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PREHISTORIC TEST-SIDE ENVIRONMENTS AND POTENTIAL FOR HUMAN ACTIVITY; GEOARCHAEOLOGICAL AND PALAEO-ENVIRONMENTAL RESULTS FROM WEST QUAY ROAD – CARNIVAL SITE

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ABSTRACT

A core obtained from Harbour Parade, West Quay represents the most recent opportunity to study the palaeo-environmental development of Southampton. A deep core was been obtained which spans the Early Holocene (Early Mesolithic; Flandrian Ib and Ic) and Middle Holocene (later Mesolithic; Flandrian II). Detailed analysis of the core has been undertaken which includes study of the stratigraphy, and the pollen, diatom, molluscan and foraminifera content of the sediments. Four radiocarbon dates have been obtained which confirm the Early and Middle Holocene age of the sequence and place the column within the regional framework.

INTRODUCTION

A number of investigations of estuarine deposits and peat have been undertaken in the area of Southampton (e.g. Nicholls & Scaife 2008; and see below), and include a variety of palaeo-environmental (i.e. pollen, diatoms, foraminifera, molluscs) and geoarchaeological analysis, and many have also been deployed here see Part One of this report (Fig. 1). These analyses provide a corpus of information especially on reclaimed land at the mouth of the River Test, north of its confluence with the Itchen, and where it becomes Southampton Water. The combined data from these sites are summarised to provide an overview of the relevance of the changing environment for human habitation and occupation in the Lower Test (Part Two of this report). The sequence at the Carnival Site comprises over 4m of alluvial/marine silts and clays, and peat accumulating from the Early to later Mesolithic during a period of rapid sea-level rise. Casual finds of worked tools in the area indicate human activity in the area at all periods from the Lower Palaeolithic onwards. Excavations on the dry land have shown that occupation may have intensified during the Bronze Age with a number of sites of this period being located in the vicinity of the site, including occupation some 300m to the east on the West Quay site (Russel & Leivers 2003). Iron Age settlement also occurs in the same general area. Only limited evidence for Roman occupation has been found on the eastern shore of the River Test, the main centre of occupation at this time being on the River Itchen to the north-east. Settlement on the east shore of the Test intensified in the Late-Saxon period with the establishment of a significant trading settlement. This developed into the walled medieval town of Southampton. What follows is the palaeo-environmental background and analyses of the stratigraphy, pollen, diatoms, foraminifera and marine molluscs, supported with radiocarbon dates (part 1), that provides the basis for broader discussion and their archaeological relevance and significance (part 2).

Palaeo-environmental background (Robert Scaife and Michael J. Allen)

The study of peat in the drowned river valleys of the Solent tributaries has a long history. Peat was found in Portsmouth Dockyard in the mid 19th century (James 1847). This was later studied for pollen by Godwin (1945) who demonstrated that these sediments were of Early Holocene age. This, along with pollen analysis of sediments associated with archaeological finds (a Neolithic mace head) found at King George V dock in Southampton Water (Godwin & Godwin 1940), are some of the earliest pollen

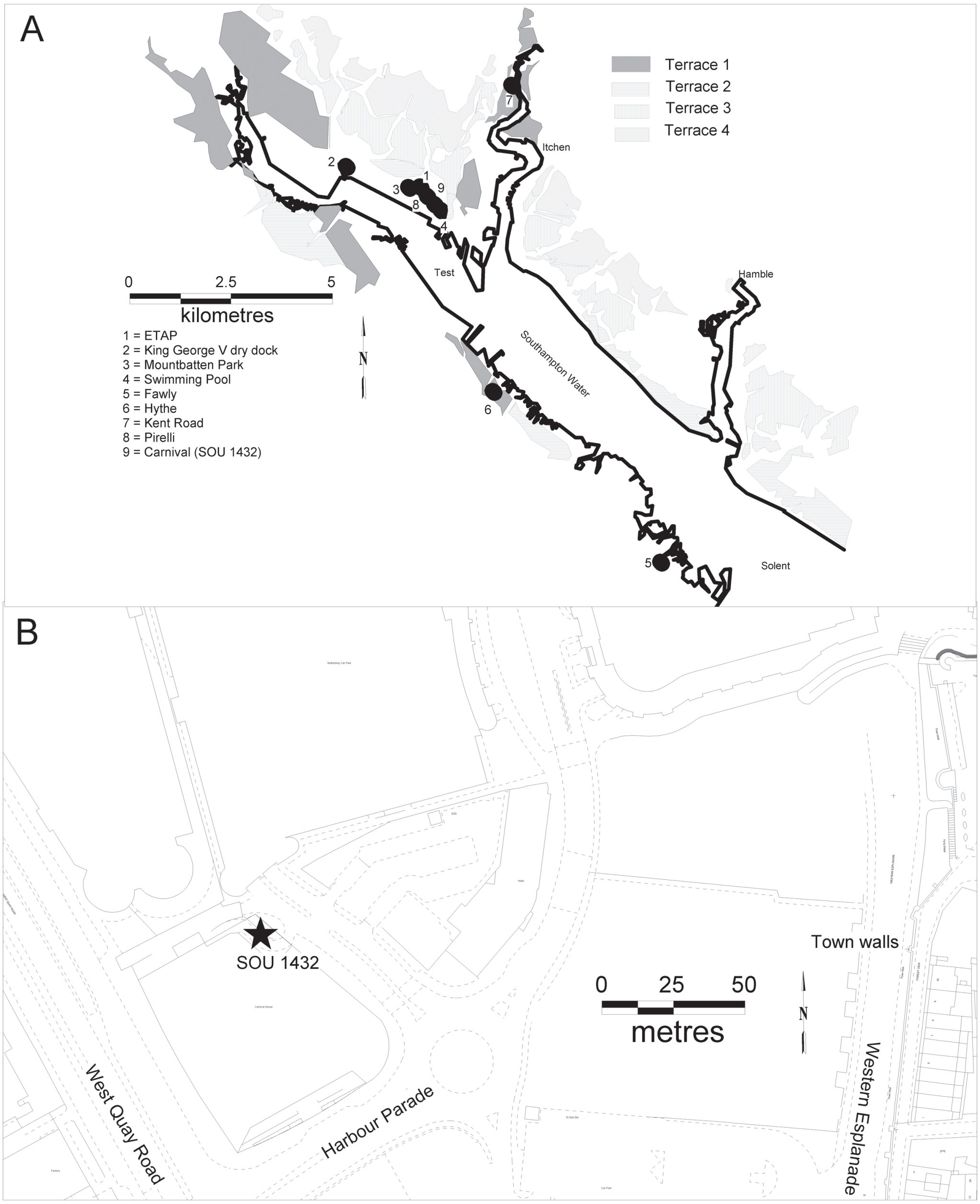

Fig 1 a) Location of the Solent and the gravel terraces and alluvium (taken from Nichols & Scaife 2008) with main other sites on Key * Carnival Site; 1, West Quay Road (ETAP) , 2, King George V Dock; 3, Mountbatten Park; 4, The New Swimming and Diving Centre; 5, Fawley; 6, Hythe ; 7, Kent Road (after Nicholls & Scaife 2008)
b) Location of the site and other in the locality (ie that done by Michal Smith at SOU for me)

Site	*SOU no*	*analysis*	*depth*	*published*
West Quay (Ibis Hotel site)	1403	C14, pollen, forams	+3.38 to –10.00m	Nicholls & Scaife 2008
Pirelli works West Quay Rd	1469	C14, pollen	+3.00 to –11.00	Wessex Archaeology 2008
Swimming Pool, Western Esplanade	796	pollen	7.10–7.65 and 10.29–11.20m	
Western Esplanade	814	Strat only		
Lido site		Peat at –5.48m OD		
Carnival site	1432	C14, shells, pollen, forams	+3.1– –11.03	This paper
New dock extension	–	stratigraphy		Shore & Elwes 1889
Electricity Light Works	–	stratigraphy – Peat at 2.7m	2.7m	Hooley 1905
New Docks, Southampton	–	statigraphy		Anderson 1933
Southampton Water	–	peat		Everard 1954

work carried out in England. Subsequently, there have been a number of important studies that have established a framework for palaeoenvironmental change in the Solent region which spans the last 12,000 years of the Late Devensian and Early Holocene periods; that is, from the closing stages of the last glacial period to the present day. These include the extensive studies of Langstone Harbour (Allen & Gardiner 2000), the Wootton Quarr project on Isle of Wight North Coast (Tomalin *et al. forthcoming*) and the Bouldnor, Isle of Wight Solent submerged Mesolithic site (Momber 2000; 2004; Scaife 2001). In Southampton recent published work has established a model of sea-level change spanning this period (Long & Tooley 1995; Long *et al.* 2000) and past vegetation development (Long & Scaife 1996; Scaife in Long *et al.* 2000).

