# Tree trunks, Bronze Age remains and an ancient channel exposed on the foreshore at Bognor Regis, West Sussex

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*Exceptionally violent storms in January 1998 exposed numerous scattered tree trunks and the snaking course of an ancient channel on the foreshore at Bognor Regis. Records of previous antiquarian and archaeological studies, particularly the discovery of a 'submerged forest', had already highlighted the foreshore as an area of importance. The remains of waterlogged trees and prehistoric finds have been found since the mid-19th century along the edge of the former course of the Aldingbourne Rife, now a small river which divides Bognor Regis from Felpham. These remains and the fills of the ancient channel have only occasionally been exposed on the beach at low tides, following the removal of beach sand and gravels by storms. The tree trunks and branches were radiocarbon dated to the Early Bronze Age. Bronze Age activity in the form of pottery, worked flints and a fence line were found along the western side of the ancient channel. Pollen evidence and dendrochronological analysis suggest that there had been a wood in the area, its demise being due to rising relative sea levels.*

## PROJECT BACKGROUND

Wessex Archaeology conducted a programme of archaeological work in 1998 on the foreshore at Bognor Regis and Felpham, West Sussex, in connection with improvements to the sea defences. Before their renewal, the sea defences consisted of a substantial sea wall and approximately 50 wooden groynes which had been in place for some 30 years. The new defences included the introduction of seven rock groynes, replacement timber groynes between them and the protection of the base of the existing sea wall by a buried rock toe.

The archaeological work comprised desk-based assessment, a survey of exposed archaeological deposits following violent storms, limited but targeted excavation, a borehole survey and a watching brief during construction (Wessex Archaeology 1999). The results of this work are presented and discussed below along with the results of research and investigations by David Bone (a geologist and local amateur archaeologist), who has been recording the geological, archaeological and palaeo-environmental remains on the foreshore since 1969.

## LOCATION AND GEOLOGY

The area of sea defence renewal ran from Gloucester Road, Bognor Regis in the west to Outram Road, Felpham in the east and was centred on NGR 49460 09903 (Fig. 1). The current outfall of the Aldingbourne Rife lies at the eastern end of the site. The Rife is typical of Sussex rivers in that it is a remnant of a much larger system that developed during the Devensian glaciation. Currently, it is a small watercourse within a large infilled channel that extends inland as far as Barnham, Westergate and Aldingbourne. Boreholes recorded by the British Geological Survey indicate that the alluvium is at least 9.85 m thick by the Rife bridge on the Bognor–Felpham road.

Modern beach deposits overlie this large infilled channel, which cuts dipping Tertiary (Palaeocene/Eocene) and Cretaceous strata, where it crosses the foreshore (Venables 1963; Bone 1986). The younger beds, the London Clay, occur to the west and the older and underlying deposits of the Reading Formation occur to the east (Fig. 2). The Reading Formation sequence comprises Upper mottled clays (5.3 m thick), 'Felpham lignite bed' (2.7 m thick), Lower mottled clays (8.5 m thick) and Basal sandy

