MID HOLOCENE COASTAL ENVIRONMENTS FROM MINEHEAD BEACH, SOMERSET, UK

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An investigation of the peat beds and submerged forest remains exposed on the present day foreshore of Minehead Bay in Somerset was undertaken following the construction of new sea defences which were thought to pose an increased threat of erosion to the already degraded peat deposits. Radiocarbon dating of peat/clay interfaces, plus the use of a range of palaeoenvironmental techniques allowed the reconstruction of the landscape during the Mesolithic, between c. *5670-4360 cal BC, which appears to have consisted of a mosaic of vegetation communities from marginal salt-marsh, to reed-bed and alder carr with mixed deciduous woodland on the higher, drier slopes of Exmoor. These varied coastal habitats would have supported a variety of wildlife from fish and wildfowl to larger animals like the now extinct aurochsen which would have grazed on the salt-marsh. Possible burning of the reed-swamp, perhaps accidentally from camp fires or perhaps as a deliberate attempt to alter the environment, is suggested from remains of Graminoid charcoal, likely to be Phragmites. A few flint tools were found during earlier surveys of the bay, including axes and scrapers, and these demonstrate that people were taking advantage of these natural resources.*

INTRODUCTION - THE AREA

Minehead lies on the north facing coast of the Bristol Channel in Somerset, southwest England (Figure 1). The town fronts onto an 'L' shaped bay with steep, high ground of Exmoor to the west and southwest and a low alluvial plain to the southeast. The construction of new sea defences between 1996 and 1999 threatened the peat deposits and submerged forest remains, which occur on the beach at Minehead. The beach today comprises mobile deposits of mud, sand and shingle, over more stable deposits of angular sandstone head, with peat and submerged forest remains (Figure 2). Prior to the onset of construction work, an archaeological assessment and survey of the affected area was carried out by Richard McDonnell (2001), which extended over 1.5km² of the intertidal zone and the immediate supratidal (terrestrial) area.

METHODOLOGY

Nine areas of peat were identified extending from below MLWS (Mean Low Water Spring) (sites 074, 075, 076 and 077), through the mid tide level (sites 027, 046 and 047), to the lower part of the strand (sites 044 and 045) (Figure 3). The total area in which peat exposures currently occur is 7.56ha, although this figure is not a value for the peat surface, as it survives only in fragmentary exposures. The Royal Commission on the Historical Monument (England) undertook the survey of the exposed peat deposits using a Leica single frequency GPS (Riley 1996).

As part of the overall programme of archaeological work, funding was available for full environmental analyses by a team of palaeobotanists and palaeozoologists at a number of different sediment exposures on the foreshore (Figure 3), to be supported by radiocarbon dating. This provided an opportunity, unique in the south west of England, to study local variation in a Mesolithic landscape. Bulk and monolith samples from both peat and associated clays were collected from eight locations. Full analysis was undertaken on samples from sites 027, 044, 045, 075 and 077 while sites 046, 047 and 076 were used for correlation and therefore had more limited work carried out on them. Site 74 had so

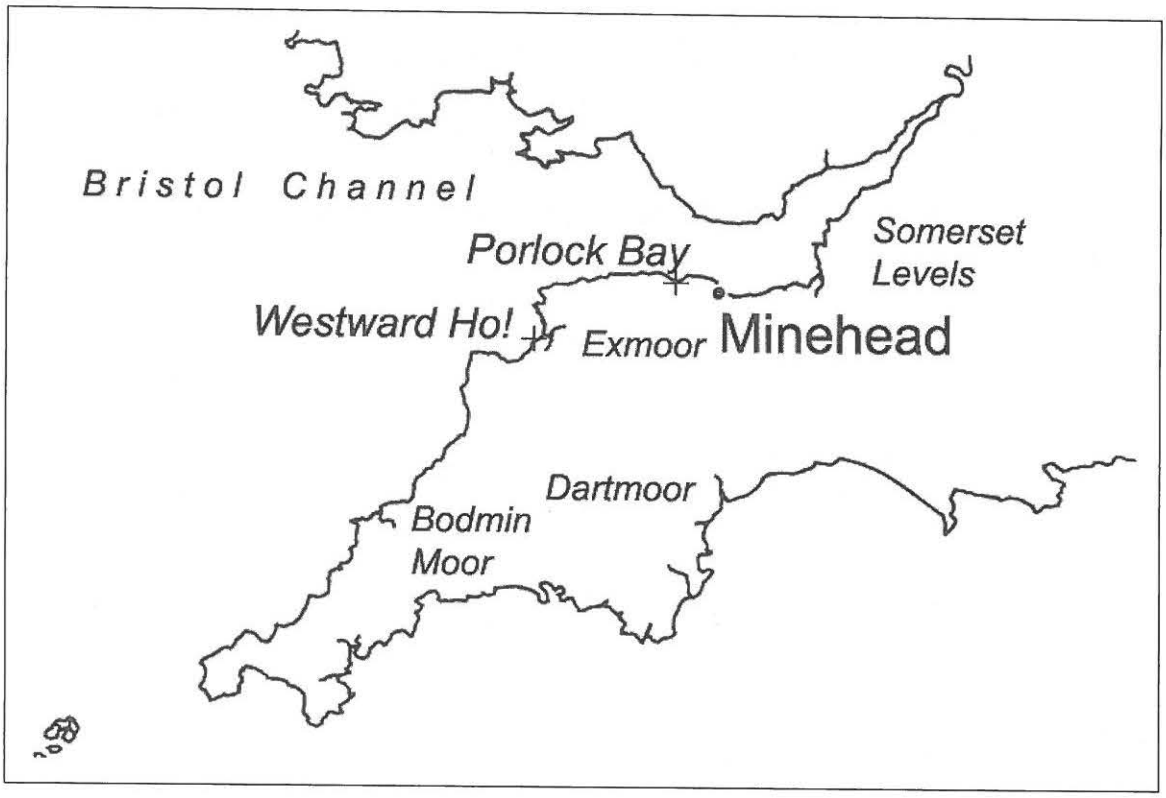

Figure 1: Location map of Minehead in South-west England.

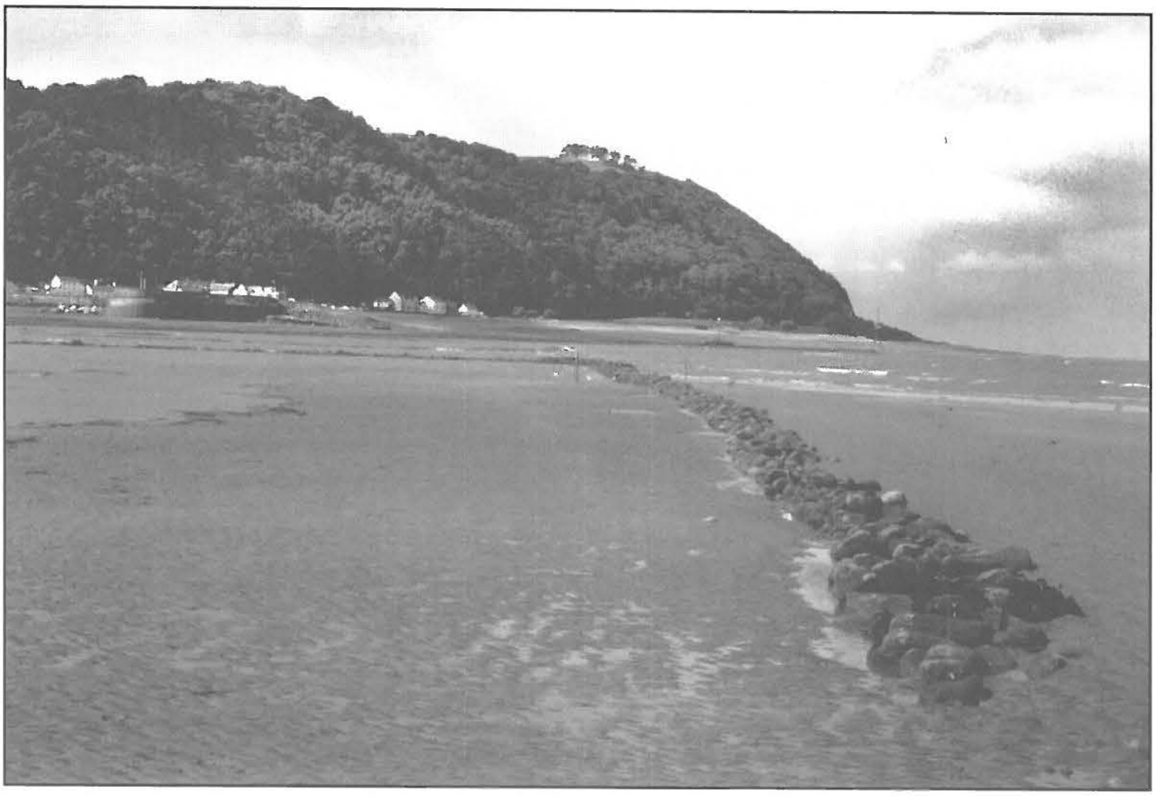

Figure 2: View of Minehead Bay.