Re-development of the fringes of the Southampton peninsula in the last decade has identified the presence of extensive deep peat and mineral sediment sequences underlying substantial depths of 19th and 20th century infill. A number of such sediment archives have been radiocarbon dated. Of these, The Mountbatten Centre is especially important providing evidence of the Early Holocene (i.e. Early Mesolithic; Flandrian Chronozone I) and the Middle Holocene (i.e. later Mesolithic; Flandrian Chronozone II) vegetation and environmental changes, the latter including Late Holocene marine transgression and development of salt marsh and mud flats (Scaife 1998a). This is mirrored at other sites which include: the New Swimming and Diving Centre (Scaife 1998b), Western Esplanade (Scaife nd), A3057 (Scaife 2000a), and the Millbrook Treatment Works (Scaife 1997), and the new Ibis Hotel (Nicholls and Scaife 2008) on the Test and Kent Road (Scaife 1992) and St Denys (Watler 1998) on the Itchen.

The presence of these peat and mineral sediment sequences are important and analysis of them has provided detailed data on the changing vegetation and environment of the Holocene period, that is, from the end of the last cold stage at *c.* 10,000 BP (8300 BC) and the seral changes in the development of Early and Middle Holocene (Mesolithic) woodland which was set in motion by climatic amelioration. These data therefore, span the Early Mesolithic (Pre-Boreal and Boreal) and Late Mesolithic Middle Holocene, (Atlantic)

Depth (m)	*m OD*	*Description*
0–3.65	*0 – –0.55*	*MADE GROUND: limestone gravel over greenish brown clayey sand*
3.65–6.40	*–0.55 – –3.30*	*Greenish grey GRAVEL AND SAND*
6.40–7.60	*–3.30 – –4.50*	*Green CLAY*
7.20 – 7.62	–4.10 – –4.52	Grey SILT/CLAY
7.62 – 7.67	–4.52 – –4.57	Lens of PEAT
7.67 – 8.68	–4.57 – –5.58	Homogeneous grey SILTS
8.68 – 9.46	–5.58 – –6.36	FEN PEAT: pale brown organic mud becoming fen peat
9.46 –9.71	–6.36 – –6.61	Blue/grey, fine SILT AND CLAY
9.71 – 11.03	–6.61 – –7.93	PEAT and Organic muds with clay lenses
11.10	*–8.00*	*GRAVEL*

phases of human occupation. Furthermore, the sequences also provide clear evidence for prehistoric changes in relative sea level which culminated in the inundation of the Solent and Southampton Water.

A somewhat later sequence of peats, starting in the Late Mesolithic and continuing into the Neolithic, developed some 140m to the north of the present site at the former Pirelli site (Wessex Archaeology 2008). Here the vegetation suggests that freshwater carr woodland was locally dominant with mixed deciduous woodland forming the dry land constituents. It is not clear why the peat beds should be younger on this site.

PART ONE: THE PALAEO-ENVIRONMENTAL HISTORY OF THE CARNIVAL SITE

The Carnival site lies at 3.10m OD (NGR 441626 1115538 – junction of Harbour Parade and West Quay Road), 230m west of the defensive circuit of the medieval walled town of Southampton (Smith 2008). It lies south of the edge of the second terrace on former salt marsh which fringed the margins of the Test and only *c.* 100m east of the sequence published by Nicholls and Scaife (2008). Previous boreholes at this location indicate approximately 3m of modern made ground, over 3.4m of alluvial/marine clays and gravels, and 3.4m of peat before the terrace gravels are reached. Peat has been identified at between 7m and 10.3m to 11.2m below ground surface (i.e.at *c.* –4m and –7.3m to –8.2m OD). The recovery of undisturbed deposits provided the opportunity to obtain a palaeo-environmental and geoarchaeological record of the development of the area, and to relate this to the potential human activity along the margins of the Test.

Coring method and basic stratigraphic record

Commercial coring undertaken prior to development recorded 4.1m of intact stratigraphy. Coring and sediment retrieval was undertaken where commercial borehole records has indicated the greatest thickness of peat. A single core was retrieved by Southern Testing, using a 150mm shell and auger rig, and eight U100 wax sealed cores recovered from 7.2m (–4.10m OD) to 11.03m (–7.93m OD) and sampling the fine-grained 'alluvial' and marine deposits, and the peats beneath the made ground and sandy gravels (see detailed descriptions below).

Contiguous undisturbed sediment samples were taken of the lower part of the 'alluvium' and full peat sequence retained using plastic liners in a U100 sampler. The stratigraphy is summarised below, with descriptions in italics taken from Southern Testing logs (Fig. 2). The contact with the gravel, although recorded, was not retrieved in the cores, and the lower 0.07m of peat and the contact with the gravel was lost in coring and retrieval.

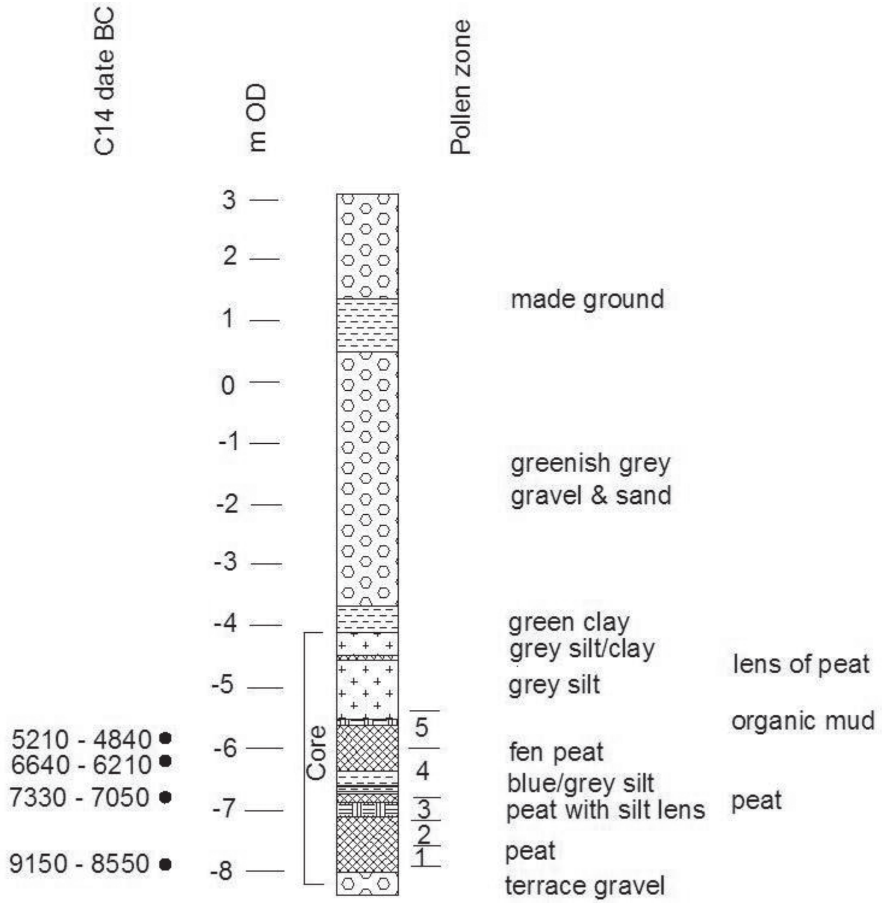

Fig 2 Sequence summary

Stratigraphy by Robert Scaife and Michael J. Allen

The upper stratigraphy of the site is summarised from the Southern Testing borehole logs and are presented below in italics, the lower portion was described in detail. The cores were split open, the exposed sediments cleaned and examined (by Scaife and Allen) and described; Munsell colours were recorded moist.

Immediately above the terrace gravels is the principal peat unit comprising peat with clay and silt lenses representing alluvial sediments, developing into fen carr peat.

Immediately above the principal basal peat there is a sequence of grey fine-grained minerogenic sediments. This significant stratigraphical change probably occurred in response to continued rising (relative) sea level. Final transgression with initially brackish water then followed by local mud flat and salt marsh occurred. By the top of this sequence there are very clear indications of major marine transgression. This major environmental change is evidenced especially in the stratigraphical changes noted, in the diatoms (Scaife, below), foraminifera (Gillespie, below) and the occurrence of numerous marine Mollusca (Allen, below) in the mineral sediment.

