a Bronze Age context at Brean Down, Jones (1990, 245) discusses the possibility that dogs served as waste disposal agents for human waste. The topic is of importance because of the health implications of the intestinal parasites which on Site B are found in an area where the presence of artefacts indicate activities of cooking and food preparation from time to time. Defecation practice is also relevant to the wider human social use of space and the marking of particular areas on the settlement periphery, which would surely have been quite obvious for reasons of smell, and with time perhaps, because of the particular associations of plants, including favoured food plants which passed through the gut, that grew there. Whitelaw (1994), using ethnographic evidence from the Kung San, refers to private activity space used for dumping and defecation; the former is not attested at Sites B and D, the latter clearly is. Anthropologists have hitherto given more emphasis than archaeologists to the role of pollution and the part which demarcation and control plays in social and cosmological order (Douglas 1966; Khare 1992).

18.4.3 Site A

This area on the edge of the former island had the greatest concentration of artefacts found: 106 pieces of debitage and 4.5 lithic tools per square metre, and greater concentrations of micro-debitage than elsewhere (Fig 5.3c). Microliths were particularly abundant, 81% of those from Goldcliff East, with 92% of the microburins; it is clear they were being made here. Some 56% of the microliths were broken, perhaps in manufacture, or use. Some primary reduction of cores took place. Microwear studies show one blade was used in butchery (2262), one with possible tar traces from hafting used to cut hide (13718), and another used in the scraping of plain siliceous plant material (13567). One bone artefact may have been used in skin preparation (2509) and a piece of tabular bone had many fine cut marks (3171), perhaps the result of butchery or skinning, but deliberate decoration cannot be excluded. The bones were mostly red deer and boar with a little aurochs and roe deer. Three unidentifiable bird bones were present. Fish were particularly abundant; 83% were eel, with crabs and bass also represented. Many of the fish bones were burnt; maybe eels were being smoked here and the bones fell onto the fire during the drying process. We have not, however, experimented to see if this happens. Debitage, flint tools, bones, fish bones, and hazelnuts were all concentrated in the same small area *c* 2m in diameter, which seems to represent the focal point of a range of craft and food preparation or smoking activities. There was no clearly defined hearth in this area. The concentration of artefacts and bone that were mostly very small objects (many found by sieving) can perhaps be interpreted as the location of a small shelter or activity area.

18.4.4 Footprint-track Sites C, E, and H

The footprint-tracks are perhaps the most unusual and engaging form of evidence of a kind never previously encountered in such abundance close to excavated sites and activity areas (Chapter 12). They make the archaeological record tangible and accessible to a much greater extent than is possible with artefacts. The impact on the wider public of this evidence of fleshed human beings is comparable in a way to that of bog bodies. Fascinating as this evidence is, its interpretation in terms of past activity patterns represents a challenge. The available clues are that the activities particularly involved children, some as young as 4 years old; adults are present, but less numerous. At Site E a peer group of four youths walked together with a common purpose, pausing to take stock at the same time. Movement on Sites C and E is not predominantly on a line to the settlement on the island but at right angles to this along the banks of a palaeochannel. The main concentration of child's prints on Site C lack clear directionality and we cannot exclude the possibility that the child was playing. However, the division between work and play in prehistory is unlikely to have been rigid and it is very clear from the ethnohistorical record that young hunter-gatherer children are often active participants in food gathering activities, as Meehan's (1982) account of life with the Anbarra of Australia shows. The most likely activities in which these individuals were engaged are fishing (perhaps checking or emptying traps or using nets) and fowling, both of which are likely to have been focused on the palaeochannel. A group of three small pointed stakes (Structure 332) in the palaeochannel has been interpreted as the possible remains of a fishing structure. Three other pieces of worked wood from this area may have been washed from such structures in the same way that scatters of worked wood from fishing structures have been found on Danish coastal sites such as Halsskov Fjord (Myrhøj and Willemoes 1997, 157). This wood emphasises the importance of continuing monitoring whenever the banded sediments are swept clear of mud.

The peer group of four on Site E were perhaps more likely engaged in fowling or even hunting given the reconstructed pattern of their behaviour. Footprint-tracks of birds are very abundant. Many red deer tracks are also present and a few aurochs. Hunting the deer, aurochs, and pig attested by the bone assemblage seems more likely to have been the province of adult males, although maybe assisted by adolescent boys for driving animals. We find human, animal, and bird footprint-tracks together in the same lamination surfaces but in no instance is there irrefutable evidence that people and animals were on that spot at the same time. However, with continued monitoring it is surely only a matter of time before the site of a kill and its associated artefacts is discovered.

18.4.5 Site W

The detailed evidence from this site excavated during 1992–94 is presented in Bell *et al* (2000) and the artefact distributions are reproduced here on CD 18.4–18.5. The previously reviewed dating evidence suggests this is broadly contemporary with Site A. An area of 48m^2 produced 13 lithic artefacts and 3.2 lithic tools per square metre. Flaking clearly took place on site although there was little microdebitage, which is most probably explained by the spatially restricted distribution of activities seen elsewhere (eg Site A) and the fact that sieving was not more extensive during excavation. Two microliths were burnt and may have been lodged in meat cooked here. Burnt bone was restricted to deer, bird, and fish: pig, otter, and roe deer may have been butchered on site but not cooked and limbs of pigs may have been taken for use elsewhere. Significantly, aurochs, present on other sites, especially Site J, were absent here. Bones were split to extract marrow. Otter is likely to have been taken for its pelt and cut marks on deer bones are consistent with skinning. Just two scrapers may have been used in skin preparation and there were none of the bone artefacts found on other sites, which have been associated with hide preparation. However, metapodials were being split in a distinctive way which it is suggested related to bone tool production or marrow extraction. Fish were numerous but came mostly from 1m^2, eel predominating with some smelt, goby, and stickleback. The small size of fish suggested the use of traps or nets. A total of 13% of the fish bones were burnt and it is suggested elsewhere (Chapter 18.4.3) that this may have happened whilst fish was being smoked. Concentrations of charcoal and burnt artefacts indicated the position of hearths though, as on the other sites, no distinct hearth pit or stone edge was present. The presence of some heat-fractured quartzite also indicates cooking activities. A sandstone rubber is of a type which elsewhere has been associated with the preparation of arrowshafts or stretching skins. One piece of quartzitic sandstone was used as a mortar probably for the preparation of plant foods. Overall there is evidence of hunting, fishing, lithic knapping, butchery, cooking and possible smoking, hide and possibly otter pelt preparation, plant processing, and probably the production of bone tools. The range of activities suggests a base camp but the low number of tools and the nucleated spatial patterning suggested by artefact distributions (CD 18.4–18.5) suggests a site on which the main occupation did not cover an extended period, thus perhaps a short-term base camp.

18.4.6 Hill Farm Trench 2

In 1992 a trench was excavated on the west side of the former island 230m north of Site W. From here, 35 lithics were found, including a microlith and a retouched flake. The lithics were not all of one context or period but some, together with a few bones, were sealed under peat which formed in the Neolithic (Bell *et al* 2000, fig 3.7). Since part at least of the assemblage is Mesolithic it shows that some less dense activity, probably including butchery, extended inland along the west edge of the island.

18.4.7 Site J

Activity was present in three distinct horizons on this site (CD 18.3): the Old Land Surface, from which most of the evidence came; overlying estuarine sediment with less evidence; and above this peat with only a little. A complication is that the sloping surface on which the site lay was covered by estuarine sediment and then peat progressively over a period of *c* 850 years. Thus, whilst estuarine sediment was covering the lower part of the site and later peat formed, activity continued a little upslope on the Old Land Surface. For this reason the stratigraphy does not provide a complete picture of the phasing of activities through time, although the relative numbers of artefacts in each horizon (CD 18.3) does point to a significantly lower level of activity in the last 850 years of the Mesolithic when peat was being laid down on the lower part of the site.

A plot of artefact distributions against a section of part of Site J (Fig 6.13) shows clear evidence that in the Old Land Surface there is, within the spatial patterns (Figs 6.13–6.17), also evidence of a sequence of activities. In that north-west section of the site the earliest activity was aurochs and red deer butchery and skin processing. This was followed by activities involving heat-fractured stones, presumably food processing, and then by some knapping and deposition of small amounts of charcoal. The main factor responsible for the stratigraphic sequence of activities is likely to be progressive burial of artefacts by earthworms (Darwin 1881), perhaps with some small-scale colluvial increments, if any bare ground was created upslope by human or animal activity or vegetation burning. It is not possible to put a timescale on the succession of activities, but if earthworms were the main factor, the separation between these specific episodes was most likely decades at least.

The fact that in the section plotted (Fig 6.13) bones are mostly in the lower part of the Old Land Surface profile does suggest that during later phases of activity conditions in the upper part of the profile may have been less favourable for bone survival. This possibility is supported by evidence for iron movement down this profile indicating some acidification. Bones were well-preserved in the overlying estuarine sediments.

Site J, Stone tools

The Old Land Surface produced the second highest density of lithics after Site A (15.3 per square metre). However, there were a much lower number of tools (0.7 per square metre). There was evidence for primary knapping – 13 microliths were present and microburins show some limited production on site. The concentration of 4 micro-scalene triangles on the west side of Site J is notable given the concentration of heat-fractured stones and aurochs bones in the same area. One crescent microlith (4527) had micro-evidence of possible impact damage suggesting hunting use. One other (9210) had possible traces of tar and microwear evidence of use to cut meat. Two other artefacts (7546 and 7631) had microwear evidence that they were used to cut soft hide or meat. J was the only site to produce lithic scrapers (5) and one of these (7951) had microwear evidence of hide working polish.

Site J, Bones and bone tools

The main species (Chapters 11 to 13) represented here were red deer and aurochs, with some wild boar and roe deer. Complete deer carcasses were processed on site. Aurochs were butchered but their hides and horns may have been taken elsewhere. Wild boar were butchered but may have been taken elsewhere to cook. In sharp contrast to Site A there were only a few fish bones on Site J, two identified, both eel. The largest concentration of bones was in the north-west corner of the site and most had been smashed for marrow extraction. Six from this concentration had distinct polish showing opportunistic use, probably in hide preparation. In the same area there was a more carefully fashioned bone artefact (10765). Thus in Area A (Fig 6.14b) a range of sources of evidence show that aurochs butchery and hide preparation was taking place and, as noted above, stratigraphically this was the earliest phase of activity on that part of the site. In Pit J on the northern edge of the excavation larger animal bones accumulated on the edge of the saltmarsh probably representing a toss zone from an adjoining activity area on dryland. Scraping and abrasion marks on a scapula (7430) and rib segments with multiple fine cut marks on a rib segment (7523) might, it has been suggested, have been caused by the scraping and cutting of sinew. From the same area, Bone 7595 was apparently used as an awl. A nearby aurochs bone (10392) had evidence of probable microlith impact.

Site J, Possible structure

In the middle of Site J (Fig 6.14; Zone B), it has been argued in Chapter 6 that a concentration of artefacts around the periphery of a roughly circular area of diameter 3m might indicate the position of a small tent, or shelter, where some knapping and the use of lithic tools (especially scrapers and retouched flakes, Fig 6.15) took place. The main concentration of artefacts here is at an intermediate depth in the Old Land Surface at a similar horizon to the heat-fractured stone concentration which lies immediately to the north-west. It must be acknowledged that in vertical section (Fig 6.13) the artefacts in this area do not pick out a very clearly defined horizon such as might confirm the existence of a structure. However, there is the complication of evidence for successive phases of activity and the possibility of some vertical disturbance – so on balance a structure seems probable. Evidence for structures is further considered later.

Site J, Cooking with heated stones

John Allen (Chapter 9) has argued that these stones, particularly quartzites, were selected for their thermal properties and are likely to have been imported to the site. They were concentrated on Site J, with small numbers on other sites. Very few joins were found pointing to reuse and movement elsewhere of the broken stones, thus possibly indicating an activity repeated at multiple locations. A marked concentration occurred in the north-east part of Site J and as noted at a middle depth within the Old Land Surface. There was no concentration of charcoal in the same area and depth. In the wider area covered by this monograph heat-fractured stones are also known from Prestatyn Middens C and D (Chapter 20.4.3–4), Westward Ho! (Balaam *et al* 1987a, plate 5), and calcined flints were abundant at Freshwater West (Wainwright 1959). Given the certainly Mesolithic date of heat-fractured stones at Goldcliff and elsewhere it is possible that some of the coastal cooking places marked by such stones and found by Leach (1911) in Pembrokeshire could be of this date; some had flints associated, but this does not, of course, exclude a later date.

Heat-fractured stones seem to be frequent finds on Mesolithic sites but their occurrence is seldom discussed. At Mount Sandel small pits were filled with burnt stone (Woodman 1985, 154); heat-fractured stone occurs at Eskmeals (Bonsall *et al* 1990) and there are possible example in photographs of Star Carr (Clark 1954, plates II and IIIB) and perhaps Morton (Coles 1971, plate XXV). They also occur in Danish middens (Andersen 1991). This raises the question of what activities they represent. Many of the Goldcliff examples show evidence of multiple fractures and crazing. They have not just been heated but have suffered thermal shock through contact with water. They could have been used to heat water in a container, eg of hide or wood, or for pit cooking.

We cooked a medium-sized salmon at Butser Experimental site by digging a *c* 20cm-deep hole, lining it with a large quartzite block from the Severn Estuary and many flints, lighting a fire on the stones, leaving it to burn for two hours, then placing a salmon wrapped in leaves on the hot stones and embers and covering with turf and earth to retain the heat. After two hours the salmon was fully cooked and delicious. Another possibility is suggested by the widespread occurrence of heat-fractured stones in sites on the American North-West coast where the ethnohistoric record shows that they were used in the steam cooking of plant foods including roots and rhizomes (Stein 2000; Hayden and Cousins 2004). The use of plant foods will be further discussed below. Heated stones and steam could of course have played a part in a range of other activities apart from cooking, eg saunas, steaming shellfish (Waselkov 1987), working wood etc.

Site J, Activities on the saltmarsh edge

The level of activity in the estuarine sediment is much less than in the underlying buried soil: 2.8 artefacts and 0.07 tools per square metre. However, some knapping took place at the edge of the encroaching saltmarsh since chips were present. The presence of only three retouched tools suggests that by this time the site was peripheral to the main activity areas. One particularly significant find from this area was the long pointed wooden stick (9224) which might have served as a spear or digging stick.

Site J, Activities at the time of peat formation

Only a very small number of artefacts show continuing activity: deposition of a few flakes, five heat-fractured stones, and three pieces of worked wood. These artefacts may point to a low level of continuing activity on neighbouring dry ground in about the last 800 years of the Mesolithic.

Site J, Worked wood

In all, there were some 42 pieces of wood with some evidence of working, all but 7 of them from Site J. These have been described individually in Chapter 10 and CD 10.4. Here, somewhat speculative consideration is given to the way that some of the most carefully worked pieces from Site J may have been used. The small collection from Goldcliff is significant because of the extreme rarity of wooden artefacts in Mesolithic Britain which amounts to little more than a paddle, part of a mattock handle and some cut branches and possible planks at Star Carr (Clark 1954; Taylor 1998). The two most carefully worked pieces are from Site J and have very similar AMS radiocarbon dates, between 4940–4710 cal BC (Table 8.2). Artefact 9224 was a 116cm-long stick, slightly curved, worked to a point at one end, less certainly at the other end, which was not so well preserved (Fig 10.1). One distinctive feature was that it was worked throughout its length (ie not just pointed roundwood). This may have been intended to remove the softer sapwood and/or to reduce the weight of an artefact that was to be carried some distance. The writer has fashioned a replica of the object from oak (Fig 18.4) and it makes a very much more robust and useful artefact than was evident from the broken pieces of wet wood excavated (CD 6.22–6.23). It might have served either as a spear or digging stick; on balance the latter is thought more probable because of the curve it exhibits. If used in this way it can be held in both hands and moved towards the worker on one side of the body. It must be acknowledged that there is no clear evidence of wear on the better preserved end such as might have been produced by digging. It was deposited on the saltmarsh edge at Site J and was broken by red deer trample. A digging stick from Lindholm on the Storebaelt, Denmark, is of similar dimensions, carefully worked throughout its length but not curved and with one end worn (Pedersen *et al* 1997, 90).

The second particularly carefully made artefact (9199) was a 'Y'-shaped object. The one remaining

Figure 18.4 A scene created at Butser Experimental site, Hampshire, reconstructing some aspects of Mesolithic Goldcliff. A small reed-thatched shelter is in the background. In front of this a hearth is being prepared for cooking with heated stones, and in the foreground is a selection of experimental artefacts. Left and foreground: reproduction wood artefacts (spear or digging stick 9224; Y-shaped object 9199; and pin 10266). With these are a reproduction of the antler mattock-hammer (7065), split antler and bones used to clean skins and a heat-fractured quartzite stone (photo M Bell)

arm was rounded by use and the shaft may originally have been longer and broken. Figure 18.4 shows a replica of this artefact on the assumption it originally had two equal arms. The object does have possible parallels on mainland European sites. Two 'Y'-shaped pieces of wood at Ageröd V Sweden show distinct cut marks on pointed arms (Larsson 1983, fig 27.5). A worked forked stick was also found at Satruper Moor, Germany (Schwabedissen 1958, fig 10a). However, the Goldcliff example is larger and carefully worked all over. Of similar size to the Goldcliff piece is an object from the North Russian site of Nizhneye Veretye 1, 'Y'-shaped but with a short cut arm between. From the drawing it looks as if the arms may be rounded in a similar way. That object was interpreted as an anthropomorphic figure with raised hands (Oshibkina 1990, fig 3.1)! If the shaft was originally much longer, then the Goldcliff object might have proved useful for catching eels hibernating in the mud and this could explain the wear at the end of the remaining arm. Other uses one can think of, such as suspending things over a fire, would not have produced the wear seen, nor required the careful working seen on this piece. Artefact 10665 might be a less well-preserved example of a similar object. Other pieces from Site J include a carefully worked wooden pin (10266) and what may be the broken point of a spear (10159). Carefully worked spears are seen at Satruper Moor, Germany (Schwabedissen 1958, fig 6). Another enigmatic piece could be a wooden bead (10462).

However uncertain their function, the presence of carefully worked wooden objects on Site J reinforces the impression from other artefacts that this was a site where a range of domestic and craft activities took place. There is also a little evidence for woodworking in the form of a few woodchips. It is probable that not all chips, and probably objects, were recovered given the mass of natural roots and wood on this site. Perhaps the chief importance of these finds is to demonstrate that wood was an important part of Mesolithic material culture, that they were capable of working it in a skilled way presumably with flint blades, and particularly that wooden artefacts can occur in a range of contexts within the intertidal zone: buried soils, estuarine sediments, and peats. The context in which the two best-preserved artefacts from Site J were found is significant. They were both just below the peat, one in the Old Land Surface, the other in estuarine sediment. The surprising thing is that the AMS radiocarbon dates indicate that they predate by centuries the encroachment of peat over minerogenic sediments. This must surely imply that by the date of these objects, when saltmarsh sediments were beginning to encroach, the findspots were permanently wet, which given the slope and the huge tidal range surely suggests permanent spring discharge at the island edge. It seems probable that a spring in this area was one of the factors that attracted activity to Site J. Spring activity is also suggested by the cementation of the Ipswichian deposits nearby by calcium carbonate derived from bedrock on the island (J R L Allen pers comm).

18.5 Unstratified artefacts: the axes/adzes and mattock-hammer

In all, four volcanic tuff axes/adzes have been found unstratified on the foreshore; two were close to Sites B and D, one was in the eastern part of the embayment and one was found 2.3km to the east at Porton. The latter two were reported in Bell *et al* (2000). None can be associated with any specific activity area but they do tell us about activities in the general area. Since these are by far the heaviest tools in the assemblage one might logically expect them to have been used either for digging, for which purpose either antler or wooden artefacts would seem generally more suitable, or woodworking which our wooden finds suggest was surely an important activity. Observations on wear suggest a more complex picture. 3/96 showed possible evidence of heavy use and resharpening (Barton 2000, fig 4.7:3/96). The larger implement from Porton does have a reasonably sharp cutting edge but Barton (2000) suggests it may have been abandoned unfinished and unused. Of the two examples reported, one (13000) has evidence of rubbing or abrasion, while on the other example (7034), not all the wear was on the pointed end and Barton (Chapter 9) suggests a possible use in scraping wood and bone. We can only conclude, therefore, that they may be multipurpose tools of which woodworking may be one function.

The mattock-hammer was also unstratified from close to the footprint Site C. It has been concluded that this example was a composite tool which originally had something mounted in the socket at one end. This is most likely to have been a lithic implement as reconstructed in Figure 18.5. This proved a most effective woodworking tool, the antler burr giving weight and balance to the implement. It proved effective in pointing pieces of roundwood. If a woodworking tool, the battered burr may have been used for hammering wedges in splitting woods such as oak. These tools add to the evidence for a range of craft and productive activities round the edge of the former island. The perforated antler mattock head from Uskmouth (Aldhouse-Green *et al* 1992; Aldhouse-Green and Housley 1993) is within the date range of occupation at Goldcliff, the nearest known dryland at the time, so it is likely to have been dropped during an expedition from Goldcliff.

18.6 Activities: conclusions

There is a wide range of activities represented at Site J: hunting, butchery, skin processing, knapping, cooking with heated stones, maybe processing plant foods, and some woodworking. It could be argued that such a range of activities suggests a base camp. Different parts of the site may have been used for

Figure 18.5 Experimental reproduction of the Goldcliff antler mattock-hammer (7065), with a flint blade added, being used as a woodworking tool (photo S Bell)

different activities during successive reoccupations. The distinct clustering of artefacts seen here is more explicable in terms of a site revisited rather than one permanently occupied. Site A shows even clearer evidence of the spatial nucleation of a range of activities in one small area: microlith production, fish cooking/smoking etc. Site W has evidence of butchery, possible skin preparation, cooking including fish processing/smoking, possible processing of plant foods. However, the number of tools was very small so the activity was interpreted in terms of short-term temporary occupation. Site B also has a much smaller artefact assemblage but one which does attest to a range of activities. It is likely to be on the edge of a now eroded activity area upslope and the evidence of defecation here and on nearby Site D emphasises their marginal location. It is uncertain whether B and D are marginal to a camp occupied for perhaps a few weeks, as envisaged at Sites A and J, or relate to the more transitory occupation at Site W. The footprint areas seem to represent more specialist activities, probably fishing, fowling, hunting and maybe the gathering of plant materials, as well as children playing.

There are also some clear contrasts between the different excavated sites. Fish bones are almost all from Sites A and W, heat-fractured stones largely on Site J. Microliths are abundant on Site A but are present in low numbers on other sites. Most striking is the complete absence of aurochs on Site W, despite their importance on Site J and presence on other sites. It is clear that rather different activities were going on in the different artefact concentrations.

Overall, however, the main concentrations of artefacts each paint a picture of diverse activities. Thus, Woodman (1985) argued that Mount Sandel was a base camp partly on the basis of a range of activities. However, considering the period over which activity took place the artefact assemblages at Goldcliff are not large and the marked nucleation of artefacts seen does not point to a palimpsest such as might be created by an extended period of permanent occupation. The evidence is more consistent with a camp temporarily and periodically visited. On the available evidence activity seems to have become much less intense in the last few centuries of the Mesolithic when peat was forming around the island. This might suggest shorter, less intense visits, but we must also bear in mind that only a tiny fraction of the margins of the former island have been investigated. Most of the island as it probably existed in the later Mesolithic has been eroded away (Fig 18.3; Allen 2000a, fig 2.1). It could be that in the late Mesolithic, as peat accumulated landward, activity moved to the southern edge of the island where there was more ready access to the estuarine resources which were clearly an important part of these people's way of life.

Figures 18.6–18.7 are reconstructions showing Mesolithic life at Goldcliff. They bring together

Figure 18.6 Panorama reconstructing various aspects of Mesolithic life and activities at Goldcliff East (Copyright © painting courtesy of the artist Victor Ambrus)

Figure 18.7 Reconstruction of a domestic scene at Goldcliff East round the campfire on which fish is being smoked (Copyright © painting courtesy of the artist Victor Ambrus)

evidence from more than one site. The reconstruction paintings were done in the field by Victor Ambrus in close consultation with the project team as part of the Time Team television programme that was made during the final season of excavations. For that reason they are interim statements which could not draw on the final results of post-excavation analysis. Figure 18.6 is based on the topographic setting of Site J at high tide. In the centre, fish traps are being worked on, a woman holds some fish, whilst children leaving a trail of footprints set a pair of cranes to flight. For the dugout canoe (bottom left) there is no evidence from Goldcliff, but there are many Mesolithic examples from continental Europe and possible examples from Tayside, Scotland, as well as Bigbury, Devon (Coles 1971). On dryland a deer is being butchered and nearby, around a hearth, fish are being smoked as a woman processes plant foods. Behind her, a sow and her piglets emerge from the reed beds. To the right two hunters bring down an aurochs at the mudflat edge. In the background, controlled burning is taking place on the island, increasing grassy and woodland edge habitats favourable to some food plants. Burning also takes place in the nearby reedbeds. Figure 18.7 is a more intimate family scene emphasising the fact that all age groups seem to have been present at Goldcliff. The family are around a campfire where a trap has been emptied and fish are being smoked. A hunter has returned with an otter. Both reconstructions show domestic dogs: our evidence (Chapter 12.3.3) suggests that domestic dogs may not have been present here, although they are known from other Mesolithic sites as noted above.

18.7 Structural evidence

Direct evidence of structures was very limited: one possible posthole on Site W (Bell *et al* 2000, fig 4.5), a possible post (Fig 6.9), and one or two pieces of cut wood on Site J which might have formed part of structures. None of this fragmentary evidence bears any clear relationship to artefact distributions, but the latter finds do offer rather better indications of the positions of structures. On three of the sites there are particularly marked concentrations of artefacts in roughly circular areas *c* 3m in diameter. The pattern is most clearly picked out by debitage on Site J (Fig 6.14, Area B) which clusters around the periphery of the circle with a less dense area in the centre. A second roughly circular concentration of artefacts to its west (A on Fig 6.14) lacks the peripheral concentration of artefacts and the section (Fig 6.13) shows a lack of horizonation in the buried soil. That concentration may represent an activity area rather than a structure. On Site A, artefacts show a strong spatial concentration although its size and edge is less clearly defined than the first example on Site J (Figs 5.2–5.4). Given the pattern now found on Site J re-examination of artefact distributions west of the island shows a rather similar circular concentration of artefacts centred on a point 9m from the southern edge of the excavation (CD 5.11–5.13). The concentration is circular, *c* 4m in diameter, and there are hints of peripheral clustering of some artefact types. There is an area of charcoal and burnt flakes in the centre about 1m in diameter which may represent a hearth. Bones are concentrated in an area to the west of this. A second concentration of burnt and unburnt bone and burnt flakes about 1m to the north of the main circular area may represent an external hearth, in which case it could suggest an entrance facing north.

One interpretation of these artefact distributions is that they define light circular structures 3–4m in diameter. That would suggest a wigwam type structure constructed of a number of roundwood poles tied at the apex and covered by either skins or reed thatch. Figure 18.4 shows a partial reconstruction made at the Butser Experimental site in Hampshire. Such a structure could be easily erected by four or five people in one day if it was reed-thatched – in much less time if a portable skin cover was used. This 3m diameter structure would sleep four people.

Alternative interpretations of the circular artefact distributions should, however, be considered. Using the ethnohistorical record of hunter-gather campsite organisation Binford (1983) has developed models of hearth-centred activities with drop zones around the hearth and toss zones in an outer arc. In Binford's examples, artefacts cluster outside rather than inside huts. Similarly, with the plans of Kung San campsites the artefacts are mostly clustered outside the huts around the hearth (Whitelaw 1994). Binford also argues that artefacts are seldom deposited to the very edges of huts and that internal hearths are generally in pits, or surrounded by stones. No hearths defined by stones or pits have been found on any of the Goldcliff sites but it is possible that hearthstones were moved elsewhere for reuse. One question here concerns scale. Particularly in the case of Site A, many of the artefacts found within the hypothetical structure were extremely small, eg fish bones and microlith fragments, so some of this material would not have been visible waste. In many Mesolithic structures the interiors are marked by dense concentrations of artefacts as at Deepcar (Radley and Mellars 1964), Mount Sandel, Ireland (Woodman 1985), and Howick (Waddington 2003). Dense artefact concentrations also occur inside the Mesolithic structures at Skateholm, Sweden, within which knapping took place (Larsson 1985).

Mesolithic structures are much more numerous on the European mainland than in Britain and these are mostly much larger, eg Bergumermeer, Netherlands, with oval structures 9m by 5m (Newell 1980); Skateholm 1, Sweden, 11m by 6m (Larsson 1985); Lillikhuse, 5.5m by 4m (Sørensen 1993); and Mollegabet II, Denmark, 5.2m by 3.2m (Skaarup and Grøn 2004). These structures are mostly within shallow pits. Comparable structures occur in the British Isles at Howick, Northumberland, a sunken pit dwelling

6m in diameter (Waddington 2003); Forvie and East Barn in Scotland (Wickham-Jones 2004); at Broome Hill, Hampshire, a pit with posts *c* 4.5m by 5m across (Morrison 1980); and Mount Sandel, Ireland, where the hollows are *c* 6m in diameter (Woodman 1985). However, both on the continent and in Britain there are also smaller Mesolithic structures comparable with those suggested at Goldcliff. Continental examples include Motala, Sweden (Carlson 2005), Niva, Denmark (Jensen 2005), and Hardinxveld, Netherlands (Louwe Kooijmans 2003) – all of which have circular structures of about 3m in diameter. In the northern British upland, Jacobi (1973) has suggested structures on the basis of concentrations of artefacts *c* 3m in diameter. The contrast between the larger structures previously described and these small structures is often rationalised as the difference between larger long-term and winter dwellings and lighter short-term summer dwellings (Grøn 1990).

18.8 Population structure

The best evidence for population structure comes from the human footprint-tracks (Chapter 12). 248 footprints have been recorded representing at least 20 individuals (Table 12.1). These were not, however, present at the same time. The largest number of people that can be shown to be present at one time is four (Persons 2–5). In some cases, we can estimate the number of years between individual walks – assuming that the distinct bands picked out by erosion are annual. Thus, the walk of Person 1 seems to be about 45 years later than Persons 2–5 (Fig 4.5). What is most striking about the footprints is that only four individuals represented by seventeen of the footprints are classified as certainly adult (aged 14+). Seven individuals represented by 103 footprints are sub-adult (aged 11–14), two individuals represented by five footprints are children (aged 7–11) and six individuals represented by 123 footprints are young children (aged 3–6). Thus, 40% of the individuals and 52% of the footprints relate to children and only 7% can be confidently identified as adults, although some of those classified as sub-adults may have been. Most informative perhaps is the group of four (Persons 2–5), who walked together on Site E, pausing and changing pace together. We may speculate that this was a peer group, maybe sub-adult males, out hunting. The presence of these footprints, on what would at the time have been mudflats with encroaching saltmarsh in places 400m east of the settlement site demonstrates the involvement of children, some as young as 3–5, in the foraging and gathering activities of the community. The Goldcliff evidence is reinforced by the evidence of contemporary footprints, at Uskmouth (3.3km to the west), and probably within the site's territory (see below), which includes the footprints of two adults and a child, and the footprints at Magor which are of an adult and a child (Aldhouse-Green *et al* 1992). Children's footprints also predominate among those from the intertidal zone at Formby (Roberts *et al* 1996) – some of which may be Mesolithic, others cover the period up to the Bronze Age. Although the role which these findings suggest for children may seem surprising to us today, the ethnographic record contains a wealth of evidence of the active engagement of even very young children in the activities of hunter-gatherers. Meehan (1982) documented this among the shellfish gathering Anbarra communities of Australia, and Scales gives other examples in Chapter 12.

More problematic has been establishing the sexual composition of the population. Scales's (2006) metrical analysis of the feet of modern children shows that published criteria for sexual discrimination between under 14s are not reliable. We can be reasonably confident that the three adults (Persons 5, 7, and 14) with footsizes between 26–28cm, and thus English shoe sizes of 9–11, are male. Even so, we cannot exclude the possibility of their being female. Those with footsizes between 23–25cm are difficult to interpret because they could be adult females or sub-adult males. Overall, the footprints provide important evidence relating to children, probable evidence of adult males, and others which probably, but not certainly, include some adult females. On the footprint evidence we should consider the possibility that this site had a predominance of young people. Given abundant evidence for contrasting age and sex compositions of different components of hunter-gatherer settlement systems this would not be out of place. Tempting as it is to associate the presence of several sub-adults with the notion of a segregated population at the transitional stage of puberty, which is attested in the ethnographic record, this theory is made less likely by the presence of young children and also needs to be considered in the context of the full range of evidence from the site. Many of the activities carried out in the settlement site are highly likely to have been carried out by adults, but would also provide opportunities for children to learn on the job. The hunting of aurochs, deer, pig, and otter are likely to have been a mainly adult male task although older children may have played a part in stalking and driving, the footprints at Uskmouth and Magor Pill show that children participated in more distant expeditions (Aldhouse-Green *et al* 1992). Many of the other activities like flint knapping, butchery, skin preparation, woodworking, and many cooking tasks are likely to have been carried out by adults but with participation of children in an apprentice role. However, the predominance of children in the saltmarsh does suggest that there were activities around the settlement where older children took more of a leading role, maybe emptying the fish traps, fowling, the gathering of plant foods, the preparation of some of these and the drying of fish. The indications are that we are dealing with a normal population, children, men and women, with maybe one or more extended families. We can certainly rule out the possibility that visits to the estuary were carried out solely by bands of male adult hunters. It looks as if the whole family went along.

18.9 Axes of movement and site territory

Footprints, like wooden trackways (Bell *et al* 2000, 157) and roads, can potentially provide us with most valuable insights to the way in which past communities were moving around the landscape and thus how the spots on the map which we call sites articulated together to form a living landscape (Bell 2003). Inevitably, we have just tiny fragments of the picture, patches of footprints which happened to be exposed at times of fieldwork. Only one of the footprint trails investigated headed directly to the island, that was Person 1 on Site H who was on a bearing of *c* 270° heading for Sites A and J. The group of four were on an average bearing of *c*140° heading south-east. On the northern part of Site C (Fig 4.3) the predominant axis is south to north but others are orientated in other directions. On the southern part of Site C recorded in 2002–03 children's prints go in many different directions but there are trails with a south-west to north-east orientation. Thus, only Person 1 was orientated on the island in a westerly direction. The others were moving more or less at right angles in a roughly north/south direction. This was along the strike of the banded sediments and thus along the edge of the palaeochannel on the banks of which the sediments were laid down. This suggests that the focus of the activity was the channel and the most likely activity was checking fishtraps, which the fragmentary evidence of Structure 332 (Fig 4.2) suggests were situated within it. Fowling may have been another channel-centred activity for which we have less direct evidence.

It is quite likely that the roughly contemporary footprints at Uskmouth, 3.7km to the west (Aldhouse-Green *et al* 1992), relate to wetland exploitation from the Goldcliff settlement. If so, the Uskmouth individuals were not heading to their island home which lay at *c* 95° but they were heading to the sea at about 145°. It is impossible to say why, but the most likely activity is fishing at the mouth of the River Usk. Close to the Uskmouth footprints a perforated antler mattock was found which might have served as a woodworking tool in the maintenance of wooden fishtraps. Other human footprints have been found on the foreshore at Magor, 6km east of Goldcliff, and others have been noted but not recorded at Redwick (Bell *et al* 2000, map 21). Both are dated by overlying peats to two or three centuries younger than the latest known dates for artefacts on Site J. The Magor individuals were heading to the east. It must be questionable whether the footprints at Magor relate to exploitation from Goldcliff because there is nearer dry ground at the estuary edge 2km north. If all these footprints, which are broadly contemporary with activity at Goldcliff, relate to exploitation from that site then we can postulate activity from that camp extending across wetland 5km to the mouth of the Usk in the west and 6km to Magor Pill in the east. Given the predominantly north to south axes of footprint movement palaeochannels clearly attracted particular attention. Speculating further, it might even be suggested that east–west communication may have made use of boat transport.

18.10 Nature of settlement pattern

Various writers have classified hunter-gatherer site types using a combination of the ethnographic record and types of sites which are regularly encountered archaeologically (eg Binford 1988; Peeters 2002). Site W was originally interpreted as an impermanent settlement of short-term duration (Barton and Bell 2000). The interpretation was based on the lack of structures, the absence of stone-lined hearths, the low minimum number of individual animals, and the small number of tools. If the tentative identification, suggested here, of a 3–4m diameter circular hut is accepted, then that interpretation needs some reconsideration. However, such reinterpretation would only point to some extension to the relative duration of activity, maybe a few days or weeks – certainly, there is no evidence to support longer-term, or permanent, settlement. East of the island, it is clear that activity extended over at least 1100 years and on Site J there is evidence of a palimpsest of activities which may well represent activities extending over decades or centuries. Sites A and J, east of the island, have provided a larger number of tools and evidence of a more diverse range of activities than the sites west of the island. The existence of a base camp, at least at Sites A and J, is most likely given the diversity of tools and activities, the composition of the population, and the probability that a sizeable wetland territory was exploited from this site. Binford (1980) defines this as a hub of subsistence, processing, manufacture, and maintenance. Given the duration of occupation, however, the artefact assemblage is not large and the distinct nucleation of artefacts militates against long-term or permanent settlement, thus suggesting a base camp occupied perhaps for a few weeks at a time. So the duration of occupation on sites east of the island may have been longer than that on its west side, given evidence presented below that the two sides were occupied at different seasons. Site B is more difficult to classify, the density of material is low but a range of activities is represented. For this reason, it is suggested that the site lay on the fringes of an eroded base camp rather than something of a more temporary nature such as an overnight field camp or extraction camp.

18.11 The use of animal and plant resources

There are two approaches to identifying the resources used in the Mesolithic. One is to look speculatively at the resources likely to have been available on a site and estimate their significance and seasonal availability. Clarke (1976) identified a long list of plant and animal resources which are likely to have been used in the broad spectrum economy of the Mesolithic, but few of these were attested by finds from specific sites. In western Britain Jacobi (1979, 1980) has speculated which resources are likely to have been important in particular areas linking this to the limited records for what is attested archaeologically. More speculatively still, at Eskmeals, models of site economy are based entirely on plants and animals which it is suggested were available in the area (Bonsall 1981). These, so-called optimal foraging models (Jochim 1983), rest on assumptions about what was present but also assume everything available was used, whereas the ethnographic record shows that some resources may have been avoided for social or other reasons. A second, more conservative approach, is to consider only those resources which are firmly attested in the archaeological record. In practice we need a combination of these approaches because not every resource has an equal chance of entering the archaeological record and being preserved on each site.

18.11.1 Animal resources

Table 18.2 outlines the animal resources attested at Goldcliff. We cannot prove that all of these were utilised, especially the birds represented only by footprint-tracks. The table demonstrates the use of six mammal species, the presence of five types of bird, only one of which, the possible mallard, is represented among the bones, thirteen types of fish and the presence of seven species of mollusc. Of these resources, red deer was represented by the largest number of bones on every site. The second most important species on Site J was aurochs. It is notable that aurochs did not occur on Site W – which surely suggests some difference in the nature or timing of activity, although hunting opportunity may have been a factor. Aurochs are represented by very few footprint-tracks, certainly by comparison with Peterstone where numerous examples have been found recently (Bell and Brown 2005). Perhaps they only occasionally ventured this far out into the wetland where channels would have been hazardous for such large animals, as Neolithic examples trapped in estuary channels at Uskmouth and Rumney show (Whittle and Green 1988; Green 1989). On Sites A, B, and W the second most important species was pig. However, both west and east of the island head and feet predominated and meat-bearing bones were absent suggesting that these may have been taken elsewhere for consumption. Roe deer were present on all sites, but in low numbers. A lack of bones of head and feet suggests that they may have been killed elsewhere and selected cuts brought to the site. That is consistent with the view that they have a greater preference for woodland than red deer. Otter was only present on Site W. This site also produced bones of wolf/dog and their footprint-tracks have been found near Site C. There is some uncertainty about whether these are wolf or dog but on balance the former is thought more likely and that is supported by the very low numbers of gnawed bones (1%). It appears therefore that they may not have had domestic dogs which are known from the British Mesolithic (Simmons *et al* 1981, 123) including a possible example from Caldey (Jacobi 1980). There is no indication of any domestic animals despite the fact that the Site J dates are just a couple of centuries earlier than the first dates for domestic cattle at Ferriter's Cove, Ireland (Woodman *et al* 1999).

There are many terrestrial mammals which were present in the later Mesolithic but are not represented here: badger, pine marten, wild cat, weasel, polecat, mole, hedgehog, red squirrel, beaver, brown bear, stoat, fox, and brown hare (Simmons *et al* 1981). By the time of Site A, Goldcliff was a bedrock island surrounded by wetland with the nearest dryland 5km to the north. Both the principles of island biogeography (MacArthur and Wilson 1967) and the effects of sustained human predation would predict that the fauna of this 'island' is likely to be more restricted than that of contemporary mainland sites and that may well explain the absence of many of the foregoing species. It is also probable that marine mammals were from time to time to be had in the estuary – whale is for instance reported from prehistoric contexts in Newport Docks (Keith 1911) and Brean Down (Levitan 1990), seals have even been known to breed in the estuary (Condry 1981) but there is no evidence of marine mammal exploitation at Goldcliff.

Birds are perhaps the most enigmatic resource. The footprint-tracks show they were very abundant but it was not possible to devote as much time to identification of the bird footprint-tracks as they deserved. There were also a small number of bird bones from the excavations, with the only identification being mallard duck from west of the island (and that was tentative). We can only speculate that birds, their eggs and fledglings, which were such a socially and economically important resource on some islands until recent times (Fleming 2005), may also have been important here.

Exploitation of fish is better attested with the presence of thirteen species as outlined in Clare Ingrem's report in Chapter 13. Many fish bones were burnt or calcined and these would survive better. So there is a suspicion that fish were a more significant resource than the surviving evidence suggests. Eels are the most important representing 83% of the bones from Site A. Also of some significance were goby, bass, smelt, and three spined stickleback. Salmon family were present on Site A, but they are only represented by two burnt bones. This low number is surprising given that from medieval times until the early 1990s, when restrictions were placed on catches,

Table 18.2 List of the faunal resources exploited (or, in the case of footprints, present) at Mesolithic Goldcliff

	Species	Site B	Site A	Site J	West of island	Footprint-tracks
Mammals	Red deer *Cervus elephas*	■	■	■	■	■
	Aurochs *Bos primigenius*	■	■	■		■
	Wild boar *Sus scrofa*		■	■	■	
	Roe deer *Capreolus capreolus*	■	■	■	■	■
	Otter *Lutra lutra*				■	
	Wolf *Canis lupus*				■	■
Birds	cf Mallard *Anas platyrhynchosa*				■	
	Crane *Grus grus*					■
	Grey heron *Ardea cinerea*					■
	Oyster catcher *Haematopus ostralegus*					■
	Black-headed gull *Larus ridibundus*					■
	Common gull *Larus canus*					■
	Tern *Sterna* sp					■
Fish	Eel *Anguilla anguilla*		■	■	■	
	Bass *Dicentrarchus labrax*		■			
	Smelt Osmeridae				■	
	Salmon Salmonidae		■			
	cf *Cyprinidea cyprinid*		■			
	Sm Gadididae		■			
	Bib *Trisopterus luscus*		■			
	Sand eel Ammodytidae		■			
	Mullet Muglidae		■			
	Flat fish		■		■	
	Goby Gobiidae				■	
	3 spined stickleback *Gasterosleus aculeatus*				■	
Shellfish	cf Crab		■			
	Whelk *Buccinum undatum*			■		
	Cockle *Cerasteroderma edule*			■		
	Rough periwinkle *Littorina saxatalis*			■		
	Flat periwinkle *Littorina littoralis*	■		■		
	Common periwinkle *Littorina littorea*			■		

Goldcliff has been an important salmon fishery. It seems probable that salmon bones, which are poorly calcified, may have survived less well than other species. Also of note is the presence of smelt, a small but delicious fish, which can be eaten like whitebait. This very oily fish was processed on the American North-West Coast to make Eulachon grease, which was their form of butter and eaten with a range of foods, particularly plant foods, some of which were stored in it (Turner 1995; Stewart 1977, 49). Whilst we cannot be sure that it was used in this way in Mesolithic Wales this does remind us that what may seem to be fairly trivial resources could have played a much more important role, emphasising the essentially complementary nature of animal and plant foods. Clare Ingrem (Chapter 13) has noted that many of the fish are small and suggested they are likely to have been caught in nets or traps. The fragmentary wooden structure (332) might be the remains of an eroded trap and some of the other worked wood from the laminated sediments here and on Site E may also have been derived from eroded traps. Crabs were caught and there are a small number of shellfish of which the edible species are cockle, whelks, and perhaps some small periwinkles.

18.11.2 Plant resources

On a site where waterlogged plant material is preserved it is difficult to distinguish those plants which were utilised from those naturally occurring. Evidence of carbonisation may help to identify those used but other plants will also have been charred in hearths or burnt with vegetation. We must consider which of the represented plants would have been useful and also which plants are not represented among the macrofossils, but may also have been important. Some of the latter such as roots and rhizomes are less likely to enter the archaeological record. In this regard we need to keep in mind Clarke's (1976) contention that a very wide range of plant resources is likely to have been utilised in the Mesolithic, a position reinforced by Zvelebil's (1994) survey of plant use during the period. Zvelebil argues that human dietary need means that plants would have made up 30–40% of the diet yet there is very little evidence of this contribution, or its diversity, from Mesolithic sites in Britain. Jones and Colledge (2001, 399) argue that archaeobotanical research in the Old World has tended to take a much narrower view of the plants which were used than research in the New World. The wealth of the New World ethnographic record must be a large part of the explanation. On the American North-West Coast the utilisation, storage, and nurturing of a very wide range of food and other useful plants is extremely well-documented among hunter-gatherers (Kuhnlein and Turner 1991; Turner 1995). In Chapter 14, Dark documented and discussed the plant remains which are preserved on the Mesolithic sites, whilst those from Site W are discussed by Caseldine (2000, 214, CD 4.20 and 13.24–13.25). This section includes a rather more speculative look at the range of plants that *could* have been used.

Table 18.3 lists plant resources with their Latin names, identifying whether the material was carbonised seeds, etc (which may suggest a more direct link to human activity), waterlogged seeds, pollen, charcoal, or worked wood according to site. Possible food and other uses are suggested on the basis of the palaeoethnobotanical references given. The only one of these uses about which we can be absolutely confident is the worked wood category, the others are suggestions. More speculatively at the bottom of the table (below the bold line) are species which are not directly attested on the site but are likely to have been present and might have represented significant resources. It should be stressed that this list is by no means comprehensive – the sources given identify hundreds of plant species that have been used by people. No attempt has been made in the table to identify medicinal uses, of which there are many (Launert 1981). A question mark in the uses column signifies that a related species is known to have been exploited in this way. Ellis (1983) provides details of the native status and distribution of these plants in Wales.

Trees and shrubs

Charred hazelnut fragments are abundant on Site A, frequent on Site J, with just 4 at Site B, and 1 on Site W. The pollen diagrams from Sites D, B, and J show that hazel was an important component and grew on all three sites as its dominance in the charcoal records and the abundance of waterlogged hazelnuts on Site J (Chapter 15) confirms. Hazel wood was worked.

Oak is a puzzle, as it is well-represented in the trees of the Lower and Upper Submerged Forest and in the pollen record. It was also worked. Yet there are no acorns, waterlogged or charred, among the macrofossils. A single acorn was found in the peat overlying Site W (Caseldine 2000; CD 13.25). Charred acorn husks occur on two Mesolithic sites in Scotland (Dickson and Dickson 2000). Zvelebil (1994) records acorns from just one Mesolithic site in Britain (Lussa River), although the charred acorns of the evergreen oak are frequently found on later prehistoric sites in the Mediterranean, southern Europe, and Near East (Renfrew 1973; Lewthwaite 1982). Acorns were an important article of diet in parts of North America, generally after processing by roasting or steaming to remove bitterness (Turner 1995). Their near absence in the British Mesolithic record must surely be a matter of preservation and the likelihood is that they made an important contribution to the diet in autumn and winter. Other trees and shrubs are also likely to have produced valued resources – eg elderberries, wild cherry, apple, sloe, bark bread from birch and elm, greens from lime and hawthorn. The only tree which seems to have minimal recorded uses is alder, although this wood was worked. It is notable that the level of Mesolithic activity declined dramatically once alder carr colonised the surroundings.

Berries and fruits

In addition to the trees and shrubs noted, these are likely to have been provided by raspberry (some charred) and blackberry.

Grasses

Common reed (*Phragmites)* is perhaps the single most important plant. Charred fragments on most sites establish a close link with human activity and it has a wide range of uses including rhizomes, shoots, sweet gum, and seeds. Sea club-rush produces nutlets, tubers, and seeds and is recognised as a significant food source on south-west Asian sites such as Abu Hureyra (Hillman *et al* 2001). Also of interest (although not specifically attested) is Lyme grass, which was later cultivated (Prance and Nesbitt 2005). This and sweet grass (*Glyceria*) are two of the grasses which produce large 'cereal type' pollen grains which are a possible source for those grains occurring here and on other Mesolithic sites (Chapter 14). Other species, not recorded here, the seeds of which have been used elsewhere, include – couch grass, floating sweet grass, and eel grass.

Greens
In addition to the trees already mentioned, greens may have been provided by orache, docks, Brassicas, goosegrass, and plantains.

Roots and rhizomes
Besides *Phragmites* and sea club-rush there are many species which produce edible roots and tubers but these are seldom preserved in the archaeological record, although there are records from Mesolithic sites in the Netherlands (Perry 1999). In North America many of these were prepared by steaming or roasting in pits for winter storage using heated-stones (Haydon and Cousins 2004; Turner 1995). Although there is clear evidence that bracken is poisonous to animals (Forsyth 1968) there is equally clear evidence that its rhizomes and young leaves have been eaten (Turner 1995). Bracken might have been an important resource, although Rowena Gale (pers comm) notes that rhizome charcoal would have been identifiable among the charcoal had it been present. Other roots or rhizomes which could have been significant are hedge woundwort, cinquefoil, marsh mallow, bulrush, club-rush, bogbean, and spike rush.

Fungi
These are likely to have been exploited but there is no direct evidence.

Marine plants and algae
Marsh samphire occurs widely in saltmarsh and mudflats and its lush salty shoots are likely to have been used. The estuary has some seaweeds which may have been eaten; some of the small *Littorina sp.* might have been brought to the site with seaweed (Chapter 13.3).

18.11.3 Resources: conclusions

From the analysis presented in Table 18.3, some plants really stand out as important in terms of their frequency, relationship to human activity, and range of uses. These are hazel, oak, *Phragmites,* and bracken. It is notable that in his speculative essay, Clarke (1976) argues for the particular high food value of oak, hazel, bracken associations. Whilst we have a reasonable basis for arguing that a wide range of animal and plants foods was exploited it is much more difficult to establish the relative importance of these two main food sources. The isotopic record from other sites in the wider region provides δ15N evidence for high meat consumption in the Mesolithic (Schulting and Richards 2000) but this does not necessarily mean that plant resources were insignificant.

18.12 Tidal influences

The environmental investigations reported in Chapters 14–17 show Mesolithic activity at Goldcliff was in an exceptionally dynamic environment, resulting from the interplay of several factors and resulting in fluctuating extents of marine and terrestrial influence. Most predictable and regular of these were tidal cycles. Nearly all activities beyond Goldcliff island would have been constrained by the state of the tide, which is a particularly powerful influence here with the second highest tidal range in the world: 14.8m at Avonmouth. At high tide, activity would have been limited to the island and boats and at low spring tides, a vast expanse of saltmarsh, mudflats, and sand was exposed stretching for kilometres in all directions and linking the island to the mainland.

Tides result from the coinciding influences of the moon and the sun on the sea surface and these factors are significant on a range of timescales (Jenkins and Bear 1995; Allen 2000c). The tidal range will have varied through time according to a range of factors, most notably the changing configuration of the coast with the Holocene sea-level rise. However, by the period of Mesolithic activity, the Severn Estuary had broadly assumed its present morphology, making it reasonable to assume that the tidal range would have been broadly similar to today. Most obvious are the twice daily or semi-diurnal tidal cycles and the spring-neap cycles of 14.77 days. The manifestation of these two factors as tides is shown in Figure 2.7 over the 38-day period of the final season of excavation. These patterns would have determined most of the activities of Mesolithic communities just as they determined the course of our excavation. Variations in high tide level over the course of one year are illustrated by Bell (1990, fig 160a). More subtle tidal cycles occur on intervals of the lunar month, a year, an 8.85 year cycle, and the lunar-nodal cycle of 18.61 years, all reflecting the relationship of the sun and moon to the earth over those periods. Allen (2000c, 1165) discusses these factors and illustrates the resulting variations in the levels of spring and neap tides over a period of nineteen years. Also significant are the exceptionally high spring tides, which as a result of solar influences, occur around the spring equinox on 21 March and the autumn equinox on 21 September, and the corresponding periods of reduced tidal range around the summer solstice on 21 June, and the winter solstice on 22 December.

The availability and abundance of many biota would have been greatly influenced both by these tidal factors and their relationships to the seasons. Tides would have been an important factor in the behaviour, inshore abundance and migration of fish. The landward migration of elver peaks at around the spring equinox and the seaward migration of eel around the autumn equinox (STPG 1989). Tides would also determine those periods of greatest vegetation development on the saltmarsh. The summer

Table 18.3 List of the plant resources present which may have been exploited at Mesolithic Goldcliff and others (below the bold line) which are not directly attested but could have been significant resources. Possible uses for these plants are suggested on the basis of the ethnohistorical and archaeological references given

Species		Site B	Site D	Site A	Site J	West of island	Uses: edibility	Other uses	Reference
Hazel	*Corylus avellana*	✖●◆	✖	✖●	✖✱●○◆	✖●◆	Nuts, oil	Wood, withies	Mabey 1972; Peacock & Turner 2000
Birch	*Betula pubescens*	◆			✱○◆	✖○◆	Sap – syrup ; bark bread	Sap – resin. Bark – string. Wood – basketry and withies	Uphof 1968; Duke 1992
Alder	*Alnus glutinosa*	✖○◆		✱	✖✱●○◆	◆	-	Wood	
Elder	*Sambucus nigra*	✖●		✖●○	✖●○	○	Berries, flowers		Mabey 1972; Renfrew 1973
Dogwood	cf *Cornus sanguinea*			●			?Berries	Wood	
Crab apple	cf *Malus sylvestris*			●	●		Apples	Wood	Mabey 1972
Sloe/blackthorn	*Prunus spinosa*	✖	✖	✖●	✖	✖	Berries	Wood	Mabey 1972; Renfrew 1973
Raspberry	*Rubus* cf *idaeus*	✖○		✖○	✖○		Berries	?Fibres	Mabey 1972; Renfrew 1973
Nettle	*Urtica dioica*				○	○	Young shoots.	Fibres – textile, dye	Mabey 1972; Turner 1998
Orache	*Atriplex* sp.	●○	○			○	Seeds, greens		Mabey 1972; Renfrew 1973
Goosefoots	cf *Chenopodium*	●○◆	◆	●○	◆	○	?vegetable; seeds/greens		Renfrew 1973
Pink family	*Carophyllaceae* undiff.	●◆		●					
Dock	*Rumex* cf *obtusifolius*	○					?greens		
Cabbage family	*Brassicaceae undiff.*				●		?greens		Renfrew 1973; Duke 1992
Cinquefoil	cf *Potentilla*				○		?roots		Mabey 1972; Turner 1995
Gypsy-wort	*Lycopus europaeus*				○	○			
Woundwort	*Lamiaceae* cf *Stachys*	●				○	tubers		Uphof 1968
Goosegrass	*Galium aparine*	●		●	●		See Chapter 14; greens, seeds		Mabey 1972; Duke 1992
Daisy family	*Asteraceae* undiff.	◆	◆	●○					
Fen sedge	*Cladium mariscus*	●			○			Thatch	
Sedge	*Carex* sp.	●		●○	○	○	Stem, base edible	Leaves – basketry	Turner 1998; Kuhnleim & Turner 1991
Sedge	*Cyperaceae* undiff.	●◆	◆		◆	◆		Thatch	
Grass	*Poaceae* undiff.	✖○◆	✖◆		✖◆	●◆	Seeds		
Bur-reed	*Sparganium* sp.				○				
Common reed	*Phragmites australis*		●				Rhizomes, shoots in growing season. Sugary gum, seeds	Thatch; basketry	Law 1998; Mabey 1972; Duke 1992
Greater plantain	*Plantago major*					●			Mabey 1972; Renfrew 1973; Duke 1992

Species		Site B	Site D	Site A	Site J	West of island	Uses: edibility	Other uses	Reference
Rush	*Juncus* sp.					●			
Sea club-rush	*Bolboschoemus martimus*					●	Nutlets, tubers, seeds		Hillman *et al* 2001; Renfrew 1973
Knotgrass	*Polygonum aviculare*					❍	?seeds		Hillman *et al* 2001, 417; Zvelebil 1994, table 2
Three-nerved sandwort	*Moehringia trinervia*					❍			
Marsh mallow	*Althea officianalis*					❍	Root		Mabey 1972; Uphof 1968
Bulrush	*Typha* sp.					❍	Tubers, shoots, flowers, seeds	Leaves – basketry	Turner 1998; Uphof 1968; Duke 1992
Bracken	*Pteridium aquilinum*	◆	◆		◆		Rhizomes and shoots	Bedding	Dimbleby 1978; Turner 1995
Lime	*Tilia*	◆	◆		◆	◆	Sap, greens	Bast – string; wood	Dimbleby 1978; Mabey 1972; Boyd 1999; Law 1998
Elm	*Ulmus*	✖◆	✖◆	✖	✖◆	✖	Bark bread	Wood	Dimbleby 1978
Ivy	*Hedera helix*	✖◆	◆	✖	✖◆	✖		?fibres	
	Pomoidae	✖	✖◆	✖	✖	✖			
Oak	*Quercus* sp.	✖◆	✖◆	✖	✱◆	✖◆	Acorns	Wood	Renfrew 1973; Blackburn & Anderson 1993
Willow/poplar	Salicaceae	✖◆	◆	✖	✖✱◆	✖◆		Wood, withies; fibre; baskets	Turner 1998
Ash	*Fraxinus excelsior*	✖◆	◆		✖		Edible fruits	Wood	Mabey 1972
Spindle tree	*Euonymus europaeus*					✖	Fruits (toxic)	Wood	Launert 1981
Eelgrass	*Zostera marina*						Rhizomes		Turner 1995
Hawthorn	*Crataegus monogyna*					✖	Berries, young leaves	Wood	Mabey 1972; Renfrew 1973
Club rush	*Scirpus lacustris*						Tubers, stems and seeds		Clarke 1976; Uphof 1968
Floating sweet-grass	*Glyceria fluitans*						Seeds		Clarke 1976; Prance and Nesbitt 2005
Bog bean	*Menyanthes trifoliata*						Rhizomes		G Clark 1972
Lyme grass	*Leymus arenarius*						Seeds	Fibres	Kuhnlein & Turner 1991; Prance and Nesbitt 2005
Couch grass	*Agropyron*						Seeds, roots		Uphof 1968; Renfrew 1973
Blackberry	*Rubus fruticosus*						Berries		Mabey 1972; Renfrew 1973
Wild cherry	*Prunus avium*						Fruits	Wood	Mabey 1972; Renfrew 1973
Spike rush	*Eleocharis palustris*						Tubers	Bedding	Meehan 1982; Turner 1998
Marsh samphire	*Salicornia europaea*						Shoots		Mabey 1972

☐ Absent ● Charred seed ❍ waterlogged seed ◆ pollen/ spores ✖ Charcoal ✱ Worked wood

Note: charcoals identified to genus have been attributed to species in cases where other macrofossils eg seeds have been identified solstice is the middle of a period of around twelve weeks from mid-May to mid-August when the highest saltmarshes would not have been inundated (Bell 1990, fig 160). This coincides with the warmest part of the year and thus the development of lush vegetation. In later prehistory, it has been argued that this was the period when seasonal pastoralists came to the wetland (Bell 2000a; Bell *et al* 2000). In the Mesolithic likewise, these are likely to have been the conditions that attracted the largest numbers of grazing animals to the saltmarshes, coinciding with evidence for human footprint-tracks at this time. It is also likely that in periods of high spring tides and stormy conditions in winter those animals remaining on the wetland would naturally have migrated to the small Goldcliff island where they might easily have been hunted without any escape route. That might provide a context for winter activity on the west side of the island.

18.13 Human agency and environmental change

Fire was another key factor which contributed to the dynamism of this environment. Much of the charcoal on the occupation sites could have derived from hearths but there were also charred trees and charred vegetation away from the main foci of settlement. Some of this might be the result of natural wildfire caused by lightning during the driest periods of summer. Such fires in woodland appear to be very infrequent in Britain (Rackham 2003; Brown 1997), even less so in coastal wetlands. The overall environmental record makes it clear that burning took place at several different times in the Mesolithic. Charcoal occurrence in the annually banded sediments shows higher values in some years during winter and other years during summer, a pattern more likely to relate to human agency than wildfire (Dark and Allen 2005). At Goldcliff the burning episodes in the Lower Submerged Forest and peat are associated with clear artefactual evidence for human activity. Furthermore burning affected woodland, as evidenced by burnt trees in the Lower Submerged Forest (Trees 43 and 49), charcoal associated with other trees (Trees 103 and 48), and reedswamp as evidenced by charred *Phragmites* remains. There are much lower charcoal values in the Upper Peat and also evidence for a much lower level of human activity. Even so, some of the oak trees in the Upper Submerged Forest (Trees 36 and 70) were also associated with charcoal. There was also charred particle evidence for the burning of *Phragmites australis* in the upper part of the banded sediments below the Upper Submerged Forest (Dark and Allen 2005), and higher micro-charcoal levels in the early reedswamp successional stages which preceded the Upper Submerged Forest (Fig 15.3) and in a later retrogressive successional reedswamp stage at Site F (Fig 15.4). Thus, whenever reedswamp communities existed, there is evidence for burning, similarly in the oak woods of both the Lower and Upper Submerged Forests. It is hard to escape the conclusion that this burning relates directly to human activity. However, given the widespread nature of fire evidence in the Lower Submerged Forest at Goldcliff East and Redwick, 4.9km away, we cannot not totally exclude the possibility that this is a result of a much more dramatic environmental catastrophe, such as impact or explosion by an extra-terrestrial body. An event of this kind took place at Tunguska, Siberia, in 1908 (Baillie 1999; Lewis 1996). However, there is no independent evidence to suggest such a dramatic cause in this case.

This evidence from the coastal zone adds to the large number of sites from which there is evidence for Mesolithic burning in upland environments (Simmons 1996) and the lowland evidence at Star Carr (Mellars and Dark 1998) and the Kennet Valley at Thatcham (Chisham 2004). The ethnographic record demonstrates many reasons why hunter-gatherers burn vegetation (Mellars 1976; Boyd 1999a), but the general assumption in Britain is that this was mainly done to create grassy areas to improve grazing and thus biomass of red deer. This seems unlikely to have been the main motivation here, where sub-climax plant communities were already very extensive as a result of the natural disturbance factors already noted. Here, a more likely reason for burning seems to be to create conditions favourable for key plant resources. The plants of the woodland edge such as raspberries could have been encouraged by this practice and it seems probable that the growth, or at least abundance, of hazel on the island was as a result of burning. There has been much debate as to whether the Holocene hazel rise was caused by burning and whether burning does increase nut production; Rackham (2003) argues this only applies to the American species. At Goldcliff, however, it is clear that high hazel values coincide with a period of particular human activity; the charcoals show that hazel was being burnt, and charred hazel nuts demonstrate utilisation of the resource. The ethnographic record provides evidence that many of the plant resources which were used at Goldcliff have been managed and made more productive by burning (Turner 1995, 1999; Boyd 1999b) and such plants are separately distinguished on Tables 18.3–4. The geographical distribution and motivation for Mesolithic burning is further discussed in Chapter 21.

18.14 Seasonality and sedentism

Seasonal scheduling and movement is central to our understanding of hunter-gather communities. The ethnographic record frequently documents highly complex patterns of seasonal scheduling with resources varying from one month to the next, as for instance in the Salish communities of the American North-West (Carlson 2001). Many writers on the British Mesolithic have put forward simpler models of the geographical areas exploited seasonally as part of a mobile settlement pattern (eg Clark 1972; Simmons 1996; and for Wales: Jacobi 1980). Others look to models derived from Denmark, where, in the later Mesolithic, more or less sedentary Mesolithic communities are thought to have existed in the most productive coastal areas (Andersen 2000). It is often suggested that sedentary coastal communities may likewise have developed in the later Mesolithic in Britain and Atlantic Europe (Bonsall 1981; Zvelebil and Rowley-Conwy 1986; Whittle 2001; Barton and Roberts 2004). One of the objectives of this project was to test these conflicting models.