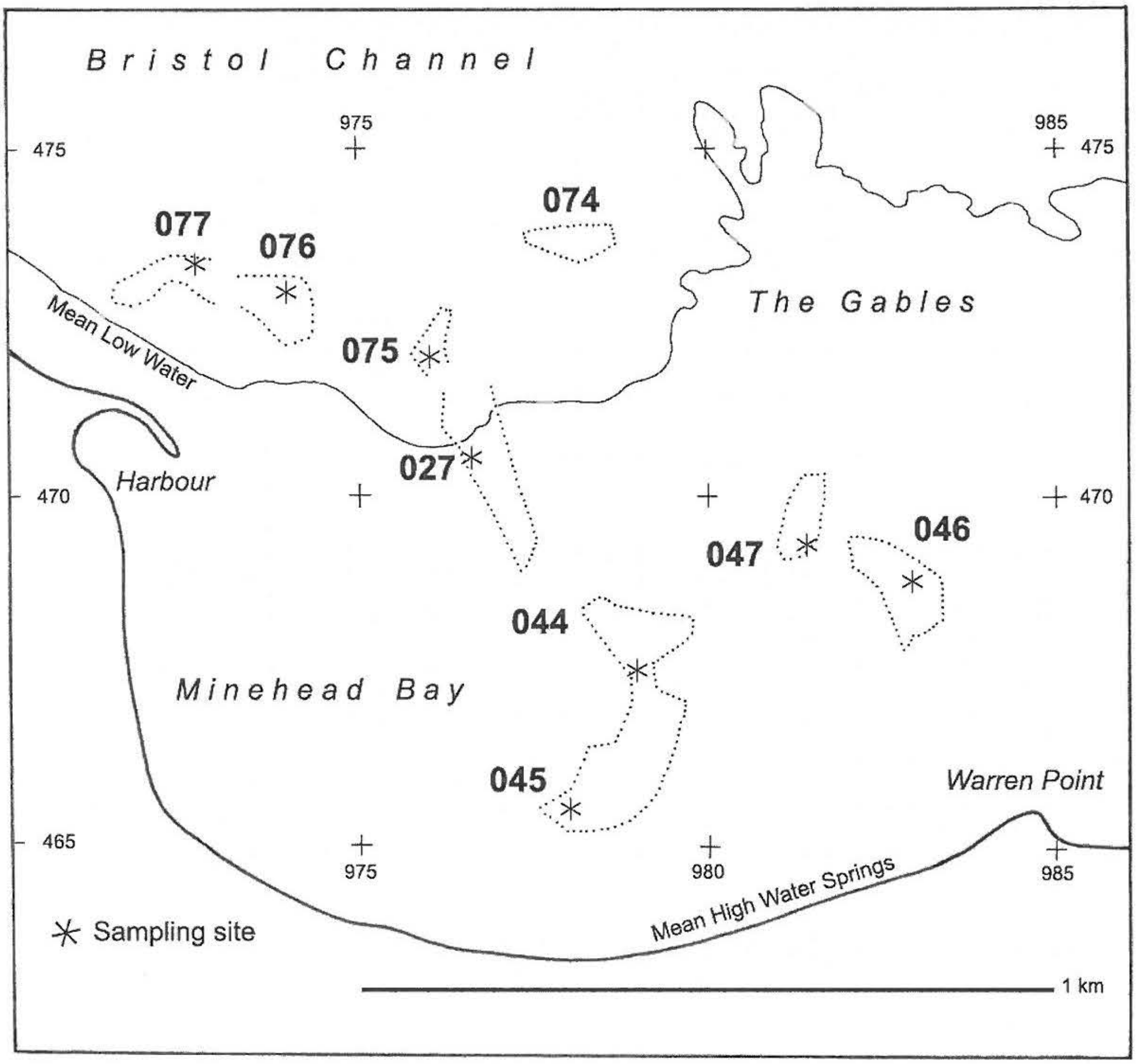

Figure 3: Location of palaeoenvironmental sampling sites.

little surviving peat that it was not considered worth sampling although this site may continue westwards as a subtidal deposit.

The recovered samples were examined for pollen (Tinsley 2001), plant macrofossils (Jones 2001) beetles (Smith 2001), diatoms (Cameron and Dobinson 2001) and foraminifera (Haslett 2001). The following account draws on the results of the specialist reports commissioned for this survey. Copies of these reports, including details of all methodologies, original diagrams and full species lists, can be found in the survey archive held by the Somerset Sites and Monuments Record. A table summarising all the results is included here (below as Table 3).

Samples for 14C measurement were taken from the bases and in some cases from the existing tops of the peat beds at each location. The Radiocarbon Laboratory at Waikato in New Zealand provided the results and Vanessa Straker at English Heritage calibrated the dates using Oxcal version 3.10 (Bronk Ramsay 2005, Reimer *et al* 2004). All dates discussed in the following text are the 2 sigma cal BC ranges.

Site	Lab. code	14 C age	2 sigma calibration	peat base OD
076 (base)	Wk 5311	6600 ± 70BP	5670-5380 cal BC	- 5.31m
077 (base)	Wk 5310	6570 ± 70BP	5640-5370 cal BC	-5.395m
027 (base)	Wk 5302	6560 ± 60BP	5630-5380 cal BC	-3.91m
077 (top)	Wk 5309	6490 ± 80BP	5620-5310 cal BC	
075 (base)	Wk 5308	6440 ± 70BP	5540-5290 cal BC	-5.025m
027 (top)	Wk 5301	6220 ±70BP	5330-4990 cal BC	

Table 1: Radiocarbon results from the Lower Foreshore sites.

Site	Lab. code	14C age	2 sigma calibration	peat base OD
047(base)	Wk 5307	5820 ± 60BP	4830-4520 cal BC	- 2.383m
044 (base)	Wk 5304	5810 ± 70BP	4830-4490 cal BC	-2.07m
044(top)	Wk 5303	5820 ± 60BP	4830-4520 cal BC	
045(base)	Wk 5305	5770 ± 70BP	4780-4460 cal BC	-1.275m
046(base)	Wk 5306	5700 ± 70BP	4710-4360 cal BC	-2.09m

Table 2: Radiocarbon results from the Upper Foreshore sites.

RESULTS

Dating of the peat beds from the upper and lower foreshores

The radiocarbon dating programme suggested that there were two main peat-forming periods in the later Mesolithic period on what is now the foreshore at Minehead. The earliest phase occurred at the sites on the present day lower foreshore, (075, 076, 077 and 027) with later peat formation on the upper foreshore (044, 045, 046 and 047) closest to present day MHW (mean high water) mark. The results of the dating are shown in Tables 1 and 2 and Figure 5. Figure 4 also summarises these results, with information added from the environmental analyses relating to the vegetation communities present at each site.

Analysis of pollen, plant macrofossils, beetles, diatoms and foraminifera

The results of all the palaeoenvironmental analyses undertaken at Minehead are summarised together in table form (Table 3). For each site location, details of stratigraphy, OD heights and dating are shown, with the results of the individual environmental analyses carried out. The vegetation communities and tidal regime suggested by these results are also shown. Plant nomenclature follows Stace (1991), insects follow Lucht (1987) and pollen taxa generally follow Bennett (1994). The principal source of information on diatom ecology was Denys (1992) and Murray (1991) was used for the foraminifera.

The interpretation of the Mesolithic environment of Minehead is supported by the data

Macros	Pollen	Diatoms	Forams	Habitat
-5.27 to -5.19m OD	grey brown organic clay			
-5.24 to -5.20m *Phragmites australis* stems and rhizomes *Schoenoplectus tabernaemontani*, *Suaeda maritima*, *Atriplex* spp. Suggest wet muddy, brackish environment. Charcoal fragments	-5.26 to -5.18m **Local:** Poaceae around 30 % TLP. Cyperaceae and *Sparganium emersum*-type each <10% TLP. Chenopodiaceae pollen – 3-5% TLP – may represent plants such as *Suaeda maritima* and *Atriplex* spp in macro record **Regional:** *Quercus;* 11%-23% TLP, *Corylus*-type: 15%-34% TLP. *Betula*, *Pinus*, *Ulmus*, *Fraxinus* and *Alnus* - consistently present.	-5.21 to -5.20m Dominated by brackish species (>50%) Marine species common (25%). Species diversity moderate. Robust marine and brackish species *Paralia sulcata* & *Navicula peregrina* dominant.	-5.21 to -5.20m *Jadammina macrescens* & *Trochammina inflata*. High salt-marsh with deposition around MHWS	**Reed swamp/ marginal saltmarsh**
-5.19 to -5.02m OD	mid grey clay with organic fragments. Disturbed by *Pholas dactylus* (piddocks) - burrowing bivalves.			
-5.19 to -5.15m Similar suite as below	-5.19 to -5.18 m **Local:** Poaceae falls to 23% **Regional**: Tree pollen, principally *Quercus* and *Corylus*-type, rises in response. Microcharcoal frequent.	-5.19 to -5.18m Marine component increases to 55%. Brackish to 30%	-5.19 to -5.18m *J. macrescens* High salt marsh, near limit of tidal influence.	**High salt-marsh. Between MHWST and HAT**
		-5.03 to -5.02 m Large number poorly preserved valves. Small component of freshwater, oligohalobous indifferent taxa.	-5.03 to -5.02m None	**Reed swamp/ marginal salt marsh**