Depth (m)	*Dept OD*	*pollen zone*	*description*
0–1.70	*3.10–1.40*		*Made Ground: fine to coarse limestone gravel*
1.70–3.65	*1.40- –0.55*		*Made Ground: greenish brown clayey sand*
3.65–6.40	*–0.55- –3.30*		*Greenish grey gravel and sand*
6.40–7.60	*–3.30 – –4.50*		*Green clay*
7.20–7.62	–4.10 – –4.52		Grey (10YR 4/1) silt/clay containing marine Mollusca (*Cerastoderma* and *Mytilus*)
7.62–7.67	–4.52 – –4.57		Lens of dark brown, humic detrital peat some wood fragments in the lower part
7.67–7.70	–4.57 – –4.60		Peat to grey silt transition
7.70–7.87	–4.60 – –4.77		Grey silt with some clay. Containing some root fragments
7.87–8.68	–4.77 – –5.58	**5**	Homogeneous grey (10YR 4/1) silts with some buff (light yellowish brown 10YR 6/4) lenses in the upper part of the unit. Shell fragments. @ 8.34 Shell fragments (–5.24m OD) @ 8.67 Shell fragments (–5.57m OD)
8.68–8.76	–5.58 – –5.66		Pale brown (10YR 4/4 to 5/4) organic mud. No visible structure.
8.76–9.46	–5.66 – –6.36		Dark yellowish brown (10YR 3/4) compacted fen peat. @ 8.98–8.99 Wood
9.46–9.71	–6.36 – –6.61	**4**	Blue/grey fine silt and clay with pale brown mottling in lower part of unit. Some organic/root fragments.
9.71–9.79	–6.61 – –6.69		Peat. Very humified
97.9–9.83	–6.69 – –6.73		Blue – grey silt and clay containing mollusc fragments
9.83–9.95	–6.73 – –6.85		Highly humified detrital peat
9.95–10.00	–6.85 – –6.90	**3**	Pale brown (10YR 4/3) organic mud
10.00–10.22	–6.90 – –7.12		Detrital peat containing some silt
10.22–10.27	–7.12 – –7.17		Lens of grey (10YR 5/1) clay
10.27–10.32	–7.17 – –7.22		Detrital peat containing lenses of silt. Heavily mixed
10.32–10.48	–7.22 – –7.38		Mixed silt (grey/green, marine?) with some detrital peat
10.48–10.51	–7.38 – –7.41	**2**	Grey silt with bands of orange clay especially at 10.38–10.49
10.51–10.67	–7.41 – –7.57		Void in core
10.67–10.80	–7.57 – –7.70		Peat/organic mud containing occasional fragments of Mollusca
10.80–10.87	–7.70 – –7.77	**1**	Silty clay lens. Possibly contaminated from side of core @ 10.87 compacted twig (–7.87m OD)
10.87–11.03	–7.87 – –7.93		Detrital peat/organic mud @ 10.97 twig fragment
11.03	–7.93		base of core

Table 1 Radiocarbon results

Depth m (in core)	*Depth OD*	*Material dated*	*Result and lab no*	*calibrated result (cal BC)*	*Phenomenon*
8.92 – 8.94m	–5.82 – 5.84	peat humin acid fraction	6084±45 BP, Wk-23565	5210–4840	Expansion of *Tilia* and *Fraxinus*
9.40m – 9.44m	–6.30 – –6.34	peat humin acid fraction	7485±51 BP, Wk-23566	6440–6240	Base of upper peat. Dominance of *Alnus glutinosa*
9.88m – 9.90m	–6.78 – –6.80	peat humin acid fraction	8161±53 BP, Wk-23567	7330–7050	Start of expansion of *Alnus* to local dominance
11.00m – 11.02m	–7.90 – –7.92	peat humin acid fraction	9428±54 BP, Wk-23568	9150–8550	Base of core. Period of dominant *Pinus*

Dating and chronology

Several samples of the organic sediments were carefully removed from the deposits from key points in the sequence. In the absence of identifiable or recognisable horizontal plant remains, small blocks of peat of between 20mm and 40mm width were removed from the cores by R. Scaife. Four samples were selected from locations within the sequence where either significant changes in the stratigraphy or the pollen record occurred. Radiocarbon dating was performed on the humin acid fraction, rather than of any identifiable or recognisable plant remains. The results are present in Table 1 and are calibrated using the calibration curve of Reimer *et al.* (2009) and the OxCal v3 (Bronk Ramsey 1995; 1998; 2001). The calibrated date ranges cited in the text are those for 95% confidence. They are quoted in the form recommended by Mook (1986), with the end points rounded outwards to 10 years where the error term is greater than or equal to 25 radiocarbon years.

The results are presented in Table 1 and Figure 2 and are discussed below in relation to the biostratgraphy and sediment history. Four results from the basal peat facies sample nearly 2m of the sequence (*c.* –7.9 to –5.8m OD) and show the development of peat at 9150–8550 cal BC to the onset of minrogenic sedimentation at 5210–4480 cal BC, spanning the Mesolithic period.

Palaeo-environmental analyses by Rob Scaife, Michael J. Allen and Jan Gillespie

The cleaned and described sediments were carefully sampled for pollen, diatoms, Mollusca and foraminifera. Samples for pollen and diatoms were taken as 10mm wide 'slices', Mollusca at 100 to 150mm sample thickness, and foraminifera ranged from subsamples of bulk samples at 100mm sample thickness to 10mm sample thickness (see Table 2).

Pollen by Robert Scaife
Pollen sub-samples were analysed from the peat units that are intercalated within the mineral sediments. Sub-fossil pollen and spores were extracted from all but one of the samples examined. As with other sites examined from this area of Southampton, pollen preservation and absolute pollen numbers were very variable and often small. This was especially the case in the upper peat levels and those samples in which *Alnus glutinosa* (alder) was important. This poor preservation reflects the high biological activity of the fen carr woodland habitat during summer and the resulting degradation of pollen. However, this site clearly offered potential for studying the

Table 2 Details of the location of palaeo-environmental and radiocarbon samples

Depth (m)	*Dept OD*	*Radio-carbon*	*Mollusc samples*	*Diatoms*	*Foraminin-fera*	*pollen zone*	*Summary description*
7.20–7.62	–4.10 – –4.52		7.10–7.20 7.30–7.35 7.50–7.55	@7.60	7.10–7.20 7.30–7.35 7.50–7.55		Grey silt/clay containing marine Mollusca
7.62–7.67	–4.52 – –4.57						Lens humic detrital peat
7.67–7.70	–4.57 – –4.60						Peat to grey silt transition
7.70–7.87	–4.6– – –4.77						Grey silt with some clay.
7.87–8.68	–4.77 – –5.58		8.10–8.20	@8.30 @8.50	8.00–8.02 8.10–8.15 8.40–8.42		Homogeneous grey silts with shell fragments.
8.68–8.76	–5.58 – –5.66					**5**	Pale brown organic mud.
8.76–9.46	–5.66 – –6.36	8.92–8.94 9.40–9.44			8.75–8.80		Dark yellowish brown compacted fen peat.
9.46–9.71	–6.36 – –6.61			@9.48 @9.64	9.49–9.50	**4**	Blue/grey fine silt
9.71–9.79	–6.61 – –6.69						Peat. Very humified
9.79–9.83	–6.69 – –6.73						Blue – grey silt and clay containing mollusc fragments
9.83–9.95	–6.73 – –6.85	9.88–9.90					Highly humified detrital peat
9.95–10.00	–6.85 – –6.90					**3**	Pale brown organic mud
10.00–10.22	–6.90 – –7.12						Detrital peat containing some silt
10.22–10.27	–7.12 – –7.17				10.24–10.25		Lens of grey clay
10.27–10.32	–7.17 – –7.22						Detrital peat containing lenses of silt
10.32–10.48	–7.22 – –7.38			@10.46		**2**	Mixed silt with some detrital peat
10.48–10.51	–7.38 – –7.41						Grey silt
10.51–10.67	–7.41 – –7.57						Void in core
10.67–10.80	–7.57 – –7.70						Peat/organic mud containing occasional fragments of Mollusca
10.80–10.87	–7.70 – –7.77					**1**	Silty clay lens. (possibly contaminated from side of core)
10.87–11.03	–7.87 – –7.93	11.00–11.02					Detrital peat/organic mud
11.03	–7.93						base of core
11.20	–/80						Gravels

vegetation and environmental history of the area.

