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ENVIRONMENTAL ARCHAEOLOGY IN THE SEVERN ESTUARY: PROGRESS AND PROSPECTS

By Martin Bell

Past environmental work on the Severn Estuary Levels, much of it in the last decade, is reviewed and areas of particular future potential are identified. The main topics in prehistory include sedimentary context, vegetation history (table of pollen sites), faunal evidence (table of faunal evidence), animal husbandry, seasonality, fishing practise, and invertebrates. There is evidence for seasonal (winter) activity in the Mesolithic. In the Neolithic and earlier Bronze Age activity on the wetlands is limited. Clearance associated with pastoralism and some arable is attested on adjacent dryland. From the middle Bronze Age to the Iron Age there was extensive wetland activity associated particularly with seasonal (mainly spring and summer) cattle husbandry. In this landscape bones may be compared with animal footprint tracks and a range of other sources of environmental evidence. Wetland, wetland-edge and dryland bone assemblages are compared, suggesting there are more ovicaprids in the wetland edge and on dryland.

The Romano-British landscape was extensively drained: in some areas marine influence was excluded facilitating year-round activity, while elsewhere ditched landscapes seem to have been subject to seasonal marine inundation. Evidence for continuity and change in the Romano-British and later landscape is noted. It is argued that future research should give particular emphasis to the analysis of biota from settlement sites and to the study of wetland / dryland interactions. The value of comparative studies using multiple sources of environmental evidence is clear but in the future resources will need to be targeted on particular research questions and priorities. An attempt is made to identify these and the sources of evidence most likely to contribute to their solution.

Introduction

History and Scope

Eighteen years ago in 1982 the writer reviewed palaeoenvironmental evidence from part of the Severn Estuary in a wider survey of Environmental Archaeology in South West England (Bell 1984). The potential of submerged forests was evident but archaeologically related work was very limited except for the major discoveries in the Somerset Levels (Caseldine 1984). There were only two pollen studies from the Severn Estuary: Avonmouth (Seddon 1964) and the Gordano Valley (Jefferies *et al.* 1968). The situation had not changed greatly when Astrid Caseldine (1990) prepared a similar survey of *Environmental Archaeology in Wales* which showed just three pollen sites in the Welsh Severn Estuary: an early study of East Moors, Cardiff (Hyde 1936); and work then newly published at Goldcliff (Smith and Morgan 1989) and small-scale work by Blackford (1990) at Rumney. Both surveys emphasised the extent to which archaeological fieldwork and palaeoenvironmental research had been focused in upland areas, as illustrated for instance by the Welsh distribution of pollen sites (Caseldine 1990, fig. 11), or the distribution of palaeoenvironmental work in Gloucestershire, what little there was being in upland Cotswold locations (Bell 1984, fig. 14).

A decade later, the situation for the Severn Estuary wetlands has been transformed: there are many palaeoenvironmental studies, particularly pollen based, and an ever expanding range of sources of palaeoenvironmental evidence is being employed in increasingly complementary ways. The palaeoenvironmental resources of the coastal zone have been reviewed within the national context of England by Bell (1997) and in Wales by Nayling (forthcoming). What is proposed here is an evaluation of the contribution which palaeoenvironmental sources are making to the main archaeological research problems in the Severn Estuary. The main emphasis will be on the local setting of archaeological sites and our understanding of the activities which took place on those sites.

Geographically this paper concentrates on the Severn Estuary proper (Figure 1) covering the area as far seaward as Brean Down on the English side and Lavernock Point on the Welsh side. Evidence from the Somerset Levels, south of Brean Down,

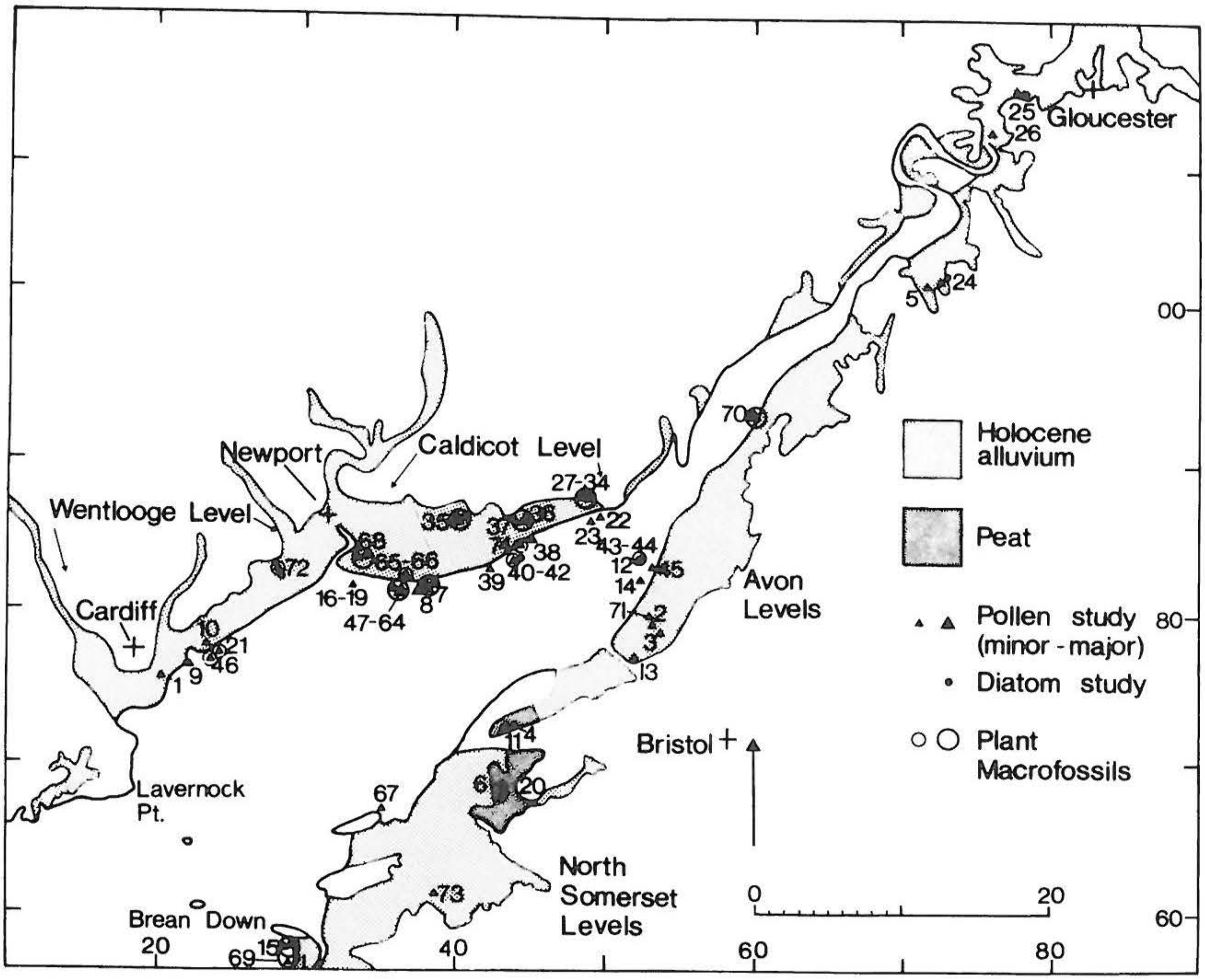

Figure 1: Severn Estuary showing the locations of pollen sites (key to numbers in Appendix 1) and other sites with botanical evidence. Scale 20km.

has previously been synthesised in many publications and is rather different in character to the Severn Estuary wetlands (eg Caseldine 1984; Coles and Coles 1986;1998). Somerset Levels archaeology comes mainly from a freshwater dominated landscape with nearby bedrock ridges, whereas the Severn Estuary evidence is predominantly from contexts close to marine influence and in the case of intertidal sites often some kilometres from the nearest dry land. Thus the two areas present rather different pictures and environmental problems.

The interface between marine and terrestrial influences in the Severn Estuary creates distinctive taphonomic and formation processes of the archaeological record, relating for instance to the way the sea creates and erodes the record. We need to be able to identify erosional hiatuses within sedimentary sequences and to recognise the effects of the sea in etching out, eroding and creating diachronous peat surfaces (Bell forthcoming a). The sea also etches out archaeological structures, palaeochannels and other landforms. Biological evidence from riverine and estuarine contexts present particular taphonomic problems of fluvial movement and reworking which have been fully rehearsed in discussion of the Caldicot evidence (Nayling and Caseldine 1997). The problems of interpretation which these processes create have to a significant extent been overcome by a multi-proxy approach: comparative studies using a wide range of palaeoenvironmental sources often relating to differing and complementary spatial scales.

The main sites can be located on the accompanying maps and the tables which provide a key to sites showing the distribution of floral (Figure 1 and Appendix 1) and faunal (Figure 2 and Appendix 2) evidence. Figure 1 also shows the main geographical areas of the Levels which have been productive of archaeological evidence: on the Welsh side the Wentlooge and Caldicot Levels and on the English side the North Somerset and Avon Levels.

Dates are given in radiocarbon years BP

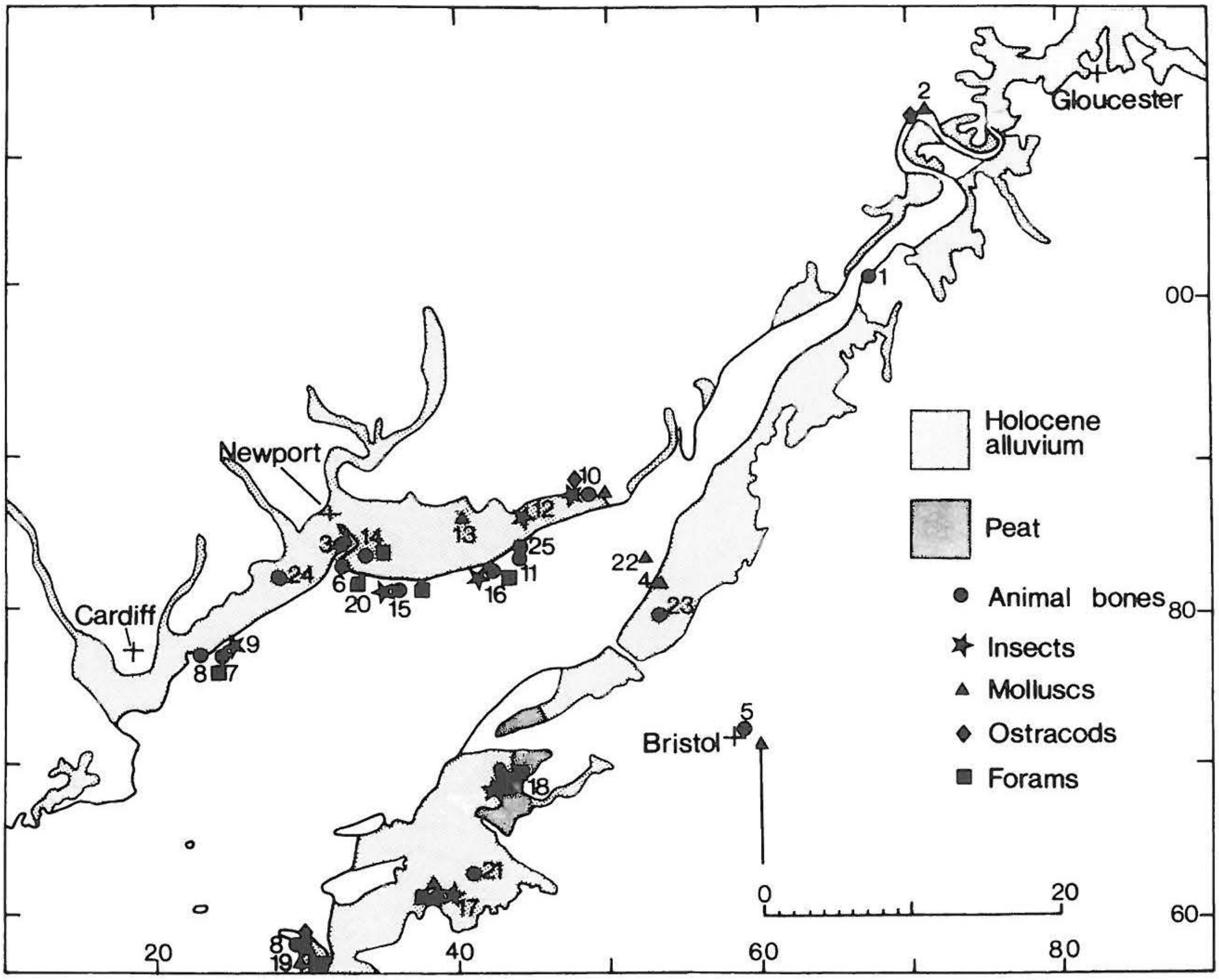

Figure 2: Severn Estuary showing sources of animal bone, insect, mollusc, ostracod and foram evidence (key to numbers on Appendix 2). Scale 20km.

followed by calibrated dates after Stuiver *et al.* (1998) which have been prepared using OxCal v3.5; calibrations are given at two standard deviations (Ramsey 1995). For a few contexts precise dendrochronological dates are known.

Sedimentary context and microfossil evidence of sea-level relationships

The broad-scale Holocene sedimentary sequence is now well-known (Allen this volume) and is briefly summarised in Table 1. The establishment of this basic stratigraphic sequence by J.R.L. Allen (1987; Allen and Rae 1987) provided the cornerstone which helped establish the antiquity, and thus archaeological importance, of the many intertidal discoveries made by the local archaeologist Derek Upton. During his regular walks on the foreshore as voluntary warden for the Gwent Trust for Nature Conservation he discovered many types of wood structure, artifacts and footprints. Some archaeologists had been reluctant to acknowledge the early dates of these features until the chronological implications of their stratigraphic position in the Allen sequence, confirmed by radiocarbon dating, established the prehistoric origin of many sites beyond equivocation.

At the base of the Holocene sequence on Pleistocene head or gravel there is sometimes evidence of a pre-incursion Old Land Surface, such as the Mesolithic to Bronze Age site at Oldbury (Allen 1998) and the Mesolithic site at Goldcliff (Bell *et al.* 2000). At Goldcliff there was limited survival of waterlogged biological evidence in the pre-inundation surface but charred plant macrofossils and bone were well preserved and the Mesolithic site represents an exceptionally well-sealed and undisturbed context.

