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REGIONAL REVIEW OF ENVIRONMENTAL ARCHAEOLOGY IN SOUTHERN ENGLAND
MOLLUSCS

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Keith Wilkinson

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REVIEW OF ENVIRONMENTAL ARCHAEOLOGY IN THE SOUTHERN REGION: MOLLUSCS

Keith Wilkinson

Summary

Analysis of sub-fossil Mollusca has been a standard component of the investigation of prehistoric sites on chalk and limestone geologies since the late-1960s, but a rather less common on later sites or on different geological substrates. The approaches and methodologies used were developed and published by Evans (1972). However, the origins of Evans' methods lie in work undertaken within Quaternary geology. Indeed some of the most important molluscan studies have been of Lower and Middle Palaeolithic sites, while Mollusca have also proven to be of use for relatively dating Middle Pleistocene sites either by biostratigraphic approaches or amino acid epimerisation.

Molluscan studies on prehistoric sites in the Wessex and South Downs demonstrate that the earliest Neolithic monuments were built in forest clearings, but that most later structures were constructed on land that had been used for either arable or pastoral purposes. Studies have has also been undertaken in off-site locations in order to address archaeological questions. The data demonstrate that Neolithic palaeosols formed in forested or long grassland environments, but that shells from the colluvial fills that developed from the Bronze Age onwards attest to arable environments that were found on the valley sides. The few molluscan studies carried out of historic period sites suggest relatively open landcapes, but that arable was not ubiquitous.

There have been relatively few studies of marine Mollusca in the southern region. However, two middens have been studied, while marine Mollusca have been recovered from a number of Romano-British sites and later sites.

Keywords: Mollusca, Palaeoecology, Prehistoric, Geochronology, Research Strategy

Cover

Snails recovered from Wessex prehistoric monuments *by Judith Dobie*

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CONTENTS

1. INTRODUCTION

This document is a review of molluscan studies undertaken to address archaeological questions in southern England. In common with all other English Heritage environmental archaeology reviews, the joint aims of the document are to identify gaps in current understanding and to highlight directions for future research at a local, regional and national level. However, in the case of this particular review more specific aims are also

- to provide a coherent picture of the development of molluscan studies in the region, and;
- to assess the contribution of archaeological molluscan studies to the reconstruction of chronologies, palaeoenvironments and palaeoeconomies in southern England.

This document is not intended to sit alone, but rather to reside alongside reviews of the archaeological mollusc studies produced for eastern England and the English Midlands (Murphy 2001) and northern England (Kenward 2009). Reviews of other classes of biological remains used in environmental archaeology in England have either already been carried out, or are in the process of being researched (e.g. Robinson 2002).

Remains of the Mollusca, i.e. land, freshwater and marine gastropods and freshwater and marine bivalves), are some of the more obvious biological finds that are commonly recovered from archaeological sites. The visibility of the relevant remains is one reason why archaeological mollusc studies have such a long history, dating back to at least the beginning of the twentieth century. However, the systematic study of mollusc shells collected in a representative manner from dedicated samples is a relatively recent activity that coincides with the arrival of the New Archaeology (sensu Binford 1972) in the 1960s. Indeed such quantitative approaches applied to both archaeological and Quaternary geological settings were, in the case of the study of land and freshwater Mollusca, pioneered in southern England (Sparks 1961; 1964; Evans 1972). A previous English Heritage environmental archaeology review outlines some of the work that resulted from these developments (Keeley 1984; 1987). However, the most important Wessex land snail evidence fell in the gap between the mixed thematic and geographic coverage of the review and was therefore not discussed. Nevertheless archaeological mollusc studies carried out prior to the April 1981 census date of Keeley's (1984; 1987) review were discussed for the Isles of Scilly, Devon, Gloucestershire, Somerset, Oxfordshire and Greater London (Bell *et al* 1984; Armitage *et al* 1987; Robinson and Wilson 1987), while marine molluscs from Wessex were covered in a text that otherwise discussed vertebrate zooarchaeology (Coy and Maltby 1987). Mollusc analyses undertaken in the South-west region (excluding Dorset and Wiltshire) and later the Severn estuary levels have also been separately discussed by Martin Bell (Bell 1987; 2000).

The present text is primarily intended to review studies of Mollusca that have been carried out to address archaeological objectives in Southern England since the previous English Heritage-sponsored review (Keeley 1984; 1987). However, given that discussion of molluscan data in the earlier publications was patchy, while much of the landmark work was carried out prior to 1980, the present text also discusses key studies of the 1960-1980s. This text has been compiled mainly from published accounts, although some important publications that are soon to be in the public domain have also been examined (e.g. Bell *et al* forthcoming). Unpublished, so-called 'grey' reports have not been reviewed, it being assumed that the most important data contained in such documents will appear in the published literature.

The subject matter of the present review comprises archaeologically-orientated studies that have been carried out of terrestrial, fresh water and marine Mollusca in southern England, while the chronological scope spans the Lower Palaeolithic to the post-medieval periods. The review does not discuss studies of Mollusca that have been carried out for purely Quaternary biostratigraphic purposes (e.g. to reconstruct environments that were not associated with humans or earlier hominin taxa), except where such studies have archaeological implications. Southern England is defined here as encompassing English Heritage's South Eastern, South Western and London regions [i.e. the modern counties of (including unitary authorities within) Cornwall, Devon, Dorset, Somerset, Gloucestershire, Wiltshire, Hampshire, the Isle of Wight, Berkshire, Oxfordshire, East Sussex, West Sussex, Surrey, Kent and Greater London) (Figure 1). In addition to palaeoenvironmental information derived from all classes of Mollusca and palaeoeconomic data obtained from marine mollusc assemblages, the review also examines the use of terrestrial and marine Mollusca for amino acid dating of Lower Palaeolithic sites (e.g. Bowen *et al* 1989; Bowen and Sykes 1999) and the isotopic study of marine mollusc shells to determine seasonality of exploitation (e.g. Mannino *et al* 2003). The main body of the review, the resource assessment, is organised on a chronological basis. Readers will notice in this section that the greatest attention is given to the later prehistoric period, particularly the Neolithic and Bronze Age. This is not bias on the author's part, but rather because archaeological molluscan studies have tended to focus on monuments in chalk and other limestone environments, most of which date from the period 4000-1000 BC. Nevertheless this study is not exhaustive. Every effort has been made to access and read all published archaeological molluscan studies, but some will inevitably have fallen through the net. In order to set the scene, a brief history of molluscan studies in archaeology and an account of methodological developments are provided prior to the resource assessment, while a series of recommendations for the direction of future molluscan studies, the research agenda, is offered both as concluding sections at the end of each period-based resource assessment and on a thematic basis as the final section of the report.

Taxonomic nomenclature used in the text is after Kerney (1999) for land and freshwater Mollusca and the *Encyclopaedia of British molluscs* (Conchological Society of Great Britain and Ireland 2008) for marine taxa. Where cited, ^{14}C dates have been calibrated (re-calibrated, if originally published using an older calibration curve) using the IntCal04 curve and OxCal 4 software (Reimer *et al* 2004; Bronk Ramsey 2008).

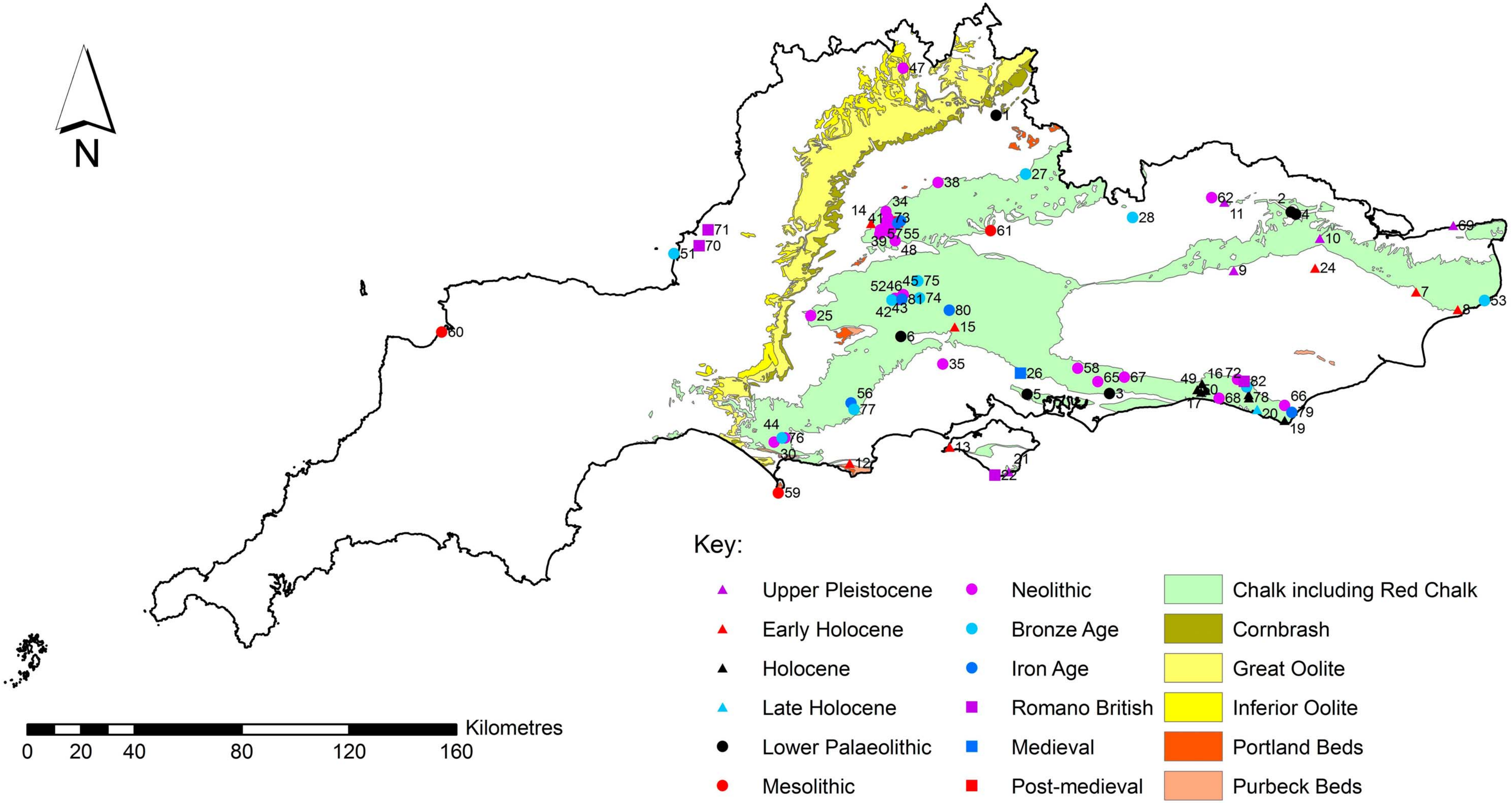

Figure 1: Sites discussed in this review, plotted against calcareous lithologies (for key see next page).

Key to Figure 1: 1. Wolvercote; 2. Swanscombe; 3. Boxgrove; 4. Northfleet; 5. Red Barns; 6. Harnham; 7. Brook; 8. Holywell Coombe; 9. Oxted; 10. Halling; 11. Bramcote Green, London; 12. Blashenwell; 13. Totland; 14. Cherhill; 15. Bossington; 16. Devil's Dyke; 17. Toadeshole Bottom East; 18. Itford Bottom; 19. Kiln Combe; 20. Bishopstone; 21. Watcombe Bottom; 22. Blackgang; 23. Asham Quarry; 24. Wateringbury; 25. Whitesheet Hill; 26. Kingsmead Bridge; 27. Wallingford; 28. Runnymede Bridge; 29. Overton Down; 30. Maiden Castle; 31. Easton Down; 32. South Street; 33. Beckhampton Road; 34. Windmill Hill; 35. Ascott-under-Wychwood; 36. Horslip; 37. West Kennet; 38. Wayland's Smithy II; 39. Silbury Hill; 41. Avebury; 42. Stonehenge; 43. Durrington Walls; 44. Mount Pleasant; 45. Woodhenge; 46. Coneybury; 47. Condicote; 48. Knap Hill; 49. Hangleton Bottom; 50. Cockroost Bottom; 51. Brean Down; 52. Wilsford Shaft; 53. Dover Boat; 54. Fyfield Down; 55. Overton Down; 56. Badbury; 57. Hemp Knoll; 58. North Marden; 59. Culverwell; 60. Westard Ho!; 61. Faraday Road, Newbury; 62. St Stephen's East, London; 63. Offham Hill; 64. Bury Hill; 65. The Trundle; 66. Combe Hill; 67.B arkhale; 68. Whitehawk; 69. Reculver; 70. Banwell; 71. Kenn Moor; 72. Southerham Grey Pit; 73. Millbarrow; 74. Earl's Down Farm; 75. Dunch Hill; 76. Fordington Farm; 77. Barford Farm; 78. Round-the-Down; 79. Bourne Valley; 80. Danebury; 81. Vespasians Camp; 82. Malling Hill.

2. MOLLUSC STUDY IN SOUTHERN ENGLAND

Geography and geology play a key role both in where Mollusca live and where they are preserved in the archaeological record. Most obviously marine molluscs live in the sea and are therefore found in natural death assemblages in littoral situations, be that relating to the present shoreline or a relic feature such as a raised beach. Shell middens resulting from the exploitation of marine molluscs are always found in such situations although from the Romano-British period onwards marine molluscs were transported inland to towns, cities and high status sites such as villas for consumption as a luxury food item. Terrestrial and freshwater Mollusca favour situations where the geology is calcareous as they must have a source of absorbable carbonate in order to build their shells, while a high pH is required in any soil or sediment in order for any mollusc shell to be preserved in the archaeological record. In southern England calcareous geologies most obviously comprise the chalk of the Wessex, South and North Downs, and the oolitic limestones of the Cotswolds (Figure 1). 'Drift' deposits derived from these geologies, such as floodplain alluvium, fluvial sands and gravels, colluvium and solifluction are also calcareous and frequently contain well preserved mollusc assemblages. In addition, further mollusc-bearing calcareous deposits such as tufas (spring deposits), loess (dust blown from of the outwash of glaciers during Pleistocene cold stages) and dune sands can all form locally in areas that may not be characterised by calcareous hard rock geologies. Therefore it is of little surprise that a map of archaeological molluscan studies in southern England closely matches the distribution of chalk, limestone and calcareous drift lithologies (Figure 1). Conversely there are large parts of the Southern Region where molluscan studies have not been undertaken for the very good reason that mollusc shell does not survive in the archaeological record. Pre-eminent of these are the Weald and areas south west of a line drawn between the rivers Parrett and Exe (Bell *et al* 1984, 104).

As was suggested in the introduction the key developments in archaeological molluscan studies are intimately linked with prehistoric sites in Wessex. The grandfather of archaeological malacology in Britain is undoubtedly Alfred Santer Kennard (Evans 1972, 5-10). In the first half of the twentieth century Kennard published over 200 molluscan reports, mostly as appendices to accounts of excavations by eminent archaeologists such as Maud Cunnington (e.g. Kennard and

Woodward in Cunnington 1929; 1931), J.F.S. Stone (e.g. Kennard in Stone 1933; Stone and Hill 1938) and E.C. Curwen (Kennard and Woodward in Curwen 1929; Kennard in Curwen 1934) in Wiltshire, Hampshire and Sussex. Many aspects of Kennard's work would be looked on askance today; for example he rarely visited the sites he studied, he mostly examined hand picked specimens and he interpreted his data in relation to outdated ideas of climate change. A particularly well known example of the last is Kennard's interpretation of molluscs from the ditch at Stonehenge as representing a humid and warm phase of the present interglacial correlated with the Bronze Age (Cunnington 1933; Cunningham 1935). Despite these failings, Kennard nevertheless established the potential of preserved mollusc shells for providing palaeoenvironmental data for sites which were difficult to examine using palynology. Following Kennard's death in 1948 there was a two decade period during which very few archaeological mollusc studies were carried out. Indeed methodological and interpretative developments in the 1950 and 1960s were made by geologists working on Pleistocene sediment sequences. Key amongst these was B.W. Sparks who developed a quantitative method based on the collection of sequential samples from a sediment sequence, processing of the samples by wet sieving through fine meshes and the recovery of all shell above 0.5mm (Sparks 1961; 1964). As is outlined in the next section, Sparks' methodology is still the basis of that used in archaeological mollusc studies at the present day. Although Sparks focussed his attention on Pleistocene deposits in East Anglia, his successor, M.P. Kerney employed Sparks' newly developed techniques to investigate Devensian Late Glacial and early Holocene sequences in south-east England (e.g. Kerney 1963; Kerney *et al* 1964). Kerney's investigations were primarily biostratigraphic and undertaken with the joint intention of reconstructing environments for areas where pollen preservation was poor and determining the pattern of Holocene colonisation of Britain by terrestrial Mollusca. In respect of the latter, Kerney's work and that later carried out by Richard Preece saw the development of a ^{14}C calibrated mollusc zonation scheme for the Late Glacial and Holocene (Kerney 1977; Kerney *et al* 1980; Preece 1998). These developments were of indirect value to archaeologists: they supplied an environmental background and a relative dating method for the Late Upper Palaeolithic and Mesolithic periods, but they provided little useful information for later prehistorians or those working on the historic periods.

If A.S. Kennard is the grandfather of archaeological malacology, J.G. Evans is undoubtedly its father. During the 1960s Evans took the analytical techniques of Sparks, distilled them into an approach more useful in archaeology and applied them to a prehistoric monuments in Wessex (Evans 1967; 1968a; 1971b). From a modern perspective it is easy to underestimate the importance of Evans' findings. For example before Evans' work it was not known that early Neolithic long barrows were constructed in arable and pastoral landscapes, demonstrating a long antiquity of farming prior to monument construction (Evans 1971b; 1990). A key product of Evans' early work was his landmark *Land snails in archaeology* (1972), a text largely based on his examination of sites in Wessex, and until very recently the only book dedicated to archaeological malacology. Since 1972 analytical methods have barely changed, but rather focus has shifted to interpretative frameworks. In the 1980s and 1990s Evans developed an interpretative approach for *in situ* death assemblages using taxocenes, i.e. groups of snail species known to be characteristic of a particular environment type in the past (Evans 1991a; Evans *et al* 1992). Also during the 1980s and 1990s mollusc analyses were being applied by archaeologists to off-site situations such as dry valleys in order to reconstruct environments at wider spatial scales than was possible from ditch fills or buried soils from archaeological sites (e.g. Bell 1983; Allen 1988; 1991). These data confirmed theories originally suggested from the limited palynological evidence then available for South-east England, for example that major deforestation first occurred in the Bronze Age (e.g. Thorley 1981; Scaife 1982). The emphasis on the wider landscape outside site boundaries has continued since the 1990s and there have been several attempts to correlate multiple mollusc sequences in order to provide a narrative of environmental change over whole landscapes (e.g. Allen 1997; 2000; Wilkinson *et al* 2002; Allen 2005b). Nevertheless, in the second decade of the third millennium techniques and interpretative approaches at a site level remain as they were in the early 1990s. Mollusc studies are still an inherent component of any investigation of a prehistoric site on chalk or limestone in southern England, but are rare in other site circumstances.

3. METHODOLOGIES

As is the case for all other biological proxies of past environments, studies of land, freshwater and marine Mollusca carried out with palaeoenvironmental objectives are reliant on the uniformitarian principles summarised in James Hutton's classic phrase 'the present is the key to the past' (Hutton 1788). In the case of Mollusca, sub-fossil (mollusc shells preserved in the archaeological record undergo limited structural change and are therefore not true fossils) assemblages recovered from archaeological sites are interpreted by analogy with present ecological data in order to reconstruct past conditions. Although there are many problems with the strict application of such uniformitarian ideas (see discussions in Lowe and Walker 1997, 162-163; Bell and Walker 2004, 21-22, 50), the concept is implicit in all archaeological mollusc studies . Therefore in order to interpret sub-fossil mollusc shells from an archaeological site with any degree of accuracy it is necessary that:
a. the sub-fossil assemblage is a representative sample of the death assemblage, and;
b. that taphonomic processes operating on the sampled sequence are sufficiently well understood so as to enable the original living community to be reconstructed.
Sampling and processing methods, and interpretative frameworks developed since the 1960s have been designed to enable these criteria to be met (Figure 2).

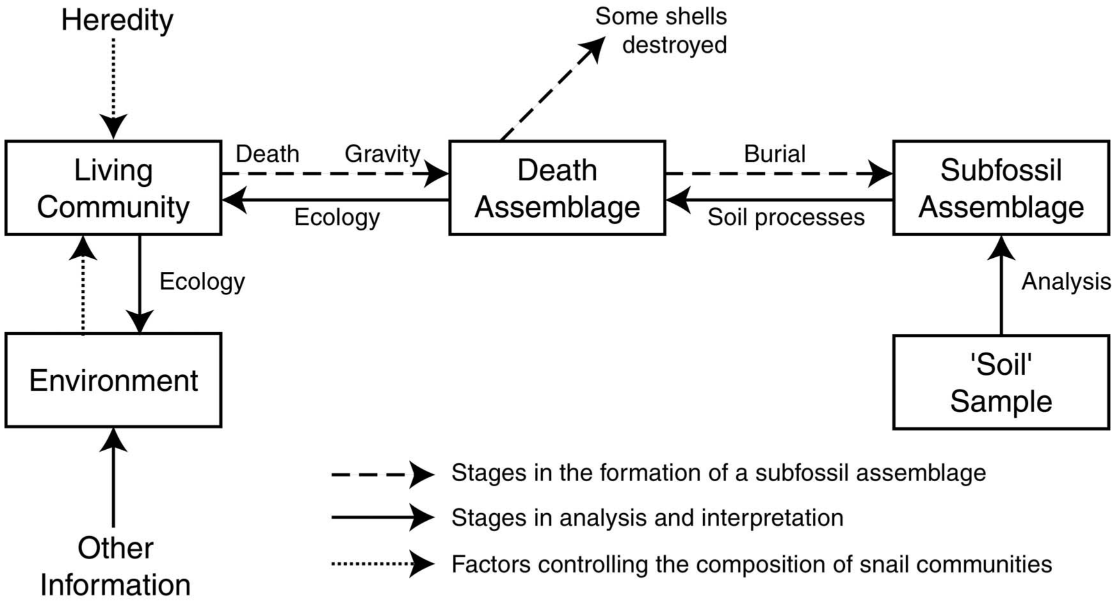

Figure 2.: The relationship between sub-fossil and death assemblages, and living communities.(modified after Evans 1972, figure 6,20)

Most studies undertaken of land and freshwater Mollusca from Upper Palaeolithic and later archaeological sites or off-site locations in southern England have employed the sampling and sample processing techniques advocated by Evans (1972, 41-47), or derivatives (e.g. Wilkinson and Stevens 2003, 117-119; Davies 2008, 3-7). Evans recommended taking continuous blocks of sediment/soil from a cleaned vertical section exposed through the feature/sequence to be sampled. Individual sample thickness would depend on inferred sedimentation rates, i.e. thicker samples (e.g. 100mm) where deposition is thought to be rapid and thinner samples (50-10mm) where accretion is slow. Samples so-taken are usually collected to a constant mass of 1kg (Evans 1972, 41), although a volumetric approach to sampling has been recommended by some authors (Carter 1990b; Wilkinson and Stevens 2003, 119). In the laboratory, individual mollusc samples are air dried, broken down in a mixture of hot water and hydrogen peroxide and wet sieved through a 0.5mm mesh. Shell apices (for gastropods), hinge fragments (for bivalves) and other readily identifiable components (e.g. aperture fragments for the genus *Vertigo*) are picked from the dried residue, identified using a modern comparative reference collection and standard reference works such as Ellis (1978), Evans (1972, 47-79), Kerney (1999), Kerney and Cameron (1979) and Macan (1969) and then quantified on the basis of apical and hinge counts. Presenting quantified mollusc data as histograms with rows representing individual samples and columns being used for species was an approach that Sparks (1961; 1964) took from palynology (e.g. see Figure 6). Since the 1970s the histogram has become the ubiquitous means of representing archaeological mollusc data except where shell numbers are very small. Sparks (1961; 1964) argued that relative data should be used in histogram production, but from the publication of Evans' *Land snails in archaeology* onwards, the dangers of complete reliance on percentage histograms has been realised (Evans 1972, 79-80; Thomas 1985; Davies 2008, 8-9). Interpretation of histograms is usually carried out by a process of manual zonation based on faunal changes that occur through the sequence. Unlike palynology statistical methods of zonation have rarely been employed (Davies 2008, 9-11). Interpretation of the zoned diagram is considered via community ecology (the assumption being made that the sub-fossil assemblage in each sample is in some way representative of a living community), the ecological tolerances of stenotopic species and taxocenes (Wilkinson and Stevens 2003, 121-126; Davies 2008, 51-66). The last, a concept introduced by Evans (1991a; Evans *et al* 1992), is at present uniquely used in archaeological malacology. It has been applied to autochthonous assemblages, such as those found in palaeosols or sequences of overbank alluvium, and makes use of the observation that characteristic sub-fossil groups of molluscan taxa in the past and at present occupied distinct microenvironments. Fauna characteristic of the same microenvironment might change over time as a result of competition processes consequent on species colonisation.