Macros	Pollen	Beetles	Diatoms	Forams	Habitat
-5.02 to -4.95m OD	very dark brown peat. Some piddock disturbance		**Base of peat at -5.02m OD. Dated to 5540-5290 cal BC**		
-5.02 to -4.98m Pred. *Phragmites*, *S. tabernaemontani*, *Bolboschoenus maritimus* Charcoal fragments	-5.01 to -4.98m **Local:** Poaceae rises to 45% in base of peat bed, falling to 30% TLP in upper part. Cyperaceae and *Sparganium emersum*-type throughout, peaking at 9% TLP and 5% TLP respectively in the mid peat bed. Range of flowering herbs especially Chenopodiaceae (3-5% TLP). **Regional:** Tree pollen around 50% TLP, principally *Quercus* and *Corylus*-type, *Betula*, *Pinus*, *Ulmus*, *Fraxinus* and *Alnus* consistently present. Microcharcoal frequent.	-4.98 to -4.94m Dominance of *Phragmites* reed suggested by leaf beetle *Plateumaris braccata*, ground beetle *Odocantha melanura* & cantharid *Silis ruficollis*. *Scirpus* - host plant of *Notaris scirpi*. *Agonum thoreyi* and *Dromius longiceps* suggest rafts of decaying material. Water beetles of Hydreanidae & Hydrophilidae - typical of permanent bodies still/stagnant water - suggest environment rich in aquatic veg. **Regional:** Bark beetles *Hylesinus oleiperda* & *Leprisinus varius* - assoc with *Fraxinus*. Weevil *Rhynchaenus quercus* with *Quercus*.	-5.01 to -5.00m Reduction in marine component to 20%. Brackish/ freshwater species - almost 60% of total assemblage.	-5.01 to -4.99m *Jadammina macrescens* High saltmarsh	**Upper salt marsh transition zone/ Phragmites reed swamp. Brackish/freshwater**
-4.98 to -4.94m Pred. *Phragmites* with *Atriplex*, *S. maritima*, Chenopodiaceae. Other species commonly associated with freshwater marsh habitats - *Lycopus europaeus*, *Mentha aquatica*, *Eupatorium cannabinum* Charred Graminoid culm fragments	-4.97 to -4.96m **Local**: Poaceae remains dominant. *Solidago virgaurea*-type - marked peak of 8.5% TLP, at time when levels of Chenopodiaceae pollen decline. **Regional:** As below.				

Table 3a: Palaeoenvironmental summaries from Lower Foreshore site. Site 075.

Macros	Pollen	Diatoms	Forams	Habitat
-5.69 to -5.39m OD	mid grey clay with organic detritus			
<u>-5.46 to -5.39</u> Stems/rhizomes of *Phragmites*. Brackish water element indicated by *S. tabernae-montani, Atriplex*, & other Chenopodiaceae Frequent *Samolus valerandi* - low creeping perennial of wet places (streams/flushes, especially on sandy or brackish soils). *Conium maculatum*, typical of damp ground, often near the sea. Charred Graminoid stem fragments	Local: Poaceae (30-40% TLP). Just below the junction with peat bed <u>(-5.40 to -5.39)</u> Cyperaceae peak at 37% TLP while Poaceae are reduced to less than 20% TLP. Chenopodiaceae pollen present. *Oenanthe* - (brackish ditches) reaches 10.8% TLP just below the clay/peat junction. Regional: - Tree pollen 30-60% TLP mainly *Quercus* & *Corylus*-type. *Betula, Pinus, Ulmus, Fraxinus, Alnus* and *Tilia* all consistently present at < 5% TLP.	<u>-5.6 to -5.61m</u> No diatoms <u>-5.4 to -5.39m</u> Low counts of the brackish aerophilous species *Diploneis interrupta* suggest a drying brackish water environment such as a salt marsh. (Cameron states that frequent and direct tidal contact would have left traces of estuarine taxa (polyhalobous plankton) which are not apparent).	<u>-5.4 to -5.39m</u> *Jadammina macrescens* High salt marsh	**Reed swamp/ marginal saltmarsh**

Macros	Pollen	Beetles	Diatoms	Forams	Habitat
-5.39 to -5.33m OD	very dark brown peat		**Base of peat at -5.39m OD. Dated to 5640-5370 cal BC** **Top of peat at -5.33m OD. Dated to 5620-53100 cal BC**		
<u>-5.39 to -5.33m</u> *Phragmites* dominant with *Samolus valerandi* and *Conium maculatum*. Freshwater marsh element suggested by *Lycopus europaeus, Mentha aquatica, Eupatorium cannabinum* & *Typha*. sp. Charcoal flecks	Local: Poaceae values remain high above <u>-5.36m</u> (30-40% TLP). *Solidago virgaurea*-type(includes *Eupatorium*) peaks (12-15% TLP). *Heracleum sphondylium* 2-3% TLP in upper part of the peat bed. Freshwater marsh element suggested by *Sparganium emersum*-type (peaks around 10% TLP between <u>-5.37 to -5.33m</u>). Regional: Tree pollen values fluctuate (30-60% TLP). Dominant contributors *Quercus*, (10 - 35% TLP) & *Corylus*-type (8 - 37% TLP). *Betula, Pinus, Ulmus, Fraxinus, Alnus* and *Tilia* all consistently present (values < 5% TLP). Microcharcoal frequent	<u>-5.39 to -5.33m</u> Ground beetles *Oodes gracilis* & *Odocantha melanura* & leaf beetle *Plateumaris braccata* assoc with dense stands *Phragmites*. *Coelostoma orbiculare* & *Cymbiodyta marginella* indicative of shallow, slow & muddy flowing waters. Assoc with decaying plant matter.	<u>-5.38 to -5.37m</u> Brackish aerophilous species *Diploneis interrupta* in top of the clay. Oligohalobous indifferent (optimum in freshwater but tolerant of slightly brackish water) *Nitzschia terrestris* also present.	<u>-5.38 to -5.37m</u> *Jadammina macrescens* High salt marsh	**Reed swamp/ marginal saltmarsh**

Macros	Pollen	Diatoms	Forams	Habitat
-5.33 to -5.28m OD	mid grey clay			
<u>-5.33 to -5.28m OD</u> *Phragmites* abundant. Fruits of *S. tabernaemontani, Suaeda maritima, Atriplex* and *Samolus valerandi* occur. *Lycopus europaeus* & *Epilobium hirsutum/ roseum* suggest freshwater conditions. Charred Graminoid culm nodes	Local: Poaceae remains dominant taxon. Chenopodiaceae increase slightly. Trace of *Epilobium*-type pollen suggests presence of fresh-water element. *Solidago virgaurea*-type decreases markedly. Regional: As in peat below.	<u>-5.32 to -5.31m</u> No diatoms.	<u>-5.32 to -5.31m</u> *Jadammina macrescens* High salt marsh	**Reed swamp/ marginal saltmarsh**

Table 3b: Palaeoenvironmental summaries from Lower Foreshore site. Site 077.

Macros	Pollen	Habitat
-5.31 to -5.30m OD peat	Base of peat at -5.31m OD. Dated to 5670-5380 cal BC	
Species typical of brackish water conditions *Phragmites* and *S. tabernaemontani*. Plus freshwater marsh plants *Lycopus europaeus, Mentha aquatica* and *Eupatorium cannabinum*.	Pollen assemblage similar to sites 075 and 077, notable peaks in *Sparganium emersum*-type and *Solidago virgaurea*-type.	**Reed swamp/ marginal salt marsh**

Table 3c: Palaeoenvironmental summaries from Lower Foreshore site. Site 076. Correlation site (single samples taken for pollen and macrofossils only from 1cm above peat/clay interface).