On some sites, for example the Avonmouth M5 bridge (Gilbertson *et al.* 1990), a peat developed at the base of the Holocene sequence. In a number of cases in the Severn Estuary and Bristol Channel region there is evidence above the base of the Holocene for some centimetres of estuarine sedimentation prior to the development of any peat, as at Goldcliff (Bell *et al.* 2000, fig. 4.4), East Moors (Hyde 1936, plate A), possibly Caldicot Pill (Scaife 1994) and probably also in the Bristol Channel site of Westward Ho! (Balaam *et al.* 1987, fig. 5). Such sequences could be explained simply as a transgressive tendency followed by a regression. An alternative possibility, in the context of the generally upward Holocene sea-level trend and the huge tidal range (today 14.8 m at Avonmouth), is that estuarine deposition occurred between Mean High Water Spring Tide (MHWST) and Highest Astronomical Tide (HAT) significantly in advance of the water table rises which engendered preservation of peat-forming organic matter, generally considered to reflect *c.* MHWST. This is an hypothesis which could be readily tested by the examination of Foraminifera included within the deposits (see below).

Within the general stratigraphic framework outlined in Table 1, it has become increasingly apparent that much spatial diversity and environmental complexity characterises the setting of archaeological sites in prehistory. Sites are frequently in ecotones, such as drier patches and the edges of water from which a range of environmental zones could have been exploited. Such boundaries are especially sensitive to environmental change. The edges of creeks and channels were especially favoured (Allen this volume) and those areas are often characterised by stratigraphies with multiple interleaved peat and clay layers. The Goldcliff landscape *c.*300 BC (Bell *et al.* 2000, figs 174-5) illustrates this complexity: here within less than 1 km, contemporary archaeology was situated in reedswamp, fen woodland and raised bog, all, at the time of human activity, subject to varying degrees of periodic marine influence.

Table 1: Simplified sediment sequence for the Severn Estuary

- Medieval and later sedimentary formations: Rumney, Awre and Northwick Formations.
- upper Wentlooge clay in the upper part of which are Romano-British stabilisation surfaces and ditches.
- middle Wentlooge peats (reed, submerged forest and raised bog) and clays with much evidence of Bronze Age and Iron Age activity on the upper peat surfaces and some evidence of activity on saltmarsh clays.
- lower Wentlooge sandy silts with many animal and some human footprints.
- Holocene basal soil and Mesolithic submerged forest.
- Pleistocene river gravels and head.

Archaeological investigations frequently require a high level of spatial and temporal resolution complementary to the broader-scale and long term perspectives which, as a generalization, are provided by Quaternary science. Archaeological investigations can help refine chronologies of coastal change, for example where wooden structures have created occupation surfaces which can be precisely dated by dendrochronology (Bell 2000). The making of Goldcliff Building 6 from wood largely cut in 273BC provides our most precise date for the transition from the middle to upper Wentlooge Formations. Although precisely dated at that spot, the inundation was not sudden and took a century or more to cover 7 buildings on 1 km of shore. The diachronous middle to upper Wentlooge transition may be explained at Goldcliff as a result of gradual transgression onto the margins of a domed area of raised bog. Differential compaction of earlier sediments will also have contributed to spatial contrasts in the altitude of sedimentary surfaces and thus the date at which transgression occurred.

On other sites the transition from middle Wentlooge peat to upper Wentlooge clays seems to have taken place a millennium or more earlier than at Goldcliff. Redwick is a case in point where inundation was underway during the period of use of rectangular structures the latest of which is dated 2930±70BP (1380-920 Cal BC; Bell *et al.* 2000, 292-299).

The ecotonal situation of sites is highlighted by the frequent occurrence of archaeological evidence at the stratigraphic boundary of the middle and upper Wentlooge Formations. Settlement sites such as Goldcliff, Redwick, Collister Pill, Rumney, Chapel Tump and Cold Harbour are within, or on, the surface of peat horizons at the transition to minerogenic sediments (Bell *et al.* 2000). At both Goldcliff and Redwick artifacts occur in peat which also contains thin clay layers. Footprint tracks of animals and people are in peat and filled with clay, sometimes buried by more peat.

In areas where peat formation was of shorter duration, or less spatially extensive, the Holocene sedimentary sequence is largely minerogenic, with thin peats or gleyed horizons containing organic-rich clay surfaces (Locock 1999a, this vol). This is particularly the case around Avonmouth, where these surfaces have localised occupation scatters of charcoal, artifacts and burnt stone at a number of sites in the Cabot Park development, such as Kites Corner (Locock *et al.* 1998; Locock 1999c). Such sites seem to have been in the high saltmarsh and to have been occupied for short periods during those parts of the year with reduced tidal extremes.

Given the widespread association on many of these sites of occupation at peat / clay transitions, an understanding of the nature of that transition assumes special importance. The assumption that minerogenics can be simply equated with marine phases, that is transgressions, and peats with terrestrial phases, that is regressions, is increasingly seen as simplistic. Haslett *et al.* (1997) have examined peat / clay transitions and found that marine Foraminifera are by no means confined to the clay horizons, but occur within the upper 50 mm of peats. Similarly many of the Goldcliff peats contain biological evidence demonstrating marine influence before the sedimentary transition to clay (Bell *et al.* 2000). The origin of this influence in occasional flooding episodes is sometimes, but not always, seen in thin clay lenses within the peat, both visibly in the field and in micromorphological thin section. There is similar plant macrofossil evidence for marine influence within the upper part of the peat associated with the Redwick middle Bronze Age structures (Caseldine pers. comm.). At Burnham-on-Sea off the Somerset Levels, Foraminifera and botanical evidence in the upper part of a peat similarly show that transgressive tendencies begin during the period of peat formation and in advance of the peat/ minerogenic transition (Druce 1998). Recent studies have particularly demonstrated the value of Foraminifera for establishing the position of archaeological horizons relative to the tidal frame, specific zones being characterised by distinctive foram assemblages (Haslett *et al.* 1997). Where increasing marine influence can be demonstrated within peats it is important, from the perspective of sea-level studies, that these horizons are dated rather than the peat minerogenic transition alone.

Other microfossil evidence has also been of great importance in developing an understanding of the nature of aquatic influences and coastal conditions in the estuary. Diatom studies have been of particular value, often in parallel with pollen work, at Barland's Farm, Caldicot, Goldcliff, Magor Pill and Brean Down (Appendix 1). Diatoms have proved similarly useful in establishing the extent of tidal influence in recent work on the Thames (Sidell *et al.* 2000). Ostracods provided evidence of aquatic conditions at Brean Down and Caldicot. Using modern analogues, Zong (2000) has demonstrated the complementary nature of these sources of evidence: pollen is particularly sensitive in establishing the balance between saltmarsh and mudflats, Foraminifera in establishing the limits of marine influence (HAT) and diatoms in establishing the position of MHWST. The recent development of tidal level transfer functions (Horton this volume) based on these indicators opens up the possibility of establishing the relationship between archaeological horizons and tidal levels with much greater precision than has previously been possible. For example, it may be established that transfer functions developed in other areas can be applied to the Severn, or failing that other functions can be developed specific to this area.

The upper Wentlooge transgression seals the most visible prehistoric intertidal archaeology but there is growing evidence that it does not represent a cessation of human activity (Bell *et al.* 2000, 337). Cattle footprints and dung occur within the lower 1 m of the upper Wentlooge Formation at Redwick demonstrating that grazing continued after the transition to saltmarsh. Wooden structures in palaeochannels at Cold Harbour 2, Collister Pill 3 and elsewhere point to continued activity, probably associated with fishing, in the saltmarsh phase, as may the Upton Track at Chapeltump. Palaeochannels at Magor Pill and Collister Pill 3 contain Iron Age sherds which can be argued to have been eroded from temporary occupation-sites on the saltmarsh. These post-peat contexts have, however, so far received little palaeoenvironmental attention and this needs to be rectified in order to establish the nature of the environment and in what ways its use changed, or continued, following the transgression. There is palaeoenvironmental evidence from Iron Age surfaces and a saltern at Banwell in the North Somerset Levels which must have remained subject to continued marine influence at this time (Rippon 2000).

Sedimentary evidence is increasingly being produced during the recording of archaeological site sequences, particularly augering, coring and borehole investigations made as part of archaeological assessments. Using these data a more detailed palaeo-geographic model of the Levels landscape may be progressively developed as J.R.L. Allen's analysis of commercial borehole records demonstrates (this vol. and forthcoming). Eventually this should make possible the creation of maps documenting the evolution of the Holocene landscape comparable to those produced by Fokkens (1998) for Friesland in the north Netherlands. The comparative value of archaeological auger logs etc could be substantially increased if a more uniform set of standards were established for core recording. Uniform standards of accuracy and precision in recording are especially needed on those sites which may provide information on past sea-level. Of particular interest are sites where peat has developed at, or near, the base of the Holocene sequence and has therefore not been subject to the effects of compaction (Allen 1999). Biological evidence of the indicative meaning in terms of sea-level will establish whether the dated peat base can be reliably taken to indicate MHWST at that time. Such contexts have recently provided new and more reliable sea-level index points in the course of archaeological and palaeoenvironmental studies in the Axe Valley (Haslett *et al.* 1997), Porlock (Jennings *et al.* 1998), Caldicot Pill (Scaife and Long 1994) and Goldcliff (Bell *et al.* 2000, fig. 17.2).

Vegetation history

The wetlands present several sources of evidence for vegetation history, notably pollen, wood identification, other plant macrofossils, and insects indicative of specific communities or host plants. Each provides evidence on different and complementary spatial scales. The handful of earlier pollen studies mentioned in the introduction had by 2000 increased to a total of *c.*74 diagrams, and 14 sites with small numbers of spot samples, from a total of 74 palynologically investigated sites. As Figure 1 and Appendix 1 show geographical coverage is uneven with the main concentration (42 diagrams) in the Caldicot Level and smaller clusters of evidence in the Avonmouth (8 sites) and Rumney (5 sites) areas.

The earliest peat sequence is in the Gordano Valley and has been interpreted as a continuous sequence from the Windermere Interstadial through the Holocene, although this sequence has not been examined in great detail (39 levels with 5 radiocarbon dates; Gilbertson *et al.* 1990). Another early peat subject to pollen analysis occurs at –9.4 m OD in a borehole at Avonmouth (Seddon 1964). It is not radiocarbon dated but the sea-level curve would suggest a date between 8-7000BP (*c.* 6450-5900 Cal BC) which is consistent with the Boreal (Zone V1) pollen spectra of elm, oak and hazel woodland. The most extensive area of submerged forest at, or close to, the base of the Holocene sequence occurs at Redwick where there are estimated to be as many as 100 tree trunks and stumps largely of oaks, one dated 7330±70 BP (Beta-134639; 6380-6020 Cal BC; Allen and Bell 1999). The trees are of impressive size: there are trunks 12 and 15m long (Figure 3) before branching, up to 0.8 m in diameter, and tree rings show ages up to 400 years (N. Nayling pers. comm.). A preliminary study of beetles from the site has recently been made (Paddock 2000) and pollen and macrofossil work is planned in 2001.

Figure 3: Redwick: A large oak tree in the Mesolithic submerged forest (Photo. Edward Sacre).

Other early peats have been dated at Gravel Banks (Appendix 1, site 12); Oldbury (Appendix 1, site 70); Goldcliff (6770±70BP Beta-60761; 5800-5530 Cal BC); Caldicot Pill (Appendix 1, sites 22 and 23) and Kenn Moor (Appendix 1, site 6).

Some of the peats dating to the first half of the Holocene contain charcoal horizons significantly predating evidence for the earliest agricultural activity in the area. Earliest of these is the Redwick submerged forest (date above), where charcoal occurs over an area 300 m across and more than one burning episode is apparently represented. So far there is no Mesolithic artifactual evidence from this site. However, at Goldcliff, a later charcoal spread is dated to *c.* 6420±80BP (Swan-28; 5540-5210 Cal BC) and is associated with an extensive Mesolithic artifact assemblage (Bell *et al.* 2000). Although some of this occurs in hearth and activity areas, the distribution and spread around the island edge, an area 800 m in diameter, implies larger-scale burning. The old land-surface associated with this burning in the excavated area did not preserve pollen and was only subject to waterlogging after the activity period, and consequently it has not been possible to assess the effects of Mesolithic activity on the vegetation. However, a lower peat, contemporary with Mesolithic occupation has now been located and analysis is planned in 2001. There is also evidence of burning on the fringes of Goldcliff island *c.* 5820±50 BP (GrN-24143; 4800-4540 Cal BC). Between 5500-5250 BP (*c.* 4300-4100 Cal BC), at Vurlong Reen there is charcoal and an increase of open habitat taxa which is interpreted as indicating human impact (Walker *et al.* 1998). Druce (1998) also found charcoal at the base of the Burnham intertidal peat dated 5370±70 BP (Wk-5299; 4340-4000 Cal BC). West of the Estuary an extensive charcoal spread occurs in association with the Mesolithic site at Westward Ho!, Devon (Balaam *et al.* 1987) and on a number of Pembrokeshire intertidal sites examined by Lewis (1992, see also Bell 2000). It seems improbable that evidence of burning, on the scale apparent at Goldcliff, Redwick and Westward Ho!, is purely the product of campfires, or wildfire. The probability is that burning was a deliberate form of environmental manipulation by Mesolithic communities, a practice increasingly attested in the British upland (Simmons 1996) but not previously documented in lowland contexts, except at Star Carr (Mellars and Dark 1998).

A model recently proposed by Simmons (2001, plate 5) represents Mesolithic burning as occurring at the upland woodland edge and around inland lakes, but not on the coast. Conversely in this region burning does seem to be well represented at the coastal woodland edge. There are hints that these coastal activities may have been linked to seasonal movements up the river valleys to uplands where burning also occurred at Wigen-Fignen-Felen (Smith and Cloutman 1988) and lithic raw materials point to coastal contacts (Barton *et al.* 1995; Bell forthcoming b).