After an earlier assessment to ascertain if fossil pollen was present in the deposits and the quality of its preservation, a full analysis was undertaken with the following aims.

- To provide a vegetation and environmental history of this region of Southampton for the time-span represented by the peat and sediment deposition. (This appears to be Mesolithic, Early and Middle Holocene from *c.* 10,000 to *c.* 3000 cal BC.)

- To ascertain if there was any evidence of prehistoric human (Mesolithic) activity in the pollen record.
- To provide biostratigraphical data with radiocarbon dates which may be of use for establishing changes in Holocene, relative, sea-level.

Method

Standard techniques for pollen concentration of the sub-fossil pollen and spores were used on sub-samples of 2ml volume taken from core/borehole 2 (Moore & Webb 1978; Moore et al. 1991). Pollen was identified and counted using an Olympus biological research microscope fitted with Leitz optics. A total of 28 samples were examined of which 27 contained sub-fossil pollen and spores. A pollen sum (dry land) of 400–500 grains per level was identified and counted for each level where preservation permitted. Wetland/marsh taxa and spores of ferns were also counted outside of this sum. A pollen diagram (Fig. 3) has been produced using Tilia and Tilia Graph with percentages calculated as follows:

Sum	=	% total dry land pollen (tdlp)
Marsh/aquatic herbs	=	% tdlp + sum of marsh/aquatics
Spores	=	% tdlp + sum of spores
Misc.	=	% tdlp + sum of misc. taxa.

Taxonomy in general follows that of Moore & Webb (1978) modified according to Bennett *et al.* (1994) for pollen types and Stace (1991) for plant descriptions. These procedures were carried out in the Palaeoecology Laboratory of the School of Geography, University of Southampton.

Pollen preservation and zonation

Pollen analysis was carried out on the organic, peat units within the core sequence. These occur between 8.70m and the base of the profile at 11.03m. Overall, pollen was sparse in these highly humified, detrital peats which in some cases made counting of even sufficient numbers for an assessment analysis difficult. However, a pollen sequence has been obtained within which five local pollen assemblage zones can be recognised in this profile. Tree and shrub pollen are dominant throughout the profile with very few herbs present. The pollen assemblage zones are characterised from the base of the profile at 11.02m upwards to 8.52m, that is to the point where there is a marked change to brackish and marine sediments with little organic content.

Zone 1: 11.00m to 10.72m. Pinus. Detrital peat with wood. This basal zone is defined by *Pinus* (pine) which attained its highest values (to 90% of the pollen sum). *Corylus avellana* type (probably hazel but may include bog myrtle) expanded during this zone from 8% to *c.* 20% 10.76m. *Salix* (willow) is also present, especially in the basal level (11%) and was probably an autochthonous component with fluctuating values. There are few herbs with only small numbers of Poaceae (grasses) in the basal sample and some fen/marsh taxa including Cyperaceae (sedges; to 7%) and *Typha angustifolia* type (lesser reed mace and bur reed). Spores of ferns comprise largely monolete forms (*Dryopteris* type; typical ferns) to 22% (pollen sum + spores). A radiocarbon date of 9150–8550 cal BC (9428±54 BP,Wk-23568) was obtained from the base of the profile.

Zone 2: 10.72m to 10.32m. Pinus-Corylus avellana type. Detrital peat, organic silts and muds. This zone marks the arrival and expansion of *Ulmus* (elm; 1–2%) and *Viburnum* (wayfaring tree or Guelder Rose) from the base of the zone. There are expansions of *Quercus* (10%), *Corylus avellana* type (hazel; to 40%) and *Salix* (willow; 20%) from the preceding zone. *Pinus* remains important throughout the zone (to 85%). There are also minor peaks of *Alnus glutinosa* (alder; to 10%). Marsh taxa become more important with a substantial peak of *Typha angustifolia* type at 10.68m (46%) subsequently with sustained but lower values and further expansion at the top of the zone (to 18%). Cyperaceae (to 10%) increases in importance in the upper part of this zone with *Lythrum salicaria* (loosestrife), *Menyanthes trifoliata* (bog bean) and *Sagittaria* (arrowhead) present. Spores remain as previously dominated by *Dryopteris* type (increasing to 45%) with some increases in *Pteridium aquilinum* (bracken; 5%)