The identification of seasonality is, however, challenging. Even on sites, such as the Dutch Swifterbant, with abundant floral and faunal evidence it has proved difficult to establish if they were used seasonally or year round (Raemaekers 1999). The debates over 50 years concerning the seasonality of Star Carr also illustrate this. Those have now been significantly clarified by critical examination of a range of faunal (Legge and Rowley-Conwy 1988) and floral (Mellars and Dark 1998) evidence. Dark (2004b) highlights the significance of plant materials which are likely to have been charred accidentally. Identification of seasonality rests on uniformitarian assumptions about the birth dates and rates of growth and migration patterns of animals and the dates when flowers, fruits, and nuts appear. Present dates are likely to be broadly applicable but there was probably some variation in the rather warmer conditions of the later Mesolithic climatic optimum (Bell and Walker 2005). In the Severn Estuary, much evidence about the seasonal migration patterns of birds and fish today has been synthesised as part of environmental assessments for the proposed Severn Tidal Barrage (ETSU 1989). An additional problem, highlighted by Milner (2005), is that we are frequently dealing with palimpsests of activity, as for instance in the succession of activities represented on Site J (Fig 6.13). There is a danger of conflating these activities into activities in one hypothetical year. Furthermore, demonstrating that a particular resource was used at one time of year does not demonstrate that the site was unoccupied at other times. We can obtain some insight to this issue by considering the evidence for the timescale of activity on a site and the quantity of artefacts. In the case of each of the Goldcliff sites the evidence does not suggest the density of artefacts that would be associated with permanent settlement over the timescale represented; we cannot, however, preclude the possibility that people lived on the Goldcliff island permanently but moved around within it. It is considered, however, that the evidence for discrete nucleations of artefacts is more consistent with models of periodic visits than long-term occupation.

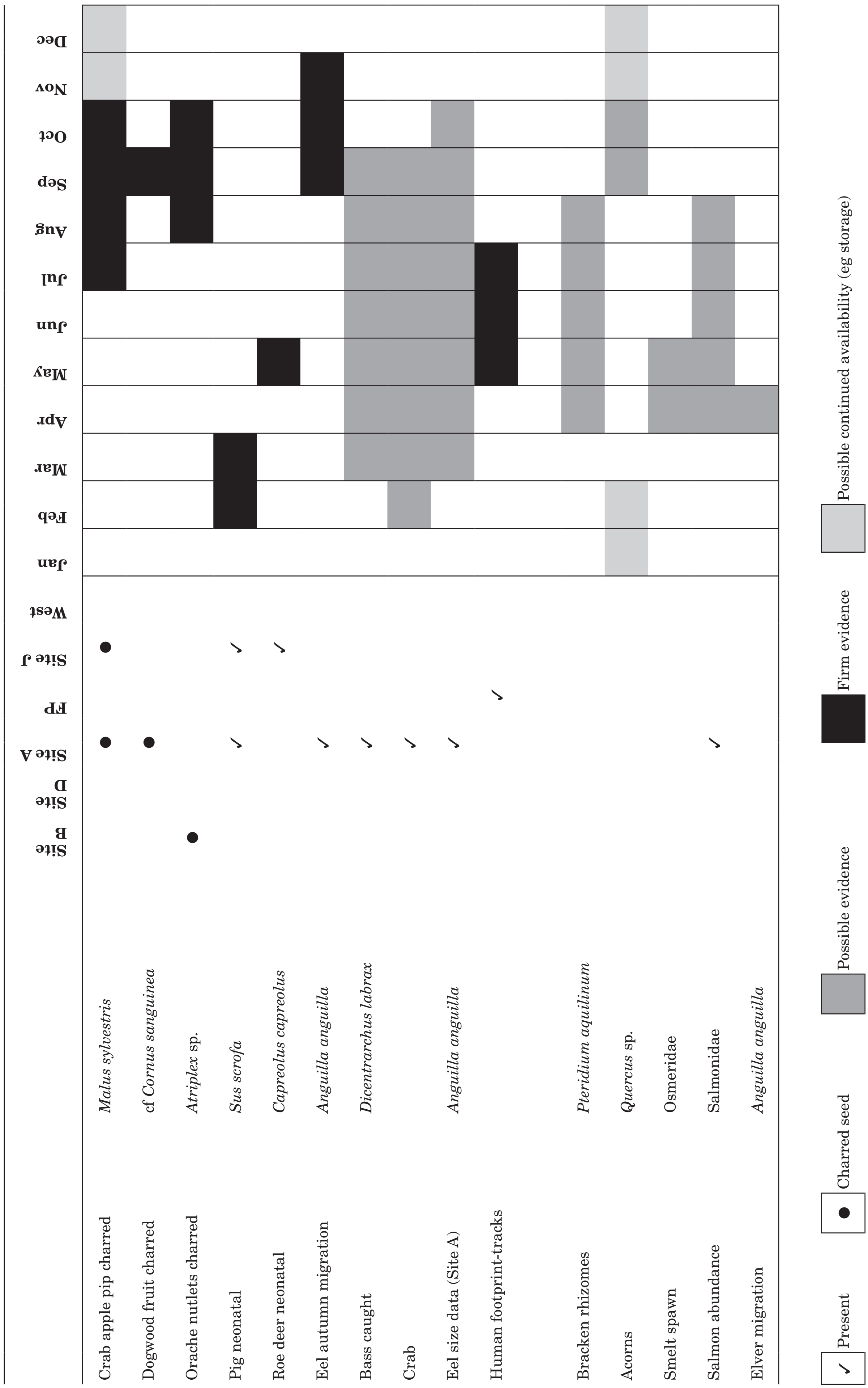
In Table 18.4, the seasonal availability of resources is represented; Site W, west of the island, is separated from those to the east. An attempt has been made to indicate how confident we can be of sources of evidence by density of shading – black for higher confidence; dark grey for less precise seasonal attribution (eg based on animal growth stages or onshore offshore migration of some fish or crabs); and light grey for resources where use is most likely to have been extended by periods of storage, eg nuts. It must be acknowledged at the outset that there are few elements of this evidence that can be regarded as conclusive seasonality indicators. The plants and animals concerned are in most cases represented by just one, or a very small number, of subfossils: the exceptions are hazelnuts and some fish. Much depends on our assumptions about the charred seeds. If charring was accidental then they are among the best indicators of seasonality. It should be noted, however, that of the thirteen taxa represented by charred seeds, at least ten have recorded use somewhere for their seeds, fruits, or nuts (as Table 18.3 shows) and it is possible that these were processed and stored. The hunter-gather ethnographic record from North America in particular provides a wealth of evidence for storage (Turner 1995). However, with the exception of hazelnuts (Mithen *et al* 2001), there is minimal evidence for storage in Mesolithic Britain – an area with less harsh winters and a longer growing season than the Canadian areas from which much of the ethnohistorical evidence derives. Thus, although it is likely that storage played a role, the charred plants are considered to be among the evidence which can more confidently be attributed to season. The foregoing problems limit the confidence we can have in individual sources of seasonality evidence. However, taken together, the range of sources does provide a broadly consistent picture.

Evidence from Site W for pig age and the size of eels and smelt indicated that activity took place in autumn and winter (Bell *et al* 2000). This is the only Goldcliff site with red deer antler not fashioned into a tool and that could suggest a similar period although Legge and Rowley-Conwy (1988) disregard antler for seasonality studies because of the high probability of its curation. What was not given sufficient emphasis in the report on Site W was the presence of charred seeds of admittedly single examples of three species: greater plantain, rushes, and sea club rush, which indicate burning in the period July to October (if not naturally burnt seedbank). Hazelnut represents a similar period but we cannot attach much significance to a single example. Thus, the most clearly defined period for Site W is late summer/autumn with the faunal evidence suggesting either that activity here extended into winter, or a separate activity episode during winter. The small number of tools from this site may suggest the latter, rather than an extended period of occupation.

The sites east of the island produce similar seasonality evidence and will be discussed together. Charred seeds, fruits, and nuts of the ten species indicated on Table 18.4 provide evidence of burning at a maximum between June and October although all could occur in August and September. This is the period when Dark (Chapter 14) suggests that reed

Table 18.4 Evidence of seasonality from the Goldcliff sites and an indication of the months in which they suggest activity

		Site B	Site D	Site A	FP	Site J	West	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hazelnuts charred	*Corylus avellana*						●												
Greater Plantain seeds	*Plantago major*						●												
Rush seeds	*Juncus* sp.						●												
Sea club-rush	*Bolboschoenus maritimus*						●												
Red deer antlers	*Cervus elaphus*						✓												
Pig growth	*Sus scrofa*						✓												
Eel size data (West)	*Anguilla anguilla*						✓												
Smelt size data (West)	Osmeridae						✓												
Reed burning prevents flowering		✓	✓																
Hazelnuts charred	*Corylus avellana*	●		●		●													
Elder fruits charred	*Sambucus nigra*	●		●		●													
Sloe charred	*Prunus spinosa*			●															
Goosefoot nutlets charred	*Chenopodium*	●		●															
Sedge fruits charred	*Cladium mariscus*	●																	
Alder fruits charred	*Alnus glutinosa*					●													
Goosegrass fruits charred	*Galium aparine*	●		●		●													


Site B
Site D
Site A
FP
Site J
West
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Crab apple pip charred
Malus sylvestris
Dogwood fruit charred
cf *Cornus sanguinea*
Orache nutlets charred
Atriplex sp.
Pig neonatal
Sus scrofa
Roe deer neonatal
Capreolus capreolus
Eel autumn migration
Anguilla anguilla
Bass caught
Dicentrarchus labrax
Crab
Eel size data (Site A)
Anguilla anguilla
Human footprint-tracks
Bracken rhizomes
Pteridium aquilinum
Acorns
Quercus sp.
Smelt spawn
Osmeridae
Salmon abundance
Salmonidae
Elver migration
Anguilla anguilla
Present
Charred seed
Possible evidence
Firm evidence
Possible continued availability (eg storage)

burning may have suppressed pollen productivity. Hazelnuts are far stronger evidence of autumn to winter activity on Site A where they are numerous, and Site J where there are several. Once again, the faunal evidence suggests a more complex picture: the presence of neonatal pigs on Sites A and J suggests activity in March to mid-April and neonatal roe deer in May. About 25% of the abundant eels were of a size which suggests they were taken during the autumn migration which occurs on moonlit stormy nights from September to November, the remaining eels could have been taken at any time of year but probably not during the winter (Ingrem this volume, Chapter 13). That is consistent with the rather less firm evidence that bass and crabs are more likely to have been inshore during the summer months. They in common with most fish species in the estuary tend to move to deeper waters in winter, the exceptions are eels and sprats which move in the opposite direction (ETSU 1989).

Most persuasive of the seasonality evidence comes from sedimentary evidence associated with the footprint-tracks. There is no doubt that the very best preserved of these such as Person 6/1 (Fig 12.7) and Persons 13 and 14 (Fig 12.11) were made in the calmest period of summer when Allen (2004) and Dark and Allen (2005) have shown that the finest laminations within the banded sediments were laid down. Scales (Chapter 12) has also demonstrated through micro-excavation of footprint blocks that the footprints of a number of other individuals were originally made in summer. Although we cannot be quite as confident about these footprint-tracks as we could if they were perfectly preserved, Scales calculates that 10 of the 14 individuals identified from footprint-tracks walked in summer. Some of the footprint-tracks (Scales 2006) were also on surfaces marked by polygonal drying cracks, which mainly form in the summer, but not exclusively so (J R L Allen pers comm). Virtually all the bird prints were also made in the finest summer sediments. That applies to the many footprints of crane (*Grus grus*). Today this bird breeds in northern Europe and Russia, wintering in the Mediterranean (Bruun 1978). It has not generally bred in Britain for 400 years, although a small toe-hold colony has recently become established in Norfolk and is the focus of a reintroduction programme (McCarthy 2006). Clearly from the footprints, it was a very common breeding bird in the Mesolithic estuary. Footprint evidence for the crane also comes from rather later Neolithic and Bronze age intertidal sediments at Formby (Roberts *et al* 1996). The other significant visitor is the tern, which does not now bred in the Severn Estuary but is a visitor during migration in April to May and August to September (Sharrock 1976). The other birds represented by footprint-tracks are present year round. Exciting as these former seasonal visitors are, they do not help resolve the seasonality issue because at Goldcliff there are no individual laminations with crane and human prints together, although they are both attested in laminations formed during the calmest summer weather. Too much significance should not, however be attached to that observation because the main concentration of bird prints on Sites C and E is lower in the sequence than most of the human footprint-tracks.

Deer and humans are represented on the same surface on Site E and this may be significant because the metrical data from the deer prints on the site as a whole indicates that both male and female deer are represented (CD 12.55). They would have been together only at the time of the Autumn rut in September to October. However, we have far too few deer tracks from any one bedding surface to be sure that both sexes were on the site together. One other piece of sedimentary evidence is that Foraminifera are present throughout the peats on Sites B and D showing that they were subject to periodic marine inundation and are not likely to have been occupied year round (Chapter 14). Similarly, on Site A sediment micromorphology (Chapter 17) shows indicators of banding which may indicate episodic estuarine incursions into the settled area.

In addition to the seasonality evidence which is represented with varying levels of confidence from the excavated sites, there are sources which we have reason to believe *may* have been significant, but for which direct evidence is lacking. Over 100 marine fish species occur in the estuary today (ETSU 1989). The salmon family are represented by only two bones from Site A. Salmon would have been available throughout the year (A Williams, Goldcliff Fishery, pers comm) at this site, which has been a major salmon fishery throughout medieval and post-medieval times. However, the greatest abundance would have been in April to August. Smaller numbers of notably large so-called ‘spring salmon’ arrive in November to January (ETSU 1989). If the paucity of salmon is down to preservation as argued above, this may have been a significant resource. Another important event in the fishery resources of the Severn Estuary, even today, is the migration of elvers (baby eels) in April when in former times they could be netted by the bucket load in the pills and channels (Wheeler 1979). Such tiny fish would not, however, survive archaeologically. Likewise, smelt, which are represented at Site W, spawn in March to May and these were a very important resource to some communities in the American North-West, but again these tiny fish would not survive archaeologically (Stewart 1977; Wheeler 1979).

The estuary which is today an important wintering area for wading birds and shelduck would have been even richer in birds when the saltmarsh, swamp, and fen were much more extensive. During the main period of activity when the island was surrounded by saltmarshes the island may have been an important site for birds with nesting sites as a source of eggs in the spring. Birds would have been particularly abundant at times when they stopped off on spring (April–May) and autumn (July–Sept) migrations and the overwintering birds would also represent an important resource (ETSU 1989).

In Table 18.3 a number of root- and rhizome-producing plants were noted, some represented on the sites, some not. These could have been a significant resource through the summer, but more particularly into the autumn when the ethnographic record suggests they may have been processed for storage as winter food. The same is likely to apply to some of the maritime seed plants, berries, and nuts noted in Table 18.4.

In conclusion, it has been argued that, given the duration of activity, the presence of discrete nucleations of artefacts on Sites A, B, J, and W, and the relatively modest numbers of artefacts, faunal remains etc, that long-term sedentary occupation is unlikely. We have evidence for charred macrofossils at Sites A, J, and B as a maximum in the period June to October and as a minimum in August and September. This coincides with the start of the eel migration which suggests activity could have extended into October and November. There was clearly some activity early in the spring and summer from the neonatal pigs and roe deer. The human footprint-tracks show with certainty that people were present in the calmest period of summer, say June to August. The remaining faunal evidence whilst not strong also points to summer–autumn activity. There is no clear evidence of winter activity, beyond about November, on the sites east of the island. In that respect, it contrasts with Site W where, what faunal evidence we have, suggests winter activity. It seems reasonable to conclude that the two sides of the island were used at somewhat different times of year; west in autumn, with activity continuing into winter; east, some activity in spring and summer, but probably a peak in late summer and autumn. The suggested contrast may well explain other differences, such as the absence of aurochs at Site W: these animals may have avoided the coastal wetland in autumn and winter. The smaller number of artefacts from Site W may perhaps point to a shorter period of activity. Dark and Allen (2005) have investigated the occurrence of charcoal within a five-year run of the annually banded sediment sequence. In the first two years charcoal deposition was mainly in winter and in the later three years mainly in summer, providing further evidence for burning and thus probably human activity in both summer and winter and not necessarily at the same time of year each year.

If, as contended here, people were visiting periodically then by counting the number of bands, of apparently annual origin, between successive footprint-tracks in Figures 4.3 and 4.5, some idea of the frequency of visits can be obtained. However, this is a minimum because it rests on the chance of successive occupations involving walks on the same small area of exposed laminations 0.3km from the settlement. In one case there are footprints on successive bands (Figure 4.3 e–f); in another footprints are three years apart; there are single cases where they are five, six, and seven years apart; one case where they are nine years apart; one 22 years apart; and one 45 years apart. It is not unreasonable to propose from this evidence, annual or at least very frequent visits to the site.

18.15 Neolithic activity at Goldcliff

The expectation when we embarked on this project was that we were likely to find evidence of Neolithic activity and thus contribute to an understanding of the Mesolithic/Neolithic transition. This objective rested principally on pollen analysis from Goldcliff East by Smith and Morgan (1989) which identified a distinct landnam event between 3740–3480 cal BC immediately after the elm decline. A reduction of woodland accompanied herbs of more open conditions, evidence initially of pastoral activity, and later a brief arable phase preceding regeneration. The stages of vegetation change were considered closely comparable to landnam episodes recorded in Northern Ireland. They argued that the agricultural episode attested must have taken place on Goldcliff island since there was no other nearby area suitable for agriculture. Their evidence was complemented by some rather less clearly marked hints of vegetation change following the elm decline in the peat sequence above Site W (Caseldine 2000). Micro-charcoal was not quantified in either of these studies, which creates some difficulty of comparison with the present work.

Archaeological evidence of Neolithic activity is, however, very limited. Evidence was found for a burning episode on the west side of the island at Hill Farm Pond *c* 3000 cal BC and another at 2100 cal BC and one or two flint flakes within the peat are likely to be Neolithic (Bell *et al* 2000, fig 3.7). No typologically Neolithic artefacts are known from the Goldcliff area, which is striking given the concentration of archaeological research.

The present project enables us to consider the vegetation changes documented by Smith and Morgan (1989) in the Neolithic in the context of new evidence for the preceding changes documented here in the later Mesolithic. A history of 2200 years of vegetation disturbance has now been documented on the site from the time of the Lower Submerged Forest when trees and reedswamp were burnt. Some trees in the Upper Submerged Forest were burnt c 4200 cal BC. More difficult to interpret is a disturbance event in Pit J at 4045–3965 cal BC (Chapter 15) when some reduction of woodland taxa and occurrence of open country taxa occurs; however, the evidence of both pollen and beetles (Chapter 16) suggests that this is perhaps more likely to be the result of a small-scale transgressive event than human activity. Thus, the burning episodes attested at Hill Farm and the vegetation disturbance after the elm decline, can now be seen as part of a longer-term pattern of vegetation disturbance involving burning. In Chapter 14, Dark critically examines Smith and Morgan's (1989) landnam event, noting that the changes described coincide with the vegetational change to raised mire and could therefore be an artefact of changes of pollen recruitment rather than a direct result of human activity. The presence of some ‘cereal-type’ pollen grains in Phase B of Smith and Morgan’s landnam is now significantly less persuasive since similar grains have been found 1800 years earlier on Site D and other wetland sites in western Britain (Chapter 14.5.5) and they are now thought likely to derive from coastal wild grasses.

Smith and Morgan considered the nature of the elm decline itself, noting that a coeval decline in oak at Goldcliff and an increase in open ground plants at other sites including Waun-Fignen-Felen (Smith and Cloutman 1988, fig 32), hinted at the possible contribution of human activity which a generation of scientists regarded as the most probable cause of the elm decline (Troels-Smith 1960; Smith 1981). Smith and Morgan (1989) acknowledged that, when they wrote, opinion was changing in favour of the disease hypothesis. That view has since been strongly reinforced by Peglar’s (1993) evidence for the very rapid nature of the decline at Diss Mere and the discovery of evidence for the elm bark beetle *Scolytus scolytus* in pre-elm decline contexts (Parker *et al* 2002; Bell and Walker 2005; Girling and Greig 1985). Tetlow (Chapter 16) records it in the peat sequence in Pit J at a level which precedes the elm decline by *c* 1000 years. A decline in elm which forms part of the disturbance event *c* 4000 cal BC (Chapter 15), some 400 years before Smith and Morgan’s elm decline, might therefore represent an earlier disease outbreak given the multi-stage elm declines now being documented by high resolution pollen analysis elsewhere (Andersen and Rasmussen 1993; Regnell *et al* 1995).

Thus vegetation disturbance marking the beginning of the Neolithic is not as clearly attested as it seemed to be from Smith and Morgan’s (1989) original study: the landnam episode is open to question and in any case there is a well-documented history of earlier vegetation disturbance involving both burning and transgressive events and the presence of ‘cereal-type’ pollen. The new evidence of preceding events challenges the assumption that the vegetation changes documented by Smith and Morgan just after the elm decline necessarily mark the advent of a new agricultural economy. In fact, if anything, the evidence presented here suggests a decrease in burning in the last 800 or so years of the Mesolithic and through the Neolithic. In that respect it joins a growing number of sites where evidence for burning and human activity declines rather than increases, at around the beginning of the Neolithic (Simmons 1996; Brown 1997; Edwards 1998).

The conclusion must therefore be that there is no absolutely convincing evidence for Neolithic settlement or agriculture at Goldcliff. That accords with evidence for a reduced level of Neolithic activity in the marine influenced parts of the Severn Estuary Levels (Bell forthcoming) during the Neolithic, in marked contrast to the Somerset Levels where, in the earlier Neolithic, there is only one century without evidence for some trackway construction (Coles and Coles 1998). The limited evidence for burning and a small number of typologically undiagnostic flints suggests periodic visits to the island maybe involving environmental manipulation comparable to that in the last millennium of the Mesolithic but certainly at a lower level of intensity than in the main period of Mesolithic activity at Goldcliff between 5900 and 4800 cal BC.

Acknowledgements

I am grateful to Professor J R L Allen, Professor Nick Barton, Dr Petra Dark, and Ms Astrid Caseldine for comments on an earlier version of this chapter and also to the many specialists and team members who contributed evidence which forms part of this synthesis.

19 Mesolithic to Neolithic human activity and impact at the Severn Estuary wetland edge: studies at Llandevenny, Oldbury Flats, Hills Flats, and Woolaston *by Alex Brown*

19.1 Introduction

This chapter sets the previously considered evidence from Goldcliff East in a wider context by presenting an outline of the research from four other study sites within the Severn Estuary, focusing on the evidence for human activity and impact at the wetland edge during the Mesolithic and Neolithic. This research was conducted under the umbrella of the Mesolithic to Neolithic Coastal Environmental Change Project and evolved in tandem with the development of research at Goldcliff with which the writer was closely involved, using a similar approach and methodology. The sites examined here help to establish whether the patterns observed at Goldcliff are seen at other sites in the wider Severn Estuary area and the study helps to focus on the wetland edge as a source of evidence for the relationship between dryland and wetland activities. Whilst we may have a reasonable understanding of the pattern of human activity within the former wetland, we have far less understanding of the relationship between these activities, and those which occurred on the neighbouring dryland. Four study sites were investigated at Llandevenny (Monmouthshire), Oldbury Flats, Hills Flats, and Woolaston (Gloucestershire) (Fig 19.1). Research involved the excavation and investigation of stratified occupation contexts, many waterlogged or sealed by peat, in addition to analysis of off-site environmental sequences. Analytical techniques included high resolution pollen, plant macrofossil and quantified micro/macro-charcoal analysis. Key aims of research were concerned with:

i) elucidating the role that human communities played in impacting upon lowland landscapes, set within the context of patterns of coastal change resulting from natural agencies, eg storms, floods, the role of grazing animals;
ii) testing whether communities occupying the wetland-dryland interface were living a sedentary lifestyle or engaging in a more mobile pattern of existence involving seasonal moves between different landscape zones;

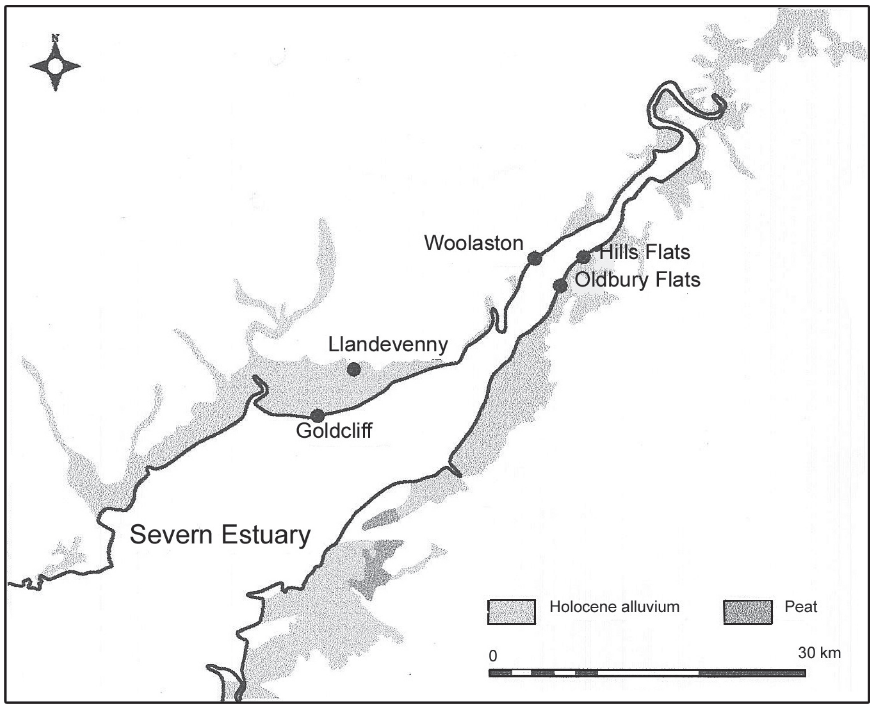


Figure 19.1 Location of study sites (Llandevenny, Woolaston, Oldbury Flats, and Hills Flats) and Goldcliff (base map by M Mathews, modified by A Brown)

iii) evaluating the role of wild plants and strategies of plant use during the late Mesolithic and early Neolithic, and;
iv) dating and identifying the beginnings of cereal cultivation. Primary data is only presented from Llandevenny, which was the principal study site.

An outline of relevant aspects of the evidence from Oldbury Flats, Hills Flats and Woolaston is included, with full details of all sites presented in Brown (2005).

19.2 Llandevenny, Monmouthshire

Research at Llandevenny has resulted in the discovery and excavation of a new stratified Mesolithic-Neolithic occupation site (ST 4125 8665), located along the northern margins of the Gwent Levels 7km north-east of the excavated late Mesolithic sites at Goldcliff. The site lies at the interface between the dry ground and the wetland (Fig 19.2) towards the edge of a promontory formed of 'Upper Old Red Sandstone' (Squirrell and Downing 1969). Excavations at the wetland edge produced a dense concentration of lithic artefacts and charcoal, concentrated within two occupation layers sealed by *c* 1m of peat. These contexts were subjected to palaeoenvironmental analyses (sequences LL1 and LL3), summarised below, augmented by additional sampling and analysis of the Holocene sedimentary sequence 220m further out onto the wetland (sequences LL2 and LL4). Here coring revealed a deep sequence of peats and estuarine silts to a depth of *c* 7m, thinning considerably in proximity to the wetland edge (Fig 19.2). This section summarises the results of selected archaeological and palaeoenvironmental research from the wetland edge. The results of palaeoenvironmental analyses on sequences LL2 and LL4 are presented in full in Brown (2005).

Lithic assemblage

The total number of worked lithic artefacts recorded during the course of excavation was 345. Excavation of a $1m^2$ test pit during 2002 produced an assemblage of 96 pieces (Brown 2002). Re-excavation and extension of this test pit by 2m during 2003 resulted in the retrieval of a further 244 pieces (Brown 2003). In addition to the main lithic assemblage, five unstratified flint flakes were retrieved 100m to the west at Green Meadow Farm, from a spoil heap derived from machine clearance during building work. The composition of the Llandevenny lithic assemblage is outlined in CD 19.1.

A restricted range of lithological types is present. Flint comprises the majority (95%), of which 40% exhibit a heavy white patina, the remainder varying in colour from predominantly dark-grey with occasional lighter grey mottles, to smaller quantities of light-grey and very occasionally, yellow-brown flint. Non-flint lithologies are also present, but in very small quantities. These include 2% chert artefacts of both Greensand and Carboniferous types, and tuff artefacts (3%) of both fine to coarse mid-grey varieties (J R L Allen pers comm), found exclusively within the basal occupation layer. The flint is derived from pebbles and cobbles of restricted size, with cortical surfaces showing evidence for water-wear. The tuff flakes are identical to material being worked at Goldcliff in the late Mesolithic, and could have been acquired from similar, geographically located outcrops. Whilst cobbles of dark grey to black tuff occur occasionally amongst gravel patches on the modern foreshore (Allen 2000), all lithologies could potentially have been acquired from either a localised source amongst the Pleistocene terrace deposits along the major river valleys, and/or marine gravel deposits along the intertidal zone.

Micro-debitage accounts for the majority of the assemblage (68%), predominantly from the occupation layers, whilst 24% comprises flakes. In general, flakes are small in size, rarely exceeding 30mm in length, with a maximum length of 45mm. Tuff flakes are larger than flakes of flint or chert. Five cores were recorded during excavation, all of flint. Two are multi-directional cores, two single platform uni-directional cores, and a single bi-polar core. The assemblage also includes a core trimming element from a bladelet core, although no bladelet cores are present within the assemblage. Five tools were recorded during excavation, including a microlith, identified as an obliquely blunted point of probable late Mesolithic date, one proto-thumbnail scraper, and three edge retouched flakes. One of the edge retouched flakes exhibited burination and damage on both the distal and proximal ends that would not be inconsistent with the artefact being hafted and utilised as a projectile point.

Palaeoenvironmental sampling

Samples were taken from the pit with the aim of producing a complete palaeoenvironmental sequence from the wetland edge, with a particular emphasis placed on the recovery of environmental data from the occupation layers. Sequence LL1 was taken from the north-facing section of the pit, whilst sequence LL3 was horizontally inserted into the south-facing section across the occupation layers (Fig 19.3). The sedimentary sequences are outlined in CD 19.2–3. In addition, an entire m^2 of the occupation layers was sampled and flotation sieved.

Methods

Sub-samples of sediment for pollen analysis were taken at 1cm intervals from sequence LL1. Samples were chemically prepared using standard laboratory preparation techniques as outlined in Moore *et al* (1991). Samples were analysed under a Leica DME trinocular microscope at ×400 magnification, with critical determinations at ×1000 magnification. A minimum of 300 pollen grains was identified per sample excluding aquatics and *Sphagnum*. All pollen percentages are expressed as a percentage of

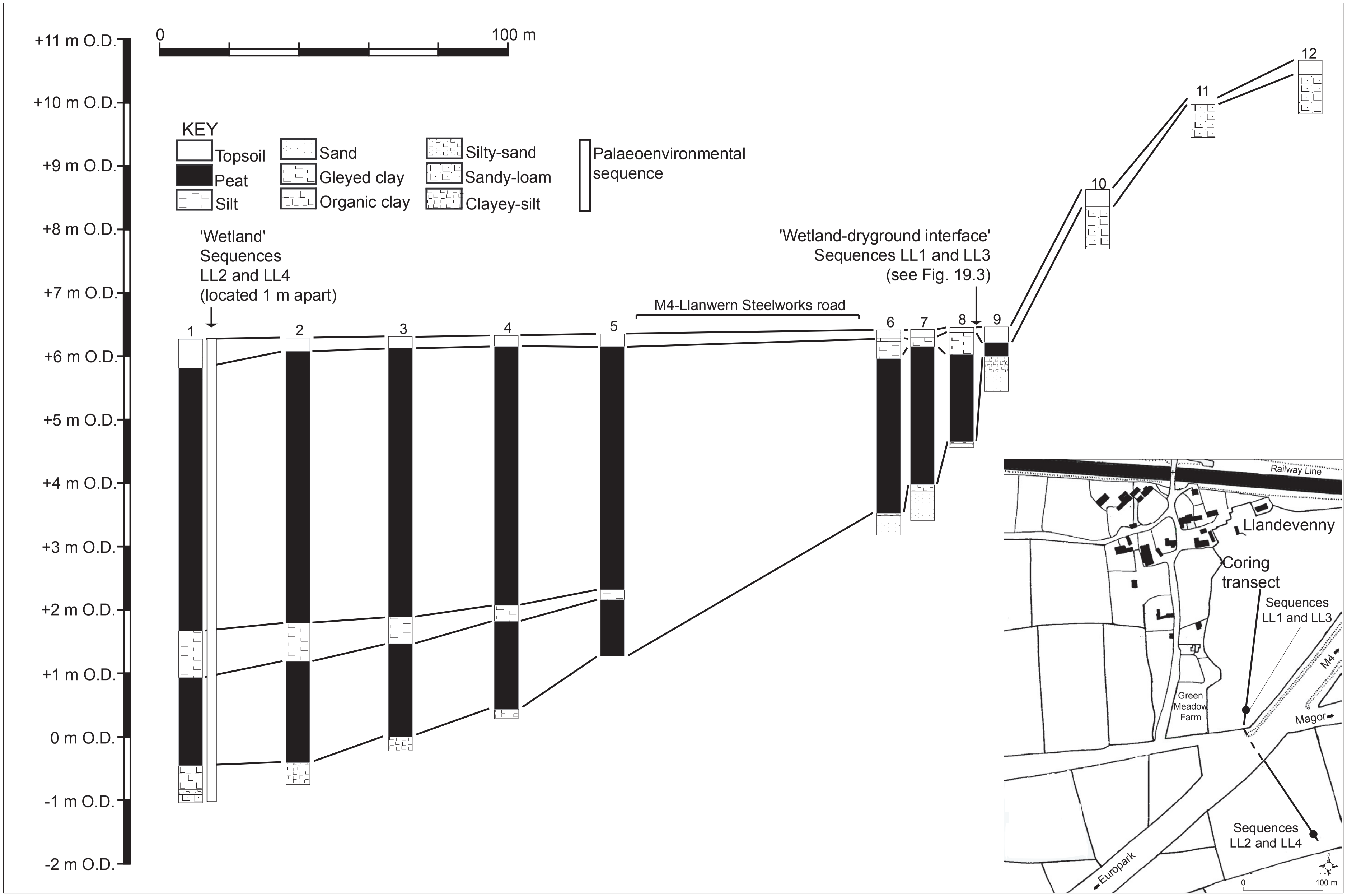


Figure 19.2 Coring transect across the wetland-dry ground interface, Llandevenny, south-east Wales (graphic A Brown)

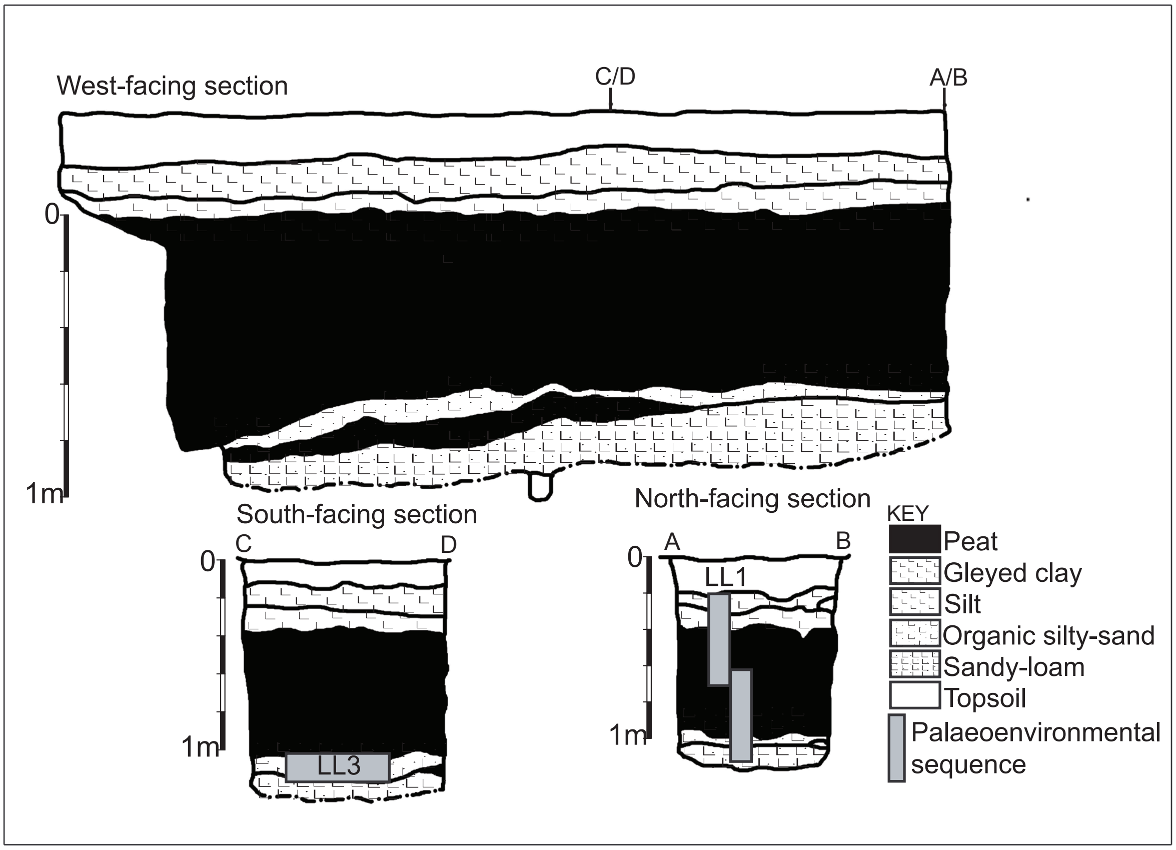


Figure 19.3 Llandevenny, pit sections, with locations of palaeoenvironmental samples (graphic A Brown)

total land pollen, excluding aquatics and *Sphagnum*, which are expressed as a sum of the total land pollen plus aquatics and *Sphagnum*. All taxa follow current nomenclature established in Bennett (1994) and Bennett *et al* (1994). Micro-charcoal was quantified using the point count method (Clark 1982). Plant macrofossil analysis was undertaken on monolith tin LL3 and bulk samples from the occupation layers. Slices of sediment 1cm thick from sequence LL3 were processed through a nest of sieves of 1mm, 500µm and 250µm mesh size. Bulk sediment samples from the occupation layers were processed using a modified version of a Siraf-type flotation tank (Williams 1973) and a nest of sieves of 4mm, 2mm and 500µm mesh size. All samples were analysed under a Meiji EMT binocular microscope at ×10 and ×20 magnification. Identification of seeds used Anderberg (1994), Berggren (1969, 1981), Martin and Barkley (1961), Tomlinson (1985), and modern reference material. Macro-charcoal was quantified for the following size classes: 250–500µm; 500µm–1mm; 1–5mm; and 5–10mm. Zonation of the pollen and plant macrofossil data was achieved by comparing the results of constrained cluster analysis (CONISS), sum of squares and optimal splitting by sum of squares using Psimpoll version 4.10 (Bennett 2000), with appropriate zone boundaries selected based upon their repeated occurrence.

Radiocarbon dates

A total of five dates were requested for Llandevenny from sequence LL1. A single date from the basal occupation layer (LL1–1, 89cm) failed due to poor yield. The remaining dates are outlined in Table 19.1 and presented as multi-plots in Figure 19.4.

19.2.1 Palaeoenvironmental interpretation

Pollen sequence LL1 (Fig 19.5) and plant macrofossil sequence LL3 (CD 19.4) were zoned separately, but are here interpreted together. Pollen and plant macrofossil zones are correlated on the basis of depth. Zone LL1 corresponds broadly to sequence LL3. The top 37cm of sequence LL1 is not included in Figure 19.5 as it is not directly relevant to the present discussion. The full diagram can be found in Brown (2005).

Zone LL1–1/LL3–1, 2, and 3

In the pollen assemblage, the high percentage of indeterminables (*c* 50%) suggest a highly biased assemblage. *Alnus glutinosa*, *Tilia*, *Corylus avellana*-type, and Pteropsida are particularly resistant to decay processes (Havinga 1984), so are over-represented in sediments where preservation is poor. Taxa such as *Quercus* and Poaceae are susceptible to decay processes, and are likely to be under-represented. However, the high values for *Tilia* suggest a *Tilia*-dominated woodland, but one in which *Quercus* was an important component. Moderate values for *Alnus glutinosa* and Cyperaceae indicate

Table 19.1 Llandevenny: radiocarbon dates from sequence Ll 1

Sample ID	Depth (cm)	Type of material	δ13 value	14C years BP	Lab code	cal BC 68.2% PROB.	cal BC 95.4% PROB.
LL 1-2	83–84	*Rubus* seeds	δ13 –27.8	4912±31	OxA-13527	3704–3656	3770–3640
LL 1-3	81–82	*Rubus* seeds	δ13 –28.5	4792±30	OxA-13528	3640–3620 (13.5%) 3590–3530 (54.7%)	3650–3510
LL 1-4	72–73	*Alnus* seeds	δ13 –27.1	4744±38	OxA-13557	3640–3550 (45.8%) 3540–3510 (13.8%) 3410–3380 (8.6%)	3640–3490 (73.1%) 3460–3370 (22.3%)
LL 1-5	56–57	1cm peat bulk	δ13 –28.0	4483±31	OxA-13493	3330–3210 (48.4%) 3190–3150 (10.4%) 3130–3090 (9.4%)	3350–3080 (89.7%) 3070–3030 (5.7%)

Note: calibration follows OxCal V3.10 (Ramsey 2005) using atmospheric data from Reiner *et al* 2004

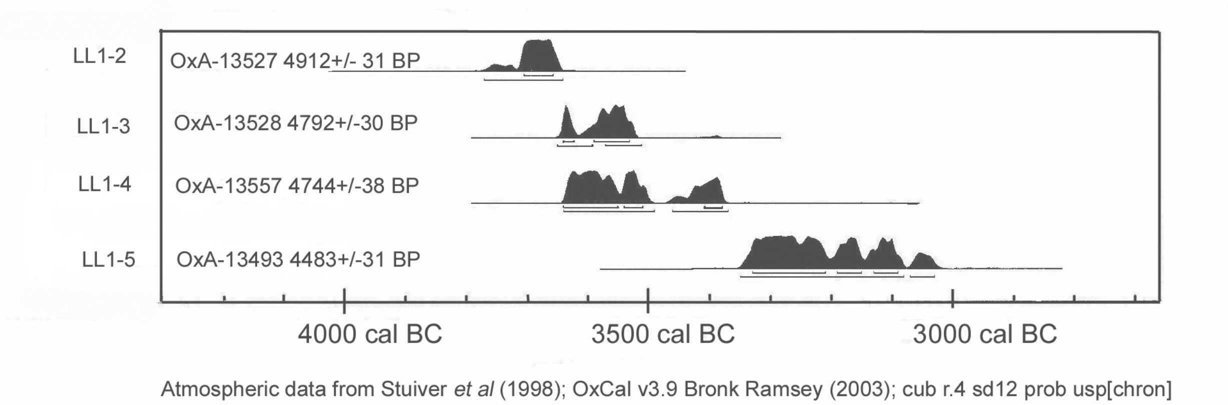


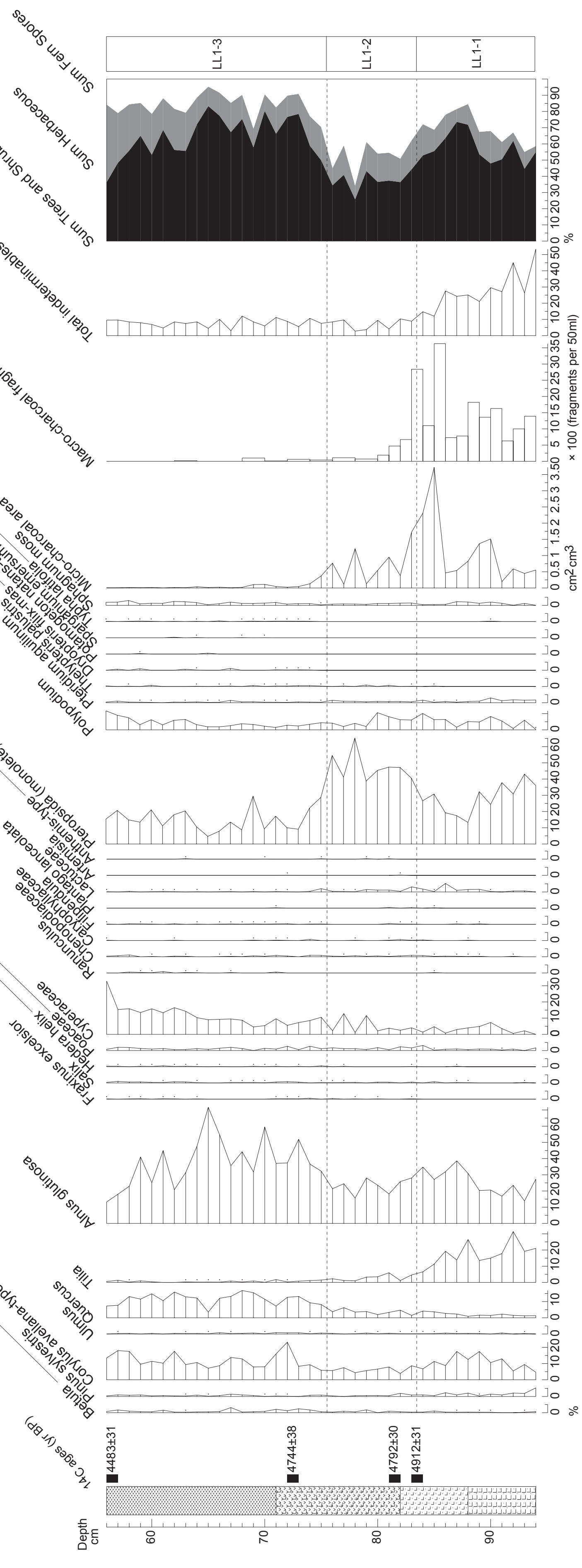
Figure 19.4 Calibrated radiocarbon plots from Sequence LL 1

the presence of stands of *Alnus* carr-woodland on the encroaching wetland. The higher levels of arboreal pollen within the basal occupation layer imply a more wooded landscape, followed by a substantial reduction in *Tilia* through the upper occupation layer. Plant macrofossil analysis produced few woodland indicators. The dominance of seeds of *Rubus fruticosus/idaeus* and *Urtica dioica* suggest an open-scrubby environment at the interface between the wetland and dry ground. Small quantities of *Stachys palustris*, *Potentilla palustris*, Cyperaceae undiff., and *Carex* within the upper, and to a lesser extent lower occupation layer, suggest an increasing marshy component to the vegetation.

Significant quantities of charcoal occur within the basal occupation layers. Macrocharcoal frequencies range from 50–350 fragments per 50ml in sequence LL1, to 50–250 fragments per 150ml in sequence LL3. Wood charcoal was identified amongst the macro-charcoal fragments, which appears fresh and displays no sign of having been water-transported. Four significant peaks in macro- and micro-charcoal in sequence LL1 (94–93, 91–88, 87–86 and 85–84cm) are accompanied by decreases in arboreal pollen, suggesting woodland clearance. Both occupation layers contain significant quantities of worked lithic artefacts, a proportion of which are thermally fractured, as well as significant numbers of charred seeds. A total of 193 charred seeds were retrieved, representing 2.3% of the plant macrofossil assemblage from the occupation layers. Of these, 185 came from the upper occupation layer, 81.6% of which are *Rubus fruticosus/idaeus*, with smaller quantities of *Plantago lanceolata*, Poaceae undiff., *Stachys palustris*, *Sambucus nigra,* and *Urtica dioica*. Charred *Rubus* seeds from the top of the upper occupation layer produced a date of 4912±31 BP (OxA-13537; 3704–3656 cal BC). Peaks in the abundance of *Rubus fruticosus/idaeus* and *Urtica dioica* occur concurrent with peaks in macro-charcoal, suggesting *in situ* burning and promotion of the scrubby vegetation growing along the forest edge. The direct association between the charred seeds, charcoal, calcined bone, and lithics strongly imply that burning was anthropogenically induced. The presence of anthropogenic indicator species, including small quantities of charred seeds of *Plantago lanceolata*, charred Poaceae undiff. and *Rumex* (cf *acetosa*) support this interpretation.

Zone LL1–2 (83.5–75.5cm)

There is a transition at 82cm from organic silty-sand to peat-with-clay, dated to 4792±30 BP (OxA-13528; 3640–3530 cal BC). The pollen data suggest areas of *Alnus* carr-woodland with isolated stands of *Betula*, and a Pteridophyte ground flora. Dryland arboreal pollen values are uniformly low, reflecting a combination of poor pollen preservation



KEY Wood peat Wood peat with clay Silty-sand 'upper occupation layer' Sandy-loam 'lower occupation layer'

· = pollen taxa < 1% TLP. Pollen percentages: Pollen sum includes all pollen and spores excluding aquatics and Sphagnum moss. Aquatics and Sphagnum moss calculated as a sum of total land pollen plus aquatics and Sphagnum moss.

Figure 19.5 Llandevenny, south-east Wales (Sequence LL 1: 56–94cm): selected taxa percentage pollen diagram. Complete diagram in Brown (2005) (graphic A Brown) and filtration of dryland pollen by plant communities growing within the wetland. *Tilia* continues to decline, probably reflecting its intolerance of permanently waterlogged conditions. Both micro- and macro-charcoal occur within the peat-with-clay, but in much reduced quantities. Smaller numbers of worked lithic artefacts have been retrieved from this context, but their association with the charcoal is harder to establish.

Zone LL1–3 (75.5–56.5cm)
Alnus glutinosa carr-woodland increases as a component of the local vegetation. This has been dated to 4744±38 BP (OxA-13557; 3640–3380 cal BC). Increasingly marshy conditions are suggested by the increase in pollen of Cyperaceae, Poaceae (probably reflecting *Phragmites*), and *Typha latifolia*. A *Quercus-Corylus avellana*-type woodland is indicated on the dryland. From 69cm, there are negligible quantities of charcoal.

19.2.2 Discussion

Although the single date from the basal occupation layer failed due to poor yield, a late Mesolithic date is indicated by the lithic assemblage. This includes a microlith, identified as an obliquely blunted point of probable late Mesolithic date (Brown 2002), and tuff flakes similar to those found in late Mesolithic contexts from Goldcliff (Chapter 9). Mesolithic activity here may be broadly contemporary with the latest phases of activity at Goldcliff East Site J (Chapter 6), but at Llandevenny there is also later activity. The top of the upper occupation layer has been dated to 4912±31 BP (OxA-13527; 3704–3656 cal BC), suggesting an early Neolithic date for occupation. There is no obvious hiatus between the lower and upper occupation layers, suggesting the possibility of unbroken occupation over the Mesolithic-Neolithic transition.

Activity appears to have been within a mosaic environment of scrub and herbaceous undergrowth along the edges of a *Tilia*-dominated woodland. The small number of tools from both occupation layers suggest a range of potential activities, perhaps including hunting, fowling, cutting, or piercing. The small number of fragments of calcined bone imply the hunting, cooking, and consumption of meat. There is compelling evidence that during both the late Mesolithic and early Neolithic, humans burnt the vegetation at the woodland edge, either to create new clearings, or to expand and/or maintain existing clearings created through natural agencies (eg wind-throw, lightning strikes, animal agencies). This promoted the growth of a number of herbaceous plant taxa already growing along the woodland edge. It is argued that this reflects a specific strategy designed to increase the productivity of locally growing, seasonally available, edible wild plant species. This hypothesis is supported by the simultaneous decline in arboreal pollen (Fig 19.5) and increases in the seeds of herbaceous taxa (CD 19.4), some charred, associated with substantial peaks in both micro- and macro-charcoal, and, significantly, lithic debitage. It is the combination of the palaeobotanical, palaeoecological, and archaeological evidence that so strongly supports the notion of a strategy of managed plant use. Many of the charred and uncharred plants can be regarded as economic plants. The dominance of seeds of *Rubus fruticosus/idaeus*, an uncommon find from British Mesolithic and Neolithic sites, suggests a reliance on the gathering of soft fruits and the *in situ* burning of berry patches following collection.

The charred seeds from both occupation layers provide important indications about the seasonality of occupation. Both suggest activity during summer and early autumn from June to October, with a minimum period of occupation during August and/or September. Some of the plants may have been stored for winter consumption when resources may have been sparse. The evidence for landscape manipulation at the wetland edge during the late Mesolithic is accompanied by evidence from sequence LL4, located 220m further out on the wetland (Fig 19.2), for repeated burning of reedswamp. Evidence for reed burning has previously been identified from early Mesolithic contexts at Star Carr (Mellars and Dark 1998), and is also recorded during the late Mesolithic from Goldcliff East (Chapters 14–15). Charcoal from one of four distinct charcoal spikes from the base of the Upper Peat (Fig 19.2) has been dated to 5868±33 BP (OxA-13702; 4780–4690 cal BC). Some of the charcoal spikes are associated with increases in pollen of Poaceae. This could represent late winter/early spring burning of reeds, encouraging the increased flowering and release of *Phragmites* pollen, and may reflect a promotional strategy designed to provide improved graze for ungulate herbivores which humans could hunt. The evidence for summer-autumn burning at the woodland edge, and possible winter-spring burning of reedbeds, although tentative, suggests the possibility of activity at Llandevenny during the later Mesolithic at stages throughout the year. A similar pattern of activity at various times through the year has been suggested for Star Carr (Mellars and Dark 1998; Dark 2004) and Goldcliff (Chapters 14 and 18). This appears contrary to existing simple bimodal models of hunter-gatherer mobility that envisage a seasonal round between upland areas during the summer and lowlands during the winter (Jacobi 1978).

There is a great deal of evidence for continuity between the upper and lower occupation layers:

i) in the exploitation of wild resources, although the incidence of charring increases during the early Neolithic;
ii) manipulation of the surrounding environment as a tool to manage and promote the increased growth of plant resources along the forest edge and wetland fringe, and;

iii) seasonal occupation during the summer and autumn.

However, the absence of evidence from the upper occupation layer for winter-spring activity could suggest a pattern of reduced seasonal mobility during the early Neolithic. Tuff flakes are also absent from the upper occupation layer. Tuff appears to have been used exclusively during the later Mesolithic. If tuff was being exploited from outcrops along the intertidal zone in proximity to Goldcliff and along the Porton Grounds towards Redwick this could explain the absence of evidence of tuff from Llandevenny in the Neolithic: communities were simply not active within the intertidal zone at this time.

Lithics are present in small quantities within the peat overlying the occupation layers (CD 19.1), between two radiocarbon-dated horizons of 4792±30 BP (OxA-13528; 3640–3520 cal BC) and 4744±38 BP (OxA-13557; 3640–3370 cal BC). The evidence for activity, although small in comparison with the occupation layers, is significant, because it demonstrates that communities were still active at this location despite the encroachment of wetland. The lack of tools or charred seeds makes it difficult to suggest a function or season of occupation. However, the focus of activity appears to have shifted elsewhere at this stage, with the assemblage perhaps representing more transitory use of this location. The surrounding vegetation remained largely open, and may have been attractive for hunting or fowling activities, although these cannot be demonstrated archaeologically. Micro-charcoal within the peat may reflect small-scale clearances along the wetland/woodland-edge. The lack of macro-charcoal would suggest these impacts were not *in situ*, supporting the hypothesis of a shift in the focus of settlement at this time. The absence of evidence for human activity coincides with the encroachment of *Alnus* carr-woodland, at which point human settlement may have moved further back from the wetland. There is no further evidence for human activity from 4744±38 BP (OxA-13557; 3640–3370 cal BC) until large-scale clearance of the woodland in the early to middle Bronze Age, dated in sequence LL2 from 3670±29 BP (OxA-13703; 2140–1950 cal BC; Brown 2005).

19.3 Oldbury Flats, south Gloucestershire

The site of Oldbury Flats (Fig 19.1) lies on the intertidally exposed eastern shores of the middle Severn Estuary, approximately 1km north-west of Oldbury-on-Severn, and represents one of the most important prehistoric sites in the Severn Estuary. Previous research has involved the retrieval of a large unstratified assemblage of worked lithic artefacts of Neolithic and Bronze Age date totalling almost 2000 items (Allen 1998). A smaller assemblage of 43 lithics, derived grey flint (91%), and chert (9%), was retrieved stratified from a buried soil sealed by peat, dating to 5310±70 BP (Beta–84850; 4230–4000 cal BC; Allen 1998). Prior to construction of a new silt pond for the Oldbury nuclear power station, rescue excavations revealed structural evidence for settlement activity. Burnt timbers from a posthole produced a radiocarbon date of 3400±45 BP (SRR–4777; 1750–1620 cal BC; Hume 1992). A total of 96 lithics was recorded, all derived from brown flint, 37 of which were stratified. Grey flint and chert, which make up two-thirds of the unstratified assemblage, only occur in stratified contexts dating to the late Mesolithic and Neolithic. Brown flint, however, only occurs in stratified contexts of Bronze Age date (silt pond site) and concentrates within the northern portion of the flats towards the silt pond site. Palaeoenvironmental analysis of the Holocene sediments was carried out by Druce (2001) in the context of research mainly focused on sea-level and coastal change. This did not, however, focus on the archaeological and associated environmental aspects. Research by this author has placed the archaeological evidence for human activity within its environmental context, and highlighted evidence for late Mesolithic occupation. This was augmented by additional, targeted fieldwork, providing data on further stratified archaeological contexts and elucidating the role of fire as a possible anthropogenic agent in landscape change.

The sedimentary sequence consists of a series of heavily eroded, geographically restricted outcrops of Holocene sediment resting on an undulating bedrock platform, composed of Triassic mudstones and sandstones, ranging in elevation from 5.2 to 5.4m OD at the Power Station (ST 607 940), to –2.5m OD adjacent to the tidal reservoir (ST 5984 9441). The Holocene sequence is exposed at several locations, and includes a diachronous sloping Old Land Surface, overlain by a series of estuarine silt and peat deposits of the middle Wentlooge Formation, ranging in date from 5530 to 2210 cal BC and in elevation from –1.5m to +4.4m OD.

Research focused on the investigation of two areas of intertidal zone (Sites A and F, Fig 19.6). Site A comprises an outcrop of two reed peats and intercalated silts overlying a buried soil, exposed for *c* 120m from ST 5991 9358 to ST 5998 9379. The base of the Lower Peat at ST 5996 9369 has previously been dated to 6330±90 BP (Wk–7326; 5477–5058 cal BC; Druce 2001). No finds were recorded from Site A during the course of excavation, though indications of human activity are represented by evidence for probable anthropogenic burning of reedbeds. The peat contains abundant charcoal, including fragments of charred reed stems and occasional charred seeds of *Cladium mariscus* (Great fen-sedge) and *Schoenoplectus lacustris* (Common club-rush). The consistent presence of charcoal is taken to suggest an anthropogenic origin for burning, supported by the retrieval of three flint flakes, stratified within the base of the peat at Site G, 60m to the north-west. The peat at Site G, although undated, is considered broadly contemporary with those at Site A, and thus with the evidence for burning.

Site F is an area of peat sealing an Old Land Surface,

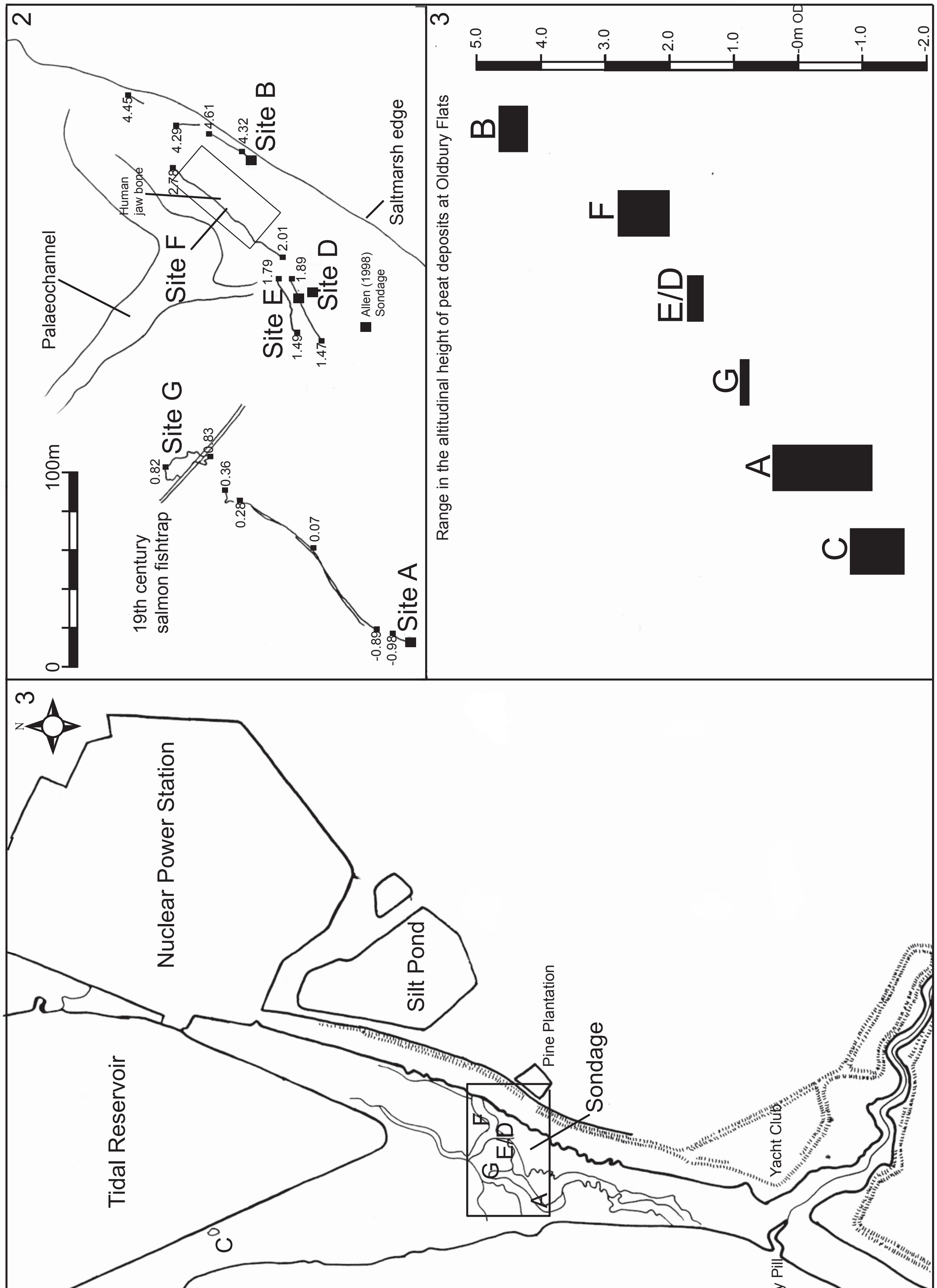


Figure 19.6 Site setting and context of Oldbury Flats, South Gloucestershire. Section 1 modified after Allen (1998). Section 2 after Riley (1998) (graphic A Brown)

exposed for a distance of approximately 60m, centred on ST 60139 93682. The peat, although undated, is considered contemporary with the peat at Site D, located *c* 50m to the south-west, and dated at its base to 5320±100 BP (Wk–7332; 4310–4000 cal BC), and at its upper surface to 4230±110 BP (Wk–7331; 2930–2600 cal BC; Druce 2001). Excavations by this author in 2001 produced a total of fourteen stratified lithics from the base of the peat and underlying Old Land Surface. The surface of the peat had abundant animal footprint-tracks and trails (Brown 2001). Additional excavations here in 2003, in conjunction with Rachel Scales, revealed a more extensive trail of animal footprints (exclusively cattle), associated with two human footprint-tracks (Scales pers comm). They form a dense trail of clay-infilled prints within the peat, but also the overlying estuarine silts, and must, therefore, have formed during the estuarine phase which seals the peat. On the basis of their stratigraphical relationship to known dated contexts, they were laid down at some point between 3096–2138 cal BC. A small assemblage of animal bones was recorded by Rachel Scales during the cleaning of the peat surface – all bones were identified as domesticated cattle (Scales pers comm). During a field visit on 11.6.05, the well-preserved, disarticulated remains of a possible cattle skeleton were excavated from Site F, totalling some 70 bone/bone fragments, including a complete pelvis, scapula, left and right femora, radii, seven vertebra, a fragmentary skull, jaw bone, and twenty-two rib-bone fragments representing at least thirteen rib bones.