Basal peats were inundated by lower Wentlooge silt deposition at various dates depending on their elevation. Silt deposition was periodically interrupted by regression phases when thin reed peats formed: there are three at Redwick (Allen and Bell 1999) and one at Goldcliff (Bell *et al.* 2000). From *c.*5900BP the rate of sea-level rise had declined to the point where, on a number of sites, peat formation exceeded sea-level rise for a period of up to 3000 years providing the long pollen records from Goldcliff, (Smith and Morgan 1989; Caseldine 2000), Barland's Farm and Vurlong Reen (Walker *et al.* 1998). Many of the exposed peat sections in the estuary show a succession from reed peat to fen woodland and raised bog sometimes with interruptions and reversals caused by marine transgressive phases. On most sites the peat sequences end with the clay deposition of the upper Wentlooge from *c.* 3500 BP, although peat formation continued at Goldcliff and some other sites (Bell 2000, fig. 5) into the Iron Age.

The three long pollen records from Caldicot Level sites all cover the elm decline *c.* 5000 BP and show vegetation changes at, or just after, the decline which have been interpreted in terms of human activity and small-scale agriculture. Goldcliff presents the most detailed sequence. Immediately following the elm decline in 5020±80 BP (CAR-652; 3970-3650 Cal BC) other woodland taxa decrease and there is an increase in plants associated with pasture and subsequently some evidence of arable followed by regeneration (Smith and Morgan 1989). This clearance is of particular interest because we can be confident that its location was on Goldcliff island, at that time *c.* 1km long by 0.5 km wide (Allen 2000), since other dryland is *c.*6 km north. The episode is comparable in character and duration to classic landnam events identified in Ireland and would be interpreted in terms of small-scale shifting agriculture which is also consistent with evidence of activity during the Neolithic period in the Vurlong Reen and Barland's Farm diagrams. The small-scale clearances which occur at these sites are consistent with the evidence that Coles (2000) presents for the short life of structures such as the Sweet Track and frequent settlement shifts are attested by settlements on the European mainland, such as Hornstaad Hornle (Maier and Vogt this volume). Other evidence for Neolithic activity in the Severn Estuary Levels is, in contrast to the Somerset Levels, very limited indeed (Bell forthcoming b). The exception is Oldbury (Allen 1998) where a Neolithic occupation surface is preserved within estuarine sediments. The environmental sequence at this site has recently been investigated by Druce (forthcoming). Here pollen evidence and a sieving programme to obtain evidence of economic plants could contribute significantly to current debates about the Neolithic economy (Bell forthcoming b) and the balance between wild and domesticated resources (Moffet *et al.* 1989). The potential is illustrated by the Stumble intertidal site in Essex which has already made a significant contribution to these debates (Wilkinson and Murphy 1995).

At Goldcliff a series of further clearances of the island in the Neolithic and Bronze Age are evident in the pollen diagrams from east (Smith and Morgan 1989) and west (Caseldine 2000) of the former island. Some of these episodes are represented by lenses of charcoal in the wetland edge (Bell *et al.* 2000, 337). In the Neolithic the island remained wooded, subject only to partial temporary clearance, but by the middle Bronze Age this had given way to a largely grassland environment. Similarly the Caldicot area was largely wooded with only small-scale agriculture in the Neolithic but became open grassland with some secondary woodland early in the Bronze Age. Pollen diagrams at Barland's Farm and Vurlong Reen, close to the dryland, reflect a similar situation with clearance occurring in the Bronze Age, *c.*3910±70BP (Beta-63592; 2580-2190 Cal BC) at Vurlong Reed and beginning *c.*3740±60BP (Beta-72507; 2340-1950 Cal BC) at Barland's Farm. On all three sites there is a marked *Tilia* decline *c.* 3700-3900BP (*c.* 2100-2400 Cal BC), and a similar but undated decline also occurs in the East Moors diagram (Hyde 1936). The lime decline is usually attributed to increased and selective grazing pressure, and landuse on the dryland adjacent to the Severn wetlands certainly seems to have been predominantly pastoral with small-scale crop growing.

Raised bog inception occurred in the Goldcliff area and at Barland's Farm *c.* 5000 BP, that is 500-1000 years earlier than raised bog inception in the Somerset Levels (Coles and Coles 1986). Neumann (2000, table 16.3) estimated that raised bog accounts for *c.* 40% of the intertidally exposed peat in the Caldicot Level. The model presented of one vast bog covering much of the Level remains to be tested by work on peat types inland of the seawall. The probability is that the original palaeogeography will turn out to be much more complex and patchy. Indeed there are clear indications that raised bog growth was an interrupted process, with sites marginal to the bog being subjected to occasional marine incursions and other areas were invaded by scrub and woodland. At Barland's Farm for instance the period of raised bog development on the sampled site was brief but raised bog continued to represent a major part of the pollen input to the site. At Vurlong Reen by contrast raised bog never developed.

The extent of raised bog development is much less clear on the Wentlooge Level where about 3% by area of the intertidal peats are raised bog, at Rumney and Peterstone (Neumann 2000, fig. 16.6). However, the extent of original raised bog development on this Level cannot be assessed on the basis of intertidal exposures in view of the evidence presented by J.R.L. Allen (forthcoming) for extensive peat erosion in the later Bronze Age or Iron Age. On this Level we have little evidence of peat type inland of the seawall and the only pollen analyses are the early study by Hyde (1936) at East Moors, Cardiff, a wood peat with evidence of raised bog development in its upper part, and studies of thin reed peats by Blackford (1990) at Rumney Great Wharf.

Each of the peat sequences contains evidence of human activity on dryland, but evidence for human activity in the wetland within the main Neolithic and earlier Bronze Age peat formation is limited to hints of activity. At Collister Pill two distinct (undated) charcoal horizons were identified in peat of Neolithic and Bronze Age date and there was a particularly marked horizon on the peat surface (Burbridge 1998). At Vurlong Reen there was evidence of burning *c.*3910±70BP (Beta-63592; 2580-2190 Cal BC; Walker *et al.* 1998), while at Redwick a large piece of charred wood has also recently been found within the lower part of the main peat sequence. The extent of activity within the peat is a topic in need of further field and laboratory examination.

By contrast, the surface of the main peat within the Gwent Levels presents a picture of concentrated human activity including buildings, trackways and occupation scatters which are thought to indicate seasonal activity on the wetlands (Neumann 2000). At Goldcliff, biological evidence including pollen, plant macrofossils, diatoms, beetles and mites show that, during the period when activity was taking place on these sites, they were also subject to occasional marine influence. Current work suggest this is also the case with middle Bronze Age structures at Redwick. At Goldcliff an area of Iron Age submerged forest has been planned and the trees identified as alder, birch and willow wood (Bell *et al.* 2000, fig. 12.1 and CD 12.1). Within this environment Buildings 1-3 and several trackways, some with dendrochronological dates in the fourth and fifth centuries BC, were constructed. Wood identification from the structures show that available local fen wood was being used, with some wood brought from further afield including dry ground, a resource which had to be increasingly turned to as the upper Wentlooge transgression drowned out local fen woodland. One of the latest, Building 6, dendrochronologically dated 273BC, was on raised bog and constructed largely of oaks from dryland sources.

At both Goldcliff and the Bronze Age palaeochannel site at Caldicot the identification of large samples of utilised and non-utilised wood was complementary to pollen analysis in demonstrating the character of the woodland (Nayling and Caseldine 1997). Among the Caldicot wood, mainly of dryland origin, there were few old trees and clearly by the Bronze Age it was a mainly open landscape containing areas of secondary woodland and scrub.

On the Welsh side of the estuary there is, so far, no conclusive evidence of peat formation after the Iron Age. Within the upper Wentlooge clay, thin, slightly organic horizons are associated with evidence of activity especially in the Romano-British period on several sites. There has been pollen or macrofossil work on those at Goldcliff and Rumney, the implications of which are considered below. In general, however, there is little pollen evidence from the Iron Age (except Goldcliff) and later and almost nothing (except Magor Pill Boat) after the Roman period.

On the English side, although peats are generally less extensive (except on the Somerset Levels) they extend further inland up valleys and it seems that some may have been protected from the inundations which progressively drowned the coastal bogs on the Welsh side during the Bronze Age and Iron Age. On the Somerset Levels at Abbots Way and East Waste peat formed into the Roman period and at Meare Heath into the early Medieval period. Housley has carried out a particularly detailed investigation of the setting of Glastonbury Lake Village. Here the sequences demonstrate the increasing clearance of the surrounding dryland during the later Bronze Age leading to the creation of an essentially agricultural dryland landscape by the time of the lake villages in the first three centuries BC (Beckett and Hibbert 1978; Housley1988; Housley in Coles and Minnitt 1995). It has also been suggested that peats in the Gordano valley also continued to form into recent times but the top part of the diagram is without radiocarbon dates (Gilbertson *et al.* 1990, fig. 2). Clearance here is just two samples from the top of the diagram and associated with abrupt changes, which might suggest an hiatus.

It is clear from the foregoing section the estuary represents a vast resource for palaeobotanical research. Of outstanding potential are the submerged forests and intertidal peats of the first half of the Holocene. Work at Goldcliff has demonstrated the possibilities of making maps of woodland of various dates and investigating the composition of that woodland using multiple sources of palaeoenvironmental evidence. Of particular interest is the dendrochronological potential of these sites and evidence of charcoal horizons in sequences from the first half of the Holocene. A research project on the changing human and natural coastal ecology of the period between 6500-3500 Cal BC (7800-4700BP) including pollen analysis, plant macrofossils and dendrochronology will begin in 2001. With regard to later prehistoric wetland contexts, now that long sequences have been established from several sites, there is a case for focusing attention on the local contexts of occupation horizons and on sieving programmes which may provide plant macrofossils (and bone evidence, see below) of wetland activities. Long peat sequences near the wetland margins offer special opportunities for developing an understanding of land-use history on neighbouring dryland.

Faunal evidence and animal husbandry

Sources of evidence

The estuary is an excellent environment for the preservation of animal bones (Appendix 2 and Figure 2) which is of special importance in the context of Wales where most of the soils are too acid for bone preservation and faunal assemblages from prehistory are few (Caseldine 1990). Table 2 gives simple bone counts for a number of assemblages around the estuary. This is a somewhat crude index of husbandry practice as compared to the calculation of minimum numbers of individuals or meat weight (Davis 1987), the latter taking account of the much

Table 2: The composition (percentage of total bones) of selected Bronze Age to Romano-British animal bone assemblages from wetland and dryland sites in and around the Severn Estuary. For locations and graphical comparison see Fig.5.

Site / Date	W = wetland D = Dryland	*Bos* Cattle	Ovi-caprids Sheep/goat	*Sus* Pig	*Equus* Horse	*Canis familiaris* Dog	*Cervus elephus* Red deer	*Capriolus capriolus* Roe deer	*Vulpes vulpes* Fox	*Castor fiber* Beaver	Other taxa	Total bones	Source
Caldicot Phase VI/VII Middle Bronze Age	D/W	18.6	57.2	8.9	0.7	5.5	1.4		7.7	0.2	Bird, fish Small mammals	586	F. McCormick *et al.* in Nayling & Caseldine 1997
Brean Down Unit 5b Middle Bronze Age	D/W	38	51	1.4	0.3	2.2	0.45				Felis 0.6 Small mammals 6	663	Levitan 1990
Brean Down Unit 4b Late Bronze Age	D/W	45	46	2	0.8	0.6	0.3				Felis 0.2 Small mammals 5	1862	Levitan 1990
Thornwell Farm Late Bronze Age – Early Iron Age	D	35	46	15	–	1.5	1.5					65	S.Pinter-Bellows in Hughes 1996
Goldcliff * Iron Age	W	80	10.5	–	4	–	5					76	Hamilakis 2000
Glastonbury Middle Iron Age – Late Iron Age	W	5	88	2	2	1						3500	Coles & Minnitt 1995
Meare East 1982 Late Iron Age	W	16	64	16	2	0.8	0.18		0.81	0.18		1104	Levine 1986
Meare 1984 Late Iron Age	W	26	53	14	4	1	1	0.4				1594	C. Backway in Coles *et al.* 1986
Meare West 1979 Late Iron Age	W	24	61	13	1	2						1876	GN Bailey *et al* in Orme *et al* 1981
Rumney Romano-British	W	23	35	4	32	0.4	0.4				Bird 5, Fish 1	222	S. Hamilton-Dyer in Fulford *et al.* 1994

* Note: Goldcliff assemblage is quantified using a modified version of the Number of Identified Specimens (NISP) method (Hamilakis 2000).

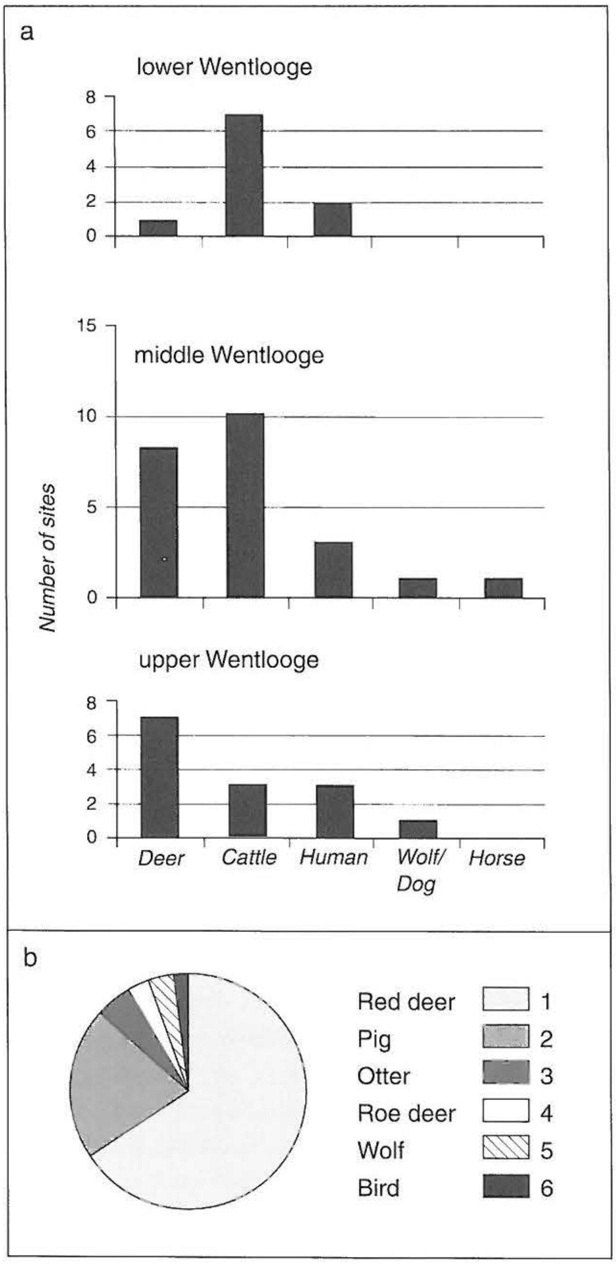

Figure 4: Severn Estuary fauna: (a) comparison of the number of sites at which footprints of the main taxa occur in the three prehistoric sedimentary units (data from Allen 1997), (b) compositionof the Mesolithic bone assemblage from goldcliff (after Coard 2000).

greater dietary contribution of, for instance, a bovid as compared to an ovicaprid. The advantage of bone counts, in this case, is that they facilitate ready comparisons between assemblages studied using different methods. Results may be affected by small sample sizes in some cases and differences in recovery methods, particularly the extent of sieving. This especially applies to the old collection from Glastonbury, which is probably a biased sample of those bones which survive from the excavations of Bulleid and Gray from 1892-1917. In making comparisons we need to keep in mind that the composition of faunal assemblages cannot be read simply in terms of original herd composition, and that we need to take account of formation processes such as the role of taphonomic factors. Bone assemblage composition in palaeochannels, as at Caldicot, or estuarine clays will also be affected by the differing hydraulic properties of individual bones or taxa (Coard and Dennell 1995). The possibility of structured deposition also needs to be considered. Social symbolic factors may have favoured the bones of some taxa over others in certain contexts. Bradley (2000) discusses the deposition of bones in natural sacred places and future studies need to be alert to the possibility that some off-site bone assemblages could represent so far unrecognised forms of structured deposition. That ritual deposition occurred is shown by Bronze Age finds of human skulls at Goldcliff (Bell *et al.* 2000, Chapter 5).