Macros	Pollen	Diatoms	Forams	Habitat
-3.96 to -3.91m OD	fairly sterile grey clay			
<u>-3.96 to -3.91m</u> Few *Phragmites* stem fragments. Frequent wood fragments. Few macrofossils - fragmented remains of *Eupatorium*, plus *Viola* sp and *Carex* spp. *Carex divisa* - species of brackish grassy places & ditches.	<u>-3.91 to -3.92m</u> **Local:** Poaceae dominate herbaceous pollen (30% TLP). *Sparganium emersum-type* and Cyperaceae 3-12% TLP. *Solidago virgaurea*-type at values >10% TLP. Chenopodiaceae pollen is present. **Regional:** Tree pollen 37-41% TLP, *Quercus* and *Corylus*-type dominant. *Pinus, Ulmus* and *Alnus* consistently present. Microcharcoal frequent	<u>-3.91 to -3.92m</u> Dominated by 2 benthic species, *Diploneis interrupta,* a brackish water species (40%), and *Nitzschia terrestris,* a freshwater species (30%). Both sp. are aerophilous & therefore highly tolerant of desiccation Marine types represented by only few valves of planktonic taxa.	<u>-3.91 to -3.92m</u> No forams.	**Reed swamp/ marginal salt marsh**

Macros	Pollen	Beetles	Diatoms	Forams	Habitat
-3.91 to -3.82m OD	woody peat. Very compact and dry with distinct narrow lenses of clean grey clay. May suggest short episodes of marine influence.				Base of peat at -3.91m OD. Dated to 5630-5380 cal BC
<u>-3.91 to -3.82m</u> Abundant *Alnus glutinosa* fruits & cones. *Betula* fruits. Other species present typical of freshwater reedswamp/alder carr transition. *Typha, Lycopus, Mentha, Lychnis floscuculi, Juncus* and Cyperaceae. *Phragmites* consistently frequent throughout. Charred *Alnus* catkin frags & Graminoid stems	**Local:** Poaceae continue to dominate the herbaceous pollen. From -3.85m herbaceous types much reduced. Poaceae <11% TLP with range of flowering herbs (including Chenopodiaceae and *Solidago virgaurea*- type) present, at <2% TLP. Coincides with significant rise in tree pollen to >75% TLP. *Alnus* dominant contributor at more than 45% TLP. Other taxa present - typical of freshwater reedswamp/alder carr transition include *Sparganium emersum*-type, with Cyperaceae at values 3-12% TLP. **Regional:** *Quercus* and *Corylus*-type (both < 13% TLP), *Pinus, Betula* and *Ulmus* consistently present at very low percentages.	<u>-3.91 to -3.82m</u> Many of the same species as Site 77. Single individual of the scolytid *Dryocoetes alni,* - only insect found in the foreshore peats at Minehead which directly indicates the presence of alder.	<u>-3.91 to -3.90m</u> - similar to below. Slightly increased percentage of the same freshwater aerophile *Nitzschia terrestris* (40%) and reduced percentage of the brackish water aerophile *Diploneis interrupta.* Uppermost sample - <u>3.89 to -3.88m</u> <20% brackish water species, while freshwater component increased to 55%.	<u>-3.91 to -3.88m</u> No forams	**Alder carr/ Freshwater reedswamp**

Table 3d: Palaeoenvironmental summaries from Lower Foreshore site. Site 027.

Pollen	Diatoms	Forams	Habitat
-2.09 to -2.08m OD	grey clay with organic streaks		
Local: Poaceae 25% TLP with Cyperaceae, *Sparganium emersum*-type & *Solidago virgaurea*-type. Peak of Chenopodiaceae (18% TLP). Regional: Tree pollen 45% TLP, principally *Quercus* with some *Pinus* and *Corylus*-type	Dominated by single species (*Nitzschia navicularis*) indicative of brackish water conditions, although presence of marine and marine to brackish taxa suggest brackish water habitat with some tidal influence.	*Jadammina macrescens* High salt marsh	**Reedswamp/ marginal saltmarsh**

Pollen	Diatoms	Forams	Habitat
2.08 to -2.04m OD	black peat	**Base of peat at -2.07 m OD. Dated to 4830-44900 cal BC. Top of peat at -2.04m OD. Dated to 4830-4520 cal BC**	
Local: -2.08m - marked change in the pollen record. *Alnus* curve begins to rise reaching more than 20% TLP. Poaceae and Cyperaceae form nearly 40% TLP. Chenopodiaceae decline to just 2% TLP. Range of other herbs includes *Lotus, Anthriscus,* Lactuceae *Achillea*-type, *Filipendula* and *Alisma* Regional: *Quercus* 5-16% TLP, *Betula, Pinus, Ulmus* & *Tilia* consistently present. Microcharcoal frequent.	-2.07 to -2.06m Dominated by species optimum in freshwater but tolerant of slightly brackish water (>40%). Marine taxa are absent. Indicates reduced salinities - freshwater to brackish environment.	-2.07 to -2.06m No forams present.	**Alder carr/ reedswamp transition**

Macros	Pollen	Diatoms	Forams	Habitat
-2.04 to -2.00m OD	grey organic clay			
Wood fragments abundant. Many *Alnus* fruits and cones. Areas of reed swamp suggested by *Typha*, with freshwater conditions suggested by *Lycopus, Lythrum salicaria* and *Alisma plantago-aquatica* Charred Graminoid culm frags	Local: *Alnus* values fall from 65% TLP in underlying peat bed to 45-55% TLP. Poaceae and Cyperaceae 10-15% TLP, *Sparganium emersum*-type, Chenopodiaceae and *Solidago virgaurea*-type present at reduced percentages. Regional: As in peat bed below. Microcharcoal frequent.	Return to assemblages dominated by brackish water species, particularly *Nitzschia navicularis.* -2.10 to -2.00m - oligohalobous indifferent taxa (optimum in freshwater) increase to 25%.	-2.03 to -2.02m -2.01 to -2.00m *J. macrescens* High salt marsh	**Alder carr/ reedswamp transition**

Macros	Pollen	Beetles	Habitat
-2.00 to -1.84m OD	dark brown/black woody peat		
Many *Alnus* fruits and cones. *Typha* plus bankside species, *Alisma, Lycopus, Mentha* and *Lythrum* suggest areas of reedswamp. Aquatics include *Potamogeton* and *Callitriche* - suggest areas of open water, *Callitriche* and *Ranunculus sceleratus* also common in wet muddy areas where temporary pools of water occurred. Presence of *Betula* fruits, *Urtica dioica* & *Solanum dulcamara* indicate areas of drier ground. Charred wood frags	Local: *Alnus* rises to nearly 80% TLP in the upper part of the peat bed. Poaceae and Cyperaceae decline to less than 10% TLP, *Sparganium emersum*-type present. Regional : As below	High proportion of species assoc with woodland moulds and fungi from dead and decaying timber. Includes *Dirhagus pygmaeus* & *Aspidiphorus orbiculatus*, *Cercylon ferrugineum*, range of Anobiidae. Species of water beetles suggest slow flowing, fresh water, filled with decaying vegetation. Species specific to *Phragmites.* Also sedge - host plant of *Plateumaris sericea. Tanysphyrus lemnae* suggests the presence of *Lemna*, (duckweed being its food plant), although no trace of duckweed was found in the pollen or macrofossil record.	**Mosaic of communities including alder carr with open pools. Some drier ground, fringing an area of reedswamp.**

Table 3e: Palaeoenvironmental summaries from Upper Foreshore site. Site 044.

Macros	Pollen	Diatoms	Forams	Habitat
-1.31 to -1.27 m OD dark grey clay with frequent organic streaks				
Abundance of wood fragments with *Alnus* fruits and cones. *Typha* associated with *Lycopus*, *Ranunculus acris/repens/bulbosus*, *Carex* and *Juncus* species. Charred wood fragments	**Local:** *Alnus* is the principal contributor to the tree pollen (60% + TLP) with levels of Poaceae and Cyperaceae pollen low. **Regional:** *Quercus* forms around 10% TLP, with *Betula*, *Pinus*, *Ulmus*, *Fraxinus* and *Tilia* present. Microcharcoal frequent.	-1.3 to -1.29 and -1.28 to -1.27m The diatoms contain a freshwater-brackish mixture with a relatively small marine component. Oligohalobous indifferent diatoms compose between 55-60% of the sample with brackish species at c15-20%.	No forams	**Alder carr**

Macros	Pollen	Beetles	Diatoms	Forams	Habitat
-1.27 to -1.12 m OD dark brown woody peat			**Base of peat bed at -1.27m OD. Dated to 4780-4460 cal BC**		
Abundance of wood fragments with *Alnus* fruits, cones & catkins. Reedswamp suggested by *Typha*, *Alisma*, *Lycopus*, & *Lythrum*. Areas of open water with *Ranunculus* subg. *Batrachium*. *Corylus*, *Rubus* sect *Glandulosus* & *Solanum* suggest patches of drier ground.	**Local:** *Alnus* dominant at over 60% TLP. In many samples clumps of *Alnus* grains occur, seen as a clear indication that alder trees were growing directly on the site. Small peak in *Salix*. **Regional:** As below	Similar fauna to Site 044 associated with freshwater reed bed and carr woodland. Two species associated with dead wood - *Haplocnemus nigricornis* & possibly *Rhizophagus* species. The scolytid *Dryocoetes alni* suggests presence of alder in the carr woodland.	Preservation poor.	No forams.	**Alder carr**

Table 3f: Palaeoenvironmental summaries from Upper Foreshore site. Site 045.

Macros	Pollen	Habitat
Very dry and well humified peat.	**Base of peat bed at Site 046-at -2.09m OD. Dated to 4710-4360 cal BC** **Base of peat bed at Site 047 at -2.38m OD. Dated to 4830-4520 cal BC**	
Small woody fragments with *Alnus* fruits and cones from site 046. Reedswamp suggested by *Typha*, *Schoenoplectus lacustris*, *Ranunculus lingua* and *Mentha* at both sites.	Local: Poaceae pollen dominates at both sites, with *Sparganium emersum*-types, *Solidago virgaurea*-type and Chenopodiaceae present at low values. Regional: Tree pollen around 50% TLP, largely *Quercus* and *Corylus*-type. *Pinus* and *Ulmus* consistently present.	**Reedswamp/ freshwater swamp**

Table 3g: Palaeoenvironmental summaries from Upper Foreshore site. Sites 046 and 047 Correlation site (single samples taken for pollen and macrofossils only from 1cm above peat/clay interface).