Sampling and processing methods have varied from those outlined above for some molluscan studies carried out as part of commercial archaeological projects from the 1990s onwards. In several such projects dedicated mollusc samples were not taken, but rather mollusc shells were extracted from dried residues following wet sieving and/or flotation programmes designed for the recovery of multiple classes of biological remains [i.e. so-called 'General Biological Analysis' (GBA) samples of Dobney *et al*. (1992)]. Examples of such studies include analyses on the Dover Bronze Age boat (Keeley *et al* 2004), Winchester Palace, London (Seeley *et al* 2006, 95) and the Shapwick House moat, Somerset (Gerrard and Aston 2007, 852-868). GBA samples are often taken on a spatial as well as stratigraphic basis and therefore it is rare that such samples derive from a continuous sediment succession. Similar sampling and extraction techniques to those used on large commercial sites have also been employed at the Lower Palaeolithic site of Boxgrove as an addition to the use of the 'standard' methodology discussed above (Preece and Bates 1999). The reason in this latter case was that an extensive wet sieving programme using a 0.5mm mesh was employed for the recovery of vertebrate bones – the retention of mollusc shells being a beneficial bi-product (Parfitt 1999).

With the exception of shell middens, sampling for molluscs on Palaeolithic and Mesolithic sites has by necessity focussed either on sedimentary layers accreting by entirely 'natural' processes (e.g. by fluvial, colluvial, periglacial or aeolian processes or carbonate reprecipitation) or from palaeosols developed in such parent materials. However, given that Neolithic and later sites frequently comprise preserved archaeological structures, sampling of these has rather been concentrated on palaeosols buried beneath banks or other constructions and the fills of ditches (Evans 1972, 31-35; Davies 2008, 67-69). Mollusc assemblages recovered from palaeosols buried beneath archaeological features have been used to provide reconstructions of environments prior to monument construction. Indeed Evans' (1971b, 1972 67, 242-279) work in the 1960s on Neolithic environments on the Wessex Downs is dominated by such analyses. These studies frequently show woodland mollusc assemblages changing to those indicative of pasture or arable some time before monument construction. However, by examining the taphonomy of shells in modern chalk grassland with known ecological histories, Carter (1990b) has pointed out that true shell stratification is only found at the top of the soil profile. Elsewhere mixing by roots, earthworms, ants and other fauna, acts to homogenise the sub-fossil assemblage and remove any time-depth relationship. Nevertheless Davies (2008, 67-68) has noted that faunal change can be seen in many of Evans' mollusc histograms from palaeosols implying that it is possible to obtain environmental change histories in such settings, albeit that resolution might be crude.

Mollusc analysis of samples taken from ditch fills has frequently been employed to obtain information on post-monument construction environments (Evans 1972, 33-35, 321-328; Davies 2008, 68-69). Such analyses rely on ditches beginning to infill with sediment soon after a monument is constructed and thereafter for deposition to outstrip pedogenesis so as to avoid the taphonomic problems of palaeosols noted by Carter (1990b). These assumptions are supported by the data from the well known Experimental Earthwork Project at Overton Down, Wiltshire (Bell *et al* 1996), as well as many archaeological studies (e.g. Bell 1990b; Evans 1990). Evans (1972, 322-328) and Limbrey (1975, 290-300) have divided ditch sediments in primary fills accumulating from erosion of the ditch sides and contemporary soils; secondary fills forming from fine debris weathered from the ditch sides together with allochthonous aeolian and colluvial sediment, and tertiary fills resulting from plough-derived material or deliberate backfill. Evans' (1972, 323) and Thomas (1982) have argued that because shells in the primary fill are mainly derived from turves at the surface of the soil through which the ditch was cut, mollusc assemblages from such fills are indicative of the environment in which a monument was built. Secondary fills are thought to begin accumulating soon after the ditch was dug and continue to form – assuming the ditch is neither cleaned nor recut – until an equilibrium is reached and soil formation occurs (Evans 1972, 324-325). The interpretation of sub-fossil mollusc shells from secondary fills of ditches is not always a straightforward task given that such assemblages frequently contain an authochthonous shade-loving component making use of the damp, dark microenvironment of the ditch and an allochthonous part derived from the ditch-side soil (Wilkinson and Stevens 2003, 123). One approach that has been employed to minimise such problems and to identify the two components contributing to the assemblage is the combined use of percentage and absolute histograms to plot molluscan data (Evans and Jones 1979; Thomas 1985; Wilkinson in Russell 2002; Wilkinson and Stevens 2003, 123-124). Tertiary fills have a lesser value for molluscan analysis given that they form as a result of a single or short series of rapid depositional episodes and from sediment/soil derived from an unknown catchment.

There is no standard methodology for sampling shell midden sites. This is perhaps of no great surprise given the additive nature of shell midden accretion and the resultant complexity of shell midden stratigraphy. Indeed only one shell midden: Culverwell, Isle of Portland, Dorset, has been *systematically* sampled in the Southern region (Thomas and Mannino 1999). Thomas and Mannino (1999) employed a variation of the approach discussed above for land snails to sample the site, taking four columns of samples, with each of the latter measuring 200x200x50mm. The samples were air dried in the laboratory and a system of bucket flotation employed to extract a flot and residue of >0.5 and 2mm respectively. Both flot and residue were sorted by eye and with the aid of a low power binocular microscope and identifications made. Minimum number of individual (MNI) counts were made on the same basis as has been discussed for terrestrial Molluscs above.

4. RESOURCE ASSESSMENT

4.1 Lower and Middle Palaeolithic

Palaeolithic sites in England are of two broad types: firstly artefacts reworked from their original point of discard as a result of fluvial, periglacial and occasionally marine processes (secondary contexts), and secondly artefact scatters preserved in the positions where they were used or made as a result of rapid burial (primary contexts) (Wilkinson 2001). The first category overwhelmingly dominates the Lower and Middle Palaeolithic record of southern England, particularly in the form of artefacts transported by fluvial processes, incorporated in bedload gravel and then preserved within river terraces (Wymer 1999, 21-22). Occasionally artefacts from such secondary contexts are associated with deposits containing mollusc shells, particularly in the Thames and southern Severn basins where deposits tend to be calcareous. However, in the other major river basin of southern England, the Solent, Pleistocene gravel strata are usually decalcified, and therefore mollusc shell preservation is rare (Bridgland 2000). Even where mollusc shells are found, the temporal dislocation between artefact discard and its incorporation in a river bed means that there is no direct relationship between hominin use of the artefact and the environment represented by the mollusc assemblage. Nevertheless molluscs from fluvial deposits associated with secondary context Palaeolithic artefacts have provided much useful evidence regarding the environment and chronology of the British Middle and Upper Pleistocene. A good example is the buried channel formerly exposed in a brick pit at Wolvercote, Oxfordshire (summarised in Bridgland 1994, 58-65). The site was investigated in the 1930s and earlier, but is now an ornamental pond. Attempts in the 1980s to find new exposures through the channel proved fruitless (Bridgland and Harding 1986). The basal deposits of the channel contain the largest Palaeolithic assemblage in the Upper Thames basin, including distinctive pointed handaxes, which are thought by Roe (1981, 118-130) to be of Middle Palaeolithic (last interglacial-glacial cycle – Marine Isotope Stages [MIS] 5e-2) date. However, Bridgland (1994, 63-64) suggests that the Wolvercote channel dates to MIS 9 on the basis of terrace stratigraphy and vertebrate biostratigraphy. Mollusc shells were recovered from gravels of presumed MIS 10 age in which the channel had been cut (Bishop 1958) and from sand and gravel layers above the artefacts (Kennard and Woodward in Sandford 1924). Both assemblages were dominated by *Trichia hispida*, although the assemblages from the channel suggested more temperate climates during deposition of sediments above the artefact-bearing layers (Gilbertson 1976).

There are relatively few Lower and Middle Palaeolithic sites in the Southern Region where artefacts have been preserved *in situ* and even fewer where mollusc shells survive in quantities suitable for analysis. Even on the few sites that meet these criteria there are no archaeological 'features' (ditches, pits and such like), so mollusc shells have been recovered from deposits *associated* with hominin activity. Boxgrove is a prime example of a site with well preserved *in situ* evidence of handaxe production. This activity took place in the lea of a chalk sea cliff, while there is associated evidence of animal butchery (horse and rhinoceros) on a plain to the seaward side of the cliff (Roberts 1986; Roberts and Parfitt 1999). Indeed the site is best known as the find spot of Britain's earliest (MIS 13) inhabitants, in the form of a tibia and teeth of *Homo heidelbergensis* (Stringer *et al* 1998; Stringer 1999). Mollusc shells were obtained both from samples taken specifically for that purpose and from GBA-type samples taken to extract vertebrate remains (Bates in Roberts 1986; Preece and Bates 1999). Samples were taken of the palaeosol (Unit 4c) in which a significant proportion of the archaeological remains were found, and overlying silts and clays. Indeed Boxgrove is the only Middle Pleistocene site in Britain where truly terrestrial conditions have been sampled (Preece and Bates 1999). Although shell preservation was poor the mollusc fauna suggests that hominin activity took place on a surface comprising freshwater pools (*Anisus leucostoma*, *Lymnaea peregra*, *Pisidium* sp), surrounded by bare muddy surfaces (*Lymnaea truncatula* and Succinidae representing wetter mud facies, and *Pupilla muscorum* and *Vallonia* sp. drier areas). Away from the pools, environments would have been vegetated, perhaps comprising mossy hollows and a thick leaf litter (*Aegopinella* sp., Clausiliidae, *Acanthinula aculeata* and *Spermodea lamellata*). The value of taking spatially diverse samples from a single stratigraphic unit is highlighted by the heterogeneous nature of the fauna across the palaeosol and its representation of minor variations in local environment (Preece and Bates 1999). Marine silts, sands and chalk blocks deposited by cliff collapse underlie the main archaeological levels at Boxgrove. Marine Mollusca in the silts of Unit 4b are mostly well preserved, often articulated valves of *Mytilis edulis* and *Modiolus modiolus*, suggesting that mussel beds existed nearby. Many examples of *Neptuna* cf. *conmaria* and *Nucella lapilis* (both whelks) were also found in the silts below the palaeosol in distinct groups and mixed with discrete clusters of well rounded flints. *Modiolus modiolus* has a present day distribution on the Atlantic coast of Iberia, and may suggest rather different sea conditions to the present day, albeit that the taphonomy of the whelk clusters is not fully understood (Preece and Bates 1999). Cliff collapse deposits interbedded with the marine sands contained rather fewer molluscan remains and these are dominated by species characteristic of rocky shores (*Littorina* sp. and *N. lapilis*) (Preece and Bates 1999).

Swanscombe in Kent is, like Boxgrove one of the best known Palaeolithic localities in Britain and is now generally accepted as being of MIS 11 age (Hoxnian *sensu* Swanscombe) (Bowen *et al* 1989; Bridgland 1994, 213-214). Its fame is partly the result of three conjoining fragments of hominin crania being found in one of the gravel pits (Barnfield Pit) that make up the site in 1935, 1936 and 1955, but also because of the presence of stratified and often *in situ* Clactonian and Acheulian artefact assemblages (Bridgland 1994, 193-194). The Swanscombe sequence comprises three fluvial cycles, in each of which gravel deposition preceded accretion of fine-grained channel fills or floodplain alluvium (Figure 3). Molluscan remains have been recovered from the Lower Gravels in association with reworked artefacts; the Lower Loam alongside *in situ* knapping waste, vertebrate footprints and a 'midden'; the Lower/Upper Middle Gravels. The latter contains secondary artefacts and was the stratum from which the hominin skull fragments were recovered (Preece 1995). As discussed previously, shells in the Lower and Middle Gravels have no precise chronological relationship with the artefacts found in the same strata. Kerney's (1971) analysis of the Lower Gravel and Lower Loam suggested that as the stratigraphy changed, the environment also altered from a swift flowing stream - characterised by the limpet *Ancylus fluviatilis* - and reed swamp to rather drier conditions in the Lower Loam. Terrestrial species probably became incorporated in the stream channel as banks collapsed, but are more likely to have lived *in situ* on terrestrial surfaces represented in some parts of the Lower Loam. It seems likely that woodland environments surrounded the river, while the present southern distribution of certain taxa (e.g. *Lauria cylindracea*, *Pomatias elegans*, *Vertigo pusilla*, *Vertigo angustior*, *Ena montana* and *Discus rotundatus*) suggests a fully temperate climate. Indeed still more temperate conditions are indicated at the very top of the Lower Loam by the presence of taxa that presently have a central and southern European distribution, and are not known from the British Holocene (e.g. *Acicula polita*, *Belgrandia marginata* and *Corbicula fluminalis*) (Kerney 1971). The mollusc fauna of the Lower and Upper Middle Gravels is more heavily dominated by freshwater taxa than that of the Lower Gravel and Lower Loam, while there also seems to be a trend from the Lower to Upper Middle Gravels for cooler climates and more open landscapes. However, the Middle Gravel mollusc fauna is best known for its 'Rhenish' elements, i.e. freshwater taxa that are today characteristic of central Europe (e.g. *Theodoxus serratiliniformis*, *Viviparus diluvianus*, *Valvata naticina* and *Pisidium clessini*) (Preece 1995). Kennard (1938) has suggested that the Rhenish suite was the result of the linkage of the Thames and Rhine systems and was established following deposition of the Lower Loam.

The Red Barns site in Hampshire is likely to date from either the same isotope stage as Swanscombe (MIS 11) or MIS 9 (Hoxnian *sensu* Hoxne) (Wenban-Smith *et al* 2000). The site was excavated by Arthur ApSimon and Clive Gamble in advance of a housing development in the 1970s. It consisted of a dense collection of debitage and flakes associated with handaxe manufacture. Most artefacts were recovered from a basal chalk-rich 'loam', which was overlain by first a cemented chalk breccia crust and then loessic deposits. Several small (2-3kg) samples were collected for bioarchaeological examination during the course of the excavation and were then processed during an English Heritage-funded post-excavation programme in the 1990s (Wenban-Smith *et al* 2000). The mollusc fauna associated with the basal archaeological levels was dominated by *Vallonia costata*, *Pupilla muscorum* and *Trichia hispida*, while *Truncatellina cylindrica* was also found in small quantities (Preece in Wenban-Smith *et al* 2000). Assemblages of this type are well known from short-turfed grasslands of the Wessex Downs at the present day, but are also characteristic of Late Pleistocene tundra environments (Kerney 1963; Evans 1968b). However, *Pomatias elegans* and members of the Clausiliidae were also noted in the Red Barns samples, suggesting that the represented environment was indeed temperate grassland.

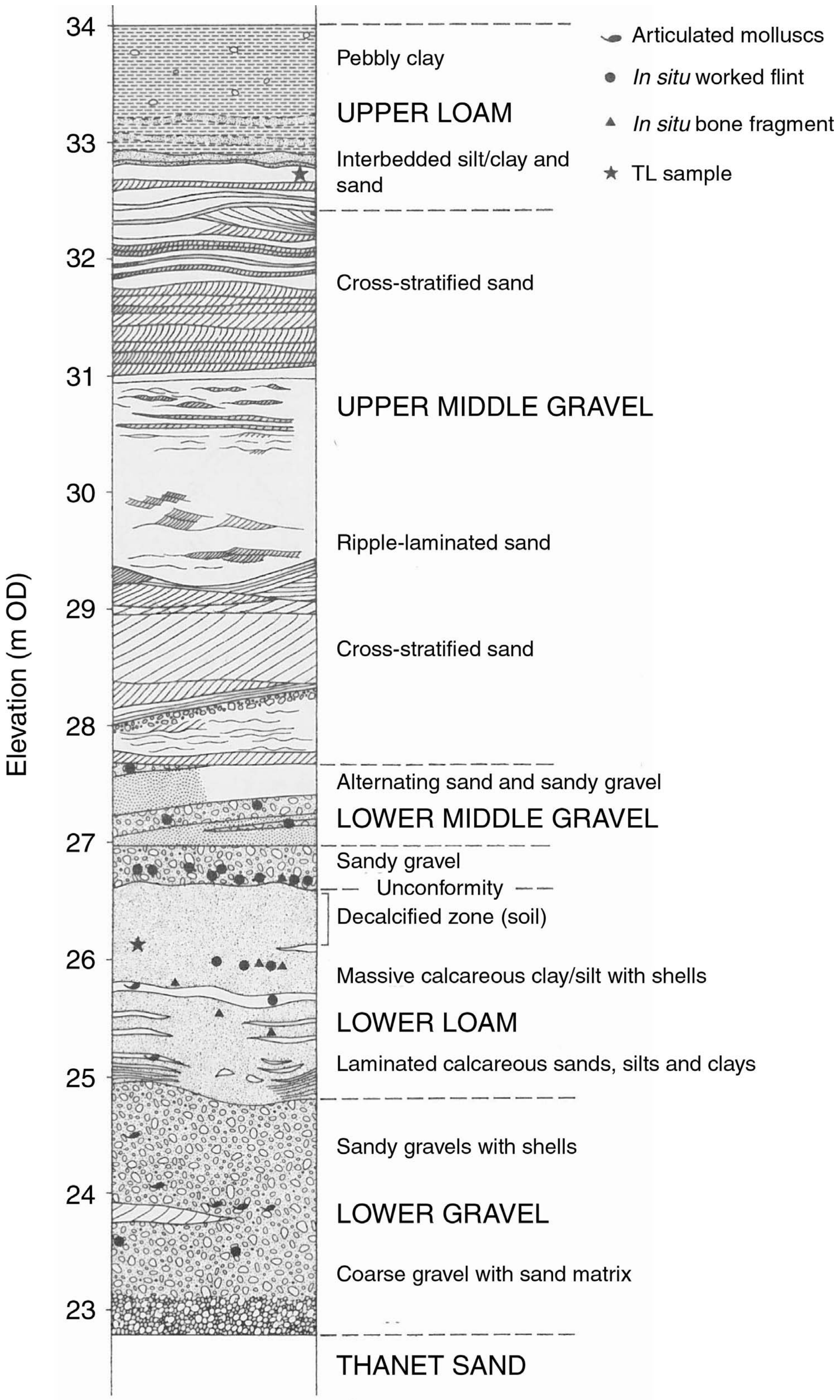

Figure 3: Schematic representation of the Swanscombe sequence showing the location of artefacts and layers rich in molluscs (modified from Ashton et al 1995, figure 25, 132)

Baker's Hole (Northfleet) is a further Palaeolithic site in the Thames basin where examination of mollusc shell – albeit mostly hand collected - has aided in the interpretation of Lower/Middle Palaeolithic artefact scatters (Bridgland 1994, 262-274). Baker's Hole is Britain's richest Levallois site and the artefacts were found during chalk extraction works from the end of the nineteenth century onwards - although the only formal archaeological investigation was by the British Museum in 1969 (Kerney and Sieveking 1977). The Levallois artefacts were mostly recovered from within coombe rock (solifluction debris) that overlies the basal chalk. Although shells have not been found in the coombe rock, an assemblage dominated by *Pupilla muscorum* and *Vallonia costata* was recovered from overlying fluvially reworked loess. These same deposits also contained a reworked Middle/Lower Palaeolithic artefact assemblage. However, a palaeosol developed within the loess also indicates stability at the end of this depositional stage. There is then a break in the depositional sequence, which is followed by the deposition of an alluvial silt. The latter contained a rich temperate freshwater and terrestrial mollusc assemblage, possibly including a MIS 7 zone fossil, *Corbicula fluminalis* (see below) (Burchell 1957). Finally the sequence is capped by loess (possibly colluvially reworked) containing a mollusc assemblage dominated by *Pupilla muscorum*, but devoid of artefacts. Mineralogical data suggest that the loess predates MIS 2-5d, and that it most closely resembles pre-Eemian loess (MIS 6) found in Belgium (Bridgland 1994, 273).

Other than purely palaeoenvironmental applications, Quaternary geologists have also used Mollusca to investigate the chronology of Middle and Upper Pleistocene sites. David Keen (1990; 2001) developed a biostratigraphic scheme using both marker species and biozone approaches, and which enables temperate marine isotope stages of the later Middle and Upper Pleistocene to be distinguished from one another. Keen (2001) states that only Mollusca from fluvial deposits and from the climatic optimum of the middle of an interglacial can be used in biozoning. He has argued that channel processes bring together mollusc shells from all depositional sub-environments in the river and that these are the only contexts that are directly comparable over long time scales, Middle Pleistocene terrestrial sequences containing Mollusca being extremely rare. Keen's (2001) zonation scheme is based mostly on species that are no longer found in the United Kingdom, but it is also reliant on absences (e.g. of *Corbicula fluminalis* in MIS 5e deposits and *Belgrandia marginata* from MIS 7 sediments)(Table 1). MIS 11 assemblages are perhaps the easiest to differentiate because of the presence of the Rhenish fauna (as discussed under Swanscombe above) (Keen 2001).