What makes the faunal potential of the estuarine environment especially great is the opportunity for comparison with a complementary dataset in the form of animal tracks, including footprints, in sedimentary formations covering the last 7000 years. The animal track and footprint resource is more abundant and geographically much more widespread than the bone evidence. The animal track evidence has been reviewed in a pioneering paper by J.R.L. Allen (1997); some of the results are here simplified as a series of histograms showing the number of sites at which the tracks of each animal type occur (Figure 4a). This can be compared to the animal tracks and bone assemblages on settlement sites thus providing some opportunity for comparison of off-site and on-site faunal composition (Figures 4a and 5). As Huddart *et al.* (1999) have shown in work on human and animal footprint tracks in Liverpool Bay, this has the potential for new insights to diverse questions including herd composition (see also Bell and Neumann 1999), hunting practice and the demographics of hunting band composition.

Mesolithic and Neolithic

Animal tracks from the lower Wentlooge consist of widespread and numerous deer and aurochsen at three sites. This can be compared (Figure 4b) with the animal bone assemblage from the Goldcliff Mesolithic site dated 6760±80BP (OxA-6683; 5750-5450 Cal BC). Footprints and bones both show deer as predominant. The absence in the settlement assemblage of aurochsen is noteworthy, given this is the second most frequent taxa represented by footprints, and bones of both aurochsen and red deer, most probably natural deaths, are frequent finds from off-site contexts in the estuarine sediment sequence. One possible explanation is that aurochsen were away from the wetland during the time of year (winter) when the site was occupied. It is also interesting that the second most abundant taxa among the bones at Goldcliff was pig, which has not so far been found among the animal track and footprint record. It seems probable that pigs avoided those areas in which footprints were preserved, preferring the cover of the *Phragmites* swamp and fen woodland. Bones of wild boar occur in off-site contexts, and there is also the hunted boar or pig fatally wounded by a microlith barbed weapon from Lydstep, Pembrokeshire (Jacobi 1980, 175; Bell 2000). Among the Marsh Arabs of Iraq, wild pigs and their hunting forms a prominant part of wetland human ecology (Thesiger 1964). Goldcliff bones also demonstrate the exploitation of otter, birds, and fish (see below), emphasising the diverse nature of the Mesolithic wetland resource.

Faunal evidence from the Neolithic is very limited. There are footprints of cattle, deer and humans at the Neolithic to early Bronze Age site at Oldbury (Allen 1998). Keith (1911) records a small group of animal bones from Alexandra Docks, Newport, including a sheep metatarsal below a human skull now dated to the Neolithic (Appendix 2, no 3). The skeletons of two almost complete aurochsen which floundered in the estuary are dated to the Neolithic at Uskmouth (Appendix 2, no 6) and Rumney Great Wharf (Appendix 2, no 7).

Animal husbandry in the middle Bronze Age to Iron Age

Figure 5 is an attempt to synthesise the faunal evidence from selected dryland and wetland contexts from the middle Bronze Age to the Romano-British period. Comparison between these sites indicates that there are no obvious chronological contrasts between Bronze Age and Iron Age assemblages; as regards exploitation of the wetland the archaeological evidence indicates use in similar ways in both periods and they are considered together. The animal bone assemblage from Iron Age Goldcliff is dominated by cattle (80%) with ovicaprids at 10%. All the animal footprints of this date identified at Goldcliff were cattle, although work on footprints was less detailed than that currently underway at Redwick. The footprints at this middle Bronze Age site are cattle (75%) and ovicaprids (24%); one probable horse was also identified. The animal bone assemblage is not yet identified but includes both cattle, ovicaprids and pig, the last not identified among the footprints. Other wetland settlement sites of the later Bronze Age have only produced small numbers of bones. At Chapeltump 2 cattle predominate with sheep, pig and deer also present (Locock *et al.* 2000). At Rumney sites 1 and 3 only cattle are represented by bones and footprints (Allen 1996), while at Cold Harbour Pill 1a deer and ovicaprid are present with other bones of deer/cattle size; one cattle footprint was identified (Whittle 1989). At Kites Corner cattle predominate with some deer and a few ovicaprids (Locock 1999c).

Ovicaprids which were not represented among the footprint sample reported by Allen (1997) before *c.* 1500BP are now shown to be present in on-site contexts from the middle Bronze Age, but in a subordinate role as compared to the more widespread evidence for cattle husbandry. This preponderance of cattle from wetland contexts contrasts, however, with both wetland edge and dryland sites. The Bronze Age wetland edge site at Caldicot has a predominance of ovicaprids over cattle and here dung beetles point to the presence of herbivores grazing largely open grassland (Osborne 1997).

A larger number of dog bones at Caldicot than the other sites may represent structured ritual deposition. At Goldcliff one dog / wolf jaw (2685±45BP, OxA-6461; 920-790 Cal BC) was contemporary with the deposition of a Bronze Age human skull in the same area of the site. Brean Down, situated at the junction of a limestone island and former saltmarsh, produced similar numbers of ovicaprids and cattle. In the later Iron Age settlements at Glastonbury and Meare the dominance of ovicaprids (53% Glastonbury and 88% Meare) over cattle (5-16%) is clear in each of four samples from separate excavations. The only fully dryland site among this group, a late Bronze Age / early Iron Age assemblage from Thornwell Farm, Chepstow, has 46% ovicaprids, 35% cattle. Pigs were absent at Iron Age Goldcliff and present in low numbers (1-2%) at Brean Down and Glastonbury. Elsewhere they reach 9-16%, perhaps suggesting that these communities had access to pannage in the secondary woodland on dryland slopes which is attested by pollen analysis. Deer were a minor resource: 1-5% of bones at most sites. The numbers are small and there is no obvious correlation with the importance of pigs.

Deer bones are commonly found in off-site estuarine contexts and they were perhaps living mainly in the wetland. Allen (1997) records the

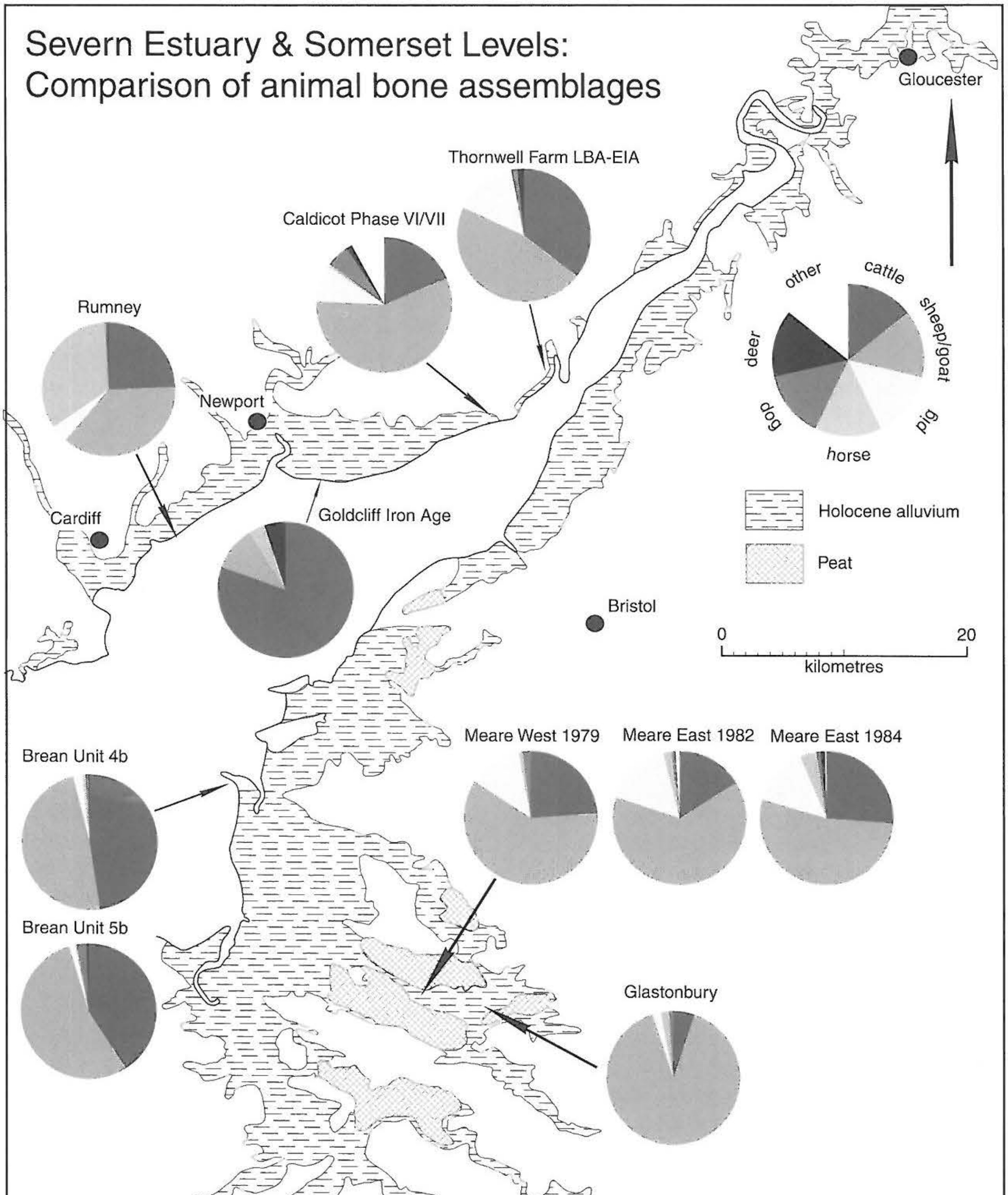

Figure 5: Composition of bone assemblages of middle Bronze Age to Romano-British date on selected dryland and wetland sites. For figures and sources see Table 2.

presence of their footprints in eight middle Wentlooge and one upper Wentlooge context (Figure 4a). This may provide some indication of their declining numbers in the increasingly utilised landscape from the middle Bronze Age. That they were still present in the third to fourth centuries BC is indicated by antlers deposited on the peat surface around Goldcliff Buildings 1-3, which could relate to some form of structured deposition (Bell *et al.* 2000, fig. 7.2).

Horses are of minor importance (1-4%) on most sites. There is no hint here in prehistory of the Levels being used in a specialist way for the raising of horses, as has been suggested in connection with the draining of the Wentlooge Level in the Romano-British period (Fulford *et al.* 1994). This accords with the view that in the Iron Age horses were not bred but captured from the wild (Maltby 1996). There is Domesday documentary evidence for the raising of horses on the Somerset Levels (e.g.Burnham, Huntspill and Tarnock)

Overall therefore, this faunal evidence indicates that during the middle Bronze Age to Iron Age the wetland was used for animal husbandry in which cattle greatly predominated, but with sheep also involved. This represents a specialist form of husbandry as compared to the wetland edge and dryland sites where ovicaprids and pigs had a greater role. Hambledon (1999) concluded from a survey of Iron Age assemblages that in western England and Wales cattle, sheep and pig were generally of similar importance.

In the Severn Estuary wetlands it is probable that these animals were grazing on saltmarsh. This is an hypothesis which Astrid Caseldine and the writer are currently testing by analysis of water-logged dung samples from Redwick. The presence of neonatal cattle at Goldcliff shows that cows were giving birth on the wetland and this activity is thought to have been seasonal and concentrated in May to August (see below). The rectangular buildings of middle Bronze Age date at Redwick and Iron Age date at Goldcliff have in some cases internal subdivisions which may have housed animals. The widths of three measurable subdivisions in Goldcliff Building 1 (0.7 m; 0.7 m and 0.8 m) point to young calves or ovicaprids rather than adult cattle. Persuasive evidence in favour of young calves comes from the presence of numerous cattle head-biting lice (*Damalona bovis*; Smith *et al.* 2000; Schelvis 2000). The recently found Iron Age rectangular buildings at Greenmoor Arch, also on the Caldicot Level, may have had a similar function; they also had cattle footprints around them (Locock 1999b).

A dairy economy?

The possibility must be considered that dairying was an important aspect of the economy, given the predominance of cattle, the suggestion that calves were kept in stalls, and the presence of cattle during the time of year when, following birth, milk production would be at its greatest. McCormick (1992) has been critical of claims for specialist dairying in prehistory, particularly the Neolithic, arguing that the first direct evidence of a dairy economy in Britain, or Ireland, is attested in the latter area during the early Christian period and produces animal bone assemblages of an age composition which contrasts with the bone assemblages for which dairying is claimed in prehistory. Moore-Colyer (1998) questions the underlying assumption by McCormick that calf survival would have been essential to stimulate milk production. At Goldcliff some of the cattle were neonatal and are likely to represent natural mortality at, or shortly after, birth, or male animals killed to ensure the availability of milk for human consumption. Millard (2000) has shown that hypotheses of dairying based on herd composition and age structure can potentially be tested by work on the nitrogen isotope composition of cattle bones and teeth.