The evidence for a distinct phase of late Mesolithic activity at Oldbury Flats has not previously been recognised. Prior to this study, the only artefacts of probably late Mesolithic date were five unstratified microliths (Allen 1998). Although no other artefacts of diagnostic Mesolithic date have been identified, it is probable that a proportion of the debitage and undiagnostic tools from the unstratified assemblage may also represent Mesolithic activity. A small assemblage of lithics excavated by Allen (1998) from the buried soil *c* 50m to the south of Site F produced a date on charcoal accompanying thermally fractured stone of 5310±70 BP (Beta–84850; 4230–4000 cal BC), but was interpreted as reflecting activity of early Neolithic date. The calibrated date, however, is more suggestive of late Mesolithic or transitional late Mesolithic/early Neolithic activity. Three flakes stratified from the base of the peat at Site G are considered to represent late Mesolithic activity broadly contemporary with the evidence for reed burning at Site A, whilst the small number of lithics retrieved from the buried soil and base of peat at Site F are considered to represent activity of a date contemporary with late Mesolithic/early Neolithic dated contexts from Site D (4310–3000 cal BC), E (4670–4400 cal BC), and the Allen Sondage (4230–4000 cal BC). The evidence corresponds to a more extensive occupation of the dryland bedrock and fringing inner marsh during the later Mesolithic than previously realised. However, these stratified contexts represent small, discrete scatters rather than large concentrations of lithics, and reflect the persistent and repeated exploitation of the estuary margins by small task groups engaged in short-term, rather than long-term occupation.

In contrast to the Gwent and Wentlooge Levels, where there is a distinct fall-off in evidence for early Neolithic activity within the wetlands compared to the late Mesolithic (Bell *et al* 2000), the evidence from the Oldbury Levels (Oldbury and Hills Flats) suggests that communities continued to exploit coastal-estuarine wetlands from the early 4th millennium BC. As in the preceding late Mesolithic, occupation continued to follow a highly mobile pattern of persistent and repeated, short-term activity. However, the cattle and human footprints from Site F, laid down at some point between 3100–2150 cal BC, and associated with domesticated cattle bones, lithics, and charcoal, suggest the presence of pastoral communities on the estuary margins during the mid to late Neolithic. These represent the earliest dated animal footprint evidence for cattle grazing by humans in the Severn Estuary. They are between 600–2100 years earlier than the animal footprints associated with the settlement at Redwick (Bell *et al* 2000), and between 300–1600 years earlier than the early Bronze Age settlement at Oldbury Flats, located on the site of the silt pond immediately south of the nuclear power station, radiocarbon dated to 1750–1620 cal BC (Hume 1992). No settlement structures are associated with the footprints, although these could be located on nearby areas of permanent dry ground. Cattle grazing may have occurred during the spring/summer, as has been suggested for Redwick (Bell 2001), although it does not exclude the possibility that people were still visiting the site for other purposes during the autumn and winter. Areas of dry ground could easily have been settled, and from here cattle could have been driven to the nearby saltmarshes to graze. Evidence has yet to emerge to support either hypothesis, although it seems logical to assume that grazing of cattle on saltmarsh must have necessitated some form of settlement close by, whether seasonally, or permanently occupied.

19.4 Hills Flats, south Gloucestershire

The site of Hills Flats (ST 625 975) lies on the intertidally exposed eastern shores of the middle Severn Estuary, 6km downstream from Sharpness, and 3km north of Oldbury Flats (Fig 19.1). The site is 3km long by 0.5km wide, comprising an uneven outer bedrock platform of Triassic mudstones and sandstones, and an inner zone of sediment of middle to late Holocene age infilling three shallow depressions along the inner margins of the intertidal zone (CD 19.5).

Previous work by Allen (1997) has produced a small yet diverse collection of 101 unstratified lithics of Neolithic and early Bronze Age date, largely retrieved from small pocket beaches at the base of the saltmarsh cliff around Hill Pill. These include an unusually high number of retouched items (29%) and core elements (29%). A complete Neolithic axe of Group I (Cornish origin) was also recorded from the foreshore (Allen 1990). A further two retouched items, including a scraper, were retrieved, also unstratified, during the course of fieldwork by this author. Allen (1997) argued that much of this material was eroded and mixed as a result of coastal erosion caused by progressive sea-level rise and is likely to have originated from either: i) land surfaces on areas of bedrock which still remained accessible at the time the artefacts were deposited; ii) areas of saltmarsh deposited during sea-level rise; or, iii) areas of peat deposited during stable or falling sea levels.

The sedimentary sequence is complex, comprising three, and perhaps as many as five, individual peat layers, separated by blue-green estuarine clayey-silts and coarsely laminated sandy-silts, the latter similar to banded estuarine sediments studied at Goldcliff East (Dark and Allen 2005). This represents a sequence of freshwater/brackish peats formed under periods of stable or falling sea level, followed by phases of minerogenic deposition, representing saltmarsh and/or high mudflats laid down under periods of sea-level rise. These are capped along the margins of the intertidal zone by further estuarine clayey-silts of the Upper Wentlooge, Rumney, Awre, and Northwick Formations.

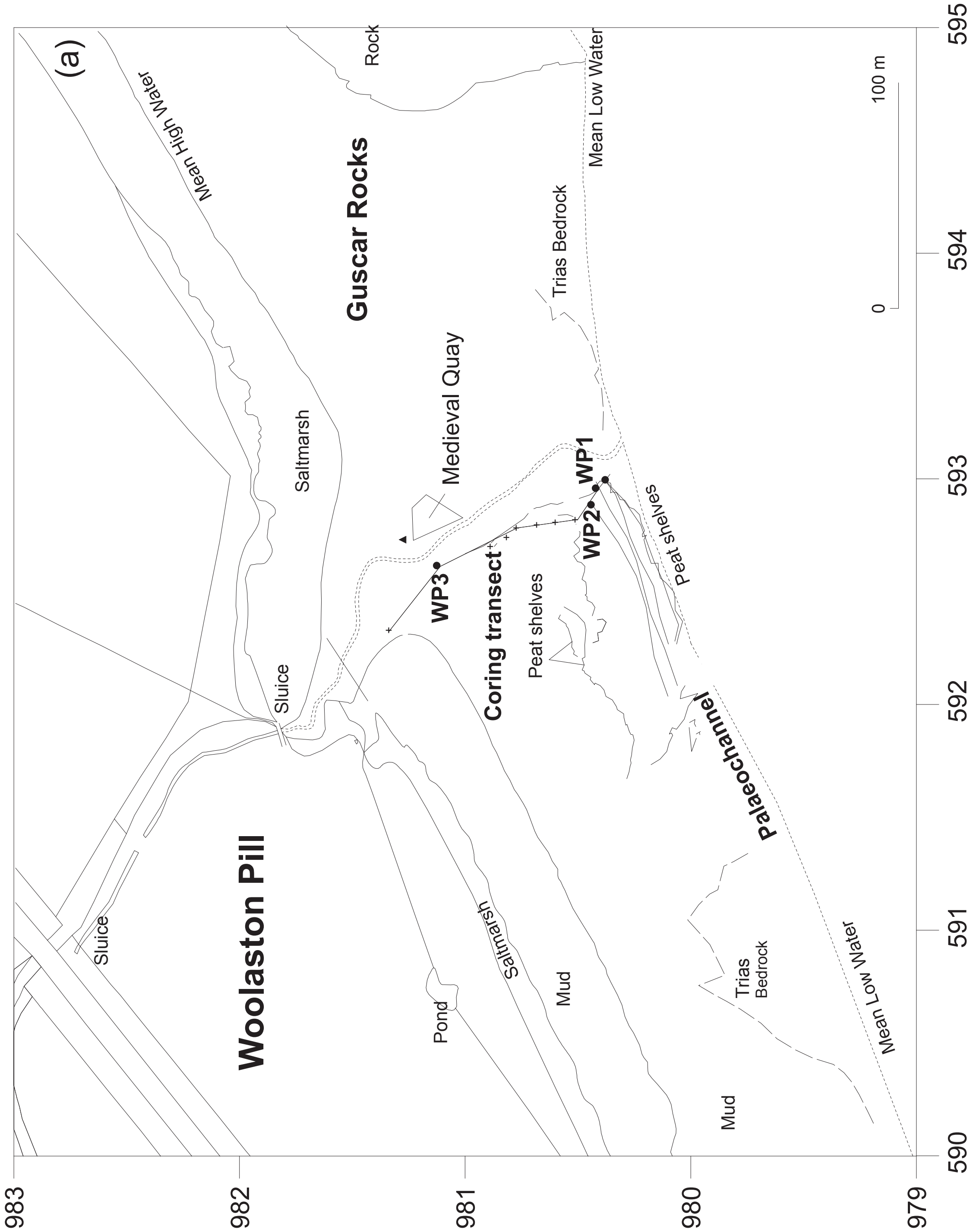
Palaeoenvironmental analysis was restricted to the Upper Peat (*c* 35cm thick). Charcoal from the base of the peat produced a radiocarbon of 5300± 31 BP (OxA-13700; 4230–4040 cal BC). Pollen and plant macrofossil analysis of the Upper Peat suggest a succession from reedswamp to sedge-fen, bounded estuaryward by saltmarsh, and landward by a *Quercus*-*Ulmus*-*Tilia*-*Corylus* dominated woodland, with *Alnus* and *Salix* within wetter areas fringing the dryland edge. Both micro- and macro-charcoal are abundant within the base of the peat, associated with high percentages of Poaceae pollen, most probably representing *Phragmites australis*. The preponderance of macro-charcoal fragments within the 1–5mm size-class, which include fragments of charred reed stem, must reflect *in situ* burning of the reedswamp. The defined nature of the charcoal spike might suggest a phase of anthropogenically induced burning of reedswamp of late Mesolithic date (4230–4040 cal BC), although this cannot be established with certainty because of the lack of associated stratified archaeology. A smaller charcoal spike midway through the peat, most likely early Neolithic in date, and contemporary with the lithic evidence, is associated with a single charred *Cladium mariscus* seed, suggesting a late summer (August-September) burn.

Although the lithic assemblage does not include any diagnostically Mesolithic artefacts, this does not exclude the possibility that a proportion of the debitage and undiagnostic tools may represent late Mesolithic activity contemporary with the evidence for burning. The high percentages of tools and cores and comparatively small quantities of debitage might suggest a special activity site. The evidence would suggest intermittent, rather than persistent visits, perhaps small hunting or foraging parties. These may represent forays along the estuary margins by communities occupying the bedrock margins, perhaps to the south at Oldbury Flats. In addition, Allen (1997, 270–1) notes that the tangs, barb, and tip of an elaborately made arrowhead had been snapped off, perhaps suggesting a ritual use of the site.

19.5 Woolaston, Gloucestershire

The site of Woolaston (ST 592 981) is located on the western shores of the middle Severn Estuary, approximately 7km upstream of Chepstow and 6km downstream of Lydney (Fig 19.1). It represents one of three major outcrops of Holocene sediment within the middle Severn Estuary, but has not, until now, been subjected to palaeoenvironmental analysis. Previous research at Woolaston consisted of investigation of numerous archaeological contexts within both the intertidal zone and adjacent dryland, the majority of which are Romano-British and medieval in date, including the Chesters Roman villa (Fulford and Allen 1991), a post-medieval mill (Fulford 1992), and medieval quay (Fulford *et al* 1992). During the course of work on the quay, small-scale sampling of the intertidally exposed Submerged Forest took place, producing a 227 year *Quercus* sequence from 4096–3869 tree-ring years BC. This formed part of research aimed at producing the first prehistoric oak tree-ring chronology for England (Hillam *et al* 1990). No finds of prehistoric age were recorded during the course of any of these investigations.

Research by this author (Brown *et al* 2005), in cooperation with the NERC Mesolithic to Neolithic Coastal Environmental Change Project, focused on an area of approximately 150m^2 of intertidal zone immediately south of Grange Pill where the Holocene sedimentary sequence is largely preserved within a broadly north-west/south-east running palaeovalley incised during the Devensian or earlier. The bedrock platform, composed of Triassic mudstones and sandstones, slopes steeply towards the estuary, and is overlain by a sequence of basal minerogenics, comprising Head and an Old Land Surface. These are sealed by two peats separated by blue-green estuarine clayey-silts (Fig 19.7). Radiocarbon and dendrochronological dates suggest that the sequence of peats and silts accumulated over a period of *c* 2000 years from 5725 to 3656 cal BC. The upper portion of the estuarine clayey-silts separating basal and upper peats is strongly laminated, with a series of dark grey organic clays and structureless organic bands. The organic bands represent short phases of organic deposition, typically undeveloped reed peats, whereas the clay bands are deposited during short-term episodic high tides or storm surges. One of these organic bands has been dated to 5420± 40 BP (OxA-14003; 4335–4245 cal BC).


(a)
Mean High Water
Rock
Guscar Rocks
Mean Low Water
100 m
0
Trias Bedrock
Saltmarsh
Medieval Quay
WP1
WP2
WP3
Peat shelves
Coring transect
Peat shelves
Sluice
Palaeochannel
Woolaston Pill
Sluice
Saltmarsh
Pond
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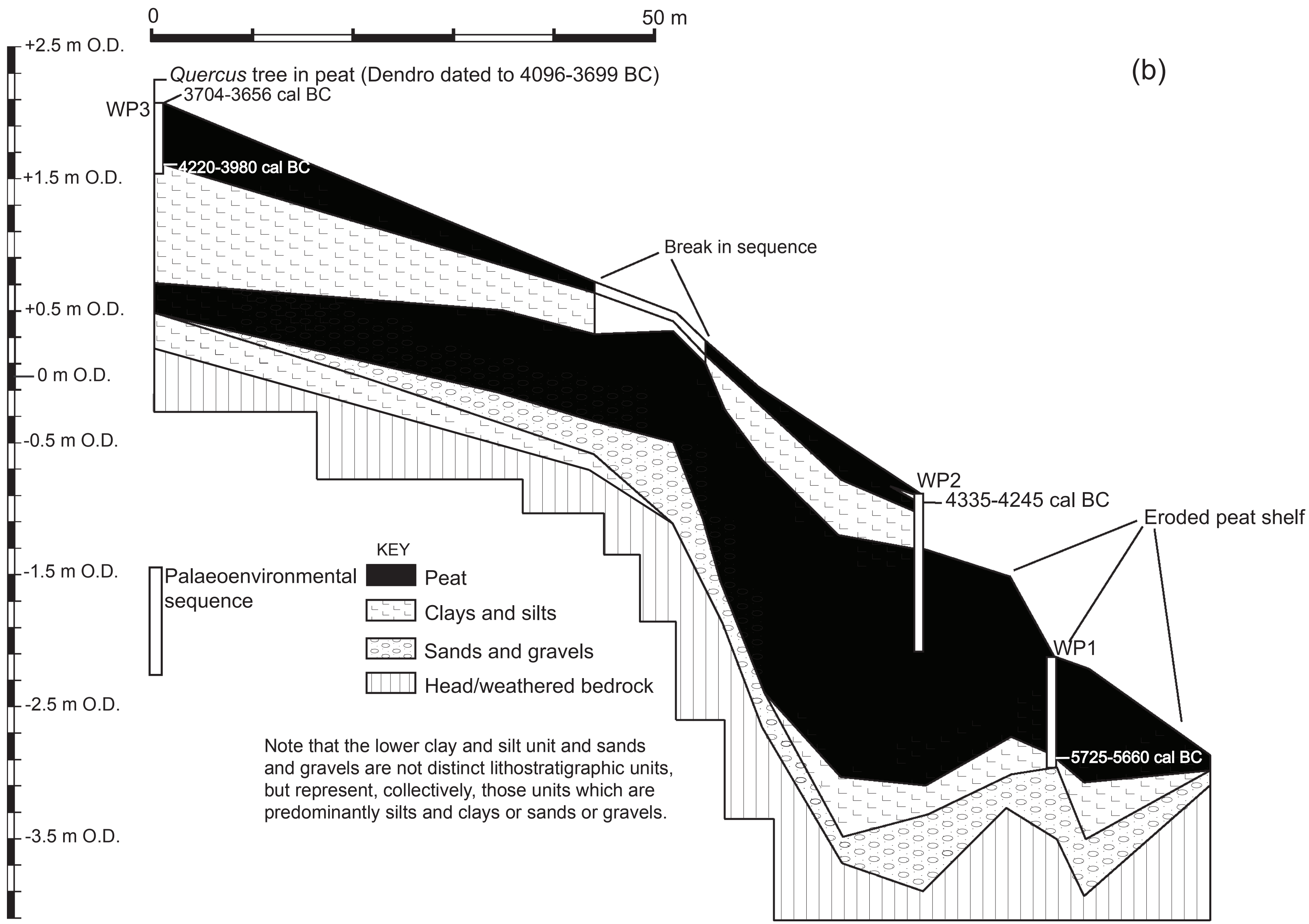


Figure 19.7 (above) Plan of the intertidal zone at Woolaston, Gloucestershire showing the coring transect (below) Schematic diagram of the Holocene sedimentary sequence at Woolaston along the transect line (graphic A Brown)

A survey of the intertidal zone was undertaken during February/March 2004 with the aim of planning existing archaeological and geomorphological features, and establishing whether there was any evidence of prehistoric activity. This produced only slight evidence of prehistoric activity, but abundant evidence for medieval and later activity. However, humans were active close to Woolaston during prehistory. A flint core of early Mesolithic date was found within a 'few metres of the Severn Estuary' at Woolaston in 1988 (Walters 1992, 11). During the course of the current survey, two flint flakes were retrieved unstratified from the base of the saltmarsh, whilst six flint flakes were retrieved from a modern soil section exposed along the edge of the saltmarsh to the immediate north of Grange Pill, centred on ST 59298 98201, and appear to relate to activity on the bedrock beyond estuarine influence or peat growth. None of the finds were diagnostic as to age. The paucity of finds from Woolaston seem likely to reflect the transient use of this location.

The entire Holocene sequence was subjected to palaeoenvironmental analysis (Brown 2005). The basal peat is characterised by a long-lived phase of *Alnus* carr-woodland from 5725 to *c* 4700 cal BC, during which there is little evidence for vegetation change or anthropogenic impact, a pattern evident also at Llandevenny and Goldcliff (Chapter 15) on the Gwent Levels. The period from *c* 4700 to 4220–3980 cal BC is characterised by a transition to reedswamp and then saltmarsh, during which there is evidence for probable anthropogenic impact in the form of a significant increase in both micro- and macro-charcoal. This occurs during the period of maximum environmental dynamism, represented by the strongly laminated clayey-silt/organic bands. There is a close relationship between repeated spikes in micro- and macro-charcoal and concurrent increases in the abundance of Poaceae pollen, associated with fragments of charred reed stem, argued to reflect the burning of reedswamp. The repeated nature of the burning, covering several hundred years, could be taken as strong supporting evidence for an anthropogenic origin. However, none of the charcoal spikes are associated with independent evidence of human activity, making it impossible to be certain of an anthropogenic origin.

Burning may have formed part of a strategy geared towards increasing the productivity of the fringing reedswamp, encouraging increased graze by browsers which humans could hunt. Such a hypothesis might be sustained by arguing that successive increases in both Poaceae pollen and micro-charcoal represent promotional burning of the reedswamp during the late winter/early spring.

19.6 Conclusion

One of the most significant outcomes of this research (Brown 2005) has been the discovery at Llandevenny of a new late Mesolithic/early Neolithic occupation site. This site is important, not only because it represents a rare class of site with evidence for unbroken occupation over the Mesolithic-Neolithic transition, but because the occupation layers contain abundant, well-preserved organic remains critical to considering questions of settlement mobility, seasonality, subsistence, and the impact of humans on the landscape over the Mesolithic-Neolithic transition. Research within the middle Severn Estuary has established an environmental context for Woolaston, whilst earlier work by Allen (1997) at Hills Flats and Druce (2001) at Oldbury Flats has been placed in a more detailed environmental context. Research at Oldbury has been important in providing new evidence for occupation and probable anthropogenic manipulation of the intertidal margins during the later Mesolithic, and the evidence for cattle husbandry during the Neolithic. Fire was a significant disturbance factor in lowland environments in prehistory. The consistent presence of charcoal through substantial portions of the sedimentary sequences from the study sites is argued to reflect the sustained impact of human communities on the landscape, although it is recognised that some fires may have been naturally-induced. Fire continued to be used into the Neolithic, although interestingly, apparently on a lesser scale than the late Mesolithic.

Evidence for the seasonality of occupation suggests that late Mesolithic hunter-gatherers may have been active at sites along the wetland edge at several stages throughout the year, though not necessarily on a continuous basis, contrary to simple seasonal bimodal models of settlement which envisage a seasonal round between upland areas during the summer and lowlands during the winter. There is clear evidence from Llandevenny, Oldbury Flats, and Hills Flats for activity in summer and autumn, with the possibility at Llandevenny, Woolaston, and Hills Flats that reed burning may have taken place in the late winter and/or early spring. There is considerable evidence from the study sites for continuity in occupation and maintenance of a mobile settlement pattern from the 5th to 4th millennia cal BC. There is significant evidence for the use of wild plants during both the Mesolithic and Neolithic, suggesting they may have made a much greater contribution to the diets of late 5th- and early 4th-millennia cal BC communities than previously considered.

This study complements the work at Goldcliff reported in earlier chapters, by demonstrating the occurrence of reed burning much more widely. It also shows that later Mesolithic activity also occurred at the wetland edge at both Llandevenny and Oldbury. At the two latter sites, as in the Prestatyn case study presented in Chapter 20, there is possible evidence of continuity of activity in the late Mesolithic and Neolithic; this is in contrast to Goldcliff where the evidence suggests that activity reduced to a very low level in the final centuries of the Mesolithic and where clear evidence of Neolithic activity is lacking.

20 Shell middens and their environment at Prestatyn, north Wales *by M Armour-Chelu; M Bell; B Brayshay; W J Britnell; N Cameron; A E Caseldine; P Q Dresser; E Fancourt; S Gonzalez; E Healey; S Johnson; J Norris-Hill; R Schulting; D Thomas*

20.1 Introduction *by M Bell*

Having reviewed new evidence for Mesolithic activity in the Severn Estuary in Chapters 2–19, the question arises: is that area unique or is the potential identified there represented in other areas of coastal wetland? The Prestatyn area of north Wales provides a test case, in this instance focusing on the wetland/dryland edge in common with Alex Brown's sites presented in Chapter 19, but also involving reassessment of some older finds including those from intertidal contexts at Rhyl. The Prestatyn area has for 80 years produced evidence of Mesolithic and Neolithic activity preserved in Holocene sedimentary sequences. Many of the most exciting discoveries were made in the early 20th century, and no palaeoenvironmental investigation had taken place until the present research. The finds include a Mesolithic mattock from below a submerged forest at Rhyl, a human skeleton from peat, Mesolithic flintwork below tufa at Prestatyn, a Neolithic scatter of flintwork, and – the main focus of this chapter – the discovery in 1990 of shell middens covering the period of the Mesolithic/Neolithic transition. These discoveries are particularly notable because many of them are well-stratified in tufa, peat, and alluvium. The well-preserved sequence enables us to address issues of late Mesolithic economy, settlement pattern, environmental relationships, and the transition to the Neolithic.

Many of the discoveries made in Prestatyn have been the result of housing development with the steady growth of this seaside town. That expansion continues and the current investigation was occasioned by plans for housing development at Nant Hall Road where Mesolithic and Neolithic finds had previously been made. An archaeological and palaeoenvironmental investigation was carried out between 1991 and 1993 with financial assistance provided by Cadw.

20.1.1 Topography and geoarchaeology

Prestatyn is in some respects a comparable case to the Severn since in the later Mesolithic it lay on the east side of what was then the estuary of the River Clwyd. South of Prestatyn there is a steep rise with rocky outcrops to the northern tip of the Clwydian range, which reaches over 200m OD within 1km of the town (Fig 20.1). The solid geology is Carboniferous Limestone overlooking the Vale of Clwyd to the west, with chert beds towards Gronant to the east. At the base of the hills along the coastal strip, the drift geology is Boulder Clay rising to 60m OD with smaller areas of sand and gravel. Seaward of this is a strip of coastal wetland 1–2km wide, between the Clwyd Estuary to the west and Point of Ayr and the Dee Estuary to the east (Fig 1.1; CD 20.1–20.2). The excavated Nant Hall Road site is on the interface between Pleistocene sandy gravels and the Holocene wetland (Fig 20.2) which is formed of Holocene alluvium with a surface *c* 5m OD, interleaved with peat and tufa (Fig 20.3).

The Vale of Clwyd has been substantially overdeepened as a result of glacial erosion and subsequent fluvial downcutting at a time of much lower sea level. With sea-level rise an estuary at the mouth of the Clwyd was created, with a funnel-shaped mouth some 9km wide between Abergele and Rhyl, extending 7km inland with its apex at St Asaph where the valley narrows. Projecting into this estuary is a promontory of boulder clay at Rhuddlan and another lower promontory, perhaps later a drier island, at Rhyl. Both were significant locations for Mesolithic activity. The former estuary of the Clwyd was subject to Holocene sedimentation with a sequence of deposits reaching a thickness of 17.8m at Foryd (Neaverson 1935; Manley 1982; Warren *et al* 1984). The coastal lowland is separated from the sea by a barrier of blown sand which stretches across the mouth of the Vale of Clwyd and extends east, seaward of the coastal lowland at Rhyl and Prestatyn where it reaches *c* 10m OD, rising further east to form the more extensive dune system at Point of Ayr. Beach gravel is deposited in places seaward of the dunes and, in the wetland behind, strips of beach gravel (Fig 20.2) represent the lines of earlier beach gravel bars. Inland of the coastal dunes there is a belt of alluvial silt about 1km wide, which in places extends further south in small river valleys. Intermittently, peat deposits form the inner part of the coastal wetland, as at Nant Hall Road and Melyd Avenue, Prestatyn.

The Holocene stratigraphy at the mouth of the Clwyd and east to Rhyl and Prestatyn has been established in outline by Manley (1982; 1988) using

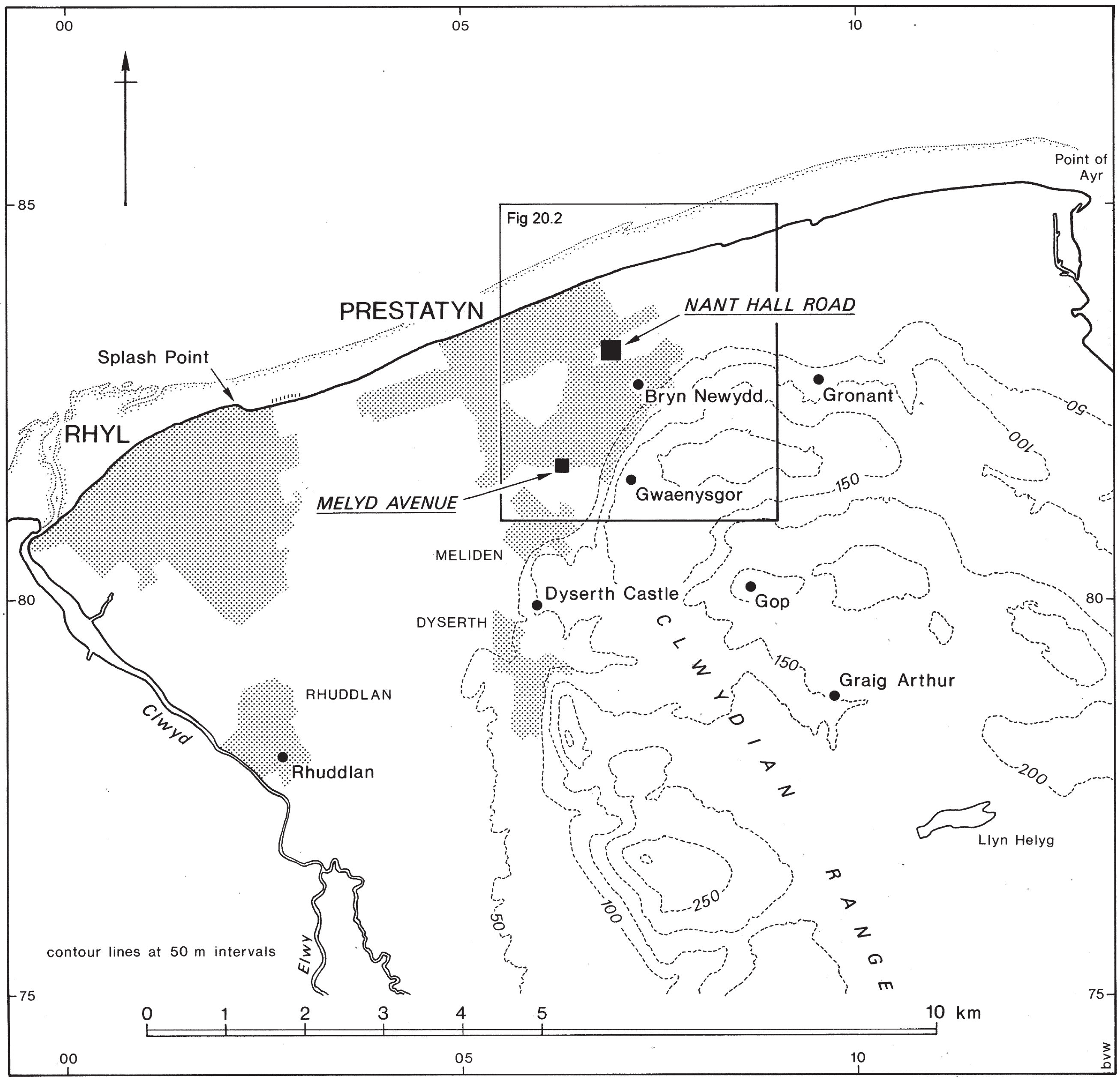


Figure 20.1 The Prestatyn/Rhyl/Rhuddlan area showing the locations of Mesolithic and Neolithic sites (Clwyd-Powys Archaeological Trust)

borehole evidence. Figure 20.3 is a schematic representation of the stratigraphy in a transect from land to sea at Prestatyn, drawing on the Manley evidence and the present project to put the excavated prehistoric middens in a stratigraphic sequence. Manley's work demonstrated that within the predominantly silty clay Holocene sequence there were two main peat layers: between Rhyl and Prestatyn a lower peat *c* –1 to –2m OD and an upper peat *c* 2m OD (Manley 1988, fig 4). The excavated middens are stratigraphically related to the upper peat where it rises against the edge of dryland to between 3 and 4.5m OD.

Mesolithic artefacts were found below tufa (spring chalk) in the 1920s when the Bryn Newydd housing estate was being built (F G Smith 1927). The extent of the tufa (Fig 20.2) was mapped by Neaverson (1942). It accumulated in a shallow bench or basin on the slope between 20 and 40m OD where a spring discharged from the limestone. On Neaverson's plan, two tongues of tufa extend downslope, one towards the site of the Nant Hall Road excavations, where our work shows that tufa extended beyond the area mapped by Neaverson onto the former wetland, where it was interstratified with peat. The other tongue 350m to the east extended to Nant Mill where there is still a strong flow of water into the millpond which discharges downslope past Prestatyn Castle (motte and bailey) into Prestatyn Gutter.

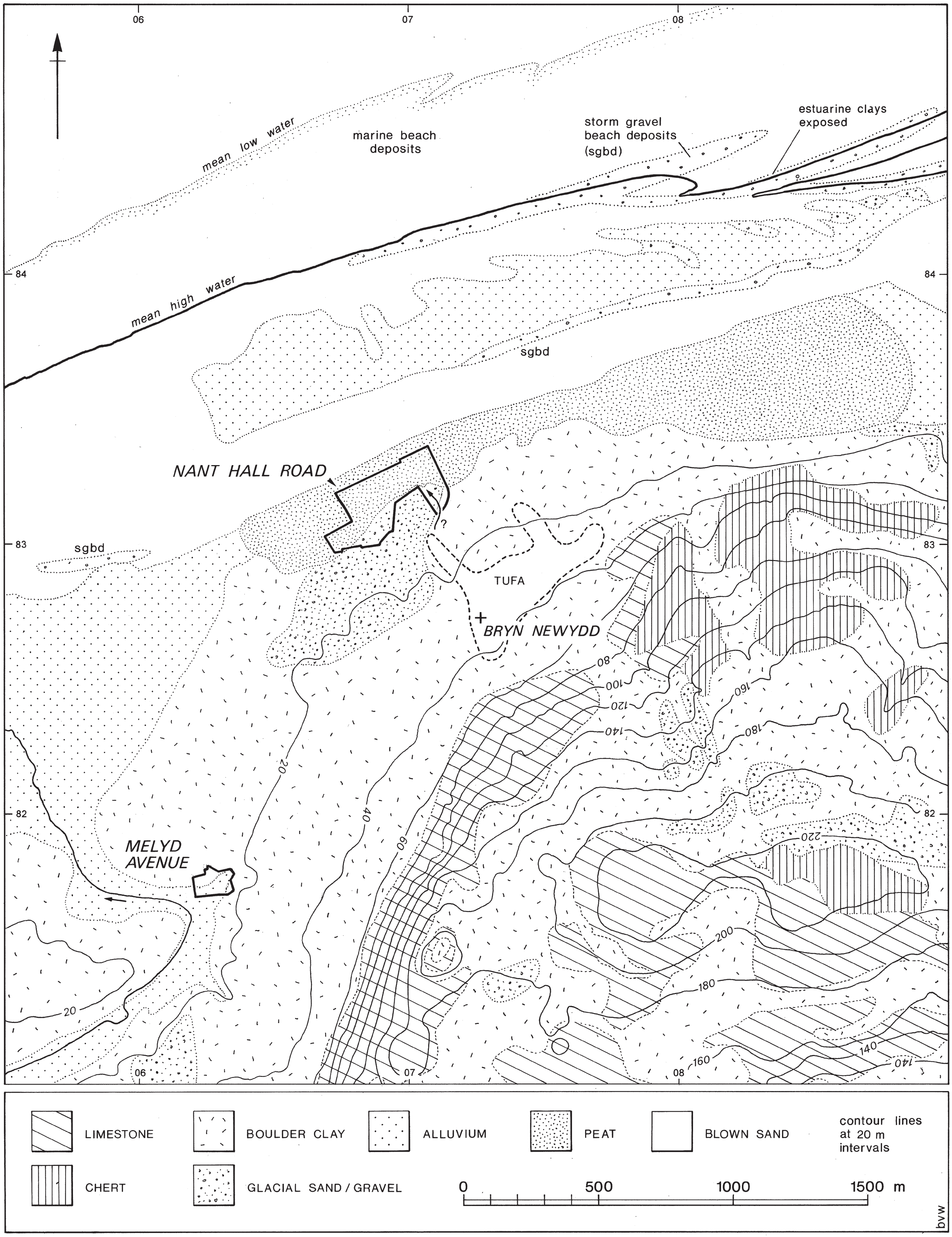


Figure 20.2 The geoarchaeological context of Prestatyn: outcrops of solid geology with Quaternary drift and Holocene sediments (graphic Clwyd-Powys Archaeological Trust)

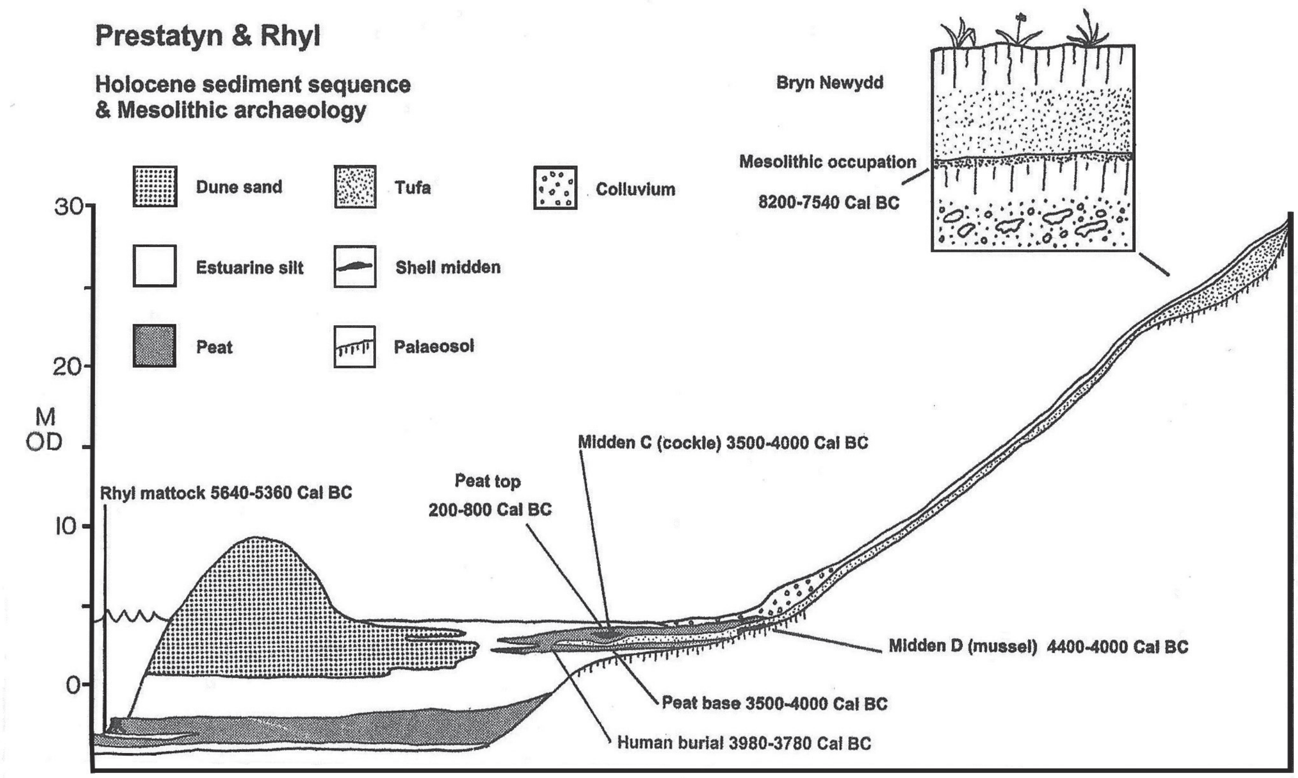


Figure 20.3 Schematic reconstruction of the Holocene sediment sequence and Mesolithic archaeology in the Prestatyn/Rhyl area (drawing M Bell)

20.1.2 Sea-level and coastal change

At the start of the Holocene, sea level was 35m below its present level. Liverpool Bay was dryland with a low coastal plain extending from north Wales to the Lake District and a wide promontory extending west to the Isle of Man. The coastal plain was progressively drowned by Holocene sea-level rise, inundating woodland and wetland, producing submerged forests and intertidal peats (Fig 1.1). In the Prestatyn area, these are recorded at Splash Point, Rhyl (see Chapter 20.14), Abergele (Pennant 1784; Manley 1982) and Rhos-on-Sea (Hall 1866). Sea-level rise led to the innundation of the Clwyd Estuary, the accumulation of silts, and the formation of saltmarsh and peats, perhaps behind a precursor of the present coastal barrier. Much later, in medieval and post-medieval times, these wetlands were reclaimed for agriculture (N Jones 2002).

Consideration of the Holocene coastal history of north-east Wales benefits from its close proximity to north-west England, an area which has probably been investigated more intensively from a sea-level and coastal change perspective than any comparable region of the UK (eg Tooley 1978; Huddart 1992; Bedlington 1994; Zong and Tooley 1996). In the Lytham area, Tooley (1978) identified eleven separate stages of marine transgressive tendency. These were separated by phases of regressive tendency, for example when peat formed over earlier marine sediments. Manley (1982; 1988) synthesised the Holocene sedimentary record from boreholes in the former wetland at the mouth of the Clwyd and east to Prestatyn and suggested correlations between these peats and other sediments and the Tooley sequence of transgressive and regressive stages.

20.1.3 Mesolithic and Neolithic archaeological background

The focus of this study is the later Mesolithic Nant Hall Road site (Figs 20.1–20.2). Earlier Mesolithic activity was discovered just 400m south of this site at Bryn Newydd by F G Smith (1924; 1926; and 1927) and Clark (1938; 1939). The finds were partly from an Old Land Surface stratified below the tufa. Hazelnuts from the site have been dated 8700±100 BP (OxA-2268; 8200–7550 cal BC) and 8730±90 BP (OxA-2269; 8200–7550 cal BC; David 1991). Other assemblages early in the Mesolithic are known from a number of sites at Rhuddlan, near the mouth of the Clwyd, 6km to the south-west (Berridge 1994), associated with radiocarbon dates of 8739±86 BP (BM-691; 8200–7550 cal BC) and 8528±73 BP (BM-822; 7730–7450 cal BC).

At Splash Point, Rhyl, 5km to the west of Prestatyn, there is an exposure of submerged forest and estuarine clays which produced a perforated antler mattock dated 6560±80 BP (OxA-1009; 5640–5360 cal BC) and other Mesolithic and Neolithic finds (Chapter 20.14). There are finds of later Mesolithic flintwork from Nant Hall Road, Prestatyn (Chapter 20.11) made during field collection by Smith (Davies 1949; Wainwright 1963). Mesolithic flints have also been recovered from a peat sequence at Melyd Avenue, Prestatyn, which was also investigated as part of the present project (Chapter 20.13) (Newstead 1938, 189–91; Blockley, 1989). Further afield, Later Mesolithic assemblages are known from lowland sites in the Vale of Clwyd at Rhuddlan (Manley and Healey 1982).

A notable concentration of Neolithic finds suggesting a focus of settlement occurs near the mouth of the Clwyd, the coastal plain and the margins of the adjacent upland in the Prestatyn area (Savory 1980, fig 5.2; Lynch 2000, fig 2.1). Here, as in the Wirral, a number of these finds come from sites which have also produced Mesolithic material. These include a substantial Neolithic flint assemblage from Nant Hall Road, Prestatyn (Chapter 20.11) and a concentration of finds of Neolithic axes around Prestatyn. A human skeleton found in peat in 1924 in Prestatyn has now been dated to the Mesolithic/Neolithic transition (Chapter 20.12). On the upland 1.4km south of Prestatyn, at 150–200m OD, a concentration of Neolithic artefacts, including axes and leaf arrowheads, has been found at Gwaenysgor (Glenn 1914, 1935; Powell 1955). 3.3km south-south-east of Prestatyn is Gop where Neolithic burials have been found in a cave and where a very large cairn (100m across and 14m high) is undated but may be Neolithic (Boyd-Dawkins 1901; Glenn 1935; Davies 1949; Britnell 1991). The only certain Neolithic tomb in the area is Tyddyn Bleiddyn, which is 13km south-west of Prestatyn (Lynch 1969; Cummings and Whittle 2004, 136).

20.1.4 Palaeoenvironmental research objectives

The palaeoenvironment of the Prestatyn Holocene sequence has not previously been investigated. The interleaving of peat and tufa facilitates a comparative study using pollen, plant macrofossils, and marine and non-marine Mollusca. Radiocarbon dates for the Nant Hall Road shell middens show that they relate to that critical period of about 500 years on either side of 4000 cal BC when the traditional view has been that hunting and gathering was rather rapidly replaced by farming. However, it has been pointed out that the evidence for cereal growing in the early Neolithic is patchy and there is growing evidence that wild resources continued to make an important contribution to the diet (Moffett *et al* 1989; Thomas 1990; Caseldine 1992). Such a debate means that coastal shell middens of appropriate age, with environmental evidence, are of special interest. Prestatyn encapsulates a number of the main research priorities identified by Caseldine (1990; 2003): investigation of Mesolithic coastal environments, the Mesolithic/Neolithic transition and Neolithic sites with economic evidence. The sites also provide evidence of the dates of clearance and agricultural activity in the climatically and pedologically favourable coastal area. This can be compared with the more numerous palaeoenvironmental sequences from the Welsh uplands.

20.2 Nant Hall Road *by D Thomas and W J Britnell*

20.2.1 Introduction

The Nant Hall Road development site, on the eastern side of Prestatyn (SJ 069 832), lies approximately 1km from the present coastline on gently sloping ground which rises from 4.05m OD at the north-west corner to about 8.25m OD at the south-east. The boundaries of the site, which extend over an area of 7.77ha, are delimited to the north by the north Wales coastal railway, to the east by Prestatyn Road (A548) and Bodnant Avenue, to the south by Nant Hall Road and Ysgol Bodnant, and to the west by the boundary with the Kwik Save supermarket. The approximate limits of the peat deposits are indicated by a slight terrace occupied by a field boundary crossing the eastern part of the site and by the line of Prestatyn Road further east.

470 lithics were found by Smith and others in the 1920–30s onwards, in a field on the eastern side of the proposed development during the course of annual ploughing. The material includes some Mesolithic material, but the majority of typologically distinct artefacts are of Neolithic date, and include six fragments of polished stone axe (Chapter 20.11). The remainder of the assemblage is predominantly of flint. Other finds reported from the site include a stone 'net sinker' with an hour-glass perforation, and a pebble with an incomplete counter-sunk perforation. The lithics came from the Field 56b, shown on the 1912 version of the 25 inch Ordnance Survey map to include the south-east corner of the development site and part of the land now occupied by Ysgol Bodnant, and Field 56 on the opposite side of Bodnant Avenue (Fig 20.4). The Ordnance Survey archaeological records suggest that most of the lithics from Field 56b came from the north-east portion of the field, concentrated on the margins of the wetland area on the eastern side of the present site adjacent to Prestatyn Road.

The present site lies about 400m to the north-east and downslope of the early Mesolithic site located in the 1920–30s during the construction of the Bryn Newydd housing estate, partly beneath tufa deposits at a height of 30m OD (Clark 1938; 1939). Other finds reported from the site include leaf-shaped arrowheads and a polished stone axe of probable Neolithic date as well as a number of Roman and later finds. Prehistoric hearths and a large deposit of cockle shells are recorded, but the dating of two groups of human burials in this area (F G Smith 1926; 1927), of which one was contracted and another associated with a large flint are, however, best regarded as uncertain.

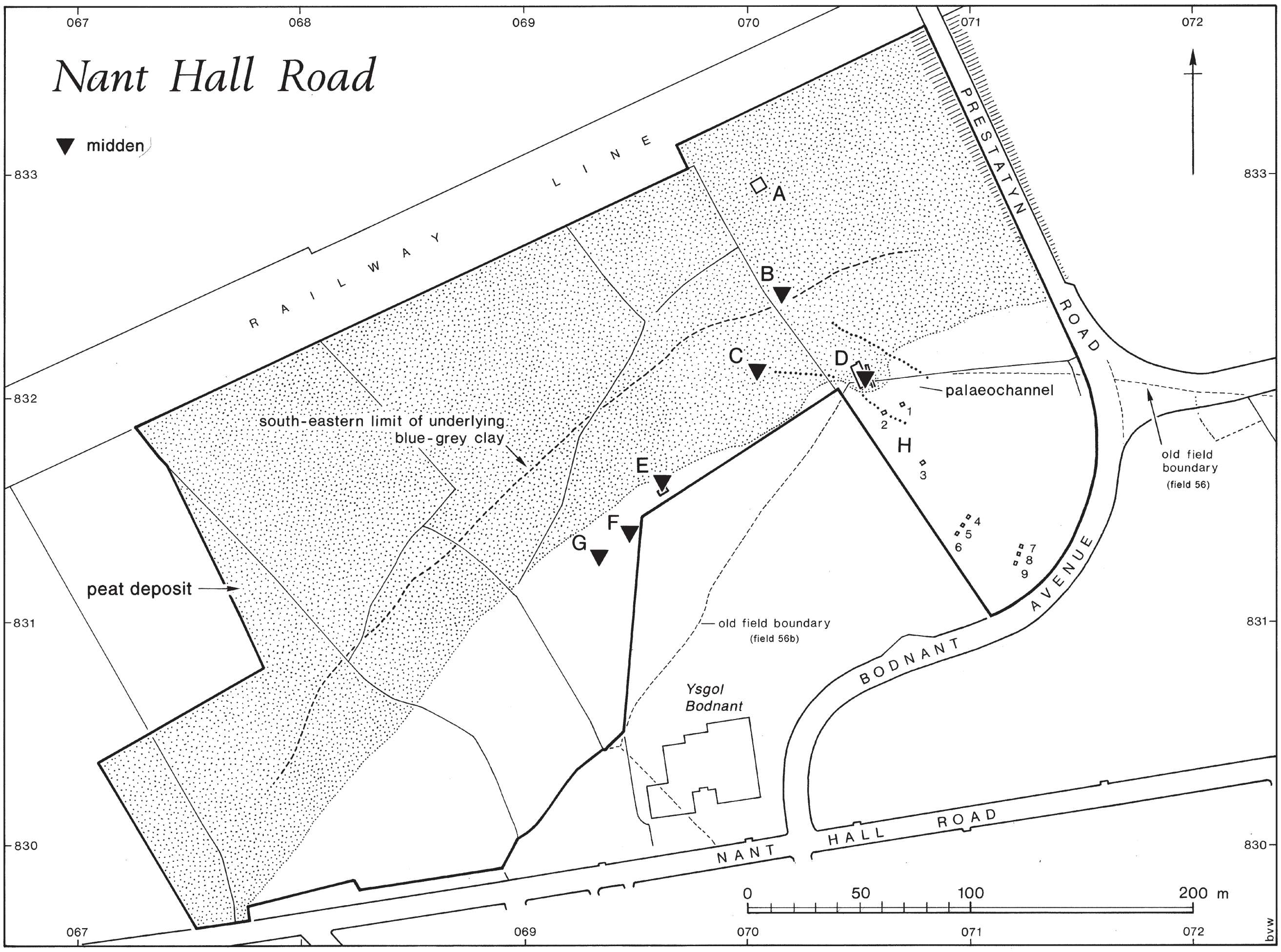


Figure 20.4 Location of excavated sites, sampling points and middens at Nant Hall Road, Prestatyn (graphic Clwyd-Powys Archaeological Trust)

The Bryn Newydd tufa occupies an oval area 12ha in extent between 23–60m OD. The nature and extent of this desposit is discussed by Smith (1926), Neaverson (1942), and Jacobi (1975): further details are on CD 20.3. The tufa is relatively thin and is sealed by, and in part interbedded with, a black layer with artefacts, bones, and charcoal representing a probable land surface. The tufa was laid down by calcium-charged springs at the foot of the Clwydian range. Neaverson (1942) noted an overflow channel leading from Bryn Newydd towards the coastal wetland (Fig 20.2); we now know that this extends downslope and interleaves with sediments at the wetland edge in the sites reported here.

At Nant Hall Road archaeological recording, limited excavation and environmental sampling were carried out during initial drainage works, and in advance of housing development and the construction of an access road from the south-east. Limited recording was also undertaken within a supermarket development immediately to the west (Thomas 1993). Access to a strip of land about 20m wide along the northern boundary was restricted by the presence of a high-pressure gas main. A strip of land 25–35m wide along this boundary is also reserved for a future road running parallel with the railway.

Initial recording work was carried out over the course of several days in September 1991 by staff of Clwyd-Powys Archaeological Trust (CPAT) and Clwyd County Council. At this stage a large pit about 40m by 46m across had been excavated for underground water-storage tanks towards the north-east corner of the development site, and a long trench orientated east-west and about 14m by 95m had been excavated for the insertion of drainage pipes (CD 20.4). Two shell middens were observed in the sides of these trenches (Sites B and C; Fig 20.4). Two narrower trenches were also cut for rising mains: one along the eastern boundary of Ysgol Bodnant which curved around to the boundary with Bodnant Avenue near the junction with Prestatyn Road towards the south-east corner of the site; and the other along the western boundary of Ysgol Bodnant up to the junction with Nant Hall Road towards the south-west corner of the site. A sequence of deposits was noted in the eastern trench including areas of redeposited tufa in the dryland area. No artefacts were noted in spoil in the trench in this area, but a shell midden was identified near the wetland margin which was subsequently excavated more fully (Site D). The trench to the west of Ysgol Bodnant was excavated and backfilled so rapidly that there was no opportunity for observation and recording, but the existence of a further shell midden (Site F) was identified on the basis of a concentration of shell in the back-fill of a stretch of pipe-trench.

Limited recording and sampling was carried out on three middens (B, D, F) in 1991, together with slightly more thorough excavation and sampling of Site C. A more concerted programme of excavation, environmental sampling and recording work was carried out over four weeks in June–July 1992 by a team of 3–4 and with help in environmental sampling by staff of the Department of Archaeology, University of Wales, Lampeter. A sampling pit was excavated for pollen analysis in the deep deposits towards the northern side of the site (Site A); more extensive excavations were undertaken on one of the shell middens (Site D) which had been identified in a pipe-trench, and hand-augering was carried out in undisturbed areas in order to map the extent of deposits over as wide an area of the site as possible (CD 20.4–20.5). Two further shell midden sites were identified by augering (Sites E and G) of which one (Site E) was also excavated (Fig 20.4). Further limited work in April 1993 including additional augering and the excavation on the line of the access road from Nant Hall Road and in advance of supermarket construction on the western part of the site. A watching brief was maintained during the construction of the access road in June 1993.

The three main palaeoenvironmental sampling sites provide a roughly north-south transect from the wetland to dryland across a distance of 110m, from Site A at the north which provides the main pollen sequence, through Site C, where a shell midden lay within peat, to Site D, where a further midden was overlain by tufa and peat. A schematic representation of the stratigraphy including middens C and D is shown in Figure 20.3. The total depth of deposits at Sites A, C, and D was respectively 2.46m, 1.20m, and 1.07m.

20.2.2 Hand-augering

Hand-augering (CD 20.4–20.5) shows that Holocene sediments are at their thickest at the north-west corner of the development site where there is a total thickness of 3.3m down to the surface of Pleistocene sands and gravels. The surface of the Pleistocene sands and gravels slopes from 7.50m OD at the south-east corner of the site to 0.75m OD at the north-west corner. This is overlain by a layer of clay of marine or estuarine origin up to 1.72m thick, the upper surface of which lies at approximately 2.85m OD, though with local variations between 2.55 and 2.90m, in a band along the northern boundary of the site. This in turn is overlain by layers of peat up to 1.29m thick (recorded as a single unit during augering), which extends and gradually peters out over the surface of the Pleistocene sands and gravels further to the south. Augering in the dryland areas to the south of the peat deposits suggests that ploughing in the area along the southern edge of the site extends to the surface of the underlying sand and gravel and has probably disturbed the early land surface in this area. Further to the north, towards the margins of the wetland area, early land surfaces are preserved below a layer of colluvial clay loam up to 0.3m thick. Redeposited tufa fragments were also present within this colluvium, with greater occurrence in the eastern half of the site. A palaeochannel was traced running across the site, which was also identified during the excavation of Sites C and D, and possibly areas H1–2. Apart from the shell midden sites, scattered cockles were also recorded in the ploughsoil in a number of auger holes along the edge of the wetland area. There is no certainty that all shell middens present have been found, given that later discoveries showed some had not been detected by augering.

20.3 Radiocarbon dating *by P Q Dresser*

One of the main objectives of the current project was to establish a reliable chronology for the Holocene sediment sequence and the associated archaeological horizons, the middens, and other contexts. The dates obtained are listed in Table 20.1, which covers the main study at Nant Hall Road and smaller-scale work at Melyd Avenue. The results are based on NBS standard; they have been calculated using the Libby half-life (5568) and have had a δ13C correction applied. The calibrations in this table, and throughout this chapter, employ the atmospheric data in Reimer *et al* (2004) and have been calibrated using OxCal version 3.10 (Bronk Ramsey 2005). Figure 20.5 presents the calibrated dates from the Nant Hall Road sites.

Assuming a Mesolithic/Neolithic boundary at *c* 4000 cal BC (Chapter 1) the dates show the mussel middens at Sites D and E began in the late Mesolithic. The cockle middens at Sites B and C correspond to the early Neolithic. Site H3 with some marine molluscs is dated to the middle Bronze Age. Site A, the environmental sampling pit, did not contain midden material, the basal minerogenic sediments are Mesolithic and the peats themselves formed between the earliest Neolithic and the Iron Age.

20.4 Excavation of the sites at Nant Hall Road *by D Thomas and W J Britnell*

20.4.1 Site A

A pit 5m by 5m was machine-excavated for environmental sampling of the wetland sequence (Fig 20.6; CD 20.6). Ground level was at 4.29m OD. It was excavated to a depth of 1m, then stepped in to 3m

Table 20.1 Radiocarbon dates and calibrated ranges for samples from Nant Hall Road and Melyd Avenue, Prestatyn

Site	Context	Local pollen assem. zone	Radio-carbon date BP	Lab code	Cal years BC/AD (2 sigma)	Dated material
Nant Hall Road, Prestatyn						
A	depth: 144–8cm	NHRA- 2/3	4900±80	CAR-1427	3950–3510 BC	fen peat
A	depth: 93–6cm	NHRA-4	4960±70	CAR-1485	3950–3630 BC	peat
A	depth: 68–73cm	NHRA-4	4230±80	CAR-1425	3020–2570 BC	fen peat
A	depth 38–41cm	NHRA-5a/5b	2520±70	CAR-1484	800–410 BC	peat
B	shell midden		4700±70	CAR-1356	3640–3360 BC	charcoal
C	depth: 79–81cm	NHRC-1	4960±80	CAR-1426	3960–3630 BC	? peat
C	bottom layer of midden		4890±80	CAR-1355	3950–3500 BC	charcoal
C	depth: 35–7cm	NHRC-1C	4340±70	CAR-1483	3350–2750 BC	peat
C	depth: 18–20cm	NHRC-1C/2	2980±60	CAR-1482	1390–1020 BC	peat
D	24 (soil layer just below midden)		5470±80	CAR-1424	4470–4050 BC	charcoal
D	21 (shell midden)		5270±80	CAR-1423	4330–3950 BC	charcoal
D	17 (layer over shell midden)		4910±70	CAR-1421	3940–3520 BC	wood
D	11 (tree throw pit base)		4330±70	CAR-1419	3250–2700 BC	wood
D	16 (tree throw pit)		4210±70	CAR-1418	2930–2570 BC	charcoal
D	6 (depth 65–7cm)		3530±70	CAR-1486	2040–1680 BC	peat
E	105 (lower layer of midden)		5530±80	CAR-1420	4550–4230 BC	charcoal
E	104 (upper layer of midden)		5110±80	CAR-1422	4250–3700 BC	charcoal
H3	palaeosol		2850±70	SWAN-14	1260–840 BC	charcoal
Melyd Avenue, Prestatyn						
	7.54–7.56m OD	MA 3	9830±110	CAR-1417	9800–8800 BC	peat
	7.78–7.80m OD		4810±60	CAR-1536	3710–3370 BC	peat
	7.99–8.02m OD	MA 4/5	3180±60	CAR-1489	1610–1310 BC	peat
	8.79–8.83m OD	MA 6/7	2050±60	CAR-1488	210 BC–AD 80	peat
	9.01–9.03m OD	MA 7a/7b	1910±60	CAR-1487	40 BC–AD 240	peat

(data provided by P Q Dresser)

by 3m for safety reasons, and further excavated to a depth of 2.60m. The following sequence was recorded in the field (CD 20.6): topsoil (Context 150), 0.16m thick; yellow-brown mottled clay (Context 151), 0.13m thick; grey-brown clay loam (Context 152), 0.24m thick; peat (Contexts 153–4), 1.11m thick; and blue-grey clay (Context 155), 0.82m thick which was thought to be of estuarine or marine origin. The surface of the underlying grey sand with angular chert fragments of presumed Pleistocene origin lay at a depth of 2.30m below the surface (1.83m OD).

20.4.2 Site B

The shell midden at Site B was composed predominantly of cockles. The midden was at least 3.2m across from east to west and up to 50mm thick, with its surface at 4m OD. It lay beneath a layer of 0.28m of peat and overlay further layers of peat up to 0.7m thick extending onto the surface of glacial drift at 3.25m OD. The blue-grey estuarine or marine clay noted in Site A petered out to the south from about this point. Charcoal from a bulk sample of marine molluscs retrieved from the midden has been dated to 4700±70 BP (CAR-1356; 3640–3360 cal BC).

20.4.3 Site C

The shell midden at Site C was composed predominantly of cockles. Limited excavation and sampling was undertaken before the trench dug for drainage works was backfilled. Ground level in the immediate vicinity of the midden was at between 4.95–4.85m OD. The following sequence was recorded in the 1.2m high section through the midden (Fig 20.7): greyish brown clayey loam topsoil (Context 1), 0.30–

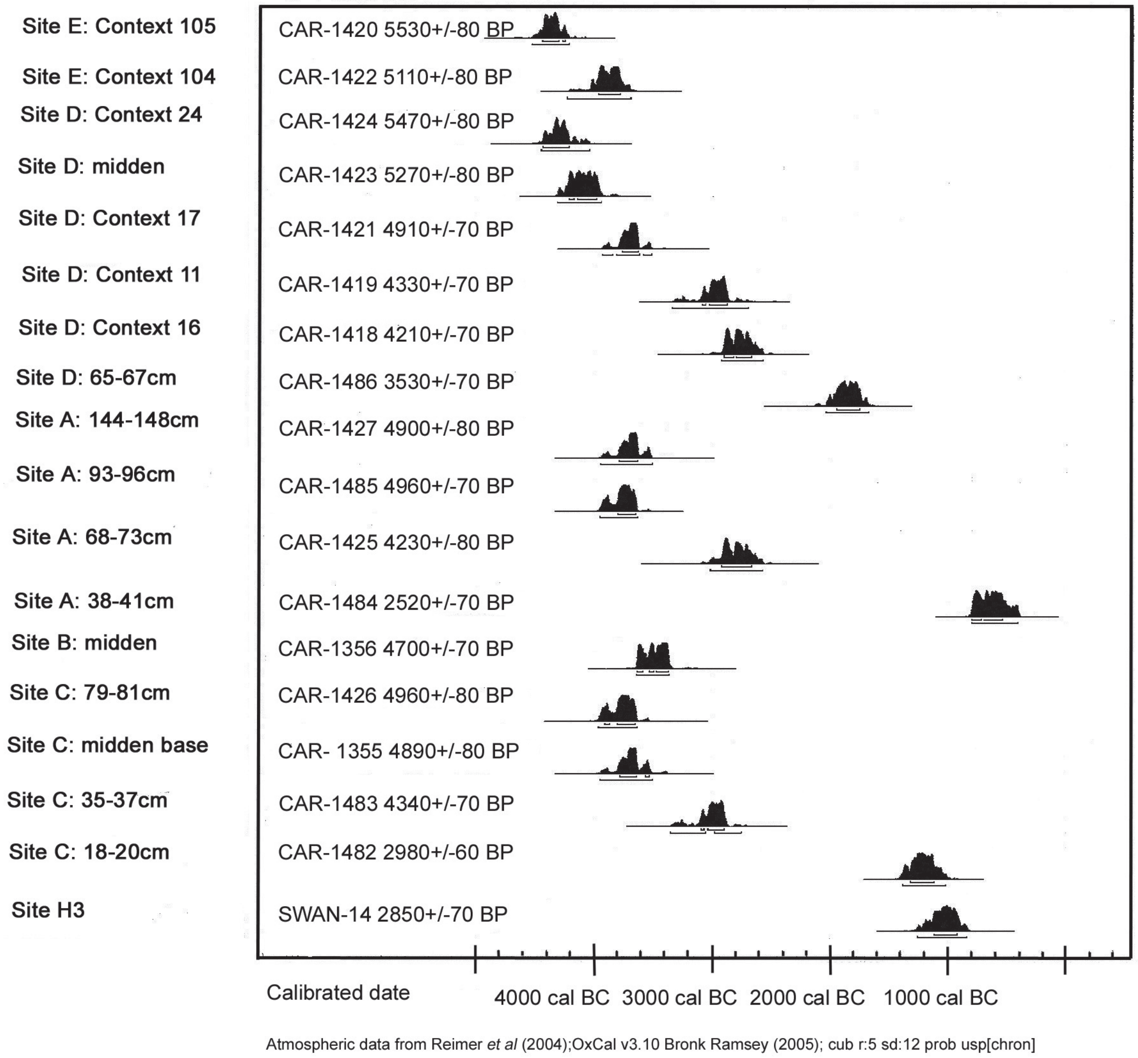


Figure 20.5 Calibrated radiocarbon dates from Nant Hall Road, Prestatyn

0.40m thick; dark brown humified peat (Context 2), 0.18–0.30m thick; shell midden (Context 3), 0.02–0.18m thick; dark brown humified peat (Context 4), 0–0.10m thick with occasional tufa; alternating water-lain laminae of greyish brown clay and tufa gravel (Context 5), 0.10–0.20m thick, with evidence of rooting and possible bioturbations extending into the underlying layer; dark brown silty peat (Context 6), 0.12–0.18m thick, containing wood macrofossils. The underlying surface of grey sand with angular chert fragments of presumed glacial origin was encountered at a depth of 1.10–1.25m below the surface (3.70m OD).

The upper surface of the shell midden lay within a slight hollow. Towards the centre the midden directly overlay a substantial piece of unworked oak with insufficient rings for dendro-dating (S Johnson pers comm). Elsewhere, the interface between the midden and the underlying layer of peat was fairly irregular, possibly due to bioturbation. For a distance of 1.8m beyond the western side of the midden, considerable numbers of cockle shells were intermixed with a bank, or bands, of tufa gravel up to 0.18m thick (Context 7), suggesting possible stream or human disturbance in this area at, or shortly after, the time that the midden was deposited.

