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Mesolithic human and animal footprints at Lydstep Haven, Pembrokeshire, 2010: the environmental context

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In 2010, winter storms stripped sand off parts of the beach at Lydstep Haven revealing intertidal peats, on the surface of which were impressed human and animal footprints. This is not the first time that the peats have been exposed. In 1917, a pig skeleton associated with late Mesolithic flint implements was found in the peats. The skeleton was subsequently radiocarbon dated to 4345–3950 cal. BC. The favoured interpretation is that the pig escaped after being shot by Mesolithic hunters only to die of its wounds. At the time of the pig's death the local environment was one of alder carr and open swamp with hazel scrub and mixed deciduous woodland in the hinterland. The human footprints were of adults and children, and the animal footprints, where recognisable, were made by red deer. It was not possible to establish a direct link between the pig skeleton and the footprints, but the recording of the footprints and subsequent analyses reported on here demonstrates the changing environment in the late Mesolithic, and the nature of the environment when animals and humans were exploiting resources offered by coastal wetlands.

INTRODUCTION

The discovery of human and animal footprints of Holocene age in the intertidal peat deposits at Lydstep Haven (Fig. 1) provided an opportunity to undertake an archaeological survey and palaeoenvironmental investigation to record the footprints and ascertain the environmental conditions around the time of their formation. This is the most westerly site along the south Wales coast where footprint tracks and their environment have been investigated and the discovery adds to the evidence for widespread use of coastal wetlands in prehistoric times. Other South Wales sites, where the footprint tracks are preserved in peat, laminated silts, or at the interface between peats and silts, reflect different environmental conditions at the time of their formation, include Kenfig (Bennett *et al.* 2010) and several sites in the Severn Estuary (Aldhouse-Green *et al.* 1993; Allen 1997; Bell and Neumann 1997; Bell *et al.* 2000; Bell *et al.* 2001; Bell 2007; Bell 2013). Footprints of similar date to the Welsh examples have been found on the Lancashire coast (Roberts 2009).

Peat deposits, often termed the 'submerged forest' on account of the large number of tree stumps and tree trunks contained within them, are a long recognised feature of the foreshore on the Atlantic coast of Britain, with, in Wales, good examples found at Borth in Ceredigion and in the numerous coves and open beaches of Pembrokeshire, Carmarthenshire and Glamorgan. Giraldus Cambrensis writing in late twelfth century (Wright 1894, 413) provides the earliest description of the submerged forest in Wales following a storm that had stripped sand off Newgale beach, Pembrokeshire, revealing tree trunks.

Recent research has demonstrated that coastal peats result from mid-Holocene episodes of sea-level fluctuation and environment change, dating to between about 6500 cal. BC to about 4000 cal. BC (Bell

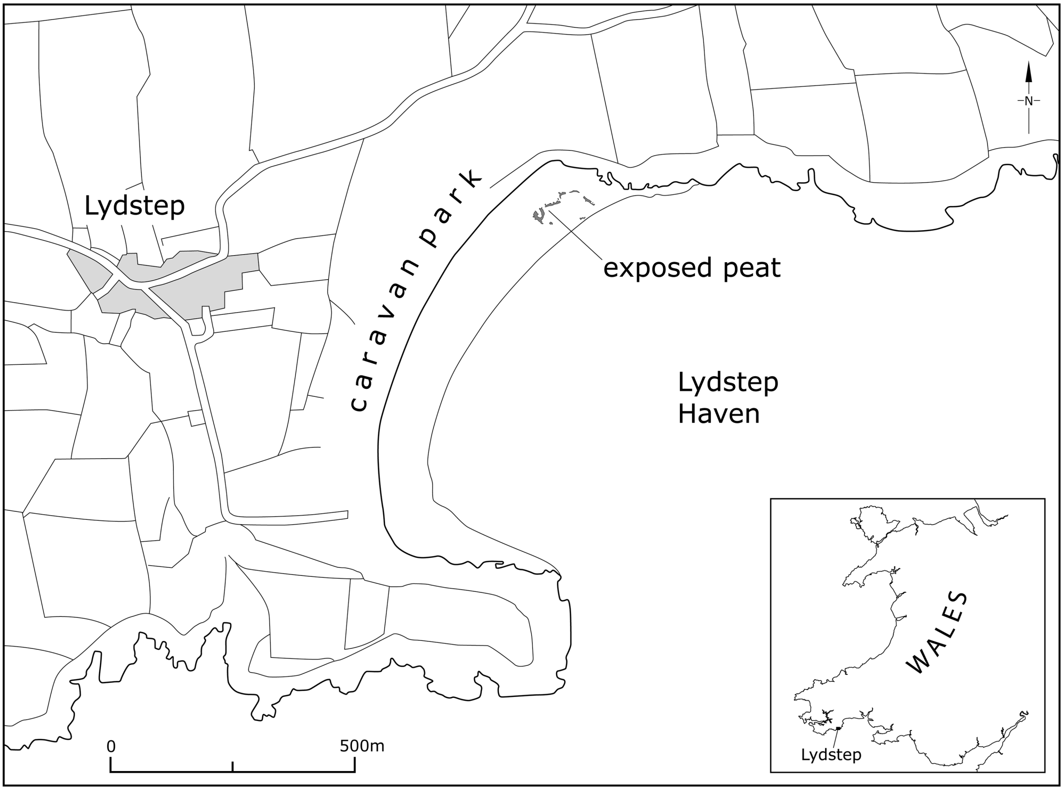

Fig. 1. Map showing the location of the peat deposits exposed in 2010.

2007, 319–20). Radiocarbon dates obtained from peats from several locations demonstrate that sea-level and environmental change in Pembrokeshire conformed to these general trends observed elsewhere. These dates are: 7050–6200 cal. BC (OxA-1411: 7640±150 BP) and 4700–3950 cal. BC (OxA-1377: 5520±150 BP) from Abermawr; 5250–4550 cal. BC (Q-530: 5960±120 BP) from Freshwater West; 5650–4950 cal. BC (HAR-78: 6370±150 BP) from Newport; 4350–3800 cal. BC (CAR-1176: 5250±80 BP) and 3510–3010 cal. BC (CAR-1182: 4540±70 BP) from Whitesands Bay; and 5400–4750 cal. BC (OxA-1378: 6150±120 BP) from Lydstep (all these radiocarbon dates are shown at 2-sigma and are taken from a CD accompanying Bell (2007). It is now generally accepted (see Lewis 1992) that in the embayed Pembrokeshire coast the peat deposits formed in shallow lagoons behind barriers—sand bars or storm beaches—when sea level was slightly lower than present levels. As sea levels rose these barriers were pushed back, or were breached, exposing the peat beds to the sea. Interestingly, Leach writing in 1918 (p. 62) expounded a similar theory, but in his model the land sank.