Artifact assemblages provide another approach to this problem. At Bronze Age Brean Down there were two fully perforated sherds (Bell 1990, 124). Such sherds are often interpreted as used in the processing of dairy products, although similar examples are not found on the other sites. What is common is a thick carbonaceous deposit on the inside of pottery vessels: this has been recorded in Bronze Age contexts at Brean Down (Bell 1990), Rumney (Allen 1996), Bronze or early Iron Age sherds at Collister Pill (Bell *et al.* 2000) and on the single Iron Age sherd from Goldcliff. One possibility, which could be investigated analytically, is that the residues relate to milk processing (Dudd and Evershed 1998).

This review of the faunal evidence has demonstrated that our understanding of animal husbandry in the wetlands has the capacity to be advanced using a comparative approach and an exceptionally wide range of data sources. Obtaining larger bone samples must be a central part of the strategy, while work on animal tracks and footprints has very great potential for providing a new perspective relating for instance to the age composition of the herd, and conceivably perhaps, through size-related differences, to its sexual composition. The potential for more detailed comparisons of on-site / off-site assemblages of both bones and footprints is considerable.

Seasonality or sedentism

It is easy to speculate that particular resources may have been exploited on a seasonal basis, but much more difficult to demonstrate this convincingly (Pals and Wijngaarden-Bakker 1998). Biological evidence for occupation at one time of year does not prove abandonment at other times. It may, however, be possible to suggest this from comparative studies using a range of sources of evidence such as biota, sedimentary evidence and the nature of human

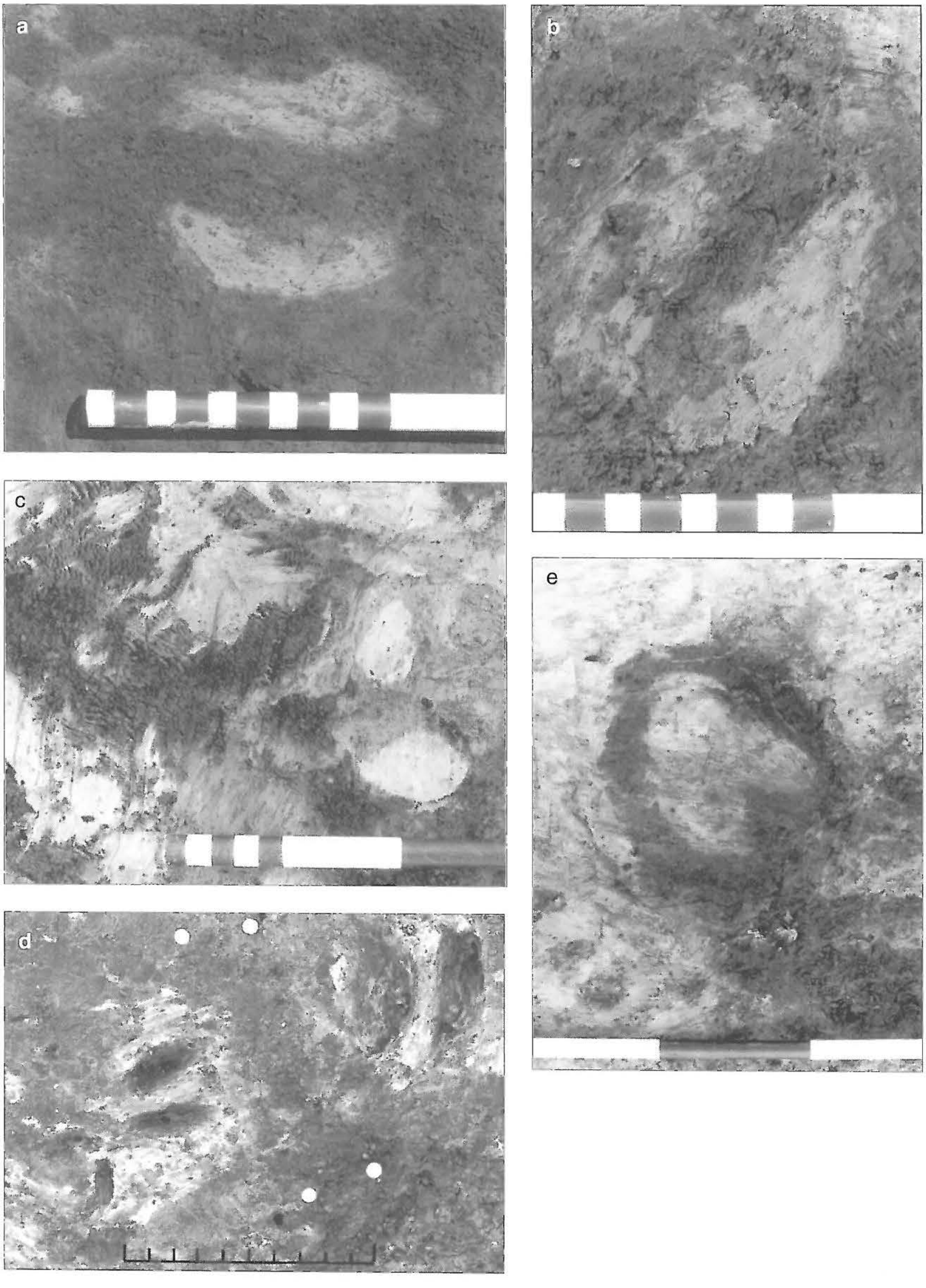

Figure 6: Footprint tracks of domestic animals around middle Bronze Age structures at Redwick. (a) and (b) Bos *sp, scale 1cm; (c) probable ovicaprid, scale 1cm and 5cm; (d) excavated ovicaprids of varied ages, scale 1 cm divisions; (e)* Bos *sp, scale 10cm. Photos. Edward Sacre.*

activities. Star Carr is an example of what can be achieved using an appropriately broad range of evidence (Mellars and Dark 1998, 215-225).

The Mesolithic island edge site at Goldcliff would have commanded an abundance of estuarine resources and has produced possible evidence for environmental manipulation by the use of fire (see above). Before excavation it seemed to be a possible candidate for Mesolithic sedentary settlement such as that which is attested in coastal contexts in Denmark (Hvass and Storgaard 1993). However, the lithic assemblage is dominated by debitage with only a small proportion of tools, which implies a limited range of tasks and temporary, rather than permanent, occupation. Ageing data from both pig bones and fish suggest that occupation was mainly in autumn or winter.

In our attempts to identify wetland seasonal activity we have in the Severn Estuary (today at least) the advantage of the second greatest tidal range in the world. There are also significant seasonal contrasts of tidal range, with a reduced range between mid-May and mid-August (Bell 1990, fig. 160). The sedimentary record in a number of cases indicates that occupation was not year-round, as occupation surfaces are interrupted by thin layers of clay representing flooding horizons. A wide range of biological evidence at Goldcliff and Redwick demonstrates that periodic flooding occurred when structures were in use. This indicates that occupation was interrupted and probably brief as suggested by the very small artifact assemblages found on all the Bronze Age and Iron Age sites on intertidal peats. A range of evidence from the Goldcliff buildings indicates that their use was within the summer window of reduced tidal extremes. This includes: the wood for Building 6 cut in April or May; the presence of neonatal animals; and flower heads on reeds cut in July or August (Bell *et al.* 2000, fig. 17.10). Use of the surrounding landscape was not, however, totally restricted to this time of year. Most of the wood for trackways was cut in winter, suggesting perhaps the need to create drier routeways for fishing, fowling or getting to boats during the wetter period of winter. Some of this wood was locally obtained wetland taxa, other structures included a more diverse range of taxa, some of dryland origin which may have been left over from earlier building activities and could therefore have been stock-piled (Morgan 2000). Seasonality evidence from other Bronze Age sites is limited, although a shed antler at Chapel Tump 2 and the presence of a narrow to incomplete final ring on wood used in the Upton Trackway (Locock *et al.* 2000) are both consistent with the Goldcliff evidence of activity concentrated in spring and summer. In contrast the main exploitation of the Humber wetlands for cattle grazing has been suggested as mainly in winter (van de Noort and Fletcher 2000) but that is inferred from present practice because there is little direct evidence as to prehistoric season of use at present available.

The Bronze Age settlement at Brean Down is in a sand dune situation overlooking the closely adjacent wetland. It is characterised by structures of stone and wood and an extremely large and diverse artifact assemblage; we can be confident that the settlement itself was occupied year round. Salt extraction was one of the activities carried out from this site in the middle Bronze Age. Recent investigation of wetland sequences south of the Down has confirmed that there were extensive salt marshes immediately south of the Bronze Age settlement in prehistory (Allen and Ritchie 2000). There is also evidence of salt extraction at Banwell Moor in north Somerset and Badgeworth in the central Somerset Levels in the late Iron Age. Solar evaporation to obtain salt would have been seasonal and is likely to have been integrated with the pasturing of animals on the saltmarsh (Bradley 1975). Current work on the large artifact assemblage from the Iron Age site on alluvium at Hallen, Avonmouth, is designed to evaluate whether the site was occupied seasonally or year-round (Barnes 1993; M. Allen pers. comm.).

Later prehistoric settlement patterns and seasonality

There is evidence in the estuary for settlement in various types of environmental context. Type A sites below are in peatland contexts, Type B in minerogenic contexts and Type C dryland sites at the wetland edge. This division helps to demonstrate the diversity of contexts used and the way in which some types of site such as roundhouses occur in a range of stratigraphic contexts whilst others, such as rectangular structures, are confined to peat contexts.

Type Ai. Round and rectangular buildings on middle Wentlooge peat shelves. These have very small artifact assemblages and there is often sedimentary, and in some cases biological evidence for periodic flooding. Where detailed investigation has taken place, use was clearly seasonal. Examples on the Caldicot Level are Goldcliff, Redwick, Collister Pill (Bell *et al.* 2000), Greenmoor Arch

(Locock 1999b), and Chapel Tump (Whittle 1989) and on the Wentlooge Level Rumney 3 (Allen 1996). All are Bronze Age except Goldcliff and Greenmore Arch which are Iron Age.

Type Aii. Charcoal and modest artifact scatters on peat shelves but without defined wood structures: examples are Chapeltump 2 (Locock *et al.* 2000); Coldharbour 1a (Whittle 1989) and Redwick 2 (Bell *et al.* 2000, 299). The stratigraphic context, and what environmental evidence we have from sites of this type, indicates that they lay at, or near, the peat bog / saltmarsh interface and they seem likely to represent temporary encampments. However, some could represent areas peripheral to larger sites which could have structures. Redwick Area 5 has been examined in detail and represents a short-lived hearth scatter 25m from rectangular Building 5 (Bell and Neumann 1999). Cold Harbour Pill 1 can also now be seen as part of a larger complex which includes a trackway and wood structures of uncertain type (Bell work in progress). All sites of this type appear to be Bronze Age.

Type Aiii. Substantial occupation sites on peat with clay mounds with roundhouses (Glastonbury), or possible evidence of tents (Meare). These sites are on the inner margin of the Somerset Levels with nothing comparable known on the Welsh side. They are later Iron Age and among the most artifact rich settlements in the period. Glastonbury, except in its final phase, is thought to have been occupied year-round (Coles and Minnett 1995). Meare (Coles 1987) is thought to be a temporary encampment in an area much of which was too wet for settlement in winter.

Type Bi. Roundhouses on minerogenic sediments. Only one example of Iron Age date has been investigated at Hallen on the Avon Levels, that has a much larger artifact assemblage than the sites of Types Ai and Aii. It remains to be established if it was permanently or seasonally occupied.

Type Bii. Small concentrations of burnt stone, charcoal and other artifacts on stabilisation horizons in minerogenic sediments. There are examples in the Cabot Park development on the Avonmouth Levels dated to the Bronze Age (e.g. Kites Corner; Locock *et al.* 1998; Locock 1999c) and on the Wentlooge Level at Rumney 1 dated to the Iron Age (Allen 1996). The saltmarsh location of these sites, their limited artifact assemblages and lack of structures suggest short-lived temporary encampments. The activities seem to be essentially comparable to Type Aii but in a minerogenic rather than peat context.

Type C. Settlements on the wetland edge. Examples are the roundhouses at Brean Down (Bell 1990) and the probable settlement beside the Caldicot palaeochannel (Nayling and Caseldine 1997). Brean is artifact rich, both sites have high status artifacts and are Bronze Age, and occupation was almost certainly year round.

The diversity of forms of settlement and stratigraphic context identified here, and in particular the contrasts between the coastal Severn Estuary and the inner wetland Somerset Levels, serve to remind us of the diverse ways in which this wetland may have been used and the importance of not just making assumptions about seasonality and sedentism but rather designing excavation, sieving and sampling strategies which, as at Goldcliff, provide a range of sources of evidence against which we can test our hypotheses concerning these key questions. Persuasive evidence of seasonal activity may come from unexpected and diverse sources, as for instance at the Neolithic Swiss site of Horgen Scheller where the composition of ovi-caprid coprolites pointed to animal transhumance (Akeret and Jacomet 1997).

Fishing in the wetland economy

Fish represent the most obvious single resource of the Severn Estuary and fishing structures are an important part of its archaeology, as they are in other coastal areas (e.g. Turner forthcoming). The role of fishing for wetland communities around the Estuary has, therefore, been another important research topic. The largest assemblage, perhaps significantly, is also the earliest, from Mesolithic Goldcliff dated *c.*6400 BP (*c.* 5300 Cal BC; Ingrem 2000). A total of 1,519 bones mostly came from three samples in a single grid square out of nine samples of 1kg processed, other squares producing single bones, or none. The assemblage (Ingrem 2000) comprised eel (56%), goby (29%), smelt (8%), stickleback (6%) and flatfish (1%). The eels were mostly 150-290 mm long and the other taxa were generally under 100 mm long. Despite their small size there is little doubt the fish represent debris from meals or fish drying, as 7% of the bones were burnt. Their small size strongly suggests they were caught in basketwork traps perhaps similar to the beautifully made Mesolithic examples from Denmark (Fischer 1995), or France (Mordant and Mordant 1992). Given this finding we must pay very particular attention to any basketry structures which appear to be stratified within palaeochannels of the lower Wentlooge Formation.