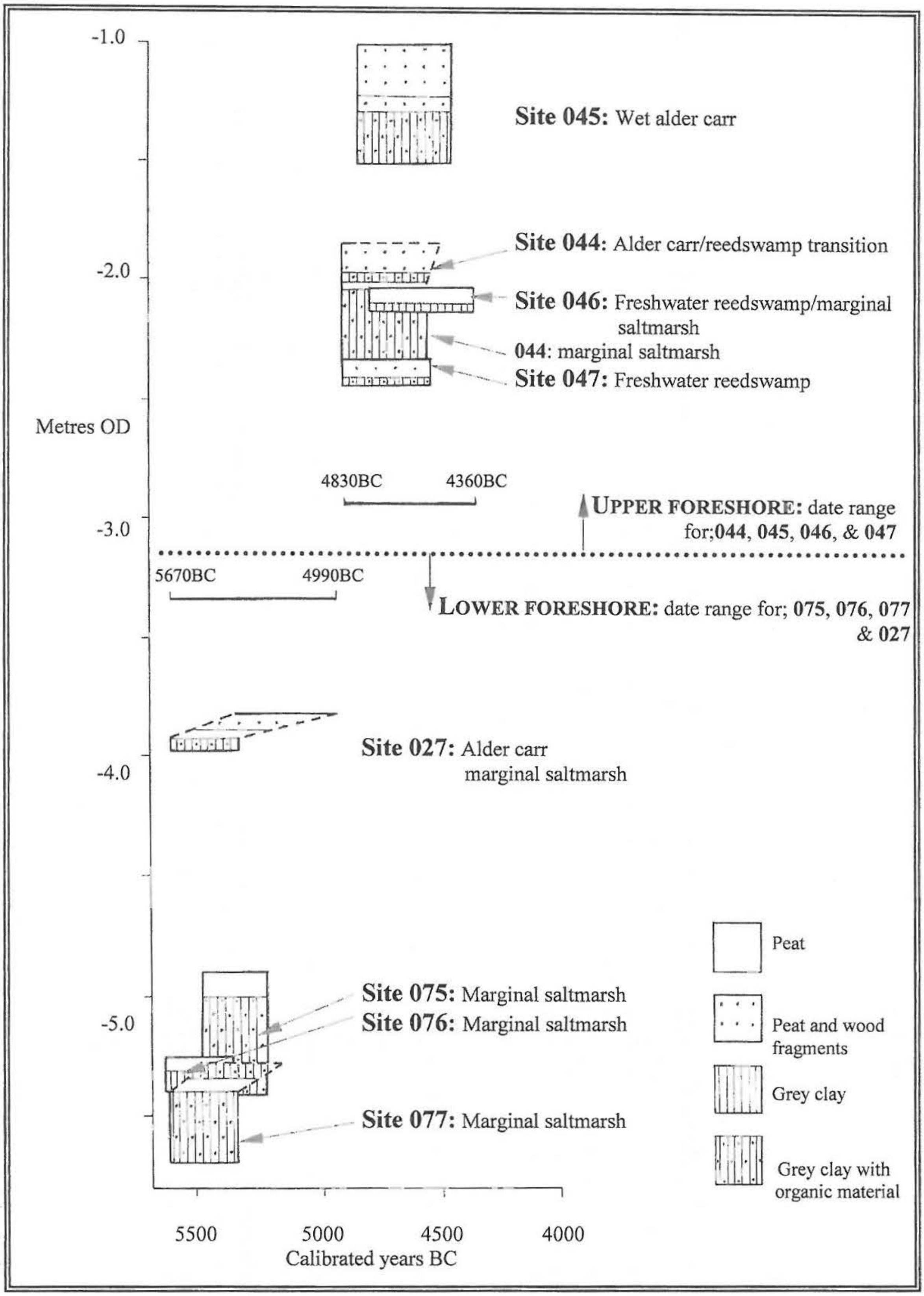

Figure 4: Stratigraphy, datum and age range of sampling sites.

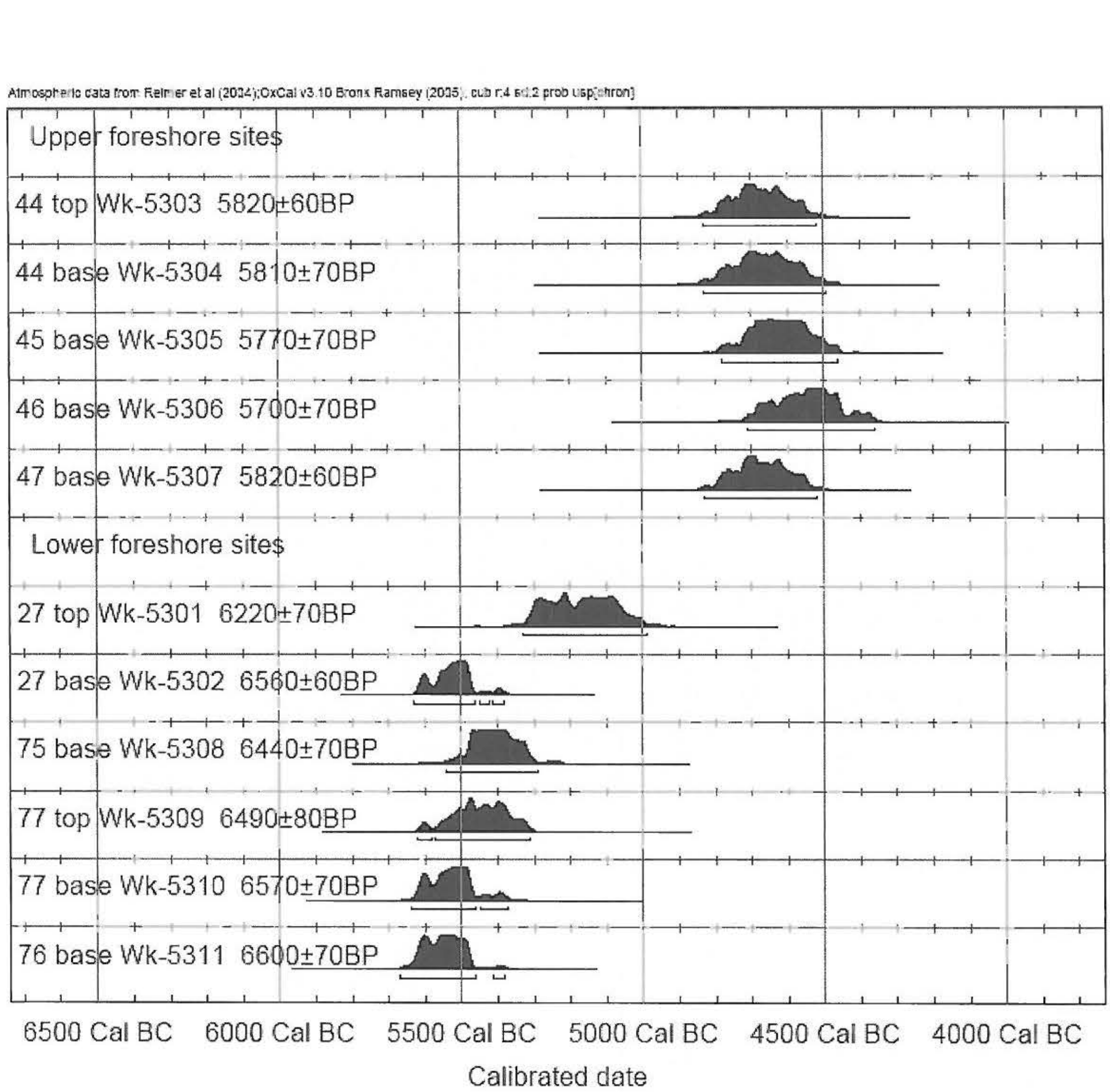

Figure 5: Radiocarbon measurements of intertidal peats.

summarised in Table 3 with illustrations showing the location of the sampling sites (Figure 3) and details of the stratigraphy, datum and age ranges for the sampling sites (Figure 4). Rodwell's accounts of British Plant Communities (1991 and 1995) providing data of present day ecologies have been used as a guide to how the environment may have looked in the past at Minehead, although it is appreciated that exact parallels cannot be drawn. Jane Brayne was commissioned by the Environment Agency (Figure 6) for a reconstruction drawing which shows Aurochs grazing on the marsh.