The sands on the beaches and coves are still highly mobile, and it is not unusual to witness a scene similar to that recorded by Giraldus Cambrensis over 800 years ago. This was the case at Lydstep Haven, where in April 2010 a local resident, Sarah Carlsen, informed the National Museum Wales (NMW) and the Dyfed Archaeological Trust (DAT) that winter storms had stripped some sand from the beach and that human and animal footprints were visible on the surface of the exposed peat. The discoveries were confirmed during a site visit by Ken Murphy (DAT) and Steve Burrow (NMW); this was followed by the

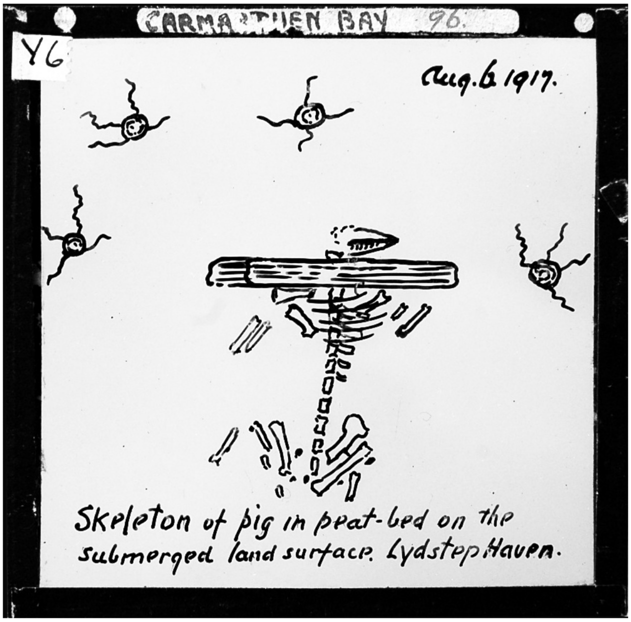

Fig. 2. A drawing by Arthur Leach of the Lydstep pig, reproduced from a glass slide in Tenby Museum.

short programme of recording described here, which has been funded by Cadw. Ken Murphy and other staff of DAT have regularly monitored the south-west Wales beaches, and 2010 was the first time in 30 years that extensive peat deposits have been recorded at Lydstep, although isolated pockets protruding through sand have been previously noted.

2010 was not the first time that the peats at Lydstep have been seen. In August 1917 approximately two acres of 'submerged land' was exposed in the northern part of the bay. Towards the centre of the bay the skeleton of a pig was found embedded in about 100mm of peat (Leach 1918, 50–1). Parts of the skull, ribs and shoulder blades of the pig projected above the surface of the peat. A tree trunk 0.3m diameter lay across the neck and shoulders, with the head to the west and the rest of the skeleton to the east of the tree (Fig. 2). Two flint implements (illustrated in Leach 1918, fig. B) lay in the peat below the tree trunk and above the skeleton, and a thin sandy-silt deposit containing freshwater shells overlay the peat and enveloped the bones that projected from it. In the previous year, November 1916, Leach collected material, including charcoal and calcined flint, which he described as a flint-working site from beneath a small peat exposure on the low water mark about 23m from the pig skeleton. He also found a flint microlith under the beachhead dunes. Worked flint from beneath the peat deposits was recorded by Lewis (1992) and in 2010 flints in a similar location were noted by one of the authors (Sarah Carlsen). A report on the skeleton by Hinton (1918) noted that it was of a sow approaching two years in age and that the general appearance of the bones and their large muscular attachments indicated that it was a wild pig. A radiocarbon determination of 4345–3950 cal. BC (OxA-1412) has been obtained from the pig skeleton, which is in the National History Museum, London. David (2007, 119–20 and fig. 5.3) has identified the implements accompanying the skeleton as late Mesolithic small backed bladelets.

METHODOLOGY

Photographs were taken and plaster casts made of a human and an animal print during two brief site visits in April 2010. At that time the surface of the peat exposure was clean and largely free of sand and weed. These initial site visits were followed up by one day of recording in May, during which the largest exposure of peat was laser scanned, the extent of the peat recorded by staff of the Royal Commission on the Ancient and Historical Monuments of Wales (RCAHMW) under the supervision of Louise Barker, borings into the peat made and samples taken. By May 2010—the day of intensive recording—sand was beginning to encroach over parts of the peat exposures, sand filled many of the footprints and weed had grown on the peat. Both the peat and the weed had to be cleared prior to recording. By the autumn of 2010 sand largely covered the peat. It would seem that this rapid re-sanding is a common phenomenon, as Leach (1918, 47) reports that the large exposure of peat visible in early August 1917 was covered by

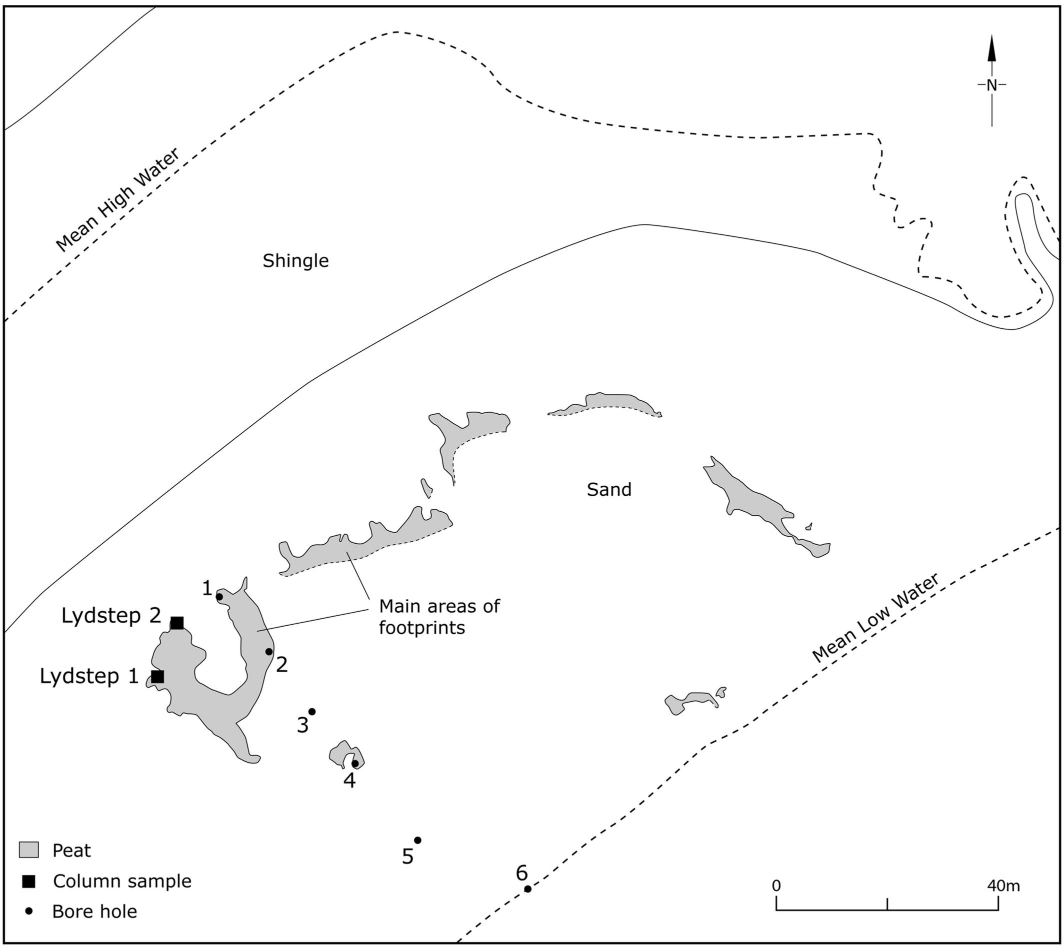

Fig. 3. Map showing the detail of the peat deposits exposed in 2010, and the location of samples and boreholes.