A strip 0.6m wide across the midden was excavated in plan from the standing section. In an area 3.6m across towards the centre, the midden contained scattered charcoal and heat-fractured stones. Two layers of varying thickness were distinguishable in the thicker part of the midden towards the centre, the lower of which contained a proportion of calcined shells, and higher densities of charcoal fragments and heat-fractured stones. The original dimensions of the midden are uncertain; it appears to have been at least 5.5m across. Bulk samples from alternate 0.5m squares of the midden deposit were retained for subsequent analysis of marine and non-marine Mollusca. No animal bone or lithics were recovered from the midden in the field, but two flakes were recovered from the subsequent wet-sieving of a proportion of the bulk samples. Charcoal from the lower layer at the centre of the midden has been dated to 4890±80 BP (CAR-1355; 3950–3500 cal BC).

Upon removal of a monolith for pollen analysis

Figure 20.6 Environmental sampling for pollen and plant macrofossils through the wetland sequence including peat at Site A, Nant Hall Road, Prestatyn. The view is towards dryland and Site D at the dryland edge is 100m away framed by the two larger trees. Tins 0.5m long (photo M Bell)

through the midden (Fig 20.7) at a point 0.6m behind the original machine-cut section, an abrupt change occurred in the stratigraphic sequence. It became evident that the probable stream deposits (Context 5) underlying the midden lay within a steep-sided palaeochannel cut through the underlying peat, the western edge of which, running on an approximate east–west orientation, was traced for a distance of 1.2m. The layer of dark peat (Context 4) and probably the midden itself, formed, or was deposited, in the top of this palaeochannel, which appears to be the same as the palaeochannel containing tufa gravel which overlies the shell midden identified in Site D. A thin band of redeposited tufa was also noted in the northern section of this machine-cut trench, suggesting that the palaeochannel continued. However, it began to peter out at a point about 14m to the north of the midden.

The point at which the monolith was taken lay beyond the channel, and the sequence here showed that the midden was stratified 0.2m from the surface of layers of peat, which continued for a depth of 0.35m below the midden, onto the surface of the underlying glacial drift. The onset of peat formation at this site has been dated to 4960±80 BP (CAR-1426; 3960–3630 cal BC).

20.4.4 Site D

This shell midden site is on the margins of the wetland area, at a point where the ground level was 5.35m OD. It was recorded in section in 1991 during pipe-trench digging. It was subsequently examined in more detail during 1992, in a trench 11.4m by 4.4m, between 0.7–1.2m from the pipe-trench (Fig 20.8–20.9; CD 20.7–20.8). The area available for excavation was limited by the presence of large trees and the pipe-trench. Topsoil and overburden was removed by machine to a depth of 0.65m, to just above the redeposited tufa gravel and clay layers (7, 22, and 23). The base of the trench was then cleaned by hand onto the redeposited tufa layer. Further excavation was limited, due to time constraints, to two strips 1m-wide, excavated down to the underlying drift deposits at a depth of about 1.15m from the modern ground surface, at about 4.2m OD.

The sequence (Fig 20.9–20.10) revealed by excavation was as follows. Above the Pleistocene drift, consisting of a yellowish-grey sandy clay, lay a thin, discontinuous layer of peaty sandy clay (Context 24), up to 0.06m thick, which formed a thin palaeosol on the surface of the drift, the surface of which sloped from 4.11m OD at the northern end of the trench to 4.37m at the southern end. The palaeosol, which entirely underlay the midden, contained fragments of charcoal, and occasional flint and chert fragments, none of which showed any evidence of being worked. Charcoal extracted from the layer has been dated to 5470±80 BP (CAR-1424; 4470–4050 cal BC).

The shell midden (Context 21) lay on top of the palaeosol, and in some places directly above the Pleistocene drift. It formed a layer between 20–200mm thick composed predominantly of brittle and often highly fragmented mussel shells with occasional shells of other marine and non-marine Mollusca. The full extent of the midden was not observed, but it measured 5m from north to south, and at least 5.5m along the contour from east to west taking into account the midden layer recorded in the adjacent pipe-trench. The upper surface of the midden was irregular and it had the appearance of being formed of a series of shallow heaps, or concentrations, petering out towards the margins. The location of occasional lithics and fragments of animal bone were recorded during excavation. Occasional scattered fragments of unworked, angular burnt stone of types found occurring naturally in the local drift, and some concentrations of charcoal were also noted, particularly in Squares 7 and 8 (see below), but there was no explicit evidence of *in situ* burning.

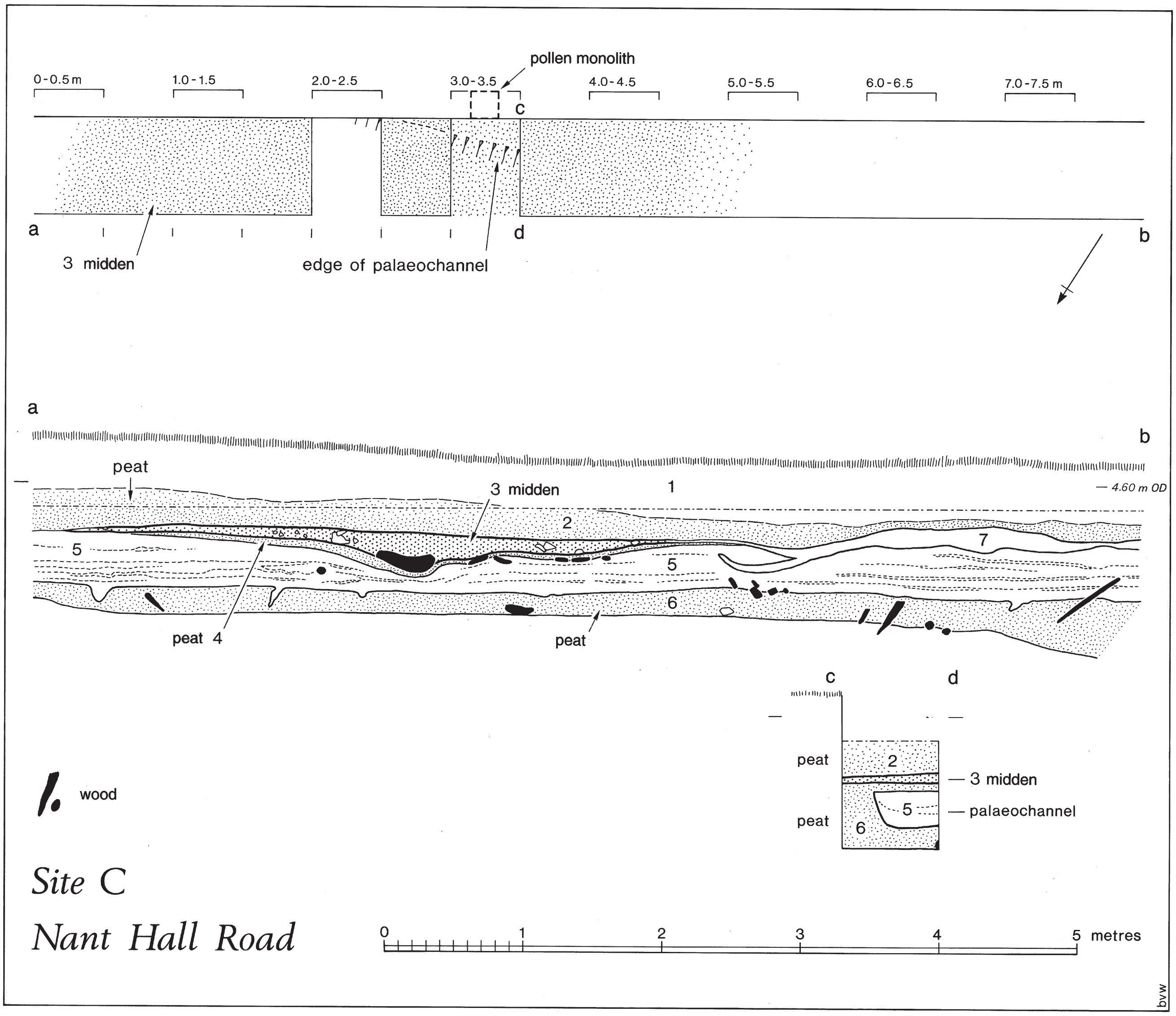


Figure 20.7 Plan and section of the sediment sequence at Site C, Nant Hall Road, Prestatyn, showing the location of the cockle shell midden (graphic Clwyd-Powys Archaeological Trust)

For the sampling of Mollusca, charcoal, lithics, and animal bone the two strips excavated across the midden in 1992 were subdivided into numbered 1m^2 boxes, which were further sub-divided into spits 50mm thick. There was no clear evidence of layering within the midden deposit, or evidence as to whether it represented one or more periods of deposition. Small numbers of lithic artefacts and animal bones were found in the midden. Four samples were recovered from each square, and where necessary each 50mm spit, one for marine mollusc identification and environmental study, and three for charcoal, lithics, and animal bones. The rest of the midden material was quantified by bucket volume and discarded. Charcoal derived from Squares 32 (lower) and 33 has been dated to 5270±80 BP (CAR-1423; 4330–3950 cal BC).

To the north of the midden was a thin, continuous layer of dark-brown peaty clay loam 30–80mm thick (Context 17), continuous with a layer 20–50mm thick (Context 19), which rose up and lay directly above the northern part of the midden. This layer was also sampled and a date of 4910±70 BP (CAR-1421; 3940–3520 cal BC) was obtained for wood from square 2. The shell midden was further overlain by a deposit of grey clay and redeposited tufa gravel, with an overall thickness of between 0.19m and 0.39m, with a fairly flattened upper surface sloping from 4.43m OD at the north to 4.65m at the south. In section it could be seen that this deposit was subdivided into three discontinuous layers (7, 23, and 22) comprised of bands of tufa gravel interleaved by thin laminations of waterlain grey clay. Augering suggests that these layers of tufa and clay were laid down in the same shallow palaeochannel as that identified in Site C, where it was 15–20m wide, which is probably the previously-noted channel running north from Bryn Newydd (Fig 20.2).

The palaeochannel deposits were overlain by a layer of peat (Context 6), 0.05–0.18m thick, which

Figure 20.8 General view of the excavation of Site D, Nant Hall Road, Prestatyn: scale 0.5m divisions (photo M Bell)

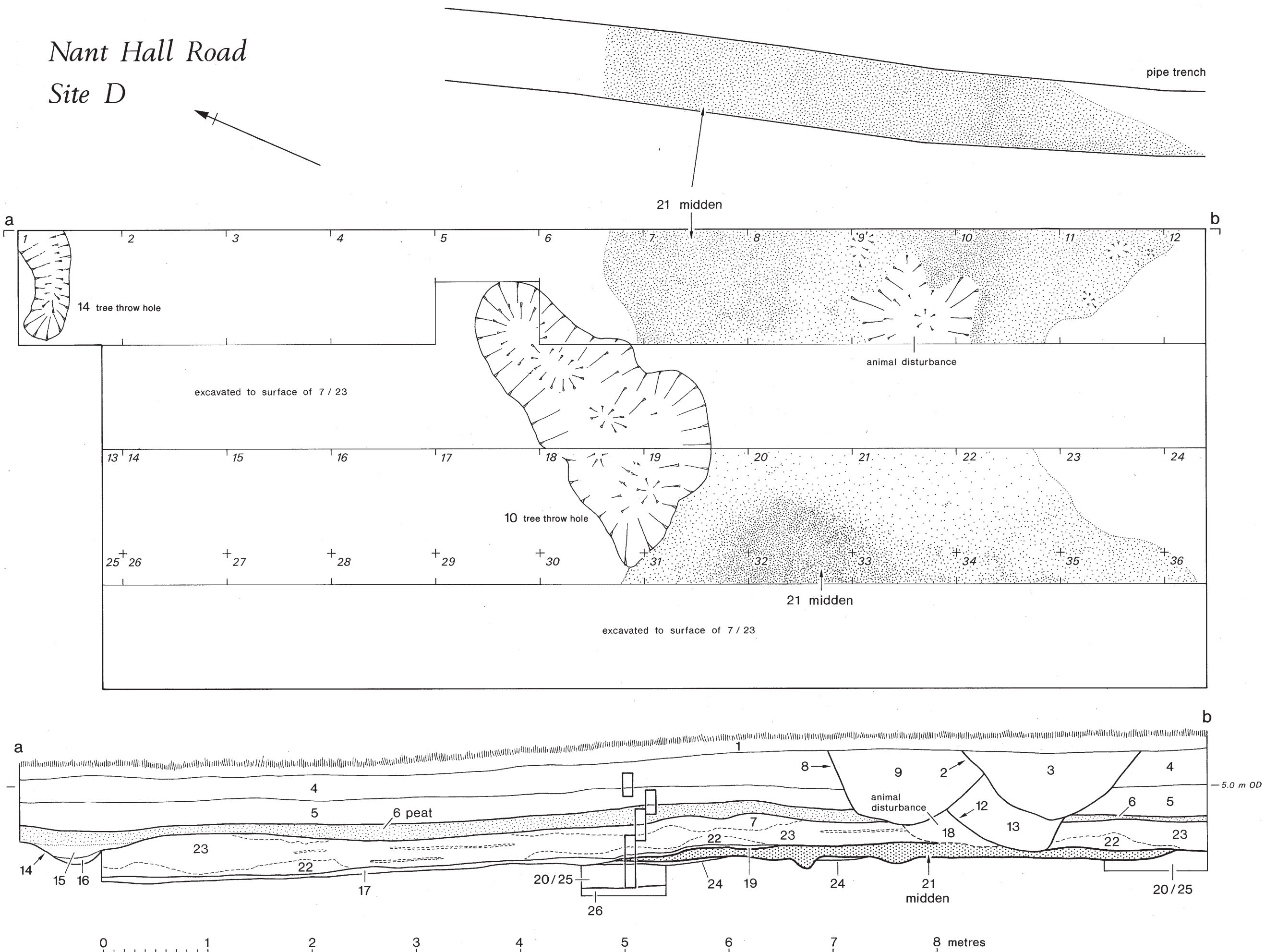


Figure 20.9 Plan and section of the excavations at Site D, Nant Hall Road, Prestatyn showing the location of the pollen monolith tins; the land mollusc samples were from the same location (graphic Clwyd-Powys Archaeological Trust)

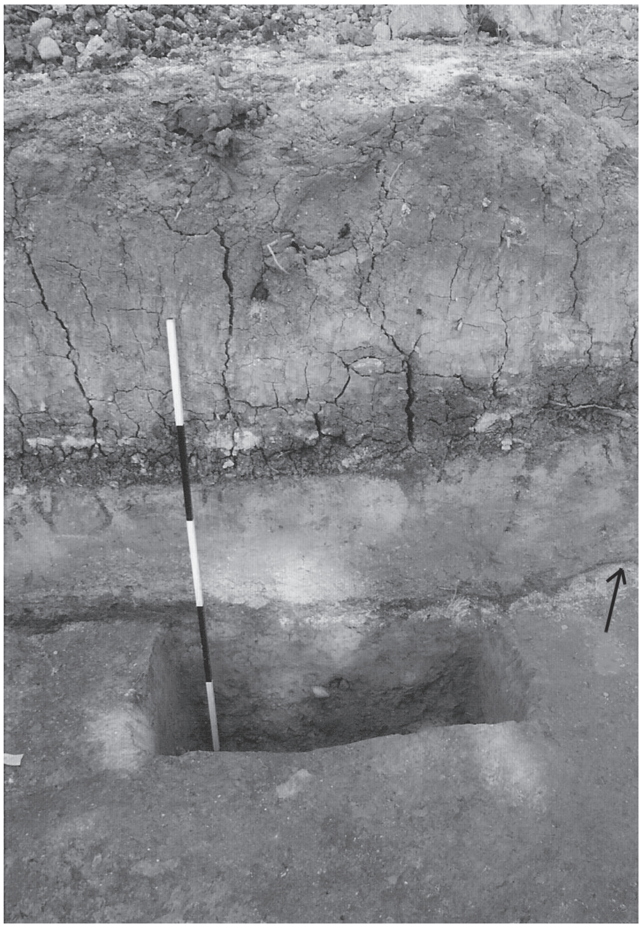


Figure 20.10 The profile sampled for pollen analysis and molluscs at Site D, Nant Hall Road, Prestatyn, midden arrowed: scale – 20cm divisions (photo M Bell)

gradually thickened to the south, probably the same peat layer as on Site C. Augering indicates a narrow tongue of peat (CD 20.4) extending southwards into the dryland area at this point, suggesting the infilling of the palaeochannel with peat. The peat layer also filled two irregular, elongated hollows (Contexts 10 and 14) cutting into the surface of the tufa and clay. These two features, orientated approximately north-east/south-west had profiles and stratification suggesting they were ancient tree throw holes. Fragments of wood from the fill (Context 11) at the base of Context 10 have been dated to 4330±70 BP (CAR-1419; 3250–2700 cal BC), and charcoal retrieved from the lower fill (Context 16) has been dated to 4210±70 BP (CAR-1418; 2930–2570 cal BC). Animal bones, a flint scraper and abundant minute fragments of lithic waste occurred in the lower fill (Context 16) of one of the tree throw holes (Context 14), suggesting the disposal of debris from knapping undertaken elsewhere. The peat was sealed beneath a layer of colluvial, grey gleyed clay with some tufa flecks (5), *c* 0.17m thick, which was in turn overlain by a layer of sandy-loam ploughsoil (4), *c* 0.15m thick and topsoil (1), *c* 0.2m thick.

20.4.5 Site E

This small shell midden was discovered by hand-augering at a point just beyond the margins of the wetland area where the ground level was 4.75m OD (Fig 20.4). Topsoil and ploughsoil were removed by machine over an area 4.2m by 2.6m to a depth of *c* 0.5m and the remainder of the trench excavated (CD 20.9–20.10) by hand down to the surface of the underlying Pleistocene drift which lay at a depth of *c* 4.11m OD, 0.64m below the modern surface. Sampling for the recovery of molluscs, lithics, charcoal and animal bone was based on numbered 1m^2 boxes.

The sequence revealed by excavation is illustrated in Figure 20.11. The underlying drift (Context 107) was yellowish-grey sandy clay, on the surface of which was a thin and patchy dark grey soil layer (Context 106) up to 20mm thick. The shell midden extended over an area of only 2m by 3m, in a layer between 10–50mm thick and like Site D predominantly consisted of highly fragmented mussel shells with occasional cockle and periwinkle shells. Two distinct layers were noted, a lower layer (Context 105), about 10–50mm thick, which covered a restricted area of 1.5m by 2.5m and comprised of 95% mussel shells with only a slight soil component, and an upper layer (Context 104), about 10–60mm thick, which covered most of the excavated area and was composed of 40% mussel shell in a dark-brown clay-loam matrix, probably representing post-depositional movement and mixing by natural agents. Charcoal, animal bone and stone fragments were recovered from both Context 104 and 105, but with no significant concentrations. Charcoal from Context 105 was dated 5530±80 BP (CAR-1420; 4550–4230 cal BC), and from Context 104, to 5110±80 BP (CAR-1422; 4250–3700 cal BC).

The midden was overlain by a layer of dark grey clay-loam (Context 103), 0.2m thick, containing scattered redeposited tufa and fragments of degraded sandstone, which was in turn overlain by 0.3m of colluvial, grey gleyed clay (Context 102), and topsoil (Context 100), about 0.2m thick.

20.4.6 Site F

Unexcavated shell midden represented by a concentration of marine molluscs in backfill of pipe-trench, and subsequently confirmed by hand-augering. It is just beyond the wetland area (Fig 20.4) at 4.10m OD on glacial drift. The shells were predominantly mussels, and it was less than 5m in diameter.

20.4.7 Site G

Unexcavated shell midden identified by augering (Fig 20.4). It was on yellowish-grey sandy clay drift at 3.88m OD, in a slight hollow. Augering suggests an elliptical shape, 3m by 1.5m. It comprised predominantly mussel fragments.

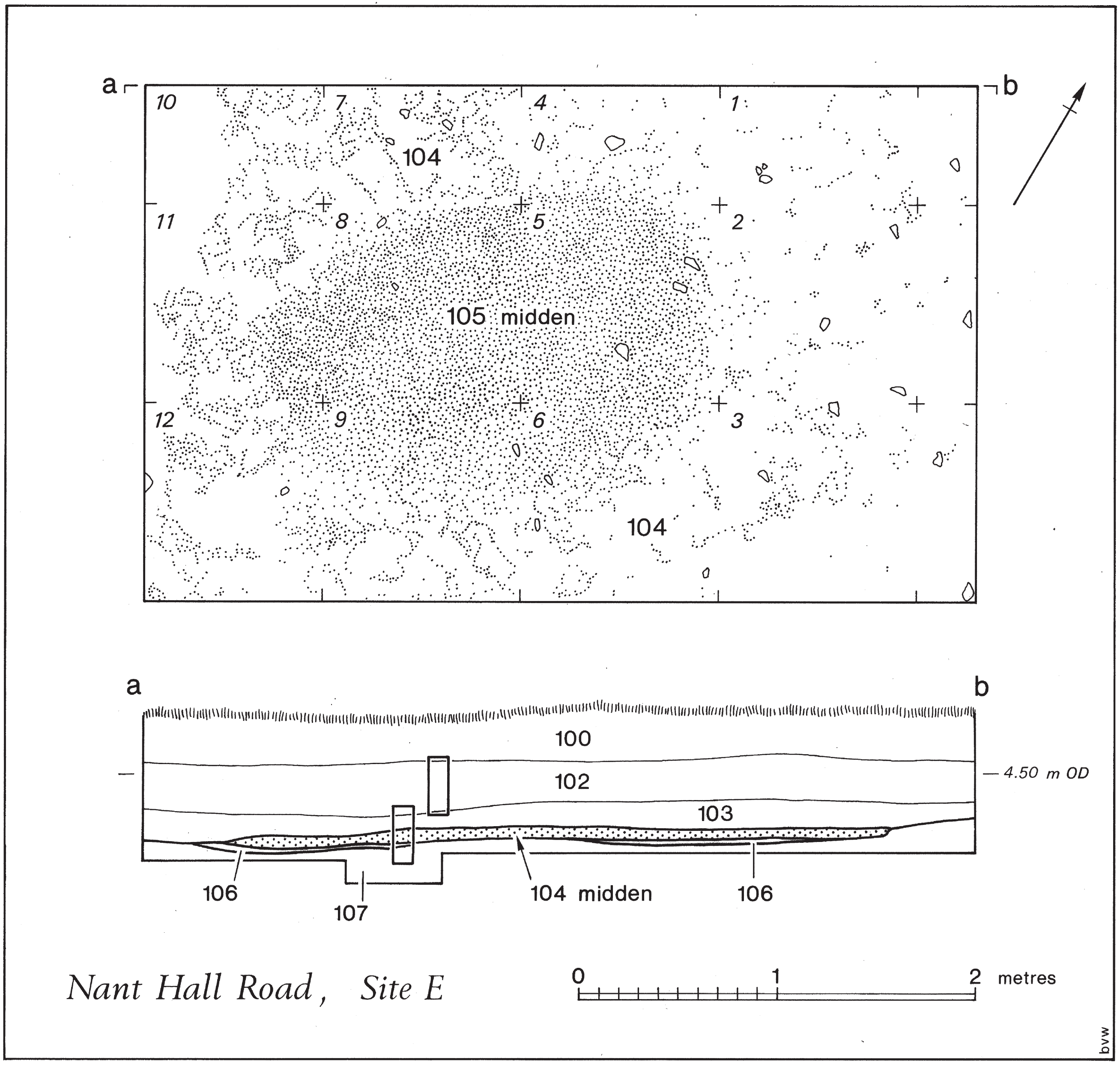


Figure 20.11 Site E, Nant Hall Road, Prestatyn, plan of midden and section showing the locations of the main environmental samples (graphic Clwyd-Powys Archaeological Trust)

20.4.8 Sites H1–9

Sites H1–9 were $1m^2$ hand-excavated test pits along the line of a proposed access road across the dryland (Fig 20.4. For further details see CD 20.11). The pits produced further evidence for a palaeochannel running from upslope in the Bryn Newydd area. Pit H3 revealed a colluvial layer above a palaeosol (Context 201), containing cockle and mussel shells, animal bone fragments, some charred cereal grains, and lithics, including two flint flakes. A radiocarbon date of 2850±70 BP (SWAN–14; 1260–840 cal BC) shows this activity occurred in the middle Bronze Age. Elsewhere, in Pits H4–9, the plough had cut down to the drift; there was redeposited tufa and some cockle shells in the plough soil with modern pottery, but the impression was that archaeological stratigraphy had in this area been largely obliterated.

20.5 Marine molluscs *by S Johnson and M Bell*

Molluscs were examined from six middens. Middens D, E, F, and G were predominantly comprised of mussels and were located just off the peat, while Middens C and B were comprised of cockles and were stratified within peat in the wetland (Fig 20.4). For details of the numbers of species present in each sample, see CD 20.12 and for the methodology see CD 20.13.

20.5.1 Mussel middens

Site D

This midden was situated on the wetland edge where wetland and terrestrial sediments interleaved. Analysis was done on upper and lower 5cm depth slices but these show almost identical species composition. The midden was overwhelmingly dominated by mussels (*Mytilus edulis*) with small numbers of common periwinkles (*Littorina littorea*) and cockles (*Cerastoderma edule*). Shells hand picked during the excavation also included oyster (*Ostrea edulis),* which was not represented in the sieved samples. Other infrequent species could have been collected accidentally with mussels attached to their byssus thread, or other resources of the seashore such as seaweed or driftwood, eg *Littorina* 'saxatalis' group and *Littorina obtusata,* some of which were tiny juveniles too small to eat. Six shells of *Macoma balthica* may have arrived in a similar way. The piddock family (Pholadidae) bore into wood and soft rock, so shells could have found their way onto the midden on driftwood etc. The barnacle fragments almost certainly arrived at the site attached to mussel shells.

Site E

Two distinct contexts were identified in this midden. A denser concentration of shell (Context 105) at the base was covered by a more diffuse shell scatter (Context 104). The assemblages from the two contexts are closely comparable (CD 20.12). Mussels overwhelmingly predominate with only small numbers of cockles, periwinkles and whelks and a single member of the Pholadidae. The only difference is 29 barnacle plates in the lower midden, probably collected attached to mussels.

Sites F and G

One small sample from F was analysed showing it was mainly composed of mussels (*Mytilus edulis*) with a few common periwinkles (*Littorina littorea*) and one cockle (*Cerastoderma edule*). No sample of G was collected, but it was noted that it was mainly mussels.

20.5.2 Cockle middens

Site C

This was predominantly a cockle (*Cerastoderma edule*) midden (CD 20.12). Some pairs of shells were found with the valves still joined and closed. 38% of the cockles were complete enough for measurement and these are plotted as a histogram in CD 20.14. The midden also contained some fragmentary mussels (*Mytilus edulis*) but no other shellfish.

Site B

Three 1kg samples of this midden were examined and almost all of the shells were cockles (*Cerastoderma edule*), the only exceptions were a few fragments of an unidentified bivalve. 47% of the shells were complete enough to measure and the size distribution is shown in CD 20.14.

Molluscs from Site H3

A small number of shells was found in a palaeosol in this test pit. The shells are of mussels (*Mytilus edulis*), cockles (*Cerastoderma edule*), common periwinkle (*Littorina littorea*), and cf banded wedge shell (*Donax vittaus*).

20.5.3 Discussion and comparison between middens

The radiocarbon-dating evidence (Fig 20.5) shows that the mussel middens on the dryland edge are earlier than the cockle middens stratified in peat. Mussels grow attached to a solid substrate, generally rocks, while cockles live in sandy and muddy sediments. Changing midden compositions could therefore reflect changing coastal ecology. A possible model is that before *c* 4000 cal BC there was a more exposed coast with some rocky areas, which after this date were covered by sediment accumulation. It is also possible that contrasting midden compositions could reflect changing social preference. The ethnographic work of Betty Meehan (1982) among the Anbarra of Australia shows that middens are not a random sample of what is available but a selection reflecting social preference. The two hypotheses of environmental change and social preference will be evaluated with reference to the wider environmental context in the conclusions.

Among the cockles there were some paired shells and others with holes. Such features are sometimes taken to indicate that assemblages, or part of them, were natural death accumulations, rather than the result of human selection. However, in this case human selection is evident from the overwhelming predominance of one species in each midden; measurements of shell size for Middens C and B (CD 20.14) which show they lack juveniles; the oval plan of the middens; and the presence of heat-fractured stones, charcoal, and lithic artefacts. Both the cockle middens were in peat, and there was no associated sand, or other minerogenic inputs, which could be associated with deposition during a storm surge. The mussel middens do contain small numbers of non-edible species, probably reflecting the greater co-occurrence of mussels and other species on rocks and in rock pools and the accidental gathering of other species attached to the byssus thread of mussels (Waselkov 1987; Wessen 1994).

CD 20.14 shows that cockles in Middens B and C were selected according to size above *c* 19mm. In her ethnographic study of Australian aboriginal midden-forming communities Meehan (1982, fig 31) records that the shellfish collected were mostly within a narrow size range which seems to have been achieved by hand selection. Both middens exhibit something approaching a normal bell-shaped distribution of size classes. However, comparison between the two middens shows that the mean size of cockles in Midden C (25mm) is larger than that in Midden B (22.5mm). Since the radiocarbon-dating evidence suggests that Midden C is earlier than B (Fig 20.5), it suggests a decrease in cockle size through time.

20.6 Growth lines and seasonality studies of cockles *by E T Fancourt*

20.6.1 Introduction

The study of shell growth lines as evidence of the lifecycle and palaeoseasonality of molluscs is known as sclerochronology. The technique has been most widely applied in America (Pusso 1991; Thompson 1975; Hall 1975). A wide range of studies are noted by Waselkov (1987) and Claassen (1998). Studies in Britain have concerned the oyster (Milner 2001) and the cockle *Cerastoderma edule* (Deith 1986). This study of the Prestatyn cockles is described more fully in Fancourt (1999).

Cockles are infaunal burrowing molluscs that live in sand and feed through siphons to the sea above (Carter 1980). The shells of *Cerastoderma edule* grow continuously throughout the life of the organism (House and Farrow 1968) with distinctive growth increments reflecting environmental changes within the lifecycle of the organism analogous to the way that treerings reflect changing environmental conditions in the life of a tree. Growth occurs along the surface of the shell situated next to the soft parts of the organism, called the inner layer (Craig and Hallam 1963). Cockle growth increments (Fig 20.12) are thought to be laid down tidally with 'dark' bands representing low tide (Whyte 1975). Micro-increments in the pattern of shell growth are caused by changes in the ratio of calcium carbonate to organic matter, with darker bands containing more organic material, conchiolin (Rhoads and Lutz 1980) apparently reflecting anaerobic respiration at low tide when the valves are closed and lighter calcium carbonate-rich bands reflecting aerobic respiration when the shell is open at high tide. A good correlation has been found between the number of tides which organisms have experienced and the number of growth increments (Rosenberg 1980).

Interruptions in shell growth are known as 'biochecks' (Rhodes and Lutz 1980) and may be caused by stochastic events such as storms, or predator attack, or more commonly by periodic events of which the most important is seasonal change related to temperature. This results in shell growth being retarded during the winter as the mantle withdraws (Romanek 1987) and in doing so a notch/groove is formed which is visible on the outside of the shell (Fig 20.12a). When the microstructure of the groove is examined in thin section it is apparent that the growth lines are so close together that they become indistinguishable. The winter groove does, however, form a distinct marker from which shell growth during the rest of the year may be measured (Deith 1983).

20.6.2 Methods, taphonomy, and diagenesis

Some 275 complete shells were selected from Midden C and 77 shells from Midden B and samples of modern cockles were collected from Ynyslas, Borth for comparison. One objective was to compare the growth increments of these prehistoric shells with those of modern cockles collected at known dates. The modern and archaeological shells were impregnated with Areldite resin and hardener to prevent shell fracture. They were then sectioned across the middle region of the shells from the umbo to the outer growing edge using a diamond cutter. Three stages of grinding followed using 75, 40, and 20μm diamond plate on a Buehler Metaserv Grinder-polisher which removed scratches on the shell section and facilitated viewing of the growth lines. Shells were then etched with 5% hydrochloric acid further enhancing the growth lines. The shells contained in resin blocks were examined under the binocular microscope. One modern shell and three archaeological examples were also coated in gold (two shells) or carbon (two shells) for examination under the Scanning Electron Microscope producing the images in Figure 20.12.

Analysis showed that a proportion of shells had holes which might relate to predation as more fully discussed on CD 20.15. It was discovered that the archaeological samples had been subject to patchy diagenic change, that is to say post-depositional chemical changes that had led to calcium carbonate recrystallisation in places. The effects of this are shown on Figure 20.12d and f. The result was that in none of the archaeological examples could individual growth lines be observed throughout the shell section. Many samples only showed small patches where the original growth lines were sufficiently distinct to be counted. Because of these diagenic changes, a modified procedure had to be applied to analysis of growth increments in the prehistoric shells, to count the growth increments in 1mm of growth in each countable shell. The age of the shell in which that growth took place was recorded, since it was anticipated that rates of growth would vary with age. The length of the shell was measured and the distance from the last winter notch. The relationship was determined between the age at death of the organism and shell length. This was done separately for the modern and archaeological samples and enabled the age/frequency composition of the two populations to be compared with one another and with von Bertalanffy (1938) growth curves for *Cerastoderma edule*. In this way the average number of lines for 1mm in each year of growth was established for both the archaeological and modern samples. Using the length from the last winter groove it was possible to arrive at an estimate of the number of lines (ie tides) within the last period of summer growth. The method is illustrated by an example from Midden C, Square 3/6, cockle 1. This was in its 5th year of life when collected. The length from the last winter line to the outside growing edge was 2.8mm. The average number of growth lines for 1mm of growth in the fifth year of life for the archaeologi-

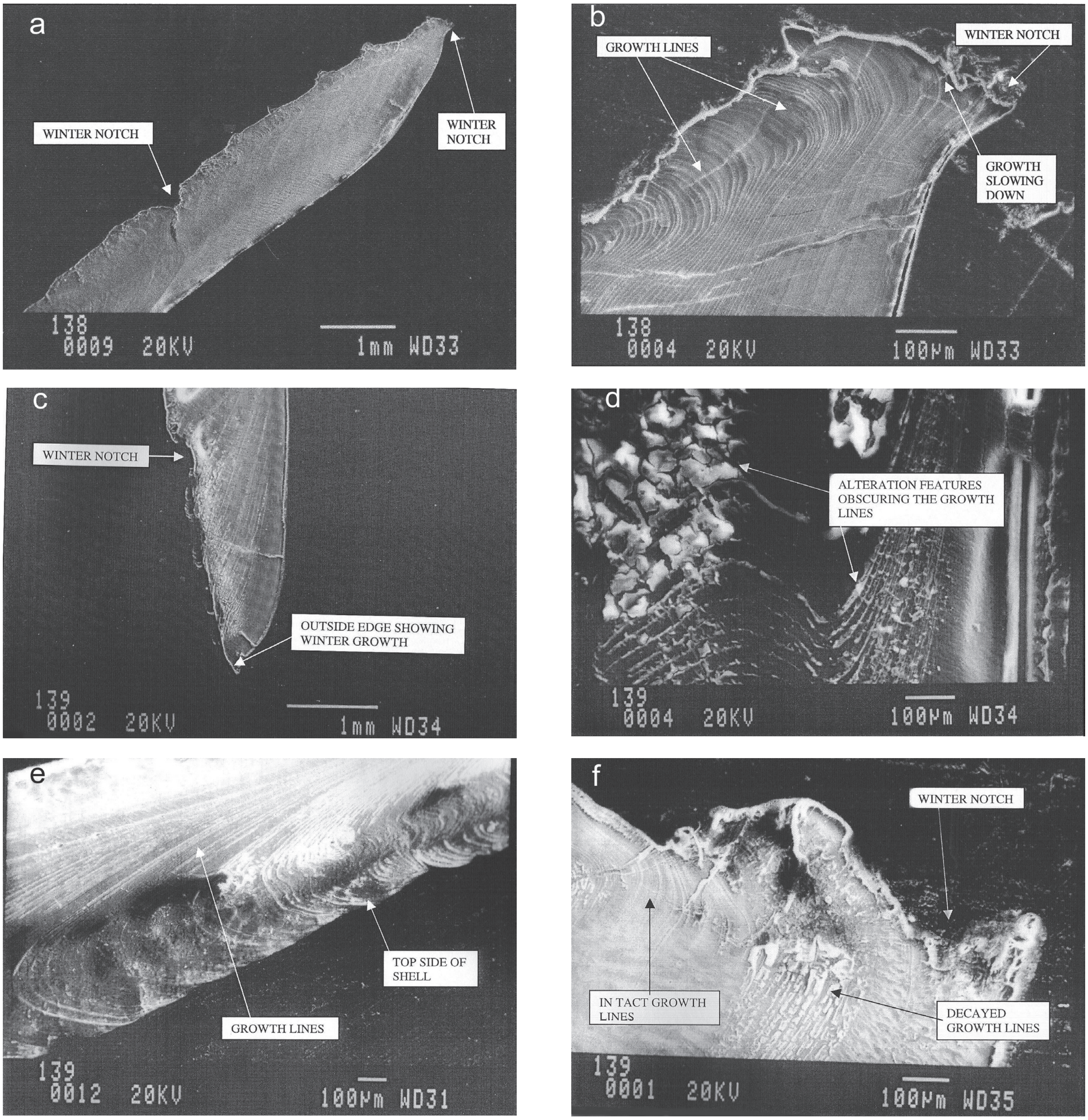


*Figure 20.12 Scanning Electron Micrographs of cockles (*Cerastoderma edule*) (a) Modern cockle with two winter notches, one at the end of growth (b) Modern cockle with growth lines, final slow growth and winter notch (c) Prehistoric cockle from Nant Hall Road, Site C (shell 7/14.1) showing two winter notches the last at the end of growth (d) Same shell as in 'c', showing growth lines and alteration features obscuring some lines (e) Prehistoric cockle from Nant Hall Road, Site B (shell 4/12a) showing growth lines, top side of shell lower (f) Prehistoric cockle from Nant Hall Road, Site B (shell 4/6.11a) showing growth lines, decayed growth lines and final winter notch (photos L Fancourt)*

cal samples is 34.4; multiplying the length (2.8mm) by the average number of lines (34.4) gives 96.3 tides, ie 48.16 days since the start of summer growth. In applying this modified procedure we need to keep in mind evidence that molluscan growth rates are not uniform (Claassen 1998), so the results may include a significant margin of error.

20.6.3 Comparative study of a modern cockle population from Borth

Nature conservation regulations prevented the collection of cockles at Prestatyn so the modern samples were collected at Ynyslas, Borth, in west Wales. Collection took place at mid-tide level on 9 March 1999,

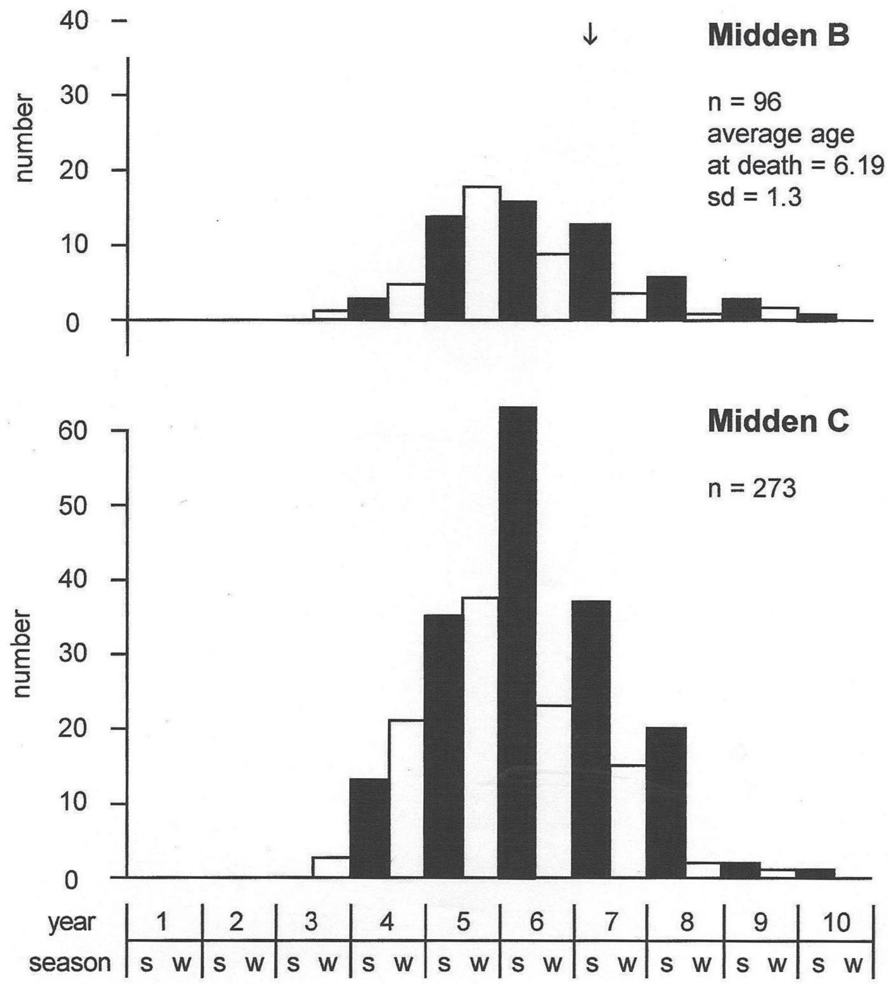


*Figure 20.13 The age of cockles (*Cerastoderma edule*) and those collected in summer and winter in Middens B and C at Nant Hall Road, Prestatyn (after data in Fancourt 1999, Appendix 7)*

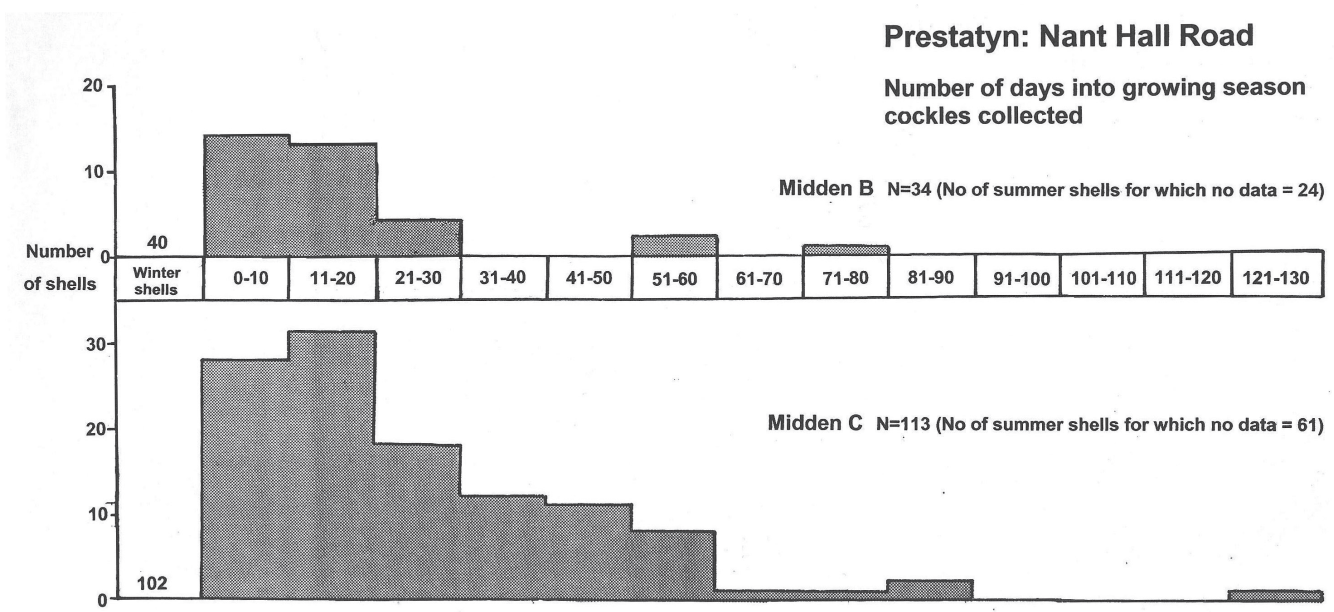


Figure 20.14 Number of days after the onset of summer growth represented by cockles in Middens B and C at Nant Hall Road, Prestatyn (after data in Fancourt 1999, Appendix 8)

when the expectation was that summer growth would not yet have commenced, and on 17 July 1999, when the expectation was that shells would display well-developed summer growth. 58 modern winter samples and 10 modern summer samples were selected for analysis.

The modern samples showed clear growth increments (Fig 20.12 a and b). Those collected on 9 March 1999, as expected, all displayed winter growth as their final increment. This is generally manifested as a notch on the outer edge of the shell which can be clearly seen as a macroband of darker material on the shell surface or as an indentation when viewed in cross section. The modern samples collected on 17 July 1999 displayed summer growth. The period since summer growth was established by counting all the lines from the last winter notch and dividing by 2 to convert tides to days.

The modern population showed rapid growth of the younger individuals (eg in years 2 and 3) and slower rates of growth with increasing age (eg 5 and older) (Fancourt 1999, fig 3.0). This accords with the von Bertalanffy (1938) model of cockle growth which indicates decreasing growth rates with age. For the modern population from Borth in the small sample of ten summer shells the number of growth lines ranged from 174–194 with an average of 185 and a standard deviation of 6 lines. Since there are two growth episodes/tides a day, this equates to 93±3 days after the beginning of summer growth. Since this modern sample was collected on 17 July 1999 then summer growth that year commenced *c* 15 April 1999.

20.6.4 Results

The distinction between winter and summer growth was generally visible in thin section, making it possible to separate shells collected in winter and summer. Figure 20.13 is a plot of the numbers of shells of each year's age distinguishing winter and summer collection in Middens B and C. Both middens comprised essentially older cockles in the age range 3 to 10 years, with a peak at years 5–6. In Midden C, 62% of the shells were collected in summer and 37% in winter. The sample from Midden B is smaller and the proportion collected in summer is 58% and in winter 41%.

Further inferences may be made concerning the timescale of shellfish collection by measuring the number of mm of shell which had grown since the last winter line. It is notable that the graph of these measurements is very similar to that obtained from the modern Borth sample which we know was collected in one day. Such a similar graphical pattern is unlikely to have existed if the shells were collected at different times throughout the summer. In that situation some of the young cockles might have had only a few days to grow and some of the older cockles the whole summer. The result would be a much less clear relationship between shell age and the amount of growth. A similarity between the Borth sample and prehistoric graphs would seem to hint that summer cockle gathering of the prehistoric assemblage had a restricted duration. Conservatively interpreted, given the small sample sizes involved and other uncertainties, this is more likely to be measured in days and weeks than months.

For shells collected in winter, the tiny winter growth increments are uncountable so it is not possible to be more precise about season of collection than 'winter'. For shells collected in summer, the number of growth lines can be counted as was done for the modern sample from Borth. It has already been noted, however, that in the archaeological sample the effects of diagenetic changes to the shells means that growth increments were only countable in places. In the better preserved shells the number of increments in 1mm of growth could be counted for different years in the cockle lifecycle. That showed the predicted pattern of slower growth rates with cockle age already described for the Borth sample (Fancourt 1999, figs 3.0, 3.1).

The average number of growth increments per mm was calculated for each year of growth. For each shell the length in mm since the last winter notch was multiplied by the average number of growth bands for shells of that age. The figure obtained was divided by 2, since there are two tides/growth cycles per day. In this way, an approximate calculation could be made of the number of days since the start of that summer's growth. The individual results for each shell are given in Fancourt (1999) and presented in summary graphical form as ten-day increments in Figure 20.14. Quite coarse ten-day increments have been selected for this graph because the averaging method employed does not allow the high precision which would have been possible if every growth band could have been counted.

In Midden B the number of shells examined was 96: of these 39 (41%) had been collected in winter. Fifty-seven of the shells had been collected in summer and for 34 of these (35%) it was possible to calculate the number of days into summer growth before they had been collected. Figure 20.14 indicates that all but three shells are likely to have been collected in the first 30 days after summer growth began.

Analysis of the Borth sample has shown that in 1999 cockles commenced summer growth *c* 15 April 1999. Deith (1983) established the commencement of growth in Scotland on April 22±10 days. What we do not know is whether the years on which these two calculations were based were typical, or atypical, for cockle growth. Claassen (1998) notes that there can be significant differences in the onset of shell growth from year to year, exact date varying according to temperature and other climatic conditions in a given year. The middens date to the end of the climatic optimum when mean temperatures were *c* 2°C warmer than at present and there is evidence for warmer summers in Europe (Bell and Walker 2005, 89) so at that time the cockle growth season may have begun earlier. However, it is not possible to quantify this, not least because it depends on unknown conditions specific to one year. As a working hypothesis it will be taken that cockle growth at the time of Midden B commenced at about the same date as at Borth in 1999. Nearly all summer-collected shells in Midden B were collected in the first 30 days of growth which indicates collection between about mid-April and mid-May. It may be prudent to allow perhaps a month on either side, bearing in mind the two major uncertainties involved: the first concerning the onset date for growth and the second the problems relating to calculations based on average growth rates over 1mm.

A larger number of shells (273) was examined from Midden C; of these 102 (37%) had been collected in winter. There were 61 shells (22%) which had been collected in summer but there was not sufficient preserved area of growth rings to calculate the average growth in 1mm. The number of shells which had been collected in summer for which the number of days since the onset of summer growth could be calculated was 113 (41%). As Figure 20.14 shows, the collection of these extended over about 60 days, twice the period represented by Midden B. Taking the date for the onset of cockle growth at Borth in 1999 this would give mid-April to mid-June, again plus or minus perhaps a month, but certainly in the first half of summer. Five shells are estimated to have been collected beyond about 2 months growth and one of these had about 130 days growth and might therefore have been collected in the second half of August.

20.6.5 Discussion and conclusions

Within the constraints imposed by diagenesis and sample size, this study indicated that cockles in both middens were mainly collected in the second half of spring and early summer with a slightly smaller proportion of shells collected in winter. The main period of cockle collection at Prestatyn corresponds to the period of *C edule* spawning in late spring and early summer when we know from modern populations that the cockles are at their fattest and have the highest calorific value. It is not clear from the cockles alone whether the winter and spring collections represent one continuous period of collection, or whether there were separate periods of winter and spring activity.

20.7 Land molluscs *by M Bell and S Johnson*

The most detailed investigation was of a column of samples through the later Holocene sequence, including the midden at Site D. In addition, spot samples were analysed from the middens at E, C, and B and sediments with shells at Pit H3. The results from this study can be compared with an earlier study by McMillan (1947) who looked at two samples of tufa from Bryn Newydd, Prestatyn about 600m south-east of the present study site. Parts of that tufa overlie the earlier Mesolithic site (Fig 20.3). The species list and the number of shells from this earlier work are small and all the species reported have also been found in the present study. The methods of mollusc analysis are those described by Evans (1972). Molluscs are attributed to ecological groups: shade-loving, catholic and open country as defined by Evans (1972), amended by observations in Kerney (1999), and wetland groups following Sparks (1961).

20.7.1 Site D

A column of fifteen samples was taken from the east section of Site D including the mussel midden and immediately adjacent to the pollen column to facilitate comparison (Fig 20.9–10). A 1kg sample was analysed from each level except 99–101cm where only 0.5kg was available. Mollusc numbers varied: they were abundant in the tufa layers, but there were very small numbers in the peats and none in the two samples below the midden. The sample taken from the midden contained only 55 shells, therefore 1kg of midden material was analysed from the bulk midden sample closest to the sample column. This produced larger numbers and has been represented on the mollusc diagram. The results of mollusc analysis are presented in Figure 20.15 with tabular results in CD 20.16.

The sample from the midden (Context 21) contained 231 shells. The main species are *Discus rotundatus* and *Carychium tridentatum* with a range of other species of shade-loving ecological preferences, which make up 77% of the assemblage. Species indicative of open conditions are minimally represented (5% of assemblage) by 9 examples of *Vallonia costata*, which can occur in woodland and 1 *Vertigo pygmaea*. Significantly there are also very low numbers (4%) of species with catholic ecological preferences which might be expected to have been larger had there been a more open area round the midden within a largely wooded landscape. In this context, the occurrence of *Ashfordia granulata* (9%) is notable. Evans (1972, 178) records this species (under the name *Monacha granulata*) as seldom found in the archaeological record. It was, however, recorded by Preece (1980) in tufa at Blashenwell, Dorset, and it may be that tufas provide suitable contexts for the preservation of this poorly calcified species. Kerney (1999) describes it as rare in woodland and more common in wet grassland. However, the associated assemblage in this case indicates that it was living in a largely wooded environment. Marshland species are present in small numbers: *Carychium minimum*, *Zonitoides nitidus*, *Lymnaea truncatula,* and *Succinia*. Species classified as freshwater make up only 2% of the assemblage, each is represented by just one or two individuals and they are slum species of water bodies subject to drying out. The only exception is a single shell of *Ancylus fluviatalis* which is found in moving water.

The peaty clay which overlays the midden (Context 17) is interpreted as a soil which developed over the midden in one to two centuries after its abandonment. It is dated 4910±70 BP (CAR-1421; 3940–3520 cal BC). The molluscan assemblage is closely comparable to that from the midden. The proportion of woodland species is lower at 56% but the difference is due to a higher proportion of marsh species (28%), confirming the encroachment of wetland onto the midden which the peaty nature of the Old Land Surface suggests.

The tufa marl layers (Contexts 7, 22, and 23) from 69–99cm produced an essentially uniform assemblage with between 500–800 shells in a sample. The assemblage is basically similar to the underlying samples with the main species being *Carychium* and *Discus rotundatus*, the latter at about half the percentage abundance of the underlying samples. This assemblage includes species which often occur in mid-Holocene woodland, or marsh contexts throughout Britain, but which have subsequently become much more restricted in their distributions. These include *Spermodea lamellata*, today regarded as a species of old deciduous woodland – it occurs locally on sites in northern Britain and the Atlantic facade with Welsh occurrences in Snowdonia and the west coast. Today it is only found at four sites in the English lowland zone where once it was widespread (Kerney 1999, 111). *Leiostyla anglica,* recorded both here and by McMillan (1947) has a similar Atlantic distribution. Evans (1972, 151) describes it as strongly anthropophobic. Boycott (1934) describes it in trickles of water in woods, which seems a good description of the inferred environment at this stage. Another species intolerant of human disturbance, which has undergone a reduction of its range over the Holocene, is *Vertigo substriata*, a species of moist habitats (Kerney 1999, 93).

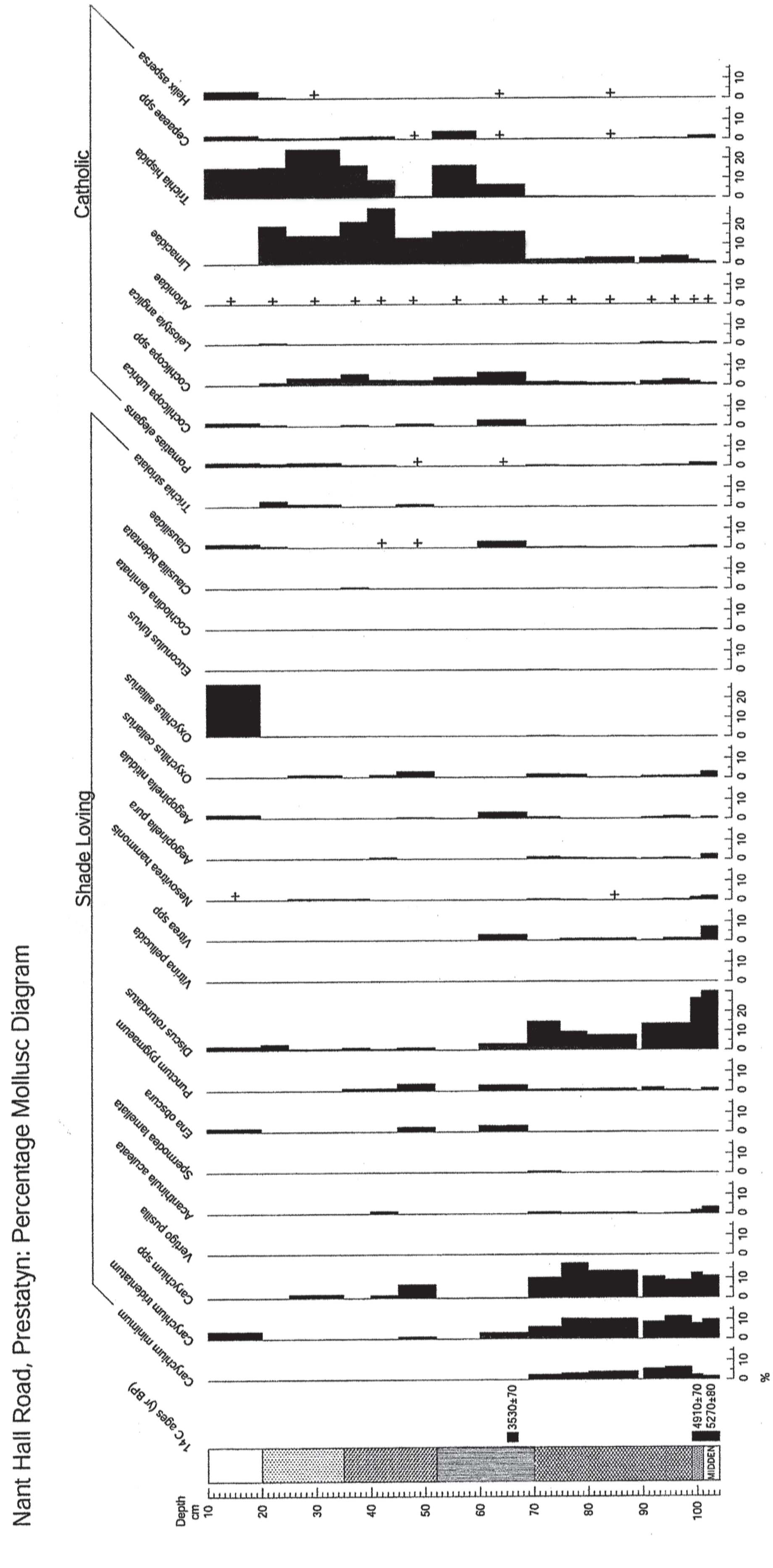
As with the underlying samples, possible indicators of more open conditions are *Ashfordia granulata* and a steady increase in *Vallonia costata* through this layer. The implication that the woodland was becoming more open towards the top of the tufa marl is supported by the appearance of *Vallonia excentrica*, an obligatory grassland species (Preece and Bridgland 1998). *Vertigo pusilla* also occurs in the same levels and in McMillan's (1947) assemblage – whilst a species of shady conditions, it is not found today in dense woodland. This is another species the distribution of which has declined markedly through the Holocene (Kerney 1999, 91).

The sediments forming the tufa marl comprised lenses of tufa gravel and marl separated by clay lenses. The field interpretation was that these filled a palaeochannel. However, the molluscan analysis does not suggest continuously flowing water in the sediments investigated. Freshwater species are mainly represented by *Pisidium* sp. – these and the other freshwater species are largely those of slum conditions: small water bodies subject to drying. The only exceptions are two shells of *Ancylus fluviatalis*, which is found in flowing water. Marsh species are well represented by *Lymnaea truncatula*, *Carychium tridentatum,* and *Succinea/Oxyloma*. The sediments at Site D are not a pure tufa but contain lenses of clay. Perhaps this was a marshy hollow within woodland, a site marginal to the main area of tufa deposition over which tufa depositing water periodically and temporarily extended. A single shell of the brackish water species *Leucophyta bidentata* might indicate occasional marine input.

In the peat layer (Context 6), at 52–70cm, the base of which is dated 3530±70 BP (CAR-1486; 2040–1680 cal BC), mollusc numbers were very low, just 20–30 per sample. There are individual shells of shade-loving species in the lower sample but these are absent in the upper sample when most of the species are those of catholic ecological preferences and open conditions, particularly the Vallonias, *Trichia hispida* and the Limacidae with one or two marshland species. This, together with evidence discussed below from the overlying layers, indicates that the landscape was largely open during the period of peat formation.

Overlying the peat is clay (Context 5) with tufa fragments (35–52cm) which gradually grades upwards into loam and topsoil. Though very different sediments, they produced essentially similiar molluscan assemblages and will be considered together. Some of the previously abundant species, which are generally regarded as shade-loving, have by this time declined. The predominant species are the Vallonias, *Trichia hispida* and the Limacidae. *Ashfordia granulata* declines where the clay with tufa gives way to loam. The topsoil sample shows an increase in species of more shady conditions, particularly *Oxychilus alliarius,* which might relate to a hedge which crossed the site at about this point. That may have been long-standing since it followed the wetland-dryland edge. The only consistently present wetland species are *Succinea / Oxyloma* and *Lymnaea truncatula* which are marsh species tolerant of drying. The occurrence of *Vertigo angustior* is of particular interest, it is characteristic of marshy grassland, which accords with the inferred conditions. Although this species was extensively distributed in the earlier Holocene, today it is very rare (Kerney 1999,101). McMillan (1947) records a previous record from the Prestatyn tufa.

The mollusc assemblage indicates that the clay with tufa (Context 5, 52cm and above) was laid down in a largely open landscape. Since tufa deposition occurred most widely in damp woodland in the first half of the Holocene, it might be inferred that this tufa-clay is eroded (eg by cultivation) from earlier deposits upslope. However, there is little sign of tufa clasts (CD 20.8) and the molluscan assemblages are quite different, suggesting little reworking. This would seem to imply that some deposition of tufa continued into the period of open landscape.


Nant Hall Road, Prestatyn: Percentage Mollusc Diagram
Shade Loving
Catholic
Depth cm
14C ages (yr BP)
3530±70
4910±70
5270±80
MIDDEN
Carychium minimum
Carychium tridentatum
Carychium spp
Vertigo pusilla
Acanthinula aculeata
Spermodea lamellata
Ena obscura
Punctum pygmaeum
Discus rotundatus
Vitrina pellucida
Vitrea spp
Nesovitrea hammonis
Aegopinella pura
Aegopinella nitidula
Oxychilus cellarius
Oxychilus alliarius
Euconulus fulvus
Cochlodina laminata
Clausilia bidentata
Clausiliidae
Trichia striolata
Pomatias elegans
Cochlicopa lubrica
Cochlicopa spp
Leiostyla anglica
Arionidae
Limacidae
Trichia hispida
Cepaea spp
Helix aspersa
%

(*cont.*)

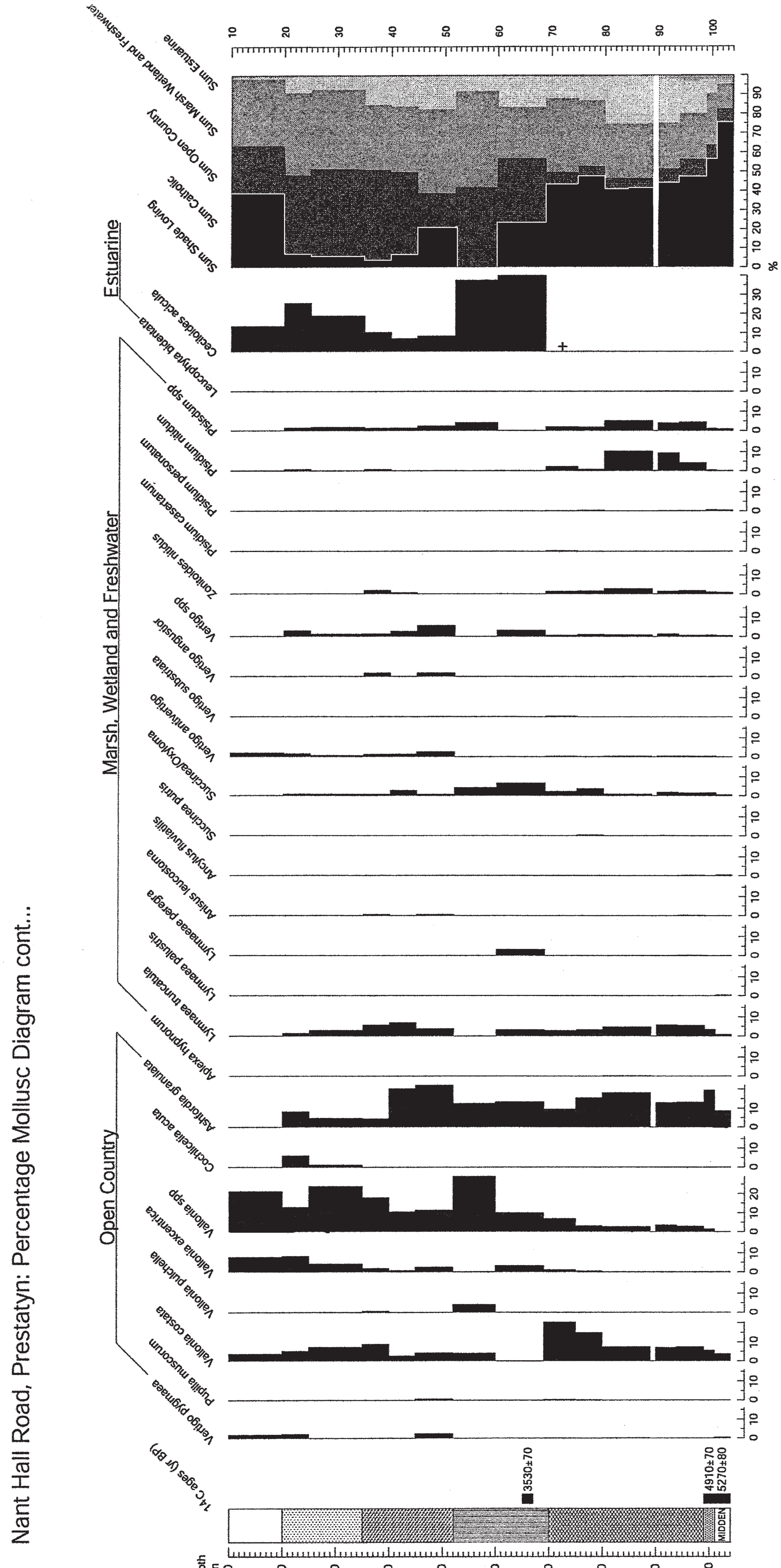


Figure 20.15 Land mollusc sequence at Site D, Nant Hall Road, Prestatyn (graphic A Brown)

20.7.2 Site E

Two samples were analysed from this mussel midden (CD 20.16): one from the denser, undisturbed basal part of the midden (Context 105, dated 5530±80 BP – CAR-1420; 4550–4230 cal BC) the other from the upper, possibly mixed part of the midden (Context 104, 5110±80 BP – CAR-1422; 4250–3700 cal BC). The midden itself (Context 105) contained a small assemblage of 57 shells. Species of shady conditions predominate, especially *Discus rotundatus* and *Carychium tridentatum*. With these, however, occur *Vallonia costata,* which can tolerate some shade but is generally found in more open conditions. In a generally wooded environment, it may be that some opening up of the vegetation occurred at the time of the midden providing suitable conditions for *Vallonia costata*, *Trichia hispida,* and *Punctum pygmaeum* – all of which occur in low numbers in woodland but are among the first to expand with clearance. The overlying, possibly mixed, midden (Context 104) has a larger assemblage of 103 shells with a lower proportion of the woodland taxa than in the underlying sample and an increased proportion of *Vallonia costata (*50%). The appearance of *Ashfordia granulata* also indicates more open areas. Thus, slight traces of clearing at the time of the midden seem to have expanded by the time of this overlying sample.