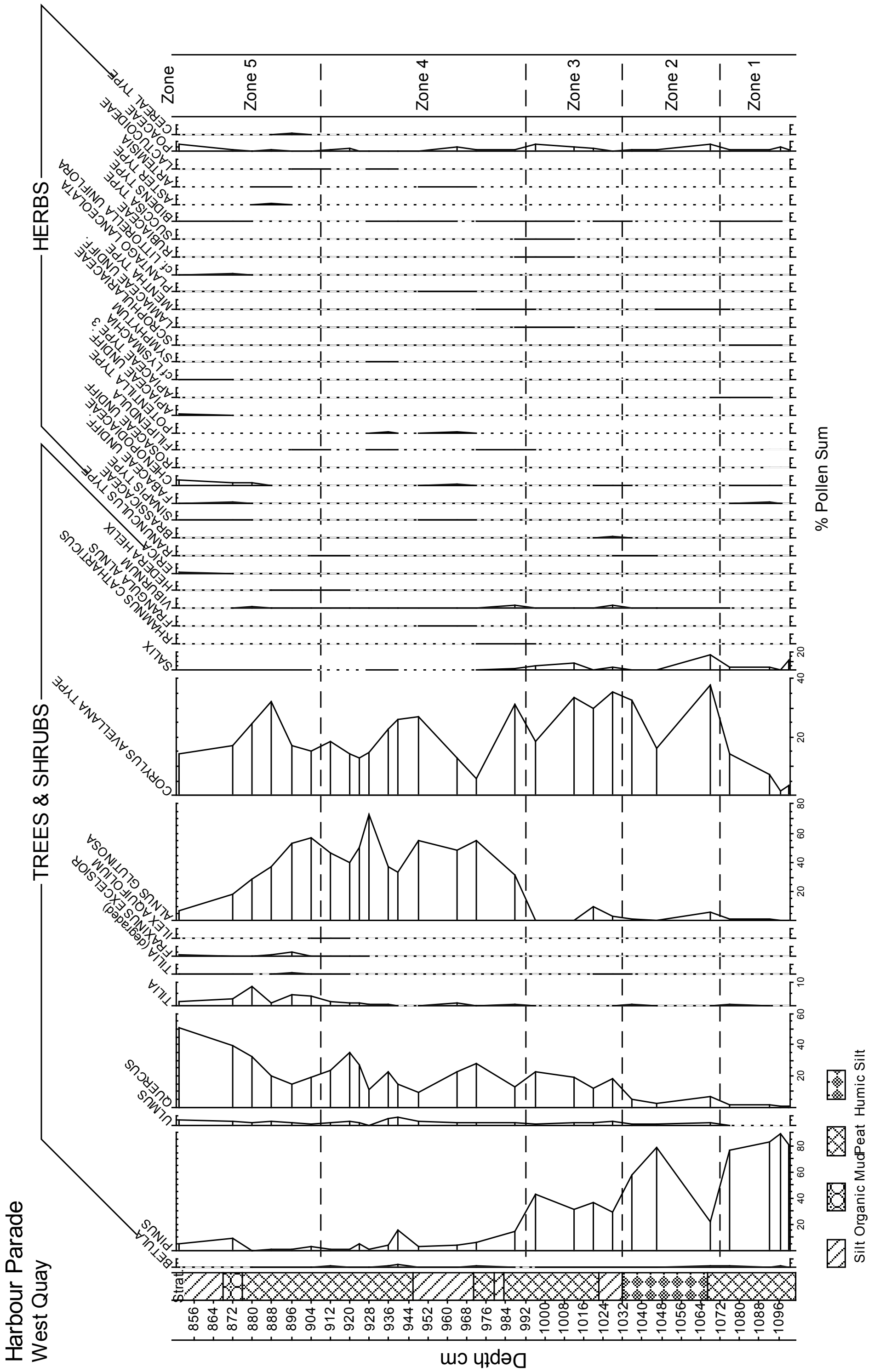

Fig 3 Pollen diagram

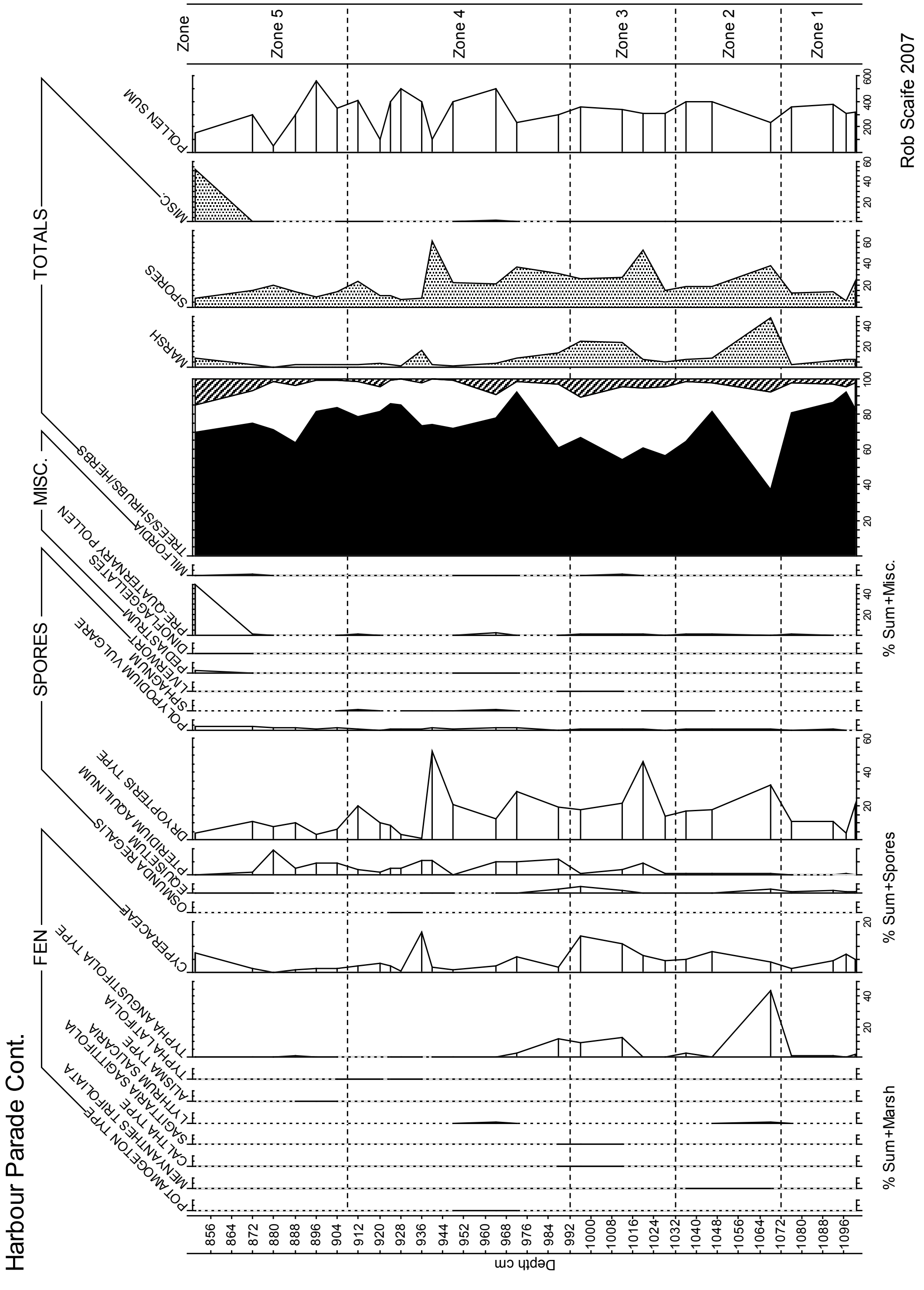

Fig 3 (*cont.*) Pollen diagram

and *Equisetum* (horsetail; peak to 6% at 10.00m) at the base of the zone.

Zone 3: 10.32m to 9.92m Quercus-Ulmus-Corylus avellana type. Peaty silt and peat. *Pinus* remains important but with decreasing numbers/percentages (*c.* 30–40%). *Quercus* (30%) and *Ulmus* (5%) become more important. *Alnus glutinosa* has a peak of 15% in the lower part of the zone (10.24m to 10.32m). *Corylus avellana* type remains important to 40%. Apart from Poaceae (8%) and *Typha angustifolia* type (15%) there are few herbs. Spores remain dominated by monolete (*Dryopteris* type) forms with a peak of *Pteridium aquilinum* (8%) at 10.0m

Zone 4: 9.92m to 9.08m. Quercus-Alnus glutinosa-Corylus avellana type. Silt and clay overlain by peat. *Alnus glutinosa* begins its expansion to substantial values (to 75%) during this zone. *Pinus*, *Corylus avellana* type and *Salix* show reduced numbers. *Quercus* and *Ulmus* continue to become more important as the dominant dry land tree taxa. *Tilia* (lime/linden) is present in small numbers throughout this zone (1%). Although a single grain only of *Ilex* (holly) is present at 9.12m, this is nevertheless possibly important, because it is emtophilous and only produces small numbers of pollen grains, and therefore is not found far from its are of growth, i.e. it was probably growing on, or near to the site. There are few herbs with only occasional Poaceae and marsh/fen taxa. Within the latter group, *Typha angustifolia* type is important as a peak across the zone 3/4 transition (15%). Cyperaceae remains but at lower values (to 10%). Spores remain and are dominated by *Dryopteris* type which declines from 9.40m. *Pteridium aquilinum* (bracken; 7–8%) becomes more important. Other spores include small numbers of *Polypodium vulgare* (common polypody), and *Sphagnum* (bog moss). There are occasional cysts of freshwater algal *Pediastrum*. A radiocarbon date of 7330–7050 cal BC (8161±53 BP, Wk-23567) was obtained from the base of the zone at 9.90m – 9.88m for the start of the primary expansion of *Alnus*. The base of the highest peat at 9.46m – 9.44m has been radiocarbon dated at 6440–6240 cal BC (7485±51 BP, Wk-23566).

Zone 5: 9.08m to 8.52. Quercus-Tilia-Alnus glutinosa-Corylus avellana type. Upper peat and overlying silt/clay. *Tilia* (lime) percentages expand to its highest values in this, the uppermost zone, with peaks to 9%. *Fraxinus excelsior*, present from the top of the preceding zone, becomes more frequent. *Alnus glutinosa* values are high at the start of this zone but decline progressively (55% to 18%). *Quercus* and *Corylus avellana* type remain important. *Pinus* occurs generally only in small numbers in this zone after its earlier importance although there are occasional peaks to 10%. There are occasional herbs but with only sporadic and/or small occurrences of Poaceae (7%), Brassicaceae (charlocks), Chenopodiaceae (possibly halophytes including goosefoots and oraches; to 6% in the upper level) and Fabaceae (vetches and clovers) are recorded. There are reduced numbers of Cyperaceae and spores of ferns. The uppermost samples (within grey marine sediments) contain large numbers of reworked/derived Pre-Quaternary (Tertiary) palynomorphs (note *Milfordia*). A radiocarbon date of 5210–4840 cal BC (6084±45 BP, Wk-23565) has been obtained for the lower part of the zone at 8.92m to 8.94m. This dates the start of the importance of *Tilia*.

Discussion and summary of the environment and changes

The changing vegetation sequence which can be inferred from this pollen analysis has been dated to the Early Holocene and Middle Holocene with overlying, later brackish water and marine sediments. This embraces the Early Mesolithic (Flandrian Chronozones Ib and Ic; i.e. the Boreal period) and later Mesolithic (Flandrian Chronozone II; i.e. the Atlantic) and spans the period by at least c. 9150–8550 cal BC (9428±54 BP, Wk-23568), in the Early Mesolithic to 5210–4840 cal BC (6084±45 BP, Wk-23565) in the Late Mesolithic.

The pollen spectra obtained relate to the pollen catchment which here includes the on-site (autochthonous) wetland component, that pollen coming from the drier terrestrial zone largely via airborne transport and, that which is possibly fluvially transported from elsewhere within the catchment.

Early Mesolithic (Early Holocene; Boreal, zone 1) shows a dominance of pine on the drier interfluve soils from a basal age of 9150–

8550 cal BC (9428±54 BP,Wk-23568) until its decline through competition from oak, elm and hazel at *c.* 7250 cal BC (the top of zone 3). Willow was growing in the local (on site) wetland, with a ground flora of grasses, sedges and other reed swamp taxa in wetter areas. Pine was dominant in the landscape here at an early stage of the postglacial and the basal radiocarbon date of 9150–8550 cal BC confirms that it has already become widely established by this date. However, in other pollen profiles from central southern England (Scaife 1980; 1987) there was an initially, expansion/dominance of juniper which was followed by pioneer birch colonisation during the period from *c.* 8300 BC to 7800 BC. It is possible that this may have occurred here but organic/peat deposits are recorded to the base of the core at 11m, no earlier minerogenic sediments are present which have been seen in other boreholes from the local area. Small numbers of hazel (*Corylus avellana*) pollen are present from the base of the profile and this also marks the early expansion of this tree/shrub into southern Britain.