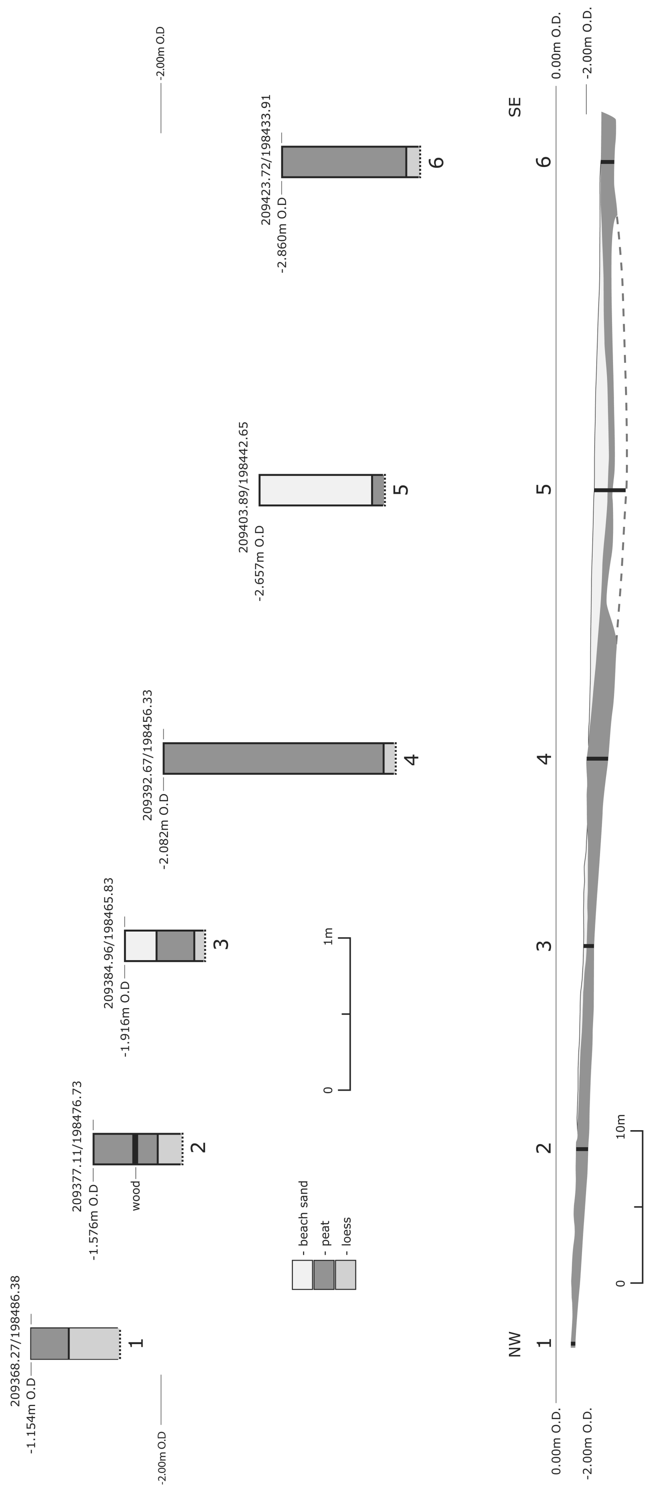

Fig. 4. Profile of the peat deposits as revealed in the survey and boreholes.

sand by the end of the same month. Following storms in early 2014, sand was once again stripped from the peat, but site visits failed to reveal detail not visible in 2010. The same storms stripped sand off Manorbier beach, 3 kilometres to the west of Lydstep, revealing pockets of peat with human and animal footprints.

THE SITE

Lydstep Haven is an east-facing sandy cove 800m across lying on the south Pembrokeshire coast (Fig. 1, SS 092 982). Carboniferous Limestone cliffs flank the cove to the north and south. The beachhead is now armoured with boulders and rocks, protecting a caravan park that lies immediately above the beach. A small sand-dune formation lay at the beachhead prior to the armouring. Although in 2010 some sand had been stripped from the beach, it was still predominantly a sandy beach with shingle (mainly formed from the eroding boulder and rock armouring) lying towards the beachhead. The peat exposures, lying in an area about 100m SW–NE and 80m NW–SE, occupied the northern end of the beach (Fig. 3), with the largest extents to the north-west and north-east, and the central part of the area under sand. This is the same location as the main 1917 exposures. On its north-west edge the peat was *c*. 0.25–0.4m thick. The borehole data show that the peat thickened to the south-east, and that it existed beneath sand, achieving a maximum thickness of almost 1.5m in borehole 4 (Fig. 4). From this point it thinned out slightly, but continued below the sand and sea beyond the mean low water mark. Tree stumps and tree trunks were

Fig. 5. Photograph taken in April 2010 looking south-west over part of the peat exposure showing of the pock-marked character of its surface.

more evident towards the low water mark and on the north-eastern side of the peat exposure than on the north-west, landward, side. On-site examination suggested that reeds were the main component of the upper layers of peat on the north-west side. The surface of the peat was very hard, and no impression was made on it by walking across it or, as has been witnessed at other locations in Pembrokeshire, by driving vehicles across it. Overall, the peat deposit was very robust, attested by its survival after several thousand years of pounding by Atlantic waves, although lumps of peat are susceptible to being ripped up if the underlying softer deposits are undermined. At Lydstep a blue-grey loess underlay the peat.

Footprints were visible on the surface of all peat exposures, but were densest and most deeply impressed on the north-west side. Here prints of humans, both adults and children, and of animals could be made out. The surface of the peat was highly weathered, crossed by many small channels and pock-marked by numerous hollows, some of which were undoubtedly the hollowed-out remnants of footprints (Fig. 5). The sheer density of the prints coupled with weathering made the on-site identification of trails very difficult. Unlike the silts, clays and sands in which foreshore footprints are normally preserved the Lydstep peat was generally not conducive to the preservation of detail of individual prints, though some is visible (Fig. 6a), nor of the prints of lightweight animals, such as the crane tracks found at Sefton in Lancashire (Roberts 2009, fig. 9). The lack of detail due to the unreceptive nature of peat for fine-grain preservation has been exacerbated by several thousand years of intermittent marine erosion. Thus, although there were numerous animal prints, only a few were sufficiently clear to identify them as probably of red deer (identified by Peter Howlett, Curator, Vertebrate Zoology, National Museum Wales). Figure 6b is shows one of the better preserved animal footprints, probably red deer.