ECOLOGICAL INTERPRETATION OF THE MESOLITHIC ENVIRONMENT

The local environment

The plant macrofossils and many of the insect remains preserved in the peats and clays are likely to represent the local communities, which became established on different areas of the foreshore at Minehead. The pollen assemblages also contain some pollen types which are likely to have a local source but other taxa will have blown in from further afield. In general, pollen of herbaceous

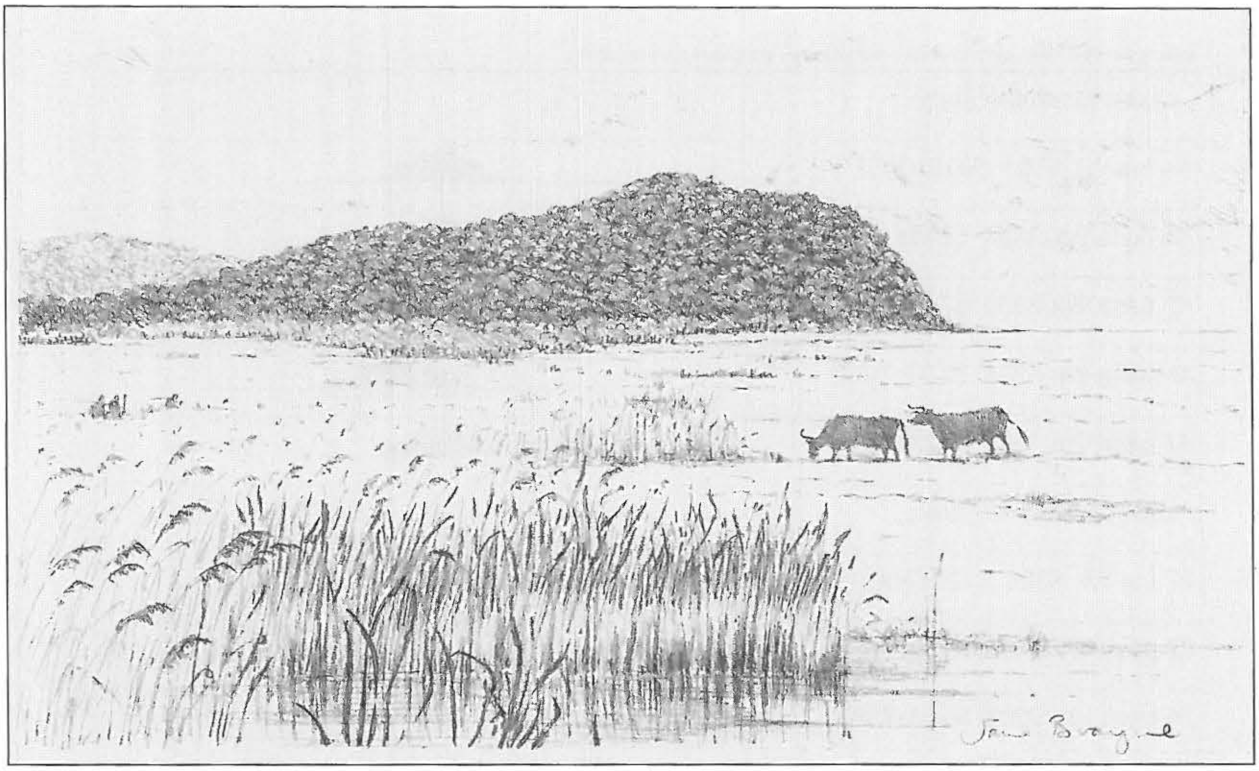

Figure 6: Jayne Brayne's reconstruction drawing.

plants is unlikely to disperse far as it is released close to the ground and therefore probably largely represents vegetation growing close to the site. The diatom assemblages contain a mixture of autochthonous species essentially of brackish and freshwater habitats with the hypertidal nature of the estuary resulting periodically in the transportation of allochthonous marine or estuarine taxa into these habitats. Some transportation of plant debris would also inevitably have occurred with the influence of the tide. Where foraminifera occur, the assemblages are very low in abundance and in species diversity, and Haslett (2001) suggested that in view of this all assemblages are *in situ*, as higher diversity normally characterises derived assemblages. The foraminifera assemblages are in fact dominated by *Jadammina macrescens* with a single occurrence of *Trochammina inflata* at site 075 (-5.21 to -5.20m OD). With this one exception, it appears that these assemblages were deposited in high salt marsh near the limit of marine influence. Taken together, the plant macrofossil, insect and pollen evidence shown in Table 3 suggests that a number of specific plant communities existed on the foreshore at Minehead during the mid-Holocene, influenced by salinity levels, the evidence for which comes mainly from diatoms and foraminifera.

Upper salt marsh transition zone - Phragmitetea

Evidence for a transitional brackish swamp/ freshwater meadow community seems to occur in both the peats and the clays at the lower foreshore sites 075, 076, 077 and the basal deposits at site 027. It is also found in the lower deposits of the upper foreshore sites 044 and 046.

The upper level of tidal influence is the area where salt marsh is replaced by freshwater marsh and is subject to tidal inundation only a few times a year. This upper salt marsh limit generally lies between MHWS (mean high water spring) tides and EHWS (extreme high water spring) tides (Beeftink 1977). Haslett (2001) stated that this area, at the limit of tidal influence, is the environment of deposition of the foraminifera *Jadammina macrescens* (see also Haslett *et al* 2001b).

Adam (1981) in his classification of the vegetation of British salt marshes, described a community of the class Phragmitetea characterised by reed beds of *Phragmites australis* (common reed). Stem and rhizome fragments of *Phragmites* and high frequencies of pollen of Poaceae occurred in many of the peat and clay samples examined. *Phragmites* is moderately tolerant of saline water, and grows widely today in fresh, open water transitions as well as brackish dykes and estuaries (Rodwell 1995). Its success is in its growth habit as a rhizomatous perennial which spreads rapidly and can survive in a wide variety of water regimes with the water table ranging from 2 metres above the substrate to more than 1 metre below in fresh, brackish and tidal waters. It is a good peat former, particularly associated with organic deposits, but also grows well on mineral substrates. At Minehead it seems to have grown on both types of deposit.

Tall reed swamps composed of *Phragmites* are often characterised by the overwhelming dominance of this species, although mixed stands can occur with *Schoenoplectus tabernaemontani* (grey club-rush) and *Bolboschoenus maritimus* (sea club-rush); nutlets of these species occurred in some samples of the peat and clay. Both species of club-rush prefer moist brackish sites with soft anaerobic silts or clays (Rodwell 1995). Some of the beetles recovered also suggest this type of reed swamp. The leaf beetle *Plateumaris braccata,* the ground beetle *Odocantha melanura* and the cantharid *Silis ruficollis* are associated with *Phragmites* and sedges and club rushes are the host plants of *Plateumaris sericea* and *Notaris scirpi*. Other predatory species of waterside ground beetle, such as *Agonum fuliginosum* and *Dromius longiceps* which are found at Minehead, are often associated with rafts of decaying material that build up at the base of reed beds. The only true indicator of a saline environment in the insect record is a single individual of the beetle *Dyschirius salinus* at Site 075, a species normally found in moist sands and silts in salt marshes.

According to Rodwell (1995), small stands of bulrush (*Typha* species) can also be found associated with the *Phragmites* community, although never as a dominant. The presence of *Typha* macrofossils and *Sparganium emersum*-type (lesser bulrush, bur-reed) pollen suggests that this was the case at some of the Minehead foreshore sites. Towards the edge of these stands Rodwell noted that *Atriplex prostrata* (spear-leaved orache) may become abundant. Seeds of *Atriplex* were recovered from the lower foreshore sites and the basal clay at site 044, although it was not possible to assign them to species. Pollen of the Chenopodiaceae was also consistently present in the peats and clays of the lower foreshore.

Contemporary studies of this upper marsh zone demonstrate that there may be an unbroken transition between brackish reed-swamp communities and non-tidal vegetation which can be species-rich and more typical of fens and wet meadows (Rodwell 1995). Taxa normally associated with freshwater conditions such as *Eupatorium cannabinum* (hemp agrimony), *Lycopus europaeus* (gipsywort) and *Mentha aquatica* (water mint), which are all consistently present in the Minehead macrofossil record, are typical of this type of environment.

Freshwater reedswamp

This community is represented in the peat deposits at sites 044, 046 and 047. Macrofossils of *Typha* species are particularly abundant in site 047 while *Alisma* and *Mentha* are consistently present at all three sites. The beetles *Plateumaris bracatta* and *Odacantha melanura* also suggest the presence of stands of *Phragmites.* According to Rodwell (1995) both *Typha latifolia* (bulrush) and *Typha angustifolia* (lesser bulrush) form open and closed reed-swamp in standing or slow-moving freshwaters, in depths of up to 60 cm or in sites which are only flooded in winter. Sub-communities more characteristic of shallower waters include *Mentha aquatica* and *Alisma plantago-aquatica* (water plantain). Zonation to open water would also allow aquatics such as *Potamogeton* (pondweed) and *Lemna* (duckweed) to gain a hold.

A *Typha* sub-community occurs on the present day salt marshes at Bridgwater and Berrow (Ranwell 1964), to the east of Minehead in the upper salt marsh area, and is recorded in association with *Phragmites* and *Bolboschoenus maritimus*. It is therefore likely that *Typha* and its associates grew in both fresh and brackish water conditions at various locations on the foreshore at Minehead in the mid Holocene.