Despite substantial sieving programmes at the Bronze Age estuary-side site at Brean Down (one water sieved sample from every 1m² of occupation horizon) the numbers of fish bones (170) was modest (Levitan 1990). Fish bones were found in sieved samples from the Middle Bronze Age saltmarsh edge site at Kites Corner on the Avonmouth Levels (Locock 1999c). At Caldicot some of the fish were complete and are likely to represent natural mortality in the river channel (Hamilton-Dyer 1997). The Bronze Age and Iron Age buildings on intertidal peat have not so far produced any fish bones, despite the sieving of many samples from within the two excavated structures where floors survive: Goldcliff Buildings 1 and 2. No fish bones were encountered in a preliminary scan of the Iron Age bone assemblage at Hallen (Barnes 1993).

Independent evidence for the contribution of fishing to the diet comes from stable carbon isotope (δ13C) values which provide an indication of the relative contributions of marine and terrestrial protein to the diet (Richards and Schulting 2000). Human skulls of Neolithic date from Alexander Docks, Newport, and two skulls of Bronze Age date from Goldcliff were from individuals who obtained less than 5% dietary protein from marine sources. An Iron Age or early Roman skull from The Orb Steelworks, Newport and a medieval skull from Redwick were from individuals who respectively obtained 10-15% and 40-50% of their dietary protein from marine resources. One possible conclusion to draw from the modest contribution of marine resources to the diet of the Neolithic and Bronze Age individuals is that they are not very likely to represent permanent residents of the coastal wetland, but were perhaps seasonal visitors or drylanders whose skulls were ritually deposited in wetland contexts.

It may be concluded from the fish bone evidence, and that of stable carbon isotopes that, whilst fishing appears to have been important in the Mesolithic, it may not have been a major resource in the Neolithic to Iron Age. Paradoxically, however, we are recognising a growing number of wood structures in palaeochannels (Bell *et al.* 2000, 303-313) which are interpreted as probably representing fishing structures. The earliest of these, at Peterstone, on the Wentlooge Level, is dated to the late Neolithic or early Bronze Age (3910±60BP; GrN-24149; 2570-2200 Cal BC), and several possible examples are dated by radiocarbon or stratigraphic position to the Bronze and Iron Ages. One example excavated in 2000 at Cold Harbour Pill comprises a crude wood fence along a palaeochannel associated with a circular basket which is almost certainly a fish trap; it is dated 2520±60BP (SWAN-241; 800-410 Cal BC). Several of the wood structures in the Caldicot palaeochannel are also likely to relate to fishing (Nayling and Caseldine 1997). A wood structure at Oldbury dated 2120±60 BP (CAR-1179; 360BC-70AD) has also been identified as possibly related to fishing (Allen 1998).

Therefore, the number of wood structures in palaeochannels in the Severn Estuary, and those of prehistoric date revealed by other recent coastal surveys in Britain and Ireland (eg Wilkinson and Murphy 1995; Tomalin *et al.* forthcoming; O'Sullivan forthcoming), suggest that we may be under-estimating the role of fishing in the prehistoric economy. Small numbers of fish bones may partly be a result of preservation factors, particularly since salmon, the most important fish resource exploited in the estuary in historic times, has partly decalcified bones. Clear priorities are to increase the sample size of human individuals subject to carbon isotope analysis, to expand sieving programmes especially in contexts with favourable preservation and to investigate the form, character and environmental conditions associated with wood structures in palaeochannels.

Invertebrates and other sources of faunal evidence

This form of evidence provides examples of the way in which the range of sources of palaeoenvironmental evidence used in the estuary has expanded over the last decade. Land molluscs have been useful in a restricted range of contexts. At Brean Down they provide evidence of the dry and open dune environment which existed from the time of the Beaker sands and during the main periods of Bronze Age occupation (Bell and Johnson 1990; Allen and Ritchie 2000). The sequence provides evidence for the early occurrence of a number of mollusc species which were introductions to Britain since the Bronze Age, although that record is complicated by evidence for the effects on the dune sequence of reworking by fauna and deflation. At Caldicot freshwater molluscs contributed to the reconstruction of conditions within the Bronze Age palaeochannel (Bell and Johnson 1997), but it was an assemblage of restricted diversity and a less sensitive indicator of conditions than diatoms, ostracods and beetles. Intertidal contexts tend to produce extremely restricted assemblages, overwhelmingly dominated by *Hydrobia* sp; these can help to demonstrate marine influence, as for instance in the case of the palaeochannel containing a track made from Bronze Age boat planks at Goldcliff (Bell *et al.* 2000, 80). Particular vigilance should be maintained in searching for tufa deposits near the areas of limestone which outcrop round the estuary. These can produce excellent sequences from the first half of the Holocene as work on the Mendips, Cotswolds and elsewhere in the country has shown. Early Holocene tufas with Mollusca have recently been located on Shapwick Heath (Wilkinson 1998) and Glastonbury (K. Wilkinson pers. com.) on the Somerset Levels

The potential for molluscan work must, however, be seen as specific and localised compared to the contribution which is being made by insects, particularly beetles. Insects have been examined (Figure 2) at Caldicot (Osborne 1997), Vurlong Reen (Walker *et al.* 1998), Goldcliff (Smith *et al.* 2000), Banwell Moor (Smith in Rippon 2000) and Redwick (Smith 2001; Paddock 2000). On each of these sites they have proved central to palaeoenvironmental interpretation and highly complementary to botanical evidence in providing a picture of local site environment. They have contributed to establishing the relative importance of marine influence and, because of their sensitivity in indicating the presence of particular plants animals or communities, they have proved especially sensitive indicators of human activities. This comes particularly from the evidence of dung beetles and other insects associated with animal husbandry such as the cattle head-biting lice and mites which provided the clearest evidence for use of Goldcliff structures as animal byres (Smith *et al* 2000; Schelvis 2000).

The important contribution which mites made to the Goldcliff study highlights the importance of always being alert to new sources of evidence which may help us to address our research questions. The estuary presents a very wide range of sedimentary contexts in which diverse, and sometimes unusual evidence may be preserved. In calcareous occupation horizons at Brean Down egg shell survived and Sidell (1993) has shown that such material can be identified using SEM. In similar contexts at Brean Down the survival of calcium phosphate-replaced coprolites of dog and possibly humans is a potentially valuable source of dietary information and demonstrates how cycles of intestinal parasite infestation would have been perpetuated in prehistoric settlements (Jones 1990). In the wetlands it has already been noted that waterlogged coprolites occur in association with the concentrations of animal footprints and should provide evidence of the main plant communities on which those animals had been feeding.

Romano-British and Later Landscapes

Ditched landscapes of Romano-British and possibly earlier date

The foregoing sections have been concerned with prehistory, during which human activity on the wetland itself appears to have been essentially opportunistic. Human communities exploited facets of the wetland which offered seasonally available opportunities. From the Romano-British period, and possibly earlier, the nature of wetland use was dramatically transformed by draining and the creation of seabanks. These made permanent settlement possible in some (but not all) areas previously used seasonally, it also made possible a different spectrum of activities in the wetland. There is far less environmental evidence available for the Romano-British and medieval periods as compared to prehistory but what we have, even so, makes a most important contribution to our understanding of the character and use of the Romano-British drained landscapes. General syntheses of the development of the Romano-British and medieval landscape have been prepared by Rippon (1996, 1997, 2000 and this volume).

Work in the last 15 years has established the widespread occurrence of Romano-British activity and associated drainage in the Severn Estuary Levels (Allen and Fulford 1986; Fulford *et al.* 1994; Rippon 1997; 2000). The earliest evidence for drainage on most sites is Romano-British, but at Hill Farm, Goldcliff some radiocarbon dates imply Iron Age origins (Locock and Walker 1998; Locock 1999a); other ditches on this site are certainly Romano-British (Bell 1994). Locock and Walker (1998, 42) propose that the earliest phase of the ditched landscape is contemporary with the intertidal Iron Age buildings and trackways, and argue that this suggests a significantly different interpretation of the site as a whole to that advanced by the writer (Bell *et al.* 2000). The available stratigraphic evidence, however, indicates that the peat horizons with the Iron Age structures are at a significantly lower stratigraphic level than the thin organic stabilisation horizon dated by Locock and Walker. The former is correlated with the uppermost true peat shown in Bell *et al.* 2000, fig. 3.5 that is at a maximum height of *c.* 3 m OD, ie 2 to 3m below the present surface. The surface dated by Locock and Walker is at *c.* 5 m OD, that is *c.*1m below the present surface. The available evidence does not, however, preclude the possibility that the upper dated landsurface was established at a later stage in the Iron Age after 1 to 2 m of the upper Wentlooge clay had been deposited above the Iron Age building horizon. Under certain conditions sediment build-up can be very rapid as at Slimbridge, Gloucestershire where 1.5 m of estuarine sediment has built up over formerly reclaimed ridge-and-furrow since the breaching of sea defences in the late nineteenth century (Allen 1986). High deposition rates in the Iron Age, or Romano-British period, do not necessarily demand the breaching of an existing barrier. Accommodation space might have been created in other ways such as erosion followed by desiccation, shrinkage and compaction (Allen 1999) of the bog margins.

The buildings and some of the stabilisation surfaces associated with the ditches have produced similar radiocarbon dates. However, these fall in parts of the calibration curve which produces exceptionally wide calibrated ranges at two standard deviations. For instance a date of 2350±60 BP (SWAN-29) for Goldcliff Trackway 9050 calibrates between 800-200 Cal BC. Given these circumstances it is not likely to be possible to discriminate, using radiocarbon, between surfaces which were extant a century or two apart in time.

The most detailed environmental picture for the Romano-British landscape comes from the Kenn and Banwell areas of North Somerset (Rippon 2000). A range of palaeoenvironmental sources indicate that the ditches carried freshwater, without direct marine influence; they were in a treeless landscape of grazed pasture and dung beetles were present. Plant macrofossils of cereals and weeds indicate some crop growing in the reclaimed wetland. Micromorphological thin sections of Romano-British horizons at Banwell show that they were stable and weathered surfaces which supported earthworms; they must have been free from inundation for extended periods (Heathcote in Rippon 2000).

At Rumney on the Wentlooge Level (Fulford *et al.* 1994) the ditched landscape was likewise open grassland, again of primarily pastoral character. The presence of a well demonstrates, without equivocation, that at that time the area was free of marine influence throughout the year. Plant macrofossils include some saltmarsh taxa but these might have been introduced in the dung of animals which had grazed on saltmarsh; dung beetles were also present. Cereal pollen and evidence of ground disturbance indicates some crop growing.

Just south of Brean Down the saltmarsh environment which had existed in prehistory was replaced in the Romano-British period by grazed grassland indicated by terrestrial mollusc assemblages (Allen and Ritchie 2000). A Romano-British ditch excavated on the present foreshore contained largely terrestrial Mollusca though it was later subject to marine influence. The ditch and Romano-British surfaces produced cereals and crop processing waste. A buried Romano-British ditch system at Hallen on the Avonmouth Levels contained mollusc assemblages of largely land and freshwater taxa making it probable that marine influence was here also excluded (Juggins 1982).

Charred cereals and crop processing waste are present at the second and third century AD wetland site at Great Pencarn Farm on the Wentlooge Level (Yates 2000) and crop processing waste is also present in Romano-British ditches at Goldcliff Hill Farm pond on the Caldicot Level (Caseldine pers. comm.). In both cases it is unclear whether crop growing was on reclaimed alluvium or nearby bedrock. Even so, evidence of cereals at five of the Romano-British wetland sites leaves little doubt that although the ditched landscapes were mainly used for pasture, some cereal cultivation did take place. This, together with the evidence of freshwater conditions, implies that sea defence banks keep out all but the most extreme tides.

Ditched landscapes in the estuary are clearly not, however, of uniformly freshwater character. The ditches at Goldcliff contain macrofossil and Foraminifera indicating estuarine influence (Locock and Walker 1998). There are likewise marine Foraminifera in Romano-British ditches at Nash (Beasley 1998; Meddens and Beasley forthcoming). In these cases we may imagine that drainage was designed to improve seasonal saltmarsh grazing in areas which, during the late summer and winter periods of higher tides, were still subject to regular marine inundation.

Barland's Farm (Nayling *et al.* 1994) provides further evidence for the Romano-British landscape although in this case without ditches. Here, biological evidence associated with a Romano-British boat contained in a palaeochannel near the inner edge of the Caldicot Level indicates a landscape of open grassland with some mixed woodland surviving on dry ground. Plant macrofossils from the Romano-British boat indicate that cereals may have formed part of the cargo (Nayling forthcoming). The Romano-British wetland at Barland's Farm became increasingly subject to marine influence which is attested in late- and post-Roman times by environmental evidence from a number of sites on both the Welsh and English sides of the Estuary (Rippon 1997).

As regards the nature of Romano-British animal husbandry associated with the ditched landscapes, there are small animal bone assemblages from five sites. At Rumney on the Wentlooge Level the assemblage (Figure 5) comprised ovicaprids (35%), horse (32%) and cattle (23%). The high proportion of horse has been explained in terms of possible military involvement in the drainage of the Wentlooge Level from the fortress at Caerleon (Fulford *et al.* 1994). On other sites cattle predominate on the wetland as they had in the more marine influenced estuarine environments of the Bronze and Iron Ages. A small assemblage in an estuary edge site at Great Pencarn Farm, Wentlooge Level comprises cattle, ovicaprids and horse (Yates 2000). Wetland ditch systems at Nash on the Caldicot Level (Meddens in Beasley 1998; Meddens and Beasley 1998) contain assemblages of cattle (66%), ovicaprid (22%), horse (10%) and pig (0.5%). In the north Somerset Levels at Kenn Moor the assemblage comprises cattle (50%), ovicaprid (36%), horse (8%) and pig (5%), a smaller assemblage at Banwell comprises cattle, ovicaprid and horse (Rippon 2000).

It follows from the foregoing that the archaeological importance of these ditched landscapes demands a high priority for environmental work in future research. Thin organic horizons on several sites indicate old land surfaces (Locock 1999a; Rippon 2000) and pollen and macrofossil investigation of these is a priority wherever they occur. At Goldcliff (Locock 1997) and Banwell Moor (Heathcote in Rippon 2000) these dark stabilisation horizons are rich in charcoal, which at Goldcliff related to the burning of reeds. Should this prove to be a recurrent feature it should be considered whether burning represents a deliberate part of landclaim, or land management, practice. The growing of reeds is a part of recent land claim strategies in the Netherlands, where they have the effect of drying out reclaimed wetland and the burning of reeds has formed part of wetland management in many periods from the Mesolithic to present (Law 1998, 198).