Table 1: A molluscan biostratigraphy of the late Middle and early Upper Pleistocene (after Keen 2001, table 1, 1663)

Age (Ka)	Stage/Substage	Fluvial index species	Terrestrial index species
130-115	MIS 5e (Ipswichian)	*Belgrandia marginata*	*Bradybaena fruticum*
240-180	MIS 7	*Corbicula fluminalis* *Pisidium clessini*	
340-300	MIS 9 (Hoxnian *sensu* Hoxne)	*Corbicula fluminalis* *Belgrandia marginata* *Pisidium clessini* *Unio crassus*	
430-350	MIS 11 (Hoxnian *sensu* Swanscombe)	Rhenish fauna *Corbicula fluminalis* *Belgrandia marginata* *Theodoxus danubialis* *Unio crassus* *Valvata naticina*	*Retinella skertchlyi* *Ruthenica filograna* *Laminifera pauli* *Platyla polita*

Amino acid epimerisation of mollusc shell is another important relative dating technique that has been applied to Pleistocene sequences in the Southern Region. The technique is based on the time dependent change of proteins in a mollusc shell following the death of an organism (L-isomer in living organisms to D-isomer in fossil material) (Bowen *et al* 1985). Using this approach D.Q. Bowen and colleagues have developed a regional chronology for central and southern Britain using D/L ratio measurements made on both marine and non-marine Mollusca (Figure 4) (Bowen *et al* 1989). Key Palaeolithic archaeological sites which have been studied include most of those reviewed above. Boxgrove is dated by amino acid epimerisation to 11 (or possibly 9), in contrast to the preferred mammalian biostratigraphy derived age of MIS 13 (Bowen *et et al* 1989; Bowen and Sykes 1999), Swanscombe is dated to MIS 11 (Bowen *et al* 1989; Bowen *et al* 1995), Red Barns to MIS 7-11 (but probably MIS 9) (Bates in Wenban-Smith *et al* 2000) and the alluvial silts at Baker's Hole to MIS 7 (Bridgland 1994, 274) (Table 2). Since its establishment in 1989 the scheme has helped in the correlation of newly found archaeological sites such as Harnham with the marine oxygen isotope record (Bates 2008).

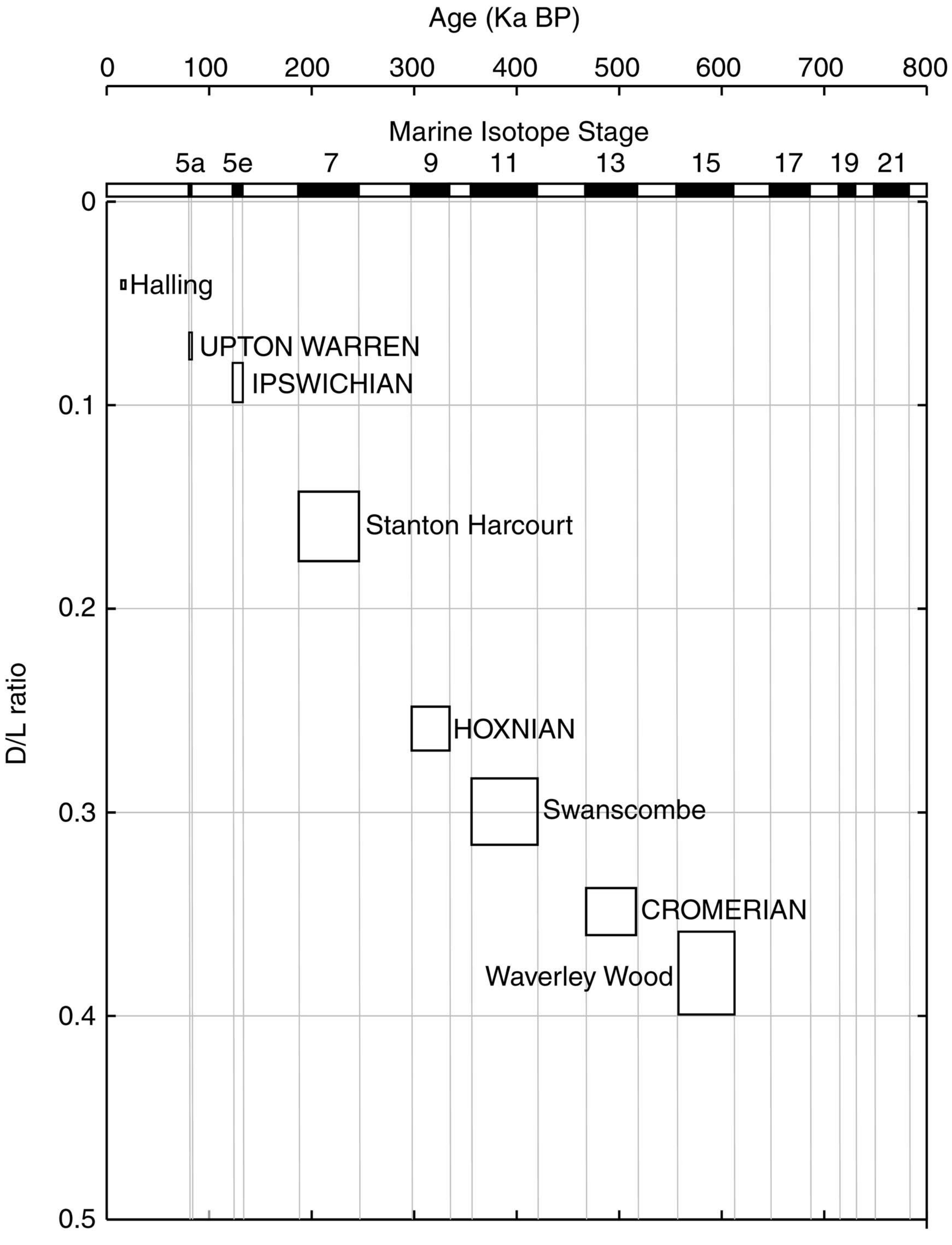

Figure 4: Correlation of D-isomer/L-isomer ratios of non-marine Mollusca from central and southern England (modified from Bowen et al 1989, figure 1, 49). The vertical extent of each rectangle represents one standard deviation of the relevant D/L ratio.

Table 2: Amino acid data obtained on non-marine Mollusca for Pleistocene sites in Southern England and northern France (after Bates in Wenban-Smith et al 2000, table 8, 223)

Site	Unit	Species	Mean D/L value	Standard deviation	Lab. No.
Portfield Pit	Fan gravels	*Trichia hispida*	0.027	0.041	LOND 50
Sussex Pad	Brickearth	*Pupilla muscorum*	0.109	0.013	LOND 340
Red Barns	Red loam	*Pupilla muscorum*	0.040	0.007	BAL 3465
	Grey loam	*Arianta arbustorum*	0.187	0.015	BAL 3466
	Grey loam	*Pupilla muscorum*	0.0143	0.023	BAL 3468
	Grey loam	*Trichia hispida*	0.226	0.026	BAL 3467
Halling	Layer G	*Trichia hispida*	0.036	0.001	
Ebbsfleet	Silts	*Trichia hispida*	0.070	0.015	BAL 3355
	Sands	*Cepaea* sp.	0.106	0.022	BAL 3358
Trafalgar Square	Grey brickearth	*Trichia hispida*	0.113	0.005	
	Grey brickearth	*Cepaea* sp.	0.094	0.005	
Woodston	Basal bed	*Trichia hispida*	0.236	0.027	
	Basal bed	*Cepaea* sp.	0.253	0.017	
Bushley Green	Basal bed	*Trichia hispida*	0.235	0.010	
Etouvie	Loess	*Pupilla muscorum*	0.043		LOND 290
Longpré les corps Saints	Unit 5	*Trichia hispida*	0.127	0.003	LOND 278
	Unit 5	*Cepaea* sp.	0.128	0.018	LOND 15/119
Biache Saint Vaast	Unit O	*Trichia hispida*	0.194	0.007	LOND 280
	Unit C	*Pupilla muscorum*	0.134	0.004	LOND 130
	Unit C	*Cepaea* sp.	0.183	0.024	LOND 285
Cagny l'Epinette	Unit I	*Trichia hispida*	0.202	0.020	LOND 46/282
	Unit I	*Pupilla muscorum*	0.168	0.021	LOND 152
Cagny la Garenne	Fluvial sands	*Trichia hispida*	0.228	0.007	LOND 40/55
	Fluvial sands	*Pupilla muscorum*	0.202	0.018	LOND 106/124

Research agenda

Relatively few *in situ* Lower and Middle Palaeolithic sites have been found in the Southern region. Those that have been investigated have all been sampled for Mollusca, albeit that in studies undertaken in the 1970s and earlier, sample sizes were small. Shells recovered from most *in situ* sites have been used for amino acid epimerisation dating and useful chronologies have been obtained.

- Systematic sampling for Mollusca should be an integral part of the investigations of all Lower and Middle Palaeolithic sites on calcareous geologies in the future, just as it has been in the recent past. Particular consideration should be paid to the volume of sediment that might need to be processed in order to retrieve a statistically valid assemblage of shells.

- Samples of taxa such as *Valvata piscinalis*, *Bithynia tentaculata*, *Lymnaea* sp., *Trichia hispida*, *Cepaea nemoralis* and *Corbicula fluminalis* need, as a matter of routine to be submitted for amino acid epimerisation measurement. Only by adding to the epimerisation database can more reliable chronologies be produced for any given region, while an improved database may also help improve chronological resolution.

- It is important also that the number of specialists working on Middle and early Upper Pleistocene molluscan assemblages is increased. Only one practitioner (Richard Preece) is currently working in the field following the death of David Keen in 2006.

4.2 Upper Palaeolithic and Mesolithic

Upper Palaeolithic sites in the Southern Region comprise either caves or open air scatters of stone tools/debitage. Molluscs have been examined from apparently Upper Pleistocene strata within Sun Hole cave, Cheddar Gorge where Late Upper Palaeolithic Cresswellian artefacts have also been found (Ellis 1983). However, molluscs found in caves are usually taking advantage of the dark, damp micro environments of the cave recess or are secondary colonists of rock rubble habitats and therefore indicate little of the exterior environment (Evans 1972, 308-311; Evans and Jones 1973). Upper Palaeolithic open air sites artefact scatters in Southern England are rarely associated with stratigraphic sequences of sufficient thickness for meaningful mollusc analyses to be undertaken, while many such scatters are located on non-calcareous lithologies where shell preservation is poor. In short, there are no significant published mollusc analyses from Upper Palaeolithic sites in Southern England. However, this is not to say that there are not important molluscan studies of stratigraphy of Upper Palaeolithic date from the area. For example shell-bearing sequences of Late Glacial calcareous loess have been studied in coastal areas of eastern Kent (Kerney 1965; Preece 1990). These assemblages are thought to date between the end of the Late Glacial Maximum at 23,000 BP and the Late Glacial interstadial at 14,000 BP (Wintle 1981; Parks and Rendell 1988). They are comprised of an extremely restricted range of species dominated by a tall, parallel-sided form of *Pupilla muscorum* that is characteristic of periglacial environments (Kerney 1963), Succineidae and rarer examples of *Columella columella* and *Trichia hispida* (Preece 1990). Of greater archaeological significance are later sites containing fine-grained, calcareous solifluction sequences and dating from approximately 14,000-11,500 cal. BP. These include Halling, Brook and Holywell Coombe in Kent; Oxted in Surrey; Beachy Head, Sussex and Ventnor, Isle of Wight and were investigated in detail in the 1960-1990s by Michael Kerney and Richard Preece (Kerney 1963; Kerney *et al* 1964; Kerney *et al* 1980; Preece *et al* 1995; Preece and Bridgland 1998). Based on the examination of shells recovered from samples from many of these sites, Kerney proposed a zonation scheme for the recolonisation of Southern England by land snails following the Late Glacial Maximum (Table 3) (Kerney 1977; Kerney *et al* 1980). Preece's (1998) work on a huge number of samples from Holywell Coombe has improved both the biostratigraphy and chronology of Kerney's (1977) original model. A restricted fauna of 17 species, dominated by the large form of *Pupilla muscorum* noted above, as well as *Vallonia pulchella* and *Vallonia costata* characterise the earliest part of the Late Glacial interstadial between c. 14.500 and 13,500 cal. BP (mollusc zone z) (Preece 1998). The 'Allerød soil', which developed later in the interstadial around 13,500 cal. BP and which continued to form into the earliest part of the Holocene contained a wider range of species including both the thermophilous taxon *Helicella itala* and arctic-alpine species such as *Columella columella* (mollusc zone y) (Preece 1998). Zone y assemblages have also been recovered from solifluction marls below colluvial dry valley deposits in East Sussex at Asham Quarry (Ellis 1985; 1986) and Toadeshole Bottom East (Wilkinson 1993; Wilkinson *et al* 2002; Wilkinson 2003). In both these cases the Late Glacial assemblages were 'contaminated' with Middle Holocene shade loving taxa that had been introduced from overlying palaeosols by bioturbation. A further Devensian Late Glacial sequence of a rather different kind was found during the archaeological excavation of a Bronze Age trackway at Bramcote Green, Bermondsey, London (Thomas and Rackham 1996). Here mollusc shells recovered from calcareous marls deposited during the Late Glacial interstadial and the Late Glacial stadial formed in a lacustrine environment. Prior to 13,080-12,850 cal. BP (11,020±60 BP, Beta 70409) *Planorbis planorbis* and *Armiger crista* dominate the assemblage alongside *Bithynia tentaculata* and *Valvata piscinalis*, suggesting that the lake was shallow and inhabited by dense aquatic vegetation (Thomas and Rackham 1996). However, the Planorbidae had declined by the Late Glacial stadial, and *Bithynia tentaculata* and *Valvata piscinalis* increased in quantity, suggesting less vegetated waters during this cold episode.

The solifluction sequences studied by Kerney and Preece in Kent were overlain by tufas during the first half of Holocene. Shells recovered from these spring deposits and overlying colluvium, were used to continue the previously discussed mollusc zonation scheme for the entire Holocene (Table 3) (Kerney 1977; Kerney *et al* 1980; Preece 1998). Mollusc zones a-d cover the Mesolithic period. They encompass the colonisation of Southern England by a succession of shade loving species which appear in the wake of the inward migration by deciduous trees. Initial colonisation was of species that are tolerant of cold climates, such as *Carychium tridentatum*, *Aegopinella* sp. and *Vitrea* sp., while the alpine species *Discus ruderatus* is found only in deposits dating from 9000-8000 cal. BC (mollusc zone b). The appearance of thermophilous, woodland dwelling species such as *Oxychilus cellarius*, *Spermodea lamellata*, *Acicula fusca* and *Leiostyla anglica* around 6500 cal. BC (mollusc zone d) characterise the Mid-Holocene 'wildwood' that covered most of Southern England. Early-Middle Holocene tufas are not just characteristic of Kent, but are found across many areas of Southern England where springs emerge from calcareous geologies. Mollusc faunas from the tufas are the most diverse of any from the Holocene in Southern England. Shells obtained from sampling such sequences have been studied at several sites including Brook, Wateringbury (Kerney *et al* 1964; Kerney *et al* 1980) and Holywell Coombe, Kent (Preece 1998); Totland, Isle of Wight (Preece 1979); Cherhill, Wiltshire (Evans and Smith 1983); Blashenwell, Dorset (Preece 1980b); Sidling's Copse, Oxfordshire (Preece and Day 1994); Bossington, Hampshire (Davies and Griffiths 2005); Langley's Lane, Somerset (Davies and Lewis 2005; Davies 2008, 97-98), as well as various sites in the Cotswolds and Mendips (Willing 1985). Although only the tufas from Cherhill, Bossington (both of which seal palaeosols containing artefacts), Blashenwell and Langley's Lane are associated with archaeological sites, changes in composition of the tufa faunas, e.g. the expansion of *Vallonia costata* and the contraction of *Discus rotundatus*, from most of these sites may be the result of Mesolithic woodland disturbance (Davies 2008 96-98). Indeed it has been suggested that Mesolithic activity was specifically focussed on tufa depositing contexts, either to take advantage of such an obvious ecotonal environment (Evans and Smith 1983; Evans 2003), or because the combination of clear water and white precipitate had great symbolic importance (Davies and Robb 2002).

Table 3: Kerney's (1977) mollusc zones for Southern England as revised by Preece (1998).

Zone	Age from	Age to	**Dominant** and characteristic species
y	14,780-12,320 cal. BC (13,160±400 BP, OxA 1751)	before 11,780-11,160 cal. BC (11,530±160 BP, OxA 2345)	***Pupilla muscorum* (large form), *Vallonia pulchella*, *Vallonia costata*, *Vitrina pellucida***, *Catinella arenaria*, *Vertigo genesii*, *Cochlicopa nitens*.
z	before 11,780-11,160 cal. BC (11,530±160 BP, OxA 2345)	9670-8910 cal. BC (9820±90 BP, OxA 2346)	***Pupilla muscorum* (large form), *Vallonia pulchella*, *Vallonia costata*,** *Abida secale*, *Trichia hispida*, *Helicella itala*, *Columella columella*, *Nesovitrea hammonis*, *Arianta arbustorum*.
a	9460-8790 cal. BC (9760±100 BP, Q 2721)	before 9240-8350 cal. BC (9460±140 BP, OxA 2088)	***Carychium tridentatum*, *Vitrea* sp., *Aegopinella* sp.**, *Vallonia* sp., *Pupilla muscorum* (small form).
b	before 9240-8350 cal. BC (9460±140 BP, OxA 2088)	8200-7480 cal. BC (8630±120 BP, OxA 2157)	***Carychium tridentatum*, *Aegopinella* sp.**, *Discus ruderatus*.
c	8200-7480 cal. BC (8630±120 BP, OxA 2157)	before 6650-6380 cal. BC (7650±80 BP, Q 2716)	***Carychium tridentatum*, *Aegopinella* sp.**, *Discus rotundatus*.
d	6650-6380 cal. BC (7650±80 BP, Q 2716)	before 4690-4330 cal. BC (5620±90 BP, OxA 2091)	***Carychium tridentatum*, *Aegopinella* sp.**, ***Discus rotundatus*, *Oxychilus cellarius*,** *Spermodea lamellata*, *Leiostyla anglica*, *Acicula fusca*.
e	4690-4330 cal. BC (5620±90 BP, OxA 2091)	before 2860-2230 cal. BC (2850±70 BP, OxA 3558)	***Vallonia* sp., *Trichia hispida*, Pupilla muscorum (small form)** *Helicella itala*, *Monacha cartusiana*.
f	before 2860-2230 cal. BC (2850±70 BP, OxA 3558)	Present	***Vallonia* sp., *Trichia hispida*,** *Monacha cantiana. Helix aspersa*.

Mollusca from non-tufaceous Mesolithic sites have rarely been recovered. However, at Faraday Road, Newbury, Berkshire mollusc shells were recovered in association with a flint scatter from a palaeosol developed in floodplain and channel fill alluvium (Ellis *et al* 2003). The stone tool assemblage was dominated by obliquely-blunted microliths, but as well as tool manufacture, butchery must have also taken place on the soil surface as indicated by cut marks on wild pig bones. One of the pig bones was ^{14}C dated to 9120-8490 cal. BC (9418±60 BP, R 24999/2) (Ellis *et al* 2003) and therefore suggests that the site is broadly contemporary with later activity on the well known Thatcham Mesolithic sites (Gowlett *et al* 1987; Healy *et al* 1992; Hedges *et al* 1996). Shells in the unmodified alluvium predating the Mesolithic lithic assemblage were predominantly of *Pupilla muscorum* suggesting that the floodplain was grassland, although marsh-dwelling taxa such as *Oxyloma pfeifferi*, *Vertigo angustior* and *Vallonia pulchella* were also found. There is only limited evidence for shade in the alluvium as indicated by *Lauria cylindracea*, *Vertigo pusilla*, *Discus ruderatus* and *Columella edentula*. The palaeosol is characterised by shade loving taxa such as *Carychium tridentatum*, *Acanthinula aculeata* and *Aegopinella nitidula*, although grassland species such as *Pupilla muscorum* and V*allonia costata* were also present at high frequencies. This assemblage suggests that Mesolithic activity took place in an open woodland environment (Ellis *et al* 2003).

Middle Holocene mollusc faunas characteristic of Kerney's (1977) mollusc zone d have also been found on fully terrestrial sites including palaeosols at Asham Quarry (Ellis 1985; 1986) and Toadeshole Bottom East, Brighton, East Sussex (Wilkinson *et al* 2002) and tree-throw hollows at Toadeshole Bottom East; Asham, Devil's Dyke (Ellis 1985; 1986), Kiln Combe and Itford Bottom, East Sussex (Bell 1983) and Ascott-under-Wychwood, Oxfordshire (Evans 1971b). In all except the last case, where a Early Neolithic long barrow protected the subsoil hollow from later truncation, burial of the palaeosols and tree-throw features was by several metres of Bronze Age and later colluvium (see below). None of these Middle Holocene mollusc assemblages are directly associated with Mesolithic artefacts, but rather provide indications of the dry land taxa that inhabited the climax woodland. The assemblages are less diverse than those from tufas given the absence of marsh communities and are instead dominated by shade loving species such as *Carychium tridentatum*, *Discus rotundatus*, *Aegopinella* sp., *Oxychilus* sp., while *Pomatias elegans* is a particularly characteristic secondary component.