The arrival and expansion to importance of more competitive oak, elm and hazel from *c.* 8000 cal BC (interpolated) is seen in zone 2. The increase in hazel may relate to human activity and even its promotion for nuts by the hunting and foraging human communities during the Mesolithic (Smith 1970). On the floodplain and the site itself, however, willow and wayfaring tree became increasingly important on-site possibly as the site became drier and followed by a change to sedge-dominated fen. Other reed swamp taxa also became more important with increases of reed mace and/or bur reed and subsequently with sedges. The small peaks of alder pollen in zone 2 and 3 are enigmatic and have been noted at other local sites such as the Itchen river at Clausentum (Watler 1998) and The Mountbatten Centre (Scaife 1998a) on the Test, and it is possible that they there were early stands of this wetland tree in suitable locations.

Oak, elm and hazel finally became established on the drier interfluves in zone 3 while pine was reduced having been out-competed by establishment of deciduous woodland. There was further expansion of alder in the wetter valley bottom and marsh areas; a phenomenon also noted above which is also seen in other pollen data from Southampton. This was probably consequent upon rising Holocene sea level during the Early Holocene, that is, the Flandrian transgression. This colonisation ultimately replaced the wetter willow-and-herb fen community that existed previously.

The establishment of a dominant deciduous woodland with the arrival of small-leaved lime as dominant or co-dominant with other deciduous trees (oak, elm, hazel) characterises zone 4. Of particular significance was the sharp increase in the established alder carr woodland (from 9.90m); this expansion attests the establishment of as flood plain carr woodland as a result of sharply rising (relative to land) sea level change which was responsible for the disruption and ponding of river systems, increasing local ground water tables and changing in the character of sedimentation. There is similar evidence regionally for such late Boreal expansion of alder from submerged peat in the Solent at Bouldnor Cliff (Scaife 2000b) and as such, the date of 7330–7050 cal BC (8161±53 BP, Wk-23567) provides useful corroboration for the early establishment of alder carr woodland. Certainly, after this expansion, alder remained as important floodplain woodland in ecologically suitable niches, but this expansion was asynchronous, and depended on the changing local habitat, and was most probably as a wave of alder becoming established in suitable habitats.

The final and significant phase of woodland development evidenced (zone 5) in this profile was the arrival and expansion of small-leaved lime. This Middle Holocene (later Mesolithic) climax woodland dominated by lime or co-dominant with oak, elm, ash and hazel and has been dated to 5210–4840 cal BC (6084±45 BP, Wk-23565) by which time lime had become an important constituent of the woodland flora. The pollen of this important tree is greatly under-represented in pollen assemblages due to its entomophily (insect pollination) and the fact that it flowers in mid-summer when all other vegetation is in full leaf (Andersen 1970; 1973). There is now a substantial corpus of evidence to show that lime (*Tilia)* was the dominant, or at least co-dominant, woodland component over much of southern and eastern England during the Middle Holocene until late prehistoric deforestation took place (Greig 1982; Scaife 1980; 1987). Alder carr remained important on lowlying river floodplains.

Subsequently the peat was finally transgressed by marine waters giving rise to typical grey mud flat and salt marsh silts. A radiocarbon date of 5210–4840 cal BC (6084±45 BP, Wk-23565) at 8.94m – 8.92m lies stratigraphically just below the change from peat to overlying brackish water and marine mineral sediments, and a date of *c.* 4800 cal BC is therefore suggested as the period of transition to estuarine conditions. However, some erosion of the upper peat surface may have occurred which would push the age to a later date.

The change from a peat-forming semi-terrestrial environment to initially brackish water and subsequently marine conditions is more clearly evidenced by the studies of diatoms (Scaife below), marine molluscs (Allen below) and foraminifera (Gillespie below).

There is no evidence in these pollen data for any significant human activity or influence on the vegetation. This is perhaps not surprising because the period spanned is that of the Early Mesolithic and it is unlikely that the hunting and foraging communities will have had any major forest clearance impact at that time. Only evidence of microscopic charcoal from fires is likely but it was not encountered in this study. Lack of any evidence is not, however, surprising since the Mesolithic of this region is viewed as communities occupying short-lived ephemeral encampments whose presence is unlikely to show up in the pollen record.

Diatoms by Robert Scaife

A series of six samples was prepared for examination of their diatom content in order to define the freshwater/saline status of the changing depositional environment. Diatom sub-samples were taken from the fine minerogenic sediments which were suspected as being of brackish or marine origin at depths of 7.60, 8.30, 8.50, 9.48, 9.64 and 10.46m (see Table 2).

Methods

Diatoms were extracted using digestion of humic/organic material from the mineral sediments by warm hydrogen peroxide (H_2O_2). Samples were washed and then dried on microscope cover slips and mounted on microscope slides using Naphrax mounting medium. Examination was carried out at high power ×400 and ×1000 using a biological microscope with phase contrast. Identification was aided by the diatom flora of Hartley (1996).

Results

Diatom frustules were recovered from only two of the samples at 7.60m and 8.50m. Diatoms were, however, only present in very small numbers. Very occasional broken/degraded frustules were observed in other samples but these were not identifiable.

8.50m: diversity was low but absolute numbers good (although still rather sparse). *Paralia sulcata* is most important with occasional *Nitzchia punctata*, *N. navicularis* and *Diploneis didyma*. These taxa suggest saline conditions of salt marsh and mud flat.

7.60m: this sample was of similar character to that at 8.50m again showing evidence of marine Mollusca. Towards the top of the core, comprising grey silt/clay with marine molluscs, this sample produced a range of typical brackish water and salt marsh taxa. These include – *Achnanthes brevipes*, *Actinoptychus senarius*, *Cocconeis scutellum*, *Diploneis didyma*, *Melosira* sp. and *Paralia sulcata*.

Conclusions

Diatoms are very variably preserved in these sediments. This is due to the differing energy and depositional environments in what is a complex stratigraphy. Although only two of six samples prepared produced diagnostic diatom floras, these are valuable in that they corroborate the other lines of evidence for change to mineral sedimentation under salt marsh and mud flat conditions. This was due to the Holocene marine transgression of the Solent and Southampton Water at or shortly after c. 4000 cal BC. These data are comparable with evidence obtained from Mountbatten Centre (Long 1988) and The New Ibis Hotel (Cameron in Nicholls & Scaife 2008).

Foraminifera by Jan Gillespie

Foraminifera (forams) are a group of marine shell-bearing protozoans, their tests in the sediment can be used for palaeo-environmental study. Planktonic forams live in marine waters of normal salinity and are very rare in brackish waters, the benthic forms live at or near the sediment-water interface and occur in brackish to normal marine habitats, and at all depths. They are ideal for palaeo-environmental analysis as many species have narrowly defined niches (Murray 1991). Study of the foraminifera in the sediments obtained from Harbour Parade, West Quay, can help characterise the marine and fluvial environment of the area, indicate the frequency of tidal inundation and corroborate evidence from pollen and diatom analysis. Nine samples extracted from a core (Table 2) were processed and examined for the presence of foraminifera.

Preparation techniques

Consolidated sediments were soaked in Calgon 10% for 24 hours prior to washing and drying to break up the clay particles. The sediment samples were washed through a 63um sieve to remove the clay fraction then air dried at 40°C. Samples were then examined and specimens picked out using a Leica MZ16 binocular microscope at ×10 – ×60 magnification.

Results

Of the nine samples, foraminifera were recovered from seven, although one of those produced only two forams.

Grey clay lens – sample 10.24–10.25m: this sample was from a lens of grey clay sandwiched between detrital peat above and below it. It contained foraminifera, although absolute numbers were not as high as those at shallower depths, they were significant and were of a brackish water taxa as those above, *Hynesina germanica,* and *Ammonia beccarii.*

Fen peat – samples 8.75–8.80 and 9.49–9.50m: sample at 8.75–8.80 was from compacted fen peat and was devoid of forams which suggests an absence of marine influence during this period. The sample at 9.49–9.50 from blue/grey fine silt and clay also contained no foraminifera which again probably shows an absence of marine influence, or lack of preservation.