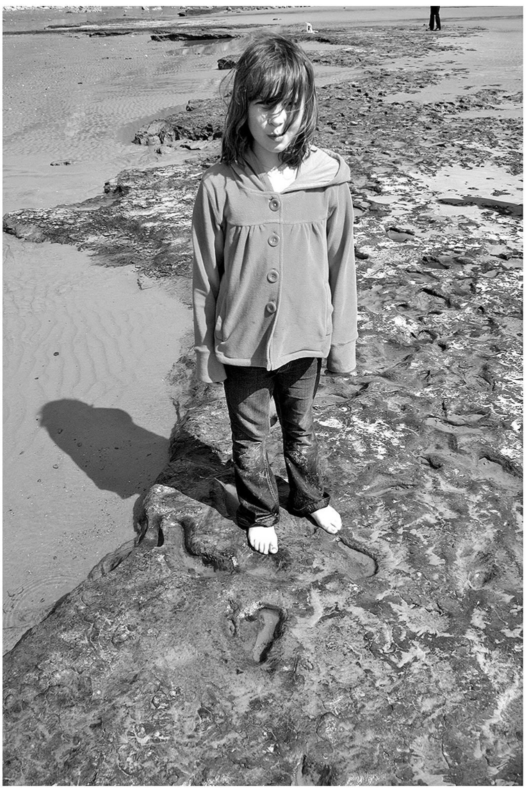

Fig. 6a (*left*). Detail of a child's footprint in the peat with a nine-year old as a scale, April 2010.
Fig. 6b (*above*). Animal footprint, probably red deer, May 2010. Scale in centimetres. *Photograph: © Crown copyright, RCAHMW.*

RADIOCARBON DATING

Four samples were taken from the Lydstep 1 pollen column and one sample from the Lydstep 2 pollen column for radiocarbon AMS dating at the SUERC laboratory in East Kilbride. The samples were peat samples apart from a wood sample taken from the base of the peat in Lydstep 1. The samples were calibrated using the calibration program OxCal 4.1 and calibrated using the IntCal09 dataset. The results presented below include other dates from Lydstep referred to in the text (OxA-1378 and 1412).

SUERC-39424
Sample and context: Lydstep 1, 1–2cm, peat
Result BP: 5280±30 BP
Calibrated range at 2 sigma: 4230–4190 cal. BC (19.3%), 4180–4040 cal. BC (69.1%), 4020–3400 cal. BC (7.0%)

SUERC-42332
Sample and context: Lydstep 1, 5–6cm, peat
Result BP: 5383±24 BP
Calibrated range at 2 sigma: 4330–4230 cal. BC (83%), 4200–4170 cal. BC (10.1%), 4130–4120 cal. BC (0.5%), 4090–4080 cal. BC (1.8%)

SUERC-39425
Sample and context: Lydstep 1, 17–18cm, peat
Result BP: 5690±35 BP
Calibrated range at 2 sigma: 4650–4640 cal. BC (1.1%), 4620–4450 cal. BC (94.3%)

SUERC-42333
Sample and context: Lydstep 1, 25–26cm, wood from base of peat
Result BP: 6222±30 BP
Calibrated range at 2 sigma: 5300–5200 cal. BC (45.5%), 5180–5065 cal. BC (49.9%)

SUERC-42334
Sample and context: Lydstep 2, 1.5–2cm, peat
Result BP: 5582±26 BP
Calibrated range at 2 sigma: 4460–4360 cal. BC (95.4%)

OxA-1378
Sample and context: Lydstep L1, 77.5–79cm, peat
Result BP: 6150±120 BP
Calibrated range at 2 sigma: 5360–4795 cal. BC (95.4%)

OxA-1412
Sample and context: Lydstep pig, bone
Result BP: 5300±100 BP
Calibrated range at 2 sigma: 4345–3950 cal. BC (95.4%)

PALAEOENVIRONMENTAL INVESTIGATION
By Astrid E. Caseldine

Two pollen column samples (Lydstep 1 and 2) were taken with a view to elucidating the environmental conditions contemporary with and/or preceding formation of the footprint tracks as well as providing further information about conditions contemporary with activity associated with deposition of flints in the area and the Lydstep pig. Previously, Lewis (1992) undertook a combined palaeoenvironmental and archaeological study involving examination of sediments from the beachhead and analysis of pollen from an exposure of intertidal deposits on the eastern side of the haven (Fig. 3) in an attempt to determine the nature of the environment contemporary with the flints and the death of the pig.

The stratigraphies of the two pollen sample sites are as follows:

Lydstep 1
0–5.5cm Black well humified herbaceous peat with reed remains.

5.5–18cm Dark brown humified peat with wood fragments including *Alnus c.* 17–18cm. *Typha* seeds. Charcoal fragments.
18–26cm Dark grey to greyish brown silt with humified peat and wood fragments. *Alnus* wood *c*. 22–23cm. *Potamogeton* seed and charcoal fragments *c.* 18cm.

Lydstep 2
0–1.5cm Black well humified herbacous peat.
1.5–8cm Dark grey silt loam with monocotyledon and wood remains.
8–35cm Dark greyish brown sandy silt with monocotyledon and wood remains.

Methods
Pollen. Samples were taken from the two pollen columns and prepared following standard procedures (Moore *et al.* 1991). The results are presented in Figure 7 and summarised in Tables 1 and 2. *Plant macrofossils.* In addition to the analysis of pollen the residues from the coarse sieve of the pollen preparations were scanned for macrofossil plant remains and some additional small samples were also sieved for plant macrofossils. The results from the pollen sievings are included in the stratigraphic descriptions and the results from the plant macrofossil samples are given in Tables 3 and 4. *Wood identification.* Two fragments of wood were identified from the pollen column from Lydstep 1. The results are incorporated in the stratigraphic description and one piece of wood was used for radiocarbon dating.

Palaeoenvironmental interpretation
The earliest pollen evidence (zone LYD1.1) from Lydstep 1, dated as beginning between *c.* 5300–5065 cal. BC (SUERC-42333), indicates an alder (*Alnus*) carr dominated local environment with a ground flora of sedges (Cyperaceae) and ferns (Pteropsida (monolete) indet.) as well as herb taxa such as meadowsweet/dropwort (*Filipendula*). A sedge (*Carex* sp.) seed and wood and monocotyledon remains in the plant macrofossil record support this. Willow (*Salix*) and ivy (*Hedera*) were also elements in the carr woodland. At this time ground conditions in the immediate area were damp enough for the preservation of pollen, indicating a high water table, but not so wet as to result in continuous peat development. Low amounts of hazel (*Corylus avellana* type which also includes bog myrtle) and oak (*Quercus*) pollen, as well as occasional birch (*Betula*) and ash (*Fraxinus*) pollen, may reflect other species within the carr woodland as well as mixed deciduous woodland in the surrounding area. The latter also included elm (*Ulmus*). Woodland in the surrounding area is probably under-represented in the pollen record because of the filtering and swamping effects of the local alder. Microscopic charcoal indicates some fire activity in the area, either the result of deliberate burning of vegetation, or domestic fires or natural fires