In contrast to Scotland and the Western Isles [e.g. Oronsay (Mellars and Wilkinson 1980)], Mesolithic coastal sites are extremely rare in Southern Britain where the continental shelf has been inundated as a result of rising relative sea levels and crustal downwarping (Mannino and Thomas 2001). Indeed the only site that has been both intensively excavated and extensively sampled in order to systematically recover Mollusca is the Culverwell shell midden on the Isle of Portland, Dorset (Palmer 1990; 1999; Mannino and Thomas 2001; Mannino *et al* 2003). Culverwell is one of two Mesolithic shell middens on the Isle of Portland [the other is the 'Old Lower Lighthouse Site 1' (Palmer 1971)] and was excavated by Suzanne Palmer between 1967 and 1995 (Palmer 1999). Marcello Mannino and Ken Thomas examined the marine Mollusca from the midden, focussing their attention on primary material protected from later disturbance by virtue of lying within a relict cryoturbation feature cut into the basal limestone (Thomas and Mannino 1999; Mannino and Thomas 2001). According to a series of ^{14}C dates the midden dates between 5730-5550 cal. BC (AA 28214, 6730±55 BP) and 6470-6240 cal. BC (AA 28218, 7525±60 BP), a period when relative sea levels were 10-20m below those of the present (Mannino and Thomas 2001). Although at least 21 marine mollusc taxa were identified, the assemblages were dominated by the rocky shore species *Littorina littorea* (edible periwinkle) and *Monodonta lineata* (thick top shell), together with *Patella* sp. (limpet). Minimum number of individual (MNI) counts suggested that there was a progressive rise in the quantity of shells of all three taxa per unit volume towards the topmost layer of the midden and then a subsequent reduction in the topmost layer (Mannino and Thomas 2001). This pattern was combined with a reduction of shell size and age profile (calculated by counting varices) in *Monodonta lineata* towards the top of the midden. Mannino and Thomas (2001) interpret this trend as being a result of the overexploitation of the shellfish resource by the Mesolithic population, resulting in younger and smaller individuals having to be collected during later site phases. Mannino *et al.* (2003) also carried out detailed stable oxygen isotope studies of *Monodonta lineata* from the Culverwell midden and a range of modern coastal locations between Portugal and Northern Ireland. Their data demonstrate that δ^{18}O values in sub-samples taken from the final varice of modern shells within the area of the *Monodonta lineata* population core exhibit variations that are attributable to seasonal changes in sea temperature (Mannino *et al* 2003). When the modern observational data were applied to archaeological examples from the Culverwell midden it was found that the vast majority of *Monodonta lineata* shells had been collected in the autumn and/or winter and that this pattern persisted throughout the entire period of midden accumulation (Mannino *et al* 2003). Therefore, although it appears that Mesolithic people were intensively exploiting the shellfish resource around Portland, they were doing so for – at most – six months of the year.

Investigations were also undertaken of the Westward Ho! Mesolithic midden in the mid-1980s, but these could not be as detailed as those at Culverwell because the Westward Ho! midden is located in the present intertidal zone. It was therefore only accessible for two-three hours per day on four-five days each year or on each alternate year (Balaam *et al* 1987). The poor accessibility meant that laboratory studies were conducted on three 500x800x300mm blocks extracted from the midden and its associated sediment during the very short fieldwork campaigns. The midden sits on blue clay of presumed marine origin which is dated by archaeomagnetism to 8400-7800 BP or earlier (Balaam *et al* 1987). In turn the midden is overlain by a freshwater peat which started forming around 4800-4360 cal. BC (HAR 5641, 5740±100 BP) (Balaam *et al* 1987). The midden was itself dated by bulk ^{14}C measurements on multiple charcoal fragments to 5480-5060 cal. BC (HAR 5645, 6320±90 BP) and 5480-4580 cal. BC (HAR 5632, 6100±200 BP), i.e. the late sixth or early fifth millennium BC. The marine mollusc shells that comprise the midden were highly fragmented, but it seems that *Scrobicularia plana* (Peppery furrow shell) and *Mytilus edulus* (Common mussel) were the main species exploited, while at least eight other edible taxa were also found (Bell in Balaam *et al* 1987). *Mytilus edulis* inhabits rocky shores, but *Scrobicularia plana* prefers muddy or sandy substrates, suggesting that at least two separate shoreface areas were exploited. *Scrobicularia plana* is not eaten today, but its presence on Mesolithic middens such as Blashenwell, Dorset (Preece 1980b) and on others elsewhere in the United Kingdom outside the Southern region, suggests its relatively common use by Mesolithic people (Bell in Balaam *et al* 1987). Non-marine Mollusca were also found within the midden. Freshwater taxa were dominated by *Pisidium personatum*, *Lymnaea truncatula* and *Anisus leucostoma*, all of which prefer damp, mud-rich environments prone to drying (Bell in Balaam *et al* 1987). The terrestrial taxa recovered were mainly of species with shade-loving preferences, including *Discus rotundatus*, *Carychium tridentatum*, *Vitrea contracta* and *Oxychilus cellarius*, suggesting that the midden accumulated in woodland or scrub (Bell in Balaam *et al* 1987). There was no evidence for brackish water species indicating that the shellfish accumulating on the midden had been brought to a fully terrestrial location.

Research agenda

Off site studies dominate the Upper Palaeolithic and Mesolithic malacological database. Such a focus is because of the perception that archaeological sites from these periods comprise lithic scatters with minimal vertical stratification and therefore there is little opportunity to sample Mollusca. However, stratified Upper Palaeolithic and Mesolithic sites do exist [e.g. at Three Ways Wharf, Uxbridge (Lewis 1991; Lewis *et al* 1992) and in various sites in the Kennet valley (Chisham 2004)] in alluvial settings. Indeed molluscan samples were taken from the Three Ways Wharf site, but the datawere not published at the time of writing.

- There is considerable potential for studying Mollusca from stratified Upper Palaeolithic and Mesolithic sites where they exist in order to examine the environments in which these hunter-gatherers operated, and also to assess the impact of intermittent settlement and craft activity on the environment.

- Davies (Davies and Griffiths 2005; 2008, 157) has demonstrated that close interval sampling of fine-grained paludal-type tufa can provide high-resolution palaeoenvironmental data suitable for examining Mesolithic manipulation of woodland. Sampling of this type should therefore be a routine activity when Mesolithic sites in such environments are examined.

- Knowledge of the shellfish component of Mesolithic diet in southern England is currently based on the examination of just two sites, one of which could not be intensively sampled. Therefore it is presently uncertain how typical the recovered dietary information is. However, analytical work undertaken by Mannino and colleagues (Thomas and Mannino 1999; Mannino and Thomas 2001; Mannino *et al* 2003) has demonstrated the potential that detailed quantitative, metrical and isotopic studies on shell midden assemblages have for investigating shellfish exploitation. Investigations on other shell midden sites should be carried out using approaches similar to those employed by Mannino and Thomas.

4.3 Neolithic

Until relatively recently the Neolithic was perceived as a period of revolutionary change from the previous Mesolithic order. Communities were thought to have settled in permanent villages, cleared woodland, cultivated crops and constructed monuments. However, current narratives emphasise the continuity from the Mesolithic, pointing out that there is little evidence of permanent settlement at least in the Earlier Neolithic: only small scale evidence for crop husbandry, and a lack of major forest clearance (Whittle 1999). Rather Earlier Neolithic groups seem to have been mobile pastorlists, who grew (but not necessarily tended on a full time basis) some cereals and constructed monuments. Indeed molluscan evidence from several sites in the Southern region has been used by Mike Allen (in Smith *et al* 1997, 184-185; French *et al* 2003) to support arguments originally made by Bush (Bush and Flenley 1987; 1988; 1993), in suggesting that Wessex valleys may have been partially cleared of woodland in the Mesolithic or otherwise did not support mixed deciduous woodland by the Middle Holocene. There are more published molluscan analyses of Neolithic sites and sequences in the Southern region than all other periods put together. The intensity of work is a product of the inherent interest in a period which saw a fundamental change of economy and lifestyle, the greater availability of sequences/palaeosols to sample over preceding periods as a result of monument construction and the research interests of John Evans [14 of the 23 case studies discussed in Evans' (1972) *Land snails in archaeology*, are from Neolithic sites in southern England]. In contrast to the Upper Palaeolithic and Mesolithic periods the vast majority of molluscan studies of Neolithic strata from the Southern region have been carried out on archaeological sites.

Before reviewing molluscan data from Neolithic archaeological sites (see Table 4 for period terminology), it is first worth examining off site data and what they say of the environment between Neolithic monuments. Evidence from colluvial dry valley sequences tends to support the view that Neolithic people had a low intensity impact on the landscape. Colluvial deposits of Neolithic age are rare (Wilkinson 2009), but several mollusc-bearing palaeosols of Neolithic age have been found in dry valleys suggesting that valley environments were stable. For example at Kiln Coombe, East Sussex a Beaker (Later Neolithic) palaeosol containing occupation evidence, included shade loving mollusc species as well as a few *Vallonia excentrica* and *Pupilla muscorum* (Bell 1983). These data suggest either long grassland or a mosaic of wooded and open habitats at the time the palaeosol developed in the late third/early second millennium BC. Nevertheless a peak in frequency of the shade loving taxon *Pomatias elegans*, a species which is also indicative of disturbed ground (Evans 1972, 133-135), suggests that clearance of the shade took place as the soil developed (Bell 1983). A further palaeosol dating to 2800-2300 cal. BC (OxA 3077, 4020±90 BP) from Toadeshole Bottom East was dominated by *Discus rotundatus*, members of the Zonitidae and Clausiliidae, suggesting woodland conditions in this dry valley during the Later Neolithic (Wilkinson 1993; Wilkinson *et al* 2002). However, evidence from the same site suggests that the landscape opened slightly by the Beaker period at 2140-1660 cal. BC (OxA 3078, 3560±80 BP; OxA 3079, 3550±90 BP) by which time *Vallonia costata* and *Vallonia excentrica* were found together with a rich assemblage of shade loving species in a tree throw hollow (Wilkinson 1993; Wilkinson *et al* 2002). Pasture is indicated in a further dry valley at Itford Bottom, East Sussex where a palaeosol of Later Neolithic date (2480-1770 cal. BC, 3720±120 BP, BM 1545 on 113 fragments of ash, oak, hawthorn and pine charcoal) was associated with *Vallonia costata*, *Vallonia excentrica*, *Helicella itala*, *Pupilla muscorum* and *Vertigo pygmaea*. When found together this combination of mollusc species is thought to be characteristic of short chalk grassland (Evans 1991a). Further palaeosols buried by colluvium and of probable Beaker age have been investigated by Allen (1995) at Southerham Grey Pit, East Sussex. Unlike Toadeshole Bottom East and Itford Bottom, the Southerham Grey Pit palaeosol was associated with a transitional fauna characterised by *Vallonia costata*, *Pomatias elegans*, *Carychium tridentatum* and *Trichia hispida*. However, species indicative of primary woodland were also present (*Zonitoides excavatus*, *Ena Montana* and *Vertigo pusilla*), suggesting, as at Kiln Combe that clearance of the tree cover was underway as the soil developed.

Table 4:Timescales used to discuss Neolithic and Bronze Age molluscan studies (modified after Champion 1999; Parker Pearson 1999; Whittle 1999)

Term	Date range	Characteristics
Earlier Neolithic	4000-3000 BC	Round-based pot styles, polished stone and flint axes, leaf-shaped arrowheads, long barrows, causewayed enclosures, cursus monuments.
Later Neolithic	3000-2500 BC	Decorated round-based pots (Peterborough Ware), Grooved Ware, partially polished stone axes, asymmetrical and transverse flint arrowheads, stone and antler maceheads, bone pins, henges, stone and timber circles, palisaded-enclosures, round barrows, ring ditches, cursus monuments.
Early Bronze Age	2500-1400 BC	Bronze, copper and gold artefacts, Beakers, Food Vessels, Collared Urns, Trevisker Ware, thumbnail scrapers, barbed-and-tanged arrowheads, flaked knives and daggers, round barrows of diverse form, cremation and inhumation, stone circles.
Later Bronze Age	1400-600 BC	Deverel Rimbrey Ware, post-Deverel Rimbrey plain and decorated wares, metalwork of Taunton, Penard, Wilburton, Ewart Park and Llyn Fawr type, circular huts, fortified sites, field systems

Despite the discussion above, Neolithic colluvium containing mollusc shells is known and therefore attests to the impact of Neolithic land-use practices in some parts of the Southern region. For example a colluvial sequence dating to 3710-3370 cal. BC (4800±70 BP, OxA-2382) at Middle Farm, Dorchester contained a mollusc assemblage indicating accumulation in a grassland environment (Allen in Smith *et al* 1997, 177). Similarly the Main Section (Series 1) from Holywell Coombe, Kent exposed colluvium and two palaeosols dating between 4690 and 1630 cal. BC (OxA 2090, 3515±80 BP; OxA 2091, 5620±90 BP), i.e. the whole Neolithic period (Preece *et al* 1998). The mollusc assemblage in the colluvium was dominated by *Trichia hispida*, the Limacidae, *Vallonia costata* and *Vallonia excentrica*, but shade loving species such as *Carychium tridentatum*, *Aegopinella nitidula*, *Discus rotundatus* and *Pomatias elegans* were also present at moderate frequencies (Preece 1998). Indeed the shade loving component increased in importance during the palaeosol phases when the landscape was more stable. Undoubtedly colluvium at Holywell Coombe formed in an open environment, but deposition does not seem to have been the result of intensive cultivation on the surrounding slopes. The accumulation rate was low and the molluscan assemblage is diverse (as at Kiln Coombe and Toadeshole Bottom East) compared to snail assemblages in Bronze Age and later colluvium. These data suggest that the Neolithic colluvium at Holywell Coombe accumulated while the surrounding slopes were used for pasture or low intensity/short lived arable cultivation (Preece 1998).

A further unique colluvial context is worthy of special mention. Fills of the 25m deep Down Farm Shaft (also known as Fir Tree Shaft), Gussage St Michael, Dorset span the period from the Late Mesolithic to the Early Bronze Age (Green and Allen 1997; Allen and Green 1998; Allen in Green 2000). Mollusc shells from an erosion cone towards the top of the shaft suggest that the woodland of the Middle Holocene was locally cleared at c. 4240-3970 cal. BC (5275±60 BP, OxA-7987), i.e. in the Late Mesolithic; an event that was associated with red deer bones and Late Mesolithic microliths (Allen and Green 1998). The remaining palaeoenvironmental data have yet to be published, but given the well-stratified ceramic assemblages, promise a detailed picture of the development of a downland environment for the entire Neolithic.

Mollusc analysis has been carried out on several alluvial sequences of Neolithic date, mostly in Wiltshire. For example the 'Avebury Soil' (sensu Evans *et al* 1988; Evans *et al* 1993) is a buried palaeosol in the Kennet valley near to the Neolithic site of the same name. Archaeological artefacts within the palaeosol suggest that it developed from the late Mesolithic to later Neolithic periods. Although found in a river valley, the soil developed in silts and clays which contain shade-loving (e.g. *Carychium tridentatum*), rather than aquatic taxa, suggesting that woodland occupied ground adjacent to a restricted channel belt. However, the fauna from the top of the palaeosol (*Vallonia excentrica*, *Helicella itala* and *Trichia hispida* characterise this stratum) suggest that clearance of the woodland occurred during the Neolithic leading to the establishment of grassland. Nevertheless there is no evidence for flooding during the Neolithic period and overbank alluvium with a distinct *Vallonia pulchella*, *Anisus leucostoma* and *Lymnaea truncatula* fauna only appeared in the Iron Age.

Neolithic channel, levee and floodplain deposits underlying the Bronze Age site of Runnymede Bridge, Surrey were also sampled for molluscan analysis during excavations carried out by Stuart Needham in 1984-1989 (Evans 1991b; Evans and Evans 2000). John Evans took an unusual approach to interpreting the molluscan data in examining the freshwater and terrestrial molluscan components separately. A diverse assemblage of aquatic taxa dominated by *Bithynia* sp., *Valvata piscinalis* and the Planorbidae characterised the basal channel sediments, but a more restricted *Bithynia* sp., *Valvata cristata*, *Valvata piscinalis* and *Pisidium casertanum* fauna was found in the overbank deposits. Evans (1991b) suggested that the channel faunas were representative of the River Thames as a whole and that shells from a variety of fluvial habitats had collected in the channel sands, while the overbank fauna was derived from a more restricted range of local environments. The terrestrial taxa found in the sequence were largely indicative of marshy and grassland bank communities, although the overbank deposits were dominated by *Lymnaea truncatula*, a species characteristic of mudflats. A late Neolithic riverine sequence on the Thames at St Stephen's East, Westminster, London was also the subject of molluscan study, although there was no direct association with an archaeological site (Sidell *et al* 2000, 52-54). The mollusc assemblages were recovered from thinly bedded sands and silts and were dominated by *Valvata piscinalis*, *Bithynia tentaculata* and *Theodoxus fluviatilis*. These data suggest that the Thames at Westminster comprised a large, fast moving freshwater stream after 2570-2280 cal. BC (Beta 127616, 3920±40 BP) (Sidell *et al* 2000, 129). There is no indication of saline water in the river at this time, while the surrounding terrestrial vegetation seems to have been shaded (Sidell *et al* 2000, 52-54).

The discussion above covers off-site situations, but it is the analysis of palaeosols and ditch sediments associated with monuments that dominates the Neolithic molluscan database. Molluscan analysis has been an integral part of most 1960s and later excavations of Early Neolithic causewayed enclosures in Southern England for example. Many such late fourth millennium BC enclosures exist on the chalk downland of the Southern region. Although once thought of as defensive structures or stock enclosures, causewayed enclosures are now interpreted as 'the focus for intense participatory ceremonialism which celebrated key aspects of the earlier Neolithic lifestyle' (Whittle 1999, 71). Land snail analysis has been carried out on both ditch sequences and palaeosols, although as Davies (2008, 69) has pointed out, the latter rarely survive beneath causewayed enclosure banks and therefore examination has necessarily focussed on the former. During the 1970s and 1980s, Thomas (1982) examined molluscan assemblages from ditch fills of six causewayed enclosures in Sussex (Whitehawk, Bury Hill, Offham, The Trundle, Combe Hill and Barkhale) and a buried soil from one (Offham Hill). Assemblages from the primary fills were taken – as discussed above – to be indicative of the environment in which the enclosure had been constructed. Therefore the overwhelming dominance of shade loving taxa in the primary fills at all the sites was taken to indicate that the monuments had been built in small-scale woodland clearings. The rarity of open country specimens in the secondary ditch fills suggested that open environments were far removed from the enclosures and colonisation routes had not been established even during the use of the enclosures. Only during a late phase at the Whitehawk enclosure was there evidence for the appearance of grassland environments (Thomas in Russell and Rudling 1996). Assemblages from the outermost ditches at this site were dominated by *Pupilla muscorum* and *Vallonia excentrica*.

Evans *et al*.'s (1988) study of molluscs from early secondary fills of the Maiden Castle causewayed enclosure ditch in Dorset, also suggests that this site was constructed in a wooded environment after 3770-3370 cal. BC (4810±80 BP, OxA-1148), albeit that conditions began to open up thereafter. At Hambledon Hill, Dorset too, mollusc evidence from basal ditch fills suggests that this causewayed enclosure was built in woodland at about 3700-3380 cal. BC (4805±45 BP, OxA-8855) (Bell *et al* forthcoming). Finally at Knap Hill causewayed enclosure, Wiltshire, shade loving taxa together with *Vallonia costata* were found in a buried A horizon below the enclosure bank indicating the presence of woodland in the area surrounding the enclosure (Sparks in Connah 1965).

Mollusc analysis from primary fills of other causewayed enclosures, however, suggests construction in rather more open environments than those hypothesised for the previously given examples. The basal fills of the causewayed enclosure ditch at Whitesheet Hill, Wiltshire, investigated when a pipeline cut through the site were dated to 3710-3370 cal. BC (4800±70 BP, BM 2784; 4820±50 BP, BM 2785) on the basis of ^{14}C dates on a pig and cow bone respectively (Rawlings *et al* 2004). Mollusc preservation from the primary ditch fill was too poor to make firm palaeoenvironmental interpretations, but Allen (in Rawlings *et al* 2004) suggests they indicate a shaded environment, albeit not primary woodland. The secondary fills were dominated by *Carychium tridentatum*, *Discus rotundatus* and the Zonitids. This assemblage has been interpreted as indicating tall, herbaceous grassland during the time that the monument was used. However, following a recut of the ditch in the later Neolithic, the mollusc assemblage changed to one indicative of pasture (Allen in Rawlings *et al* 2004). Mollusc assemblages from buried soils at Windmill Hill, Wiltshire suggest that this causewayed enclosure was constructed in species-rich, grassland scrub after 3800-3350 cal. BC (4870±70 BP, OxA-2406) (Fishpool in Whittle *et al* 1999, 127). However, Evans' (1972, 242-248) earlier analysis of a buried soil beneath the outer bank of Windmill Hill revealed a fauna dominated by the Zonitidae, *Carychium tridentatum*, *Discus rotundatus* and *Vallonia costata*. This was argued to represent a woodland environment, albeit one that did not immediately pre-date monument construction - shells relating to the pre-monument landscape had been removed by de-turfing (Evans 1972, 246). Even accepting that the Whitesheet Hill and Windmill Hill causewayed enclosures were built in long grassland, it is still the case that this class of Earlier Neolithic monument were constructed in landscapes that were utilised neither for arable agriculture nor grazing. There is no evidence from molluscan assemblages in buried soils for prior forest clearance, as is the case for other Neolithic monuments classes (see below), before the establishment of long grassland or open woodland. In other words the molluscan evidence suggests that causewayed enclosures in the Southern region are associated with landscapes that would have been perceived of as virgin by Earlier Neolithic communities.

Cursae are slightly later monuments than causewayed enclosures, but in the Southern region they are considerably less numerous than the latter. Cursae are thought to have the combined the functions of boundary markers (both actual and symbolic) and processional ways (Whittle 1999). The 10km-long Dorset Cursus of 3650-2900 cal. BC (4570±120 BP, OxA-624) was, according to molluscan evidence, built in a substantial woodland clearing (Entwistle and Bowden 1991; Allen in Green 2000, 43-45). However, molluscan evidence from the cursus ditches also suggests that woodland regeneration occurred while the monument was in use, thereby arguing that the original clearance was specifically for the cursus. Other Earlier Neolithic enclosures for which it is more difficult to fit to a typological framework also seem to have been constructed in woodland clearances according to molluscan analysis of basal ditch sediments. The Handley Down mortuary enclosure on Cranbourne Chase, Dorset is a good example. This monument was built somewhere between 3700 and 3000 BC in a very small woodland clearance, but just as was the case with the Dorset Cursus the woodland was allowed to regenerate once the site had fallen into disuse (Allen in Green 2000, 43-45). On the other hand, Mike Allen's (in Smith *et al* 1997, 167) analysis of mollusc shells from a pit predating construction of the The Flagstones enclosure near Dorchester, Dorset indicates grassland environments at 3960-3630 cal. BC (4960±80 BP, HAR-9161) which predated monument construction in the Later Neolithic.