The ditches themselves have also been shown to represent key contexts for Foraminifera, diatom and ostracod evidence of aquatic conditions, and plant macrofossil and beetle evidence of conditions in the ditches as well as wider landuse practices in the ditched landscapes as at Kenn and Banwell on the North Somerset Levels (Rippon 2000). Understanding of these landscapes will also be enhanced by palaeoenvironmental sampling from other archaeological features, especially agricultural structures like the corn dryer at Kenn Moor in north Somerset (Rippon 2000).

Environmental research in post Romano-British contexts

In the post-Roman period a particular challenge is to establish what happened to the Romano-British landscape both on and off the wetland, particularly given the evidence for continuity of the ditch layout on the Wentlooge Level from the Romano-British period to today (Allen and Fulford 1986; Fulford *et al.* 1994). In most areas peat formation ceased during the Bronze Age or Iron Age, although some peat is also likely to have been lost by peat cutting, a practice which can now be documented at least back to the Romano-British period at Greenmoor Arch on the Caldicot Level (Locock 1999b). Establishing the date of the latest peat will contribute significantly to our understanding of landscape development on the levels. Exceptionally thick peats of 6.2 m have been identified by Allen (this vol and forthcoming) close to the bedrock at Llandevenny, an area close to Barland's Farm and dry land with evidence of Iron Age, Romano-British and Medieval sites. If it could be established that any peats close to dryland continued to form in the post-Roman and early Medieval periods such sites would represent a most valuable resource for investigating questions of continuity and change (Bell and Dark 1998), across this cultural interface of such particular importance in the archaeology of Wales. Such remaining areas of thick and potentially late peats must not be lost before their palaeoenvironmental potential has been assessed. In a similar way the one late peat in the Somerset Levels, at Meare Heath, which has been subject to pollen analysis indicates that the cleared agricultural landscape established during the late Iron Age at the time of the lake villages, continued through the Romano-British period and apparently well into sub-Roman times (Beckett and Hibbert 1978). Similarly at Brean Down there is evidence that a mainly terrestrial environment, with some freshwater influence, continued into a horizon with a radiocarbon date (1500±60BP, AA-28729; 420-660 Cal AD; Allen and Ritchie 2000) closely similar to the radiocarbon dates obtained for the sub-Roman cemetery on this site. Perhaps, therefore, the drained and protected Romano-British landscape was maintained into the fifth century or beyond. Such continuity may not be wholly unexpected in that part of fully Romanised Britain for which we have the richest settlement and cemetery evidence of sub-Roman activity extending over a period of centuries (Rahtz and Fowler 1972).

By the medieval period there are many other sources of evidence for landscape and rural economy (Rippon 1997). Palaeoenvironmental research is perhaps most profitably directed towards specific goals. For instance the strategy at the Magor Boat was focused on establishing the environmental context of the boat (a tidal creek within a saltmarsh) and investigating any evidence of cargo, barley chaff indicating a possibly earlier cargo of cereals (Nayling 1998). In historic periods environmental evidence can potentially provide alternative datasets for comparison with evidence from historical sources or field landscape archaeology.

Conclusions

Wetland / dryland interactions

One of the main challenges for wetland archaeological research is to establish its relationship to wider dryland archaeology. An attempt has recently been made to consider wetland-dryland relationships in the Severn Estuary and its surroundings in the Mesolithic and Neolithic (Bell forthcoming b). For later prehistory, the Bronze and Iron Ages, there is the concave landscape model proposed for the Somerset Levels by Coles and Coles (1986, fig. 34). In the Severn we now know a good deal more about the prehistoric archaeology and environments of the wetland, than the adjacent dryland. Bronze Age permanent settlement seems to have been just off the wetland where dry ground rises, for instance the hypothetical settlement beside the Caldicot palaeochannel and the excavated settlement at Brean Down. Estuarine resources, grazing and fishing and at Brean salt extraction, were probably an important part of the economy of these sites. The concave landscape model for the Somerset Levels has the main grazing resource on the lower slopes around the wetland edge, conversely in the estuary it appears that saltmarsh was a key pastoral resource. Overall pastoralism seems now to have been rather more important and arable activity of smaller scale than suggested by the original concave landscape model.

The Iron Age settlement pattern remains more problematic. There is a string of impressive hillforts flanking the Gwent Levels (Davies and Lynch 2000, fig. 4.1) and similarly on the English side (Rippon 1997, fig. 11). There has been little recent excavation, so we do not know when most originated and whether any were of Bronze Age origin. Some of these hillforts have substantial annexes for which a pastoral function is often suggested. One hypothesis is that these are the parent settlements from which groups sallied fourth to exploit seasonal grazing. However, there are suggestions of difference: we have no evidence of rectangular buildings in the hillforts, and here pottery is abundant in a way that it is not on the wetland sites. An alternative is that the wetland was occupied by an underclass of cattleherders and marshmen perhaps serving the hillfort dwellers but separate from them (Bell *et al.* 2000, 348). If the existence of these people was to some degree separate, whether seasonally or year round, then the dramatic environmental changes represented by the upper Wentlooge transgression would have impacted to a very significant extent on their way of life.

These observations serve to emphasise the importance of a conscious and wide ranging quest for clues as to dryland – wetland relationships using, for instance, provenancing of pottery or stone finds, comparative studies of animal bone assemblages as attempted above, and possibly, given the varied geology which surrounds the Levels, work on bone geochemistry (for a human bone example see Evans *et al.* 2000).

We also need a much better understanding of how people were using the dryland edge. Of special interest are the lower slopes surrounding the wetland at the base of which is what has been called the colluvial-alluvial interface (Bell 1981). This ecotone contains dryland from which wetland can be exploited and archaeological evidence is frequently found here. It is the part of the wetland where evidence of prehistoric activity comes closest to the surface and is particularly vulnerable to impact from modern development and agriculture. Such interfaces have been the subject of targeted investigation on six sites: Brean Down (Bell 1990, fig.78), Goldcliff (Bell *et al.* 2000, fig. 3.6); and three sites on the route of the Second Severn Crossing: Vurlong Reen and Stoop Hill on the Caldicot Level (Parkhouse 1990; Parkhouse and Lawler 1990; Ferris and Dingwall 1992) and Awkley on the Avon Levels (Barnes 1993, 25). At the base of Spaniorum Hill at the edge of the Avon Levels substantial post-Roman colluviation was identified in an auger transect across the Avonmouth Levels (Juggins 1982).

Only at Brean Down was there significant prehistoric colluviation. This resulted in the cultivated soil associated with the earliest middle Bronze Age settlement being totally eroded down to underlying Pleistocene breccia. There is evidence of small-scale human activity represented by lithic material on three other sites but only at Stoop Hill is there a thin colluvial sediment with a single prehistoric sherd; further colluviation occurred later at the time of an adjacent Romano-British settlement. Although the sample of sites is small, the paucity of colluvium on the Welsh sites suggests that the contributing slopes were used mainly for pasture with smaller-scale arable as indeed the pollen evidence also suggests. By contrast the higher slopes surrounding the Levels in North Somerset and around Bristol, which is mainly limestone, show evidence of field systems of prehistoric and Romano-British date (Fowler 1978) and there seems to be more evidence of colluviation. It would be instructive to plot the field and air photographic evidence for

Table 3: An attempt to specify some of the key archaeological research problems in the Severn Estuary and the sources of environmental evidence which may contribute to their solution.

Problem	*Spatial scale*	*Time scale*	*Sources (in approx. order of importance)*
Character of pre-inundation Mesolithic environment and the role of human agency	Landscape (eg submerged forest) to site	10,000-5000 BP	(i) Pollen (ii) Plant macrofossils (iii) Dendrochronology (iv) Insects (v) Soils (vi) Forams, diatoms and ostracods
Mesolithic economy	Occ. site	ditto	(i) Animal bones (ii) Plant macros. (iii) Isotopic studies (iv) Footprints
Neolithic economy: relative importance of wild resources, domestic animals and crop growing	Occ. site	4000 –2000 Cal BP	(i) Plant macros. (ii) Animal bones (iii) pollen studies (iv) Isotopic studies (v) Footprints
Seasonality V Sedentism	Occ. site	10,000- 2000 BP	(i) Tree rings (ii) Plant macros. (iii) Sediment increments + micromorphology (iv) Fish (v) Animal bones
Nature of the wetland economy	Site & Landscape	1500-0BC	(i) Beetles & mites (ii) Footprints and bones (iii) Plant macros. (iv) Pollen
Role of fishing	Activity area & occ. site	7000 BC to AD 1550	(i) Fish (sieving) (ii) isotopic studies (i) Fishing structures
Role and origins of dairying	Occ. site & Landscape (footprints)	4000 Cal BC- AD 1550	(i) Isotopic studies (ii) Chemical residues (iii) Animal bones (iv) Footprints
Relationship of human activity to stratigraphic change	Occ. site & landscape	10,000-present	(i) Forams & diatoms (ii) Sedimentary studs.+ Micromorphology (iii) Plant macrofossils (iv) Pollen
Romano-British landuse	Site: ditches & soils	0-600 AD	(i) Plant macrofossils (ii) Forams, diatoms & ostracods (iii) Beetles (iv) Pollen (v) Soils + micromorphology (vi) Molluscs
Continuity and change	Landscape and occ. site	Esp. 4000-2000 Cal BC & 100 BC-1100 AD	(i) Pollen (ii) Economic plants
Transport of goods: rural / urban	Site: boats & waterfront	1st AD to recent	(i) Plant macros. (ii) Animal bones inc. fish

features such as field systems, droveways and enclosures on the foothills between these upland settlements / fieldsystems and the Severn wetlands in order to establish whether there is evidence of droveways such as are associated with a pastoral prehistoric economy at Fengate, Cambridgeshire (Pryor 1998).

Multi-proxy sources

Comparison of Figures 1 and 2 and Appendices 1 and 2 demonstrates that botanical research has been much more extensive than faunal research. Beetles and the small bone assemblages from wetlands have made a contribution to our understanding of the Levels which is disproportionate to the number of studies and the resources expended. However, a central point to emerge from this review is the extent to which a wide range of sources of evidence complement one another within a multi-proxy approach. Pollen, beetle or bone studies are of interest in their own right, but when it is possible to compare evidence from multiple sources, our environmental reconstructions are much fuller and where the sources of evidence are in agreement hypotheses can be advanced with greater confidence. This is illustrated by the complementary use of palaeoenvironmental sources at Caldicot (Nayling and Caseldine 1997), Romano-British sites on the North Somerset Levels (Rippon 2000), Brean Down (Bell 1990) and Goldcliff (Bell *et al.* 2000). Where different sources of evidence are not in agreement it helps to identify problems of interpretation which can then be tackled in fresh ways. Future strategies should continue to draw on multiple sources but should now be able to do so in a more targeted way. This is necessary because finite resources mean we cannot employ all sources of evidence and carry out comprehensive environmental investigations on every site. Over the last 20 years the basic sequences, appropriate sources of evidence and research problems have, to a significant extent been identified. This should help to make possible a more selective and targeted approach in future.

Archaeological research questions and priorities

Table 3 is an attempt to identify some of the main archaeological questions which emerge from the foregoing discussion and to specify the sources of palaeoenvironmental evidence which may most effectively contribute to their solution. The topics are in loosely chronological, rather than priority, order. This is, of course, a provisional statement designed to help curators, contractors and researchers make decisions about which sources of evidence may be particularly helpful in a given context. Specification of research priorities is an invidious activity in archaeology and must always be subject to the stochastic factor of future unexpected discoveries. A stratified Palaeolithic site, a well-preserved shell midden, or boat find, might require the revision of much of what is said here about research priorities.

Research in recent years has done much to establish the general sedimentary and environmental history of the estuary. Given that existing background it should become increasingly possible to establish the environmental context of some sites by means of targeted smaller-scale work. Table 3 highlights that the main archaeological research problems, as perceived here, are likely to be solved by investigation of occupation horizons on sites. The value of comparing on-site with off-site evidence has also been emphasised, but so far occupation horizons have in general received rather less emphasis than broad-scale, long-term, or off-site environmental investigations. A related general point is the priority of sieving programmes of occupation horizons to provide adequate samples of palaeoeconomic evidence: fishbones, animal bones and economic plants.

This review has also shown that both floral and faunal research has been greatly concentrated in the Caldicot Level (Figures 1 and 2), which is where the main concentration of known prehistoric sites occurs. The very limited amount of palaeoenvironmental research in the inner Estuary, upstream of the original Severn Bridge, is notable and this area should receive attention when suitable archaeological sites come to light, as most notably at Oldbury (Allen 1998).

Interdisciplinary perspectives

A large part of what has been achieved in the Severn in the last twenty years has come about through interdisciplinary cross-fertilization. This has probably been easier to achieve in the confederation of interests represented by the SELRC than within a single monolithic project in which particular interests are inevitably ascendant and it may often be more difficult to adapt to new research opportunities and questions as they arise. Given the success of an interdisciplinary approach it is the contention of this piece that a deeper interdisciplinary dialogue should be a central and explicit objective of future programmes. A conscious effort needs to be made to identify practical steps which may help to advance this agenda. The following are suggestions as a basis for future discussion:-

(i) To record data on scales of spatial, altitudinal and chronological resolution which are appropriate to the needs of cognate disciplines, when there is a significant probability that data important to that discipline will be obtained.

(ii) Scientists from cognate disciplines should be involved where possible in the planning and field stages of projects in situations where fellow scientists can benefit from the time-depth perspective provided by archaeological sites.

(iii) To make the results of work available in an easily accessible form.

(iv) To explore the possibility of standardised recording of sediment sequences in coring exercises.

(v) To explore the possibilities and potential value of creating common databases (e.g. digital maps, radiocarbon lists, auger logs and bibliographic information) which may enhance data availability to the scientific community as a whole.

The costs of interdisciplinary collaboration along these lines are not in every case likely to be great. Involvement of scientists from other disciplines will help to ensure that archaeologically funded work does not duplicate research being done by others and is expended on achievable objectives. It will also open up opportunities of research support, funding and a broader perspective on environmental change which goes well beyond what might realistically be provided from within the discipline of archaeology alone.