A rising water table is reflected in an expansion in sedges (zone LYD1.2), decline in alder and development of peat between 4650–4450 cal. BC (SUERC-39425). The appearance of aquatic taxa, including duckweed (*Lemna*), pondweed (*Potamogeton*), water-milfoil (*Myriophyllum*), bur-reed/lesser bulrush (*Sparganium* type) and bulrush (*Typha latifolia*), and presence of ragged-robin (*Lychnis flos-cuculi*), mint (*Mentha*) type and nettle (*Urtica*) indicate a fen environment. Further evidence for this is provided by fen pondweed (*Potamogeton coloratus*) seeds recorded around the time of peat development as well as a sedge seed, while later there is evidence for great fen-sedge (*Cladium mariscus*). Although alder continues to dominate the local woodland, a more open environment results in a change in pollen source area and increased representation of arboreal taxa from the adjacent drier land area, notably oak, elm and hazel, the appearance of lime (*Tilia*) and slight increases in birch (*Betula*) and pine (*Pinus*). Other components of the carr woodland include willow and holly (*Ilex aquifolium*), and twining plants such as ivy and honeysuckle (*Lonicera periclymenum*). Occasional Chenopodiaceae (e.g. goosefoots, oraches)

Table 1. Local pollen assemblage zones for pollen site Lydstep 1

LYD1.1 25–17.5cm *Alnus*
Arboreal pollen, namely *Alnus*, dominates the assemblage but begins to decline towards the end of the zone. *Quercus*, *Ulmus* and *Corylus avellana* type occur in low amounts while *Betula*, *Pinus*, *Salix* and *Hedera* occur occasionally. Herbaceous pollen is relatively scarce, mainly Cyperaceae. Pteropsida (monolete) indeterminate spores values are low. Microscopic charcoal is relatively frequent.

Interpretation: Alder carr woodland locally with mixed deciduous woodland in the surrounding area.

LYD1.2 17.5–6cm *Alnus-Cyperaceae–Corylus avellana* type
Arboreal taxa remain dominant but *Alnus* values fall before increasing again slightly. *Corylus avellana* type, *Quercus*, *Ulmus* and *Betula* values increase. *Tilia* is present as are a greater range of shrubs. Cyperaceae values show a distinct increase and Poaceae pollen is consistentally present. Herbaceous taxa include *Filipendula* and Chenopodiaceae. Aquatics are present including *Lemna* and *Typha latifolia*. Spores are more frequent, particularly *Polypodium*. Microscopic charcoal values peak twice before falling markedly.

Interpretation: Alder carr with an understorey of sedges and herb taxa as well as wetter pools with aquatic species. Mixed deciduous woodland on the adjacent drier land. Two distinct episodes of burning.

LYD1.3 6–4cm *Quercus–Alnus*
Arboreal pollen declines. *Quercus* pollen increases while *Alnus* values decline. Other values are similar although a greater range of herbs are present, including *Plantago lanceolata*. Of the aquatics, *Sparganium* type and *Typha latifolia* values show a marked increase. Microscopic charcoal is scarce.

Interpretation: Decline in alder carr locally and expansion in swamp taxa. Mixed deciduous woodland continues to prevail in the surrounding area.

LYD1.4 4–2cm *Quercus–Poaceae*
Quercus values remain constant as do *Corylus avellana* type whereas *Alnus* values decline further. *Fraxinus pollen* is present. Poaceae values increase markedly. Herb taxa include *Aster* type and Apiaceae and aquatics include *Menyanthes* and *Nymphaea*.

Interpretation: Swamp and fen taxa expand locally while alder carr declines further. Mixed deciduous woodland continues to dominate in the surrounding area.

LYD1.5 2–0cm *Cyperaceae–Poaceae*
Cypereaceae taxa increase and Poaceae values are largely maintained. Arboreal taxa values are generally low. Herb taxa include *Plantago lanceolata* and *Lythrum* spp. Aquatic taxa continue to be quite well represented.

Interpretation: Sedge communities expand and swamp/fen dominates locally. The presence of *Plantago lanceolata* and slight changes in the arboreal taxa may indicate some opening up of the mixed deciduous woodland.

pollen hints at the presence of salt marsh in the area and an increasing marine influence. Two peaks in microscopic charcoal, accompanied by macroscopic charcoal, one around the time of peat development and one later in the record suggest fire events in the area and possible Mesolithic activity, assuming the charcoal is not derived from natural fires.

An expansion in reed and sedge swamp communities takes place around 4330–4080 cal. BC (SUERC-42332), while alder woodland declines locally, resulting in an open environment. Representation of aquatic species increases, both the range of taxa and the frequency. Aquatic taxa include water-starwort

Table 2. Local pollen assemblage zones for pollen site Lydstep 2

LYD2.1 6–0cm *Alnus–Corylus avellana* type – Cyperaceae

Alnus and *Corylus avellana* type dominate the arboreal pollen assemblage accompanied by lesser amounts of *Quercus* and *Ulmus*. Cyperaceae pollen dominates the herbaceous assemblage. Chenopodiaceae pollen and aquatic taxa are more frequent later in the zone. Pteropsida (monolete) indet. taxa dominate the spores. Microscopic charcoal is present.

Interpretation: Alder carr dominates locally with an understorey of sedges and other fen species. Mixed deciduous woodland including hazel, oak and elm is present on the adjacent drier ground.

Table 3. Waterlogged plant remains from Lydstep 1

Sample depth (cm)	0–1	1–2	2–3	5–6	9–10	13–14	16–17	17–18	21–22
Sample size (ml)	25	40	50	50	50	50	50	50	50
Rubus sp. (brambles)	–	1	1	1	–	–	–	–	–
Hydrocotyle vulgaris L. (marsh pennywort)	–	–	1	–	–	–	–	–	–
Ajuga reptans L. (bugle)	–	1	1	–	–	–	–	–	–
Lycopus europaeus L. (gypsywort)	–	–	1	–	–	–	–	–	–
Potamogeton coloratus Hornem. (fen pondweed)	–	–	–	–	–	–	1	–	–
Eleocharis palustris (L.) Roemer & Schultes / *E. uniglumis* Link Schultes (common spike-rush/ slender spike-rush)	–	–	2	–	–	–	–	–	–
Bolboschoenus maritimus (L.) Palla (sea club-rush)	–	1	3	–	–	–	–	–	–
Cladium mariscus (L.) Pohl (great fen-sedge)	–	–	–	–	1	–	–	–	–
Carex sp. – biconvex (sedges)	–	–	–	–	–	–	1	–	1
Carex sp. – trigonous (sedges)	–	–	2	–	–	–	–	–	–
Typha sp. (bulrushes)	–	–	–	>50	–	–	–	–	–
wood remains	+	+	–	+	+	+	+	+	+
monocotyledon remains	+	+	+	+	+	+	+	+	+
substantia humosa	+	+	+	+	+	+	+	+	+
charcoal frags > 500 µm	–	–	–	–	3	–	34	4	–
charcoal frags > 250 µm	–	–	–	–	–	–	21	2	–
Daphnia sp. – ephippia (water fleas)	>20	>100	>100	–	–	–	–	–	–