The final distinctive monument class of the earlier Neolithic in the Southern region is the long barrow. These were built to entomb collections of mostly disarticulated human bone that had been excarnated elsewhere [although articulated skeletons do exist, as for example in the north passage of Hazleton long barrow, Gloucestershire (Saville 1990)] – possibly in causewayed enclosures. Evans' (1971b; 1972, 257-261, 328-332) mollusc analysis of a ditch sequence and a palaeosol associated with the South Street long barrow, near Avebury in Wiltshire is probably the most cited archaeological molluscan study from the British Isles. South Street long barrow was excavated in the late 1960s by Paul Ashbee and charcoal from the soil buried beneath it was ^{14}C dated to 3800-3100 cal. BC (4760±130 BP, BM-356) (Evans and Burleigh 1969; Ashbee *et al* 1979). Molluscs in the palaeosol were argued by Evans (1971b; 1972, 257-261) to indicate progression from an open woodland environment (*Discus rotundatus*, Zonitidae, *Vallonia costata* and *Pupilla muscorum*), through a clearance event characterised by a peak in frequency of *Pomatias elegans*, to arable (*Vallonia costata*, *Vallonia excentrica* and *Pupilla muscorum*) and then pastoral (*Vallonia costata*, *Vallonia excentrica*, *Helicella itala* and *Vertigo pygmaea*) land usage. The monument is thought to have been built in the last pastoral phase and ard marks relating to the arable phase are a well known feature of the palaeosol (Fowler and Evans 1967; Ashbee *et al* 1979). However, Carter's (1990b) work on land snail taphonomy in modern chalk downland soils led him to suggest that only the last of these environments could be reliably reconstructed owing to the homogenising effect of bioturbation lower in the stratigraphy. The mollusc assemblage from the primary fill of the ditch flanking South Street long barrow was almost identical to that of the top of the palaeosol and was dominated by *Vallonia costata*, *Vallonia excentrica* and *Helicella itala* (Evans 1972, 328-332). The overlying secondary fill was initially dominated by *Trichia hispida*, *Vallonia costata* and the Zonitidae and suggested that the ditch and the surrounding area had become vegetated. However, a higher secondary fill had ard marks cut into it and contained a mollusc assemblage characterised by *Vallonia excentrica*, *Pupilla muscorum* and *Helicella itala*. Beaker sherds were also found in this layer, suggesting an arable land usage during the Later Neolithic-Earlier Bronze Age interval (Evans 1972, 328-332).

Evans (1972, 248-251) also examined molluscs from a palaeosol at Beckhampton Road, a second long barrow in the Avebury area. The Beckhampton Road palaeosol dates between 4350-3660 cal. BC (NPL 138, 5200±160 BP from charcoal in the buried soil) and 3370-2900 cal. BC (BM 506b, 4467±90 BP on an antler from the long barrow mound) (Smith and Evans 1968). The changes in mollusc fauna are similar to that of South Street, i.e. open woodland dominated by *Discus rotundatus*, *Carychium tridentatum* and Zonitids to an open landscape characterised by *Helicella itala*, *Vallonia costata* and *Vallonia excentrica*, but there is less palaeoenvironmental detail because a coarser sampling interval was used (Evans 1972, 249). Although carried out at a similar low level of detail, analyses of mollusc shells from palaeosols buried beneath the nearby Horslip and West Kennet long barrows seem to indicate the same landscape changes pre-dating barrow construction as seen at South Street and Beckhampton Road (Evans 1972, 261-264).

Outside the Avebury area, Evans and Rouse (in Whittle *et al* 1993) examined mollusc samples from a buried soil and ditch sequence at Easton Down long barrow in North Wiltshire. This structure was built in a grassland environment as indicated by the presence of *Pupilla muscorum* in the buried soil, although like South Street, the soil had previously been cultivated. Multiple spatially differentiated samples taken from the buried soil suggested that the exact character of the grassland buried by the long barrow varied, and while the open country species *Vallonia excentrica*, *Vallonia costata*, *Helicella itala*, *Pupilla muscorum* and *Vertigo pygmaea* predominated, shells of shade loving taxa were found beneath the south-western part of the mound. Molluscan and micromorphological evidence suggested that a boundary between short and long grassland (or possibly woodland) passed beneath the south-western part of the site before the long barrow was constructed. Although shells from the primary ditch fill at Easton Down long barrow were similar to those in the buried soil, those from the secondary fill included *Carychium tridentatum*, *Discus rotundatus* and *Aegopinella pura* and have been interpreted as suggesting that secondary woodland developed some time after construction (Evans and Rouse in Whittle *et al* 1993). The woodland finally seems to have been cleared in the Early Bronze Age and the area cultivated. Harris and Evans (in Whittle 1994) have examined mollusc shells extracted from samples from the 2.8m deep ditch of the Millbarrow chambered tomb, Winterbourne Monkton in north Wiltshire (SU 0943 7220). The primary fill of the ditch accumulated after 3520-2920 cal. BC (4560±90 BP, BM 2730; 4450±60 BP, BM 2729; 4560± BP, BM 2731) according to three dates on red deer antler (Ambers and Housley in Whittle 1994). The primary fill was characterised by a fauna dominated by *Vallonia costata* and *Vallonia excentrica*, together with *Helicella itala*, and suggests that the barrow was built in open grassland (Harris and Evans in Whittle 1994). The mollusc assemblages became more diverse in the secondary fills of the ditch as *Carychium tridentatum*, *Punctum pygmaeum*, *Aegopinella nitidula*, *Vitrina pellucida* and *Vitrea contracta* appeared, suggesting that the ditch had been overgrown and that the monument was no longer maintained. The top of the secondary fill was characterised by a woodland assemblage (*Clausilia bidentata*, *Oxychilus cellarius* and *Acanthinula aculeata* joined the species previously outlined), although *Vallonia costata* still dominates. Finally the woodland was cleared and open grassland, characterised by *Vallonia costata*, *Vallonia excentrica* and *Trichia hispida* appeared. Although there is no chronology for these events the pattern of vegetation change broadly matches that seen in long barrow sequences from the Avebury region.

Further away from Avebury still is the Ascott-under-Wychwood long barrow in Oxfordshire, another one of Evans' classic sites. Molluscs from a palaeosol dating from 3650-3370 cal. BC (BM 492, 4735±70 BP on charcoal) at this site suggest a landscape that had changed from woodland (*Discus rotundatus*, *Carychium tridentatum*) to grassland pasture (*Vallonia costata*, *Pupilla muscorum*) some time before the barrow was built, although unlike South Street, there was no intervening arable phase (Evans 1971b; 1972, 251-256).

Based on molluscan data from long barrow sites such as South Street, Beckhampton Road, Ascott-under-Wychwood and Easton Down, Evans (1990) was able to suggest that such barrows were located at boundaries and that a common pattern of landscape change could be detected. Long barrows were built in grassland environments, while prior woodland had been removed several decades prior to barrow construction. Therefore, unlike causewayed enclosures, long barrows were built in situations where they could be seen and on land which had previously been used for farming. Where it was possible to analyse shells from ditch fills as at South Street and Easton Down, it was apparent that the cleared landscape was not maintained following long barrow construction and that secondary woodland later developed. Only in the Beaker period was the woodland removed once again and the ground around the barrows cultivated.

Several Later Neolithic funerary monuments have been the subject of molluscan study. For example Evans (1972, 332-335) examined a buried palaeosol and ditch deposits from a round barrow at Hemp Knoll, Avebury dating from 2570-1770 cal. BC (3745±135 BP, NPL 139 C 154). A *Vallonia excentrica*, *Vallonia costata* and *Helicella itala*-dominated fauna was found in the buried soil suggesting that the barrow was constructed in short grassland, but shell preservation in the ditch was poor and the post-construction environment could not be reconstructed. Ditch deposits from the 2200-1730 cal. BC (3590±80 BP, HAR 5543) North Marden round barrow, West Sussex have also been examined (Thomas and Carter in Drewett 1986). The basal secondary fills appear to be of Later Neolithic date and are characterised by *Vallonia costata* and *Vallonia excentrica*, suggesting that either short-turfed grassland or arable conditions persisted after barrow construction. However, mollusc assemblages higher in the secondary fill were almost entirely of shade-loving affinity and included

Carychium tridentatum, *Discus rotundatus* and *Aegopinella nitidula*, while open country taxa were absent. By reference to Cameron's (1973) work on modern woodland mollusc faunas, Thomas and Carter (in Drewett 1986) were able to suggest that a wooded environment had developed over the barrow. However, it is unclear *when* the woodland developed. Open country taxa (*Vallonia costata*, *Vallonia excentrica* and *Helicella itala*) dominated assemblages in the uppermost ditch fills suggesting that grazed, short-turfed grassland succeeded the woodland.

In contrast to earlier Neolithic causewayed enclosures, but in a similar way to long and round barrows, mollusc analysis from a number of sites across the Wessex Downs suggests that Later Neolithic monuments, including the henges at Avebury, Stonehenge, Durrington Walls, Mount Pleasant and Woodhenge, Wiltshire and Mount Pleasant, Dorset were all built in grassland environments (Evans 1971b; Evans and Jones 1979; Evans 1984b; Evans *et al* 1985; Allen 1997). For example a buried soil beneath the Avebury henge monument was studied by Evans during excavations by F de M Vatcher in 1969 (Evans 1972, 268-274) and by Evans *et al.* (1985) when it was revealed by development works in 1982. The molluscan assemblages collected during both episodes of work are broadly similar. The soil B horizon contained a highly mixed mollusc assemblage including the tall, Late Glacial form of *Pupilla muscorum* and *Discus ruderatus* [a species that became locally extinct in Britain at the end of mollusc zone b (see Table 3) (Kerney 1977)] as well as extant shade loving and open country taxa. However, the top 0.15m of the soil contained a well stratified assemblage in which woodland clearance, partly characterised by a clear peak in the frequency of *Pomatias elegans* was succeeded by grassland in which taxa such as *Vallonia costata*, *Vallonia excentrica* and *Helicella itala* predominated.

Evans (1971a) was also able to study a buried palaeosol beneath the bank of the Durrington Walls henge monument during excavations carried out by Geoffrey Wainwright in 1966-1968 (Wainwright and Longworth 1971). The buried soil was associated with Later Neolithic activity and predated construction of the enclosure ditch around 2880-2230 cal. BC (4000±90 BP, BM 400 on antler) (Burleigh 1971). The mollusc assemblages recovered were similar to those discussed for long barrows above, suggesting an initial forested environment characterised by the Zonitidae, *Carychium tridentatum* and *Discus rotundatus*; succeeded by a clearance zone highlighted by a peak in *Pomatias elegans*, and finally grassland (Evans 1971a). The latter was inhabited by *Vallonia costata*, *Vallonia excentrica* and *Pupilla muscorum*, but the rare xerophile, *Truncatellina cylindrica* was also found, suggesting that the henge was built in short sward grassland with bare, broken patches (Evans 1971a). As the only chronological information relates to monument construction it is unclear when the forest had been cleared.

Woodhenge is located only 60m south of Durrington Walls and comprises a concentric series of postholes that are thought to have once supported upright timbers. These were enclosed by a ditch and exterior bank (Cunnington 1929). Although the postholes were completely excavated by Maud Cunnington in 1926-1928 (Cunnington 1929), a test trench was dug across the bank and ditch in 1970 as a follow up to the Durrington Walls project, to ^{14}C date the Woodhenge monument and to collect molluscan samples (Evans and Wainwright 1979). A ^{14}C date on antler from the base of the ditch indicates that construction took place around 2480-2030 cal. BC (3817±74 BP, BM 677). Molluscs from the palaeosol beneath the bank suggested an identical pattern of environmental change to that discussed for Durrington Walls above. Woodhenge was therefore built in short grassland characterised by *Vallonia costata*, *Vallonia excentrica*, *Helicella itala*, *Pupilla muscorum* and *Truncatellina cylindrica* (Evans and Jones 1979). Shells from the ditch fills indicate that the environment remained continuously open following construction. Indeed *Pupilla muscorum*, a species characteristic of very short, disturbed grassland, dominated all the assemblages dating from the Later Neolithic to Romano-British periods (Evans and Jones 1979).

Stonehenge is 3km from Durrington Walls and Woodhenge. Indeed the most recent excavators of Durrington Walls have suggested that the huts, the terraces and postholes of which were found at this site, comprised the 'workers village' for the builders of Stonehenge (Parker Pearson *et al* 2005). Evans (1984b) has analysed mollusc samples from the henge ditch and from the ditch of the adjacent Avenue. Shell preservation in the primary fill of the henge ditch (Stonehenge I) was very poor while a colonising fauna dominated by *Vallonia costata* - suggestive of grassland on the ditch exterior – was found at the base of the secondary fill. Antler from the base of the ditch was dated to 3340-2890 cal. BC (BM 1617, 4390±60 BP), while a further antler fragment from the base of the secondary fill produced a result of 3340-2900 cal. BC (BM 1583, 4410±60 BP). In other words the Stonehenge I ditch appears to be earlier than those of the henges previously discussed. Increased species diversity was noted higher up in the secondary fill, and although still dominated by *Vallonia costata*, the fauna also included *Lauria cylindracea*, V*itrea contracta*, *Carychium tridentatum* and *Discus rotundatus*, while xerophiles were rare. Evans (1984b) has suggested that this assemblage is indicative of monument abandonment and colonisation of the area by woodland or scrub. At the very top of the secondary fill and within the modern soil profile, xerophilous grassland taxa such as *Pupilla muscorum* and *Vallonia excentrica* predominated. It is possible therefore that these shells have been moved downwards by earthworm action, but their quantity and apparent transition from a preponderance of *Pupilla muscorum* to *Vallonia excentric*a suggests that clearance occurred prior to the insertion of a Beaker period burial into the ditch sediment in 2340-1910 cal. BC (BM 1582, 3715±70 BP on a human femur). The ditch of the Avenue proved to be relatively shallow, while the *Pupilla muscorum* and *Vallonia excentrica*-dominated fauna is the same as that seen within the modern zone of pedogenesis in the henge ditch.

A final example of a henge in the Durrington Walls/Stonehenge environs is Coneybury. In many respects this monument is unusual and seems to have been utilised in a different way to other henges (Allen 1997). The mollusc assemblages recovered from secondary fills of the ditch were dominated by *Carychium tridentatum*, *Discus rotundatus*, *Aegopinella pura*, *Vitrea contracta* and *Vallonia costata* (Bell and Jones in Richards 1990, 154-158). Given that >85% of the assemblage is characteristic of shaded environments, it has been suggested that woodland had recolonised Coneybury soon after construction. Indeed Bell and Jones (in Richards 1990, 154-158) further argue that because assemblages at the base of the secondary fill were dominated by shade loving taxa, it is also highly likely that the henge was constructed close to woodland, if not within it.

Fewer henges outside Wiltshire have been the subject of land snail analysis. One notable example is Mount Pleasant, Dorset, which was excavated by Geoffrey

Wainwright in 1970-1971 (Wainwright 1979). Mollusc samples were taken from a palaeosol buried beneath the 1.5m high bank, from fills of the 2.45m deep enclosure ditch and from a further palaeosol at the base of the ditch (Evans and Jones 1979). The palaeosol contained sherds of Plain Ware bowls, while charcoal was dated to 2880-2470 cal. BC (4072±73 BP, BM 644) (Burleigh 1979). Shells from the palaeosol buried beneath the bank were poorly preserved, but the assemblage was nevertheless dominated by species of open country preference (*Vallonia excentrica*, *Pupilla muscorum*, *Helicella itala*) and *Trichia hispida*, suggesting a similar grassland environment to that evidenced at the other henges discussed above (Evans and Jones 1979). The mollusc assemblage from the palaeosol at the base of the ditch contained a predominantly shade loving assemblage of the Zonitidae, *Carychium tridentatum* and *Discus rotundatus*, although *Vallonia costata* was also present. These taxa are likely to indicate a long grassland environment, although there is evidence in the form of an increase in *Pomatias elegans* and expansion of open country taxa, of the removal of this vegetation at the top of the palaeosol. The date for this event was ^{14}C dated (on charcoal) to 2120-1420 cal. BC (3410±131, BM 664), i.e. the Later Neolithic or Early Bronze Age (Burleigh 1979), and is followed by deposition of chalk rubble and then aeolian silt (Evans and Jones 1979). Samples from both the latter are dominated by *Pupilla muscorum* with lesser quantities of *Trichia hispida*, *Vallonia costata*, *Vallonia excentrica* and *Helicella itala*, indicating that a very dry, short grassland environment followed the clearance episode. Taller grasses are indicated later in the sequence as the open country indicators decline and *Trichia hispida* expands. The windblown deposits were buried by a tertiary fill of Romano-British date in which *Vallonia costata*, *Helicella itala* and later, *Cernuella virgata* are characteristic, suggesting that conditions were becoming drier – presumably as a result of ploughing (Evans and Jones 1979). A second ditch sequence from a timber structure dating to 2870-2210 cal. BC (3988±84 BP, BM 667) within the western part of the henge was also sampled (Evans and Jones 1979). A buried palaeosol predating 2200-1780 cal. BC (3630±60 BP, BM 668) contained a similar shade loving fauna to that seen in the palaeosol in the main enclosure ditch. Removal of the shade occurred at 1680-1440 cal. BC (3274±51 BP, BM 669) after which *Pupilla muscorum* dominates a predominantly open country assemblage indicating, as was the case in the aeolian deposits of the main enclosure ditch, short turfed and dry grassland until the Romano-British period. From the latter period onwards arable environments characterised by the Limacidae, *Vallonia excentrica*, *Helicella itala* and *Cernuella virgata*, have predominated (Evans and Jones 1979).

Detailed molluscan analysis has been carried out of ditch sediments from the possible Mile Oak henge in East Sussex (Wilkinson in Russell 2002). The primary fill dates from 1670-1410 cal. BC (3250±60 BP, OxA 5106), while the ditch was filled by the time a Bronze Age settlement developed on the site at 1390-1040 cal. BC (2975±50, OxA 5108) (Bayliss *et al* 2002). The dominance of *Vallonia excentrica* in the primary ditch fill suggests that the 'henge' was built in an open environment, although the presence of shade loving species such as *Cochlodina laminata*, indicates that a shaded refuge existed nearby. In the secondary fill the proportion of open country molluscs declined, while shade lovers such as *Carychium tridentatum* and *Discus rotundatus* increased as a proportion of the whole assemblage. Such changes might have been interpreted to suggest the ingress of vegetation onto the site. However, an absolute frequency histogram was plotted alongside the percentage diagram (reproduced here as (Figure 5), and the latter indicates that there was no reduction in the absolute number of open country molluscs, but rather an increase in the number of shade loving individuals (Wilkinson in Russell 2002). Therefore it seems likely that shade loving taxa had colonised the ditch and became more numerous by taking advantage of the dark, damp micro environment of the feature.

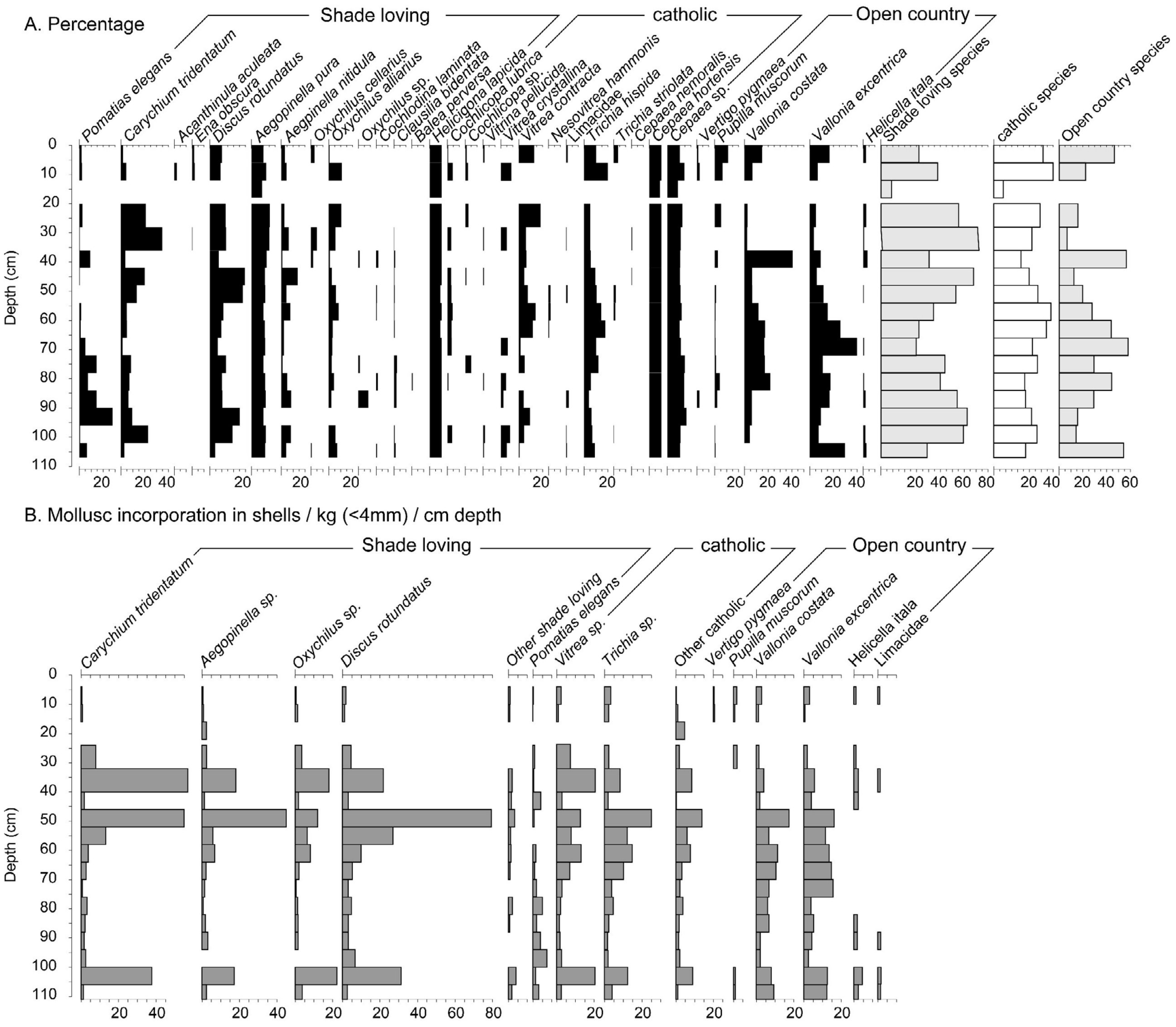

Figure 3: Percentage and absolute frequency histograms from a ditch sequence at Mile Oak 'henge', East Sussex (modified after Wilkinson in Russell 2002, figure 2.47, 73)

Meanwhile the environment outside the ditch was likely to have remained open. Nevertheless, higher in the secondary fill there was evidence of the spread of shaded environments outside the ditch as characterised by expansion of *Discus rotundatus* and *Aegopinella nitidula*. Then, just before the construction of a terrace for a Bronze Age round house, shade lovers declined and were replaced by a diverse open country assemblage including *Vallonia excentrica*, *Vallonia costata*, *Pupilla muscorum*, *Vertigo pygmaea* and *Helicella itala*, suggesting the presence of a grassland environment.

Condicote Henge in Gloucestershire is the final non-Wiltshire henge in the Southern region from which molluscan data have been published. Ditch fills from this henge monument were sampled during excavations carried out by Alan Saville in 1977 (Saville 1983). The monument was constructed before 2350-1750 cal. BC (3670±100 BP, HAR-3067) in a woodland environment according to the molluscs from the primary fill of the ditch (Bell in Saville 1983, 39-46). However, the majority of the shade-loving molluscs recovered from the ditch were taxa such as *Carychium tridentatum* and *Vitrea* sp., which are also characteristic of long, ungrazed grassland (Cameron and Morgan-Huws 1975; Carter 1990a). It is therefore possible that long grassland rather than woodland was present at the time of henge construction. Whichever explanation is correct, it would seem that Condicote Henge was built and used in an unfarmed landscape.