20.7.3 Site C

This cockle midden was within the wetland peat and is dated 4890±80 BP (CAR-1355; 3950–3500 cal BC). A sequence of samples through the midden from the monolith used for pollen analysis did not contain any land molluscs. However, two samples of the midden were also analysed (CD 20.16). Sample 14/14 contained 659 shells. The environment seems to have been predominantly shaded by trees or scrub as indicated by the combination of *Carychium tridentatum* and *Discus rotundatus*. Shade-loving species make up 38% of the assemblage. Evidence for woodland is strengthened by the presence of treeroots immediately below the midden (Fig 20.7). Species indicative of open conditions are poorly represented comprising 6%, mostly *Vallonia costata* (5%), however, alone among the Vallonias this species can occur up to this level of abundance in closed woodland (Evans 1972, 157). The abundance of *Ashfordia granulata* could, however, support the existence of damp grassy patches in a mainly shaded landscape. Species tolerant of marshy conditions make up 36% of the assemblage and there is in addition 12% of freshwater species; these are, however, species that can live in ditches or pools subject to periodic drying. The only exceptions, indicative of running water, are a couple of *Pisidium nitidum*. Clearly, the earlier stream channel on Site C, with its tufa fill, by this time no longer carried flowing water and was a marshy channel with wet pools. A second sample (3/6) from the midden contained a tiny assemblage of fifteen shells and the most that can be said about this is that it is of comparable composition to Sample 14/14.

20.7.4 Site B

Two samples were examined from this cockle midden dated 4700±70 BP (CAR-1356; 3640–3360 cal BC) which was stratified within peat; they produced closely comparable assemblages (CD 20.16). Both are dominated by marsh species and those of the freshwater slum (ie stagnant) group of which *Zonitoides nitidus*, *Lymnaea truncatula, Pisidium obtusale,* and *Pisidium casertanum* predominate. Also present are *Ashfordia granulata* and *Carychium minimum,* which are found in wet grassy and marsh areas. Woodland species such as *Discus rotundatus* only make up about 15% of both samples and some of these, such as *Carychium tridentatum*, are also found in long grassland. The site of Midden B had wet pools probably subject to drying with only occasional moving water. It seems to have been grassy with only limited tree or scrub cover.

20.7.5 Site H3

This is the furthest from the coast of the sites investigated (Fig 20.4), not so much a clearly defined midden as an Old Land Surface with evidence of settlement including marine molluscs, particularly mussels. Activity here is much later than the other sites, dating to the Bronze Age (2850±70 BP – Swan–14; 1260–840 cal BC). The land molluscs (CD 20.16) also contrast with the earlier middens, species with a preference for shaded woodland conditions are few (9%). The environment was favourable both to slugs (Limacidae) and the Vallonias including the grassland species *Vallonia excentrica*. Species of open conditions comprise 43% of the assemblage. Damp, slightly marshy grassland is also indicated by *Ashfordia granulata* occurring with smaller numbers of other marsh species making up in total 12% of the assemblage including *Vertigo antivertigo* and *Vertigo angustior.* None of these are indicative of moving water so by this time the palaeochannel from Bryn Newydd was no more than a marshy hollow in a grassy pastoral landscape.

20.7.6 Conclusions

The deposits on Site D that contain tufa include very few species indicative of flowing water. This is characteristic of many tufas which contain mollusc assemblages indicative of shaded marshy woodland with small pools and trickles of running water (Evans 1972, 299). Assemblages similar to those at Prestatyn are found in tufas at Holywell

Combe, Kent (Preece and Bridgland 1998) and Sidlings Copse, Oxfordshire (Preece and Day 1994). The middens appear to have been just back from the shore without direct marine influence. Both the earlier mussel middens and the later cockle middens were in an essentially wooded terrestrial landscape. Interpreting the nature of this environment is made more difficult by the fact that certain species, such as *Leostyla anglica*, which are only found in woodland in much of Britain can occur in open conditions in the more humid oceanic areas in the west (Kerney 1999). There is evidence of this from Martin Willing's (pers comm) analyses of tufa sites in Western Britain. However, at Prestatyn there are only hints of small-scale openings in the woodland at the time of Middens E and C and possibly D. That evidence rests mainly on interpretation of the occurrence of two species. *Vallonia costata* is more common in open environments but because it also occurs in low proportions in woodland it can expand when small clearings appear (Evans 1993) as it did in a tufa sequence of Mesolithic date at Blashenwell, Dorset (Preece 1980). Interestingly McMillan's (1947) small assemblage from the Bryn Newydd, Prestatyn tufa includes 17% of *Vallonia costata,* which is a higher proportion than normally attained in full woodland (Evans 1972, 157). The second species is *Ashfordia granulata,* which is recorded as rare in woods (Kerney 1999) but abundant here. These two pieces of evidence suggest the possibility of small-scale openings within the woodland, but we will return to this question in the light of the other sources of environmental evidence in the conclusions (Chapter 20.16.3). There is clearer evidence for opening within the woodland at the time of the upper sample from Midden E. The sequence from Site D shows that the main clearance of this landscape took place in the middle Bronze Age. The clay and tufa deposits at 35–52cm produced very similar molluscan assemblages to that from Site H3, in that case dated to the late Bronze Age. Evidence has been noted on Site D that small-scale tufa deposition may have continued after the main clearance.

The tufa and midden layers have molluscan assemblages characteristic of Kerney's (1977) mollusc assemblage Zone d, although one of the three characteristic species *Acicula fusca* is absent. The assemblages reported here have a number of similarities to that recorded by McMillan (1947) from the Bryn Newydd tufa as noted above. Her assemblage does, however, lack all the species indicative of Zone d, which could indicate that it is significantly earlier than the present assemblages since Zone d began *c* 7600 radiocarbon years BP (Preece and Bridgland 1998). However, McMillan's assemblage is tiny (63 shells) so this cannot be asserted with confidence. On Site D, the Roman introduction of *Helix aspersa* is present down to 25cm but there were also fragments much lower, which are likely to be intrusive, perhaps down drying cracks which are apparent on the photographs (Fig 20.10). Also present above 25cm is *Cochlicella acuta* which has an almost entirely coastal British distribution (Kerney 1999, 186), apparently appearing on some sites in later prehistory, for instance during the late Bronze Age at Brean Down (Bell and Johnson 1990); elsewhere, as here, it barely extends below the modern topsoil.

20.8 Pollen analysis by *B Brayshay and A E Caseldine*

This investigation provides a record of the environmental changes, including evidence for possible human activity, during the period shortly before, contemporary with, and postdating the deposition of the middens at Prestatyn. The study complements previous palynological studies in the coastal area of lowland north-east Wales concerned with vegetation succession, for example at Ddol (Preece and Turner 1990) in the coastal hinterland, and studies primarily concerned with sea-level change, including pollen, diatom, and lithostratigraphic studies (Prince 1988; Bedlington 1994). Pollen analysis was carried out on three profiles from Nant Hall Road. These included a profile from the deepest part of the wetland deposit (Site A) which was located in the stratigraphic survey, a profile from a cockle midden (Site C) and a profile from a mussel midden (Site D). For notes on the methodology employed see CD 20.17.

20.8.1 Site A

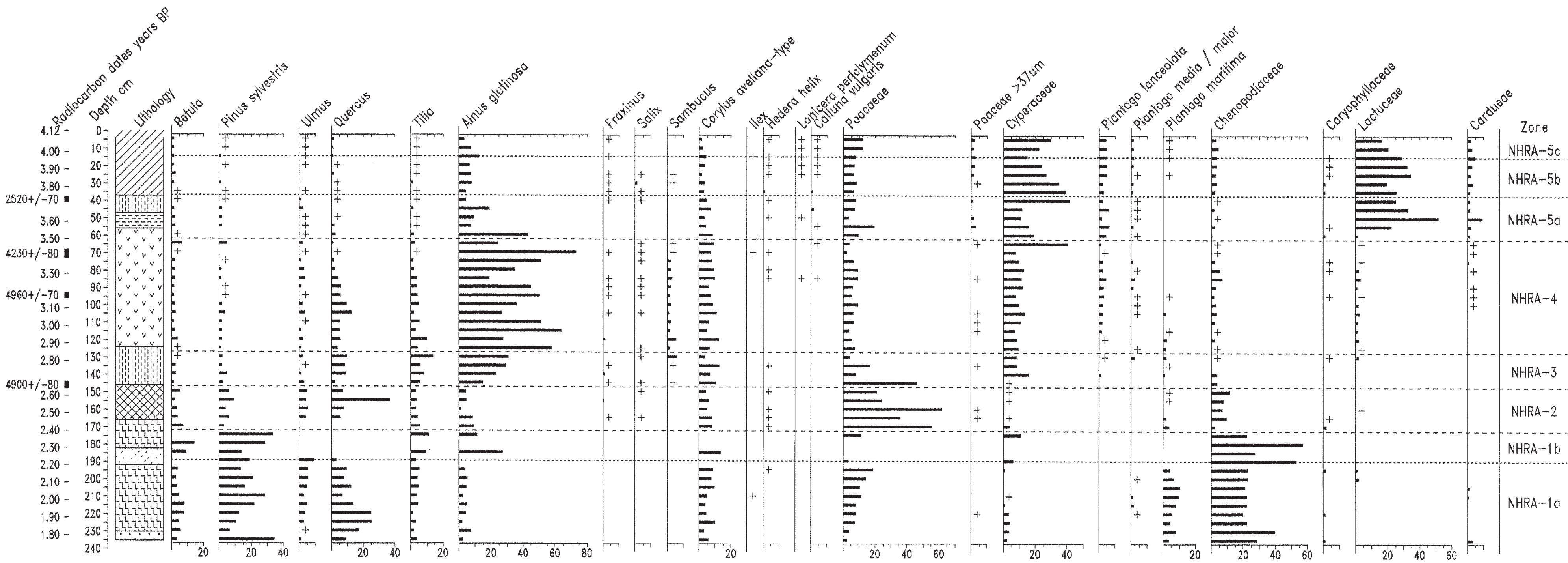
The pollen data from Site A (Fig 20.16) are divided into five local pollen assemblage zones compared with the sediment lithology on CD 20.18.

Early/mid-Holocene estuarine and saltmarsh/coastal fringe vegetation

The pollen spectra from NHRA-1 indicate that the basal blue-grey clays which underlie the fen peat deposits probably accumulated in a marine or estuarine environment and represent a period of positive sea-level tendency. High frequencies of Chenopodiaceae and *Plantago maritima* suggest the local presence of saltmarsh and/or coastal fringe vegetation. Chenopodiaceae pollen cannot be differentiated to species level but may reflect a coastal marsh community, perhaps with *Salicornia* or *Atriplex hastata* as found on coastal clay substrates (Adam 1981; Rodwell 2000).

The arboreal component of the pollen assemblage indicates the local presence of *Quercus*-dominated woodland, possibly occupying the better drained hill slopes of the limestone escarpment. *Tilia, Betula, Ulmus,* and *Corylus* are recorded in low frequencies but *Tilia* and *Ulmus* may be under-represented and have formed significant local populations at this time. The status of *Pinus* in the local vegetation at this time is difficult to assess as pollen frequencies fluctuate considerably throughout the zone (falling from *c* 35% TLP in the basal sample to 8% TLP

Prestatyn Site A



(cont.)

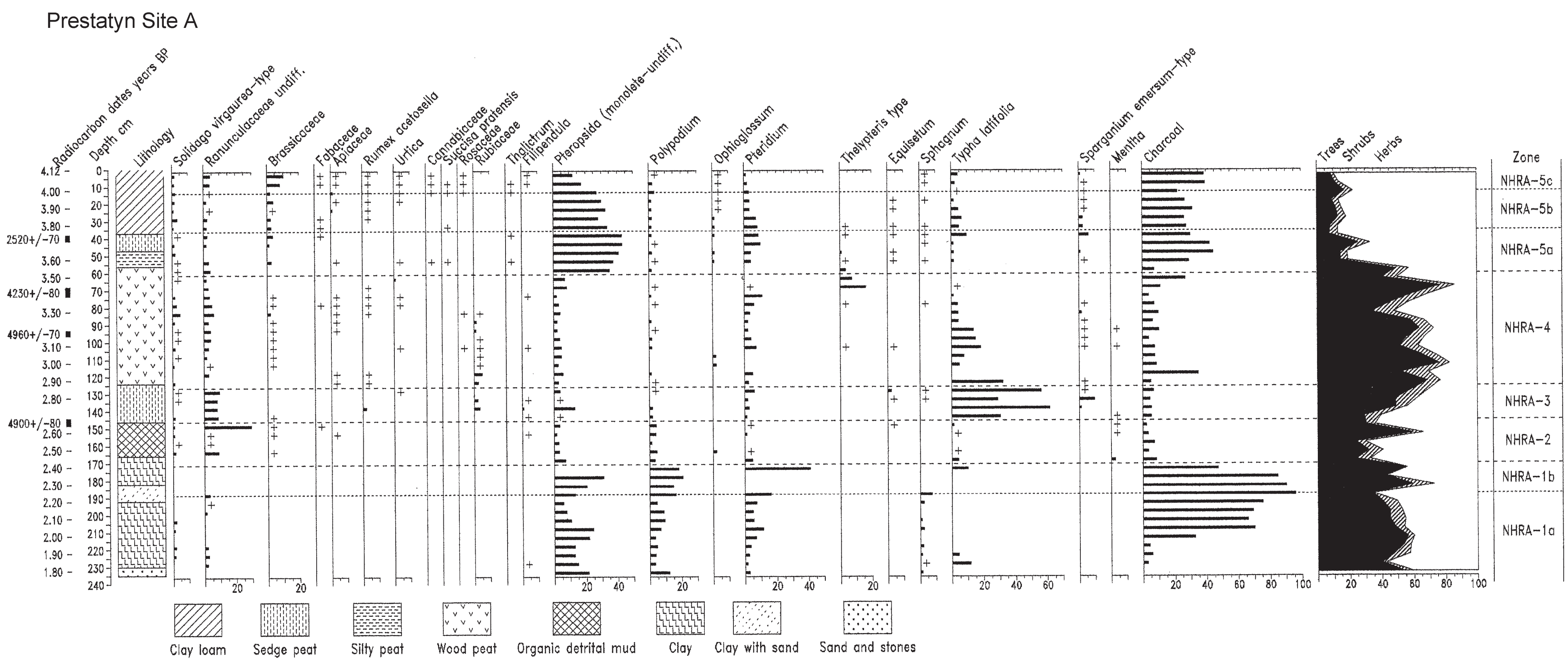


Figure 20.16 Pollen diagram from Site A, Nant Hall Road, Prestatyn (graphic A Caseldine)

then rising again to *c* 35% TLP). Possibly the proportions of *Pinus* pollen represent a regional rather than local aspect of the pollen rain and may be over-represented in the pollen spectra because of poor pollen preserving conditions, but *Pinus* also tends to be over-represented in estuarine/marine deposits because of its buoyancy in comparison with other types of pollen (Hopkins 1950; Caseldine 1992, 2000; Scaife 1993, 1994). Watkins (1990) reports a rapid *Pinus* expansion at Llyn Cororion, in lowland Gwynedd, at between *c* 8425–7750 BP, rather earlier than the date of the deposits here (see below), and suggests that this was a local rather than regional feature due to edaphic factors which enabled *Pinus* to colonise areas of poor soil conditions created by a fall in lake water levels. Walker *et al* (2001) have also suggested the behaviour of *Pinus* was largely influenced by local controls, probably soil moisture levels.

Generally pollen and spore concentrations as well as preservation were poorer in the blue-grey clays of NHRA-1 than in the overlying peats: concentrations and preservation deteriorated further during NHRA-1b. Possible explanations include increased, possibly rapid, sediment accumulation resulting in low pollen concentrations, calcareous inwash leading to pollen deterioration, or alternatively a marine inundation. The maintenance of estuarine/marine conditions is demonstrated by very high Chenopodiaceae and *Pinus* values.

A decline in *Ulmus* and *Quercus* occurs during NHRA-1b, which could relate to anthropogenic activity but there is a lack of herbaceous pollen evidence to support this and the picture may be affected by less favourable conditions for pollen preservation, the low pollen count, and over-representations of local taxa. *Tilia*, which is a more resistant pollen grain, does increase in certain levels. However, although the pollen record for human activity in the area is inconclusive throughout NHRA-1, there is a marked increase in charcoal values in the latter half of NHRA-1a which declines during NHRA-1b (see below).

Mid-Holocene reedswamp communities

The estuarine/saltmarsh period is followed by a distinct change in environmental conditions and vegetation at the site. In NHRA-2, pollen concentration and preservation improve and there is a sedimentary change from the basal blue-grey clays to humic clay. Poaceae pollen frequencies dominate the pollen spectra. *Typha latifolia* is present, and there is a corresponding decline in saltmarsh/coastal fringe indicators (Chenopodiaceae and *Plantago maritima*). A high proportion of the Poaceae pollen is typical of *Phragmites* as described by Faegri and Iverson (1975); the presence of *Phragmites* is confirmed by the macrofossil record (below).

Ulmus and *Quercus* values recover during this zone and together with *Tilia, Fraxinus* and *Corylus* indicate mixed deciduous woodland on the dryland. *Pinus* values are much reduced, probably largely reflecting reduced marine inputs. Although this zone is roughly contemporary with nearby Midden C, evidence for human activity at Site A is limited. Charcoal values are low in the pollen record but the plant macrofossils indicate the burning of reedswamp. Some large pollen grains of the grass family (Poaceae) could be attributable to certain wild grasses found in coastal situations, or cultivated cereals.

A second phase in the transition from estuarine/saltmarsh conditions to fen carr, when the pollen representation of plant species associated with reedbed and tall herb fen changes, is recorded during NHRA-3 the beginning of which is dated 4900±80 BP (CAR-1427; 3950–3510 cal BC). *Typha latifolia* replaces Poaceae as the dominant NAP taxa and *Sparganium* type, Ranunculaceae, Rubiaceae, Cyperaceae, and *Alnus* increase and occasional grains of *Mentha* and *Filipendula* occur. The pollen spectra in NHRA-2 and NHRA-3 are similar to those recorded from existing reedswamp communities (Brayshay 1992; Kent *et al* 1994) which correspond to NVC category S4 (*Phragmites australis* reedswamp and reedbeds) and S12 (*Typha latifolia* swamp) (Rodwell 1995). *Phragmites australis*/*Typha latifolia* reedswamp communities occur in modern coastal vegetation in the 'upper marsh' (*sensu* Adam 1981) and provide an indication of reduced marine influence, resulting in a seaward shift in the zonation patterns of the local coastal plant communities.

Alder carr

A third stage in the fen carr succession is indicated as *Alnus* became dominant in the local vegetation. This was probably expanding locally into the wetland as the reedswamp developed (see NHRA-3). The expansion of *Alnus* provides a good indication of environmental conditions in the area at this time. In a discussion of the present-day ecology of *Alnus*, Bennett and Birks (1990) suggest that *Alnus* occupies wet, mildly basic habitats, which include brackish-freshwater transitions in estuaries. Pollen isochrone maps suggest that the spread of *Alnus* was 'patchy and erratic in time and space' (Bennett and Birks 1990), partly because of the very specific requirements for seed germination and establishment. Its spread appears to be controlled by the local availability of suitable habitats and is time transgressive. Hence the establishment of *Alnus* at Prestatyn was somewhat later than at other sites (eg Chambers *et al* 1988; Watkins 1990) in north Wales. The radiocarbon date of 4900±80 BP (CAR-1427; 3950–3510 cal BC) at the beginning of NHRA-3 also dates the 'elm decline'. A marked fall in *Ulmus* pollen is accompanied by a similarly distinct decrease in *Quercus* pollen followed by the appearance of *Plantago lanceolata* pollen. However, whereas *Quercus* appears to recover very quickly to former levels, *Ulmus* shows only a minimal recovery later in the zone. In contrast, *Tilia* increases at the beginning of the zone and maintains high values throughout. It seems likely that the primary factor responsible for the elm decline was disease, however, the timing of its impact may have been affected by human activity and climatic factors (Peglar 1993; Peglar and Birks 1993; Parker *et al* 2002). From the increase in *Tilia* it seems likely that lime expanded into areas formerly occupied by elm.

There are indications in the pollen spectra that there were some openings in the woodland canopy. *Hedera helix* appears to have been present in the understorey and herbaceous grassland communities may have been present locally. *Plantago lanceolata* is first recorded in NHRA-3 together with an increasing diversity of herbaceous taxa such as Brassicaceae, *Plantago media*/*major* and species of Caryophyllaceae, Ranunculaceae, and *Urtica* and *Rumex*. This evidence for possible anthropogenic activity occurs at the time of the later middens composed of cockles and is accompanied by a slight increase in charcoal though charcoal values remain relatively low.

During NHRA-4 small but interesting peaks in the pollen/spore representation of *Plantago lanceolata,* Chenopodiaceae, Ranunculaceae, *Hedera helix* and *Pteridium* occur, corresponding to a period of fluctuating *Alnus* and declining *Quercus* and *Tilia*. Charcoal values, though generally still low, also increase and it seems likely that these fluctuations in the pollen spectra represent disturbance within the woodland. A radiocarbon date of 4960±70 BP (CAR-1485; 3950–3630 cal BC) at 3.16m–3.19m OD appears too old, given the date of 4900±80 BP (CAR-1427; 3950–3510 cal BC) at 2.64m–2.68m OD which appears to be consistent with the broader sea-level evidence and the 'elm decline'. A date of 4230±80 BP (CAR-1425) at 3.39m–3.44m would also tend to suggest the 4960±70 BP date is too old. Using the 4900 BP and 4230 BP dates, an interpolated date for this level would be *c* 4440 BP with an interpolated date of *c* 4540 BP for the initial increase in *Plantago lanceolata* and Chenopodiaceae pollen. This period of woodland disturbance and agricultural activity is consistent with the lithic evidence recovered from the fills of tree boles dated to the middle to late Neolithic (4210±70 BP (CAR-1418; 2930–2570 cal BC) to 4330±70 BP (CAR-1419; 3250–2700 cal BC)). Although the increase in *Plantago lanceolata* is most likely attributable to human activity and an increase in grassland, the increase in Chenopodiaceae pollen which occurs at the same time could relate to the closer proximity of saltmarsh, rather than disturbed ground or cultivation. Immediately preceding, and concurrent with, the increase in Chenopodiaceae pollen there is a rise in *Typha latifolia* pollen which suggests wetter conditions and possibly an increase in the water table. At the same time there is a decline in *Alnus*, indicating a reduction in alder carr. An increase in surface wetness could also result from clearance activity locally, which in turn would have led to increased run-off. This may account for the older than anticipated radiocarbon date if older carbon had been washed into the site. By *c* 4300 BP (interpolated date) *Tilia, Quercus* and *Ulmus* appear to be much reduced but this may simply be a masking effect of the high *Alnus* values. However, by *c* 3500 BP (interpolated date) the appearance of the landscape had significantly altered.

Post-woodland

The uppermost LPAZ, NHRA-5, in the sequence opens as the pollen representation of all arboreal pollen taxa is drastically reduced and sedge and fern dominated communities appear to have been locally abundant. The reduction of *Alnus* may represent the natural, *in situ*, demise of the wood, which has a tendency to degenerate as a result of attack by wood-decaying bacteria and fungi, especially in fen carr situations, rather than any deliberate clearance by people in the area. However, increased agricultural activity, notably grazing, may have helped prevent woodland regeneration and charcoal values are consistently higher which may, or may not, relate to human activity associated with burning of woodland or scrub. Initially, a fern- (*Thelypteris* type) and sedge-dominated community colonised the open conditions created by the decline in the *Alnus* carr. The *Alnus* decline at the LPAZ NHRA-4/5 boundary is accompanied by a change in the sediment lithology from woody peat to silty peat. There are major changes in the pollen spectra at this transition which is dominated by Lactuceae and Pteropsida, two taxa noted for their resistance to decay. Possibly this sedimentary and vegetation change reflects the erosion of soils in the catchment which results in an influx of resistant pollen types into the sediment rather than a vegetation change. The pollen representation of ruderal species increases across this zone, further supporting the suggested disturbance of vegetation in the catchment. *Plantago lanceolata*, Brassicaceae, *Solidago virgaurea* type, Cardueae and Chenopodiaceae are all present, together with a number of large Poaceae/cereal type grains, which together with the sedimentary change can be interpreted as indicators of cultivation and agricultural activity.

Towards the end of LPAZ NHRA-5a the pollen spectra reflect a change in conditions in the wetland area. The silty peats are replaced by a sedge peat and this is reflected in the increased abundance of Cyperaceae, *Sparganium,* and *Typha latifolia* pollen in NHRA-5b. These changes indicate a return to wetter conditions and organic sedimentation at the site and are in agreement with the plant macrofossil evidence (below). Finally, the sedge peats are overlain by a clay loam deposit *c* 2520±70 BP (CAR-1484; 800–410 cal BC). Agricultural indicators increase suggesting a period of instability in the catchment area possibly associated with intensified deforestation and/or farming which resulted in the erosion of soils in the catchment. Later in this phase 'cereal type' pollen increases and Cannabiaceae type pollen is present, providing further evidence for cultivation. At Llyn Cororion in lowland Gwynedd an increase in Cannabiaceae pollen has been dated to 780±60 BP (SRR-3467; 1050–1390 cal AD) (Watkins 1990).

Some of the vegetation and sedimentary changes described in LPAZ NHRA-5 could also relate to fluctuations in sea level. The increasing Chenopodiaceae, Brassicaceae, Lactuceae, and *Plantago maritima* pollen frequencies could, for example, indicate an expansion of coastal fringe/saltmarsh vegetation in the locality. The minerogenic sediments (silty peat and clay loam) may represent a return to low energy estuarine conditions rather than an influx of eroded material from the catchment.

20.8.2 Site C

Details of the sediment lithology recorded at Site C, which included a section through a shell midden, are given in CD 20.19 (this does not include the upper 0.25m of the profile exposed). The pollen data from Site C (Fig 20.17) are divided into two local pollen assemblage zones (LPAZs) which are summarised in CD 20.19. The results of the pollen analysis from Site C provide a detailed picture of the vegetation at the site before, during, and after the deposition of the cockle midden deposits. Importantly, these data indicate that *Alnus, Tilia,* and *Corylus* woodland communities were dominant vegetation elements in the landscape and that sediment accumulation began at this site during this period. It also suggests that the cockle midden in Site C was accumulating in the context of a predominantly wooded landscape, although Chenopodiaceae and *Plantago maritima* indicate saltmarsh/coastal environments in the area

A radiocarbon date of 4960±80 BP (CAR-1426; 3960–3630 cal BC) dates the beginning of peat accumulation at the site and is consistent with the low *Ulmus* values and presence of *Plantago lanceolata* in the basal pollen level which suggest a post 'elm decline' date for NHRC–1a. An increase in the pollen representation of *Hedera helix* indicates the woodland canopy was open enough for this species to flower but the pollen record throughout NHRC–1a suggests only a low level of clearance activity at this time. As well as *Plantago lanceolata*, occasional grains of large Poaceae/cereal type pollen are recorded but, as previously mentioned, could derive from either wild grasses or cereals. Charcoal is also present and values are generally higher than at Site A, probably reflecting the closer proximity of Site C to the areas of burning.

There is evidence of a distinct episode of vegetation disturbance during the period of midden deposition, dated to 4890±80 BP (CAR-1355; 3950–3500 cal BC). This is preceded by a sharp increase in charcoal values at the beginning of NHRC–1b and fluctuations in arboreal taxa, including an increase in *Tilia* suggesting an expansion in lime woodland. A marked decline in *Tilia* immediately predating deposition of the midden is accompanied by a slight decline in *Ulmus*, fluctuations in *Alnus* pollen frequencies, increases in *Corylus, Betula,* and *Lonicera* and increased frequencies of Poaceae, many herbaceous taxa (*Plantago lanceolata, Rumex*, Chenopodiaceae) and ferns (Pteropsida (monolete) and *Pteridium*). Although this may suggest some open, possibly disturbed habitats around the midden areas, from the decline in *Tilia* it is likely that most of this activity was taking place on the adjacent drier ground. There is no clear evidence of cultivation or agricultural activity but the changes might result from pastoralism. The increase in *Corylus*, and to a lesser extent *Betula*, may reflect colonisation of abandoned areas by scrub.

The radiocarbon dates suggest that the midden was established in alder carr shortly after peat growth began at Site C and around the time reed swamp was beginning to be replaced by alder carr at Site A. In which case the vegetation changes at the time of the midden at C are only marked by very slight evidence of changes at Site A, 80m away and further from dryland. This emphasises the local nature of the vegetation disturbance. Given the radiocarbon dates from C which bracket the midden cover 550 years there seems to be very slow accumulation there. The small clearance represented began during the period of the midden *c* 4890 BP but could have continued throughout the later period of increased activity represented in Site A up to *c* 4230 BP. The fact that there are only slight hints from *c* 4900 BP at Site A but stronger evidence later could relate to the fact that C is nearer to the disturbed area(s) (?dryland edge) which then expanded registering more strongly at Site A. An increase in charcoal values immediately above the midden at Site C may well also reflect this later period of activity, which is also represented by the lithics from the fills of the tree throw pits. There is close agreement between the date of 4340±70 (CAR-1483; 3350–2750 cal BC) from the peat above the midden and the middle to late Neolithic dates from charcoal from the fills.

The existing woodland communities appear to have revegetated any local disturbed areas during the time period represented in LPAZ NHRC–1c, above the midden levels. *Tilia* once again appears dominant in the dryland wood communities, with *Alnus* fringing the wetland. The recovery in woodland supports the idea that no large-scale clearances for agricultural purposes had taken place when the Mesolithic/Neolithic shellfish gatherers were busy in the area and the evidence is consistent with that recorded at other sites in Wales during this period (Caseldine 1990). Herbaceous taxa indicative of clearance activity are, however, consistently present throughout NHRC–1c, suggesting small-scale activity continued during the remainder of the Neolithic and the earlier Bronze Age in the region as a whole and this is consistent with the lithic evidence. By around 3150 BP (interpolated date) a slight increase in *Plantago lanceolata*, declining arboreal values, and increase in charcoal indicate a rise in the level of activity. This is consistent with the period of Bronze Age activity represented in Pit H3.

In the upper pollen assemblage zone (NHRC–2) there is evidence of widespread deforestation and

Prestatyn Site C

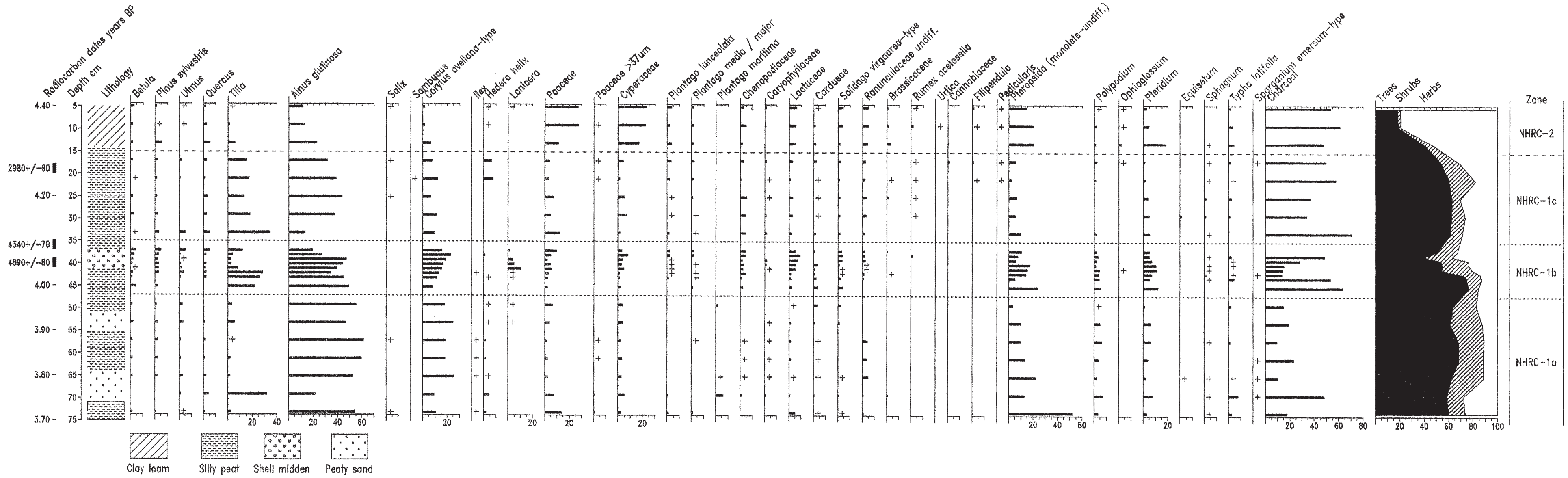


Figure 20.17 Pollen diagram from Site C, Nant Hall Road, Prestatyn (graphic A Caseldine)

an increase in open, grassland and sedge-dominated plant communities from c 2700 BP (extrapolated date). The incidence of particulate charcoal also remains relatively high and the evidence suggests a period of intensified settlement and/or land-use which postdates the period when the middens were formed. Around 2600–2700 BP a lithostratigraphic change to a clay loam occurs and, as at Site A, may reflect a return to estuarine conditions, or eroded material from the catchment as a result of intensification of agriculture, or both.

20.8.3 Site D

A spot sample (65 cm) was taken from a peat layer (Context 6) and the remaining samples were taken through the following sequence of deposits:

97–98 cm	Tufa ?redeposited becoming increasingly organic downwards (Context 23)
98–101 cm	Humic peat, possible land surface (Context 17)
101–03 cm	Shell midden (Context 21)
103–05 cm	Peaty/organic sandy clay, palaeosol (Context 24)
105–06 cm	Sandy clay palaeosol (Context 24)

Pollen preservation was poor in all the samples analysed, reflecting the increased dryness of the sedimentary environment at this midden site which was located at the landward margin of the wetland. The pollen assemblage also seems to comprise a high proportion of pollen/spore types which are most resistant to decay and this may indicate some distortion of the data. The results of pollen analysis are shown in CD 20.20.

Alnus, Tilia, and *Corylus* dominated the pollen assemblage at the time of the midden and associated levels. Comparison between the radiocarbon dates on Sites D and A show that whilst this midden was being deposited in woodland at the dryland edge, saltmarsh was accumulating at Site A. The fact that Site D is on the dryland edge is likely to account for the higher *Tilia* values seen here by comparison with Site A. The higher *Alnus* values at Site D as opposed to Site A are likely to reflect alder carr just beyond the tidal limits fringing the dryland at a time when saltmarsh existed at Site A. There is clear evidence for the disturbance of vegetation at the time of Midden D with increased frequencies of *Plantago lanceolata*, Chenopodiaceae, Caryophyllaceae, Ranunculaceae, and Pteropsida. The radiocarbon dates clearly show that this disturbance predates the disturbance episodes represented at Sites C and A. The relatively high values of *Plantago lanceolata* suggest disturbance in the immediate vicinity of Midden D, again reflecting its dryland edge location, with fluctuating disturbance episodes only registering later in the diagrams out in the wetland. However, high charcoal values recorded towards the end of NHRA-1a could relate to activity at the midden at Sites D and E and perhaps the other mussel middens. By the time of the spot sample at 65cm, *c* 3530±70 BP, there was still some woodland of similar composition but it was now of significantly reduced extent with a much larger proportion of herbaceous taxa. Pteropsida, *Pteridium,* and *Plantago* are the major taxa, the latter at 15% indicating grazing.

20.8.4 General discussion

Pollen analysis from Site A provides a detailed picture of vegetation change at the Nant Hall Road site since the mid-Holocene. The sequence of local pollen assemblage zones reflects the predominantly local autochthanous peat forming communities at the site. Initially a landscape in which saltmarsh/coastal fringe vegetation dominates the local element of the pollen spectra is indicated. The high pollen frequencies for *Quercus, Pinus, Tilia,* and *Corylus* are thought to represent local and regional pollen input reflecting the vegetation in the wider landscape around the site. With the development of reedswamp and *Alnus*-dominated communities at the site, the pollen representation, thought to originate from the wider landscape, declines. This is possibly due to taphonomic factors rather than to vegetation change – caused by the increased pollen productivity of the vegetation at the site suppressing representation of the pollen rain from the wider source area.

Comparisons between the pollen sequences from the midden horizons (Sites C and D) and the longer sequence from Site A indicate that the middens were deposited in *Alnus*-dominated local woodland, probably fringing the drier land with mixed deciduous woodland in the hinterland. The earlier midden, Site D, was deposited while saltmarsh conditions persisted at Site A while the later midden, Site C, was deposited around the time reedswamp gave way to carr-woodland as the latter expanded seawards during a marine regressive phase.

With distance from the wetland the pollen spectra become less diverse and the pollen signature weaker as a result of a deterioration in conditions suitable for pollen preservation. Also there are differences between the profiles which reflect the position of the sampling sites in relation to the mosaic of vegetation communities in the area. For example, *Tilia* has much higher pollen frequencies in the profiles from the most landward sites (Sites C and D), possibly as a result of the sites being located towards the edge of the *Alnus* carr and closer to the wooded landward margins of the wetland area where one would expect *Tilia* to grow.

Two or three distinct episodes of anthropogenic disturbance are suggested by: the increased pollen frequencies of herbaceous taxa such as *Plantago lanceolata, Rumex,* Chenopodiaceae, and *Pteridum* (species associated with open disturbed habitats) in the midden deposits (the earliest in the midden horizon at Site D, the later associated with the midden at Site C); and by the main disturbance evidence apparently a little later at Site A. However, the limited impact on woodland, the modest values of disturbance indicators and comparison between the three sites indicates that disturbance was small-scale and localised. There is no evidence of any major clearance until the later Bronze Age. The increased representation of 'ruderals' may represent herbaceous communities developing in the disturbed areas around the middens. The presence of grazing animals in the woodlands could also have contributed (ferns are poorly represented possibly due to grazing) or by the movement of people through the area around the middens. The high charcoal representation in the estuarine sediments at Site A may relate to human activity associated with the earlier midden at Site D, and possibly the other mussel middens. Whereas, the lack of markedly higher charcoal values in the levels at Site A contemporary with the later middens, may well be a result of the different depositional environment reedswamp/carr-woodland exerting a filtering effect and reducing the charcoal representation. Some support for this view is provided by the higher values of charcoal recorded at the later midden Site C, which was closer to the dryland. The presence of charred macrofossil remains does, however, suggest there may have been some attempt at deliberate management of the reedswamp, which is seen at Mesolithic sites in the Severn Estuary (Chapters 14 and 19).

20.9 Plant macrofossil analysis *by A E Caseldine*

There were two aspects to the plant macrofossil studies undertaken at Nant Hall Road. The first was to complement the pollen analytical work by providing more detailed information about the stratigraphic sequences and hence the local environmental conditions recorded. The second was to recover any evidence of plant use associated with the middens. Methods of sample preparation and analysis are outlined on CD 20.21.

20.9.1 Site A

The lowest sample (1.93–1.98m OD) [219–14cm] examined from the environmental pit in Site A contained *Juncus* (rush) seeds as well as a few remains of monocotyledons, but generally plant remains were sparse (CD 20.22). Foramanifera were also present. The results suggest an open environment with comparatively few plants growing in the immediate vicinity and are consistent with the other environmental evidence for estuarine conditions.

Remains were more frequent in the sample above (2.53–2.58m OD) [159–4cm] and comprised mainly rhizomes etc of monocotyledons including *Phragmites australis* (common reed). One charred node and a few other charred monocotyledon fragments, demonstrating burning, were present. Poaceae (grass) caryopses were also frequent. Foraminifera were again present. The evidence suggests the development of reedswamp and the beginning of a freshwater hydroseral succession, although there are also a few seeds indicative of saltmarsh, namely *Aster tripolium* (sea aster), cf. *Glaux maritima* (sea milkwort) and Chenopodiaceae (goosefoots). Overall, the evidence is in close agreement with the pollen record (above).

A very different local environment is indicated by the next sample (2.93–2.98m OD) [119–14cm] which was essentially woody. Apart from wood and leaf fragments, *Alnus* (alder) fruits, cone-scales and bud scales were abundant, indicating alder carr. Of the other taxa represented in the assemblage, Cyperaceae (sedges) are the most characteristic element of the herbaceous layer in such woodland, while *Eupatorium cannabinum* (hemp-agrimony) and *Urtica dioica* (common nettle) are typical of the tall herb component with *Epilobium hirsutum* (great willowherb) found occasionally, and *Rubus fruticosus* agg. (bramble) typical of the undershrubs (Rodwell 1991a and b). The presence of *Rubus* could also point to a woodland-edge element and the opening up of woodland by grazing and coppicing (Ellenberg 1988), though *Rubus* cover increases markedly if browsing by deer and stock is prevented (Rodwell 1991a and b). The occurrence of *Sonchus asper* (prickly milk-thistle) is of interest because this is a plant of cultivated ground or wasteland and coincides with pollen evidence for some Neolithic forest clearance (above).

The penultimate sample (3.43–3.48m OD) [69–4cm] examined was still quite woody and contained abundant *Alnus* fruits and cone-scales and frequent *Carex paniculata* (greater tussock-sedge) nutlets, indicating the continued presence of alder carr. *Moehringia trinervia* (three-nerved sandwort), which is a woodland herb, is also represented as is the aquatic *Ranunculus sceleratus* (celery-leaved buttercup). A similar environment to that in the previous sample is indicated but the presence of *Ranunculus sceleratus* may suggest the presence of pools of open water as the latter commonly occurs in and by slow streams and in ponds. The plant macrofossil evidence for local alder carr in the last two samples is consistent with the high *Alnus* pollen values recorded in LPAZ NHRA-4 (above).

The final sample (3.93–3.98m OD) [19–14cm] contained frequent *Chara* (stonewort) oogonia, and abundant *Juncus* seeds. The former indicates the presence of standing water and the latter a marshy environment. Also represented were *Ranunculus sceleratus, Ranunculus* Subgenus *Batrachium* (crowfoots), *Mentha arvensis/aquatica* (corn/water mint), and *Eupatorium cannabinum*, all of which are likely to have been derived from a marsh or stream-bank situation.

20.9.2 Site C

Two stratigraphic samples were examined from the sediment column from Site C. One sample was from the level of the midden itself (4.04–4.08m OD) [41–37cm] and the other from the top of the underlying peat (3.99–4.04m OD) [46–41 cm]. Plant remains were sparse. *Rubus fruticosus* was present in both samples and *Urtica dioica* and *Eupatorium cannabinum* also occurred in the peat sample as well as frequent wood fragments. Again, along with the pollen evidence, a carr environment is suggested. No charred plant remains other than charcoal occurred in the midden.

20.9.3 Sites D and H3

The remaining evidence is from the mollusc samples, which were also scanned for plant remains of palaeoeconomic significance. There were no plant remains from the midden itself in Site D but in the layers above the midden (Context 22) a carbonised grain of *Triticum* (wheat) and another very poorly preserved possible cereal grain were recovered. None of the other areas yielded any definite cereal evidence apart from Site H3 from which a grain of *Hordeum* (barley), a few fragments of possible indeterminate cereal and four glume bases, three of which were possibly referable to emmer wheat (*Triticum* cf. *dicoccum*) and one of which was in a *T. dicoccum*/*spelta* (emmer/spelt) category, were identified. In addition, there was a fragment of hazelnut (*Corylus avellana*) shell. Whether the cereal evidence reflects local cultivation is uncertain though the presence of cereal type pollen in the pollen record (above) would tend to suggest this. Other possible evidence for the utilisation of wild plant resources may be fragments of charred *Rubus fruticosus* found in samples from midden horizons on Sites E and F, but their presence may simply be a reflection of the material collected for fuel or clearance of vegetation at the site.

20.9.4 Charcoals *by A E Caseldine and S Johnson*

Charcoals were obtained from bulk sieving samples of the midden and other occupation layers. Samples from Sites D and C produced good-sized samples of charcoal and were sub-sampled selecting from the range of sizes. The samples were submitted for radiocarbon dating. CD 20.23 lists the species present. Much of this charcoal is from midden layers and is likely to reflect wood selected as fuel, but small-scale burning of local woodland could have contributed. Oak is the main wood identified, but hazel is also well-represented. Both are likely to have grown on the dryland and wetland fringe, with alder, the other well-represented tree, on the wetland. The dominance of oak in midden deposits at Site D contrasts with the pollen evidence in which alder and lime dominate, possibly reflecting deliberate selection or differences in preservation. In contrast, there is close agreement between the charcoal and pollen records from the midden at Site C, with alder and hazel dominating in both cases. The later sample from Site D, Context 16, a tree throw hole, lacks oak and has a more varied range of trees with Maloideae (hawthorn group), birch, and hazel, perhaps hinting that by this time the wood was more open and scrubby.

Diatoms
Samples from Site A were examined by Nigel Cameron but they were only preserved in the top sample 6–7cm and these were predominantly freshwater species (CD 20.24).

20.10 Animal bones *by M Armour-Chelu*

A small assemblage of faunal remains came from midden layers and buried soils. A total of 116 fragments was recovered, some by hand and some from sieved deposits. A full list of identifications is given in CD 20.25–20.6. A total of 26 fragments was recovered from the mussel middens at Sites D and E associated with radiocarbon dates of the late 5th millennium cal BC. Only three fragments could be identified to taxon, all red deer, comprising an antler from Site E, a first phalange, and the shaft of a femur from Site D. The femoral shaft is well preserved and bears a series of fine cut marks on the posterior aspect of the distal portion of the bone. These run diagonally to the long axis of the bone and indicate that the meat was filleted from the bone. The remaining fragments from these two middens included fifteen of large ungulate size, three probably derived from red deer, and the rest from large-bodied taxa such as aurochs or elk; seven were of small ungulate size, including the distal portion of a humerus tentatively identified as sheep or goat; this was from Site D midden, Context 21.

The remaining contexts are of the early 4th millennium cal BC and comprise: two fragments from the cockle midden at Site C; eight fragments from soil layers and a tree throw hole which postdate the midden at Site D; three fragments from a soil layer postdating the midden at Site E; and 77 fragments from a buried soil layer in test pit H3. A total of seven fragments could be identified to taxon. A mandible of cow complete with two molars in wear, indicating an animal which probably died between three and four years of age, was identified from the soil (Context 17) postdating the Site D midden. A cow calcaneum was identified from the soil layer immediatedly above the Site E midden (Context 103); the tuber calcis was fused at the time of death, indicating that this animal was at least three years old at the time of death. Two pig teeth were recovered from the fill of the tree throw hole at Site D (Context 11), including an unworn lower permanent premolar which indicates that this animal died during the second year of life (Silver 1969).

From the palaeosol at Site H3 (Context 201), which is dated to the Bronze Age, came the upper molar of a domestic cow and the upper premolar and molar of a sheep or goat. These teeth were in wear indicating that they were derived from mature animals. Seven of the small ungulate long-bone fragments from this context appeared to have been smashed for marrow-fat extraction and this suggests that butchery activities were carried out in this area of the site.

CD 20.25 shows that only ten bones from the Prestatyn assemblage could be identified to taxon (10 bones) or element (24 bones) and these were all derived from sub-adult or mature animals. Bones identified from red deer, cattle, and large ungulate-sized animals were largely represented by the most robust skeletal elements, such as teeth (3), humeri (3), calcaneum (2), mandible (1), and radius (1). A similar pattern of element representation is apparent from the sheep/goat, pig and small ungulate animals where five teeth, one humerus and a metacarpal were identified. Teeth and distal humeri are the most durable body parts (Behrensmeyer and Dechant Boaz 1980), and significantly comprised 50% of all elements identified from the site. These findings indicate that the assemblage is biased in favour of robust elements derived from mature animals and suggests that a significant proportion of weak or juvenile bones from the site have not survived.

Taphonomic analyses of the assemblage (CD 20.27) showed that a high proportion of bones were abraded with rounded and smoothed edges. These modifications may have been caused by transport or local ground water effects. Variation in the colour of the bones from Contexts 11 (Site D, tree throw hole) and 21 (Site D, midden) suggest that these assemblages are of mixed origin and possibly contain transported material. Evidence of bone decay and loss *in situ* is indicated by the presence of associated loose teeth in Contexts 11 (Site D, tree throw hole) and 201 (Site H3). These teeth were derived from a pig mandible, (right canine, premolar, third premolar), and a sheep/goat maxilla, (left premolar and molar), which probably decayed *in situ* whilst the more resiliant teeth survived. One fragment from Context 201 and possibly a fragment from Context 21 showed indications of burning.

20.11 Flint and chert lithics *by E Healey*

20.11.1 Introduction

The lithic artefacts from the excavations at Nant Hall Road come from contexts ranging from late Mesolithic/early Neolithic to late Bronze Age in date. They were recovered both by hand from excavations and from the samples which were wet sieved for the recovery of environmental evidence. The general classification of the artefacts, together with the relevant dating evidence, is given in CD 20.28 and a selection of artefacts is illustrated in Figures 20.18–20.19.

The earliest material comes from the pre-midden and midden deposits at Site D (Contexts 24 and 21) and the soil layers overlying this midden (Contexts 17 and 19), as well as the shell midden deposits at Site E (Context 104–5) and the Site C midden which are associated with radiocarbon dates which largely fall within the later fifth to early fourth millennium cal BC, indicating a late Mesolithic/early Neolithic cultural background. The material from one of the tree throw holes (Context 16), in the surface of the tufa gravel overlying the midden at Site D, is associated with a date in the first half of the third millennium cal BC, indicating a middle to late Neolithic background (Fig 20.5). A radiocarbon date of the late 3rd to early 2nd millennium cal BC from the base of the peat layer overlying the tufa gravel deposit at Site D suggests that the material from this layer (Context 6) is of early Bronze Age date. Material from the soil layer (Context 103) overlying the Site E shell midden is not securely dated. Material from the palaeosol sealed below a layer of tufa gravel at Site H3 is associated with a radiocarbon date of the late 2nd to early 1st millennium cal BC.

In all contexts small pebble flint was for the most part knapped to produce flakes for use, although some chert was also used. Since pebble flint is not necessarily subject to the same reduction methods as nodular raw materials it is not always possible to use the standard reduction categories, and so the classification of the material is considered in more general terms of parent and product waste (Berridge 1994, 99). The assemblage from Nant Hall Road is also considered in the light of a large collection of lithic artefacts collected by Gilbert Smith in the 1930s from Fields 56 and 56b adjacent to the excavated sites (Fig 20.4), and of the material from some earlier excavations in Prestatyn at Melyd Avenue and Bryn Newydd (Fig 20.2), as well as the material from slightly further afield at Rhuddlan.

20.11.2 Raw materials

Flint pebbles, chert and a fine-grained igneous rock are represented amongst the excavated material used for artefact manufacture.

Flint

This is the most regularly used raw material. It is mostly in the form of small pebbles, the exceptions being a flake from a ground and polished implement and perhaps a microlith of light brown translucent flint (no 8) and a couple of other flakes (eg no 13) of similar material from Context 17. The pebbles come in a variety of colours (eg fifteen colours in Context 16, CD 20.31) ranging from a striking opaque orange with a black line and a black or grey cortex, through lighter orange-browns, mid-browns and greys, some of which are semi-translucent, to opaque light browns and greys which are the most common. Cortex varies from chatter marked to quite smooth and water-worn. The flint is in a relatively fresh condition but some is patinated and some burnt. It has been suggested that translucent and opaque pebbles come respectively from drift and coastal deposits (R Cowell pers comm). Whilst in some cases this may be true, it seems more plausible that all the pebbles would have been picked up on or near the beach and probably derive from the Irish Sea drift. Some pebbles also have older scars which have been virtually obliterated by rolling in water, also suggesting a coastal or riverine origin. The flaking quality of the pebbles is not particularly good, for example one core (no 3) has much step-fracturing on its face suggesting difficulty in detaching flakes. The pebbles selected were evidently quite small, the largest flakes measure only 49mm and the cores are all smaller than this. Larger nodules were available, such as those recovered from Context 19, Square 23, which measure up to 90mm in maximum length and 320g in weight (the surviving cores weigh less than 35g) but apart from testing, these do not seem to have been used.

Chert

The chert presumably derives from the Carboniferous Limestones in the area (Fig 20.2) (Manley and Healey 1982; Berridge 1994, 95). It is mostly black in colour, sometimes stripey and of varying coarseness, the blacker material being more fine-grained. Only a very small amount appears to have been used for artefact manufacture, though it must be said that sometimes it is extremely difficult to be sure whether or not a piece has been worked. Most of the chert recovered consists of small, apparently unworked, angular lumps which must occur naturally in the drift deposits underlying the site. The artefactual material from the excavations consists of a few small flakes and some struck nodules.

?Igneous rock

Four flakes and some chips of a fine-grained, grey rock were recovered from Context 16. The flakes have traces of grinding and polishing on them and presumably originate from a single ground and polished implement which had been imported to the site and reworked.

20.11.3 Technology/flaking strategies

The classification of an assemblage which utilises small pebble flint is not without its problems because it defies conventional categorisation. The artefactual material was therefore basically separated into: firstly parent waste; secondly product waste (the latter of which was itself further subdivided largely on the basis of the presence or absence of cortex and probable position in the knapping sequence); and thirdly the reduction technology was considered.

20.11.4 Parent waste

This general category includes pieces from which removals have been struck such as conventional cores (nos 2, 4–5), struck or tested nodules, and remnants of pebbles with negative points of impact (no 7), which seem to be the by-products of anvil or bipolar flaking.

Cores (nos 1–5 and 9)

Twenty-one flint and four chert cores were present. Their main characteristics are summarised in CD 20.29. Both the flint and the chert cores are small, the maximum weight being 30g or less and their maximum dimension 35mm. The flint cores often retain a substantial amount of cortex on them suggesting that the unworked pebble was not much larger which is indeed corroborated both by the size of preparation flakes and other flakes (see below). Despite the small size, several cores have been flaked from more than one direction (no 5) and one seems to have been rejuvenated (no 4). Although no classic rejuvenation pieces were recovered, four flakes, clearly struck to create new platforms, suggest that this was a deliberate tactic. The cores seem to have been abandoned, either because of their size, or because of the step fracturing on the face of the core (no 3). There is no evidence for the reuse of the cores.

Struck or tested nodules

Pebbles or nodules from which a flake has been struck, but not been worked further. It includes the three flint nodules, from Context 19, Square 23, each of which has a single flake scar but which have been discarded without further development. It is not obvious why the flaking was not pursued, as these nodules are markedly larger than the pebbles and had the potential to produce several largish flakes. A number of chert chunks also show truncated scars, but much of this is likely to be due to modem damage and disturbance rather than from deliberate flaking.

20.11.5 Product waste

These pieces were struck or removed from a parent lump. They have been tentatively subdivided into preparation flakes, flakes with cortex, flakes without cortex and chips and shatter fragments (see CD 20.30). More specific classification in terms of the stage represented by any particular flake within the core reduction sequence (see for example Harding 1990, 217) was not felt to be relevant to the material from Nant Hall Road.

Preparation flakes

Pieces which have been struck to prepare a surface from which flakes can subsequently be removed either from the top of pebble to 'open' a platform or to prepare the face for removals. They are characterised by cortex, or other natural scars, over all, or most of, their dorsal surface and frequently on the butt.

These tend to be relatively thick in comparison to other flakes and frequently irregular in shape. They range in length from 16–49mm (average 27mm) and in thickness from 4–20mm (average 7.6mm). They are found in almost all contexts. One preparation flake (no 12) has been modified with edge retouch

Inner flakes
Flakes struck in the process of core reduction and tool manufacture; they are separated into flakes with cortex and those without. Inner flakes with cortex are flakes which have some cortex remaining on their dorsal surfaces, but which are generally smaller and thinner than preparation pieces. They range in length between 11–37mm (average 22mm) and in thickness between 2–13mm (average 4.3mm). One has been retouched as a scraper (no 11) and one fragment has a retouched edge (no 14). Among the inner flakes there are two typical thinning or shaping flakes, but there is no other evidence to corroborate the manufacture of bifacially flaked implements. Two of these flakes have been modified by retouch (eg no 13).

Blade-like flakes
True blades are not present amongst the assemblage, but seventeen removals from other contexts can be described as blade-like because of their general proportions (the blade-like pieces in other contexts were not separately counted). Two of these have been modified – one considerably altered and retouched as a microlith (no 8) and the other with abrupt edge retouch (no 15).

Core trimming pieces
Removals deliberately struck to create or renew a face or platform edge so that further removals can be struck thus prolonging the life of the core. Four such pieces were noted, three of which change the direction of flaking and a fourth which removes an extensive area of step fracturing. They are, however, not core trimming elements *sensu stricto*.

Small flakes and chips
In addition to the flakes described above, small flakes (less than 10mm in length) were recovered from sieved contexts. Especially noteworthy are those from the tree throw hole (Context 16) where over 4500 small flakes and chips were found densely packed together. These were sorted by raw material type and colour and into flakes of various size groups as summarised in CD 20.31. The initial breakdown of the flint by colour suggested fifteen different pebbles. However, some of these groups may be variations in the colour of one pebble. The bulk of the material from this context (almost 90%) consists of small flakes and chips. Conjoins were effected on one group only; others may be possible but time did not permit an extensive study. No cores were present and only one retouched piece, a scraper (no 11). The flakes and chips are for the most part undiagnostic and it is likely that they are knapping debris and shatter from core reduction. The nature of the raw material and the technology employed makes it unlikely that without considerable reconstruction the debris could be separated into functional categories or platform preparation, core face preparation, and retouch flakes such as those described by Newcomer and Karlin (1987) for the material from Pincevent. The density and restricted distribution of this deposit suggests that it was a dump for knapping debris, the quantity of minute pieces (virtually flint dust) suggesting that the original knapping was done over a skin or basket.

20.11.6 Flaking mode

The flaking mode was probably that of direct percussion using a hard hammer (though none was recovered). The plain striking-platforms suggest that the core was opened by removing one end of the pebble (eg nos 2 and 3) and the core face prepared by striking flakes (see preparation flakes above) from the platform to remove the cortex. Other pebbles and some flakes seem to have been flaked on an anvil, evidence of the rebound being seen both on the end of some cores and on the flakes (no 7) (David 1990, 226). The flake beds on the cores indicate that for the most part flakes were produced. The chert core (no 1) and some of the flint cores have more blade-like scars but this may be as much to do with the original shape of the pebble as a blade technology. No real difference in technology could be detected between the cores in the different contexts, probably due to the nature of the raw material, though it may be significant that the larger and more regularly flaked cores largely come from post-midden contexts (eg 103).

20.11.7 Modification

Pieces with retouch or other modification are as follows. A single microlith of narrow blade geometric form (Jacobi's class 7a2) was found in Context 17, Site D. It is made of semi-translucent light brown flint – a type of flint which is unusual amongst the flaking debris, only three other pieces being recovered (eg no 13). A burin (no 10) comes from a post-midden Context 17. It is a good example of a double-ended truncation burin. Two other pieces have somewhat enigmatic facets, and it is by no means clear that these were deliberate and are best described as *burins de fortune* or pseudo-burins. Only one scraper is present (no 11). The distal end of a relatively large cortical flake has abrupt retouch forming a convex shape. The retouch is relatively shallow because the flake is thin. Its butt end is splintered suggesting that the blank may have been struck using the *écaillé* technique. Other retouched pieces include, on the one hand, examples on which the retouch does not alter the natural shape of the blank, and which do not fall into any other conventional tool category. Typical examples are nos 14 and 15. The retouch is

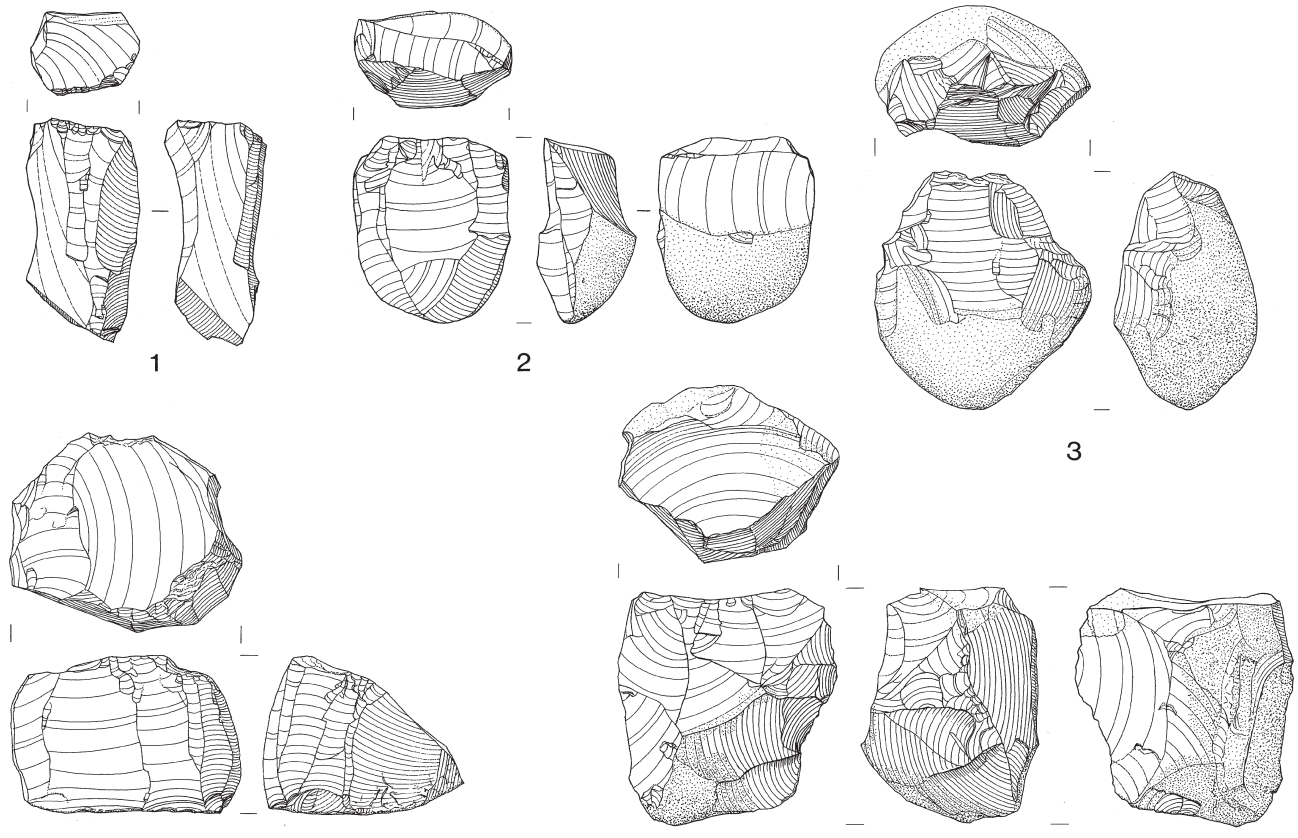


Figure 20.18 Lithic artefacts from Nant Hall Road, Prestatyn: scale 1:1 (drawing Clwyd-Powys Archaeological Trust)

usually abrupt nibbling edge retouch. On the other hand, flake no 13 has more extensive semi-invasive retouch from alternate faces. It is made on a flake of light brown translucent flint, which is not common amongst the raw materials present. It is from a post-midden context and probably belongs to a later phase of activity. No certain retouch was noted on chert flakes, though one piece has an area of high gloss along a concave edge.