(*Callitriche*), bogbean (*Menyanthes trifoliata*) and white water-lily (*Nymphaea*) as well as bulrushes and pondweed. A local vegetation succession is indicated by an increase in *Sparganium* type and *Typha latifolia* pollen (zone LYD1.3), which is also represented in the plant macrofossil record by abundant bulrush seeds, followed by an increase in Poaceae and then Cyperaceae pollen, the latter occurring *c.* 4230–3400 cal. BC, suggesting a succession of bulrush communities followed by reed (zone LYD1.4) and sedge (zone LYD1.5) swamp. Accompanying the increase in Poaceae pollen is the presence of rhizomes of common reed (*Phragmites australis*) in the plant macrofossil record, while coincident with the increase in Cyperaceae pollen is the occurrence of sedge seeds including common spike-rush/slender spike-rush (*Eleocharis palustris*/*E. uniglumis*) and sea club-rush (*Bolboschoenus maritimus)*. Both spike rush and slender rush are typical of marshes, slender rush especially in coastal marshes, while sea club-rush is commonly found in reed swamp as well as the margins of ponds in coastal areas, becoming dominant where salinity values increase (Rodwell 1995). Other pollen taxa indicative of swamp communities include Apiaceae, which includes marshworts, purple loosestrife (*Lythrum salicaria*), water purslane (*Lythrum portula*), bindweed (*Calystegia*), and bedstraws (Rubiaceae). Marsh pennywort (*Hydrocotyle vulgaris*) is represented in both the pollen and plant macrofossil assemblage. Other plant macrofossils include gypsywort (*Lycopus europaeus*) and bugle (*Ajuga reptans*), the former found in wet grassland, fens and by lakes while the latter occurs in woods as well as wet grassland. Pollen taxa such as Chenopodiaceae may indicate salt marsh in the area as may *Aster* type, although the latter includes species found by streams and ponds as well as sea aster. Also present in the microfossil record is *Mougeotia* (algae) which is indicative of shallow, stagnant mesotrophic water in spring-time (van Geel 1978), while *Daphnia* (water fleas) ephippia (resting eggs) are frequent in the upper peat samples along with the macroscopic plant remains. This may be of significance as ephippia are more likely to be produced when water bodies such as ponds are liable to drying up for part of the year, perhaps during summer droughts.

Table 4. Waterlogged plant remains from Lydstep 2

Sample (cm)	0–1	1–1.5	1.5–2	2–3	4–5	6–7	12–13	13–14	16–17	20–21	28–29
Sample size (ml)	25	25	25	50	50	50	50	50	50	50	50
Rubus sp.(brambles)	1	5	2	1	–	–	–	–	–	–	–
Rubus sp. frags	–	–	–	6	–	–	–	–	–	–	–
Lycopus europaeus L. (gypsywort)	–	1	–	1	–	–	–	–	–	–	–
Cladium mariscus (L.) Pohl (great fen-sedge)	1	–	–	–	–	–	–	–	–	–	–
Carex sp. – biconvex (sedges)	–	1	1	–	–	–	–	–	–	–	–
Carex sp. – trigonous (sedges)	–	–	1	–	–	–	–	–	–	–	–
Carex sp. – frags	–	1	–	1	–	–	2	–	–	–	–
Poaceae (grasses)	–	–	1	–	–	–	–	–	–	–	–
cf. Poaceae	1	–	–	–	–	–	–	–	–	–	
Typha sp. (bulrushes)	1	1	2	–	–	–	–	–	–	–	–
wood remains	+	+	+	+	+	+	+	+	+	+	+
monocotyledon remains	+	+	+	+	+	+	+	+	+	+	+
substantia humosa	+	+	+	+	+	+	–	–	–	–	–
charcoal frags > 500 µm	–	–	–	–	–	–	6	1	1	–	–
charcoal frags > 250 µm	–	–	–	–	–	–	16	–	–	–	–
Daphnia sp. ephippia	–	1	3	–	–	–	–	–	–	–	–
Simocephalus spephippia	1	1	1	–	–	–	–	–	–	–	–

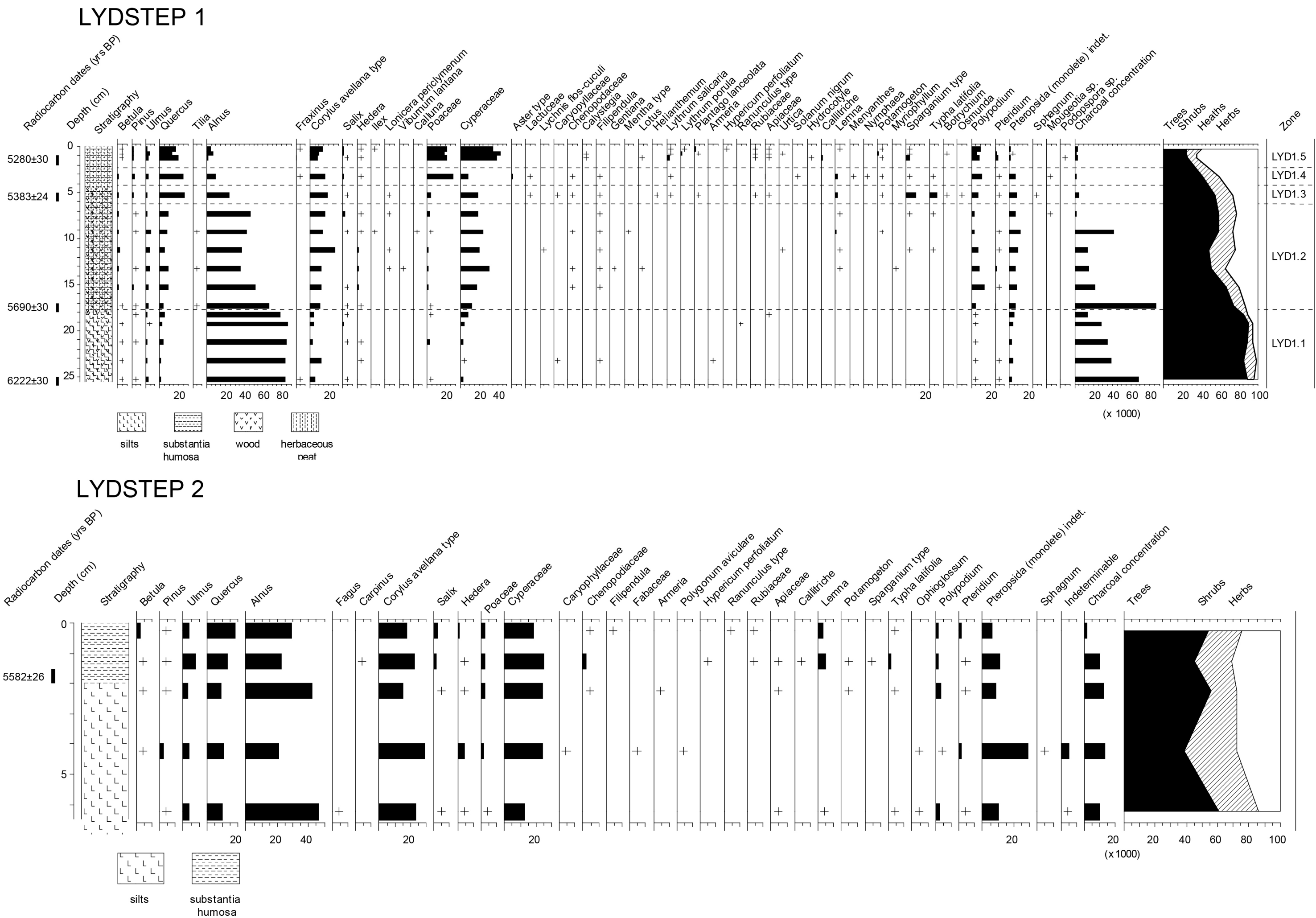

Fig. 7. Relative percentage pollen diagram from Lydstep 1 and 2.