Molluscan analysis of Neolithic deposits in the Southern region paints a better picture of changing environments in the chalk downland of the third and fourth millennium BC than is afforded by palynological data. The paucity of colluvium of Neolithic date and the presence of palaeosols in dry valley situations for much of the Neolithic argues for a landscape that was not intensively cultivated. Indeed molluscs from such palaeosols indicate that open woodland environments characterised such low lying areas, while data from causewayed enclosures suggest that 'upland' environments were forested in the Earlier Neolithic. Nevertheless, long barrows seem to have been built at approximately the same time as causewayed enclosures or slightly later, and mollusc evidence from palaeosols buried beneath these monuments indicates that construction was in grassland. Nevertheless once constructed, the landscape around long barrows was not kept open and secondary woodland or long grass was able colonise. Later Neolithic environments on the other hand seem to have been predominantly open. Mike Allen (2005a) has highlighted the fact that Beaker (Later Neolithic) settlement is predominantly in dry valley situations and that it is sealed by colluvium of the same date suggesting arable land-usage on the surrounding slopes. Molluscan evidence from ditch fills of several long barrows also suggests that cultivation in the areas surrounding these monuments took place in the Beaker period, while henges all (with the possible exception of Coneybury and Condicote) seem to have been constructed in grassland environments. It is nonetheless notable that Allen's review of molluscan and palynological work in the wider Stonehenge landscape (summarised in Allen 1997) suggests that grassland formed just one – albeit the majority – element in a mosaic of Later Neolithic environments on the Wessex Downs. His data suggest that as well as grassland, the Stonehenge landscape included primary and secondary woodland as well as small arable plots (Allen 1997).

Research agenda

- Most Neolithic monuments that have been examined by molluscan analysis are in Wiltshire and to a lesser degree Sussex and Dorset. However, Neolithic sites suitable for land snail study exist elsewhere on the Wessex Downs, on the North Downs (Kent), in the Cotswolds and in river valleys with headwaters in such locations. Attention should be given to sampling for molluscs on Neolithic sites in these situations as and when sites are impacted by development. A particularly important question to be asked of mollusc data from such new sites is whether they support the hypotheses discussed in the text above, which are largely derived from sites in Wessex.

- Where investigated spatially, mollusc assemblages from buried soils have proven heterogeneous and reflect microenvironmental differences and the presence of boundaries (Evans and Rouse in Whittle *et al* 1993; Davies 2008, 67-68). Therefore future studies of such strata need to be based on multiple, spatially differentiated samples in order to both examine variation in such microenvironments and to recover representative data.

- Potentially important molluscan data of Neolithic date collected from excavations undertaken in the 1970s and 1980s remain unpublished. The molluscan data from Hambledon Hill are soon to appear in the public domain (Bell *et al* forthcoming), but the results from extensive mollusc sampling of Crickley Hill, Gloucestershire have not been published. It is particularly important that such data are reported given that the focus of British archaeology has changed since the 1980s and opportunities to investigate monumental sites of Neolithic date are now rare.

- As was stated in the opening paragraph in this section, most molluscan analyses conducted of Neolithic strata have been of palaeosols or ditch sequences associated with monuments. Off site alluvial and colluvial sequences have not been examined as extensively as similar deposits of Mesolithic or Upper Palaeolithic date. Nevertheless work reported earlier in this section indicates that Neolithic deposits in such off site locations do exist. Mollusc analysis of alluvial and colluvial sequences is vital in order to fill palaeoenvironmental gaps between the point data afforded by study of buried soils and ditch sediments. Indeed in spatial terms monuments are exceptional features where human activity is untypical and which occupy <1% of the Southern region. Dry valleys and alluvial settings comprise a much greater proportion of the landscape and therefore molluscan data from them would provide a more representative picture of Neolithic environments.

4.4 Bronze Age

As Table 4 indicates the Neolithic-Bronze Age transition was a gradual process that took place over many centuries. Indeed many authors argue that it is solely changes in metallurgical technology that differentiate the Early Bronze from the Beaker period (Parker Pearson 1999). Only in the late Bronze Age do the appearance of complex societies, the secondary products revolution and the new monument types that were once thought to characterise the Bronze Age as a whole, mark significant changes in the archaeological record (Champion 1999). Off site sediment sequences suggest that it was in the Late Bronze Age that people began to have a significant and widespread impact on the Southern region environment (Thorley 1981; Bell 1983; Wilkinson 2003). Such changes were largely the result of the introduction of the plough, but were also the result of agricultural intensification/extensification. The result was widespread erosion, demonstrated by the fact that the majority of examined dry valley sequences in the Southern region began accreting sediment in the Late Bronze Age. For example a chalk band containing a typically restricted molluscan fauna indicative of cultivation (*Trichia hispida* with slightly lesser numbers of *Vallonia costata* and *Vallonia excentrica*) of Late Bronze Age date marks the beginning of colluviation at Kiln Combe, East Sussex (Bell 1983). The Itford Bottom Later Neolithic palaeosol discussed in the previous section was similarly overlain by colluvium of Bronze Age date. This colluvium contained the same mollusc taxa as noted at Kiln Combe together with *Pupilla muscorum*, suggesting that deposition took place in an arable landscape (Bell 1983). Other dry valley evidence from Sussex also suggests that colluvial deposition was initiated in the Late Bronze Age. For example all seven dry valleys sampled prior to the construction of the A27 Brighton Bypass contained basal Late Bronze Age colluvial deposits (Wilkinson 1993; Wilkinson *et al* 2002; Wilkinson 2003). Colluvium associated with ^{14}C dates of 1130-560 cal. BC (2700±90, OxA 3081) and 1010-560 cal. BC (2660±70, OxA 3083) at Toadeshole Bottom West seems to have accreted in a grassland environment characterised by *Trichia hispida*, *Vallonia costata*, *Vallonia excentrica*, *Vertigo pygmaea* and *Helicella itala* (Wilkinson *et al* 2002). However, the Toadeshole Bottom Later Neolithic palaeosol discussed in the previous section was succeeded after 1730-1410 cal. BC (3260±70 BP, OxA 3080) by colluvium containing *Trichia hispida*, together with *Vallonia costata* and *Vallonia excentric*a (Wilkinson *et al* 2002; Wilkinson 2003). As previously stated this combination of species, which is also found in Bronze Age colluvium in other dry valley sites along the Brighton Bypass including Eastwick Barn, Hangleton and Cockroost Bottom, is characteristic of arable environments (Bell 1983; Wilkinson *et al* 2002).

Indications of the wider Bronze Age landscape have also been provided by land snail analysis of boundary ditches such as the well known examples on Cranborne Chase (Entwistle and Bowden 1991). These assemblages are almost entirely of open country taxa suggesting that the ditches were dug to divide pasture. Late Bronze Age linear ditches have also been sampled at Earl's Down Farm, near Durrington Walls in Wiltshire (SU 212 422) (Cleal *et al* 2004). As with the Dorset examples, the Earls Down Farm ditch sequences were dominated by open country species, in particular *Pupilla muscorum*, but with lesser numbers of *Vallonia costata*, suggesting that short grass pasture surrounded the ditches (Allen and Wyles in Cleal *et al* 2004). A further Wiltshire example, namely the Middle Bronze Age fills of a field system ditch from

Dunch Hill, Tidworth (SU 2050 4860), was also dominated by *Pupilla muscorum*, with lesser quantities of *Vallonia costata* (Allen in Andrews 2006). The environment outside the ditch was interpreted – in contrast to the examples given above – as being either arable or of short-turfed grassland. The molluscan data from Bronze Age field boundaries may fit with Richard Bradley's (1978, 47) hypothesis that arable systems of Wessex in the Middle Bronze Age gave was to an economy of ranches by the Late Bronze Age. In the latter, pasture – as evidenced by mollusc data – would be separated by linear ditch system property boundaries.

Dry valleys along the route of the A27 Brighton Bypass were not the only locations sampled for molluscan study during the project. For example at Coldean Lane a Bronze Age settlement site was also sampled at relatively coarse intervals during the rescue excavations (Wilkinson in Rudling 2002). The site was dated by 11 ^{14}C dates and their results suggest occupation between 1680-1570 cal. BC and 1020-800 cal. BC when the Bayesian approaches of Bayliss and Orton (Bayliss and Orton 1994) were applied (Bayliss *et al* 2002). Mollusc samples from the ditch bounding the settlement contained a *Vallonia excentrica*-dominated fauna in the primary fill, suggesting that the settlement was constructed in short grassland. The secondary fills contained higher proportions of shade loving molluscs (represented mainly by the Zonitidae) and *Vallonia costata*, indicating the development of vegetation within the ditch, but open conditions outside. The fills of a hut terrace which must have accumulated following the abandonment of the site were also sampled. The initial *Vallonia costata*-dominated assemblage has been interpreted as indicating an adjacent arable environment (Wilkinson in Rudling 2002). However, *Pupilla muscorum* dominated the assemblage of the final terrace fill suggesting short turf grassland, while the presence of *Cernuella virgata* indicates that the deposit accumulated in the historic period.

Mollusc samples from a further Bronze Age settlement in the Brighton area were obtained during excavations preceding the construction of new halls of residence for the University of Sussex. The Varley Halls site comprised four Middle Bronze Age hut platforms associated with Deverel Rimbury pottery and surrounded by a palisade ditch (Greig 1997). One of the hut platforms (number 3) was ^{14}C dated to 1510-1270 cal. BC (3130±50 BP, BM 2936 on charcoal) and the palisade ditch to 1430-1130 cal. BC (3050±50 BP, BM 2917 on a cow bone) (Greig 1997; Ambers and Bowman 2007). The mollusc samples were taken from the modern soil, through fills of one of the hut platforms and from the palisade ditch. The site was grassland pasture at the time of the excavation and the assemblage of *Trichia hispida*, *Vallonia costata*, *Vallonia excentrica*, *Pupilla muscorum* and *Helicella itala* obtained from samples through the modern turf line is typical for short sward environments (Wilkinson in Greig 1997). The palisade ditch contained only secondary fills forming after the palisade had rotted. These contained mollusc assemblages dominated by shade-loving taxa such as *Carychium tridentatum*, *Vitrea contracta* and *Discus rotundatus*, while *Trichia hispida* and *Vallonia costata* were found at lower frequencies. *Carychium tridentatum* and *Vitrea contracta* decreased upwards through the ditch sequence while *Discus rotundatus* increased. These changes suggest that the ditch contained a long grassland vegetation during initial accumulation of the secondary fill, but that shade gradually spread to the area around the ditch following site abandonment (Wilkinson in Greig 1997). The hut terrace contained a series of colluvial 'fills' which were initially dominated by *Vallonia costata*, but later *Vitrina pellucida*, *Vitrea contracta*, *Discus* *rotundatus* and *Carychium tridentatum* became more important components of the assemblage and suggest a shift from short turf to long grassland. This latter development may have corresponded to the spread of shade from the palisade ditch once the site fell into disuse (Wilkinson in Greig 1997).

Away from East Sussex, mollusc analyses of Bronze Age settlements are rare. One notable example, however, is the examination of aeolian deposits associated with the Bronze Age settlement on Brean Down, Somerset. Excavations in 1985-1986 revealed two stone structures, thought to be remains of hut walls and which were associated with Trevisker Ware pottery (Bell 1990a, 37-62). ^{14}C dates on charcoal from this phase of the site (Unit 5b) centred on 1300-840 cal. BC (2870±80 BP, HAR 7018) suggesting activity in the Middle Bronze Age (Walker 1990). Shells from stabilisation levels in the aeolian sands (Unit 7) that preceded this Middle Bronze Age settlement suggest that the dunes were occupied by a short, dry grass sward (*Vallonia costata*, *Vallonia excentrica*, *Helicella itala* and *Truncatellina cylindrica*) (Bell and Johnson 1990). However, some damper, shadier areas may have been present, as evidenced by the presence of *Clausilia bidentata*, *Macrogastra rolphii*, *Balea perversa*, *Carychium tridentatum*, *Acanthinula aculeata* and *Aegopinella nitidula*. These shade loving taxa had disappeared in samples from the top of aeolian deposits (Unit 5d) that immediately preceded the settlement. The Middle Bronze Age human activity is associated with a stabilisation level within the sands (Unit 5b), and yet the molluscan fauna is also dominated by *Helicella itala* and lesser frequencies of *Vallonia excentrica*, while the presence of *Truncatellina cylindrica* suggests an open area with very little vegetation. Late Bronze Age occupation evidence was found in the overlying aeolian sand (Unit 4), from which two Class B1 gold bracelets were also recovered (Bell 1990a, 6; Needham 1990). Molluscs from this level also indicate open, dry and unvegetated conditions, but the assemblages are characterised by *Cernuella virgata* and *Cochlicella acuta*, both species that were once thought to be historic period introductions into Britain (Kerney 1966). However, the latter at least has also been found in Bronze Age deposits at Gwithian, Cornwall (Spencer 1975), and therefore seems to have arrived in Britain in the Middle Holocene to colonise coastal sand dunes, and only moved inland in the historic period. Taken as a whole, the molluscan assemblages from Brean Down suggest a very limited human impact on the local environment in the Bronze Age, it being unclear whether the removal of shade in the pre-Middle Bronze Age dunes was the result of human or natural processes. Given that Brean Down is a coastal site, marine molluscs were found during the excavation. However, only in midden deposits from Late Bronze Age Unit 4 was there reasonable evidence for human exploitation of shellfish. *Patella vulgata* (limpet) and *Littorina littorea* (common periwinkle) dominated the assemblage of 403 individuals, suggesting exploitation of the near shore environment (Bell and Johnson 1990). In other units marine molluscs were found in small numbers, but these were most likely shells dropped by birds, or smaller-shelled taxa brought to the site in seaweed (Bell and Johnson 1990).

Bronze Age settlements on floodplains have on occasion also been the subject of molluscan study. For example Robinson (in Thomas *et al* 1986) examined shells from alluvial sediments over and underlying Bronze Age occupation deposits at Wallingford, Oxfordshire. The basal channel deposits contained mostly aquatic taxa, presumably derived from much of the stretch of the river, while the terrestrial species that were found are indicative of wet grassland banks. The overlying floodplain deposits were dominated by terrestrial taxa such as *Vallonia pulchella* and *Trichia hispida* suggesting damp grassland, although gradual increases in *Vertigo pygmaea* and *Vallonia costata* suggest that conditions became drier over time. Robinson (in Thomas *et al* 1986) suggests that this environment was managed by Bronze Age people, perhaps as grazing. Bronze Age human activity on the floodplain corresponded with the driest grassland phase, while the occupation deposits were sealed by overbank sediments characteristic of wetter conditions and which suggest the previous management regime had been abandoned.

Perhaps the best known Bronze Age settlement in an alluvial situation in the Southern Region is Runnymede Bridge, Surrey (Needham 1991; 2000). Molluscan evidence from Neolithic strata has already been discussed in the previous section. That from the Bronze Age argues for the persistence of freshwater habitats. The freshwater environments comprised channel fills dominated by *Valvata piscinalis*, *Bithynia tentaculata*, *Bithynia leachii* and lesser quantities of *Theodoxus fluviatilis*, *Gyraulus albus* and *Valvata cristata*, and overbank alluvium characterised by terrestrial taxa such as *Trichia hispida*, *Vallonia costata* and *Carychium minimum* with low numbers of the aquatic species noted above (Evans and Evans 2000). A Late Bronze Age palaeosol and associated occupation deposits contained a very similar fauna to the Middle Bronze Age floodplain, suggesting that conditions on the floodplain remained open (Evans and Evans 2000).

Mollusca recovered from samples taken through ditch sequences from a number of Bronze Age round barrows have been examined by Mike Allen. For example, samples from the Fordington Farm barrow near Dorchester suggested that the barrow, built to cover two inhumations dated to 2350-1950 cal. BC (3715±54 BP, UB-3304; 3767±47 BP, UB 3305), was constructed in an open dry grassland (*Vallonia excentrica* and *Pupilla muscorum*) (Allen in Bellamy 1991). The barrow was expanded over time, but the successive ditches that enclosed the larger mound contained a similar mollusc fauna to the original, albeit that over time *Vallonia costata* became more important than *Vallonia excentrica*. Indeed the third ditch included turfs removed when the barrow was enlarged, and these too contained the *Pupilla muscorum*-*Vallonia costata*-dominated grassland assemblage. Allen (in Bellamy 1991) suggests that the barrow was built and used in an environment that was heavily grazed by sheep and cattle, and that only in the Iron Age was the area ploughed (evidenced by an increase of *Trichia hispida* and reduction of *Pupilla muscorum* in the fills of the fourth ditch). Ditch fills from the Barford Farm barrow, Pamphill, Wimborne Minster contained a similar mollusc assemblage to that at Fordington Farm, with *Pupilla muscorum*, *Vallonia costata* and *Vallonia excentrica* dominating (Allen in Howard 1989). However, the presence of *Discus rotundatus* and *Carychium tridentatum* suggest that the ditch itself may have been shaded. The primary ditch fill was associated with a ^{14}C date of 2430-1690 cal. BC (3639±120 BP, HAR 9597), but was truncated by a recut. However, the fills of the recut contained the same Mollusca as those of the earlier ditch suggesting the presence of grassland environments through the history of ditch infilling. Molluscan faunas from the primary fill of the ditch surrounding the Round-the-Down barrow near Lewes, East Sussex on the other hand were primarily of shade-loving taxa (Allen in Butler 1995), thereby suggesting that barrows were not always built in open pasture. *Carychium tridentatum*, *Discus rotundatus* and *Vitrea contracta* dominated the lowermost assemblages suggesting that long grassland existed when the barrow was built.

However, the increasing importance of *Discus rotundatus*, *Aegopinella nitidula* and *Oxychilus cellarius* and the presence of *Balea perversa* and *Acicula fusca* in later fills suggests that woodland had spread to cover the barrow. A tertiary fill developed in the historic period (as evidenced by the appearance of introduced species of the Helicidae) in which a molluscan fauna characteristic of arable environments and dominated by *Pupilla muscorum* was found.

Molluscs from palaeosols buried beneath Bronze Age barrows have been investigated in the few circumstances where such soils exist. For example sampling was possible of the King Barrow Ridge barrows near Stonehenge when the palaeosols were exposed in tree throw holes after storms in October 1987 and January 1990 (Cleal *et al* 2004). The B horizons of the two barrows examined (G30 and G32) contained assemblages dominated by *Pupilla muscorum*, *Vallonia costata*, *Vallonia excentrica*, *Helicella itala* and *Pomatias elegans*, and suggests ungrazed grassland prior to barrow construction (Allen and Wyles in Cleal *et al* 2004). In the A horizon beneath G30, *Vallonia excentrica* dominated over *Vallonia costata*, while *Pupilla muscorum* was present at much lower frequencies and the compulsive xerophile *Truncatellina cylindrica* was also noted. These data suggest that the barrow was built in grazed, short-turfed grassland, but that grassland environments had existed throughout the history of the soil (Allen and Wyles in Cleal *et al* 2004).

Several unusual features of Bronze Age date have also been the subject of molluscan study. Wilsford Shaft, Wiltshire is just such a site and given its location 1.6km south-west of Stonehenge is of great interest. Originally excavated in 1960-1962 by Edwina Proudfoot, the site comprises a human-constructed, 30m deep shaft filled over a period of about 800 years by cultural and colluvial deposits (Ashbee *et al* 1989, 1). ^{14}C dates from the base of the shaft suggest that it was in use around 1500-1380 cal. BC (3151±29 BP, combination of OxA 1214-1217 and OxA 1229) (Housley and Hedges 1989). Depositional infilling, which occurred very rapidly following removal/disintegration of a timber shaft head structure, was both initiated and completed to a depth of 3.6m below surface while Deverel-Rimbury style pottery was in use (Ashbee 1989). The basal 2m of deposits have been permanently waterlogged since they accumulated, but water table fluctuations extend to 12m from the base (Bell 1989a). Bulk samples were taken irregularly from the upper fills (>5.7m depth – samples higher in the sequence were accidentally destroyed), and more consistently from the waterlogged deposits during the various excavation campaigns. Sample processing was carried out on site, albeit that it is uncertain what sieve size was used (Bell 1989a). The mollusc assemblages recovered reflect conditions around the mouth of the shaft over the c 150 years that the Bronze Age fills accumulated (Bell 1989b). The domination of the assemblages by *Pupilla muscorum*, *Vallonia excentrica*, *Vallonia costata*, *Trichia hispida* and *Helicella itala* suggests the presence of short grassland pasture albeit with some areas devoid of vegetation. The almost complete absence of shade loving taxa has led Bell (1989b) to suggest that forest clearance had occurred a long time prior to shaft construction. As has been noted in the previous section, this hypothesis accords well with current knowledge of the Later Neolithic in the Stonehenge area (Allen 1997).

The Dover Boat is another example of an unusual Bronze Age feature where mollusc analysis has played a key role in palaeoenvironmental reconstruction. The boat was found in Dover, Kent in 1992 during the construction of a pedestrian underpass beneath the A20 (Parfitt 2004). A combination of dendrochronology and ^{14}C dating suggests that the boat was built between 1575 and 1520 cal. BC (Bayliss *et al* 2004), while geoarchaeological work demonstrates that it was abandoned in a creek infilled by tufaceous deposits (Keeley *et al* 2004). Bedded silts then buried the boat and completed the filling of the channel. A peat forming the base of the investigated sequence and cut through by the channel was dated to 2850-2280 cal. BC (3985±65, OxA 7997) (Bayliss *et al* 2004). It contained a mollusc assemblage indicating accretion in a marshy backswamp (*Carychium minimum*, *Lymnaea truncatula*, Succineidae, *Vertigo angustior*) with drier areas occupied by tall vegetation (*Discus rotundatus*, *Aegopinella* sp., *Oxychilus* sp.) and wetter zones comprising well vegetated pools (*Valvata cristata*) (Figure 6). Taxa from tufa beneath the boat, but forming the first channel fills above the peat suggest that palaeochannel deposition commenced in a slow-flowing, shallow stream (*Valvata piscinalis*). However, immediately before the boat was abandoned the prevalence of *Ancylus fluviatilis* indicates that fluvial energies were greater and that the channel bed was stony (probably as a result of the presence of tufa pellets). At the same time, the predominantly shade loving terrestrial component of the mollusc fauna was replaced by open country taxa including *Vallonia costata* and *Pupilla muscorum*, suggesting the clearance of taller vegetation bordering the channel and the development of grassland. The earliest silts infilling the boat (context 4933, Figure 6) contained an interesting fauna dominated by *Lymnaea peregra*, a characteristic colonising species. Later assemblages from tufa deposited inside the boat were similar to those underneath it, although the decline of *Ancylus fluviatilis* and increase in marsh dwelling taxa suggest that the boat was now located in a marginal position at the edge of the channel. The bedded silts that completed the channel infill seem to have accreted in rather deeper and slower moving water than the tufa judging from the presence of a mixed assemblage of *Valvata piscinalis*, *Pisidium nitidum*, *Ancylus fluviatilis* and *Lymnaea peregra*. Perhaps the key finding of the molluscan study of the Dover Bronze Age boat was that all sampled sediment units formed in fully freshwater environments, despite a. the probability that the boat was a sea-going vessel and b. the proximity (<200m) of the present shore face to the site.