At least two different ground and polished implements are represented in the assemblage, both in contexts of post-midden date. One is a flint flake from Context 6 with an area which has been ground and polished and the other is a stone implement of which four pieces survive from Context 16. All are small flakes struck from larger objects and unreconstructable, except that on the flake both the face and the striking platform are ground forming a sharp angle presumably having been struck from the side or butt of an axe.

20.11.8 Illustrated artefacts *(Figs 20.18–20.19)*

1) Core of black chert. Site D, Context 17, Square 4.
2) Small core of yellow-brown-grey flint. Site D, shell midden layer, Context 21, Square 20.
3) Core with much step-fracturing on face, chestnut flint. Site D, shell midden layer, Context 21, Square 20.
4) Core of yellow-grey mottled flint. Note cortical platform from which a rejuvenation flake has been struck. Site D, Context 21, Square 20.
5) Changed orientation core of chestnut and black flint. Site D, post-midden soil layer, Context 17, Square 4.
6) Core trimming element of grey opaque flint. Unstratified.
7) Blade fragement of opaque grey flint, with inverse nibbling edge retouch. Struck by *écaillé* method. Site E, Context 103.
8) Small geometric microlith of Jacobi class 7a2 with light retouch on leading edge, of light brown semi-translucent flint. Site D, post-midden soil layer, Context 17.
9) Core fragment with a possible burin spall removed on edge in grey opaque flint. Site E, Context 104, Square 8.
10) Double-ended truncation burin, on blade of yellow-grey opaque flint with rolled cortex. Site D, post-midden soil layer, Context 17, Square 15.
11) End scraper on a large flake of yellow-orange opaque flint with a black cortex. Note splintered butt end. Dimensions 49 × 27 × 13mm. Site D, Context 16.
12) Preparation flake with scale flaking on distal half of right edge. Yellow-brown opaque flint. Dimensions 41 × 28 × 14mm. Site D, post-tufa gravel peat layer, Context 6.
13) Flake of light brown translucent flint with one side retouched with semi-invasive flaking and butt end inversely retouched, removing bulb of percussion. Site E, general midden deposit, Context 104, Square 2.
14) Blade-like piece of mid-brown-grey flint, slightly patinated, with nibbling edge retouch on one edge and backed with cortex. Site E, general midden deposit, Context 104, Square 10.

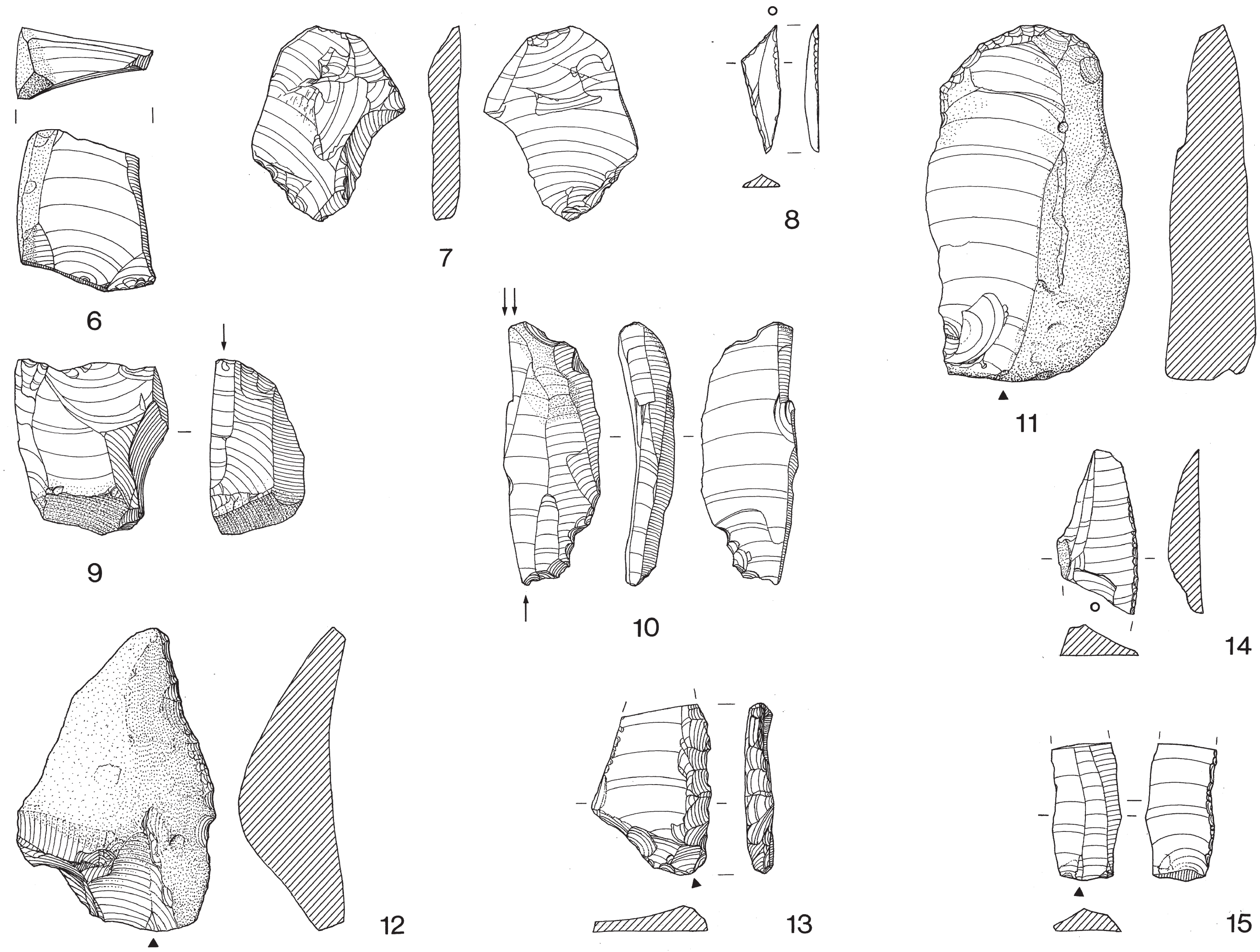


Figure 20.19 Lithic artefacts from Nant Hall Road, Prestatyn: scale 1:1 (drawing Clwyd-Powys Archaeological Trust)

15) Blade of cherty grey flint with inverse nibbling edge retouch. Site D, Context 24, Square 20.

20.11.9 Discussion

The date for the various contexts at Nant Hall Road is relatively well and independently established (Fig 20.5). There is little amongst the lithic material which is chronologically sensitive, the only really datable artefact being the microlith (no 8) from Context 17 which is of late Mesolithic form (Jacobi 1980). Deposits attributed to a late Mesolithic/early Neolithic cultural background include the bulk of the lithic material which comes from Contexts 24 and 21, 104–05, 17, and 19 and Site C. There is nothing to distinguish this material from the rest of the material which includes the microlith and the burin. Contexts 11 and 16, both fills of tree throw holes, are dated to the middle to late Neolithic and contain the only other datable pieces, namely the flakes from ground and polished artefacts. As the typological aspect of the assemblage is undiagnostic so is the technology. The use of an anvil or *écaillé* technology as a strategy for getting flakes from small pebbles is similar to that used at other coastal sites such as Stackpole Warren (David 1990, 226), Freshwater West (Wainwright 1959), and see also Jacobi (1980). It is usually considered to be a post-Mesolithic technology (David 1990, 226). It is also likely that the constraints of the raw material affected the morphology of the finished pieces. No clear production target is apparent. The proportion of waste products to modified pieces is high, and in turn the proportion of cores to flakes also seems high (3.5% or 6.7% if all struck pieces are included), modified pieces accounting for under 2%. Especially notable is the high proportion of flakes with cortex on them. This is likely to be a function of the capacity of the raw material when each pebble could only have produced a limited number of flakes, most with some cortex.

20.11.10 Comparison with other lithic assemblages in the area

The area was clearly exploited from the late Mesolithic/earlier Neolithic through to middle and late Neolithic times as is evidenced both from the material from Nant Hall Road and the other broadly contemporary material from Prestatyn.

The F G Smith Collection

The most immediate point of comparison is between the excavated material from Nant Hall Road and the immediately adjacent lithic scatter collected by the late F G Smith from Fields 56a and 56b in the 1930s, though this collection includes a much higher proportion of chert.

Smith's collection was catalogued by Frances Lynch in 1956 (pers comm). It has been examined by Geoffrey Wainwright (1963, 125, fig 15) and a proportion of it was looked at again by the present author in 1992/93. There is no detailed information on the exact location of the lithic scatter, or whether it was a continuous spread. However, a sketch plan boxed with the artefacts suggests that the scatter was concentrated in Field 56b, the former field to the north-west of Bodnant Avenue (Fig 20.4). The collection comprises cores, flakes, and blades, as well as a retouched component consisting of scrapers, microliths, piercers, and a fabricator. Both chert and flint have been used as raw material for artefact manufacture, artefacts of chert accounting for about 7% of the assemblage. The flint is mainly pebble flint, but some with chalky cortex has also been used and in general is similar to that from the middens. Typologically, the assemblage is mixed; the bulk appears on typological grounds to be Neolithic, but there is a clear Mesolithic presence indicated by the microliths (Wainwright 1963, 125). Cores account for about 11% of the worked material. Almost all are of flint, only two being chert. As with those from the middens they are small, and made on pebbles. Most seem to be uni-directional (single plaform) cores which produced blade-like flakes, but changed orientation cores are also present and there are a few larger bi-directional cores like those from Site H3. There is one sub-discoidal core with a flake removed from it in a Levallois-like fashion, which may be Neolithic in date. As with the material from the middens, the small size of the pebbles seems to have dictated the use of the *écaillé* technique. All stages of core reduction are present in the assemblage, and the products are similar to those from the middens, although chert seems to figure more prominently (*c* 12% of the removals). Few of the inner flakes seem to have been retouched, though a number exhibit edge damage. There is a limited range of retouched forms amongst which scrapers predominate (*c* 45%). They are made on small flakes often with cortex remaining on the dorsal surface. The retouch forms a rounded contour on the distal end and extends to a greater or lesser amount down the sides. The retouch is semi-invasive scale-flaking, often at a fairly abrupt angle. A few flakes have been retouched to form sharp points or piercers; there is a single fabricator and some flakes from polished stone axes. The microliths have been identified by Wainwright as follows: two microlithic rods, a lanceolate point, two obliquely blunted points and two crescentic types (Wainwright 1963, 125, fig 15). The artefacts from this flint scatter seem to have components of different affinities covering a broad time band, from the earlier Mesolithic to the later Neolithic or Bronze Age. Although there is no precise point of comparison between the flint scatter and the artefacts from the middens, the use of the same raw materials, and the technological and typological aspects suggest that it was connected to the middens and perhaps is the occupational material of which the middens represent a specific and specialised facet. All in all, it suggests that there was considerable and prolonged activity exploiting the sources in this area in prehistoric times.

Bryn Newydd

The Bryn Newydd site lies on the edge of the limestone hills to the south of Nant Hall Road (Figs 20.2–20.3). It was excavated by F G Smith (1927) and the lithics were re-examined by Clark (1938; 1939), and Wainwright (1963, 115, fig 10). The artefacts are made of local Carboniferous chert and included microliths. It was attributed by Clark to the Tardenoisian or late Mesolithic (Clark 1938, 330; note that Wainwright 1963, 114, identifies it as Sauveterrian). It should be noted that dates of 7305–6778 cal BC (OxA-2268) and 7976–7538 cal BC (OxA-2269) have since been obtained for the assemblage (David 1990).

Melyd Avenue

Melyd Avenue, to the south-west of the Nant Hall Road site, has produced some 122 lithic artefacts, 51 flint (beach pebble), and 57 chert, recovered during the excavation of a Roman site: 71 flakes, 17 cores, and 13 retouched pieces including 3 scrapers, 2 knives, an awl and a microlithic rod or triangle. A late Mesolithic or possibly early Neolithic date has been suggested (Berridge 1989, 124). See below for further discussion of this site.

Bryn Rossa

Most of the material from Bryn Rossa, Prestatyn consists of Neolithic material, including leaf-shaped arrowheads, but Wainwright (1963, 125, fig 15) identified an obliquely blunted point, a backed bladelet, and possibly a crescent.

Other sites

The sites at Rhuddlan (Manley and Healey 1982), Tandderwen (Brassil and Green 1991) and further afield at Brenig (Healey 1993) also testify to later Mesolithic activity in north Wales. Unstratified finds from Gop Cave are also attributable to Mesolithic activity and include two obiquely blunted points, two lanceolate points, a broad point retouched down both edges, and four scalene triangles (Wainwright 1963, 115) – suggestive of an earlier Mesolithic date, though the bulk of the assemblage is Neolithic and includes burials.

20.12 'Prestatyn Woman' reconsidered *by R Schulting and S Gonzalez*

20.12.1 The Prestatyn human skeleton

In 1924, workers found a human skeleton while digging on High Street, Prestatyn, opposite to what was known as the Pen-isa'r-dre corner. The remains lay below some 1.22m of peat, at the contact with the underlying boulder clay, the two layers separated by a thin layer of estuarine clay (F G Smith 1924; Davies 1949, 298). Gilbert Smith, an architect working at the site at the time, recorded the stratigraphy (CD 20.32). The skeleton was found at the bottom of the peat, the skull being filled with blue clay containing roots. The skeleton lay facing south-east, with the skull detached about 60cm from the rest of the other bones which were found 'in a heap'. Given the way in which the skeleton was recovered, it is not entirely clear whether it represents an intentional burial. A cut and worked ox tibia reportedly found near, or associated with, the skeleton was radiocarbon dated but found to be modern (270±50 BP) (Huddart *et al* 1999). However, close examination of records held at the Royal College of Surgeons suggests that this bone was not in direct association with the human skeleton but derived instead from the overlying gravels in layer 4. The ox bone is stained the same dark colour as the human skeleton, which suggests it did lie for at least some time in contact with peat.

The skeleton itself was thought to have been lost in the bombing of London in the Second World War (Davies 1949, 298), but it did in fact survive and was transferred from the Royal College of Surgeons to the Natural History Museum, London (Catalogue no 4.903), where it was examined in March 2001 and April 2007. The cranial and postcranial remains are identified as belonging to a small, slightly built, young adult female. The cranium exhibits sharp orbital margins, and gracile brow ridges and nuchal area, all of which are characteristic of females (Bass 1987). As is common for the Neolithic, the head shape is dolichocephalic, with a width/length index of 67.5. The maxilla is damaged, but includes the dental arcade from the right third molar to the left canine; the only teeth actually present are the three molars and two premolars, the others being lost post-mortem. M1 has been worn to an enamel ring, and the cusps of M2 and M3 are wearing flat but with minimal dentine exposure. Both premolars are worn to dentine stubs with no surviving enamel. This concurs with Sir Arthur Keith's (reported in Davies 1949, 298–300) observations on the dentition, in which he noted that the anterior teeth of the maxilla and the now missing mandible were worn to a far greater extent than the molars. This could suggest the use of the front of the jaw in a non-dietary activity, such as the chewing of hides to soften them. Occlusal caries are seen on all three maxillary molars, with M2 being affected at both its lateral and proximal margins. Keith further noted numerous abscesses in the mandibular teeth, with one tooth being lost ante-mortem as a result of this condition. The wear on the maxillary molars suggests an age-at-death in the range of 25–35 years. Relatively little of the postcranial skeleton survives, probably through a combination of poor preservation and incomplete recovery. The surviving elements include the glenoid portion of the left scapula, the right clavicle, the right rib, the left and right humeri (both missing their proximal ends), left and right ulnae and radii (missing either proximal or distal ends), and the major part of the shafts of all the lower limb long bones (femur, tibia, fibula) for both left and right sides (proximal and distal ends are missing in all but the right tibia and fibula, which retain their distal ends) (CD 20.33–34). None of the long bones is complete, though the stature of *c* 1.45m estimated by Keith on the basis of the partial bones is probably reasonably accurate. The right distal radius displays a well-healed Colles fracture (CD 20.34); this injury is typically the result of holding out one's hands to protect oneself from a hard fall.

In light of the modern date on the ox bone, an AMS estimate was sought on the human skeleton itself. An initial result of *c* 5000 BP indicated a date very early in the Neolithic, but this was subsequently retracted due to a problem with contaminated filters at the Oxford Research Laboratory. The sample was re-run, providing a later estimation of 4867±38 BP (OxA-16606; 3750–3535 cal BC). The calibrated date range may need to be modifed to take into account a suggestion of some consumption of marine foods, on the order of 10–15% of the overall protein intake based on the stable carbon isotope value ($\delta^{13}C$ = –19.4‰). However, assuming 10% contribution of marine protein affects the calibration only slightly (3695–3525 cal BC) in terms of the full two sigma range (Table 20.2; CD 20.35), though it does substantially increase the likelihood of the later part of this range (CD 20.35). The associated stable nitrogen

Table 20.2 AMS dates and stable isotope values on human bone collagen from Prestatyn and Gop Cave

Site	Cat. No.	Material	Lab No.	Date BP	±	Date BC		$\delta^{13}C$	$\delta^{15}N$
Prestatyn	4.903	R femur	OxA-16606	4867	38	3750	3535	–19.4	9.9
Gop Cave	47.97/96	mandible	OxA-10645	4840	40	3905	3525	–20.3	9.2
Gop Cave	47.97/103	mandible	OxA-10646	4570	45	3500	3100	–20.5	10.1
Gop Cave	19.259	cranium	OxA-10644	4350	40	3085	2885	–19.6	11.0

Note: calibrated with Calib 5.0.2 (Reimer *et al* 2004), taking estimated marine reservoir correction into account, using –12‰ and –20.5‰ for marine and terrestrial end points, respectively

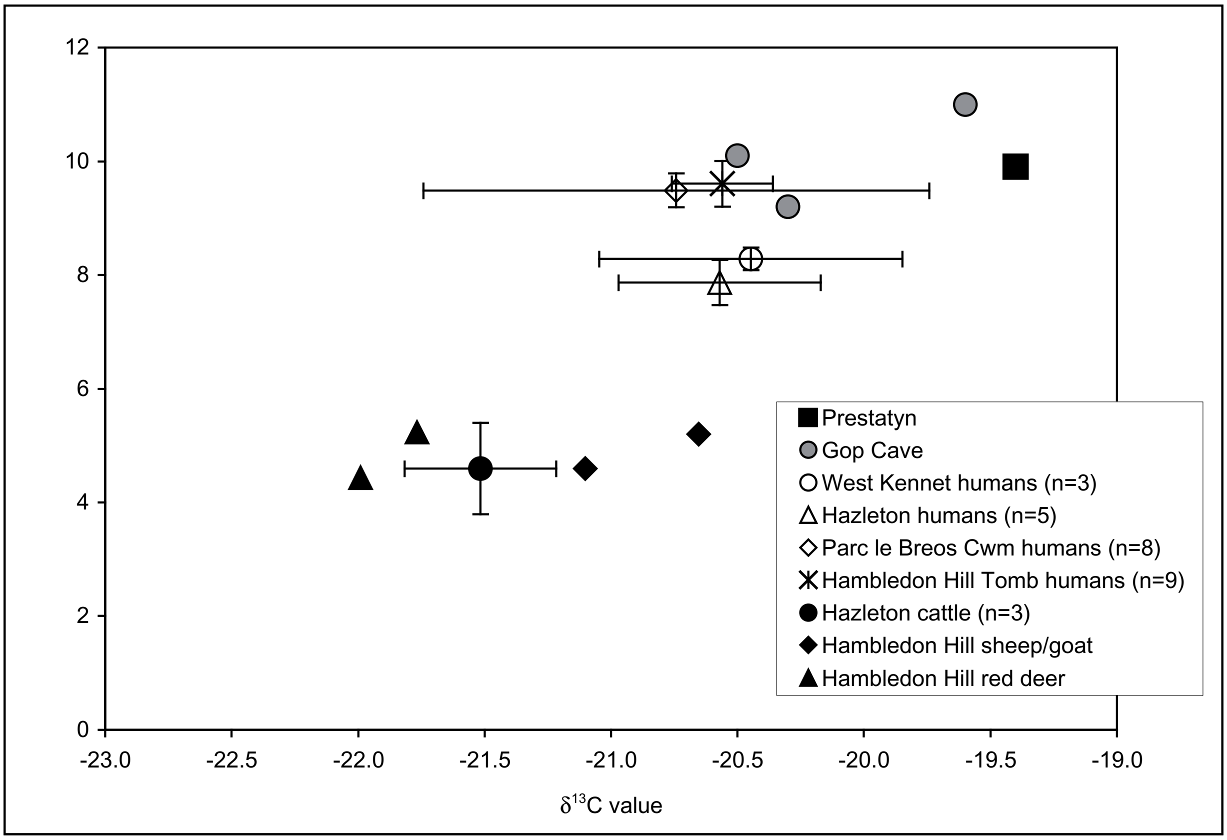


Figure 20.20 Stable carbon and nitrogen isotope values for Prestatyn and other Neolithic humans and fauna from southern Britain (additional data from Richards 2000)

value (δ^{15}N = 9.9‰) is only very slightly elevated relative to Neolithic individuals showing a terrestrial diet (δ^{13}C values of –20‰ or lower). The C:N ratio of 3.2 is within the accepted range for collagen. Stable nitrogen isotope measurements reflect the trophic level at which an organism is feeding. Usually marine ecosytems return higher values, since the food webs have the potential for many more strands (ie more trophic levels). It is possible, then, that this relatively low (for a marine system) δ^{15}N value reflects the consumption primarily of shellfish, which of course would fit in with the presence of middens at Nant Hall. However, it is important to acknowledge that shellfish remains can accumulate very rapidly, and may be represented quite out of proportion to their dietary significance (Bailey 1978; Chapter 20.16.5). In any case, the proportion of marine foods consumed by this individual is relatively low, arguably near the resolution limits of the technique. In a Mesolithic context, such low consumption of marine protein on a near-coastal site would be unexpected, though recent results from a number of sites in south Wales and in Ireland have demonstrated that even within the Mesolithic near-coastal diets may have been quite variable (Schulting and Richards 2002a; Woodman 2004). The nature of the coastline and its suitability for fishing may be pertinent factors here, along with the available terrestrial options.

If, however, the individual is seen within a Neolithic context, as the date certainly implies, then the minor importance of marine protein would be in keeping with the diets of other individuals from this period (Fig 20.20) (Richards and Hedges 1999; Richards *et al* 2003; Schulting and Richards 2002a, b; Schulting 2004). In fact, the Prestatyn individual would represent one of the strongest 'marine' signals known for the Neolithic of southern Britain, though matched by some individuals from the Cotswold-Severn tomb of Parc le Breos Cwm in south Wales (Richards in Whittle and Wysocki 1998). The presence of caries also suggests that cereals featured in this individual's diet. Caries are caused by carbohydrates in the diet, and are very unusual (though not entirely absent) in Mesolithic populations in north-west Europe (Meiklejohn and Zvelebil 1991). On the other hand, caries rates for Neolithic individuals are also low (*c* 3% of teeth) (Brothwell 1985; Brothwell and Blake 1966; Schulting 1998).

In terms of other lines of evidence, both the archaeological and environmental evidence at Nant Hall is inconclusive regarding the nature of the economy at *c* 4900 BP. Charred wheat and barley grains and glume bases were found at Sites D and H3, but probably relate to an occupation later in the Neolithic (Caseldine Chapter 20.9). The small amount of identifiable fauna from Site D includes a possible sheep/goat humerus, and other early fourth millenium cal BC contexts also contain domestic cattle and wild or domestic pig (Armour-Chelu Chapter 20.10). The presence of wild fauna (red deer, elk/aurochs) and of course the shell middens themselves do clearly indicate the continued use of wild resources, and the absence of Neolithic pottery is also noteworthy. With regards to the lithics, the material from the middens is largely undiagnostic, with but a single microlith. A nearby lithic scatter collected in the 1930s is mainly of Neolithic character, though a Mesolithic component is also present (Healey Chapter 20.11).

Taken together the evidence for the interpretation of the Prestatyn skeleton is most parsimonious with a definition as a 'Neolithic' individual. That is, this individual lived and died at a time when new domesticated resources had long been available in the wider region, landscape modification was being practised on a larger and more permament basis, and material technology had changed. This is not to say that there are not elements of a 'Mesolithic' lifestyle evident here as well, but we must be clear what we mean by this. After all, farmers may also hunt and gather. By 3750–3535 cal BC a number of generations had already been living with the new resources and ways of organising themselves.

Nevertheless, despite its date lying firmly within the Neolithic, Prestatyn in many respects could still be said to reflect a transitional situation, incorporating elements of both the old and new ways of living. In such a context the use of the terms 'Mesolithic' and 'Neolithic' can be problematic and overly dichotomise what was in reality a more fluid situation (Pluciennik 1998). Intermittent seasonal use of the coastline for the collection of shellfish and terrestrial game hunting in the near-coastal zone are likely to be practices with great antiquity. The addition of some domestic animals may initially not have had that great an impact in some areas (though any serious commitment to keeping viable herds of livestock, and growing cereals, would presumably have prompted a decision to emphasise either hunting and gathering or mixed farming).

Unfortunately, the nature of the Prestatyn burial cannot be determined, or even whether it was an intentional burial. If it was intentional, the find takes on additional interest as an alternative burial practice to that of interment in mortuary monuments. As has often been noted (Kinnes 1975; Megaw and Simpson 1979), mortuary monuments can include only a very small proportion of the population that must have lived in their vicinity for the millennium that makes up the early and middle Neolithic. This raises the question of where the remainder of the population was buried. Needless to say, unmarked flat graves (assuming it is an intentional burial) like Prestatyn would be very difficult to find, and even when found, would be next to impossible to date typologically in the absence of grave goods.

Cave burial is a more common alternative form of burial known for the early/middle Neolithic, and is being increasingly recognised as an important feature of this period (Chamberlain 1996; 1997; Lynch 2000; Barnatt and Edmonds 2002; Schulting and Richards 2002a; Schulting 2004). In fact, middle to late Neolithic dates have been obtained on three humans from Gop Cave, located only some 10km from Prestatyn, and just a few hundred metres away from the better known massive Gop cairn, which may also date to the Neolithic (Davies 1949; Boyd Dawkins 1901; Barnatt and Edmonds 2002) (Table 20.2). Perhaps surprisingly, the three dates obtained do not overlap with one another at two sigmas, indicating the use of the site over a number of centuries, possibly as wide-ranging as *c* 3500–2900 BC; bearing in mind that some fourteen individuals are represented (Boyd Dawkins 1901), the span of use might be considerably greater than even this. As with Prestatyn, the associated $\delta^{13}C$ and $\delta^{15}N$ values suggest individuals with typical terrestrial diets. The most recent individual, however, is similar to Prestatyn in having slightly elevated isotopic values indicating the possiblity of some marine input (Fig 20.20). As more Neolithic burials from non-monumental contexts are identified, it should be possible to investigate further the relationship between different burial options. On the basis of current evidence, it does not seem that those interred in monumental and non-monumental contexts had significantly different diets (Schulting 2004).

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20.13 Investigations at Melyd Avenue, Prestatyn *by M Bell, A E Caseldine, J Norris-Hill, and D Thomas*

This site at SJ 063818 is 1.4km south-west of Nant Hall Road (Fig 20.2). Excavation of a later prehistoric site and Romano-British bathhouse and industrial complex here in the 1930s and 1970s–1980s revealed traces of Mesolithic and Neolithic activity associated with peat (Newstead 1937, 1938; Blockley 1989). This site was also the subject of housing development and a small-scale excavation was carried out here in 1992 in tandem with work at Nant Hall Road to provide the palaeoenvironmental dimension not provided by earlier work on this site. Although evidence for Mesolithic and Neolithic activity is limited here, it provides a comparative perspective to Nant Hall Road enhancing our understanding of the wider Prestatyn landscape. The full results of work at Melyd Avenue will be published elsewhere but those aspects relevant to the themes of this monograph are summarised on CD 20.36–20.44 with a summary of the excavation, pollen, and plant macrofossil analysis. Here we highlight some key points relevant to wider interpretation.

The site is on boulder clay at between 15 and 8m OD; its lower part includes up to 3m of stratigraphy with quartz sand overlain by wood peat and peaty silts. Excavations by Newstead (1937; 1938) produced 68 artefacts of flint and chert, five from peat and the rest from a charcoal-rich prehistoric layer above peat. The lithics included some pieces which appear to be Mesolithic and a Neolithic polished axe. A further assemblage of 122 lithics came from the 1884–85 excavations and included a single microlith of later Mesolithic date (Berridge 1989). Our interpretation of the lithic finds from earlier excavations suggests that some are likely to be *in situ* below and within peat – others may be from colluvial deposits reworked, probably from a little up-slope, as a result of cultivation, probably in the middle Bronze Age.

Our investigation in 1992 included an environmental sampling pit, which revealed a 2.5m sequence of tufa sand and clay overlain by peat, peaty clay loam and then an artificial Romano-British stone surface. No lithics were found. Pollen and plant macrofossil analysis (CD 20.38–20.44) showed only slight hints of vegetation disturbance in levels infered to be Mesolithic as at Nant Hall Road. Disturbance was greater from 4800 BP but still small-scale, temporary and mainly pastoral. The main clearance was middle Bronze Age with an increase in both pastoral activity and crop growing, as also seen at Nant Hall Road. This was 1000 years before an Iron Age settlement was established at Melyd Avenue (Blockley 1989). At the base of the Melyd Avenue sequence there is evidence for tufa, perhaps Mesolithic and Neolithic activity was attracted by a spring. The quantity of lithic material is modest, given the scale of excavations at Melyd Avenue, and suggests small-scale and short-term activity consistent with the picture of limited vegetation disturbance before the middle Bronze Age.

20.14 Splash Point, Rhyl *by M Bell*

At Splash Point, Rhyl, 5km to the west of Prestatyn (Fig 20.1), many finds of Mesolithic to Bronze Age date were discovered on the foreshore in the early part of the 20th century (Grimes 1951, 140–1; Manley 1982; Manley 1988, 13; Burrow 2003). In 1910, a perforated antler mattock was found 'in blue clay where the tide had worn away the submerged forest' (Davies 1949, 327). This mattock has subsequently been radiocarbon dated to 6560±80 BP (OxA-1009; 5640–5360 cal BC; Bonsall and Smith 1989, table 2; 1990, table 3). Mattocks of this type are concentrated in coastal, wetland, and riverine situations (Zvelebil 1994). Two other Welsh examples from Uskmouth (Aldhouse-Green and Housley 1993) and Ynyslas (Houlder 1994, plate 2) are from intertidal contexts, as is the functionally similar, but unperforated, mattock hammer from Goldcliff East (Chapter 11, 7065). The latter implement is very similar to a description of a 'shed antler with cut tines and a heavy butt end (which) seems to have been used as a mallet' described by Morris (1923) as found on the Rhyl foreshore, but without any specified context. F G Smith (1924, 120) notes the discovery of artefacts of flint, 'similar to those found at Prestatyn', in the Lower Peat. One piece of debitage from the Lower Peat is in the National Museum of Wales (Burrow 2003, 152–4) with a collection of animal bone from the submerged land surface. Three polished stone axes of Neolithic type are recorded as having been found on the beach at Rhyl, on 19 May 1920/1 (Morris 1923), 28 March 1926 and 21 April 1926 (Glenn 1926). The two first clearly come from estuarine clay at Splash Point: the 1920/1 find was *in situ* 15cm (6in) below the peat and the other had blue clay adhering. The third is more enigmatically described as from the 'Rhuddlan foreshore (Rhyl)' although Davies (1949) attributed it to a site 'to the east of Rhyl Promenade' the end of which is Splash Point. The two axes found in 1926 are both described as of Graig Lwyd stone (Group VII), the Neolithic axe factory which dominates the north Welsh coast 32km to the west. Unstratified finds from the Rhyl foreshore include: a bronze chisel and spearhead, both apparently of Bronze Age date; three pebbles with hour-glass perforations and four with incomplete perforations or pecked holes; two perforated stone possible net-sinkers; a perforated oyster shell; and a collection of bones which includes both wild and domestic species (Morris 1923; Glenn 1926; Davies 1949). A further enigmatic reference concerns Smith's (1924) discovery 'near Rhyl at 15 feet OD (4.6m)' of floors with the shell debris of edible molluscs, with animal bones, flints and stones. No more precise location, or further indication as to date, is provided.

Submerged forest peats are still regularly exposed on the foreshore at Rhyl. (See CD 20.45 for a plan of the peats exposed in 2005 and 2006.) When visited on 20 July 2004, the peat exposure A was an area directly north of the viewpoint at the east end of Rhyl promenade. It was 58m seaward and measured 220m E-W and 13m N-S. Three trees were exposed (Fig 20.21; CD 20.46–20.48). At the western end of the exposure, the peat was 4cm thick, trees were rooted in underlying boulder clay but to the east the peat overlay estuarine silts. One main peat layer was exposed but to the east this was divided into two peat layers each *c* 4cm thick by a thin layer of estuarine clay. Just to the east of peat exposure A, were tilted blocks of peat. Experience in the Severn Estuary (eg Allen and Rippon 1997; Allen and Bell 1999) shows that this is evidence for the former existence of a palaeochannel, but the size of this feature is unknown.

When visited on 25–27 July 2005 the exposure at A was smaller but there was a new exposure 350m east at B, measuring 250m by 40m (CD 20.49). The peat surface was clean and numerous deer footprint tracks were visible (Fig 20.22; CD 20.52–20.53)

Figure 20.21 The Submerged Forest at Splash Point, Rhyl, on 20 July 2004 (photo M Bell)

together with a trail of five aurochs prints with a stride length of 1.7m. Five wood samples from the inner peat have been identified by Scott Timpany: 3 are *Quercus*, 1 *Alnus*, and 1 *Salix*. At the west end of this exposure the peat was underlain by estuarine silts, in this were two or three poorly preserved footprint-tracks of humans at SJ 02385 82521 (CD 20.54) together with deer prints. On the same occasion an outer peat exposure at D was visible *c* 250m from the seawall and developed on silt (CD 20.50). Eight samples of wood from this have been identified by Scott Timpany: one is *Alnus*, the rest are *Salix*.

When visited on 22–24 July 2006 the peat at B was exposed but less clean and only traces of animal footprint-tracks could be seen. At SJ 02431 82542 a fragment of a Gronant chert core was found in the Old Land Surface developed on Head and sealed by peat (CD 20.51). B was separated from C by a palaeochannel containing a tree. There was another palaeochannel at the east end of C. On this occasion, peat was also exposed at D at the base of the seawall 700m east of the end of the original Promenade. This is a little landward of a strip of submerged forest marked on the Geological Survey Drift Sheet 95. Some 400m to the east of D, also at the base of the seawall, is the grid reference of the site where Tooley (1978, 27) dated a peat at 2.43m OD dated 4725±65 BP (Hv-4348; 3640–3370 cal BC).

Information on the foreshore stratigraphy and its correlation with borehole records south of the seawall is provided by Neaverson (1935) and Bibby (1940). From the earlier records and the observations of 2004–06 the stratigraphic sequence can be tentatively reconstructed as follows:

Latest
(vi) Estuarine sediments
(v) Upper Peat with Submerged Forest including oaks, probably the peat dated 3640–3370 cal BC; deer and aurochs prints
(iv) Estuarine sediments. Human and deer footprint tracks. *Possible* context of Mesolithic mattock and polished axes.
(iii) Lower Peat and Submerged Forest of willow, *possible* context of flint artefacts reported by F G Smith (1924)
(ii) Estuarine sediments
(i) Boulder clay
Earliest

Figure 20.22 Top: human with deer footprint-track (scale box 7cm); bottom: deer trail at Splash Point, Rhyl on 27 July 2005 (photo M Bell)

The stratigraphy may well be significantly more complex and there may be more than two peats. The peat may originally have thickened to the east. Neaverson (1935) reports that the Upper Peat at that time was 0.9m (3ft) thick. In places, the Upper Peat rests directly on a soil developed on the boulder clay. The coastal topography shows a slight promontary at Splash Point and the foreshore observations suggest that the boulder clay dips to the east below estuarine sediments. The topographic situation may therefore be the margin of a former island, or promontary, of boulder clay with a palaeochannel of unknown size indicated by the tilted peat blocks between peat exposures A and B. It is clear that between 1910 and 1926 a significant site at Splash Point was undergoing erosion. In common with a number of the sites considered here there is evidence of both Mesolithic and Neolithic activity, in this case extending into the Bronze Age. Evidence for human activity observed during the recent visits is limited to the human footprint-tracks and the core fragment. However, as the peat and early Holocene exposures differ at every visit the area could well repay future vigilance.

20.15 Footprint-tracks at Prestatyn Gutter and Point of Ayr

F G Smith (1924) reported finds of chert artefacts on the foreshore at Prestatyn Gutter. A visit on 23 July 2006 showed small exposures of grey Holocene clay at the foot of the shingle beach where it gives way to a level sandy foreshore. The date of this sediment is at present unknown but it is of significance because the sediment surfaces were marked by the footprint-tracks of a bird (CD 20.55) and a two-toed animal, probably an ovi-caprid (CD 20.56). Dr Michael Keith-Lucas (pers comm) of the Botany School, Reading University has also observed deer footprints in foreshore exposures of estuarine silts 5km east-north-east of Prestatyn at Point of Ayr, but when the area was examined in 2004–06 it was covered in sand.

20.16 Conclusions: the Mesolithic/Neolithic transition in the Prestatyn area *by M Bell*

20.16.1 Coastal change and palaeogeography

Sea-level rise was extremely rapid in the early Holocene and by the time of the Bryn Newydd site, 8200 cal BC, it was at about 6.5 fathoms, with a coastline about 14km north of Prestatyn. However, submarine contours show that north of the Point of Ayr there is a stretch of deeper water known as the Welsh Channel over 10m deep. That may represent a palaeochannel of the River Dee which suggests that within 5km north of Prestatyn there were riverine, or possibly estuarine environments at the time of Bryn Newydd. Even so, Bryn Newydd was manifestly not a coastal site but may have had estuarine resources within its daily exploitation territory.

When early Mesolithic activity took place at Rhuddlan *c* 7600 cal BC, sea level was at about –9m (5 fathoms), thus the main coast was about 10km to the north. The buried Holocene valley of the Clwyd at Rhyl goes down to 17.8m (9.7 fathoms). Estuarine environments are therefore likely to have come within 3km of Rhuddlan at the time of its first Mesolithic activity. By the time when the Mesolithic mattock was deposited at Splash Point, Rhyl (*c* 5400 cal BC) marine/estuarine influence was lapping at the edge of the boulder clay island or promontory at Rhyl and the estuary extended up the Vale of Clwyd probably to St Asaph. The Rhyl site was therefore at one side of the mouth of the extensive Clwyd estuary, an area of *c* 34km². The typologically later Mesolithic site at Hendre, Rhuddlan is not radiocarbon dated but must relate to the time of this estuary.

When the first Mesolithic activity took place at Nant Hall Road, *c* 4200 cal BC, the Site A evidence indicates that highwater spring tide marine influence extended to the limit of silt deposition underlying the later peat, ie *c* 45m seaward of the mussel middens. This occurs at the time of Tooley's (1978) marine transgression stage LVI between 4300–3700 cal BC and at that point marine influence here extended further inland than at any stage in the Holocene. At Nant Hall Road that is followed by peat inception *c* 3700 cal BC during a marine regression phase, which is the most marked in the north-west England coastal sequence, and occurs between LVI and LVIa. The dated lower peat at Rhyl, ie above the Mesolithic mattock, relates to the same transgressive stage. The cockle middens are stratified within the peat and are dated *c* 3600 cal BC. Since the mussel middens are earlier than the cockle middens we have hypothesised that the change in midden composition reflects changing coastal ecology from a rocky or stony to a sandy shore. This interpretation is supported by the other environmental evidence and accords with the transgressive/regressive sequence from the wider region (Tooley 1978; Shennan *et al* 1983).

This brings us to the circumstances responsible for later Holocene wetland formation. There is no evidence for further marine influence during the period of peat formation. One possibility is that peat formed behind a precursor to the present coastal dune barrier. Any barrier must, however, have lain significantly to seaward of the present shore. Manley's (1982; 1988) auger transects show sand deposition generally postdated peat, the top of which at Site A is dated *c* 810–403 cal BC. Sand also occurs in some boreholes where there was no peat; here the sand is often at lower OD heights, suggesting perhaps deposition following coastal erosion of peat. On some sites in north-west England the dune barrier is thought to have formed in the later Holocene, post-elm decline or later (Tooley 1990; Pye and Neal 1993), although more recently evidence has been presented for a dune barrier from early in the Holocene (Huddart 1992). Dating the initial formation of dune barriers is problematic because earlier lines formed to seaward at times of lower sea level will generally have been eroded away. In this topographic situation, between the estuaries of the Clwyd and Dee, the existence of the dune barrier to seaward seems the most probable mechanism of wetland inception. The palaeogeographical context inferred for Mesolithic activity at Nant Hall Road is closely comparable to that which existed at the complex of later Mesolithic sites at Eskmeals, Cumbria (Bonsall *et al* 1990; Clare *et al* 2001). Here there were numerous sites along a former shoreline, which at the time of activity, was prograding (ie building up) seawards with a peaty wetland forming behind a coastal barrier. At both Eskmeals and Prestatyn Mesolithic activity extended into the wetland, although activity at Eskmeals on dryland was far greater than at Prestatyn.

Preservation of the Mesolithic and Neolithic sites at Prestatyn owes much to the association of tufa and peat. Springs rich in calcium from the Carboniferous Limestone deposited tufa, which buried the site at Bryn Newydd upslope. Spreads of tufa downslope (Fig 20.2) show that the springs once discharged north to Nant Hall Road and traces of channels with tufa deposits were identified in the excavations of Sites C and D. At some stage that drainage became choked with tufa and drainage was diverted to roughly its present easterly line between Nant Mill Pond and Prestatyn Gutter. At the time when Midden D was in use, and during the later formation of tufaceous silt, there is no evidence of a stream on the site but tufa-depositing waters seem periodically to have extended over the area. Tufa springs represent water sources which were utilised by animals and people alike and there are many cases of their being associated with archaeological sites, particularly in the Mesolithic period (Evans 1972; Preece and Bridgland 1998, 379).

20.16.2 The middens and wider comparisons

Six middens have been identified at Prestatyn: four at the wetland edge composed mainly of mussels, and two within peat composed mainly of cockles. Other middens may not have been located. Pit H3 suggests that some were obliterated by later cultivation. Accumulations of cockles were also reported by Smith 400m away at Bryn Newydd and other possible middens have been mentioned at Rhyl (F G Smith 1924), although their date and location is uncertain. Lithic finds from Bryn Newydd, Melyd Avenue, Bryn Rossa, and Prestatyn Gutter, together with the find of 'Prestatyn Woman' 400m west of Nant Hall Road, indicate that Mesolithic/Neolithic activity covered an extensive area, perhaps 3km by 800m along the wetland edge, within which there were a number of distinct foci.

Despite the strongly coastal focus of the Welsh Mesolithic, middens are poorly represented. The only possible examples are accumulations of shells in contexts which also have Mesolithic artefacts at Daylight Rock and Nanna's Cave, Caldey (Lacaille and Grimes 1955) and at Freshwater West, Pembrokeshire (Wainwright 1959). Other examples are likely to be buried in topographic contexts similar to Prestatyn. Such contexts should be particularly watched especially where they are close to areas which historically have been highly productive of shellfish such as Carmarthen Bay, the Conwy Estuary, and Menai Straits (Jenkins 1984). In some areas, such as the rocky shores of Pembrokeshire and Anglesey, middens close to the strandline will seldom have escaped erosion.

Middens in southern Britain are restricted to those at Westward Ho! in North Devon dated 6000–4800 cal BC (Balaam *et al* 1987b) and Portland dated 6460–5300 cal BC (Palmer 1999). In Scotland middens are much better represented and more substantial in the later Mesolithic with examples on Oronsay (Mellars 1987), Morton (Coles 1971, 1983), Risga (Pollard *et al* 1996), the Oban area (Lacaille 1954), and in the Forth Valley (Sloan 1984; 1989). One factor responsible for the preservation and visibility of these Scottish middens is that they are on the isostatically raised later Mesolithic shoreline, or in the case of some Oban middens, in former sea caves of that shore. The Scottish middens are much larger than the examples from Wales and England. A notable feature of many of the Scottish sites is that there may be evidence for continuity of activity from Mesolithic to Neolithic, as we see at Prestatyn (and may be indicated at Westward Ho! by lines of hazel stakes postdating the midden, which date to *c* 3780–3370 cal BC) (Balaam *et al* 1987a).

20.16.3 People/environment relations and sustainability

The special property of sites with peat and tufa is the opportunity they provide for comparison between a range of sources of palaeoenvironmental evidence particularly in this case, pollen, plant macrofossils and molluscs. At Nant Hall Road it appears that the mussel middens were set about 45m back from contemporary high spring tide level in a largely oak woodland with lime and hazel. Lime is more abundant on Sites B and C nearer dryland. As wetland environments developed over former saltmarsh to the north, alder became the dominant wetland tree. The Westward Ho! midden, which at the time of its excavation was exposed on the foreshore, also originally formed in a woodland a little inland from the shore, again with hints from the beetles for a coastal dune barrier (Balaam *et al* 1987a). At the Culverwell midden conditions were shaded and damp (Thomas and Mannino 1999). Some of the Scottish middens also formed in woodland as at Carding Mill Bay (Connock *et al* 1991) and even the small island at Morton (Evans in Coles 1983). However, the largest complex of late Mesolithic middens on the small exposed island of Oronsay were in a primarily grassy environment with evidence of woodland near one of the excavated middens (Paul 1987). The Northton midden on Harris, which was once thought to originate in the Neolithic but which radiocarbon dates now show began in the Mesolithic (Gregory *et* al 2005), also has evidence for an open environment from the time of the first activity (Evans 1971). Thus, some of the Scottish middens were clearly in more open environments than those of Wales and England. This is consistent both with the much more substantial nature of some Scottish middens, implying greater concentrations of human activity, and with evidence for unwooded areas particularly on the most exposed west coast of the Scottish islands (Bennett 1989).

There are hints of some small areas of more open conditions within the largely wooded landscape of the Prestatyn middens. The molluscan evidence centres on the occurrence of two species. *Ashfordia granulata* is present at between 10–20% in most Mesolithic levels but is seldom found today in woodland. *Vallonia costata* is a mainly open country species which can live in woodland. It is known in woodland at the levels of abundance found in the middens, but not generally in those encountered in the tufaceous marl overlying Midden D. Because it can live in woodland, it is often the first species to expand when small clearings are created. Thus, a small clearance at the tufa site of Blashenwell in Dorset during the Mesolithic was marked by a peak of *Vallonia costata* (Preece 1980). *Vallonia costata* is also notably abundant in the basically wooded environment of the Morton midden in Scotland (Evans in Coles 1983). Hints of some opening in the woodland from these two species gain support from the occurrence of small numbers of other species in the lower part of Midden E (Context 105), the occurrence of *Punctum pygmaeum* and *Trichia hispida*. By the time of the upper context (104) in Midden E, species of open conditions had expanded indicating that the previous modest opening had increased in size.

Prior to Site E, Context 104, the molluscan evidence for openings at the time of the middens is acknowledged to be slight and equivocal. It is, however, significantly strengthened by associated pollen and macrofossil evidence. The pollen likewise hints at small openings within the woodland represented by small reductions in some tree taxa and the occurrence of Poaceae with scattered occurrences of *Plantago lanceolata*, perhaps Ranunculaceae and bracken. The pollen evidence suggests greater disturbance at Site D, which is on the dryland edge. The small-scale nature of disturbance is emphasised by the fact that the later changes seen at Site C are only very slightly represented at Site A further from the dryland edge. Charcoal occurrence suggests the possibility of small-scale burning. The earliest evidence comes from the silt at the base of the Site A sequence where the presence of charred *Phragmites* is reminiscent of the burning of reedbeds seen in the Severn Estuary and elsewhere (Chapters 14 and 19). At Prestatyn, however, we do not see the extensive charcoal spreads seen at Goldcliff or Westward Ho! On the neighbouring north-west English coast of Merseyside on the Wirral and Sefton coast there are also marked episodes of vegetation disturbance and charcoal deposition in the later Mesolithic (Cowell and Innes 1994). At Prestatyn, however, the pollen, plant macrofossil, and molluscan evidence appear in agreement in suggesting only small-scale and temporary disturbance of the woodland in the late Mesolithic and early Neolithic, with some increase in the extent of the cleared areas within woodland during the Neolithic but probably after the main period of midden use (Chapter 20.16.10). The less well-dated Melyd Avenue sequence tells a similar story – again there are hints of small-scale Mesolithic and Neolithic disturbance.

It seems probable, given similar evidence from the Severn Estuary and elsewhere (Chapters 14 and 19), that the small-scale opening of the woodland in the later Mesolithic and early Neolithic is the result of deliberate human action, maybe to encourage particular plant resources. We cannot, however, exclude the possibility that such small-scale disturbance was the result of natural tree throw holes which might have created more open patches attractive for the temporary encampments represented by the middens. Indeed, there is evidence that natural tree holes attracted activity during the mid- to late Neolithic phase in the early 3rd millennium cal BC represented on Site D. The charcoals hint that by this time there was secondary scrubby woodland and the molluscan evidence suggests more open conditions within a still largely wooded landscape after the main period of midden use. Brown (1997) emphasises that natural tree throw areas would be attractive for settlement. It is also possible that the presence of much knapping debris, including flakes from polished axes, represents deliberate votive deposition, a practice documented on a number of sites by Evans *et al* (1999). It is notable that the main clearance of the Prestatyn area, and more intensive agriculture including arable, occurs in the middle Bronze Age at both Nant Hall Road and Melyd Avenue. In this climatically and pedologically favourable coastal belt, it seems that agricultural intensification occurred at the same time as in both lowland (Yates 2004), and parts of upland England (Fleming 1998). This is significantly before the main phase of clearance and agricultural intensification in some areas of inland and upland Wales (Caseldine 1990).

The question arises: did people have any impact on the molluscan resources? CD 20.14 indicated a possible reduction in cockle size between the earlier Midden C and the later Midden B. Size reductions have been reported from a number of midden sequences worldwide, although Claassen (1998, 47) cautions against the common assumption that this is necessarily a consequence of human predation. Instead, she identifies a range of ecological factors such as predation by birds, otters etc, which might produce similar effects. Claassen's conclusion that human predation seldom affects mollusc populations is challenged by Mannino and Thomas (2002) who produce convincing evidence for the impact of predation including that from the Mesolithic midden at Culverwell, Dorset. An important factor in distinguishing the effects of human predation from other factors is that, in the case of human predation, size reduction is accompanied by a reduction in age (Waselkov 1987). At Nant Hall Road, there is some evidence of age reduction as shown on Figure 20.13, so human predation may have had some effect on the cockle population.

20.16.4 Seasonality and sedentism

Many writers have suggested that in the later Mesolithic coastal communities became at least semi-sedentary. The hypothesis is well-supported by a range of evidence from the substantial Ertebølle middens of Denmark (Andersen 2000): semi-permanent settlement has also been suggested on Oronsay (Mellars 2004). There has, however, been a tendency to extend the sedentism hypothesis widely on the basis of very limited evidence. Thus, Bonsall *et al* (1990) argued for semi-permanent settlement foci at Eskmeals; Cowell and Innes (1994) on the Merseyside coast; and Sloan (1984, 1989) for middens in the Forth Valley; Waddington (2003) for Howick in Northumberland; and Mannino and Thomas (2002) for sites in north-west Europe more generally. The problem is that in Britain, with the exception of Oronsay, the advocacy of this hypothesis tends not to be accompanied by detailed evaluation of evidence for seasonality and sedentism. In the case of Prestatyn, the evidence does not support the idea of a sedentary population. The middens are small, the number of artefacts low, and the effect on the environment modest. The evidence is consistent with small-scale, short-term activity. Each of these small middens might plausibly be interpreted as the product of a single short visit.

Taphonomic factors mean that the mussels were too fragmentary to reach any conclusions about the season of gathering. Seasonality studies of the cockles were made difficult by diagenic changes to the shells which meant that only small areas of growth increments could be measured and from these calculations made on the basis of average growth rates. It is known that molluscan growth rates are not uniform through the year (Claassen 1998) so these calculations inevitably involve a margin of uncertainty. However, the study does seem to have produced clear evidence that cockles were mainly collected over a very limited period in spring and early summer with smaller numbers collected in winter. This could be interpreted as distinct winter and spring periods of activity. However, there is no interruption in shell accumulation and the middens are very slight, so it is perhaps more likely that that they are the results of one continuous period of activity extending over late winter and spring. Spring, of course, in these terms means the onset of cockle growth. At Borth, in 1999, growth started some 23 days after the formal onset of spring at the spring equinox. It could be therefore that that activity was largely confined to spring. It has been noted that around the time of spawning in spring shellfish resources have their greatest calorific value. Shellfish are often important to hunter-gatherer communities because they help them cope with the late winter and early spring period when other resources can be scarce, the stored food of winter being exhausted and many of the resources of the summer's growth not yet available. Spring and winter are the times of year when the ethnographic sources indicate shellfish were most exploited (Waselkov 1987, table 3.3).

The seasonality evidence from Prestatyn can be compared to that from other British middens. On Oronsay, a range of sources of seasonality evidence, particularly fish otoliths and seal ages, show that different middens were in use during different stages of the year (Mellars and Wilkinson 1980; Mellars 1987). Periodic visits at various times of year are also evidenced by cockle shell growth increments and other seasonality indicators at Morton (Deith 1983). Marine Mollusca and fish at Ferriter's Cove, Ireland point to activity in late summer and autumn (Woodman *et al* 1999), and at Culverwell shell seasonality suggests activity mainly in late autumn and winter (Thomas and Mannino 1999).

20.16.5 Contribution of shellfish and other resources to the diet

Shellfish middens when they occur are a highly visible part of the archaeological record and this has probably contributed to the emphasis given to hypotheses of coastal sedentism. One advantage of middens is, however, that they do provide us with a sounder basis for quantification of diet than is the case with much palaeoeconomic evidence. It is possible to make a reasonable calculation of the area of each midden, we also know the number of shells of each species per litre of excavated midden. Using this information a calculation has been made of the numbers of shells in the three middens C, D, and E for which we have adequate data. Using the information from Waselkov (1987), the dietary value of each species can be calculated giving the total dietary value of molluscs in these three middens in terms of meat yield, calorific value, protein, fat, and carbohydrate. Midden E was totally excavated so these results are the most reliable. The total number of shells is estimated at 15,300, which would yield 40,847 kilocalories. If we divide that number by the average daily requirement of 2250 kilocalories the midden could have supported a person for eighteen days. If, however, assuming a band of say three adults and three children, then they could have stayed for four days. However, it is improbable that during their stay shellfish was their only, or even main, article of diet. If shellfish contributed 20%, the average of the midden-forming Anbarra communities documented by Meehan (1982), then that band could have stayed for around 21 days. Plant resources would also have made a contribution represented by charred *Rubus* seeds, a hazelnut fragment, and the presence of cereal grains in a context postdating the midden on Site D. Other plant resources present in the area are likely to have been utilised and these potential assets are more fully discussed in relation to similar sites in the Severn Estuary (Chapter 18.11.2).

There is no evidence for fishing despite the sieving of many samples. It is particularly difficult to evaluate the contribution of hunted vertebrates. A few bones of red deer, cow and pig, and possible sheep/goat were present in the middens. One deer, or aurochs, would have provided a far greater dietary input than all the shells in the midden. What we do not know is whether the few bones are all that remains of animals hunted and at least partly consumed at the site, or joints of meat brought from elsewhere for the coastal sojourn. The animal footprint-tracks present at Rhyl, Prestatyn Gutter, and Point of Ayr, as in comparable coastal contexts in the Severn Estuary (Chapter 12) and in intertidal contexts at Formby just 31km north-east of Prestatyn (Fig 1.1; Huddart *et al* 1999), emphasise the rich animal resources of coastal wetlands. Whatever the uncertainties of quantifying contributions to the diet, the shellfish evidence is consistent with a substantial body of ethnographic evidence, which shows that shellfish are generally a supplement to the diet rather than the main basis of subsistence (Bailey 1975). The palaeoeconomic evidence as a whole supports the environmental evidence in demonstrating that activity at the Prestatyn middens was small-scale and short-term.

20.16.6 Settlement types

This raises the question of how the Nant Hall Road site related to a wider settlement system. One possibility is that the middens were what Meehan (1982) has called 'meal time camps': places where people stopped for a meal near the shell beds. Meehan records that sometimes these were only a short distance from the main settlement. The evidence is not consistent with this interpretation: the numbers of shells and the cockle seasonality evidence suggests activity over days or weeks. There is other artefactual evidence: a few mammal bones, lithics, and heat-fractured stones which suggest a stay greater than a few hours. Healey (Chapter 20.11) suggests the possibility that the middens may be a specialised aspect of the settlement pattern with the main occupation site represented by the flint scatter of the Smith collection, which was within 100m of Site D. If that had been a large settlement, or one occupied for an extended period, shell gathering over a longer period may be expected along with more artefactual evidence. The evidence is more consistent with a relatively short-term extraction or activity camp occupied briefly but repeatedly, in order to exploit particular resources. This would have taken place within a wider settlement pattern of logistical mobility in which base camps occupied for longer periods would have been supported by short-term activity camps (Binford 1988; Peeters 2002). Most of the other sites in the area, the lithic scatters at Prestatyn Gutter, Splash Point, Rhyl, and Melyd Avenue, appear to be modest scatters consistent with short-term activity camps. The few Mesolithic artefacts from the Clwydian upland above Prestatyn at Gwaenysgor (Glenn 1914) and Gop Cave (Burrow 2003) may derive from hunting or other short-term activity camps.

The only really likely candidate for a base camp in the area, with longer-term, but not necessarily sedentary use, and the broader range of activities which that implies, is the excavated complex of sites at Rhuddlan. This covers an area of *c* 8ha and has been identified as a multiple focus site (Manley and Healey 1982, 5). There are hints of timber structures on some sites (Quinnell and Blockley 1994). Rhuddlan has both earlier Mesolithic material *c* 7600 cal BC (Berridge 1994) and a separate concentration which is typologically later (Manley and Healey 1982). The Rhuddlan sites have larger numbers of lithics than others in the area and a more diverse range of artefact types suggesting the broader range of activities expected at a base camp. Discovery at the earlier site of art in the form of decorated pebbles (CD 20.58) also serves to suggest the particular social significance of this site. It may not be too implausible to associate art with social communication and thus the activities associated with an aggregation camp where concentrations of people came together for periodic occupancy (Peeters 2002). A periodically occupied base camp, or aggregation camp, is favoured here over the model of coastal sedentism. This is partly because all the other sites in the area seem to better fit a model of short-term seasonal use. In particular, sites from upland areas, such as Brenig (Lynch 1993, 32) do not have the specialised toolkits which might be expected from short-term hunting visits by segments of the community. This makes it more probable that the whole group, or most of it, visited the upland for part of the year.

20.16.7 Burials, diet, and settlement pattern

Radiocarbon dating has now shown that the 1924 find of 'Prestatyn Woman' is contemporary with the later cockle middens nearby at Nant Hall Road and that date is consistent with its position in a comparable stratigraphic sequence. The isotopic evidence presented by Schulting and Gonzales indicates that only a small proportion of that person's diet was derived from marine resources. That accords with the evidence from the midden for short-term seasonal use of coastal resources even after the beginning of the earliest Neolithic in Wales (Chapter 20.16.10). These factors are significant because the assumption is often made that burials in the Mesolithic indicate coastal sedentism: the identification of a community with a particular long-term focus of settlement. In Denmark that hypothesis is well-supported by a range of evidence for intensive and year-round settlement (Andersen 2000). In western Britain there is some evidence for Mesolithic burial in caves and, after a distinct gap in the late Mesolithic (Chamberlain 1996), the practice recurs in the Neolithic (Schulting 1998). There is little evidence to suggest sedentary occupation directly associated with these caves. Some, notably on Caldey, have evidence of Mesolithic occupation but in no case does the concentration of artefacts imply sedentism. The isotopic evidence for a strongly marine diet on Caldey suggests, however, much of the year was spent on the coast (Schulting and Richards 2002a). The pattern is more consistent with short-term activity sites as at Prestatyn. In north Wales human remains have been found in the cave at Pontnewydd, 13km south-south-west of Prestatyn and these date both to the Mesolithic (7420±90 BP: OxA-5819; 6440–6080 cal BC) and the Neolithic (4495±70 BP: OxA-5820; 3370–2920 cal BC; Aldhouse-Green *et al* 1996). At Gop Cave, 3.6km south-east of Prestatyn, there were at least fourteen Neolithic burials in a chamber built in the cave; associated artefacts indicate a date after 3400 cal BC (Burrow 2003), ie after the midden phase at Prestatyn but possibly at the time of the later Neolithic activity. There are also Neolithic human remains at Orchid Cave, near Mold, 28km inland (4170±100 BP: OxA-3817; 3050–2450 cal BC). The practice of cave burial in this area, as elsewhere in western Britain, overlaps with, and continues after, the main use of megalithic tombs from 4100 cal BC (Schulting and Whittle 2001). There are seven megalithic tombs along the coast of north Wales. Of these only Tyddyn Bleiddyn is as close as the Vale of Clwyd, *c* 12km south-west of Prestatyn (Cummings and Whittle 2004). In addition to megalithic tombs there is a huge cairn at Gop for which a Neolithic date is possible (Britnell 1991).

20.16.8 Movement and territories

The working hypothesis suggested by evidence from the Prestatyn area is a settlement pattern of logistical mobility, ie with seasonal base camps and short-term activity areas, elements at least of this pattern apparently continuing into the first 600 years of the Neolithic. What then can be deduced about the pattern of these people's movement? Here as in south Wales the types of lithic raw material used provide valuable evidence. In drawing on this evidence we do, however, need to keep in mind that lithic procurement does not necessarily relate to an individual community's movement, it may be supplemented by the exchange of lithics between communities as is well attested in the ethnographic literature. This is especially evident in the Neolithic period when it is clear that particular rock types, and outcrops, had a social significance beyond their utilitarian properties (Edmonds 1995; Bradley 2000).

Two lithic sources were of particular importance in this study area. Beach pebble flint originated from the Irish Sea Till, which extended to the coast of north-east Wales and up the Vale of Clwyd to Denbigh (Jenkins 1991). The other is black and banded Carboniferous Limestone chert which outcrops near Gronant *c* 2.5km east of Prestatyn at *c* 90m OD (Sargeant 1923). The outcrop is about 2km by 2.5km in area and includes exposures in recent quarries (CD 20.57). Chert also outcrops in a very narrow discontinuous band down the east side of the Clwydian Range but it is highly likely that the main source was the rocky outcrops above Gronant. That was the main raw material used at the Bryn Newydd site. It also dominated the assemblage from Prestatyn Gutter (F G Smith 1924) and formed 47% of the 1984–85 Melyd Avenue assemblage (Berridge 1989, 24). Carboniferous chert was extensively used at Rhuddlan and at assemblages inland up the Clwyd Valley at Ruthin (Brassil 1992) and Tandderwen (Brassil *et al* 1991). Chert was also an important component of assemblages in the upland of Hiraethog at such sites as Llyn Aled Isaf (Brassil 1989) and the Brenig Valley (Healey 1993) which are 30km south-west of Prestatyn. Activity at Brenig is dated 7650±80 BP (HAR-656; 6650–6370 cal BC); 7300±100 BP (HAR-1135; 6390–6000 cal BC) and 7190±100 BP (HAR-1667; 6250–5840 cal BC; Lynch 1993). Pebble flint is the other raw material used at these sites, which emphasises the link between their occupation and coastal activity. If chert procurement relates mainly to territory rather than exchange then it implies a territory ranging round the former estuary of the Clwyd and up to 30km inland to Hiraethog. There are hints of wider patterns still. North Wales chert was used on the opposite side of the Dee Estuary at sites on the Wirral and Sefton coasts, respectively 20km and 30 km north-east of Prestatyn. These have been hypothesised to relate to a time when Liverpool Bay and the Dee Estuary was dry land and groups migrated seasonally across that area (Cowell and Innes 1994). A few pieces of Gronant chert are also represented on sites as far to the west as Aberffraw on Anglesey, 75km away (Ireland and Lynch 1973).