Alder carr communities and alder carr/ freshwater reedswamp transition

The natural succession from freshwater reed swamp is to marsh/fen type vegetation and then to a habitat dominated by alder (*Alnus glutinosa*) carr. Alder carr characterises the peats at sites 027 and 044 and the peats and organic clays at site 045. These deposits are dominated by high percentages of alder pollen (50-85%), wood fragments, fruits, female cones and male catkins of alder. Such high alder pollen values suggest that alder was growing on site and the presence of clumps of alder grains in some samples, representing the remains of whole catkins, supports this view. Alder timbers have been identified in the submerged forest remains close to the peat deposits of sites 044 and 045. Alder woodland is characteristic of wet to waterlogged organic soils and is often associated with fen peats in open water transitions. Alder woods typically have few other associated trees; alder usually dominates and can form a closed canopy, although in the initial establishment of the woodland in present day communities, *Betula pubescens* (birch) can occasionally occur (Rodwell 1991). Fruits and pollen of *Betula* are present in some of the samples, while *Salix* (willow) pollen also occurs at low values. Willow is insect pollinated and a low pollen producer compared with alder and its presence is likely to indicate willow growing close to the site in association with alder. This is typical of younger stands of carr woodland (Rodwell 1991). The only direct evidence of alder from the insect record is the presence of single individuals of *Dryocoetes alni* from the peat at sites 027 and 045. The number of insects feeding specifically on alder is very low compared to those feeding on oak and ash, for example (Girling 1985; Robinson 1993; Smith, Osborne and Barrett 2000). The main woodland species encountered at Minehead are those associated with moulds and fungi on dead and decaying timber, including *Haplocnemus nigricornis, Throscus elateroides, Cercylon ferrugineum, Dirhagus pygmaeus* and a range of Anobiidae.

Although alder is predominantly a tree of fresh water wetland sites such as fens, river and streamsides, it can grow in brackish-freshwater transitions in estuaries where the soils are always wet (Bennett and Birks 1990). Oak also grew in this wet woodland in places, as some *Quercus* timbers have been identified in the submerged forest remains on the upper foreshore.

The field layer in this type of carr community is often formed of tall herbs (Rodwell 1991) including *Eupatorium cannabinum*, *Urtica dioica* (common nettle) and *Lythrum salicaria* (purple loosestrife). Sprawlers such as *Solanum dulcamara* (bittersweet), undershrubs such as *Rubus* (bramble) and herbaceous species such as *Mentha*, *Ranunculus repens* (creeping buttercup) and *Poa trivialis* (rough meadow-grass) also occur. These were all recovered in the macrofossil record. Many of the herbaceous pollen taxa that occurred could be from species typical of wet woodland. These include *Lysimachia* (eg yellow loosestrife, creeping jenny), *Lythrum salicaria* (purple loosestrife), *Lythrum portula* (water purslane), *Filipendula* (meadow-sweets), Brassicaceae (cabbage family), *Lychnis* (eg ragged robin), Ranunculaceae and *Rumex obtusifolius*-type (eg water dock). Zonations from woodland through to swamp and to aquatic vegetation are common in carr communities. At Minehead, areas of open water within the carr are suggested by the presence of macrofossil remains of floating-leaved plants such as *Ranunculus flammula* (water crowfoot), *Potamogeton* and *Callitriche* (water starwort). Many of the water beetles in the faunas examined, such as *Hygrotus inaequalis* and *Hydroporus scalesianus*, are typical of permanent bodies of still or stagnant water, often rich in aquatic vegetation. Others such as *Coelostoma orbiculare* and *Cynbiodyta marginella* are often found amongst the mud and decayed plant matter at the edge of such bodies of water.

The wider environment

The pollen evidence suggests that, when the peat on the lower foreshore was forming, drier land around Minehead Bay supported woodland of *Quercus* (oak) and *Corylus* (hazel) with occasional *Tilia* (lime) and *Fraxinus* (ash). Several species of beetles that were found are specific indicators of the trees with which they are associated. Both the scolytid (bark beetles) species *Hylesinus oleiperda* and *Leprisinus varius* are associated with ash and the weevil *Rhynchaenus quercus* with oak. Mixed deciduous woodland of this type suggests well-drained soils, in contrast to the environment of the reedbed and carr. The most likely location was the steep slopes of Exmoor which rise behind Minehead Bay and are today covered in oak dominated woodland.

DISCUSSION

Overall the radiocarbon dates have shown that peat accumulation on the foreshore at Minehead occurred over a period of approximately 1310 years (Tables 1 and 2 and Figure 4). The earliest date for peat formation as part of an upper salt marsh transition community (perhaps similar to the present day Phragmitetea association), is from the base of the peat bed at site 076 (5670-5380 cal BC). A similar community developed in the peat at site 077 (5640-5370 cal BC) and at site 075 (5540-5290 cal BC). At site 027 higher up the foreshore, at some time after 5630-5380 cal BC the salt marsh transition community changed to alder carr presumably as tidal influence diminished. Whether alder carr ever developed in the area of sites 075, 076 and 077 is unknown, as it cannot be estimated how much peat has been lost by erosion. The dates for the surviving tops of the peat beds at sites 077 and 027 (5620-5310 cal BC and 5330-4990 cal BC respectively) show that these communities existed for around 700 years from 5670 to 4990 cal BC.

There does not appear to have been any overlap in the periods of peat formation on the lower and upper foreshores, although some erosion of the upper levels of the lower peat has undoubtedly occurred. The earliest dates for the base of the peat beds on the upper foreshore are from site 047 (4830-4520 cal BC) and 044 (4830-4490 cal BC). At site 047 the start of peat formation was associated with the development of a freshwater reed swamp and at site 044 with a reed swamp/alder carr transition. At this latter site the stratigraphy is complex and peat formation was apparently rapid. The basal date overlaps with a date of 4830-4520 cal BC for the top of the band and above this, a thin horizon of organic clay suggests a flooding episode, before a further (undated) period of peat development. The alder carr/reed swamp transition community apparently remained established throughout. At site 045 alder carr was established when the basal peat began to form (4780- 4460 cal BC) and this date overlaps with that from the peat base at site 046 (4710-4360 cal BC) where the vegetation community was more typical of the upper salt marsh transition zone.

It is perhaps best to see the coastline at Minehead in the Mesolithic period as a mosaic of vegetation communities with areas of marginal salt marsh, reed bed and alder carr co-existing at different locations down the foreshore. It seems likely a delicate balance existed between these communities which grew on both peat and clay soils. This suggests that a combination of fluctuations in tidal rise and fall, plus variations in the degree of freshwater input from the landward side determined the dominant vegetation communities at any time or place. The landscape would therefore have included both brackish and freshwater swamps, in some cases with a succession to alder carr depending on slight and very localised changes in the relationship between fresh and saline waters.

The occurrence of the same vegetation communities, notably the marginal salt marsh, but also to a lesser degree the alder carr, indicated in both the minerogenic sediments and the more organic peats is interesting. The topography of an upper salt-marsh is typically fairly level with only a slight gradient upwards and landwards. A reduction in tidal influence may have caused a change in sedimentation from minerogenic material brought in by tidal waters to more organogenic, with an increase in the accumulation of organic matter provided by plant decay. Increased freshwater input may also have affected the rate of organic matter accumulation. The *Phragmites* reed bed community is a transitional one, which can tolerate some changes in salinity from brackish to more freshwater. It is not perhaps surprising, therefore, that the community does not alter greatly with this change from minerogenic to organogenic, although a few more typical freshwater marsh species such as *Lycopus europaeus* and *Mentha aquatica* do occur in the peat deposits. Alder is also known to be able to tolerate slightly brackish conditions (Bennett and Birks 1990) so perhaps this tree started to become established at sites 044 and 045 whilst this area was still affected by tidal waters, but was at the start of a negative sea level tendency.

Examination of peat/clay transitions by Haslett *et al* (1997) showed that marine foraminifera are not confined to clay horizons and occur within the upper 500 mm of peats, demonstrating marine influence before a sedimentary transition to clay. At Minehead Site 77 high salt-marsh foraminifera, *Jadammina macrescens* occurs in the peat bed associated with reed-swamp/marginal salt-marsh pollen 300 mm below the peat clay transition.

EVIDENCE FOR HUMAN ACTIVITY

Boyd Dawkins (1870) first described the peat and submerged forest deposits at both Minehead and Porlock Bay. At Porlock Mesolithic flint flakes and blades were recorded from the surface of a head deposit sealed by blue clay and deposits of peat. At Minehead it appears that flint artefacts were recovered from below the peat and submerged forest deposits 45 at about SS 9785 4655. The material is now in the British Museum and consists of Mesolithic flakes and blades (Wymer 1977, 247). No further stratified lithic material was recorded during the archaeological assessment and survey associated with the sea defences scheme (McDonnell 2001).

Abundant charcoal (both micro and macroscopic) was found in the Minehead sediments and although natural fires cannot be entirely ruled out, it seems likely that this is evidence of human activity in the area. The charcoal was found in both clays and peats, high frequencies were particularly associated with the reed bed community, but charcoal was also found in some samples associated with the alder carr. Some of the charcoal fragments showed morphological features characteristic of the Poaceae family (the grasses); some was of wood. Microscopic fragments were examined in the pollen preparations; the majority had no diagnostic morphological features, being too thick to allow penetration by transmitted light, but around 10% of all fragments seen in the slides from Sites 027, 075, 077 and the base of Site 044 (all from reed bed assemblages) showed 'graminoid' features with markedly sinuous outlines to epidermal cells. These sites also produced occasional graminoid culm nodes in the macrofossil samples, thought to be from common reed stems. Site 45, which records alder carr throughout, had abundant micro charcoal in some samples, but no fragments with 'graminoid' features were observed, with only occasional charred wood fragments in the macrofossil record.