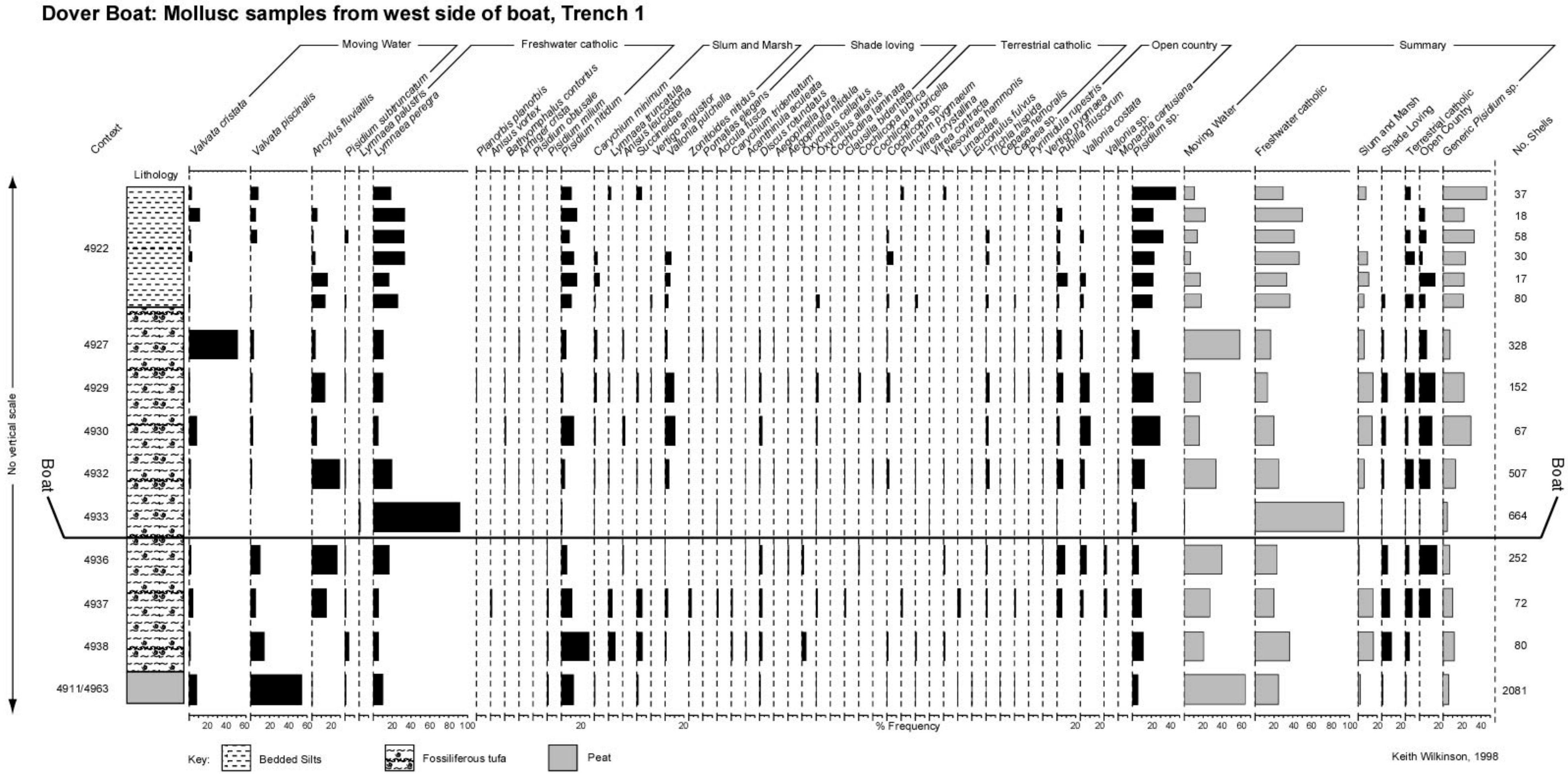

Figure 4: Percentage histogram of molluscs from beneath, within and above the Dover Bronze Age boat (after Wilkinson and Stevens 2003, figure 46, 114-115)

Molluscan analysis of Bronze Age deposits and palaeosols in the Southern region suggests that sites were used in open landscapes that had a relatively long history of prior grassland or arable cultivation prior to human activity in the Bronze Age. Many dry valley colluvial sequences also seem to have been initiated in the Bronze Age. Nevertheless molluscan evidence reviewed in the previous section would seem to suggest that open cultivated landscapes of the southern English chalklands at least had their origin in the Beaker period. Population increase, the introduction of the plough and consequent intensification/extensification in the Bronze Age merely accentuated the development of the open farmed landscape, while also leading to the first major erosive episodes since the Late Glacial.

Research agenda

- The Bronze Age is known to be a period of agricultural intensification which was accompanied by (either as the cause or the consequence of) population increase, social stratigraphication and the development of complex societies. Palynological (e.g. Thorley 1981; Scaife 1982; Waton 1982; Waller and Hamilton 2000) and geomorphological evidence (e.g. as reviewed by Wilkinson 2009) clearly demonstrate the impact of these changes on the vegetation and the wider environment. Molluscan data are, however, at present equivocal on these changes, largely because when compared to Neolithic sites, relatively few Bronze Age sites have been examined. Nevertheless molluscan data from Bronze Age contexts have the potential to examine the effect of intensification on local environments surrounding archaeological sites and therefore more analysis of all types of Bronze Age sites are needed.

- Assuming that the Bronze Age was the period when much of southern Britain was cleared of woodland, it is particularly important that newly created pasture and arable environments can be distinguished from one another. Evans' (1991a) taxocenes offers one way forward, but modern ecological studies of molluscs associated with known land use at experimental farms such as Butser, Hampshire may offer another way forward (while accepting that colonisation by introduced helicids and prior use of chemical fertilisers and pesticides makes such locations imperfect proxies).

- Bronze Age people appear to have made greater use of floodplains than their Neolithic forebears, perhaps because the introduction of the plough enabled heavy alluvial soils to be cultivated. However, comparatively little is known of the environments of these Bronze Age landscapes, in part because there are only molluscan data from two relevant sites in the Southern region (i.e. Wallingford and Runnymede). Molluscan analysis of Bronze Age floodplain sites might enable a better characterisation of this important landscape type thereby going some way to explain why it was only exploited intensively from the second millennium BC.

4.5 Iron Age

The chronological point at which the Bronze Age becomes the Iron Age is as difficult to pin down as the change from the Neolithic to Bronze Age. Indeed the reasons for the uncertainty are exactly the same as for that earlier transition: monuments such as hillforts and domestic pottery styles once thought to have been characteristic features of the Iron Age are now known to have their origins in the Bronze Age (Haselgrove 1999). Even the prime indicator of the Iron Age, iron production, has been found from a Late Bronze Age site at Bucklebury, West Berkshire (Collard *et al* 2006). Nevertheless, however defined, the Iron Age does mark a change in the archaeological record of southern England. Whereas Bronze Age settlements are few and often small, those of the Iron Age are many and are of a huge variety of sizes from single farmsteads to oppida occupying many hectares (Haselgrove 1999). Conversely there is little evidence from the Iron Age for the disposal of the dead.

Conventionally the southern British Iron Age is divided into three phases: Early Iron Age - 800-300 BC, Middle Iron Age – 300-100 BC, and Late Iron Age – 100 BC-AD 43 (Haselgrove 1999). However, the first millennium BC corresponds to a relatively flat part of the ^{14}C calibration curve meaning that even dates with small estimated errors will represent several centuries of calendar years, while for many parts of southern England, pottery typologies equate in an uncertain way to real time. Thus molluscan data from Iron Age sites are rarely attributable to a narrowly defined chronological range. Typical of this problem are dry valley fills. At Kiln Combe generic Iron Age pottery was found at the top of a palaeosol where it was associated with a *Vallonia* sp., *Trichia hispida* and *Helicella itala*-dominated fauna that suggests open conditions (Bell 1983). However, at Itford Bottom similar Iron Age pottery to that found at Kiln Combe was more widely spread through the lower colluvial layers and the *Trichia hispida* dominated assemblage together with *Vallonia* sp., and *Pupilla muscorum* indicates an arable land usage (Bell 1983).

Some dry valleys examined along the route of the A27 Brighton Bypass contain Iron Age colluvium, but problems of separating Early Iron Age from Late Bronze Age ceramic fabrics and the fact that Iron Age Sussex Ouse and Romano-British East Sussex Ware pottery are very similar make is difficult to differentiate Iron Age strata from those of Bronze Age or Romano-British date (Wilkinson *et al* 2002). Nevertheless arable or heavily grazed pasture land-use is attested for the Iron Age by a faunas dominated by *Vallonia excentrica* and *Pupilla muscorum* at Hangleton Bottom, while at Toadeshole Bottom East *Trichia hispida*, *Vallonia costata*, *Vallonia excentrica* and *Helicella itala* suggest much the same conditions (Wilkinson *et al* 2002). Colluvial dry valley fills in the Bourne Valley, Eastbourne, East Sussex were dated by archaeomagnetic techniques to the 300 BC to AD 300 interval (Allen 2007). They were dominated by *Trichia hispida*, *Vallonia costata*, *Vallonia excentrica* and *Pupilla muscorum*, i.e. a typical assemblage characteristic of arable environments. However, shade-loving taxa such as *Aegopinella nitidula*, *Discus rotundatus*, *Carychium tridentatum* and *Trichia striolata* appear towards the top of the colluvium, suggesting that the site was on the shaded edge of a field (Allen 2007).

Further Iron Age mollusc assemblages were associated with a another A27 site, namely colluvial fills accumulating behind lynchets of Early Iron Age date at Eastwick Barn (Barber *et al* 2002). Unsurprisingly the colluvium was characterised by a fauna indicative of arable land-usage dominated by *Vallonia excentrica*, with lesser numbers of *Vallonia costata*, and fewer still of *Trichia hispida* and *Helicella itala* (Wilkinson in Barber *et al* 2002). Molluscs from further lynchet deposits have been examined at Bishopstone, East Sussex, although as with the dry valley fills discussed above, there were problems of separating Iron Age from Romano-British strata (Bell 1977). However, given that the mollusc assemblages did not change noticeably through the sequence, chronological differentiation is not a particular issue in this case. The Bishopstone assemblages are characterised by *Vallonia costata*, *Vallonia excentrica*, *Trichia hispida* and *Pupilla muscorum* in approximately equal quantities and they probably indicate the presence of arable environments (Thomas in Bell 1977). Evans (1972, 317-321) has also examined mollusc samples from Iron Age lynchet accumulations at Fyfield Down I and Overton Down in Wiltshire. Assemblages from both sites conform to the pattern seen above: domination by *Vallonia excentrica*, with lesser quantities of *Vallonia costata*, *Trichia hispida* and *Helicella itala* (Evans 1972, 317-321). Interestingly Evans (1972, 317-321) notes that *Pupilla muscorum* only occurs in profusion at these sites in samples from the modern grassland turf.

It is perhaps surprising given the frequency, scale and number of archaeological investigations that have been carried out of Iron Age monuments and settlements in the Southern region, that so few molluscan analysis have appeared in publications. Evans (1972, 337-341) carried out an analysis of samples taken from a buried soil and ditch sequence at the Badbury late Iron Age earthwork near Blandford Forum, Dorset. He interpreted the prevalence of *Pupilla muscorum* and *Helicella itala* over *Vallonia costata* and *Vallonia excentrica* in the palaeosol beneath the earthwork and in fallen turfs in the primary fill of the ditch as indicating that the monument was constructed in an arable environment (Evans 1972, 338). The base of the secondary ditch fill was characterised by shade loving taxa such as *Carychium tridentatum*, *Discus rotundatus* and the Zonitidae, but these were probably taking advantage of the damp, vegetated microenvironment of the ditch – although Evans (1972, 339) suggests woodland was also present outside the ditch. Open country taxa such as *Pupilla muscorum* and *Helicella itala* dominated the upper secondary fills indicating similar arable environments to those indicated in the buried palaeosol.

Few mollusc analyses have been carried out – or at least published - of the best known Iron Age monument type, namely hillforts. Danebury in Hampshire is one exception where there is extensive molluscan evidence. Evans (1984a; Evans and Hewitt 1991) examined samples from land surfaces predating the hillfort banks, from pits, quarry hollows and from a linear earthwork outside the hillfort. The earliest feature sampled was a soil buried beneath a linear earthwork predating the hillfort and which is thought to date from the 7-8th centuries BC (Cunliffe 1995, 16). Assemblages towards the base of the buried soil contained a shade loving assemblage characterised by *Carychium tridentatum*, *Pomatias elegans* and *Discus rotundatus*, suggesting a woodland environment in the Late Bronze and/or Early Iron Age (Evans and Hewitt 1991). This then changes to a fauna in which *Vallonia excentrica*, *Vallonia costata* and *Pupilla muscorum* predominate and indicating that pasture immediately preceded construction of the bank. The palaeosols sealed by the hillfort ramparts, the earliest of which date to the 5th century BC (Cunliffe 1995, 16), have been sampled at three different locations. However, the mollusc assemblages at each sample point were similar and are dominated of *Pupilla muscorum*, with lesser quantities of *Vallonia excentrica* and *Helicella itala* (Evans 1984a; Evans and Hewitt

1991). These assemblages suggest that the Danebury Early Iron Age hillfort was built in grazed short-turfed grassland.

Mollusc data from one other hillfort have been published, namely an Early Iron Age quarry fill sequence from Vespasian's Camp, Amesbury, Wiltshire (Allen in Hunter-Mann 1999). The quarries are thought to have been dug to provide chalk to build the ramparts and are about 1.5m deep (Hunter-Mann 1999). The mollusc assemblages were dominated throughout by *Pupilla muscorum* and *Vallonia costata*, with slightly lesser frequencies of *Trichia hispida* and *Helicella itala* (Allen in Hunter-Mann 1999). The predominance of *Trichia hispida* and *Vallonia excentrica* at the base of the quarry suggests disturbed open conditions. *Pupilla muscorum* increased in importance in later layers suggesting an open trampled grassland environment during the use of the hillfort. Thereafter *Pupilla muscorum* became less important, but *Vallonia costata* and *Trichia hispida* increased in number, indicating that the top of the hill was cultivated. Frequencies of *Helicella itala* later increased while *Trichia hispida* decreased, suggesting short turfed grassland or arable conditions. The topmost sample included *Carychium tridentatum* and members of the Zonitidae which mark the appearance of the longer grassland and woodland that now occupy the hill.

Molluscan evidence from Iron Age deposits in the Southern region presents a picture of open and mostly arable environments. However, it must be emphasised that this interpretation is on the basis of relatively few analyses. As was the case for Neolithic monuments, molluscan evidence from Iron Age ditch sequences provides a picture of site use and disuse, albeit one that cannot be accurately dated because of problems of residuality, chronologically undiagnostic pottery styles and the flatness of the ^{14}C calibration curve in the first millennium BC. The molluscan data that have appeared in print suggest that Iron Age monuments were built in open environments but that conditions did not always subsequently remain open.

Research Agenda

- There is a perception among some environmental archaeologists and Iron Age specialists that it is not worth undertaking molluscan work on sequences associated with Iron Age sites, perhaps because the data recovered will merely demonstrate open conditions. However, the few mollusc analyses that have been undertaken provide useful records of site use and disuse following monument construction. It would therefore seem worthwhile to undertake mollusc analyses of Iron Age ditch sequences to examine post-abandonment land-usage.

- Problems of chronology are of particular significance when interpreting molluscan data thought to date from the Iron Age – more so than for any other period in the Holocene. It is therefore important that molluscan analyses are only undertaken on sequences that can be precisely dated.

4.6 Romano-British

As is the case for the Iron Age relatively few molluscan studies have been published from historic period sites in Southern England and those that have often relate to a small number of samples taken to resolve a specific archaeological problem. However, colluvial dry valley fills, which as discussed above were originally targeted at examining prehistoric landscape change (Bell 1983), often contain thick sequences of Romano-British deposits (Preece 1980a; Bell 1981; 1983; Wilkinson 1993; Allen 1994; Wilkinson *et al* 2002). As is the case with Bronze and Iron Age dry valley colluvium, molluscan assemblages from Romano-British colluvium in Southern England are dominated by the open country taxa *Vallonia excentrica* and *Vallonia costata*, and the catholic taxon *Trichia hispida*. The presence of such assemblages suggests that Romano-British 'hillwash' formed as a result of cultivation of the surrounding slopes just as was the case for the Bronze and Iron Ages. However, both Bell (1983) and Wilkinson (2003) have noted the importance of *Pupilla muscorum* in the Romano-British assemblages from colluvium. Indeed, given that *Pupilla muscorum* is found in low frequencies in the medieval deposits that overlie Romano-British colluvium in Sussex dry valley sites such as Kiln Coombe, Hangleton Bottom, Toadeshole Bottom (East and West) (Bell 1983; Wilkinson *et al* 2002), it would appear that a high frequency of this taxon is a peculiar characteristic of the Romano-British period. *Pupilla muscorum* is not usually associated with arable environments and therefore Bell (1983) has interpreted its importance in Romano-British rural landscapes as indicating either pronounced periods of fallow or alternatively that stable grassland had developed on lynchet banks. Sites such as Itford Bottom and Kiln Coombe (Bell 1983) and Eastwick Barn (Wilkinson *et al* 2002), East Sussex are examples where Romano-British dry valley colluvium is associated with lyncheted field systems. Although these lynchets were originally constructed in the Iron Age they were in use in the Romano-British period and the archaeological evidence suggests an arable land-use regime during the early historic period. Indeed an examination of molluscs from colluvium accumulating behind the Eastwick Barn lynchets discussed above suggest arable environments in the Romano-British period characterised by mollusc assemblages dominated by *Vallonia excentrica* and *Vallonia costata* (Wilkinson in Barber *et al* 2002). At Bishopstone, East Sussex molluscan faunas from Romano-British phases of the Rookery Hill lynchet were dominated by *Vallonia excentrica*, *Vallonia costata*, *Trichia. hispida*, *Helicella itala* and the Limacidae, indicating arable conditions (Thomas in Bell 1977), while similar lynchet accumulations at Fyfield and Overton Down, Wiltshire also contained molluscs suggesting Romano-British cultivation (Evans in Fowler and Evans 1967). Mollusc assemblages associated with Romano-British colluvium banked behind lynchets at Malling Hill, East Sussex have been examined by Allen (1995) where associated deposits were exposed by quarrying. *Pupilla muscorum* dominated these assemblages alongside lower quantities of *Trichia hispida* and *Vallonia excentrica*, suggesting the presence of grazed short-turfed grassland.

A Romano-British landscape of a rather different character was investigated by Stephen Rippon (2000) on the north Somerset Levels. Land, freshwater and brackish water Mollusca were some of the many palaeoenvironmental proxies used to investigate the landscape of these intertidal lands reclaimed by construction of coastal defences in the third century AD. Nevertheless even by the end of the first century BC intertidal conditions were interspersed with areas of drier ground without human intervention. A saltern close to the village of Banwell typifies this Late Iron Age/early Romano-British mosaic landscape. Brackish water assemblages of *Hydrobia ulvae* and *Hydrobia ventrosa* were found from sediments associated with the saltern, but a dry ground open country assemblage of *Vertigo pygmaea*, *Pupilla muscorum* and the marsh-dweller *Vallonia pulchella* was found amongst the rubble left when the saltern fell into disuse (Davies in Rippon 2000). The saltern was buried by freshwater alluvium containing an assemblage dominated by *Bithynia tentaculata*, although there was still some evidence of brackish conditions as demonstrated by the presence of low numbers of *Hydrobia* sp. Drainage ditches cut into this alluvium in the third century AD at Banwell and Kenn Moor had primary fills containing *Anisus leucostoma* and *Bithynia tentaculata*, and *Bithynia tentaculata*, *Bathyomphalus contortus*, *Lymnaea peregra*, *Armiger crista*, *Planorbis planorbis*, *Planorbarius corneus*, *Anisus leuconstoma* and *Aplexa hypnorum* respectively (Davies in Rippon 2000). A very few *Hydrobia* sp. were noted in both assemblages which otherwise suggested a freshwater environment (vegetated in the case of Kenn Moor) that dried seasonally to leave a muddy substrate. The few terrestrial shells that were found were all of open country preference suggesting that the fields on either side of the ditches were heavily grazed. A comparison of the assemblages from the Romano-British ditches on the North Somerset Levels with modern mollusc faunas from drainage ditches of the Gwent Levels (Drake 1986), suggests that conditions in the two ditch complexes were very similar (Rippon 2000). Ditch assemblages dominated by *Anisus leucostoma* are similar to modern 'neglected' ditches, while those in which other planorbids and *Bithynia tentaculata* are found equate with 'regularly cleaned and vegetated ditches' (Rippon 2000).

Marine mollusc shells of Romano-British date have been recovered from a number of sites in the Southern region, most notably from towns. In most cases the shells have simply been identified and then quantified, and rarely has any attempt been made to use metrical approaches to differentiate shell source within or between sites. Given that marine shells are found in Romano-British sites that are located at some distance from the coast – attesting to sophisticated transportation and trade networks – such metrical studies could provide interesting palaeoecological and dietary data. An example of where such an approach has been taken was a collection of oyster (*Ostrea edulis*) shells recovered during a watching brief from 2-4th century AD urban deposits at Ilchester, Somerset (Wilkinson in Broomhead 1998). Ilchester is 35 km from the sea, but is connected to it via the rivers Yeo and Parrett suggesting that boats might have supplied the Roman town with shellfish. Measurements made of shell size (by measuring from the hinge to the outside of the valve and a second measurement at right angles to the first) demonstrate that the exploited oysters came from two different sources or perhaps that they were collected during two seasons (Wilkinson in Broomhead 1998). The oyster shells were deposited in rubbish pits in association with a very few mussels (*Mytilus edulis*) and limpets (*Patella vulgata*), but many animal bones and plant macro-remains.