A further change in the pollen source area is indicated at the beginning of zone LYD1.3 by an increase in oak, probably reflecting the reduced influence of alder and the more open swamp environment locally, and suggests oak woodland nearby. The presence, occasionally, of ribwort plantain (*Plantago lanceolata*) and an increase in the final level (LYS1.5) perhaps hints at some opening of the woodland cover. The first appearance of ribwort plantain is dated to 4330–4080 cal. BC and coincides with slightly lower elm values, though representation of elm is poor. A further slight fall in elm coincides with the increase in ribwort plantain shortly after 4230–3400 cal. BC but elm is still plainly present in the area at this time. Around this date the presence of a fungal spore of *Podospora*, a species indicative of dung (van Geel 1978; Van Geel *et al.* 1981; Van Geel 2003), may indicate the presence of livestock and grazing animals in the area. Microscopic charcoal values are significantly reduced compared to previously.

A decline in elm, the 'elm decline', is an event which consistently occurs around 3800 cal. BC at sites in Britain and is thought to be primarily the result of disease, though human activity may have played a role in certain circumstances (Parker *et al.* 2002). It is possible that the slight decline in elm *c*. 4230–3400 cal. BC (SUERC-39424) equates with the beginning of this event in the area and is the result of disease rather than human activity, even if humans were present. Accompanying the decrease in elm is an increase in oak and hazel suggesting they expanded into areas formerly occupied by elm. Equally, the death of elms may have created open areas favourable to species such as ribwort plantain as well as grazing animals. The presence of ash may also indicate some disturbance of the woodland cover and opening of the woodland canopy as ash is shade intolerant and its presence in the pollen record may indicate increased flowering.

The pollen record from Lydstep 2, the flint site, corresponds to part of the record from Lydstep 1. The flint, a Late Mesolithic/Early Neolithic blade core (identified by Steve Burrow) was from a silty loam immediately below the peat. Pollen failed to survive in the lowest sediments although macroscopic charcoal was evident in the macrofossil samples. However, pollen did survive in the silty loam above as conditions became wetter. Again the evidence suggests alder carr with sedges and ferns and mixed deciduous woodland nearby. Aquatic pollen taxa, particularly duckweed and bulrush, increase in frequency as peat develops. Bulrush seeds are also present along with sedge, great fen-sedge and gypsywort seeds, reflecting a fen environment. Peat development is dated to *c.* 4460–4360 cal. BC (SUERC-42334), probably marginally later than at Lydstep 1 where wood from the base of the peat was dated to 4650–4450 cal. BC, and it is likely the record from Lydstep broadly correlates with the latter half of LYD1.2. The record appears to end just prior to the increase in oak observable in the record from Lydstep 1.

DISCUSSION

Combined with the work of Lewis (1992) and Leach (1918) the present investigations provide a record of the environmental conditions contemporary with later Mesolithic activity at Lydstep Haven. Spatial variation in the vegetation in the area can be identified by comparison of the evidence from this study with that of Lewis (1992). The evidence suggests that *c.* 5300–5065 cal. BC alder carr was growing on the wet soils in the vicinity of Lydstep 1, whereas seawards of this site, at Lewis's pollen site (LY1), a date of 5360–4795 cal. BC (OxA-1378) suggests peat was already beginning to form around this time, or shortly after. Wetter conditions in that area are also suggested by higher values for willow. The influence of alder at Lewis's site is less marked with sedges more strongly represented, suggesting a more open woodland environment locally and leading to increased representation of hazel as a result. The latter was probably from hazel growing nearby on the drier slopes and headland on the eastern side of the bay, though some of it could derive from drier areas within the carr woodland. On the drier land of the headlands, as well as hazel, mixed deciduous woodland, including oak and elm, prevailed. The presence of salt marsh in the wider area is suggested by the occurrence of Chenopodiaceae pollen at Lewis's pollen site.

An expansion in alder carr occurs at Lewis's site possibly around the time of peat development dated to *c.* 4650–4450 cal. BC at Lydstep 1, though at the latter alder declines as sedges increase and a more open woodland is suggested. A similar more open fen carr environment is suggested by the pollen evidence both from the minerogenic deposits preceding peat development at Lydstep 2 and after peat development, which did not occur until 4460–4360 cal. BC. The presence of Chenopodiaceae pollen at all three sites indicates the presence of salt marsh in the area.

A lack of dates and the lower resolution of Lewis's pollen diagram makes it difficult to be completely certain about the relationship between Lydstep 1 and Lewis's site but it is possible that the lower part of Lewis's pollen diagram, up until a hiatus in the pollen record mid-zone Ly2, broadly correlates with the pollen record from Lydstep 1 but further radiocarbon dates from Lewis's pollen site would be necessary to confirm this. Certain pollen types, namely ivy (*Hedera*), meadowsweet/dropwort (*Filipendula*) and sedges and aquatics as a group, display a similar pattern of representation at both Lydstep 1 and Lewis's pollen site. However, whilst alder carr continued to dominate at Lewis's site (LY1), a more open environment prevailed at Lydstep 1 with a decline in alder and an expansion in swamp communities *c.* 4330–4080 cal. BC and a further expansion in sedges *c.* 4230–3400 cal. BC. Throughout all these periods mixed deciduous woodland continued to prevail on the dry land surrounding the bay.