The source of the charcoal cannot be established with certainty although some may have originated from burning on the uplands adjacent to Minehead Bay, subsequently being washed or blown down onto the wetlands below. There is well-documented evidence for burning of upland vegetation during the Mesolithic period (approximately 8000 - 4500 BC) (Simmons and Innes 1985; Simmons 1993; Caseldine and Hatton 1993). Simmons (1993) suggested that Mesolithic communities might have used fire to keep open clearings in upland woodland to encourage grazing by large herbivores (and therefore to facilitate hunting in a generally forested environment). Caseldine and Hatton (1993) have produced compelling palynological evidence for the burning of upland woodland on Dartmoor during the Mesolithic; though they accepted that the nature of the exploitation strategy involving fire remained hypothetical, they concluded 'from what is understood about the economy of the Mesolithic in the British Isles, it is likely that fire was used to modify woodland to encourage and direct game'. It is possible that similar patterns of exploitation to those identified on Dartmoor existed on Exmoor during the later Mesolithic. At Hawkcombe Head, inland from Porlock at an altitude of 413 metres, Mesolithic flint artefacts have been found at the interface between mineral soils and overlying blanket peat (Norman 1982). The site has been interpreted as more than a short-stay hunting camp, as can be seen by the enormous quantity of flint brought there to be worked into tools. With a water source to hand and food readily available, small groups congregated here long enough to leave the kind of traces that are not normally found on sites of this period and must be considered as a frequently used *locale* within the Hawkcombe Head landscape (Paula Gardiner pers comm).

The Mesolithic people of Exmoor would have been able to hunt deer in the uplands but the coastal plain, with its reed beds and wet carr woodland, would have offered a rich complementary resource for wildfowling. However, the identification of 'graminoid' charcoal in the Minehead sediments demonstrates that burning of grasses, as well as trees was taking place, and this could have occurred in the reed beds of the bay itself. Similar microscopic charcoal has been found in Mesolithic age marsh sediments from Walpole, further north in Somerset (Tinsley unpublished data). On the north side of the Severn Estuary at Goldcliff East, Bell *et al* (2003) have reported the presence of 'graminoid' charcoal with epidermal cells exhibiting "sinuous outlines resembling those of common reed" in coastal sediments of Mesolithic age. Reed charcoal has also been reported from the Mesolithic site at Star Carr (Dark 1998; Hather 1998). It is possible that reed beds might have been burned accidentally during dry periods as a result of stray sparks from fires made at temporary camps used for exploitation of the marshes. However, Bell *et al* (2003) speculated that the burning of reeds at Goldcliff East might have been deliberate, forming part of a hunting strategy.

THE MINEHEAD FORESHORE SITES IN THEIR REGIONAL SETTING

The broad scale Holocene sedimentary sequence for the Severn Estuary Levels is well known (Allen 2001; Bell 2001) and shows a generally upward Holocene sea-level trend. However much of this research has concentrated on inter-tidal sites in the Severn Estuary proper which Bell (2001) describes as covering the area from below Gloucester as far west seaward as Brean Down on the English side and Lavernock Point on the Welsh side.

Minehead, which lies on the Bristol Channel coast, together with other sites along the north Somerset and Devon coast, discussed here provide additional data from intercalated peat and silt deposits often associated with evidence for human activity. Just south of Minehead Bay, at Porlock, intertidal peats were first described by Boyd-Dawkins in 1870. These inter-tidal peats, along with sediments from the adjacent Porlock Marsh were examined by a multidisciplinary team to assess their archaeological and palaeoenvironmental potential (Canti *et al* 1995). Up to three beds of peat intercalated with clays were identified and evidence from pollen analysis and macrofossil remains revealed alternating episodes of alder carr, freshwater swamp and salt marsh, which were related to changes of sea level (Jennings *et al* 1998). The organic deposits from this site have radiocarbon ages ranging from 6609-6425 cal BC (7730 ± 50 BP, Beta 81655) to 3940-3530 cal BC (4925 ± 60BP OXa 6402). Swamp communities similar to those found at Minehead occurred around 6609-6425 cal BC but were replaced by alder carr by 5987-5777 cal BC (7070 ± 50 BP, Beta 86775). These dates for the Porlock peat beds are significantly earlier than those from Minehead though a further episode of carr development occurred around 5257-4914 cal BC (6160 ± 70 BP, Beta-81654) at Porlock, a period when alder carr is recorded in Site 027 at Minehead.

Further south-west along the Bristol Channel coast at Westward Ho! submerged "forest beds" were noted in the nineteenth century and a midden was recognised beneath the peat (Hall 1870). More recent investigations at this site (Balaam *et al* 1987) revealed that the peat deposits appeared to be of two distinct ages. Peat started forming, at the earliest, by 4829 cal BC (5190 ± 80 BP, Har-6363) and ceased, at the latest, by 3796 cal BC (5740 ± 100BP, Har-5641). This is a little later than most of the lower foreshore deposits at Minehead. Pollen analysis of the Westward Ho! peats revealed an on-site carr community dominated largely by *Salix* with only a little *Alnus* in contrast to the alder dominated carr from the Minehead and Porlock sites. However, the woodland on the drier soils away from the coastal plain appears to have been very similar to that on the slopes above Minehead Bay, with oak, elm, ash and lime and an understorey of hazel.

To the east of Minehead, the site at Stolford, examined by Heyworth and Kidson (1982) showed the deposition of layers of wood fen peat behind a shingle ridge around 4500-3800 cal BC (5330 ± 120BP, I3397) and 4460-3990 cal BC (5380 ± 95BP, NPL 147). More recently work at Burnham-on-Sea by Druce (1998) provided evidence for exposures of three intercalated peat and silt layers in the intertidal area. The lowest peat beds showed a similar date range to the exposures at Minehead. Pollen and foraminifera evidence demonstrated a decline in marine influence prior to the formation of the lowest peat layer C at 5440-5080 cal BC (6340 ± 70BP, Wk 5298). Pollen from the peat indicated a brackish/freshwater environment in close proximity to birch and willow fen. Following an episode of middle to high salt-marsh conditions, a further peat band formed in a brackish to freshwater environment above MHWST around 4660-4340 cal BC (5590 ± 70BP, Wk 5297). Evidence from foraminifera in the upper part of a peat again shows that transgressive tendencies began during a period of peat formation and in advance of the peat/minerogenic transition.

Allen (2001) and many other authors have noted the peats and organic layers such as those described here from Minehead, that resulted from the establishment of intertidal to supratidal organic marshes. They record fluctuations, such as changes in the rate of sea level rise, interpreted from biostratigraphic analyses as positive and negative sea level tendencies, in the underlying upward trend of sea level.

Allen (2001) has summarised the complex interaction of local, regional and supra-regional factors that are involved in later Quaternary sea level changes in the Severn Estuary and Bristol Channel. The Holocene marine transgression started to affect the present estuary and channel *c.* 11,000 BP (Allen 2001) and sea level rose rapidly until *c.* 6-5000 cal BP when the rate slowed. On the basis of data from Porlock, Jennings *et al* (1998) suggest a possible slower rate of *c.* 2.1 mm/year. It is generally accepted that sea level has risen in the order of 30-40 m in the last 10,000 years (Heyworth and Kidson 1982). However, the middle and late Holocene sections of the peat-based sea level curves (such as Heyworth and Kidson 1982; Jennings *et al* 1998) may not be an accurate guide to contemporary mean sea level by up to a few metres, as sediment compaction affecting the altitude of the silt – peat contact has not been taken into account in their construction (Allen 2001).

According to the model put forward by Haslett *et al* (2001b), mid and high marsh environments such as those identified at Minehead are associated with the decrease in the rate of sea level rise in the mid-Holocene, which may be related to 'stable or negative sea level tendencies'. Haslett *et al* (2001a) record data from the Somerset Levels which suggest a late Holocene increase in the rate of sea level rise, with a change from high to low marsh dominance in the environment of the estuary margins. These conditions would post-date the sequences identified at Minehead.

CONCLUSION

When considering the evidence from the locations discussed on the north Somerset and Devon coastline, a picture emerges of the vegetation of the coastal plain of this part of the Bristol Channel during the middle Holocene. From around 5600 BC through to 3700 BC the vegetation of this plain was sometimes carr woodland dominated by alder or willow, sometimes freshwater reed-swamp and sometimes brackish reed-swamp. The supratidal peat marshes would have provided favourable occupation sites for exploitation of adjacent environments with the more minerogenic marshes also being used perhaps on a more seasonal basis for hunting, wildfowling, fishing and reed-cutting (Allen 2001).

The Minehead evidence is important because of the number of sites investigated, which are in close proximity to each other, and the range of types of palaeoenvironmental information analysed. It demonstrates the ecological diversity of the plant communities of the coastal plain in this part of the Severn Estuary 6000 years ago. Had fewer sites been examined, only a limited and partial picture would have emerged. The Minehead evidence therefore reinforces the importance of using multiple sampling locations to achieve as representative as possible an interpretation of the palaeoecological data.

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