What is particularly notable is that the later Mesolithic and early Neolithic middens and related contexts at Nant Hall Road have only a small proportion of chert. The greater use of beach pebble flint may be explicable in terms of the coastal focus of these people's activity: they are likely to have come across suitable pebbles whilst strandlooping. Even so, it is notable that they did not make greater use of the local chert. It is thus improbable that the episodic later Mesolithic and early Neolithic visits to Prestatyn were primarily for the purpose of lithic procurement. This is a significant conclusion because elsewhere as at Morton, Scotland (Deith 1983) and Culverwell, Portland (Palmer 1999) shellfish gathering has been seen as a subsistence activity associated with visits primarily for lithic procurement. The limited use of chert at Nant Hall Road might even be stretched to advocate that late Mesolithic and early Neolithic Prestatyn lay at the western edge of the annual territory of a group habituated to the use of pebble flint from Irish Sea sources. However, that is probably pushing the evidence beyond what the small sample of lithics from the site will allow.

20.16.9 A model of settlement patterns

Drawing together the evidence for activities, seasonality, movement, and environmental relations, we can develop a hypothetical model of logistical mobility. There are two types of assumption that we need to make in order to develop a rounded picture. Both are to varying degrees questionable, so they need to be made explicit from the outset. The first concerns the need to infer additional resources which are not represented by the archaeological record, but are highly likely to have been available. In identifying these resources we must keep in mind that dietary preference and social avoidance may mean that resources which were abundant were not used. The second assumption relates to the patchiness of known sites in time. In order to relate known sites of different dates to a wider settlement system we must to some extent assume that where we have a site in a particular topographic context occupied for a period, there are likely to be sites in comparable locations used in similar ways during other periods. This assumption may be partly justified by the long periods of activity represented at several of the sites but there must also have been significant settlement pattern disruption as a result of sea-level rise.

For the early Mesolithic about half of the potential exploitation territory is now below the waters of Liverpool Bay, consequently the picture of settlement patterns is particularly fragmentary. The pattern of raw material use does, however, suggest that territories may have extended across the Dee Estuary to the Wirral and Sefton areas. To extrapolate from the later Mesolithic, we may envisage the use of now drowned short-stay coastal sites and the probability of base camps in the river valleys of the Dee and Clwyd with expeditions in summer to the uplands of Hiraethog. When the drowning of Liverpool Bay was well advanced (Fig 1.4), occupation took place at the Bryn Newydd site. It may have been a seasonal base camp, possibly occupied in winter, to judge from the presence of hazelnuts. They may have exploited animals coming to a spring, represented by the tufa, to drink and the camp would have overlooked what was then the headwaters of the Dee Estuary and animal movement within that valley.

With the establishment *c* 7500 cal BC of something corresponding to the present topographic context we have more evidence from which to reconstruct the settlement pattern. A main, but apparently not permanent, base camp in the Rhuddlan area has been suggested. This would exploit the richest habitat of the area, the Clwyd Estuary, which it overlooked (Manley 1982). An important, but undocumented, resource is likely to have been migrations of salmon and eels up the River Clwyd. Jacobi (in Berridge 1994) has plausibly suggested that the decoration on one of the Rhuddlan pebbles (SF6, CD 20.58) represents a basketry fish trap such as is well known from Mesolithic sites in Denmark (Pedersen 1995). Traps have been inferred from fish size in the Severn Estuary (Chapter 13). Some salmon are likely to have been around all year but the main runs are likely from April to early autumn. Young eels or elvers would have migrated in April. From a base camp at Rhuddlan part of the group made expeditions to the coast eastwards including Prestatyn in late winter and early summer. Those involved in these expeditions are likely to have been mostly woman and children, since almost universally they carry the main responsibility for shellfish gathering (Meehan 1982; Claassen 1991). There is evidence that these visits involved small-scale modification of their environment, perhaps to increase plant resources useful on expeditions later in the year when shellfish were not collected.

Visits to the coast may have lasted just a few days. In late May or June the entire group may have decamped up the Rivers Clwyd or Elwy to seasonal pastures new on the upland of Hiraethog. This upland area *c* 360m OD, was a partially open landscape in the late Mesolithic and Neolithic (Hibbert 1993). Grassy areas are likely to have been created by a combination of exposure and grazing pressure by wild herbivores. Elsewhere these factors were augmented by the burning activities of Mesolithic communities (Chapter 21; Caseldine 1990), but at Brenig, Hibbert (1993) found no evidence of burning or deliberate Mesolithic clearance. The main resource offered by this area is likely to have been deer and other animals attracted by lush seasonal growth of herbage beyond the treeline. Activity in the upland is likely to have been concentrated between June and August. Healey (1993) notes that the lithics indicate a range of activities taking place at Brenig suggesting some duration to occupation. Maybe activity continued into autumn, or involved separate short visits in autumn or winter because hazelnuts were found at Brenig Site 53 (Lynch 1993).

By late summer, most of the group had probably returned to the Clwyd Estuary at Rhuddlan, or similar sites. Here they are likely to have exploited the seasonal runs of salmon, eels, and other fish. The rich resources available at this time are perhaps the most likely time of year for population aggregations involving different groups in social interaction. In the autumn, nuts, berries, and other plant foods would be collected and sufficient stored reserves laid in for the winter. Perhaps late summer and autumn saw logistical expeditions to the Dee Estuary where, even today, there is a colony of 450 grey seals, which would be easily hunted when hauled out on breeding sites in September. The group is likely to have been based in the main base camp on the former Clwyd Estuary through the winter. Here there would have been vast flocks of migratory birds. From here, expeditions would have taken place up to the Clwydian Range and up the River Clwyd, perhaps involving visits to such sites as Tandderwen (Brassil *et al* 1991) and Ruthun (Brassil 1992). This model is, of course, no more than a hypothetical jigsaw of which only certain pieces are represented by the archaeological record. Its main value is perhaps to highlight possible patterns that can be tested by future work.

20.16.10 The Mesolithic/Neolithic transition

The Prestatyn middens are of special interest because the distribution of radiocarbon dates (Fig 20.5) spans the period of the latest Mesolithic and the earliest sites classified as Neolithic. Among the earliest Neolithic sites are megalithic tombs. In England and Wales none of the dated tombs predate 4100 cal BC and most fall in the range 3900–3100 cal BC (Schulting and Whittle 2001). Dates for the earliest pottery, eg at the Sweet Track 3807 BC on the Somerset Levels (Hillam *et al* 1990) and charred cereal grains (Brown 2005) point to dates for the initial Neolithic *c* 4000–3800 cal BC. The earliest certain evidence of cereal cultivation at Nant Hall Road is on Site D, Context 22 in a layer of tufa marl above the palaeosol dated 3906–3534 cal BC which seals the midden. Context 22 predates the tree throw pit dated 3200 cal BC so it is reasonable to suggest some use of cereals at the time of the later cockle middens. A notable find of a domestic cattle bone from Ferriter's Cove, Ireland is dated 4495–4165 cal BC (Woodman *et al* 1999), so the possibility of the earlier introduction of cattle to Britain needs to be kept in mind. There is a tentative identification of sheep or goat from Nant Hall Road Midden D, but being tentative, no great significance can be attached to that. Cow bones from post-midden layers at Sites D and E might be wild or domestic.

The evidence suggests that groups were using Prestatyn in very similar ways between 4600–3400 cal BC. Many of the other coastal sites in the area, which lack the stratified evidence of continuity seen at Nant Hall Road, nonetheless provide evidence of activity in both the Mesolithic and Neolithic, as at Bryn Newydd, Melyd Avenue, Bryn Rossa, all at Prestatyn and Splash Point, Rhyl and Rhuddlan. This is also a characteristic of the lithic scatters on the opposite side of the Dee in the Wirral and Sefton, Merseyside (Cowell and Innis 1994). The overall picture is therefore comparable with that described in Scotland where Armit and Finlayson (1992) identify a number of sites that were being used in similar ways across the conventional Mesolithic/Neolithic divide, including several middens. Armit and Finlayson advocate a model of gradual transition. The north Welsh and Scottish evidence is consistent with current syntheses of this period which challenge earlier models of full sedentism and a fully agrarian economy from the early Neolithic. Rather they propose a gradual transition with continued mobility, use of wild resources alongside domestic animals, and some small-scale crop growing (Whittle 1996; Thomas 1999). Nant Hall Road brings a degree of chronological precision to the transition by indicating that the seasonal use of this site ended *c* 3400 cal BC.

Midden E comprised two distinct layers, the lower (Context 105) with dense mussel shell, the upper (Context 104) a scatter of mussel shell in a soil matrix. The shell became progressively more diffuse away from the centre of Context 105, suggesting that Context 104 may represent disturbance of Context 105. The plan of the midden surface hints at alignments of shell fragments in 104 trending west-north-west to east-south-east (Fig 20.11), with less distinct alignments at right angles to this. This suggests that the surface of the midden has been affected by cross-ploughing, a practice which is generally associated with the scratch ploughs of prehistory (Fowler and Evans 1967). Significantly there is no mention of shell occurring in the overlying clay loam (Context 103), nor are there obvious shells in the photographs in this overlying layer (CD 20.9). Cultivation may therefore have taken place soon after the time of the midden and before burial by clay loam sediments. Context 104 was only 1–6cm thick so that would imply shallow cultivation. Disturbance by cultivation is consistent with the section (Fig 20.11) which shows an Old Land Surface below the midden in slightly lower areas but not where the underlying drift is slightly raised. Land molluscs from Context 104 indicate that slight woodland disturbance attested at the time of Context 105 had by this stage enlarged.

A literal interpretation of the radiocarbon dates would be that the date for Context 105 relates to the making of the midden and that the date for Context 104 of 5110±80 BP (CAR-1422; 4250–3700 cal BC) relates to the hypothesised subsequent cultivation phase. However, that would make this evidence for cultivation significantly earlier than the earliest well-stratified cross-ploughmarks in Britain, in the old land surface below the South Street long barrow in Wiltshire, dated 4760±130 BP (BM-356; 3800–3100 cal BC). In order to accept the date for Context 104 we must, however, assume that wood charcoal was incorporated in the soil at the time of its cultivation. We cannot be confident about that, because just as shells were reworked into Context 104, so too charcoal from the midden, or some later phase of activity, could have been incorporated. The cultivation phase could therefore relate to a later phase of Neolithic activity, perhaps that represented by cereal grains on Site D. The molluscan evidence indicates that this occurred in a small clearing in a largely wooded landscape, making it unlikely that it is as late as the agricultural phase represented by a largely open middle Bronze Age landscape at Site H3.

The occurrence of a small cleared area with cultivation on the site of the midden is unlikely to be coincidental. Claasson (1998) notes that old middens may be attractive to people because of the distinctive calcareous vegetation that grows on them. Guttmann (2005) has demonstrated from micromorphological and other sources that middens in Scotland, the Scottish Islands, and Orkney were cultivated because of the calcareous and nutrient-rich soil which would have existed where middens were located. This may have been one of the factors which brought people back repeatedly to these places.

Also relevant to issues of continuity is the evidence of polished stone axes. The earliest flake from these is found in peat, Context 6 on Site C dated *c* 3800 cal BC below the midden. There are also four flakes in tree throw feature 16 on Site D dated 2920–2518 cal BC. Each of these artefacts is from contexts postdating 4000 cal BC, which fits the interpretation that they are Neolithic. However, there is evidence from Nab Head in south-east Wales (David 1990) and an abundance of better stratified evidence from Ireland for the use of ground stone technology in the Mesolithic (Woodman 1985). There are a further six polished axe fragments from Smith's Nant Hall Road collection and a cluster of nine Neolithic axes from the Prestatyn area including finds from Bryn Newydd, Prestatyn Churchyard, Melyd Avenue, and Splash Point, Rhyl. Lynch (2000) observed that this axe cluster included material from a number of geological source groups indicating connections with diverse groups perhaps via seaboard communication. Axes from various sources, local and distant, are likewise represented at the later Neolithic ritual complex at Llandegai (Lynch and Musson 2001).

Reconstructing the settlement pattern for the Neolithic is perhaps more tenuous than the later Mesolithic. It appears that similar patterns of mobility continued for *c* 600 years after 4000 cal BC. The extent of mobility may have reduced, since there is, for instance, little evidence of Neolithic activity on the upland at Brenig (Lynch 1993). This is consistent with a somewhat curtailed pattern of movement involving an increasing number of small openings within woodland that the environmental evidence indicates after *c* 3800 cal BC (Caseldine 1990). At Nant Hall Road some cereal cultivation may have been practised in small cleared areas from the time of the later middens, or a little later, but there is no clear sign of a fundamental change in the character of the settlement during the period of midden use.

This is not to argue, however, that Neolithic communities were all necessarily mobile. This has been argued in some parts of Britain, such as Wessex, where houses appear to be lacking. That proposition does not fully accord with the emerging picture from Wales, where some substantial wooden structures have an arguably domestic function. 50km to the west, in a not dissimilar coastal topographic situation at Llandegai, are two substantial rectangular wooden structures one dated 3900 cal BC (Lynch and Musson 2001). Another possible Neolithic structure is represented at Moel y Gaer, 20km to the south-east, dated 4944 ±40 BP (SRR-497; 3800–3640 cal BC; Britnell 1991). Others occur in Wales at Clegyr Boia (Vyner 2001) and in association with domestic animals and charred cereals below the megalithic tomb at Gwernvale 5050±75 BP (CAR-133; 3980–3660 cal BC; Britnell and Savory 1984). Aspects of these structures are comparable with the Neolithic rectangular buildings now being identified widely in Ireland and Scotland (Grogan 1996). It is notable that the Welsh examples suggest these structures existed from very early in the Neolithic. It may be argued that Gwernvale and Llandegai are on sites which later unquestionably had a ritual function. However, there is no evidence of such a function during these early phases and there is good evidence for the establishment of megalithic tombs on sites with long histories of earlier activity, not least at Gwernvale itself (Chapter 21.12). If this line of reasoning is accepted then at least two hypotheses suggest themselves. One is that some communities became mainly sedentary after 4000 cal BC but continued a degree of seasonal logistical mobility. The existence of substantial rectangular buildings implies a home base, but not necessarily year-round occupation by the whole group, as seasonal mobility associated with the great cedar wood houses of the American North-West clearly shows (Ames and Maschner 1999). An alternative proposition is that for the first 600 years or so of the Neolithic some groups settled down and built rectangular structures whilst others maintained an essentially Mesolithic pattern of logistical mobility. On balance, this latter scenario might best fit the Prestatyn evidence. However, as Dr Schulting argues (pers comm), that model is rendered unlikely by an absence anywhere in Britain of microliths securely dated after 4000 cal BC.

Later in the Neolithic around 3400 cal BC descendents of those who had once visited the site seasonally may have budded off from their community to adopt this spot as the focal point for their activities, which by this time involved a greater commitment to farming. It is at this stage that we get increased opening of woodland perhaps at the time of the activity at the tree throw hole on Site D and the cross-ploughing at Midden E. The apparent deliberate deposition of debris from knapping elsewhere in the Site D tree throw hole is reminiscent of deliberate middening in tree throw holes seen on a number of Neolithic sites such as Barleycroft, Cambridgeshire; this was interpreted there as part of a Neolithic woodland-based way of life involving settlement mobility and short-term sedentism (Evans *et* al 1999). It may be that much of the Smith lithic collection relates to a later phase of more settled activity.

The most enigmatic element of the local Neolithic settlement pattern lies 1.4km south of the Nant Hall Road site but high above Prestatyn in the uplands at between 150–200m OD at Gwaenysgor (Fig 20.1). Poorly documented excavation of this hilltop site by Glenn (1914, 1935) produced polished axes, leaf arrowheads, a total of 1500 lithic artefacts and Neolithic bowl pottery (Burrow 2003, 158–9). The finding of cockles and oysters might link this upland site with coastal exploitation, although given the stratigraphic uncertainties we cannot be confident the shellfish and lithics were associated. Glenn thought he had found evidence of walls and terraces but subsequent work by Powell (1955) indicated these features were recent and that the site had been largely destroyed by a combination of agriculture and the earlier excavation. Given the discovery of several axes and leaf arrowheads the possibility should not perhaps be totally excluded that this represents some sort of focal site or even enclosure, but whatever its nature it is not clear how it relates to initial seasonal and later perhaps permanent settlement on the coastal lowland below at Nant Hall Road.

21 Mesolithic coastal communities in western Britain: conclusions *by Martin Bell*

21.1 Introduction

The foregoing chapters have reviewed the Mesolithic and initial Neolithic coastal communities of Wales and adjoining areas and the sedimentary contexts associated with evidence of these periods, considering particularly submerged forests, intertidal peats, and related coastal contexts (Chapter 1). The results of detailed archaeological and palaeoenvironmental investigations at Goldcliff East have been presented (Chapters 2–18). These results have been compared to smaller-scale investigations of comparable Severn Estuary sites at Llandevenny, Woolaston, Oldbury, and Hills Flats (Chapter 19). Excavation of a sequence of middens at Prestatyn, north Wales, stratified within a coastal wetland and tufa sequence has provided the opportunity for palaeoenvironmental analysis and reappraisal of earlier finds from north-east Wales made over the last century, in particular intertidal finds from Rhyl (Chapter 20). The main evidence from this range of sites spans the period from 6000 cal BC to 3000 cal BC. It provides a new perspective on the archaeology of the later Mesolithic and the transition to farming in western Britain.

This concluding chapter synthesises some of the key themes which emerge from the sites investigated and from comparison with other sites in the area. The role of coastal sedimentary contexts in preserving well-stratified sequences with organic artefacts and environmental evidence is highlighted, as is the contribution of submerged forests to the development of more precise chronologies of human activity and environmental change. The interplays between natural disturbance factors, fire, and human agency are considered. Also reviewed are the types of Mesolithic settlement and activity areas, evidence for Mesolithic territories, seasonality and patterns of movement, and finally the transition to agriculture.

The chapter concludes with a bullet point outline of what the writer considers to be the main weaknesses (Chapter 20.13) and the main strengths (Chapter 21.14) of the research reported here. It is hoped that, in the self-reflexive spirit advocated by Hodder (1999), this will be helpful to those evaluating the present project or planning future research.

21.2 The coastal archaeological record

In Chapter 1 some of the key sedimentary contexts containing evidence of Mesolithic archaeology were identified (Fig 1.3) with a particular focus on evidence from the intertidal zone. Using Admiralty charts it is possible to reconstruct in a general way the palaeotopography and inundation history of the landscape drowned by Holocene sea-level rise (Fig 1.4). This basic submarine contour information does not allow for erosion or deposition in the Holocene. It is possible to take this into account using evidence from submarine cores and the increasing availability of submarine geophysics. For instance, data obtained by the oil industry has recently been utilised in reconstructing the Mesolithic palaeotopography of the North Sea (English Heritage 2006). On a much smaller scale a combination of submarine boreholes and geophysics has been used to reconstruct the formation of the Menai Strait as Anglesey became an island (Scourse and Roberts forthcoming). In the Severn Estuary such work has not yet been undertaken, although there is relevant borehole data, for instance obtained in the 1980s as part of the environmental assessments for the proposed Severn Tidal Barrage. These are subject areas with future potential. The palaeoshore reconstructions in Figures 18.2–18.3 draw on evidence from submarine contours, intertidal exposures, and information on the Holocene pre-inundation topography provided by borehole surveys on the reclaimed wetlands.

Submarine landscapes are becoming an increasingly important focus of archaeological research, with a growing heritage agency involvement in maritime archaeology leading to a developing technical capability to explore landscapes below the sea (Flemming 2004; English Heritage 2004). These developments will make it increasingly possible to explore the drowned earlier Mesolithic landscapes between 9500 and 6000 cal BC which precede those of the later Mesolithic discussed here. Our focus here, however, has been on the more accessible, but until recently equally neglected, archaeological resource of the intertidal zone.

Perhaps the most frequently exposed context in which artefacts are found are old land surfaces that have been subsequently buried by coastal sediments. These often began as dryland sites but are particularly important, being much better preserved than those which have remained dryland and have been subject to active pedogenesis for upwards of 6000 years (Murphy 2004). Goldcliff Sites A, B, J, and W; Llandevenny; Oldbury; and the Prestatyn mussel middens all began as dryland sites. Theoretically artefacts from these old land surfaces might relate to any part of the Mesolithic up to the time of burial. However, the available dating evidence, supplemented by artefact typology, indicates that the first focused activity on those soils relates to the period immediately preceding marine transgression when the sites were a little above the limits of normal tidal influence. Goldcliff was settled when it became an island at high spring tide. Here the Old Land Surface became waterlogged and peat-covered during the time of continuing Mesolithic activity. The preservation of wooden artefacts in the Old Land Surface and estuarine sediments at Site J highlights the archaeological potential of these intertidal contexts. Palaeochannels also emerge as an important context with evidence of a fragmentary wood structure at Goldcliff Context 332. It is surely only a matter of time before a palaeochannel reveals a well-preserved fish trap, dugout canoe, or other artefacts. Similar potential exists in the banded sediments which have been such a rich source of footprint-tracks at Goldcliff. Footprint-tracks have also been found in the Old Land Surface at Site J and on peat at Sites J and F. Footprint-tracks occur at many other sites in the Severn Estuary (Allen 1997b), and are also present at Westward Ho! (Scales 2006), Formby (Roberts *et al* 1996), Pembrey (Strahan 1907a), and Rhyl (Chapter 20). It is probable that footprint-track evidence is preserved far more widely than is generally appreciated. This study has also served to emphasise the potential of wetland edge sites as at Goldcliff, Prestatyn, and the wetland edge sites investigated by Brown (2005; Chapter 19). Such sites produce well-preserved sequences, with the advantage that some of them are less deeply buried and can be more easily and cheaply excavated using conventional archaeological methods than some of those in the intertidal zone, as the excavations at Prestatyn and Llandevenny show.

Coastal wetland and intertidal sites offer a far wider range of datasets than dryland sites, on the basis of which it is possible to develop hypotheses and explore new areas of theoretical debate (van de Noort and O'Sullivan 2006). The point is very clearly made by the footprint-tracks and the evidence they provide for population composition, especially the role of children, axes of movement, and even – in the case of Goldcliff Persons 2–5 – prehistoric peer group interaction. Other examples which illustrate the point are the human intestinal parasites (Dark 2004a), and the entirely new perspective they provide on past toilet practice as an aspect of the social use of space, and the diverse datasets which are available for reconstructing prehistoric activity patterns. A wide range of sources of evidence mean that ideas can be developed and interpretations tested. Such a multi-proxy approach is now widely applied in palaeoenvironmental studies. The level of detail preserved in certain contexts is remarkable, for instance, the interface between Old Land Surface and estuarine sediments on Goldcliff Site J where we have deer footprints (eg Fig 12.13), preservation of wood artefacts (Figs 10.1–10.4), and even the nests of hazelnuts buried by squirrels (Fig 6.12). Particularly notable from the recent work at Mesolithic Goldcliff is the way diverse sources of evidence, artefactual and environmental, so strongly complement one another in addressing social questions such as the identification of activity areas, seasonality, patterns of movement, and coping strategies.

The palaeoenvironmental studies reported here also illustrate the benefit of comparing environmental sequences along a transect in order to develop a more spatial picture of plant and insect communities, environmental change, and human activity. Thus, the transect of palaeoenvironmental sample sites across the island at Goldcliff at the time of the Upper Submerged Forest (Fig 15.1) helps to build up a picture of the relationship between wetland and dryland plant communities and the history of colonisation from dryland to wetland, as well as the spatial distribution of human activity. The value of environmental sites along a wetland-dryland transect is similarly demonstrated by the Prestatyn sequence (Fig 20.4) and those from Llandevenny and Woolaston (Chapter 19).

Transects across the wetland-dryland interface are especially important in helping to relate what people were doing in wetlands to the wider patterns of dryland activity. Our objective here should be a 'seamless approach', linking maritime, submarine, intertidal, buried Holocene landscapes, dryland, and upland within a single conceptual scheme and models of human activity. This approach has been particularly developed in coastal surveys around the Solent in Langstone Harbour (Allen and Gardiner 2000) and Wotton Quarr (Tomalin *et al* forthcoming). The full achievement of the seamless ideal is a challenge given the different forms of evidence, visibility, and techniques required in the various landscape facets. However, wetland edge transects take us part of the way towards that goal and reconstructing seasonal patterns of movement likewise contributes (Chapter 21.7 below).

21.3 Submerged forests and the chronology of coastal change

There is growing evidence for episodes of marked environmental change and sea-level fluctuation in the mid-Holocene (Bell and Walker 2005). In the period preceding the Lower Submerged Forest in the Severn Estuary a marked sea-level rise of 2.3m per century is recorded in the Baltic between 7000–6200 cal BC (Christensen *et al* 1997). At around 6250 cal BC the Greenland ice cores record the Greenland Holocene 8.2 Ka BP event, a marked drop in temperature which is thought to be the result of catastrophic drainage of ice-dammed lakes in the final stages of wastage of the Laurentide ice sheet (Alley *et al* 1997). This is interpreted as a pronounced dry episode because carbon in the cores indicates a 90% increase in the incidence of fire with a further increase a century later. These marked changes occur some 500 years before the inundation of the Lower Submerged Forest and show that the period preceding the establishment of Mesolithic activity at Goldcliff was one of widespread coastal change, in addition to the local changes documented around Goldcliff in Chapter 18.2.

In the Lower Submerged Forest at Goldcliff and contemporary forest at Redwick, 72 trees comprise a tree ring sequence covering both sites and spanning 431 years. This is a floating chronology, not yet linked to absolutely dated trees in a wider dendrochronological sequence, which are few and distant at this period. Their date is, however, reasonably precisely known from radiocarbon dating of successive decadal blocks of wood and wiggle matching the resulting curve to the radiocarbon calibration curve. Thus, the Lower Submerged Forest was growing from 6179–5826±19 cal BC, not allowing for missing sapwood. Significantly the basal forest at Goldcliff and Redwick cross-matches with the submerged forest at Gravel Banks 14km away and that at Bouldnor Cliff in the Isle of Wight 140km away. The latest rings in the four sites span *c* 225 years, with Bouldnor the oldest, then Gravel Banks *c* 55 years later, then Goldcliff Lower Submerged Forest *c* 125 years after that and Redwick *c* 50 years later. However, some of these trees lack bark edge so the separation in time of trees on each of these sites is not precise. It does, however, suggest that inundation was not as a result of one single event, but a process which may have spanned a century or two.

The drowning of the Severn Estuary Lower Submerged Forest was followed by deposition of thin and patchy estuarine sediments, then by a period of stasis lasting perhaps 100 or 150 years, during which the Lower Reed Peat formed. This was succeeded around 5600 cal BC by banded silts with footprint-tracks representing a marine transgressive phase which Druce (2005) has identified widely in the Severn Estuary. Allen (2005) shows that it is represented elsewhere in southern Britain. At around this time there is also evidence for rapid sea-level rise in the Baltic (Christiansen *et al* 1997) and a particularly marked sea-level rise *c* 5650 cal BC is indicated by the drowning of coral reefs in the Caribbean-Atlantic region (Blanchon and Shaw 1995; Blanchon *et al* 2002).

An analysis of the dates of peats in the Caldicot Levels (Allen 2005; Allen and Haslett 2006) indicates marine regression phases marked by formation of peats as follows: second peat 5500 cal BC, third peat 5000 cal BC and the development of the fourth peat (called here the Upper Peat) 4600–4000 cal BC. Close to Goldcliff island the thicker Upper Peat represents the merging of the third and fourth peats of more distant sites. The main period of Mesolithic activity at Goldcliff spans the time from the Lower Submerged Forest through the period of banded silts with footprint-tracks to some time between Allen's (2005) second and third peat. By the time of the Upper Peat (Allen's third and fourth peats) activity was at a much lower level.

More widely in the Severn Estuary, Allen (2005) and Druce (2005) recognise a distinct period of negative sea-level tendency centred on 4500 cal BC. Allen (2005) shows that a pronounced and long-lasting negative tendency at the time of the fourth peat is widely represented in other coastal wetlands of southern England and north-west Europe. Within the Severn Estuary Upper Peat there is generally evidence for colonisation by trees which on the wetter sites is mostly alder and birch, as at Redwick (Timpany 2005), but in some places conditions were sufficiently dry for oaks. At Goldcliff these formed the Upper Submerged Forest for which a floating dendrochronological sequence was presented in Chapter 8. Here sixteen trees span 239 years which, as the wiggle-match radiocarbon dating technique shows, grew between 4477–4239±16 cal BC, not allowing for missing sapwood. Some of the Goldcliff trees have sapwood and these suggest that the trees died, not in a single event, but over perhaps a period of 100 years. There are three other sites in the Severn Estuary and Bristol Channel where trees of similar date have been absolutely dated by dendrochronology. The Sweet Track was built, apparently in response to rising watertables, in 3807/06 BC, some 430 years later than the Goldcliff Upper Submerged Forest. The Submerged Forest at Stolford is dated 4052–3779 BC, thus 28 years later than the Sweet Track. Finally the submerged forest at Woolaston, originally dated by Hillam *et al* (1990) and further worked on as part of the present project (Brown *et al* 2005), is dated 4096–3699 BC, dying about 80 years after the Stolford Submerged Forest. Thus on present evidence the death of these trees does not represent one event but changes over timescales of between 80 and 540 years.

Local variations of decades in the dates of tree deaths may be compatible with Allen's (2005,46) observations concerning time lags of transgressional and regressional sequences. Variations are also to be expected as a result of factors local to specific sites. Notwithstanding the observed variations, it is clear from dating evidence presented here from the Upper and Lower Submerged Forests and that presented by Allen (2005) for the dates of peat inception, that submerged forests and peats formed at similar dates widely across southern England. Allen (2005) argues that, given their geographically widespread nature, the regressive and transgressive tendencies represented by these sequences are likely to be the result of broader patterns of sea-level change. He has demonstrated that peat inception on a number of sites shows a broad correspondence to the periods of rapid Holocene change identified by Mayewski *et al* (2004). Increasing chronological precision, particularly in the dating of submerged forests, will help to clarify the extent to which these changes are coeval from site to site and thus their relationship to wider regional, hemispheric, and global environmental changes. In the interim, we can conclude that from before the time of the Lower Submerged Forest to the time of the Upper Peat was a period of high coastal dynamism and pronounced landscape changes which must have been highly perceptible to Mesolithic communities.

21.4 Ecodynamism, fire, and human agency

It is a notable feature of the Mesolithic sequence, not only at Goldcliff but the other Severn Estuary sites (Chapter 19) and Prestatyn, that human activity is concentrated during periods of maximum environmental dynamism. It may also be the case that activity is best preserved in these periods. It is further significant that a similar range of human activities continued notwithstanding really dramatic environmental changes. At Goldcliff the surroundings changed from dry woodland to reedswamp to saltmarsh and mudflats to reedswamp and back to fen woodland. At Prestatyn, the changes were from rocky shore to saltmarsh behind coastal dunes to reedswamp to fen woodland. Similar changes are documented at the Mesolithic sites at Llandevenny, Oldbury (Chapter 19), and Westward Ho! (Balaam *et al* 1987a). Such changes seem also to have characterised the period of Mesolithic activity at Chedzoy (Norman 2003, 33). At a number of sites (eg Freshwater West, Wainwright 1963) activity is concentrated at the stage when saltmarsh was being overgrown by peat, thus suggesting a relationship between activity and ecotonal transitions. The high degree of dynamism associated with continuing later Mesolithic activity in this study area is at variance with two recurrent themes in the, generally rather deterministic, literature about environmental relations in this period. One is the assumption that coastal exploitation would only have been possible when conditions of ecological stability had been attained (Yesner 1988). The other is that significant environmental changes disrupt human activities and lead to changes in economy, settlement pattern etc. Admittedly these coastal environments involve complex mosaics, so that, at any one time, a range of environments was available for exploitation from most sites. Obviously the increasing proximity to marine resources was an important factor. The essential point, however, is that it is the dynamism of the coastal environments which makes them so diverse and productive and attractive to human communities rather than an inherent stability. One of the lessons from Goldcliff, Westward Ho!, and the study of middens more generally (Mellars 1987; Claassen 1998; Andersen 2000) is that the economy of the sites was not wholly, or even mainly, dominated by marine resources. Hunting and the exploitation of plant resources were manifestly important at Goldcliff. It was the abundance of these resources which was most significantly affected by the dynamism of the coastal fringe.

Dynamism results from predictable tidal factors which give rise to a constantly variable extent of marine influence (Fig 2.7) and from stochastic factors such as storms causing tree throw, leading to inundations, and triggering cycles of erosion. Floods result in influxes of marine waters which are attested by minerogenic bands within many of the peat sequences discussed here. Such incursions are clearly defined in the Lower and Upper Peat at Goldcliff by pollen evidence for saltmarsh plants, Foraminifera, and insects (Chapters 14–16). The result of these disturbance factors was the creation of a mosaic of woodland edge communities with grass and herb patches that would naturally attract grazing animals and people (T Brown 1997). Small-scale changes, such as tree throw, are likely to have been utilised by people as the occurrence of artefacts in tree throw pits at Neolithic Prestatyn (Chapter 20.4.4) and many other sites shows (Evans *et al* 1999). The large numbers of animal footprint-tracks at Goldcliff and many other sites in the Severn Estuary, and elsewhere, illustrate how attractive the coastal fringe was to animals. Concentrations of animals would themselves constitute a significant environmental disturbance factor since grazing would maintain and extend the sub-climax woodland edge plant communities. People would thus have been attracted to the coastal fringe by congregations of animals and concentrations of useful plants such as those listed in Table 18.3.

The evidence for environmental dynamism in the coastal zone is a particularly marked case of a growing emphasis within the historical sciences on the role of stochastic (ie chance) events and their contribution to contingency – in other words, unique historical configurations of phenomena (Bintliff 1999). Increasingly the role of environmental perturbations, disturbance factors, and patch dynamics are emphasised as providing a counterbalance to traditional ecology with its emphasis on patterns of regularity, succession, and climax (Worster 1990; McGlade 1995; Simmons 1999). The interplay between regular successional change and stochastic factors is well illustrated by the palaeoenvironmental studies reported here. Appropriate emphasis on disturbance factors is of particular significance in archaeology because it sets the role of human agency within a broader spectrum of the full range of natural as well as cultural processes (Bell and Walker 2005). Previously, ecological texts tried to factor out human agency in the quest for natural and stable systems. Archaeologists have often tended to assume that all disturbance was human, without considering the other possibilities (T Brown 1997). Thus, a dynamic view of ecology is one which much more readily integrates human agency within environmental systems.

One example of the recent emphasis on disturbance ecology is the theory of Vera (2000) who has challenged the accepted view of the wildwood as a closed, dense stand of tall trees. He argues that oak and hazel, two of the most widespread species commonly, as at Goldcliff, do not regenerate today in closed woodland. He states that the higher pollen productivity of trees as compared to herbs has overemphasised the extent of woodland cover and that the effect of grazing animals in the wildwood was to create a more park-like landscape with grassy glades and scrubby patches within which tree regeneration could occur. Vera's work has been influential in highlighting the potential ecological role of grazing animals and disturbance factors – which is in line with the results of the present research in the coastal zone. Vera has also identified the difficulty of establishing the degree of woodland openness from pollen analysis as modern pollen recruitment studies demonstrate (Groenman-van Waateringe 1993). That is clearly most relevant to establishing the environmental context of Mesolithic and early Neolithic activity. His work has stimulated much debate, leading to the identification of significant aspects of the palaeoecological record which are at variance with his model. Vera contends that regeneration of oak and hazel required open conditions created by grazers. However, extensive stands of both trees existed in Zealand and Ireland where there were few grazing animals (Svenning 2002; Bradshaw *et al* 2003; Smith and Whitehouse 2005). The evidence presented here from the Lower Submerged Forest in the Severn Estuary, and that from submerged forests elsewhere (Bell 1997), does not support his view of low branched, park-like woodland. The trees were tall and straight with the first branches often 10m or more from the ground, quite different from what we see in park woodland today.

Important as it has been in opening up debate about the character of the wildwood, in the context of the present research there are two significant weaknesses with the Vera hypothesis. The first is spatial – the assumption that the activities of grazing animals will have been evenly distributed across the landscape. This is not the case in the real world, especially one so topographically, climatically, and vegetationally contrasting as the study area (Taylor 1980b; Caseldine 1990). In reality grazing animals, and the people who hunted them, would have been concentrated in particularly favoured areas such as the woodland edge on the upland and coast, areas around water, and topographically-favoured routes for animal movement such as valley corridors and passes between upland. It is in these areas that the effects of grazing animals in creating more open park-like woodland would have been especially concentrated; other areas which attracted less grazing pressure would have the tall closed woodland of traditional expectation.

The second significant weakness of the Vera hypothesis in the present context is that herbivore grazing is fore-grounded as the main relevant disturbance factor. However, it is but one of a range of factors requiring consideration (Bell and Walker 2005, fig 6.1). It has been shown, for instance, that beavers were a significant environmental disturbance factor in river valleys and lowlands in prehistory (Coles and Orme 1983; Coles 2001; Coles 2006). More significantly still, Vera followed traditional 'classical' ecology in factoring out the role of human agency. For instance, from one of his case study areas, New England, there is very clear ethnohistorical evidence that burning by native Americans was a key factor in the creation and maintenance of the parkland landscapes which he describes and attributes to the grazing activities of bison (Cronon 1983). Since his theories were developed in continental Europe, where until recently there was little evidence for human impact before farming, the expectation was perhaps that hunter-gatherers had a minimal effect. This assumption is not supported by evidence from this study area.

Evidence has been presented for charcoal spreads, some of which must derive from campfires, and also charred trees in the Lower and Upper Submerged Forests. We cannot ignore the possibility that some burning resulted from natural wildfire (Chapter 18.13), particularly given previously noted evidence for greatly increased fire incidence at the time of the Greenland Holocene 8200 BP event in the ice cores (Alley *et al* 1997). However, burning on several sites, including Goldcliff, is not restricted to woodland and is often coeval with human activity. During the reedswamp phase which succeeded the Goldcliff Lower Submerged Forest there is clear evidence of charred grasses, probably reeds, which also occur among the micro-charcoal in the later banded minerogenic sediments (Dark and Allen 2005). The Goldcliff burning occurs at times when there is evidence for Mesolithic activity, although this activity is significantly less at the time of the Upper Submerged Forest and times of charcoal deposition in the Upper Peat. The association with Mesolithic activity at Goldcliff makes it highly likely that people were responsible for burning.

The Goldcliff evidence can be compared to evidence of charcoal spreads and pollen evidence for vegetation disturbance more widely across the study area, as shown on Figure 21.1. We will begin by a review of evidence in the coastal wetlands and then turn to the uplands. Charred trees also occur in the contemporary Lower Submerged Forest at Redwick, 6.5km to the east, where there is no direct evidence of human activity at the time (Bell *et al* 2003). In Chapter 19, evidence of grass, probably reed, micro-charcoal, and vegetation disturbance is reported from the sites at Llandevenny and Oldbury associated with stratified Mesolithic artefacts, and also at Woolaston and Hills Flats where there is no stratified evidence of Mesolithic activity. Possible Mesolithic vegetation disturbance has also been reported from Vurlong Reen (Walker *et al* 1998). In the Bristol Channel charcoal occurs below intertidal peats without archaeology at Burnham-on-Sea (Druce 1998) and in the Somerset Levels, where reed charcoal occurs in later Mesolithic sediments at Walpole (CD 21.1) and there is also a charcoal horizon at Shapwick (C Bond pers comm). Reed charcoal is also reported from intertidal peats at Minehead where Mesolithic flints were found below a submerged forest (Boyd Dawkins 1872). At Westward Ho! there are extensive charcoal spreads below the Mesolithic submerged forest; pollen analysis suggests only small-scale vegetation disturbance (Balaam *et al* 1987a), although more recent work by the writer has revealed at least two substantial charred trees within the submerged forest and settlement area.

Turning to coastal Pembrokeshire the early 20thcentury accounts by Leach (1913) and others often refer to the presence of charcoal below, and within, submerged forests, often associated with lithics, eg at Freshwater West. A Mesolithic disturbance phase at Abermawr has been documented by Lewis (1992) and vegetation disturbance in the coastal wetland at Dinas by Seymour (1985). Inland, 4.5km up the Gwaun Valley, pollen work at Esgryn Bottom (Fyfe 2005) shows significant evidence of open environments during the Mesolithic, together with later Mesolithic environmental manipulation and fire management. Evidence of Mesolithic vegetation disturbance 5km further up the same valley at Waunwelin shows these effects were not purely local (Seymour 1985). North of this, there is no evidence from the great sweep of Cardigan Bay, echoing the paucity of Mesolithic activity here, except along the Lleyn peninsula (Fig 1.6). In north Wales charcoal is recorded at the Submerged Forest of Penrhos, Anglesey (G Smith *et al* 2002). Also in Anglesey is Mesolithic charcoal at Capel Eithen (White and Smith 2002) and nearby on the mainland in a dryland lowland context a charred pine tree at Llandegai (Lynch and Musson 1999). The only other evidence along the coast of north Wales is the small-scale vegetation disturbance identified from Prestatyn (Chapter 20.19.1) where evidence for charred reed also occurs.

In the north-east part of the survey area evidence of vegetation disturbance during the Mesolithic largely derives from coring and pollen analysis carried out as part of the North West Wetlands Survey. In Merseyside there are four sites with evidence of vegetation disturbance, three of which (Bidston Moss, Sniggery Wood, and Knowsley Park) show multiple episodes and at two sites there is cereal-type pollen, some as early as 4500 cal BC (Cowell and Innes 1994, table 17). None of these is directly associated with a Mesolithic site although finds are many in the wider area (Fig 1.6).

Turning now to the uplands, a marked concentration of sites with evidence of vegetation disturbance during the Mesolithic occurs at the head of the south Wales valleys on the southern slopes of the Brecon Beacons. The most detailed picture comes from Waun-Fignen-Felin where there are multiple disturbance episodes from 6500 cal BC associated with charcoal and abundant lithic evidence for Mesolithic activity (A G Smith and Cloutman 1988; Barton *et al* 1995). Four other sites within 20km have also produced evidence of vegetation disturbance, although in these cases without associated lithic evidence. At three of these charcoal occurs: Nant Helen (Chambers *et al* 1988), Coed Taff (Chambers 1983), and Pen Rhiw-Wen (Cloutman 1983). At Boncyn Ddol, Snowdonia, vegetation disturbance and charcoal are associated with Mesolithic flints from a nearby lithic scatter (Caseldine and Griffiths 2004). In upland areas, the presence of charcoal at the base of peat is often taken to mean that burning was responsible for peat inception (A G Smith and Cloutman 1988). It is notable, however, that we find the same situation in coastal contexts where it is clear that peat inception was caused by sea-level related water table rise. Perhaps, therefore, the stratigraphic position of charcoal relates rather more to the human manipulation of transitional plant communities than specifically to peat inception.

There is more scattered evidence of vegetation disturbance from other uplands where there is no direct association with Mesolithic lithics: Exbridge on Exmoor (Fyfe *et al* 2003); Llyn Mire in mid Wales (Moore 1978); the Breiddin in the upper Severn Valley (A G Smith *et al* 1991); and Moel y Gerddi, Gwynedd (Chambers *et al* 1988). This is supplemented by some evidence of vegetation disturbance and charcoal in the wetlands of Manchester and Cheshire, just one site in Staffordshire and none in Shropshire (Fig 21.1), the last two counties having rather less evidence of Mesolithic activity.

Thus in the mapped area, there are a total of 40 sites where vegetation disturbance has been claimed in the Mesolithic. On 28 of these (70%) the disturbance is radiocarbon dated. Most of these episodes fall in the later Mesolithic between 6000–4000 cal BC but there are instances up to two millennia earlier (CD 21.1). Of the sites 29 (73%) have recorded charcoal occurrence, while on the remainder the evidence of vegetation disturbance comes from fluctuations in pollen spectra. Mesolithic artefacts have been found on thirteen (33%) of the sites. As regards their OD relationships, nineteen (48%) are below 10m OD, two sites (5%) between 10m and 100m OD, and six sites (15%) above 100m OD. The strength of evidence from these sites varies greatly; in some cases we are dealing with no more than a charcoal spread (eg Freshwater West) which might derive from a hearth. Burnt tree roots at Capel Eithin and Llandegai could derive from a lightning strike and many of the charcoal occurrences could derive from wildfire. Vegetation disturbances marked in pollen diagrams might derive from a range of disturbance factors, such as storms, floods, beavers, other fauna etc. Although the evidence from many of these sites is clearly open to a number of possible interpretations, there are some marked regularities in the patterns they form. The evidence from Goldcliff for human vegetation disturbance is regarded as strong. What is particularly striking is that at least seven other coastal sites in the Severn Estuary/Bristol Channel area have also produced comparable evidence of charcoal and at Llandevenny, Oldbury, and Hills Flats there is possible evidence of reed burning: on four of these sites there are Mesolithic artefacts (Chapter 19; Brown 2005). The other really well-documented site is Waun-Fignen-Felen, where there is also artefactual evidence. It is particularly notable that around this site there is a group of other upland sites without artefacts, which seem to show evidence of the same patterns. It can be concluded, therefore, that in this study area there is strong evidence for the manipulation of vegetation by Mesolithic communities. That evidence is particularly marked in the coastal wetlands and

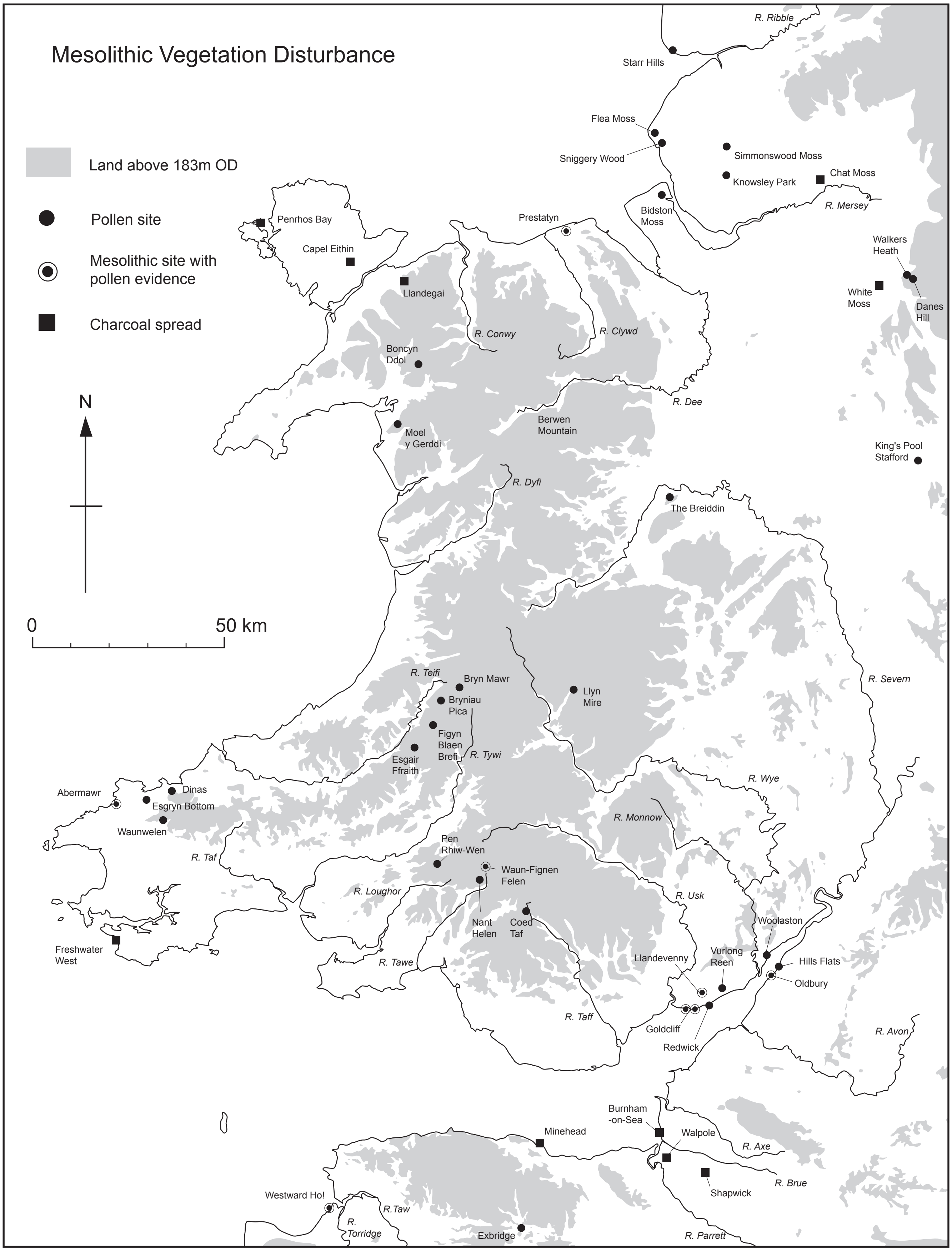

Figure 21.1 Sites in Wales and adjoining areas with evidence for Mesolithic vegetation disturbance in the study area (for full details of sites see CD 21.1) (graphic S Allen)

submerged forests and has been most fully documented in the Severn Estuary, Bristol Channel, and North West Wetlands. Thus, on present evidence, and keeping in mind the much greater concentration of pollen studies in the uplands (Caseldine 1990, fig 11), in this area Mesolithic impact was not predominantly an upland and moorland phenomenon. Our evidence calls for a revision of the previous distribution evidence of Simmons (1996) for the British Isles generally, as well as the suggestions from the sites mapped by Zvelebil (1994, fig 4) – where only 10 out of 105 sites were on the coast. Clearly burning did occur in uplands and there is evidence that vegetation changes at this time contributed to the development of moorland. However, the present research shows that upland evidence is by no means the whole picture.

The time of year during which burning took place varied. At Goldcliff evidence from banded sediments suggests that in four out of five years there was more burning in summer than winter (Dark and Allen 2005). The suggestion has also been made in Chapter 14 that burning in August and September suppressed pollen production. Certain locations may only have been combustible at the end of exceptionally dry summer spells in drought years, thus helping to reconcile Rackham's (1980) view, concerning the virtual impossibility of burning British woodland, with the evidence on the ground. It is also at the end of summer that burning is most often attested ethnohistorically (Boyd 1999b). However, reedbeds are generally burnt in Britain today at the end of winter and early spring when there is abundant dead material (Law 1998) as at the Magor Marsh Nature Reserve in the Severn Estuary (D Upton pers comm) and Wicken Fen in East Anglia (Friday 1997). On these sites it takes place on a six- to ten-year cycle when thick dead material has built up and in order to regenerate new growth.

The lowland, coastal emphasis of burning may help to clarify the reasons why it was done. The general assumption in the uplands is that it was primarily to increase browse for red deer. Such a theory is much less readily applicable in coastal situations in which sub-climax plant communities and reedswamp were so extensive. In this area we may suppose that the direct effects on plant resources were more important. Zvelebil (1994) contends that human physiological requirements mean plants would have contributed 30–40% of the diet. It is probable that burning on the island edge at Goldcliff gave rise to, or at least encouraged, the development of hazel woodland which is attested throughout the period of Mesolithic activity, and the charred hazelnuts indicate these were a significant resource. There are many other woodland-edge plants which would have been encouraged by burning and which we know, or suspect, were utilised, eg reeds, bracken, raspberries, blackberries, etc (Table 18.3).

The evidence from this study area supports the speculative suggestions of Clarke (1976) regarding the importance of plant resources in the Mesolithic, particularly those of coastal and wetland situations. It may also provide some support for the theory of Zvelebil (1994) who concludes from the evidence of burning and antler mattocks that there may have been some form of plant husbandry in the Mesolithic based on nuts, wetland plants or wild grasses. What is envisaged, at least by this writer, is not domestication but some, as yet undefined, point along the spectrum identified by Harris (1989) from wild plant procurement to cultivation. As Blackburn and Anderson (1993) argue in the case of California, most human communities cannot be simply classified as food procurers or agriculturalists but are at various stages in a continuum from food procurement to domestication of their environment. This might have included some of the wide range of practices which are attested ethnohistorically such as burning, tilling, pruning, maybe transplanting etc (Fowler and Turner 1999).

It is also conceivable, but certainly unproven, that there existed on coastal and perhaps riverine sites, subject to episodic environmental instability, a situation comparable to that described by B D Smith (1995 a and b) in the floodplains of eastern North America. Here seed plants flourished in the disturbed environments created by rivers on the floodplain margins where human settlement further contributed to environmental disturbance. In that context certain plants may have become pre-adapted to cultivation or even domestication by a co-evolutionary combination of natural environmental disturbance and human agency. In the North American case some of these plants became local domesticates, but domestication subsequently lapsed with the introduction of more productive plants from elsewhere. It might even be that the manipulation of certain coastal wild grasses was accompanied by, or resulted in, genetic changes which gave rise to the larger 'cereal-type' grass pollen grains which have been identified as evidence of precocious crop husbandry in the North West Wetlands and the Isle of Man (Innes *et al* 2003; Cowell and Innes 1994). However, this suggestion is not supported by the occurrence of 'cereal-type' pollen in much earlier contexts in Ireland (O'Connell 1987). At present, the notion of some form of plant husbandry must remain no more than a speculative possibility, awaiting a much more concerted campaign of sieving and plant macrofossil analysis which this study strongly suggests should be a key priority when a suitable site is next excavated.

Simmons (2001) highlights the role of fire, not just for practical purposes of clearance and cooking etc, but he also notes that the observation of distant fire would have served as symbols of presence and territoriality. It would have been one way of reading what other groups were doing and transmitting knowledge about ecological practice. Similarly in aboriginal Australia, fire sometimes seems to have been used just as much to impart a human signature on the land as for purely utilitarian purposes (Head 1994).

21.5 Settlement and off-site activity types

As archaeologists we tend, almost unconsciously, to concentrate our efforts on spots on the landscape which we define as sites. Such an approach is particularly unhelpful in the case of hunter-gatherers whose activities are spatially extensive and diffuse – involving a wide range of what Foley (1981) has called off-site archaeology. This issue goes some way towards explaining the previous neglect of finds from submerged forests and inter-tidal contexts. Many are scatters of a few flakes or tools, seen perhaps as of limited significance in a literature dominated by tool typology. In attempting to classify types of site, one of the biggest difficulties we face is deciding whether a concentration of artefacts equates to a focus of activities and people at one time, or represents a superimposed palimpsest of many small-scale episodes over an extended timescale. We can only readily resolve this where we have evidence of artefact distribution within a site. This again highlights the value of sites in coastal contexts where individual activity episodes tend to be stratigraphically separated. Furthermore, on well-preserved wetland sites there are greater possibilities for use wear analysis (Chapter 9.2; van Gijn 1990) when even small collections, including unretouched artefacts, can provide important evidence of activities. Where they can be identified, transitory activities taking just a few moments or hours can be as important in understanding a people's way of life as a dense but poorly-preserved artefact concentration. The case is perhaps most clearly made by the need to extend our understanding of plant use in Mesolithic Britain.

Literature on hunter-gatherers defines types of activity area and settlement which we can order from the very transitory and short-term to longer-term settlements (Binford 1980, 2001; Peeters *et al* 2002). Table 21.1 lists some types of site and provides examples of these from the study area. In certain cases, we have sufficient evidence to classify a site with reasonable confidence and these site classifications are in bold. In other cases there is little evidence, although a suggestion can be made on the basis of sites in similar locations etc; these classifications are in conventional type. Finally some are little more than guesses and these are in italics.

At the transitory end of the spectrum are stations (Binford 1980) such as positions from which hunters observe animals. Leach (1913) identified many flint scatters along the cliff tops of Pembrokeshire and some scatters of just a few artefacts are likely to represent sites of this type where hunters observed animal movement on coastal plains. Other sites with dominant views over lowland are Gop Cave and Dyserth Castle and others in upland locations. Also transitory are kill sites; there are some finds of animal bones in submerged forests that could be of this type but most are apparently natural deaths. The only one which is confidently associated with hunting is the boar found with microliths dated to the late Mesolithic at Lydstep; this is interpreted as an escaped hunted animal. Activity locations are those of short-term extractive tasks (Binford 1980). Generally these are difficult to identify in the archaeological record but are here well-represented by the footprint-track sites in saltmarsh locations at Goldcliff, Uskmouth, Magor, and Rhyl and probably also by some of those groups of a few artefacts found below, or in, submerged forests (CD 1.2). Meehan (1982) defines a class of meal-time camp. Some scatters of a few artefacts and a hearth might be explained in this way but there are none which indisputably fit this description. Likewise represented by small numbers of artefacts, but difficult to identify positively, are foraging camps used for less than one day (Peeters 2002). Field camps have been defined as temporary operation camps used for overnight trips or stays (Binford 1980) and this might fit the artefact scatters from sites such as Gwernvale, Abermawr, Melyd Avenue Prestatyn, and probably some of the cave sites such as Aveline's Hole which prior to burial use was used by red deer hunters (Jacobi 2005). Extraction camps are defined as special purpose camps used for more than one day (Peeters *et al* 2002). It seems appropriate to make a distinction here between those in coastal and upland locations. In the coastal group are the midden sites at Prestatyn and Westward Ho!, Frainslake and some of the cave sites. The description might also be applied to Goldcliff Site W where tools were few. In the upland group are sites such as Waun-Fignen-Felen, Brenig, and Llyn Aled Isaf.

Residential base camps, defined as hubs of subsistence, processing, manufacture, and maintenance (Binford 1980), are somewhat problematic. Much of the wider literature seems to assume long-term residency lasting months. However, in this study area we have found evidence of sites with a wide range of activities with all age groups of a human population represented but where the density of artefacts and their clustering is not consistent with occupation lasting several months at a time. Such sites may be called short-term base camps and imply a settlement system with high residential mobility, at least at certain times during the year. Such sites are Goldcliff Sites A and J, Bryn Newydd Prestatyn, and less certainly sites such as Hawcombe Head, Newport, Pembrokeshire, Baggy Point, Aberystwyth, Abersoch, and the occupation on the islands at Lundy and Bardsey. There are also locations where denser concentrations of artefacts suggest longer-term, maybe winter, base camps. Perhaps the clearest candidate is Rhuddlan; others may be the Nab Head and Birdcombe.

We can predict the existence of aggregation camps, places where larger numbers of people come together for periodic meetings (Peeters *et al* 2002). Such gatherings would be paramount in the social life of a community, times for selection of partners, exchange of artefacts, foods, goods, and the transmission of ecological and social knowledge through oral history, song, and dance. The most likely situations for this role are the densest concentrations of artefacts at the Nab Head with its many beads, figurine and ground stone axes, and Rhuddlan with its decorated pebbles (David and Walker 2004). Nab Head would make a rather good autumn aggregation site when seals would have been abundant nearby and a larger gathering might have been supported by this resource. The suggestion of an aggregation site might, of course, be combined with the earlier suggestion that these denser concentrations of artefacts are indicative of a longer-term winter base camp for a segment of the population. It is also possible that the concentrations of sites around Priddy and the Black Mountains represent aggregation sites. One factor which makes this hypothesis appealing is that both were places where people came together to construct monuments later in the Neolithic, pointing perhaps to the continued social significance of place or landscape features.

There are also those sites where the most significant activity was ritual and/or burial. The suggestion has recently been made that the Lydstep pig was a ritually-killed animal (Chatterton 2006) and this is a possible, but maybe over-imaginative, theory. Eleven cave sites (CD 21.2) have produced evidence of Mesolithic human bones all dating before 5500 cal BC. Of particular note are the concentration of burials on Caldey and the largest group in Britain, the early Mesolithic site of Aveline's Hole on Mendip (Schulting 2005).

21.6 Axes of movement

Having attempted to define different types of site, it remains to suggest how they were interrelated as parts of a living landscape. This is a challenge since we have just fragments of the original pattern. On the site scale we have seen how axes of movement are reflected by the orientation of human footprint-tracks indicating at Goldcliff that the predominant movement was along palaeochannels, rather than simply to and from settlements on dryland. Foley's work on off-site artefact distribution patterns demonstrates that frequented radial routes from a settlement location are marked by linear artefact scatters which could potentially be used to identify axes of movement (Foley 1981; Renfrew and Bahn 2000, 192). In the writer's experience, a walk along most stretches of the Pembrokeshire Coastal Path generally produces a few Mesolithic flints and this is confirmed by the distributions recorded by Leach (1913) and Wainwright (1963, pl X). Some represent major artefact concentrations such as the Nab Head (David 1990), others must be more transient locations: hunting stations, activity locations, meal-time camps, foraging and field camps. On the Pembrokeshire coast earlier Mesolithic people were moving along the former degraded clifftops of the Ipswichian coastline looking out over a coastal plain. In the later Mesolithic, the landscape was dramatically transformed to a rocky shore and from the coastal path the movements of fish, birds, and sea mammals could be observed. What is striking is that some sites, particularly the Nab Head, were used under the very different environmental conditions of the early and later Mesolithic.

Clues to routeways may also be contained in those 'persistent places' frequented over extended timescales, of which the best example is Waun-Fignen-Felen (Barton *et al* 1995). The existence of long-established routeways, and more particularly perhaps the intersection points of different routes, may be the most economical explanation for sites where concentrations of Mesolithic artefacts occur below later Neolithic tombs, as for instance at Gwernvale (Britnell and Savory 1984) and just east of the study area at Hazleton (Saville 1990). More general information about possible routeways is provided by the distribution patterns of lithic and other raw materials used. Both in Wales (Jacobi 1980) and south-west England (Roberts 1996) several authors agree that movement was primarily from coast inland up the river valleys.