Microscopic and macroscopic charcoal recorded during the present study indicates fire activity and hence possible human activity, as might the appearance of ribwort plantain, while archaeological evidence clearly demonstrates a human presence in the area during the late Mesolithic/early Neolithic. Flint artefacts from minerogenic deposits below the foreshore peat, including the Late Mesolithic/Early Neolithic flint recovered from directly below the peat at Lydstep 2, and from the beachhead deposits (Leach 1918; Lewis 1992) confirm human activity in the area during the Late Mesolithic and Early Neolithic. Leach (ibid.) recorded flint flakes, chipped pebbles, a calcined flint and charcoal from a deposit, *c.* 15cm in depth, of sandy clay or silt with fragments of limestone, shale and grit, which lay below a compressed wood peat *c.* 10cm in depth. Apart from the flints from the beachhead deposits, where there was no peat, all the flints pre-date peat development, although as demonstrated by the dates from the three pollen sites this varies across the area as does the depth of the flints within the minerogenic deposits. Hence at L1 (Lewis 1992) the flint lies below a date range of 5360–4795 cal. BC and at Lydstep 2 the flint is earlier than 4460–4360 cal. BC. The presence of charcoal at the possible hearth site recorded by Leach, as well as the flint artefacts, appears to support the view that the microscopic and macroscopic charcoal recorded at Lydstep 1 and 2 is likely to be due to human activity. From the limited evidence available from Lydstep 1 and Lydstep 2 it is probable that the area was wooded at the time the flints were deposited with alder on damper soils and hazel and oak woodland on drier ground.

The present study also provides further information about the environment contemporary with the Lydstep pig, originally recorded by Leach (1918). The pig was found protruding from woody peat deposits, *c.* 15cm in depth, and overlain by a peaty sandy silt, *c.* 5–7.5cm in depth, containing fresh-water shells, including *Limnaea pereger* (*Radix peregra*, wandering pond snail), *Anodonta* sp. (freshwater mussel), and *Planorbis umbilicatus* (*Neoplanorbis umbilicatus*, ram's horn snails). A tree trunk lay across the neck and shoulders of the pig and two Late Mesolithic microliths lay in the peat between the neck and the tree trunk. Lewis (1992) obtained a date of 4345–3950 cal. BC (OxA-1412) for the pig and, because of the lack of sufficient dates from the pollen site L1, concluded the faunal remains related to a level in either pollen zone Ly2 or Ly3. The dates of 4330–4080 cal. BC and 4230–3400 cal. BC from the upper peat deposits at Lydstep 1 suggest that the pig relates to a period of reed and sedge swamp development at Lydstep 1. Correlation of the Lydstep 1 diagram with Lewis's L1 diagram suggests that this period broadly corresponds with the lower part of zone Ly2 which continues to indicate an alder carr environment locally, and which is consistent with the stratigraphic evidence from the pig site. Overall, the palaeobotanical evidence suggests alder carr woodland towards the centre of the bay where the pig skeleton was found with open swamp towards the dry land, also noted during the archaeological survey, and hazel scrub and mixed deciduous woodland on the headlands.

The association of the pig skeleton with the flint implements have lead most authorities (David 2007; 119; Bell 2007, 328, table 21.1) to conclude that this was a late Mesolithic hunting site; the pig escaping then dying, and the flints the remains of the projectile that killed it. This is the most likely explanation. An alternative suggestion is that, on the basis of the freshwater mollusc evidence, it was ritually killed and then deliberately weighed down by the tree (Chatterton 2006). However, although it is possible the pig could have sunk into the underlying peat, it is equally possible the pig skeleton is contemporary with the peat in which it was found and a more utilitarian view is perhaps more likely, that the tree happened to fall across the remains of the dead animal some time after it attempted to escape into carr woodland and died. It has been suggested that the small size of the pig and the terminal Mesolithic radiocarbon date indicate that is could have been an escaped domestic animal (Lewis 1992, quoted in Schulting 2000, 30). However, as David (ibid.) points out, the date from the Lydstep pig pre-dates the earliest recognised Neolithic activity in the area.

The date of 4230–3400 cal. BC from Lydstep 1 may also broadly date, or at least predate by not very much, the footprints and the footprint tracks which, if not contemporary with the pig, may indicate a continuation of activity in the area. There appears to be a hiatus during the middle of zone Ly2 in the pollen record from Lewis's pollen site (Lewis 1992) when pollen did not survive which could indicate drier conditions and might relate to the period when the footprints were made. Human and animal footprint tracks have been widely recorded in the silts of the Severn Estuary where investigation of the mechanics of their formation and preservation have led to the conclusion that the depth and detail of the track was a function of the strength of the sediment, with moisture content of particular significance, the tracks surviving because of a degree of drying (Allen 1997). Although the footprint tracks, or what remains of them, at Lydstep are in peat it is likely that similar conditions in terms of moisture content would need to exist to enable the footprints to survive, perhaps suggesting they represent activity during the summer months when conditions are likely to have been drier (the presence of *Daphnia* ephippia in the macrofossil record may tentatively lend some support to this view), and immediately prior to inundation by the sea. In light of the pig skeleton, it is tempting to suggest that the footprints were the result of human predators stalking prey on the edge of a lagoon. If this were so, then it is interesting to note that both children and adults were present.

Footprints within peats have also been recorded at Kenfig (Bennett *et al.* 2010) where they occur in the lower of two intertidal peat layers. The footprints are thought to be probably Neolithic in date although there is some uncertainty about their date. As at Lydstep, the pollen assemblage from Kenfig is dominated by Cyperaceae and to a lesser extent Poaceae but differs in there being quite strong representation of halophytic herbs including Chenopodiaceae, sea plantain (*Plantago maritima*) and sea-milkwort (*Glaux maritima*), leading to the suggestion of reedswamp or sedge fen at the upper edge of saltmarsh, though the occurrence of sea club-rush in the plant macrofossil record from Lydstep possibly suggests an increasingly brackish influence locally. Representation of pollen from dry-land vegetation, notably trees and shrubs, at Kenfig is low and it is suggested perhaps reflects the distance to the dry land as well as other factors such as the over-representation of wetland pollen taxa and, possibly significant woodland clearance, though the latter explanation is considered unlikely (Bennett *et al.* 2010). Clearly, although there was a much stronger salt marsh influence at Kenfig and alder carr was growing in the vicinity at Lydstep, sedge and reed swamp communities predominated in the local area of the footprints in both instances and, even allowing for some removal of deposits, suggests the conditions were suitable for the formation and preservation of the footprints. Certainly, it seems more likely that ancient footprints would be more likely to survive and/or be easier to detect in a herbaceous peat rather than a wood peat, as was indeed found to be the case at Lydstep.

As well as human footprints, deer footprints, including red deer, were present at Lydstep and the majority of the mammal tracks at Goldcliff were also of deer, probably red deer, with some evidence for aurochs (Scales 2007). Wild boar was absent from the footprint tracks though present in the bone assemblages at Goldcliff, leading to the suggestion that wild boar may have preferred the wooded Goldcliff island or reed swamps in the area rather than salt marsh (Scales and Ingrem 2007). Certainly the evidence from Lydstep suggests that wild boar inhabited an environment comprising carr woodland and reed swamp communities, though its presence in the carr woodland may reflect its attempt to escape whilst being hunted rather than its preferred habitat. Equally, deer footprints in the peats at Lydstep demonstrates their presence in these environments as well. Deer were typically a woodland/woodland-edge species and the occurrence of footprint tracks may reflect movement into the wetland area during the summer months when water was less plentiful.

In conclusion the palaeobotanical evidence from Lydstep demonstrates the changing environment in the Late Mesolithic and the nature of the environment around the time the Lydstep pig was hunted and humans and other animals were exploiting resources offered by these coastal wetlands.

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NOTES

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