4.7 Medieval

Mollusc studies from medieval archaeological sites are even less common than those from Romano-British stratigraphy. Nevertheless many of the colluvial dry valley fills introduced in previous sections of the text included medieval layers. The Kiln Coombe dry valley sequence in East Sussex investigated by Bell (1983) was located within 70m of a deserted medieval settlement that was itself excavated as part of the Bullock Down survey (Drewett 1982). Distinct calcareous colluvium of 12-14th century date and containing a restricted *Trichia hispida*, *Vallonia excentrica* and *Vallonia costata*-dominated fauna was found towards the top of colluvial sequence, suggesting that an arable land-use predominated around the settlement (Bell 1983). The dry valley transect trench at Hangleton Bottom, Brighton, East Sussex was also positioned close to a deserted medieval settlement (Wilkinson *et al* 2002). The c 1m thick sequence of medieval colluvium found in the dry valley was characterised by the same *Trichia hispida*, *Vallonia excentrica* and *Vallonia costata* fauna as at Kiln Coombe, suggesting that cultivation was the economic basis of the village. However, the presence of similar mollusc assemblages in medieval colluvium sampled in locations that were not adjacent to medieval settlements [e.g. Toadeshole Bottom East and West, Brighton, East Sussex (Wilkinson *et al* 2002)], suggests that arable environments on the South Downs extended beyond the immediate catchments of farming villages.

A few studies of medieval sequences have been carried out away from the South Downs. For example a molluscan study of floodplain alluvium post-dating 260-560 cal. AD (1620±50 BP) has been reported from Kingsmead Bridge, Wiltshire (Davies 1998). Interpretation according to Evans' (Evans *et al* 1992) wet ground taxocenes and by use of Detrended Correspondence Analysis suggests that conditions were initially extremely wet grassland (assemblages dominated by *Anisus leucostoma* and *Lymnaea truncatula*), but later, flooding became less common and short grassland developed (*Vallonia pulchella* and *Pupilla muscorum*). This is likely to have comprised water meadows used for pasturing cattle. The final samples indicated a return to slightly wetter conditions once more as river levels rose (expansion in *Lymnaea truncatula*).

4.8 Post-medieval

As is the case for the other historic periods there are very few published molluscan studies of Post-medieval sites. Those that have been undertaken have mostly been of alluvial environments. For example Davies and Grimes (1999) have studied modern molluscan faunas in various watermeadow features in the Wylye valley, Wiltshire in order to better interpret overbank alluvial assemblages. Abandoned drainage features were found to be occupied by *Trichia hispida*, *Vallonia pulchella*, *Cochlicopa*, *Carychium minimum*, *Carychium tridentatum*, and *Lymnaea truncatula*, while disused carriers were characterised by the first three only.

A sequence of 12-17th century deposits infilling the moat of Shapwick House, Shapwick, Somerset was sampled for a series of bioarchaeological proxies, including molluscs during excavations conducted in 1997 (Gerrard and Aston 2007, 852-868). The sedimentary characteristics of the moat and the fact that organic artefacts were preserved indicate that the feature would have contained water. However, the domination of the mollusc assemblages by *Anisus leucostoma*, a species characteristic of 'slum' type environments (Sparks 1961), suggested that the water was both shallow and muddy, while the presence of *Planorbis planorbis* and *Armiger crista* indicated the presence of aquatic vegetation (Wilkinson in Gerrard and Aston 2007, 865-868). This then was hardly an impressive feature, although it is notable that the same aquatic molluscan assemblage was found through all 1.25m of sampled deposits, suggesting that the moat was maintained.

Mollusc data obtained from GBA samples taken from 16th century fills of the 'Great Gutter' at Winchester Palace, Lambeth, London have also been recently published (Seeley *et al* 2006, 95). This feature was a 0.8m square section drain built from Purbeck 'marble' in 1253-1254 in order to carry waste away from the Bishop of Winchester's residence to St Mary Overy Dock and hence the Thames (Seeley *et al* 2006, 41-42). The fills began to accumulate once the drain no longer underwent cleaning, but during a period when it continued to be used! Throughout the period of sediment accretion it would appear that a freshwater source was used for flushing as no brackish water molluscs were found. Therefore the adjacent Thames was not being used, given that this was brackish by c. 2000 cal. BC (Sidell *et al* 2000, 109-110). The basal fills of the Great Drain included species of the Planorbidae and *Valvata cristata*, suggesting the presence of aquatic vegetation in the source water, while *Carychium minimum* and *Lymnaea truncatula* indicate muddy areas at the interface of alluvial and terrestrial environments. The latter seems to have been shaded judging by the presence of *Discus rotundatus*, *Vitrea contracta*, *Aegopinella pura*, Clausilidae and the lack of open country taxa. However, the upper fills of the drain were dominated by aquatic species indicative of extensive, fast moving water bodies suggesting that a large water body was being employed for flushing (*Valvata piscinalis*, *Theodoxus fluviatilis*, *Bithynia tentaculata*) (Seeley *et al* 2006, 41-42).

Research agenda

The research agenda outlined below are relevant for all sub-divisions of the historic period. There have been comparatively few on-site studies of terrestrial and freshwater Mollusca from sites of the Romano-British period and later, and those that have been undertaken have been targeted at addressing particular research questions. As was the case for the Iron Age, there is a view that molluscan assemblages from historic sites will merely confirm what is already known, i.e. that open environments were associated with site use and abandonment. However, there are useful themes that future molluscan analysis might explore.

- Off-site molluscan assemblages demonstrate the importance of open environments in the historic period, but as was the case for the Iron and Bronze Ages, it is unclear whether the data are indicative of arable or pastoral environments. This state of affairs is unfortunate given that for the medieval and post-medieval periods in particular much is known of the economy on the basis of the documentary record. For example the South Downs and the Cotswolds were both known as sheep pasturing areas of huge importance in the wool trade. However, without investigation of the molluscan ecology of unimproved pasture and pre-modern cultivated fields, archaeological molluscan studies will not be able to differentiate areas used for sheep grazing from those employed as arable fields. An explanation for the presence of high frequencies of *Pupilla muscorum* in Romano-British open country assemblages also needs to be further explored.

- Several terrestrial molluscan taxa are thought to have been introduced into Britain during the Romano-British and medieval periods. These include the deliberate import of the edible snail, *Helix pomatia* which is known to have been farmed by the Romans (Kerney 1966), but also the accidental introduction of a number of species of the Helicidae, including *Helix aspersa*, *Candidula intersecta* and *Cernuella virgata* (Evans 1972, 175-179). However, the chronology of colonisation by these potentially important zone fossils has never been firmly established. Either AMS dating or the establishment of a chronology by artefact association may help in understanding the timing of their appearance in Britain.

- Marine mollusc shells are a relatively common find on Romano-British and later occupation sites, even those that are located at some distance from the modern coast. However, little is currently done with the shells other than identifying, counting and/or weighing them. Nevertheless for the larger marine mollusc assemblages there is the potential to reconstruct trade and collection practice through metrical and isotopic studies.

5. RESEARCH AGENDA

Research agendas specific to individual periods have been included in the text above. In this section research agenda themes common to mollusc analysis of sites from multiple chronological periods are discussed.

As was outlined in Section 2 the key developments in archaeological mollusc analysis took place in the 1960s. Since the publication of *Land snails in archaeology* (Evans 1972), there have been few significant methodological developments and samples are taken, processed, analysed and interpreted in the same way today as they were in 1972 (e.g. compare Evans 1972, 40-84 with Davies 2008, 3-9, 51-66). However, over the same time period archaeological field practice has altered, mainly as a result of archaeology becoming an integral part of the planning system. Whereas in the early 1970s excavations were either conducted by a central Government-funded organisation or the few archaeological trusts and 'excavation committees', now they are conducted by the numerous private archaeological units. Changes in heritage law have also meant that there has been a huge increase in the number of archaeological excavations that are carried out. The net result is that it is now unusual for the archaeological mollusc specialist to take their own samples. Instead samples are taken by an organisation's generic environmental archaeologist or even by site staff. In order to simplify sampling strategies, but perhaps also to reduce the number of samples taken, flotation samples are commonly the only type of 'bulk' sample taken. While such an approach does make for simplicity and therefore efficiency, there are associated problems for the recovery and interpretation of Mollusca. Firstly flotation samples are usually of 30 litres size or greater, meaning that it is impractical to collect them from vertical sections at sufficient resolution for a meaningful palaeoenvironmental reconstruction. Secondly flotation samples are commonly taken from a wide variety of archaeological features such as pit and post-hole fills, hearths, occupation surfaces etc, as well as ditch fills and palaeosols. Taphonomic and contextual uncertainties mean that mollusc shells from the first few categories are difficult to interpret and therefore have little palaeoenvironmental value. Lastly, unless 0.5mm or finer meshes are used for both flots and residues when employing the flotation technique, and both fractions are systematically sorted to 0.5mm, then the mollusc assemblages that are recovered will be biased towards large-shelled species. In summary, the evidence of the last 40 years has demonstrated that the sampling and processing techniques first advocated by Evans (1972, 41-47) remain the most appropriate and that flotation samples should only be used for mollusc study in the last resort. In other words, despite the supposed efficiency saving of taking a single category of sample, dedicated samples should be collected for molluscan study.

Chronology has often posed a significant problem when interpreting molluscan assemblages given that molluscs are commonly sampled from colluvial deposits of one sort or another (dry valleys and ditch sequences for example) that often lack other classes of biological remains that can be dated using ^{14}C approaches. It is often the case that the date of ditch construction might be known because of ^{14}C determinations on, for example, antler 'picks' found in the primary fill or of material at the top of a buried soil from an adjacent bank. However, the chronology of secondary fills is often poorly defined and entirely based on (often reworked) artefact inclusions. In a dry valley situation chronological uncertainty might be at an even higher order of magnitude. Palaeosols (i.e. breaks in deposition) might be dated by ^{14}C dates on included (often secondary) charcoal derived from trees of unknown age, but all other chronological information is on the basis of reworked artefacts of an unknown provenance which are contained in the colluvium. Sequences with such chronological uncertainties would not be sampled for any other palaeoenvironmental proxy, yet for molluscan study specialists have of necessity had to work on colluvial deposits. However, Preece's (1991; Preece and Bridgland 1998) use of mollusc shell as source material for AMS ^{14}C dating at Holywell Combe has demonstrated that the absence of associated plant or animal bone in a sequence need not prevent a reliable ^{14}C chronology being obtained. Prior to the advent of the AMS technique the requirement for large samples for conventional ^{14}C dating meant that several shells were required to provide a single date. Given that sub-fossil mollusc shell is partly comprised of geological carbonate, older ages than expected were often produced (e.g. Burleigh and Kerney 1982). AMS ^{14}C dating requires much smaller samples and thus a single shell can be dated, while if a litter-feeding (*Arianta arbustorum* at Holywell Combe) rather than a 'rock-scraping' species is chosen the problem of the inclusion of geological carbonate can be minimised (Switsur and Housley 1998). The ^{14}C dating programme at Holywell Combe targeted shells and plant macro remains from the same stratigraphic position and demonstrated a linear correlation between dates obtained on the two ($r = 0.86$) (Switsur and Housley 1998). Therefore, not only is the chronological resolution of contexts sampled for Mollusca every bit as important as those examined for other biological remains, but an absolute chronology can be obtained by dating the very proxy that provides the palaeoenvironmental data.

Whereas methodologies for sampling and analysing molluscs have barely altered since the early 1970s there have been advances in the development of ecological frameworks by which land and freshwater Mollusca are interpreted (e.g. see Davies 2008, 12-42). Evans' (1991a; Evans *et al* 1992) taxocene approach using purely sub-fossil data is one example of such progress, while Davies' (1992; Davies 2003) modern ecological studies of floodplain faunas are another. Nevertheless without further ecological advances (both in autecology and synecology) the interpretation of sub-fossil mollusc assemblages will not progress beyond the current paradigm. Key areas where future ecological studies are required include:

i. Examination of cultivated environments with the aim of determining whether characteristic mollusc faunas exist and whether the latter can be differentiated from those found in pasture. There are several problems inherent to such investigations, namely:
    a. Modern arable environments are unlike those of the archaeological past.
    b. Pesticides and other agrichemicals are likely to have impacted land-snail faunas either directly, or indirectly through the removal of food or host plants.
    c. There has been an influx of colonising mollusc taxa since the Romano-British period which have outcompeted other species that are likely to have previously been characteristic of arable environments in prehistory.

Nevertheless it might be possible to minimise the impact of these problems by sampling palaeosols buried beneath historic period earthworks of known date and where the contemporary land-use is known from written or cartographic sources. Field boundaries would be the ideal features to study. Surface sampling different land-use zones within 'ancient' experimental farms such as Butser, Hampshire might be a further way forward, although it is accepted that these areas have been previously impacted by modern cultivation practice and colonisation by 'introduced' mollusc taxa.

ii. Davies (2008, 158) has suggested that modern ecological work on floodplains, particularly traditionally cut water meadows, and also on different types of floodplain grassland is needed to better characterise mollusc faunas that inhabit these areas. As well as work on the present day ecology, it might also be possible to sample historic palaeosols in such environments that formed under a known land-use.

While there have been a number of ecological studies to improve interpretational frameworks, there has been comparatively little work on shell taphonomy on archaeological sites since the early 1970s. Both Thomas (1985) and Carter (1990b) have examined the problem of shell movement in soils and the implications of the homogenisation of mollusc assemblages by earthworm redistribution. As a result of his work Carter (1990b) recommended that future sampling efforts be focussed on the tops of palaeosols and on ditch fills that are unimpacted by pedogenesis. Although Evans (1990) has considered how ditch fills accumulate, there have been no studies specifically examining the derivation of shells in such deposits or their subsequent taphonomy. This lacuna in knowledge is unfortunate given that the majority of mollusc analyses undertaken as part of present day commercial archaeology are of necessity from ditch deposits as most earthwork sites (where palaeosols might be preserved) are under some form of protection. However, the experimental earthwork at Overton Down offers an unparalleled opportunity to examine shells in ditch deposits, their derivation and how far they reflect micro-environments within the ditch as well as on the exterior.

The final research agendum must be to increase the specialist base. The untimely deaths of John Evans in 2005 and of David Keen in 2006 has removed two of the most senior and active researchers in the field of archaeological and Quaternary conchological research. Compared to the 1980s and 1990s when many PhD students researched archaeological mollusc-related topics under Evans at Cardiff or Ken Thomas at UCL, there are few new researchers. Indeed an examination of the bibliography of this report demonstrates that other than Evans, Keen and Thomas, only Mike Allen, Martin Bell, Paul Davies, Richard Preece and myself have published regularly on archaeological/Quaternary molluscan assemblages in the last two decades. Moreover two of these researchers now rarely work with archaeological Mollusca. Therefore without a new generation of Masters-trained (at the very minimum) molluscan specialists there is a real danger that the skills developed by Evans, Kerney and Sparks, will be lost. Thus there is a good chance that a review of archaeological mollusc studies written in 20 years time may contain very few additional citations to those quoted here.

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APPENDIX Gazeteer of Published Molluscan Sites In the Southern Region arranged by Period. The Final 'Ident.' Column Refers To The Identifying Number Used In Figure 1.

Name	NGR	Type	Period	Reference	Ident.
Wolvercote	SP 498105	Alluvium	Lower Palaeolithic	Bridgland 1994, 58-65	1
Swanscombe	TQ 598743	Alluvium	Lower Palaeolithic	Conway et al. 1996	2
Boxgrove	SU 921 065	Buried soil	Lower Palaeolithic	Roberts and Parfitt 1999	3
Northfleet	TQ 615 735	Alluvium	Lower Palaeolithic	Bridgland 1994, 262-274	4
Red Barns	SU 613 062	Colluvium	Lower Palaeolithic	Wenban Smith et al. 2000	5
Harnham	SU 142 278	Alluvium	Lower Palaeolithic	Bates 2008	6
Oxted	TQ 385 525	Buried soil	Upper Pleistocene	Kerney 1963	9
Halling	TQ 705 645	Buried soil	Upper Pleistocene	Kerney 1963	10
Bramcote Green	TQ 34934 78061	Alluvium	Upper Pleistocene	Thomas and Rackham 1996	11
Watcombe Bottom	SZ 544 773	Solifluction	Upper Pleistocene	Preece et al. 1995	21
Reculver	TR 204 693	Loess	Upper Pleistocene	Preece 1990	69
Brook	TR 065 445	Tufa	Early Holocene	Kerney et al. 1964	7
Holywell Coombe	TR 220 379	Tufa	Early Holocene	Preece and Bridgland 1998	8
Blashenwell	SY 951 805	Tufa	Early Holocene	Preece 1980	12
Totland	SZ 325 865	Tufa	Early Holocene	Preece 1979	13
Cherhill	SU 0311 7005	Tufa	Early Holocene	Evans and Smith 1983	14
Bossington	SU 343 314	Tufa	Early Holocene	Davies and Griffiths 2005	15
Wateringbury	TQ 6876 5344	Tufa	Early Holocene	Kerney et al. 1980	24
Devil's Dyke	TQ 266 102	Colluvium	Holocene	Ellis 1985 1986	16
Toadeshole Bottom East	TQ 280 775	Colluvium	Holocene	Wilkinson et al. 2002	17
Itford Bottom	TQ 4410 0493	Colluvium	Holocene	Bell 1983	18
Kiln Combe	TV 5733 9649	Colluvium	Holocene	Bell 1983	19
Asham Quarry	TQ 440 061	Colluvium	Holocene	Ellis 1985; 1986	23
Hangleton Bottom	TQ 262 071	Colluvium	Holocene	Wilkinson et al. 2002	49
Cockroost Bottom	TQ 2482 0779	Colluvium	Holocene	Wilkinson et al. 2002	50
Culverwell	SY 685 694	Midden	Mesolithic	Palmer 1999	59
Westard Ho!	SS 42945 29494	Midden	Mesolithic	Balaam et al. 1987	60
Faraday Road Newbury	SU 4774 6738	Alluvium	Mesolithic	Ellis et al. 2003	61
Whitesheet Hill	ST 806 356	Ditch	Neolithic	Rawlings et al. 2004	25

Maiden Castle	SY 669 884	Ditch	Neolithic	Evans et al. 1988	30
Easton Down	SU 0637 6610	Buried soil	Neolithic	Whittle et al. 1993	31
South Street	SU 091 693	Buried soil	Neolithic	Evans 1971; 1972, 257-261	32
Beckhampton Road	SU 066 677	Buried soil	Neolithic	Evans 1972, 248-251	33
Windmill Hill	SU 087 745	Buried soil	Neolithic	Evans 1966; 1972; Whittle et al. 1999	34
Ascott-under-Wychwood	SP 299 175	Buried soil	Neolithic	Evans 1971; 1972, 251-256	35
Horslip	SU 086 705	Buried soil	Neolithic	Evans 1972, 261-263	36
West Kennet	SU 105 677	Buried soil	Neolithic	Evans 1972, 363-264	37
Wayland's Smithy II	SU 281 854	Buried soil	Neolithic	Evans 1972, 265	38
Silbury Hill	SU 100 685	Buried soil	Neolithic	Evans 1972, 265-267	39
Avebury	SU 100 669	Buried soil	Neolithic	Evans et al. 1985	41
Stonehenge	SU 121 421	Ditch	Neolithic	Evans 1983	42
Durrington Walls	SU 152 435	Buried soil	Neolithic	Evans in Wainwright and Longworth 1971, 329-337	43
Mount Pleasant	SY 710 899	Ditch	Neolithic	Evans and Jones 1979	44
Woodhenge	SU 150 434	Ditch	Neolithic	Evans and Jones 1979	45
Coneybury	SU 134 416	Ditch	Neolithic	Bell and Jones in Richards 1990, 154-158	46
Condicote	SP 151 281	Ditch	Neolithic	Bell in Saville 1983, 39-46	47
Knap Hill	SU 121 636	Buried soil	Neolithic	Sparks in Connah 1965	48
Hemp Knoll	SU 068 674	Buried soil	Neolithic	Evans 1972, 332-335	57
North Marden	SU 802 160	Ditch	Neolithic	Thomas in Drewett 1986	58
St Stephen's East	TQ 302 797	Alluvium	Neolithic	Sidell et al. 2000, 52-54	62
Offham Hill	TQ 399 118	Ditch	Neolithic	Thomas 1982	63
Bury Hill	TQ 0005 124	Ditch	Neolithic	Thomas 1982	64
The Trundle	SU 877 110	Ditch	Neolithic	Thomas 1982	65
Combe Hill	TQ 574 021	Ditch	Neolithic	Thomas 1982	66
Barkhale	SU 976 126	Ditch	Neolithic	Thomas 1982	67
Whitehawk	TQ 330 048	Ditch	Neolithic	Thomas 1982	68
Southerham Grey Pit	TQ 4332 0902	Colluvium	Neolithic	Allen 2005	72
Millbarrow	SU 0943 7220	Ditch	Neolithic	Whittle 1994	73
Wallingford	SU 607 885	Alluvium	Bronze Age	Thomas et al. 1986	27
Runnymede Bridge	TQ 007 723	Alluvium	Bronze Age	Evans 1991	28
Brean Down	ST 29575 58725	Dune sand	Bronze Age	Bell and Johnson 1990	51
Wilsford Shaft	SU 1086 4148	Colluvium	Bronze Age	Bell 1989	52
Dover Boat	TR 3201 4126	Alluvium	Bronze Age	Keeley et al. 2004	53
Earl's Down Farm	SU 212 422	Ditch	Bronze Age	Cleal et al. 2004	74
Dunch Hill	SU 2050 4860	Ditch	Bronze Age	Andrews 2006	75
Fordington Farm	SY 6989	Ditch	Bronze Age	Bellamy 1991	76

	8989				
Barford Farm	ST 9669 0055	Ditch	Bronze Age	Howard 1989	77
Round-the-Down	TQ 4333 0914	Ditch	Bronze Age	Butler 1996	78
Fyfield Down	SU 141 710	Dump	Iron Age	Evans 1972, 317-319	54
Overton Down	SU 130 703	Lynchet	Iron Age	Evans 1972, 320-321	55
Badbury	ST 956 030	Ditch	Iron Age	Evans 1972, 337-341	56
Bourne Valley	TV 6002 9949	Colluvium	Iron Age	Allen 2007	79
Danebury	SU 323 376	Buried soil	Iron Age	Cunliffe 1984; 1991	80
Vespasians Camp	SU 146 417	Ditch	Iron Age	Hunter-Mann 1999	81
Bishopstone	TQ 471 006	Lynchet	Late Holocene	Bell 1977	20
Kingsmead Bridge	SU 588 141	Alluvium	Medieval	Davies 2003	26
Overton Down	SU 1300 7065	Ditch	Post-medieval	Bell et al. 1996	29
Blackgang	SZ 4932 7603	Colluvium	Romano British	Preece 1980	22
Banwell	ST 390 617	Alluvium	Romano British	Rippon 2000	70
Kenn Moor	ST 423 677	Alluvium	Romano British	Rippon 2000	71
Malling Hill	TQ 4232 1108	Lynchet	Romano British	Allen 1995	82

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