Homogeneous grey silt – samples 8.10–8.15 and 8.40–8.42m: these two samples came from the same unit as the sample above (8.00–8.02), that is the homogeneous grey silts containing shell fragments. Both of these samples contained high numbers of foraminifera of species diagnostic of saline conditions. As with the higher units above these were also of low diversity and of the *Ammonia beccarri, Hynesina germanica* and *Elphidium williamsoni* association, *A. becarri* being predominant.

Homogeneous grey silt – sample 8.00–8.02m: this sample came from towards the top of a unit of homogeneous grey silts with some shell fragments, and contained buff coloured lenses in the upper part of the unit. Unlike the lower samples only two foraminifera were present in this sample, both being the brackish water taxon *Ammonia beccarii.* As the numbers are so low, it is possible that these could have arrived by a process of reworking of the sediment or transportation from another area.

Grey silt – sample depths 7.10–7.20, 7.30–7.35 and 7.50–7.55m: these three samples nearest the top of the core came from grey silt/clay, some of which contained marine Mollusca. Foraminifera were present in all of these samples, the majority were in a good state of preservation. They were all of a brackish water, mud flat fauna and were abundant in numbers although diversity was small. The assemblage consisted of *Ammonia beccarii, Hynesina germanica, Elphidium excavatum* and smaller numbers of *Elphidium williamsoni* i.e. a fauna similar to that found in the present day Hamble Estuary (Alve & Murray 1994).

Conclusions

The changing depositional environmental conditions are demonstrated within this stratigraphy by the foraminiferal evidence which corroborates with that found in the pollen and diatom analysis. It represents the onset of more marine conditions during the Holocene marine transgression. The lower part of the core contains an absence of marine influence from the detrital peat, but sandwiched between the peat is a band of clay which has indications of saline conditions representing a possible fluctuating sea level at this time, evidenced in the form of brackish water foraminifera. From this point (grey silts) conditions continue to represent one of saline influence demonstrating continuing Holocene sea level rise. A possible slight fluctuation is noted at around 8m with inconclusive evidence for saline conditions from the foraminifera. This is followed by continuing marine transgression as evidenced by the sedimentary, foramininiferal, diatom and pollen results.

Marine Mollusca by Michael J. Allen

A set of four spot samples was taken from the upper 'alluvial' facies of the sequence (Table 2). These were recovered from calcareous and non-pollen bearing deposits above a long stratified sequence of sediments which were analysed for pollen. This analysis provides information (together with foramaniferal evidence) of the fine-grained silts in the sequence lacking pollen.

Methods

Moist samples were weighed and recorded; they were disaggregated in warm water and sieved onto a 0.5mm mesh. All shells were extracted and identified under a ×10-×30 stereo-binocular microscope and are presented in Table 3. Due to the very high numbers of Ventrosia ventrosa and Peringia ulvea ('Hydrobias') these were considered together and not split to species, but the majority are P. ulvae. Similarly due to the limited palaeo-environmental information to be gained, the Rissoidea have not been split into species. In the analysis all Cerastoderma cf. edule and Cerastoderma spp. were considered as C. edule. Percentages of marine species were calculated (excluding brackish-water shells), and the proportions of marine to brackish water calculated (Table 3). Brief notes on the habitats of the species recorded are given in Appendix 1.

Results: marine Mollusca and environmental change

Although the samples were relatively small (c. 475g ave.) shell numbers were high with 464 marine shells and 1691 fresh-brackish water specimens being recorded, totalling 2155 shells (Table 3). Numbers of shells per kilogram decline upwards, and is largely due to the declining numbers per kilogram of Ventrosia ventrosa/Peringia ulvae.

The lowest sample (at 8.10–8.20m) from grey silts with light yellowish brown lenses was dominated (91%) by fresh/brackish-water shells of *Ventrosia ventrosa/Peringia ulvae* which can occur in exceptionally high numbers in estuarine muds and salt marsh. Relatively high proportions of the small fragile bubble shell *Retusa obtusa* are also present. These occur in brackish and muddy environments and prey on *Peringia ulvea* (McMillan 1968; Macan 1977; Kerney 1999). Notably these are accompanied by moderately high percentages of *Scrobiularia plana* which also inhabits organic muds and salt marsh, and the rare species of cockle *Cerastoderma glaucum* that is able to tolerate fluctuating salinities (McMillan 1968; Barrett & Yonge 1984). This clearly indicates salt marsh and muddy estuarine conditions open to some marine influences (*Cerastoderma edule*). The high number of the small marine Rissoidea shells may be considered to be occurring in strand lines high in the tidal frame as observed in parts of Portsmouth harbour today (Allen pers. obs).

At the base of the upper grey clay (7.50–7.55m) – the putative transition between brackish and marine conditions – increasing marine influences can seen with the increase in *Littorina littorea/saxatilis* and the presence of *Littorina littoralis.* Marine shells constitute 18% of the assemblage. There are, however, also concomitant increases in species that tolerate lower salinities including *C. glaucum.* Further, *R. obtusa,* which feeds on the brackish-water species *P. ulvae,* shows a significant increase in relative proportion abundance. Here, therefore, there is an apparent contradiction in the ecological evidence, but this is typical of transition phases where inwashed material in strand-lines may be mixed with less saline-tolerant species.

The upper two samples (7.30–7.35 and 7.10–7.20m) from the top of the cored sequence show a progressive increase in marine taxa from 18% to 43%, and this is accompanied by a strong decline in species that can tolerate less saline conditions, i.e., *C. glaucum* and *R.*

Table 3 Mollusca from upper grey silts

Depth (m)	*8.10-8.20*		*7.50-7.55*		*7.30-7.35*		*7.10-7.20*	
sediment	*Grey silt with buff lenses*		*transition*		*Grey silt/clay with shells*			
wt (g)	*420*		*360*		*562*		*556*	
	no	*%*	*no*	*%*	*no*	*%*	*no*	*%*
'MARINE' MOLLUSCA								
Cerastoderma edule	2		16		18		8	
Cerastoderma cf edule / spp.	–	22	7	16	13	20	24	39
Cerastoderma spp.	3		1		4		1	
Cerastoderma glaucum	7	13	19	12	20	12	2	2
Scobicularia plana	7	13	12	8	21	12	9	11
Mytilus edulis	1	2	2	1	5	3	7	8
Littorina littorea/saxatilis	2	4	25	16	34	20	19	22
Rissoidae	18	33	12	8	17	10	9	11
Retusa obtusa (Montagu)	14	26	57	37	39	23	6	7
Littorina littoralis	–	–	3	2	–	–	–	–
Proportion of marine shells of total	–	*9*	–	*18*	–	*34*	–	*43*
marine total	*54*	*154*	*171*	*85*				
BRACKISH-WATER MOLLUSCA								
Ventrosia ventrosa/Peringia ulvae	532		711		325		115	
unident.	1		6		–		1	
brackish total	*533*		*717*		*325*		*116*	
TOTAL	*587*		*871*		*496*		*200*	
wt shells frags (g)	36	87	100	41				
shells per kg	1398	2419	883	360				

obtusa. The assemblages become dominated by the truly marine species *C. edule,* and *Littorina* spp. which originate from the top and middle of lower shores in a marine environment. The species present tend to suggest the presence of some intertidal organic muds locally (*Scobicularia plana*), but generally indicate sandy and muddy marine environs confirming the post-late Atlantic marine transgression, indicated previously.