In parallel with the archaeological research agenda of Table 3 is a suite of palaeoenvironmental research questions which are not in essence archaeological, but which are nonetheless very relevant to archaeological issues and to which archaeological evidence can make important contributions. In understanding the scale of environmental phenomena affecting coastal wetland communities there is a linked group of research questions of which the following are examples:-

(i) To what extent are the transgressive and regressive episodes of sea-level tendency coeval from site to site, and region to region?

(ii) What are the factors driving transgressive and regressive episodes locally as well as regionally?

(iii) Have sea-level falls, as well as rises, occurred in the Holocene?

(iv) To what extent are long-term processes and catastrophic events determining the pattern of coastal environmental change?

(v) Research into the changing tidal range of the estuary.

Answers to many of these environmental questions, and the associated archaeological questions depend on the development of increasingly precise chronologies. Dendrochronology has the potential to make a major contribution and all opportunities to develop tree-ring sequences should be seized. Where dendrochronological dating is not possible there is a need to apply well thought out radiocarbon dating strategies on more ambitious scale than has been usual.

In the context of increasing concerns about global warming there is a growing interest, not just in long-term gradualistic processes of coastal change, but in the role and recurrence interval of events. Examples are the floods and storms which have increasingly impacted on coastal environments and riverine floodplains in recent times. Human perception of environmental change in the past, as in the present, is to a significant extent made up of the memory of extreme events which in many cases may form the visible manifestation of longer term trends. In this respect the timescales of Quaternary and archaeological enquiry and the interests of those responsible for managing the coastal zone are increasingly coincident.

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Appendix 1: Pollen analyses and associated environmental work in the Severn Estuary, ordered according to publication date. For the locations of sites see Figure 1.

No	*Site*	*NGR*	*Start date*	*End date*	*Notes*	*Other evidence*	*Reference*
1	Cardiff East Moors	*c.* ST2176	–	–	1 diagram, 11 levels		Hyde 1936, Godwin 1943
2	Avonmouth BH 9	ST 531796	–	–	2 levels		Seddon 1964
3	Avonmouth BH C	ST 538788	–	–	3 levels		Seddon 1964
4	Gordano Valley	c. ST4372	–	–	–		Jefferies *et al.* 1968
5	Longney	SO766 116	*c.* 5090BP	*c.* 2830BP	Wood peat		Brown 1982, 1987
6	Kenn Pier	ST 430680	*c.*6100±100 BP (lab no not given) 5300-4750 Cal BC	*c.* 3510±100BP (lab no not given) 2150-1500 Cal BC	31 levels 4 dates (different core)		Butler 1988
7	Goldcliff East site 1	ST3786 8220	5950±80BP (CAR-659) 5050-4610 Cal BC	3130±70BP (CAR-644) 1530-1210 Cal BC	75 levels 16 dates	Diatoms, Macrofossils	Smith and Morgan 1989
8	Goldcliff East site 2	ST37858208	5660±80BP (CAR-778) 4690-4340 Cal BC	4390±80BP (CAR-773) 3340-2880 Cal BC		18 levels, 5 dates	Smith and Morgan 1989
9	Rumney aurochs	ST2294 7745	4060±70BP (CAR-831) 2880-2460 Cal BC		4 levels estuary/saltmarsh	Forams	Walker in Green 1989
10	Rumney	ST220 788	Undated: Upper Wentlooge		10 sites		Blackford 1990
11	Gordano Valley	ST436 729	11020±190 BP (SRR-3203) 11600-10600 Cal BC	3820±100BP (SRR-3199) 2600-1950 Cal BC	39 levels 5 dates		Gilbertson *et al.* 1990
12	Gravel Banks	*c.* ST5282	7030±100BP (I-4903) 6080-5710 Cal BC		6 levels; 1 date	Molluscs	Gilbertson *et al.* 1990
13	Avonmouth M5 Bridge	*c.* ST5277	4305±100BP (lab no. not given); 3350-2550 Cal BC		5 levels; 1 date		Gilbertson *et al.* 1990
14	Avonmouth ICI	c. ST5383	5100±100BP (IGS-29) 4250-3650 Cal BC	3100±100BP (IGS-27) 1650-1000 Cal BC	3 levels		Gilbertson *et al.* 1990
15	Brean Down	ST2915 5847	One date 5620±100 BP (HAR-8546) 4710-4250 Cal BC		1 diagram 10 levels	Diatoms, molluscs macros	Crabtree 1990
16-19	Uskmouth	ST336 820	6260±90BP (CAR-1178) 5500-4950 Cal BC	5810±80BP (OxA-2628) 4850-4460 Cal BC	4 diagrams; 25 levels	Forams, Footprints Sediments	Caseldine in Aldhouse-Green *et al.* 1992
20	Kenn Moor	ST 4355 6945				Diatoms	Rippon 2000, Stockley 1995

No	Site	NGR	Start date	End date	Notes	Other evidence	Reference
21	Rumney Ditch B4	ST2441 7827	Romano-British		3 levels	Plant macros	Fulford *et al.* 1994
22	Caldicot Pill 333-340	ST49940 86615	6660±80 (Beta-79886) 5720-5470 Cal BC		1 diagram; 33 levels		Scaife 1994
23	Caldicot Pill Oscar 3	ST49490 86315	One date 5620±70BP (Beta-79887) 4620-4330 Cal BC		1 diagram; 7 levels		Scaife 1994
24	Slimbridge	SO723029	–	3110±50BP (Beta-80696) 1500-1210 Cal BC	No diagram	Diatoms	Hewlett and Birnie 1996
25	Elmore	SO780 156	–	2360±60BP (Beta-81686) 800-200 Cal BC	No diagram	Diatoms	Hewlett and Birnie 1996
26	Longney	SO761 129	–	2340±60BP (Beta-80693) 800-200 Cal BC	10 levels peat/clay interface		Hewlett and Birnie 1996
27-34	Caldicot	ST488 886	4670±80B (CAR-1323) 3650-3100 Cal BC	2400±70BP (CAR-1405) 780-370 Cal BC	8 diagrams 63 levels	Macros, diatoms, insects, molluscs	Nayling and Caseldine 1997
35	Barland's Farm	ST405 864	5920±50BP (Beta-72511) 4940-4680 Cal BC	2900±60BP (Beta 72506) 1290-910 Cal BC	1 diagram; 48 levels 6 dates	Macros, beetles, molluscs, diatoms	Walker *et al.* 1998
36	Vurlong Reen 1	ST452 873	5740±70BP (Beta-63595) 4780-4400 Cal BC	2470±60BP (Beta-63590) 780-400 Cal BC	1 diagram, 50 levels, 6 dates	Macros, beetles	Walker *et al.* 1998
37	Vurlong Reen 2	ST 452 873	4720±60BP (Beta-63598) 3640-3370 Cal BC	4010±60BP (Beta-63596) 2900-2300 Cal BC	1 diagram; 16 levels, 3 dates	Macros, beetles	Walker *et al.* 1998
38	Collister Pill roundhouse	ST 4527 8550	?	*c.* MBA	1 diagram; 16 levels	Charcoal	Burbridge 1998
39	Redwick	ST4244 8372	?c 5670±90 BP (Beta-128779) 4720-4340 Cal BC	*c.* MBA	1 diagram; 31 levels		De Volder 1998 Caseldine in prep.
40-42	Magor Pill boat	ST4382 8427	Constructed AD 1239/40		3 diagrams; 11 levels	Diatoms, Plant macros	Caseldine and Burrow in Nayling 1998
43	Gravel Banks S1	ST5230 8385	7150±70BP (Wk-5826) 6210-5840 Cal BC	6460±70BP (Wk-5860) 5540-5300 Cal BC	2 diagrams 4 dates	Foraminifera Plant macros	Riley 1998, Druce forthcoming

cont.

No	Site	NGR	Start date	End date	Notes	Other evidence	Reference
44	Gravel Banks S2	ST5248 8376					Riley 1998, Druce forthcoming
45	Severn Beach	ST5350 8375					Riley 1998, Druce forthcoming
46	Rumney 5	ST2389 7790	Wood structure 2750±60BP 1020-800 Cal BC		1 diagram, 4 levels	Plant macros	Caseldine and Burrow in Nayling 1999
47-64	Goldcliff foreshore	ST3578 8212 to ST3692 8202	5920±80BP (CAR-1501) 5000-4580 Cal BC	Dendro. *c.* 270BC	18 intertidal diagrams 270 levels; 25+ dates	Plant macros, beetles, diatoms	Caseldine 2000
65	Goldcliff pond peat	ST3708 8213	4320±80BP (SWAN-133) 3350-2650 Cal BC	3180±70 (SWAN-104) 1620-1260 Cal BC	1 diagram; 18 levels 3 dates		Caseldine 2000
66	Goldcliff pond ditch	ST3707 8214	Romano-British	–		Plant macros	Caseldine in prep.
67	Woodspring Bay	?c ST3567	Unknown	–			Druce forthcoming
68	Nash	ST338838	Romano-British	–		Plant macros. Forams Diatoms	Beasley 1998 Meddens and Beasley forthcoming
69	Brean sea-defences	ST29555855	Prehistoric to sub-Roman		1 diagram, 10 levels	Forams, Diatoms Ostracods, Mollusca, Plant macros.	Allen *et al.* 1996 Allen & Ritchie 2000
70	Oldbury-on-Severn	ST59849441-ST60189369	6490±90BP (WK-7329) 5620-5300 Cal BC	3930±100BP (Wk-7327) 2900-2050 Cal BC	4 diagrams 9 dates (Wk-7327)	Forams Plant macros.	Druce forthcoming
71	Kites Corner	*c.* ST535800	Bronze Age		No diagram pub.	Charcoal	Locock 1999c
72	Great Pencarn Farm	ST28143358	Iron Age	Romano-British	1 diagram, 12 levels	Plant macros, Diatoms	Yates 2000
73	Banwell	ST390617	Romano-British		1 diagram, 7 levels	Micromorphology	Rippon 2000
74	Upton Trackway	ST44648504	2400±70BP Car-960 780-370 Cal BC		1 sample	Wood, plant macros	Locock *et al.* 2000

Appendix 2: Sites with Faunal evidence in the Severn Estuary, other associated environmental evidence is also noted. For the locations of sites see Figure 2.

No	Site	NGR	Date	Bones	Insects	Molluscs	Ostracods	Forams	Notes and other evidence	Reference
1	Sharpness Docks	SO670 022	–	X						Lucy 1877
2	Westbury on Severn	c. SO710135	–			X	X			Prevost 1901
3	Newport, Alexandra Docks	ST3106 8401		X					–	Keith 1911 Bell *et al.* 2000, 69
4	Hallen	ST53468226	Romano-British			X				Juggins 1982
5	Bristol waterfront	ST590727	C12-13th AD	X					Diatoms, Plant macros.	Jones and Watson 1987
6	Uskmouth aurochs (excav. S. Parry)		4660±70 BP (CAR-1069; 3650-3100 Cal BC)	X					3 aurochsen, 1 largely complete	Whittle and Green 1988
7	Rumney aurochs	ST2294 7745	4060±70 BP (CAR-851; 2880-2460 Cal BC)	X				X	Pollen, forams	Green 1989
8	Brean Down	ST2957 8725	3560±90 BP (Har-9156; 2200-1650 Cal BC) to present	X		X	X		Coprolites Eggshell	Bell 1990
9	Rumney RB site	ST244 782	Romano-British	X	X				Pollen, Plant macros	Fulford *et al.* 1994
10	Caldicot	ST488 886	4670ñ80 BP (CAR-1323; 3650-3100 Cal BC) to 2400±70 BP (CAR-1405; 780-370 Cal BC)	X	X	X	X		Pollen, Plant macros	Nayling and Caseldine 1997
11	Magor Pill boat	ST4382 8427	Dendro. AD 1239/40	X						Nayling 1998
12	Vurlong Reen	ST452 873	5740±70 BP (Beta-63595; 4780-4400 Cal BC) to 2470±60 BP (Beta-63590; 780-400 Cal BC)		X				Pollen, Plant macros	Walker *et al.* 1998
13	Barland's Farm	ST405 864	Post 2900±60 BP (Beta-72506; 1290-910 Cal BC)			X			Pollen, diatoms Plant macros.	Walker *et al.* 1998
14	Nash	ST337840	Romano-British	X				X		Beasley 1998
15	Goldcliff	ST3691 8194	5920±80 BP (CAR-1501; 5000-4580 Cal BC) to 1930±50 BP (CAR-1503; 50BC-220 AD)	X	X			X	Mites	Bell *et al.* 2000 Haslett *et al.* 1997
16	Redwick	ST4225 8369	7330±70 BP (Beta-134639; 6380-6020 Cal BC) to 2930±70 BP (Swan-225; 1380-920 Cal BC)	X	X			X	Pollen, Plant macros	Paddock 2000 Bell in prep
17	Banwell	ST388 616	Romano-British	X	X	X		X	Pollen, Micromorphology	Rippon 2000
18	Kenn	ST425 681	Romano-British	X	X	X		X	Diatoms	Rippon 2000
19	Brean sea-defences	ST29555855	Prehistoric to Sub-Roman	X		X	X	X	Pollen, Diatoms Plant macros	Allen *et al.* 1996 Allen & Ritchie 2000
20	Uskmouth	ST336 820	6260±90BP (CAR-1178; 5500-4950 Cal BC) to 5810±80BP (OxA-2628; 4850-4460 Cal BC)					X	Pollen, Plant macros Footprints	Aldhouse-Green *et al.* 1992

cont.

No	Site	NGR	Date	Bones	Insects	Molluscs	Ostracods	Forams	Notes and other evidence	Reference
21	Puxton	ST407 632	Early Romano-British & Medieval	X						Rippon in progress
22	Gravel Banks	c. ST5282	7030±100 BP (I-4903; 6080-5710 Cal BC)			X			Pollen	Gilbertson *et al.* 1990
23	Kites Corner	c. ST535800	3350±60BP (Beta-134901; 1860-1490 Cal BC)-2610±70BP (Beta-129554; 950-400Cal BC)	X					Charcoal	Locock 1999c Locock *et al.* 1998
24	Great Pensarn Farm	ST28143358	mid second to late third cent. AD	X					Diatoms, Plant macros Pollen	Yates 2000
25	Chapeltump II	ST44708514	3080±70BP (CAR-956; 1520-1120 Cal BC)-2520±70BP (Car-899; 800-410 Cal BC)	X					Plant macros	Locock 2000

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