21.7 Territory and patterns of movement

We have found little or no evidence to support the hypothesis that Mesolithic communities in the study region were sedentary, ie occupied one site throughout the year. The evidence suggests that they moved around seasonally, exploiting a range of resources at different times of year. The question is, what was the annual home range of a group, ie the extent of the territory which they covered in a year, and what was the pattern of a group's movement? Lithic raw materials provide some clues to patterns of movement. However, all but the south-easterly corner of Wales, where Goldcliff lies, has been glaciated, thus moving erratic rocks. It is also likely that lithic raw materials, particularly of more unusual rocks, were exchanged between groups. At Goldcliff, the main raw materials used were beach flints; these were predominantly small and are likely to have been derived from the Irish Sea Till to the west. Volcanic tuff ultimately derived from north Wales is likely to have come from deposits of glacial origin. Large cobbles of quartzite, which became heat-fractured, are also thought to be glacially derived. Although small gravel grade flint is common in the head at Goldcliff, the sediments exposed intertidally at the site do not contain pieces of flint, tuff, or quartzite of the size used on site. Allen (2000c) does, however, report finding tuff blocks in Pleistocene sediments between Redwick and Magor. The quartzite cobbles selected for cooking purposes may have been obtained from the river gravels of the Usk or Ebbw which implies a source perhaps 5–10+km to the north-west. Some were originally sizeable boulders and this surely suggests transport by dugout canoe or other craft; maybe they were also valued ballast in trips from the river to the more choppy waters of the estuary. The nearest source of

Table 21.1 Classification and definition of types of hunter-gatherer settlement patterns with suggested attribution of selected sites in the study area, their cultural and topographic context and date

Site Type	Definition	Source	Examples in study area	Season	Ecological zone	m OD	Date	Source
Station	Special purpose task group location, eg observing animal movement	Binford 1980	*Some sites now on cliff tops in Pembrokeshire*	Any	Upland overlooking coastal plain	c 50–200	Early Mesolithic	Leach 1913
			Gop cave, Clwyd	Any	Upland overlooking coastal plain	c 50–200	Later Mesolithic	Burrow 2003, 157; Boyd Dawkins 1901
			Gwaenysgor, Clwyd	?	Upland	212	?	Glenn 1914
Kill and escaped kill sites	Animal killed or with weapon injury		**Lydstep, Pembs**	?late winter	Coastal wetland	c0 OD	5300±100 BP (OxA-1412)	Leach 1918; Lewis 1992
Activity location	Short term extractive task	Binford 1980	**Goldcliff footprint areas, Gwent**	**Summer**	mudflats/saltmarsh	–4 OD	5500–4650 cal BC	This vol, chapter 4 and 12
			Uskmouth, footprints and mattock, Gwent	?	mudflats/ saltmarsh	–2 OD	6250±80 BP (OxA-2627)	Aldhouse-Green *et al* 1992
			Magor, Gwent	?	mudflats/ saltmarsh	0 OD	5720±80 (OxA-2626)	Aldhouse-Green *et al* 1992
			Rhyl mattock, Clwyd		Saltmarsh	0 OD	6560±80 BP (OxA-1009)	This vol, chapter 20.14
			Porlock, Somerset	?	?woodland	c0 OD	?	Boyd Dawkins 1872; Riley & Wilson-North 2001
			Little Furznip/ Freshwater West, Pembs	?	Saltmarsh	c0 OD	pre 5960±120 BP (Q540)	Wainwright 1963
			Whitesands, Pembs	?	Saltmarsh	c0 OD	pre 5240±80 BP (CAR-1183)	Hicks 1897
Meal-time camp	Where groups stop for a meal, eg near shell beds or fish traps	Meehan 1982	No examples					
Foraging camp	Used for less than a day	Peeters *et al* 2002	Possibly some intertidal flint scatters	Any	Coastal wetland woodland edge	c0	–	–
			Waun-Fignen-Felin (some sites), Powys	Any	Upland	485	–	Barton *et al* 1995
Hunting camp	Hunting weapons maintained/ repaired	–	**Aveline's Hole, Somerset**	?	Rocky gorge migrating route	100	Very early Mesolithic, pre burials	Jacobi 2005; Schulting 2005
Field camp	Temporary operation camp used for overnight trips/ stays and maintenance activities	Binford 1980	Gwernvale, Powys	?	? woodland ? clearing	75	6895±80 BP (CAR-118)	Britnell and Savory 1984
			Abermawr, Pembs	?	Coastal	0 OD	5520±150 BP (OxA-1377)	Lewis 1992
			Prestatyn: Melyd Avenue, Clwyd	?	Woodland/ wetland edge	c15–8	Later Mesolithic	This vol, chapter 20

Table 21.1 (*cont.*) Classification and definition of types of hunter-gatherer settlement patterns with suggested attribution of selected sites in the study area, their cultural and topographic context and date

Site Type	Definition	Source	Examples in study area	Season	Ecological zone	m OD	Date	Source
Extraction camp (lowland)	Special purpose camp used for more than a day in lowland (including small middens)	Peeters *et al* 2002	**Goldcliff Site W, Gwent**	**Winter**	Coastal wetland edge	0 OD	5600–5200 cal BC	Bell *et al* 2000, chapter 4
			King Arthur's Cave, Herefordshire	–	River valley woodland	100	–	Barton 1995
			Madawg, Herefordshire	Late summer/ autumn	River valley woodland	?c50	6655±65 BP (OxA-6082)	Barton 1993, 1994
			Prestayn Nant Hall Road, Clwyd	**Spring**	Coastal wetland edge	3–5	4500–3400 cal BC	This vol, chapter 20
			Westward Ho!, Devon	?Spring	Coastal wetland edge	c0 OD	6000–4400 cal BC	Balaam *et al* 1997
			Freshwater West, Pembs	?Spring	Coastal lowland	10	? Later Mesolithic	Wainwright 1959
			Frainslake, Pembs	–	Fen woodland	c0 OD	–	Gordon Williams 1926; Leach 1918
			Nanna's Cave, Caldey, Pembs	?	Island	21	Later Mesolithic	Lacaille and Grimes 1955
			Ogof-yr-ychen, Caldey, Pembs	?	Island	10–20	Later Mesolithic	David and Walker 2004
			Tadderwen, Clwyd	?	River terrace woodland	33	Later Mesolithic	Brassil *et al 1991*
Extraction camp (upland)	Special purpose camp used for more than a day in upland		*Kerry, Montgomeryshire*	*?Summer*	Upland	507	?	Wainwright 1963
			Craig-y-Llyn, Rhondda	*?Summer*	Upland	460	Later Mesolithic	Wainwright 1963; Jacobi 1980
			Waun-Fignen-Felen (some sites), Powys	**Summer**	Upland moorland	485	10,180–3670 cal BC	Barton *et al* 1995
			Pant Sychbant, Rhondda	–	Upland	340	Early and Later Mesolithic	Jacobi 1980
			Brenig, Denbigh	Summer	Upland grass moor	400	6600–5800 cal BC	Lynch 1993
			Llyn Aled Isaf, Conwy	Summer	Upland	363	5810±150 BP (No lab no)	Brassil 1989; Jenkins 1991
Residential base camp (temporary) / short term base camp	Hub of subsistence, processing, manufacture and maintenance. Occupation for a few weeks or months	Binford 1980	**Rhuddlan, Clwyd**	Winter	Estuary edge	20	8200–7450 cal BC	Quinnell and Blockley 1994; Manley and Healey 1982
			Prestatyn Bryn Newydd, Clwyd	Winter	Lowland slope	30	8200–7550 cal BC	Clark 1938, 1939
			Priddy, Somerset	Summer	Upland plateau	240	5000±80 BP (Grn-1880)	Taylor 2001
			Birdcombe, Somerset	*?Winter*	Wetland edge	10	Early and Later Mesolithic	Gardiner 2000
			Ogmore, West Glam	*?Winter*	Coastal	c0–10	Later Mesolithic	Burrow 2003
			Burry Holmes, West Glam	?Autumn/ winter	Low hill overlooking coastal plain	20	Early Mesolithic	David and Walker 2004
			Trwyn Du, Anglesey	?Autumn/ winter	Overlooking coastal plain	?0–30	8640±150 BP (Q-1385)	Burrow 2003
			Valley Field, Caldey	?	Hill within coastal plain	30	Early Mesolithic	David and Walker 2004

Table 21.1 (*cont.*) Classification and definition of types of hunter-gatherer settlement patterns with suggested attribution of selected sites in the study area, their cultural and topographic context and date

Site Type	Definition	Source	Examples in study area	Season	Ecological zone	m OD	Date	Source
Aggregation camp	Many people but periodic use. Occupied for a few weeks	Peeters *et al* 2002 This vol	**Nab Head, Pembs**	?Autumn	Hill overlooking coastal plain, later coastal cliff	30	8690–3540 cal BC	David 1990 ; David and Walker 2004
			Rhuddlan, Clwyd	?Autumn	Estuary edge	20	8200–7450 cal BC	Quinnell and Blockley 1994; Manley and Healey 1982
			Daylight Rock, Caldey, Pembs	?Autumn/ winter	Hill overlooking coastal plain, later island	12–20	8450–7650 cal BC, and later Mesolithic	David and Walker 2004
			Goldcliff Sites A and J, Gwent	**Aug–Sept**	Woodland/ saltmarsh edge	c0 OD	5600–4700 cal BC	This vol, chapters 2–18
			Baggy Point, Devon	?	Cliff top	c30	Later Mesolithic	Wymer 1977, 57; Jacobi 1979
			Hawcombe Head, Somerset	Summer	Upland	425	Later Mesolithic	Riley and Wilson-North 2001
			Clevedon, Blackstone Rocks, Somerset	*?Spring/ autumn*	Coastal island	c0 OD	Later Mesolithic	Sykes 1938; Jacobi 1979
			Newport/ Traeth Mawr, Pembs	*?Winter*	Estuary edge	0–10	?	Wymer 1977; Lewis 1992
			Aberystwyth, Ceredigion	*?Autumn/ spring*	River then cliff edge	10	Early and Later Mesolithic	Thomas and Dudlyke 1925
			Abersoch Llyn, Gwynedd	*?*	Coastal lowland	?c30	Early Mesolithic	Burrow 2003
			Lundy, Devon	*Spring/ autumn*	Island	50–140	Later Mesolithic	Jacobi 1979
			Bardsey, Gwynedd	*Spring/ autumn*	Island	?c0–20	Later Mesolithic	Edmonds *et al* 2004
			Chedzoy, Somerset	*?Winter*	Woodland wetland edge	9	Later Mesolithic	Norman 2003
Ritual and burial sites	Locations used for ritual and burial	See CD 21.2	**Caldey, Pembs**	–	Hill overlooking coast	5–30	7800–5640 cal BC	Schulting & Richards 2002
			Aveline's Hole, Somerset	–	Rocky gorge	150	8650–7830 cal BC	Schulting 2005
			Worms Head Cave, West Glam	–	Rocky hill in coastal plain	0–30	8190–7580 cal BC	Conneller 2006
Long-term base camp			No examples					
Short-term sedentism	Year on year residential stability	Whittle 2001	No examples					
Embedded sedentism	Residential continuity over generations		No examples					

In **bold**, confident attribution; in normal type, possible attribution; in *italics*, guess based on other sites in similar locations or assemblages. Note on dates: for sites discussed in this volume where dates are available, the calibrated ranges cal BC are given. For full details of individual dates see relevant chapter. For other sites, where single or few dates are available, the original radiocarbon dates BP are quoted. I am grateful to Elizabeth Walker for advice on several sites.

usable flint is likely to have been in the gravels of the River Usk, some 6km to the east, which was also the margin of the Devensian ice front. The significance of these raw materials suggests that the lower reaches of the Usk were linked to Goldcliff and hints at the possible role of inland movement up the Usk itself. A smaller proportion of chert was employed at Goldcliff and this is likely to derive from Carboniferous strata 7km+ to the north-east or from gravels derived from those outcrops.

At Waun-Fignen-Felen in the uplands of south Wales, cherts derived from the mouth of the River Avon and north Somerset were used with flint, probably of glacial derivation from the Bristol Channel (Barton *et al* 1995). The Avon source points to the possibility of movement of some 93km up the River Usk, in which case that might have been linked to seasonal activity at Goldcliff. The north Somerset origin of some lithics may suggest movement up the Tawe from Swansea Bay and the Bristol Channel. The find at Waun-Fignen-Felen of a mudstone bead of Pembrokeshire origin also indicates a link perhaps 100km to the west and might suggest larger territories in the early Mesolithic, since many such beads were found in early Mesolithic contexts at the Nab Head (David 1990). Inland movement up the river valleys is also suggested by the finding of beads made of marine shells at Madawg rock shelter in the Wye Valley with late Mesolithic microliths (Barton 1993; 1994).

Just as raw materials may hint at annual territories and patterns of movement so they may also suggest the existence of boundaries between groups. Thus at Goldcliff there is no evidence for the use of flint fresh from the Wiltshire chalk which is found on sites in and around the Somerset Levels. This may suggest that annual movements did not involve significant periods of activity on the English side of the Estuary. Thus, the proposition floated in Chapter 1 that the estuary was more of a link than a barrier is not supported by the evidence. Significantly the later Mesolithic Somerset Levels site of Chedzoy has raw materials which Norman (2003) contrasts with those used on sites both on Mendip to the north and the Blackdown Hills to the south-west. The Chedzoy raw materials include 45% chalk flint with fresh cortex and Greensand chert from the Westbury/Wincanton area. Thus the linkages from Chedzoy are 40–50km in a south-easterly direction. Lithics from Priddy on the Mendips also apparently derive from flint and chert outcrops about 40km to the east (Taylor 2001). The absence of chatter-marked beach pebbles at Birdcombe (Gardiner 2000) likewise hints that this group was more linked to the chalk areas to the east than the Severn Estuary just 8km to the west. Mesolithic sites at Charterhouse on Mendip did, however, make use of beach pebble flint (Todd 2003). A possible explanation of these patterns is that the concentration of sites on Mendip involved separate groups from the Severn Estuary and the chalklands to the east coming to the same geographical area which might support the earlier suggestion of aggregation camps around Priddy.

In north Wales, Carboniferous Gronant Chert, which outcrops within 2.5km of Prestatyn, was the main raw material on the Bryn Newydd site but was less important than beach flint at Nant Hall Road, possibly hinting that the group which made the shell middens came from the west where flint was the main raw material. The use of Gronant Chert in the Wirral suggests movement of some 20km in a north-eastery direction across the Dee Valley. Its use in the upland sites of Brenig (Lynch 1993) and Llyn Aled Isaf (Jenkins 1991) points to movement up the tributaries of the Clwyd about 20km from the outcrops.

Other possible geographical linkages have been suggested in the literature. Thus, Jacobi (1980, fig 4.33) notes close comparison between coastal lithic assemblages at Pen-y-Bont, Ogmore and upland assemblages at Craig y Llyn, arguing that the sites were linked as part of an annual territory extending *c* 38km inland. Clark (1972, fig 13) envisages some of the groups on the Pennine crest coming from the Liverpool Bay area, presupposing a movement inland of 50–80km. In the Black Mountains**,** Olding (2000) reports many flint scatters (not shown on Figure 1.6) and hypothesises distinct summer and winter camps on the basis of OD height. However, many of these are only about 5km apart suggesting much smaller-scale mobility than the other studies.

An additional perspective on these issues is provided by evidence for the isotopic composition of human bone. Mesolithic humans from Caldey have isotope compositions indicating a substantial marine contribution to the diet, whereas those from the Gower have evidence of smaller marine contributions to the diet (CD 21.2), suggesting perhaps the existence of some sort of social barrier north-south across Swansea Bay (Barton and Roberts 2004). Early Mesolithic burials from Aveline's Hole on Mendip show little evidence of a marine contribution to the diet (Schulting 2005), in that case suggesting the absence of movement up what was then the River Severn from the sea which at that time lay about 100km to the west. Thus, at least in the early Mesolithic, there were communities who did not include the sea within their annual round.

In south-west England, south of the area mapped here, the overall pattern of lithic finds is again strongly suggestive of axial inland movement up river valleys (Berridge and Roberts 1986; Roberts 1999). This is supported by the use of pebble flint and shell beads at sites such as Three Holes Cave, probably a campsite on the route up the River Dart and its tributaries between the Devon coast and the uplands of Dartmoor, a distance of some 30km (Roberts 1996).

Evidence for the annual home range from western Britain can be compared with evidence from elsewhere. Raw material studies in Scotland show mobility over distances of 25km to 75km (Wickham-Jones 2005). In Ireland Woodman *et al* (1999, fig 8.5) envisaged annual territories extending between 60km and 90km inland but, in contrast to what is suggested in the more strongly valley-dominated topography of Wales, extending a similar distance along the coast. At the winter base camp at Hardinxveld in the Netherlands, it is suggested that the summer camp was some 30km away, although in this case raw materials indicate contacts covering a radius between 80km and 160km (Louwe Kooijmans 2003, fig 77.21). Coles (2000) argues that 150km was the limit of the coastal zone exploited around the North Sea in the later Mesolithic because this was the zone not penetrated by farming for an extended period. However, this is perhaps an unusual case because the wetland belt itself is between 50km to 90km wide. The distribution of distinctive axe styles in Denmark suggests Mesolithic territories spanning 50km or less (Fischer 2003). The size of annual territories is bound to vary significantly according to ecological richness, the distribution of resources and population levels and social factors. In the study area most movement seems to be over distances of 30km to 50km, sometimes up to 100km, with the predominant, but not sole, axis of movement being up river from coast to upland.

Drawing on evidence in the foregoing for the existence of territories, linkages, and boundaries to movement, the highly speculative suggestion is advanced of maybe twelve territorial units in the mapped area (CD 21.3–21.4). The average size of most of those territories where Mesolithic activity is abundant is 2700km^2. There are two much larger areas in which Mesolithic activity is sparse: Ceredigion and the Welsh Marches. Population density figures for hunter-gatherers have been calculated using a range of figures proposed for the British Isles by the Prehistoric Society (1999) according to whether artefact distributions suggest that population levels were high (0.09 persons per km^2), low (0.05 persons per km^2) or sparse (0.02 persons per km^2). The calculations suggest the mapped area may have supported a population of *c* 2500 with an average overall density of 0.05 persons per km^2. The average population size in each territory is *c* 200. This is significantly more than the normal hunter-gatherer band size of under 100 (Renfrew and Bahn 2000) and much more also than is suggested by the density of artefacts on most sites in the area. It is probable therefore that each of the suggested territories was divided into five or ten smaller units which were perhaps also based on the river valleys. If we accept that the hints of barriers suggested by the raw materials and the evidence of environmental manipulation point to some degree of group ownership of environmental resources, and therefore that for the most part territories did not overlap, then one implication is that the annual territories are more likely to have been typically 30km to 40km across than over 100km – simply because sufficient territories of the band size suggested by the artefact scatters cannot be fitted in.

21.8 A model of seasonality and movement

On the basis of the foregoing observations concerning the different types of site and offsite context, evidence for patterns of movement, and what is known of the seasonality of activity, a hypothetical model of seasonal movement is proposed in Figure 21.2. Its speculative nature must be emphasised, the model is in places anchored by evidence from the sites reported here, but observations about other types of site and their seasonality, for which the evidence is limited, are little more than guesswork. The value of such models is that they make explicit some of our assumptions and impressions about what was going on in a way that can be challenged and tested by future researchers. It also helps to identify those types of site which badly need future investigation in order to create better models. It is, of course, simplistic to propose a single model for Wales when there is clear evidence of differences within the area, most notably perhaps between the main concentration of sites in Pembrokeshire and the rest of the area. It is clear that not all of the site types represented were found throughout the area; shell middens, for instance, are lacking in the Severn Estuary where the waters are extremely muddy, and molluscs, whilst present, are not abundant.

The model proposed accepts the general validity of movement between coastal lowland in winter and inland upland in summer which has been proposed by earlier writers (Clark 1972; Jacobi 1980; Simmons 1996). Such a model is inherently probable in a landscape such as Wales where there are such marked topographic, climatic, vegetational, and resource contrasts between a coastal belt and the uplands. The model developed here envisages a wider range of distinct types of site and a greater residential and logistical (ie task specific) mobility than previously proposed models. This is because a greater diversity of site types is now evident and because some sites like Goldcliff, with evidence for a range of activities suggesting a home base, have an insufficient abundance of artefacts to suggest occupation for several months on end.

This model envisages the main winter home base situated near the head of an estuary, as at Rhuddlan, or in a river valley, such perhaps as the Mesolithic flint scatter known at Usk (Walker forthcoming), 20km up the River Usk from Goldcliff. Occupation at these hypothetical winter base camps may have taken place from about November to March. A greatly valued resource will have been the large spring salmon making their way up rivers such as the Usk between November and May (Gough *et al* 1992). Stored food will have been very important at this time of year and the possible pits at Rhuddlan (Quinnell and Blockley 1994) could have been used for food storage, as is attested by storage of hazelnuts in pits elsewhere (Mithen 2000a). During the winter there are likely to have been hunting and fishing expeditions, including those to extraction camps and overnight

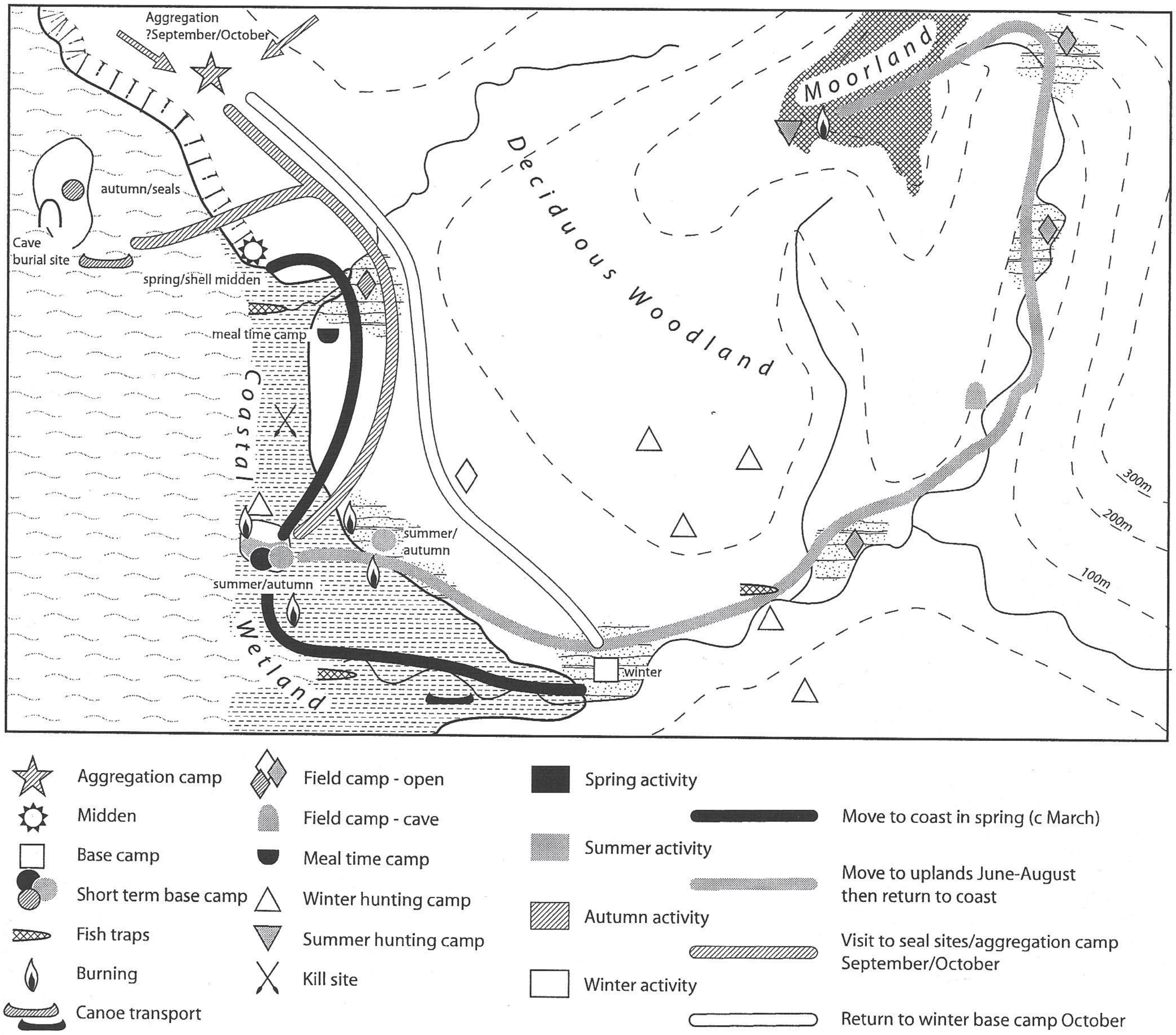

Figure 21.2 Hypothetical model of the seasonal movements in the annual territory of a typical community in the study area. Hypothetical contours are at 100, 200, and 300m. The inland extent of the annual territory is in the order of 35–50km. For clarity small-scale movements of <5–10km to extraction camps, kill sites, meal time camps etc are not shown (graphic M Mathews)

camps. Goldcliff Site W, on a wetland island, may have been used in this way and some of the caves were probably used as overnight bases for hunting. At the very onset of spring it is probable that the group moved to the coast. They were certainly present at Goldcliff in spring and early summer. The coastal areas, which are rich in sites, have a milder climate, are virtually frost free, and plant growth occurs throughout the year in coastal Pembrokeshire (Lockley 1970; Bell and Walker 1992, fig 5.7). The growing season decreases by thirteen days per 100m rise (Simmons 1996). Thus logically, the earliest date at which people are likely to have arrived at an upland site, such as Waun-Fignen-Felen in central Wales, at 450 m OD, is around a month after the onset of the growing season. On purely botanical grounds, therefore, it is likely that the early weeks of spring would be spent in the most climatically favourable coastal areas.

Plant growth in the Berwyns and Cambrian Mountains begins in early May (Ellis 1983). Thus around late May or early June it may be supposed that the main annual migration of animal herds, and the people who followed them, would have begun up valley, maybe the earlier part of this range given the slightly warmer conditions of the climatic optimum (Bell and Walker 2005, 89). Stops would have been made overnight at caves such as those in the Wye Valley and field camps set up on major routes such as Gwernvale and at other favoured hunting locations. We do not know if this annual migration involved the whole community or just the most able-bodied. The active engagement of children in the economic life of the coastal Goldcliff settlement might suggest that all were involved. On the other hand, the footprint-tracks show that children were on the coast during the calmest period of the year, judged to be June to August. On balance it seems probable that a subset of the community remained on the coast through the height of summer particularly to fish. An alternative possibility is that the return of the whole group to the coast happened before the development of more turbid water conditions towards the end of August.

Activity in the uplands is likely to have taken place during the mildest time of year in June to August when bands are likely to have visited the uplands such as Waun-Fignen-Felen and sites at the head of the Taff in the south and Brenig and Llyn Aled Isaf in the north. The main activity must have been hunting of red deer and other mammals which were taking advantage of the summer's growth of grass above the much denser woodland cover of the lowlands. The collection of plant resources such as bilberries and bracken rhizomes may also have been significant activities. Clear evidence from a number of upland sites, reviewed above, indicates that Mesolithic communities burnt upland vegetation to improve the grazing for deer and to promote the plants of the woodland edge. Since it is envisaged that the axis of inland movement was predominantly upriver, and the pattern of rivers in Wales is essentially radial, it follows that a visit to the uplands would also provide the occasion for contact and perhaps exchange with groups who had moved from other coastal areas.

During August, or perhaps a bit later if the whole community did not migrate to the upland, there was a return down valley to the coast. This move is likely to have been accompanied by gathering the first fruits of autumn; hazelnuts and sloe berries from late Mesolithic contexts in the Wye valley caves may reflect use at this time (Barton 1997). During the down-valley migration, some localised burning, pruning etc may have occurred to provide useful plants on expeditions during the following year (using North West Coast American analogies, Boyd 1999a). It is possible that some food gathered would have been stored at the winter base camp but the Goldcliff evidence suggests that people did not tarry long at a hypothetical base camp but went to the coast in August/September where they were engaged in fishing, hunting, and the gathering of autumn fruits and seeds – a site such as Goldcliff serving as a temporary base camp for logistical expeditions to other suitable food gathering sites. The presence of charred seeds, including raspberry at Llandevenny, indicates activity at the wetland edge at this time (Chapter 19). Whilst conditions were warm and dry in August it is probable that some woodland and the dead growth of previous years' reed beds was burnt.

In the eastern coastal wetlands of the study area it is likely that about September groups moved a few kilometres inland from the coast to a winter base camp. The upper section of the model (Fig 21.2) suggests the possibility of a rather different pattern on the rocky coast of Pembrokeshire and maybe north-west Devon. Here, the possibility is suggested of aggregation camps where several groups met in a coastal hilltop (later clifftop) location at Nab Head, Pembrokeshire (David 1990); beyond the study area to the south-west, a possible example is the complex of sites in the Trevose Head/Constantine Bay area of north Cornwall (Johnson and David 1982). Jacobi (1980) has noted that these rocky coastal areas of Cornwall and Pembrokeshire, where bevelled pebbles are found, lie close to seal rookeries. Activities at these sites are most likely to have taken place during the breeding season, which for the grey seal is between September and November (Burton 1976), or less probably when they were near shore in June to September (Hope Jones 1988, fig 25). Such resources might have supported an aggregation camp. Sealing and fishing in autumn is also perhaps the most likely occasion for expeditions by boat to the larger offshore islands where there is much evidence for Mesolithic activity on Caldey, Lundy, and Bardsey. Earlier in the Mesolithic Caldey was also significant as a burial location. It is possible that some groups spent the winter in mild but windy coastal locations such as the Nab Head, but in general it is thought more likely that most groups repaired to more sheltered inland estuary head or riverine locations for the winter, as is indicated on the lower part of Figure 21.2.

21.9 A pattern of islands

A striking aspect of the later Mesolithic settlement pattern of Britain is the occurrence of several important sites on offshore islands, many tiny, some linked to larger land areas at low tide. Goldcliff is one of the latter. Mesolithic activity begins at the point when it became an island, though for much of the time it may have been reachable on land at low tide and across 5km of coastal wetland. The midden at Culverwell on Portland (Palmer 1999) is a much larger island which may have been linked to the mainland by a proto-Chesil Beach. The midden at Morton, Scotland, was on a small island of just 600m^2 about 1km from the mainland to which it was linked by a tombolo (Coles 1971, fig 2). The most substantial middens in Britain on Oronsay are on an island of about 4km^2. Within the study area Mesolithic activity is also known on the islands of Lundy (Jacobi 1979) and Bardsey (Edmonds *et al* 2004, 2005). Rhyl may also have been an island of dry ground reached across wetland by the end of the Mesolithic. A functional explanation for the focus on islands is the richness of coastal resources they offered as demonstrated by the middens. This is not just a matter of shellfish gathering because Oronsay, Morton, and Goldcliff actually have quite broadly-based economies. Another factor was lithic raw material, clearly important in the case of Portland chert (Palmer 1999). Deith (1990) has suggested that the main factor which brought people to Morton periodically through the year was raw material procurement. There seems to have been no such motivation at Goldcliff where good raw materials do not seem to have been available very close to the site, but more probably in the river and outwash gravels of the Usk to the west. At Goldcliff the economy was as much terrestrial as marine, notwithstanding the tiny size of the island. In the case of Oronsay, we know that seals were an important resource and the same is likely in the cases of Bardsey and Lundy. Mithen (2000 a and b) showed that activity on Oronsay occurred at a time when neighbouring southern Hebridean islands seem not to have been occupied.

The foregoing points raise the question as to whether this focus on islands can be mainly explained by environmental and economic factors. Tilley (1994) and Cummings (2000) have argued that the coastal emphasis of the Mesolithic and early Neolithic in Pembrokeshire might relate more to the social significance of place, eg particular rock outcrops, rather than purely economic or environmental factors. Significantly, however, although Goldcliff would have been a prominent rocky rise in the river plain throughout the Mesolithic it was only when it became an island that it attracted activity. Pollard (1996) has highlighted the possible significance of the shore as a liminal zone, a place of mediation between land and sea, dominated by lunar cycles in the form of tides and associated perhaps with death. In the Severn Estuary tidal factors are highly likely to have been a very powerful influence on people's lives and the resources they used. Given these factors we cannot rule out the possibility that one factor that brought people to small coastal islands was not just the resources they offered, but the particular significance attached to those places in the cosmology of the time and conceivably at a particular stage of either the annual cycle or the human life cycle (Gilchrist 2000). The latter could be one explanation for the high proportion of children and young people among the footprints.

Despite the concentration on islands and the interesting possibilities this suggests, there is no apparent uniformity in the seasons when they were exploited. Fish otoliths from Oronsay show that different middens on the small island were used at different times of year (Mellars and Wilkinson 1980), and seals were exploited on one midden in autumn. Some argue for visits at several times of year as part of a seasonal round (Finlayson and Edwards 1997) but there is growing evidence that the island may have been semi-permanently occupied (Richards and Mellars 1998; Mellars 2004). Tidal banding on the shells at Morton also shows that visits were made at various times of year (Deith 1983). On Portland seasonality evidence from the shells points to activity mainly in late autumn to winter (Thomas and Mannino 1999). At Goldcliff the main focus of activity was in September and October but people were also there in spring and during the calmest period of summer in June to August and on Site W in winter. Generally then the evidence does not suggest visits at one specific time of year but at various times of year. It might be argued that, as at Oronsay, this points to coastal sedentism, However, in cases such as Goldcliff and Morton the islands are small and the concentration of artefacts seems insufficient to argue for sedentary activity.

21.10 Change in the Mesolithic

Evidence has been presented from the distribution of sites and patterns of lithic raw material movement which suggests that in this study area annual territories were largely based on river catchments. This is also inherently likely because some of the resources which we can identify as being most highly valued, salmon and eels, migrated up and down rivers. That being so the sea-level changes of the Mesolithic (Fig 1.4) had a major impact on territory sizes. The changes in the length of rivers in the study area between 9500 and 4000 cal BC (CD 21.5) show the average reduction in river length over this period was 46% or 58km. The greatest reduction in the length was the Severn at 195km (50%). A number of the rivers were, in the early Holocene, part of single systems, thus the seven rivers in the south-east corner of the study area were all tributaries of the Severn.

As well as the significant changes in river length the dramatic environmental changes in the Mesolithic included the inundation of the Bristol Channel and Severn Estuary, Cardigan, and Liverpool Bays. The question arises as to when the annual territories and patterns of movement which have been tentatively identified became established. The indications are that this happened early in the Mesolithic well before the end of broad blade microlith types dated around *c* 7950 cal BC (David and Walker 2004). This is suggested because several of the main upland artefact concentrations contain both early and later microlith types, as at Waun-Fignen-Felen; the head of the Taff; Gwernvale; Llyn Aled Isaf; the Brenig; and the Pembrokeshire coast (Fig 1.6). It has already been suggested that long-established routeways are the most likely explanation for this apparent continuity.

21.11 An evolutionary model for the Mesolithic?

The literature often contains implicit, or explicit, assumptions of an evolutionary model for the Mesolithic represented by a trend towards greater social complexity (Zvelebil 1998). That model rests to a significant degree on the outstandingly preserved and intensively investigated Danish record in which there is evidence for greater sedentism, elaboration of material culture including pottery, burials, grave goods, and art. The suggestion has also been made that in the later Mesolithic communities on the Atlantic fringe, including Britain, likewise became sedentary (Zvelebil and Rowley-Conwy 1986). There is also the widespread view that environmental manipulation using fire predominantly occurred in the later Mesolithic (Zvelebil 1994; Simmons 1996).

It is appropriate to test the theory of increasing complexity against evidence from the study area investigated here. No evidence has been found to support the idea of larger, more densely occupied sites in the late Mesolithic. Indeed some of the most dense sites (eg Nab Head and Rhuddlan) began in the early Mesolithic and there are fewer sites in the last millennium of the Mesolithic (David and Walker 2004, fig 17.12). Groundstone axes at Nab Head could indicate elaboration of material culture but there is no evidence of pottery. No evidence has been found in the study area, or more widely in England or Wales (Whittle 1997), for coastal sedentism, although it must be acknowledged that the evidence from Oronsay could be interpreted in this way (Mellars 2004). In the study area the evidence suggests, however, only short-term seasonal base camps and a high degree of logistical mobility.

In the study area most of the sites with evidence for fire are later Mesolithic and that would be consistent with a more intensive use of plant resources, consequent upon the hypothesised reduction of 40% or more in the length of river valley-based annual territories. However, since, contrary to earlier opinion, the majority of sites with evidence for burning are coastal it may well be that we have lost earlier Mesolithic sites of this type as a result of sea-level rise. Indeed beyond the study area some of the best evidence for human manipulation using fire comes from the very beginning of the Holocene at Star Carr (Mellars and Dark 1998) and Thatcham (Chisham 2004). Claims that the occurrence of 'cereal-type pollen' several hundred years before the beginning of the Neolithic represent evidence of precocious cereal-growing by late Mesolithic communities (Innes *et al* 2003) are not supported by the evidence (Chapter 21.12).

The evidence for Mesolithic burial practice in Britain shows its greatest concentration in the study area (Conneller 2006), but it is very different in character to that found in Denmark. All the human remains are in caves and they date between 8800–5500 cal BC (CD 21.2). There is no evidence for more burials, cemeteries or grave goods in the later Mesolithic, indeed the most persuasive evidence for these traits comes from Aveline's Hole in the early Mesolithic (Schulting 2005). Art is poorly represented in this area compared to the richness of Scandinavia. Even so, there is rather more than from most of the rest of Britain – the Nab Head figurine, the Rhuddlan decorated pebbles (CD 20.58; David and Walker 2004), the possible geometric rock art at Aveline's Hole (Mullan and Wilson 2005), all of which appear to be early, not later, Mesolithic. Thus on present evidence there is very little to support an evolutionary model for greater complexity in the later Mesolithic. The only evidence which may support this model is for an increased scale of environmental manipulation in the later Mesolithic and that is notable, in contrast with the very limited evidence for Mesolithic environmental manipulation in continental Europe. Raemaekers (1999) argues that in the Netherlands evidence for increasing social complexity in the late Mesolithic has been overemphasised. The validity of the model has also been challenged in Denmark where Fischer (2002, 384) argues that some of the claimed traits of complexity were present long before the later Mesolithic, and there is also growing evidence for earlier Mesolithic burials (Brinch Petersen and Meiklejohn 1995).

21.12 Transition to the Neolithic

Given the history of pre-existing settlement, apparent seasonal movement and evidence of landscape disturbance which has been described, the question arises what happened with the advent of agriculture? Here this question is examined from a mainly environmental perspective and thus complements other recent surveys which have examined the problem in this area respectively from a mainly artefactual emphasis (Burrow 2003) and a focus on tombs and their location (Cummings and Whittle 2004). Some aspects of the Neolithic evidence from the Severn Estuary and its hinterland are reviewed in more detail by Bell (forthcoming).

Two distinct models of the Mesolithic/Neolithic transition were identified in Chapter 1. One envisages a gradual transition with the continuing exploitation of wild plant resources, only limited cereal growing and continued mobility, albeit now with domestic animals (Whittle 2001; Thomas 1999). Armit and Finlayson (1992) argue, thus, for a protracted period of transition, with the main social changes coming near the end rather than the beginning of the Neolithic. The other model gives greater weight to recent isotopic evidence for human diet which suggests a rapid and complete transition from a Mesolithic diet, making significant use of marine resources, to a Neolithic diet which appears to have made very little use of them (Richards and Hedges 1999). It has recently been argued, however, that continued consumption of a low proportion of marine foods (<20%) might be difficult to trace isotopically in diets of certain compositions, for instance those involving cereals (Milner *et al* 2004).

Recent literature has reacted against the environmental determinism of literature in the period 1950–1980 by denying, or ignoring, the relevance of ecological evidence altogether (Klassen 1999). The elm decline exemplifies this. Once seen as a direct result of economic change and the feeding of domestic animals with leaf fodder, it is now widely considered to result from a natural disease outbreak which may, or may not, have coincided with the earliest farming in Britain (Pegler 1993). Consequently there is now no clear dividing line between the two periods, although it was argued in Chapter 1 that the dates of chambered tombs, the earliest cereal grains, domestic animals, and other cultural traits are all consistent with a change occurring within a couple of centuries of 4000 cal BC (Schulting 2000). It follows that clearances which occur within a couple of centuries, possibly much more, of the elm decline could be the result of activities by either hunter-gatherers or farmers.

This is particularly an issue at Prestatyn, which, depending on where one puts the boundary, could be considered a site which spans the transition. The mussel middens clearly date before 4000 cal BC, and produced one microlith. The cockle middens are younger than 4000 cal BC. The slight evidence for cereals and possible domestic animals are stratigraphically later than the middens and there is no evidence to demonstrate that the midden users had any of the traits associated with a Neolithic way of life.

It might conversely be argued that establishment of this site marks the beginning of a precocious Neolithic. However, given that we have no well-dated Neolithic evidence in the study area as early as the dates of these middens, the hypothesis favoured here is one of continuity of an essentially Mesolithic way of life for maybe as much as 500 years after 4000 cal BC. That would not of course preclude the possibility that Neolithic traits were assimilated during this period. That interpretation accords with the prevalent model of significant continuity in this period but it does not fit the isotopic evidence for sudden dietary change. In many ways it is irrelevant what label we attach to the Prestatyn community, the essential point is that the site demonstrates continuity of similar activities, a seasonal mollusc extraction camp, apparently for around 400 years, on either side of the 4000 cal BC divide.

Our original expectation was that activity at Goldcliff might also span the transition. The earlier excavation at Site W produced evidence of later Mesolithic activity and the previous pollen study of Smith and Morgan (1989) indicated a landnam event just after the elm decline. However, as Dark demonstrates in Chapter 14, the relevant vegetation changes coincide with major natural ecological changes, such that pollen recruitment factors may account for some of the observed patterns. In the event the field investigations reported here have shown Mesolithic activity was at a very much reduced level from *c* 4800 cal BC and no certain evidence of early Neolithic activity has been found, but it cannot totally be discounted.

The case studies at Llandevenny and Oldbury in Chapter 19 suggest activity both in the late Mesolithic and early Neolithic which, with Prestatyn, suggests that some wetland edge sites may have been particularly favoured as continuing foci of activity. Pollen diagrams from these sites and others at the wetland edge, such as Vurlong Reen (Walker *et al* 1998) and Caldicot (Nayling and Caseldine 1997), indicate only small-scale Neolithic clearance episodes. More extensive clearances occur in the late Neolithic when the lime decline is interpreted as indicating increased grazing. During the Bronze Age, a more open landscape is attested and from the middle Bronze Age there are seasonal settlements and many wood structures in the wetland (Bell *et al* 2000).

Artefactual evidence for Neolithic activity within the Severn Estuary wetlands is very limited (CD 21.6). One polished axe has been found in the intertidal zone (Green 1989) and another from peat at Dowlais steelworks, Cardiff (Burrow 2003, 260). On the English side of the estuary there are a number of axes from Oldbury and Hills Flats (Allen 1990b; 1998). What is particularly notable, however, is that of the many wood structures in the intertidal zone of the Severn Estuary Levels almost all date from the middle Bronze Age and later (Bell *et al* 2000). The only exception is a wooden structure in a palaeochannel at Peterstone dated 3910±60 BP (Grn-24149; 2580–2200 cal BC), ie late Neolithic or early Bronze Age (Bell *et al* 2000, 305; Bell and Brown 2005).

The peatlands of the Somerset Levels present a very different picture with nineteen trackways between 3800 and 3000 cal BC; these earlier Neolithic trackways were constructed at a time of marked clearance on dryland between 3800–3100 cal BC (Coles and Coles 1998). The density of finds suggest wetland dependence rather than simply wetland passage. In the later Neolithic fewer trackways were constructed and woodland regeneration took place between *c* 3100–2800 cal BC. Significantly, wood structures are now beginning to turn up in the Somerset Levels peats in the clay levels at Walpole, where the earliest dated wood structure is 3950–3620 cal BC (C and N Hollinrake pers comm). Roundwood post alignments on peat at Westward Ho! are dated to the early Neolithic but it is unclear what purpose they served; they might be either trackways, fishtraps, or other structures (Balaam *et al* 1987a). Wood structures which may be associated with fishing occur elsewhere in Neolithic contexts at Hartlepool (Waughman 2005) and Wotton Quarr, Isle of Wight (Tomalin 2000). In the North West Wetlands, artefact scatters, mostly round the wetland fringes, point to the existence of sites, and small-scale clearance episodes are attested by the environmental evidence. This area has not, however, produced wood structures or evidence of concentrated *in situ* Neolithic activity within the wetland (Cowell and Innes 1994). On balance it seems that Neolithic activity may be focused at the dryland-wetland edge extending into freshwater and peat-dominated areas of wetland but making less use of the maritime-dominated areas, such as the Severn Estuary, which had been more utilised in the Mesolithic. This accords with the previously noted isotopic evidence for the reduced significance of marine resources.

Evidence from the coastal wetlands, investigated in detail here, needs to be put in context by comparison with evidence from the wider study area. Figure 21.3 shows the distribution of some of the

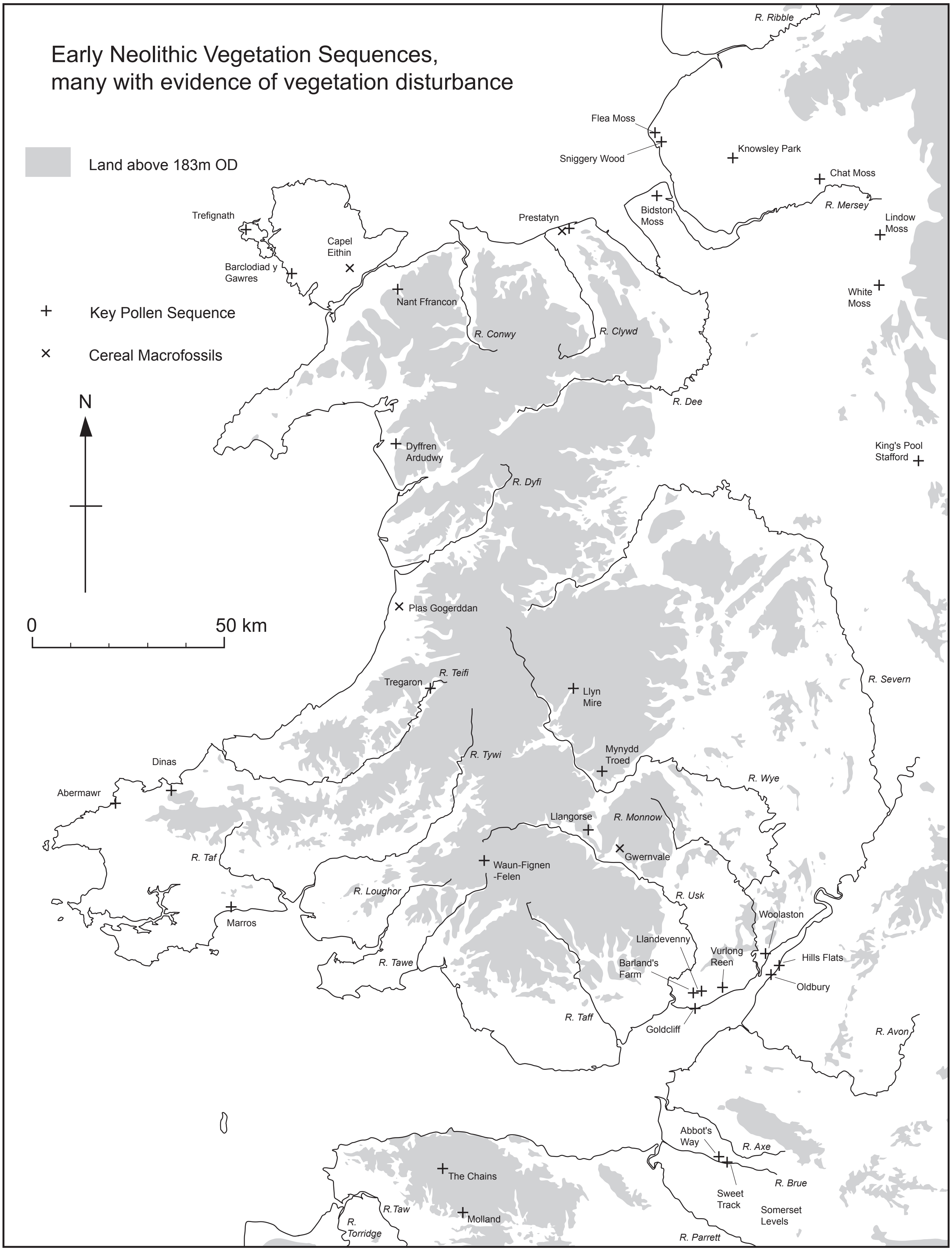

Figure 21.3 Sites in Wales and adjoining area with evidence of early Neolithic vegetation disturbance in the study area (for full details of sites see CD 21.7) (graphic S Allen)

key pollen sites, many with evidence of Neolithic vegetation disturbance; about 60% of clearances are in the coastal zone, 40% in upland or inland locations. The distribution is quite similar to that of Mesolithic disturbance episodes (Fig 21.1) and at many sites there is evidence of disturbance in both periods. Vegetation disturbance episodes occur in the earlier Neolithic at Abermawr (Lewis 1992) and Dinas (Seymour 1985). At Nant Ffrancon some vegetation disturbance occurs just after the elm decline, but clearance is more extensive *c* 700 years later (Hibbert and Switsur 1976). At Lindow Moss, burning and clearance is attested just after the elm decline (Turner and Scaife 1995). Kings Pool Stafford has some vegetation disturbance and 'cereal-type' pollen at the elm decline but the main clearance is 1500 years later (Greig 1996). However, in the River Severn Basin sites such as Crose Mere show very limited evidence of Neolithic activity (Barber and Twigger 1987). What, in the older literature, appeared to be a very marked increase in small-scale and short-term vegetation disturbance just after the elm decline is now not so apparent, small-scale vegetation disturbance having been identified on many sites much earlier (CD 21.1 and 21.6). This is particularly apparent in the North West Wetlands where clearance episodes occur from 5800 cal BC with possible cereal pollen grains on two sites from *c* 4800 cal BC (Cowell and Innes 1994). Similarly on the Isle of Man evidence has been found for vegetation disturbance from *c* 5800 cal BC with evidence of 'cereal type' pollen from *c* 4800 cal BC. This has been interpreted in terms of a pioneer phase of forest farming and cultivation which is especially represented in the Irish Sea Province where it is argued to show the introduction of farming as early as in neighbouring continental Europe (Innes *et al* 2003). This case rests entirely on what is described as the 'key palynological signature' provided by cereal-type pollen. It has, however, been shown at Goldcliff and elsewhere that 'cereal-type' pollen occurs much earlier. The view taken here is that these grains cannot be taken as definite evidence of cereal growing and are more likely to derive from wild grasses. The earliest evidence for cereal macrofossils is consistent with a date around 4000 cal BC (Brown 2005). In this study area, sites with charred cereal grains are very few. The earliest cereals and domestic animals are in pre-cairn contexts at Gwernvale around 3800 cal BC (Britnell and Savory 1984, 152). At Plas Gogerddan, cereals occur with hazelnuts and crab apples dated to 3500 cal BC clearly demonstrating the continued use of wild resources into the Neolithic (Caseldine 1990).

In dryland contexts where we have evidence for the environment before construction of early Neolithic tombs it generally suggests they were places with a history. Gwernvale exemplifies this with preceding late Palaeolithic, Mesolithic, and early Neolithic activity (Britnell and Savory 1984). The Mynydd Troed tomb was constructed in a forest clearing (Crampton and Webley 1966). In north Wales, Trefignath, Anglesey, had evidence for pre-monument grassland and possible cereal pollen *c* 3900 cal BC (C A Smith and Lynch 1987), Barclodiad y Gawres incorporated cut turves from wooded with open habitats (Powell and Daniel 1956) and Dyffryn Ardudwy was in secondary woodland (Dimbleby 1973). At Carreg Coitan Arthur, Pembrokeshire, a chambered tomb with a significant surrounding concentration of Mesolithic flints again shows this was a place with a history (Thomas 1923; Barker 1992; Lewis 1992). These sites do fit a pattern seen south-east of the immediate study area, where clearance and pre-monument activity is very well attested among the Cotswold-Severn tomb group at Hazleton on the Cotswolds (Saville 1990), South Street, Wiltshire and Ascott-under-Wychwood, Oxfordshire and Wayland's Smithy, Berkshire (Evans 1972). There is also evidence of earlier activity and hints of openings within woodland from early excavations of several other Cotswold-Severn tombs (Bell forthcoming).

Despite these hints of long-established activity from a number of tombs the isotopic evidence indicates, as already noted, that marine resources, which had been important in the Mesolithic, were now little used. This is even the case at tombs very near the coast such as Parc le Breos, Gower, constructed *c* 3600 cal BC. Here the strong muscular development of some male skeletons has supported the idea of a partly mobile way of life (Whittle and Wysocki 1998). This is not, however, seen among the individuals in all south Welsh tombs, suggesting a diversity of lifestyles between tomb building groups (Wysocki and Whittle 2000). Several of the main concentrations of later Mesolithic sites mapped on Figure 1.6 coincide with Neolithic activity on Figure 1.7. The clearest example is the main concentrations of Mesolithic sites and tombs around the Pembrokeshire coast. Other areas include the mouth of the river Avon and the Ogmore/Mount Pleasant area where two apparently Neolithic enclosures have recently been found (Burrow *et al* 2001). There are similar concentrations around Prestatyn and Rhyl and the Wirral.

Cummings and Whittle (2004, 28) argue that the Neolithic settlement area was probably generally situated below the typical hillside megalithic tomb. This does gain a measure of support from Figure 1.7 where there are areas with axe distributions and lithic scatters downslope from tombs. Examples are in the Mount Pleasant/Ogmore area, the mouth of the River Avon, the Cardiff area, Llandegai, and the mouth of the Conwy. In the British Isles one of the arguments in favour of mobile Neolithic communities has been the absence of domestic structures. However, Cooney (2000) has cautioned against the general application of models mainly developed in Wessex. Large numbers of substantial, often early, Neolithic houses have been found in Ireland, some with evidence for significant local cereal growing. Wales has a smaller number of structures, several of which are similar to the Irish forms. Two houses are known from Llandegai (Lynch and Musson 2001; Kenny 2005). There is also a structure below the Gwernvale tomb (Britnell and Savory 1984) and a possible Neolithic house at Moel-y-Gaer (Britnell 1991). Earlier excavations also produced domestic structures of different forms at Clegyr Boia and Mount Pleasant (Savory 1980). Some later Neolithic structures are less substantial, as with the round stake structure at Trelystan, Cefn Cilsanws and Upper Ninepence, Walton (Burrow 2003).

The Trelystan structures are in an upland situation and may represent seasonal visits by pastoralists (Britnell 1982). The continuation of seasonal visits to the inland and upland areas is suggested by vegetation disturbance in both the later Mesolithic and Neolithic at Waun-Fignen-Felen, Llyn Mire and the Berwyn Mountains. Moorland areas of the Cambrian Mountains and Exmoor have been argued to show pollen evidence of small-scale grazing activity soon after the elm decline which tipped the balance in favour of blanket peat inception (Moore 1981; Merryfield and Moore 1974). However, there is very limited evidence of Neolithic artefacts on the Cambrian Mountains and evidence of Neolithic settlement is lacking on Exmoor where a scatter of artefacts suggests some, probably seasonal, exploitation of this upland (Riley and Wilson-North 2001). At a lower level on the Exmoor site of Mollard Common there is a loss of woodland at the elm decline with evidence of increased pastoralism (Fyfe *et al* 2003). Generally in the region the inland and upland areas have fewer Neolithic sites. Notable exceptions are the Cotswolds and Mendip with higher concentrations of tombs, other monuments, and lithic scatters than in most of Wales which may be explained by the greater agricultural favourability of the limestone soils (CD 21.8). An inland exception within Wales is the tomb group in the Black Mountains where there are also concentrations of Mesolithic and Neolithic artefacts, particularly on the flanks of the Golden Valley (Olding 2000). It is tempting to see this concentration in terms of the continued significance of seasonal patterns of movement up the Rivers Usk and Wye as suggested above in the Mesolithic.

During the later Neolithic there is the emergence of regional ritual complexes from around 3400 cal BC. The most northerly of these is on the coastal lowland at Llandegai where a cursus and henges (*c* 3100 cal BC) are preceded by the early Neolithic house sites and slighter evidence of Mesolithic activity, including a decorated pebble similar to those from Rhuddlan (Lynch and Musson 2001). Soil below the later Neolithic henge points to the existence of grassland. A ritual complex comprising a cursus and later timber circle was established in the Severn valley at Sarn-y-bryn-Caled; the cursus implies an opening in the valley floor woodland in the earlier Neolithic (Gibson 1994). Also in the Welsh Marches the Walton Basin complex includes a cursus and two large palisaded enclosures of *c* 2800 cal BC, in an area with a concentration of Mesolithic lithics, earlier Neolithic lithics and axes showing a history of activity (Burrow 2003; Gibson 1999). In the south on Mendip there is the line of four henge enclosures at Priddy which were established in a grassland environment with some hazel scrub, in an area with very abundant evidence of preceding Mesolithic activity and also Neolithic flintwork (Taylor 1978, 1980, 2001). Also on Mendip are the recently identified great timber circle and probably succeeding stone circles at Stanton Drew (David *et al* 2004).

Wider themes emerge from this brief review of aspects of the Neolithic evidence. In the earlier Neolithic clearances are mostly small-scale and short-term and evidence of cereal cultivation remains quite limited (Caseldine 1990). Some clearances were probably not very different, in terms of scale and duration, from the vegetation disturbances which were equally widespread in the Mesolithic. A step change in the character of human impact just after the elm decline is implicit in the older literature, but no longer seems to be justified by the evidence, now that it can be seen in the longer perspective provided by the Mesolithic. What is particularly notable is that many areas show concentrations of activity in both the Mesolithic and Neolithic, and some have histories of woodland disturbance in both periods. That might be interpreted in terms of continuity of activity, in line perhaps with evidence for the continued use of wild plants. Others have explained the use of sites in both periods in terms of the enduring significance of particular sacred mountains (Tilley 1994; Cummings 2000; Cummings and Whittle 2004). In Brittany Scarre (2002) has rationalised a comparable coastal distribution of tombs, not in terms of coastal resources or agricultural favourability, but rather perceptual issues relating to the liminality of the coastal zone.

The contention here is that these arguments do not take account of the organic, specifically vegetational, aspects of the environment. We have seen that there is a growing body of evidence for Mesolithic vegetation disturbance in this study area, both in the coastal lowlands and in the uplands. In tandem with that there will have been natural disturbance factors: the effects of storms, floods, and grazing animals which would have been concentrated in specific landscape facets, particularly in certain coastal locations. Areas of sub-climax, woodland-edge plant communities – whether created naturally, or as a result of human agency – would have been attractive to both grazing animals and people and are thus likely to have been perpetuated over extended timescales. Clearance was not the sole factor that would have created conditions attractive to subsequent communities. Occupation sites are likely to have supported distinctive plant communities created by concentrations of people. Plants they favoured would have been carried back to the campsite, some also becoming concentrated by human toilet practice in the edges of a campsite, as the intestinal parasites at Goldcliff suggest. The ethnohistoric evidence of hunter-gathers in other parts of the world also opens up the possibility that favoured plants may have been transplanted and encouraged (Blackburn and Anderson 1993). Shell middens are also likely to have been particularly attractive because of the distinctive plant communities they supported (Claassen 1998). At Prestatyn there is evidence that an old mussel midden was subsequently cultivated and evidence for Neolithic cultivation on earlier middens has been more widely reported by Guttmann (2005).

It follows from the evidence presented here that Mesolithic communities had a significant impact on selected parts of their environment both in the uplands and extensively around parts of the coastal zone, less certainly in the river valleys. Of particular importance would be the long-frequented paths linking together those favoured settlement sites. The particular significance of paths is suggested by analogy from the North-West Coast of North America where routeways such as along the Willamette Valley were marked by burned grassy areas and where the earliest European maps show lines of small grassy prairies strung out along a trail like beads on a string (Boyd 1999a; Leopold and Boyd 1999). The pattern of cleared areas and sub-climax plant communities which this would have created, and the paths linking together these frequented patches, are likely to have been important factors in structuring both the Mesolithic and the Neolithic landscapes. It has been shown that the distribution of existing aboriginal clearings and grassy areas was a significant determinate in the selection of sites for settlements by Europeans in both the Puget Sound area of the American North West (Boyd 1999a) and in Tasmania (Kohen 1995). Those analogies should obviously not be taken too literally; there is no suggestion that, in the Welsh study area, the Neolithic represents the advent of foreign settlers! It is widely seen in terms of the adoption of new ideas by indigenous Mesolithic communities. However, underlying landscape structures created in the Mesolithic may provide a framework within which we can reconcile some apparently contradictory aspects of the transition. On the one hand, continuity is suggested by the frequent occurrence of Mesolithic and Neolithic activity in the same areas, comparable vegetation disturbance in the two periods, evidence for the continued use of wild resources, and continued mobility. On the obverse, there is evidence for rapid dietary change from human bone isotopes, in particular a turn away from marine resources (which is seen also in the archaeological record in the Severn Estuary), and the seemingly rapid adoption, apparently at about the same time, of new ideas: tombs, pottery, domestic animals, and cereals. Long-term vegetation structures created by patterns of recursive movement and disturbance in the Mesolithic provide a landscape framework which helps to reconcile evidence for rapid change with clear evidence for continuity in the underlying structures of landscape relationships. The principle might be called the 'structuration' (ie creation of patterns and structures) of landscape by antecedent conditions or ways of life.

In a similar vein, Giraldus Cambrensis, providing the quote at the head of Chapter 1, sought to understand the traces of earlier landscapes he observed on the beach at Newgale in AD 1172. He did so within the frameworks of contemporary knowledge, advancing a biblical explanation. It is now clear that submerged forests and drowned intertidal landscapes, which Giraldus was the earliest writer to record, contain a wealth of evidence of the ways of life and environmental relationships, not of the biblical Noah, but of the later Mesolithic and potentially the transition to farming. That evidence suggests that hunter-gather communities played a significantly greater role in the structuring of landscapes in the coastal and lowland zone than has previously been apparent. Thus, it is appropriate to end with another quote, a comment on the native American environmental legacy in the islands of Puget Sound, USA: 'far from being creatures of their environment, the Indians had shaped their world and made it what it was when the whites arrived' (White 1999, 46).

21.13 Limitations of the project and future directions of research

1. The research reported here in the Severn Estuary developed as two parallel projects, one funded by NERC with a mainly environmental focus, the other focusing on the Mesolithic archaeology and funded by Cadw and others. We had also anticipated that the later deposits would produce some evidence of Neolithic activity. As a consequence of these two factors it is acknowledged that we have ended up with a dating strategy which is somewhat unbalanced. The Upper and Lower Submerged Forests and peat have precise chronologies. Mesolithic activity on Sites B and D is well dated, but activity on Site J has only two dates from wood objects, while Site A has one date on a hazelnut. Bone samples with cut marks submitted from Site J had insufficient collagen for dating. With hindsight we should have obtained a larger number of dates for specifically archaeological samples from both Sites J and A.
2. At Goldcliff our original research objectives emphasised the Mesolithic/Neolithic transition, Smith and Morgan (1989) having previously identified a landnam episode at Goldcliff. In the event our research has found no archaeological evidence for Neolithic activity and Dark (Chapter 14) has suggested that the apparent impact at this time may be an artefact of other vegetational changes. In expectation of continuing activity into the Neolithic, our original objectives led to rather greater focus on the palaeoecology of the Upper Submerged Forest than now seems archaeologically appropriate given what we now know about the decreased level

of activity at this time. However, the apparent absence of Neolithic activity is itself significant and the detailed environmental picture from the Upper Submerged Forest makes an important contribution to our understanding of the broader environmental sequence within which the archaeology lies.

3. With hindsight we would have directed the main emphasis of research at Goldcliff somewhat differently. The original expectation was that Site B was the one with the greatest potential for organic artefacts and well-stratified evidence of Mesolithic activity. In the event, it was Site J that produced most of the waterlogged wood. It was only at the post-excavation stage that the richness of Site A in terms of microliths and fish bones from sieving became fully apparent. With hindsight we would have undertaken a larger excavation area and more sieving of Site A, and smaller areas of Sites B and D would have been excavated.
4. What could be achieved with the footprint-tracks was inevitably limited by the narrow tidal window and the difficulties of working so low in the tidal frame. Greater emphasis should, in particular, have been given to recording and identification of bird footprint-tracks.
5. The collection, sieving and sorting of samples represented a considerable slice of the project effort, even so, we recognise with hindsight that the sieving programme should have been expanded, particularly in the most productive areas of Site A to maximise fish bones, bird bones, evidence of plant use, and microliths.
6. The contribution and potential of use wear studies has been very well demonstrated by the sample of artefacts reported on by Dr van Gijn in Chapter 9.2. In particular this helps to highlight the role of plant resources. Future programmes of research on similar sites would be well advised to give much greater emphasis to this aspect.
7. The timescale and resources of this project did not allow for refitting of lithic waste from knapping. Had this been possible it would have contributed to the identification of activity areas particularly on Sites A and J and would probably also have helped separate out different phases of activity on Site J.
8. We have found experimental approaches to understanding the evidence of activity areas and artefact use valuable and now regret that we did not make greater use of systematic experimentation at an earlier stage in the project.
9. Research on other Mesolithic and Neolithic sites in the Severn Estuary work has necessarily been on a small scale by comparison with the detailed work at Goldcliff and it is to be hoped that in the future the potential identified by Alex Brown at sites such as Llandevenny and Oldbury will be explored further.
10. Work at Prestatyn had a mainly environmental emphasis in putting previous discoveries in a new ecological context. Given the significance of the shell middens discovered and the uncertainties regarding the nature of the site represented by the previously collected Neolithic flint scatter we regret that circumstances prevented a more extensive archaeological excavation on this site.

21.14 The main achievements of the research

1. The project had from the outset the objective of developing an integrated approach to environmental and archaeological research. This has involved a wide range of sources of environmental evidence, which has proved invaluable in disentangling the effects of environmental change and human agency but also in addressing other more specifically archaeological questions relating for instance to plant utilisation and the seasonality of activity.
2. Key coastal geoarchaeological contexts which preserve Mesolithic sites have been defined. The project demonstrates that classes of Mesolithic intertidal site known in western Britain for 150 years have far more archaeological potential than has been generally appreciated. The locations of previous finds have been mapped and are detailed. Well-preserved Mesolithic wood and bone artefacts can survive in a range of intertidal contexts not just peats.
3. The project represents a case study of intertidal archaeology. It demonstrates that it is possible to excavate sites and obtain worthwhile evidence under difficult circumstances. Many of the approaches, methods, and techniques which have been developed here are applicable more widely. Our hope is that this work will encourage other investigations of intertidal archaeology, particularly of Mesolithic sites.
4. The environmental and stratigraphic investigations carried out have enabled old finds made over a century or more to be seen in a new context particularly in the Prestatyn and Rhyl areas of north Wales.
5. The project has helped to facilitate the development of dendrochronological research in the intertidal zone and the application of wiggle-match dating techniques to the development of chronologies of coastal environmental change.
6. The contribution of human and animal footprint-tracks to an understanding of directly associated occupation sites has been demonstrated for the first time. It has provided some of the clearest evidence yet for the role of children some aged as young as 3 to 5 years in the gathering and productive activities of Mesolithic communities.
7. Evidence for Mesolithic burning of both reedswamp and woodland in the coastal zone has been clearly documented for the first time and evidence has been presented that this may be quite widespread in western Britain. This is

complementary to extensive evidence for Mesolithic burning in upland landscapes.

8. The project provides evidence for the utilisation of a wider range of plant and animal resources than any other later Mesolithic site in England or Wales. It highlights the need for a much greater focus on hunter-gatherer use of plant resources.
9. It has been demonstrated that the submerged forests and coastal wetland sequences have particular importance in looking at change during the late Mesolithic and the beginning of the Neolithic.
10. The detailed case studies at Goldcliff and Prestatyn, as well as comparison with neighbouring sites in both areas have provided a basis for a wider review of the later Mesolithic and early Neolithic in western Britain. This supports previous models of social territories based on axial movement along river valleys. On the basis of the new evidence, a model of seasonal movement is proposed which is significantly more complex than earlier models.
11. This research complements previous artefact and monument focused studies of the Mesolithic and Neolithic in the study area by providing an environmental, landscape, and geoarchaeological perspective.
12. Many sites in the wider study area show evidence of continued activity through stages of the Mesolithic and from Mesolithic to Neolithic. Evidence is presented which suggests this does not necessarily reflect economic or group continuity. It may reflect what has been called the structuration of landscape by antecedent conditions: patterns of paths, clearings etc once established have a tendency to be perpetuated over extended timescales and to influence the actions of subsequent generations.

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