PART TWO: THE CHANGING TEST EDGE ENVIRONMENT AND ITS IMPLICATION FOR HUMAN ACTIVITY AND ARCHAEOLOGY (Michael J. Allen)

The Carnival site

The cored sequence has provided evidence for environmental change during the Early-Middle Holocene period (Table 4). Peat had

Table 4 Summary of the local environmental history

Dept OD	*Summary description*	*Radiocarbon*	*pollen zone*	*pollen*	*Mollusca*	*Diatoms*	*Foramininfera*	*Interpretation*
–3.30- –4.10	Green clay							Brackish / marine mudflats in estuary
–4.10 – –4.52	Grey silt/clay				Transition from brackish to marine and inter-tidal muds	Brackish water and salt marsh	Brackish water and salt marsh	
–4.10 – –4.52	Grey silt/clay				Transition from brackish to marine and inter-tidal muds	Brackish water and salt marsh	Brackish water and salt marsh	
–4.52 – –4.60	detrital peat and transition							
–4.60 – –5.58	Grey silts and homogene-ous grey silts		5	Alder carr remained important on low-lying river floodplain.	Brackish salt	Brackish water and salt marsh	Brackish Saline conditions	Neolithic onwards Continued marine transgression – mudflats
–5.58 – –5.66	Pale brown organic mud							Late Mesolithic / Early Neolithic
–5.66 – –6.36	Fen peat	–5.82 – –5.84: 5210–4840 cal BC –6.30–6.34: 6440–6240 cal BC	4	Establishment of dense alder carr woodland on the site and floodplain. Establishment of a dominant deciduous woodland with the arrival of small-leaved lime as dominant or co-			?absence of marine influence	Mesolithic wet freshwater marsh and alder carr floodplain,
–6.36 – –6.85	Blue/grey fine silt with peat lens	–6.78m- –6.80m: 7330–7050 cal BC				No diatoms	?absence of marine influence	
			3	Further expansion of alder in the wetter valley bottom and marsh areas. Colonisation ultimately replaced the wetter willow-and-herb fen community. This was probably consequent upon rising Holocene sea level.			Brackish water	Incursion or high level tidal ingress

Dept OD	*Summary description*	*Radiocarbon*	*pollen zone*	*pollen*	*Mollusca*	*Diatoms*	*Foraminінfera*	*Interpretation*
–6.85 – –7.93	Detrital peat with intermitted lenses of grey alluvial silts/clays	–7.90- – 7.92: 9150–8550 cal BC	2	The arrival and expansion to importance of more competitive oak, elm and hazel from c. 8500 BP (interpolated). Willow and wayfaring tree became increasingly important on-site followed by a change to sedge-dominated fen. Possible occasional alder in suitable habitats.		No diatoms		Development of woodland on interfluves With will carr developing into sedge-dominated fen
			1	Early Mesolithic (Early Holocene; Boreal) dominance of pine on the drier interfluve soils from a basal age of 9150–8550 cal BC (9428±54 BP,Wk-23568) until its decline through competition from oak, elm and hazel at c. 8000 BP (the top of zone 3). Willow was growing in the local (on site) wetland				
–7.10	gravel							Late glacial cold stage gravels

started forming by 9150–8550 cal BC. The pollen sequence shows a change in the adjacent dryland vegetation from pine dominated woodland at this time to increasing deciduous woodland domination from about 7000 cal BC. The deciduous pioneers were oak, elm and hazel, with small-leaved lime becoming probably dominant by 7330–7050 cal BC. The vegetation on the actual site reflects wetter conditions locally. During this phase the sequence started with willow wetland that developed through sedge dominated fen to alder carr woodland.

There was a major change in the local environment shortly after 5210–4840 cal BC, where there was a change from wet woodland to estuarine conditions as a result of rising relative sea level. It is estimated that the transition at the present site occurred at about 4000 cal BC. However, we postulate that the actual change may have been somewhat later, the top of the present sequence having perhaps been lost by erosion. This suggestion is strengthened by the evidence for continued peat formation into the Neolithic at the Pirelli site 140m to the north.

The evidence suggests inundation of the alder carr at, or shortly after, 4000 cal BC, although there was some lamination of the upper peat deposits indicating fluctuating sea levels. There were no peat deposits above –4.52mOD suggesting a definitive change to estuarine or intertidal conditions. The diatoms from these deposits only indicate saline conditions. The foraminifera are slightly more informative suggesting a development from brackish to more saline conditions. The marine Mollusca also indicate an initial brackish phase presumably representing mud flats, becoming progressively more marine above about –4.4mOD.

No obvious indications of human activity were identified. This does not discount the possibility of contemporaneous human settlement in the general area, but that any such activity did not leave any obvious traces in the proxy palaeo-environmental remains from the analysed core. The palaeo-environmental evidence from here broadly corroborates that from other sites in the general area. The main exception is the somewhat later evidence from the Pirelli site which may be due to local site-specific preservational and environmental conditions.

The local sequences and its implications for human activity

The data here can be summarised, in combination with that from West Quay Road (fig. 1; Nicholls & Scaife 2008) to which it is almost identical (Fig. 4). The combination of data from these two sites and that at Pirelli Cable Works Site (Wessex Archaeology 2008), allow us to record the changing coastal, edge, floodplain and estuarine environments of the current Test margins.

The local sequence shows Late Glacial gravels indicating cold stage high energy riverine activity. These are superseded by Early Mesolithic (Boreal) peat formation indicating locally wet but terrestrial fen and marsh peatland environments dominated by willow and buckler ferns (*Dryopteris*) locally. The marsh was subject to flooding and estuarine sedimentation leaving silt lenses. In the wider environment on higher drier ground pine woodland dominated. Development of more woody flora over the marsh was indicated at *c.* 8000 cal BC until *c.* 7500 cal BC by increasing willow, wayfaring tree and alder locally, concomitant with the development of deciduous woods (oak, elm and hazel) on the drier higher land to the north. Increased wetness as a result of sea-level rise lead to further alder in the wet floodplain and marsh areas by *c.* 7500–7000 cal BC. This alder colonisation ultimately replaced the wetter willow-and-herb fen community. By the later Mesolithic (*c.* 6500 cal BC), continued rising sea-levels resulted in increasing alluvial sedimentation and the cessation of peat growth in the immediate locality, but this was finally subsumed by fen peat developing from *c.* 6500 to about 5000 cal BC, and the establishment of alder carr.

These Mesolithic (9000–5000 cal BC) environments were not conducive to settlement or camp sites and hearths as seen in other floodplains such as the Kennet valley (e.g. Wymer 1962; Healy *et al.* 1992; Ellis *et al.* 2003), but provided an ideal seasonal resource-base sites for the acquisition of reeds, withies, for basketry and matting, peat for burning and for the hunting of fish and fowl. As such the archaeological trace of Mesolithic activity is likely to be slight, and certainly there is no evidence of alteration of the vegetation by human activity. Isolated Mesolithic finds in the form of flint blades, tranchet axes, scrapers etc , are present from Millbrook, Town Quay, Southampton Old Docks, Western Esplanade etc (*cf.* Wymer 1977, 121) confirming a Mesolithic presence, and presumably exploitation of the environment and its resources. These locations and environments were not, however, the location of settlement or more sedentary activity, but would have provided other important resources from fish and shellfish to wild fowl and reeds etc.

By what we presume to be the later Mesolithic and earlier Neolithic periods rising sea-levels subsumed the alder carr and lead to development of saltmarsh and mudflats leading to the deposition of grey silts above the peaty facies. These muddy estuarine conditions remained locally from Neolithic through Bronze Age periods into historic times and were only changed by the human modification, reclamation and creation of dryland along the estuarine marines by increasing local land levels by import and dumping of clays, and latterly more rubbly detritus. Thus these areas provide long and well-sealed sequences, enabling us to date and develop a history for the changing environmental conditions, and of the changing coast and estuarine configuration. They are, however, less likely to provide direct evidence of human action, but do provide potential areas of important resources for, in particular, Mesolithic communities.

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APPENDIX 1.

Brief notes on ecology and habitats of the of species recorded

Littorina littoralis (flat periwinkle): – lives particularly in the middle and top of lower shore, and especially on *Fucus*.

Littorina cf. *littorea/saxatilis* (common/rough periwinkle): – lives especially middle shore and below (especially upper and top of the middle shore), on rocks and weed.

Rissoidae: – generally common from mid-tide level to 12–23 fathoms, but some species are more habitat specific.

Cerastoderma edule (common cockle): – Inhabits sand and mud on the middle and lower shore, from the low water mark to a few fathoms.

Cerastoderma gluacum (lagoon cockle): – found on the lower shore of the estuaries being a specialist able to tolerate fluctuating salinity. It is believed unable to tolerate high shore expose due to intolerance of desiccation.

Scrobicularia plana (peppery furrow shell):- an estuarine specialist able to tolerate lowered salinity it is generally found where organic material is high where it burrows up to 20cm inot fin mud. Common in salt marsh.

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Scobicularia plana (Peppery furrow shell): – an estuarine specialist able to tolerate lowered salinity it is generally found were organic material is high and it burrows up to 20cm into fine mud. Common in salt marsh.

Retusa obtusa (bubble shell): – lives on mud and muddy sand on the shore and sublittoral, surviving to salinities of 20‰ (brackish), carnivorous feeding on *Peringia ulvae* (*Hydrobia ulvea*).

Peringia ulvae (*Hydrobia ulvae)*: – is a common gastropod, which tolerates lowered salinity and is generally associated with salt marshes. They can reach densities of up to sixty thousand per square meter. They bare fully formed young, which can disperse on a raft of mucus.

Ventrosia ventrosa (Hydrobia ventrosa): – generally much less common than *P. ulvae* and prefers quite brackish creeks or lagoons.