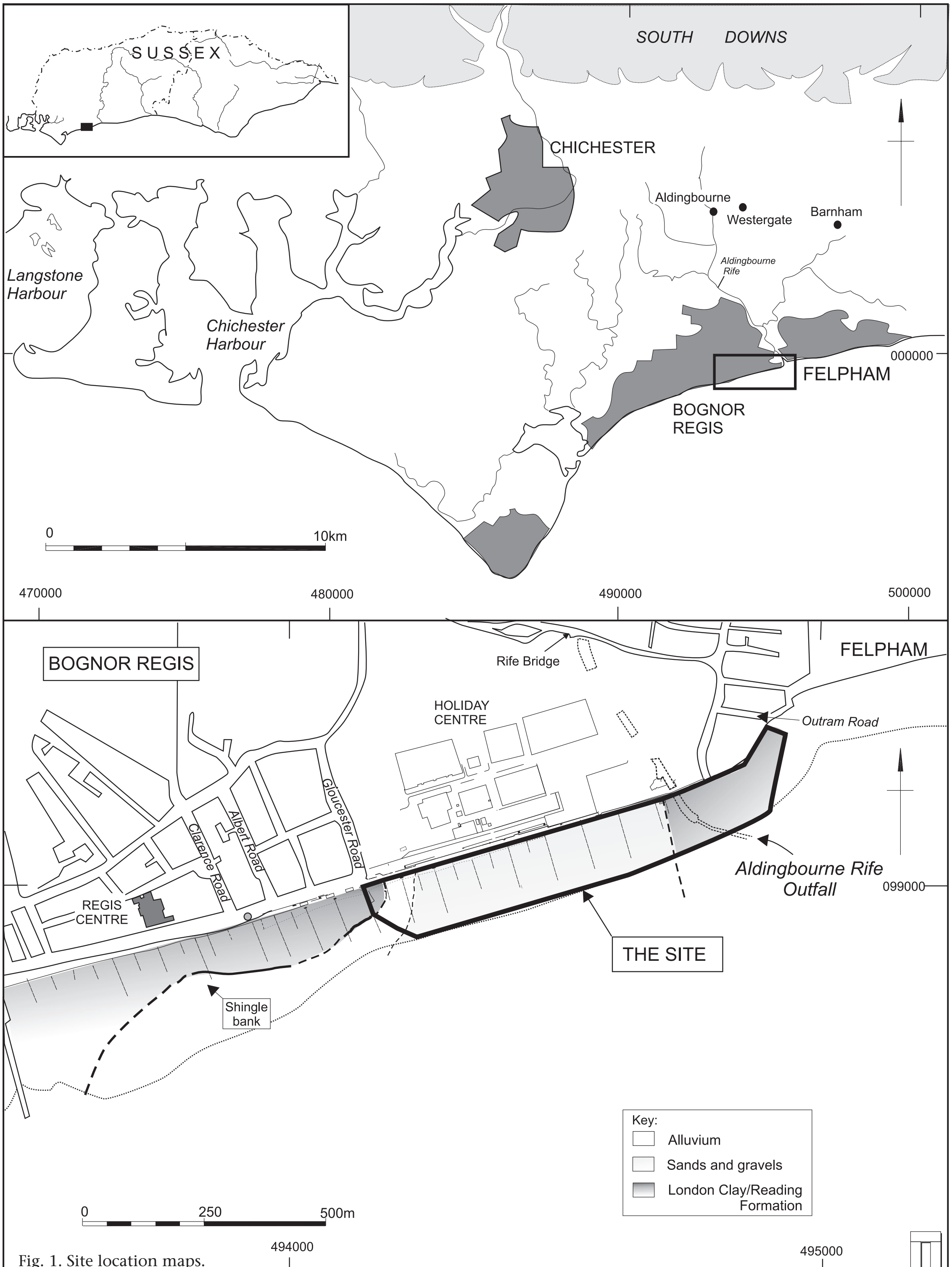

Fig. 1. Site location maps.

clay (1.5 m thick). The Reading Formation overlies Upper Chalk. The 'Felpham lignite bed' is exposed in the eastern part of the site and comprises part of a geological Site of Special Scientific Interest (SSSI). A new Palaeocene–Eocene transition-aged flora, one of only three of its type known in the country and of international importance, has been discovered within this area (Bone 1986; Collinson & Cleal 2000).

## ARCHAEOLOGICAL BACKGROUND

Sea level, in southern England, has risen by approximately 65 m over the last 10,000 years. The sea gradually invaded the lower portions of the main river valleys and turned them into tidal estuaries and bays into which near-shore, estuarine and fluvial sediments were deposited (Bellamy 1995). Sedimentation was a fairly slow process and the larger rivers remained as tidal inlets well into medieval times. The rivers now have very gentle gradients as they approach the sea (Jones 1981; Robinson & Williams 1983). Sea defences have long been necessary to prevent incursion into the valley of the Aldingbourne Rife. They had been constructed near its mouth by the early 15th century (*VCH* 1997, 170). Maps show that in 1778 the site was low-lying marsh (Fig. 3) which by 1876 had been inundated by the sea and become foreshore. The Aldingbourne Rife now flows across a floodplain 1 km wide between Bognor and Felpham. This has been drained and reclaimed, the river channel has been straightened, and sluice gates and a culvert have been constructed across the beach to control the discharge to the sea.

In 1998, the alluvium filling the former river channel of the Rife was partially re-exposed together with a 'shingle bank' marking its western side on the foreshore below high tide mark. Exposures of the alluvium have occurred infrequently when the beach sand has been removed. Such exposures, particularly the presence of stumps of trees and prone trunks 20 ft (*c*. 6 m) long, were first noted in early geological studies of the area (Dixon 1850, 31; Dixon & Jones 1878, 71). Some of the trees were described as being *in situ*. Animal remains were also found, including antler fragments from fallow and red deer that were reported by local naturalist, H. L. F. Guermonprez (1915). Later, Martin Venables (1931, 368), partially quoting from Dixon (1850), noted:

> At the western margin of the alluvium on the shore opposite Clarence Road, the remains of a submerged forest may be observed where the clay, of the same grey, plastic form, contains numerous scraps of wood, twigs of trees, acorns, hazel nuts, and other objects typical of a more or less wooded area together with shells of *Scrobicularia*, in the position of life, and side by side with these the trunks of fallen trees up to 20 feet in length, and stumps of others remaining where they grew. This, then, was a marshy woodland area and at times completely swamped.

Venables noted the archaeology of the area in June 1964. It is probably the unnamed site described as a 'submerged forest' in his natural history column in a local newspaper (Venables 1964), although this article also indicates that he had previously worked on the site in 1945. Unfortunately, Venables's records and field notes have since been lost, with the exception of some brief notes in his unpublished 'Mudlarks File'. A small number of Venables's specimens from the site are currently in David Bone's collection.

Mesolithic implements from the site, including some 30 'blades and flakes unretouched' and two examples of 'other' artefacts, are recorded in Wymer (1977, 294) and were then in the former Bognor Museum, but their present location is now unknown. Much of the collections from Bognor passed to both Chichester District and Littlehampton Museums, but enquiries have failed to re-locate them. Palmer (1977, 87–8) includes a brief description, based on information provided by Venables and Alan Outen, and the site is also briefly mentioned in notes by the British Geological Survey (Berry & Shephard-Thorn 1982). Further details on the local geology were added by Bone (1986).

## RECENT FIELDWORK

The general layout of the 'shingle bank', which marks the western side of the ancient channel of the Aldingbourne Rife, was compiled by David Bone from approximate measurements taken by pacing the foreshore during sporadic exposures in March 1997 (Fig. 1).

The evaluation fieldwork strategy proposed the excavation of an array of hand-dug test-pits to record the deposits. However, before any commercial fieldwork was undertaken, exceptionally violent storms, including a devastating hurricane at nearby Selsey in January 1998, removed the superficial beach deposits exposing archaeological and geological deposits. This exposed the 'shingle bank' and nearby

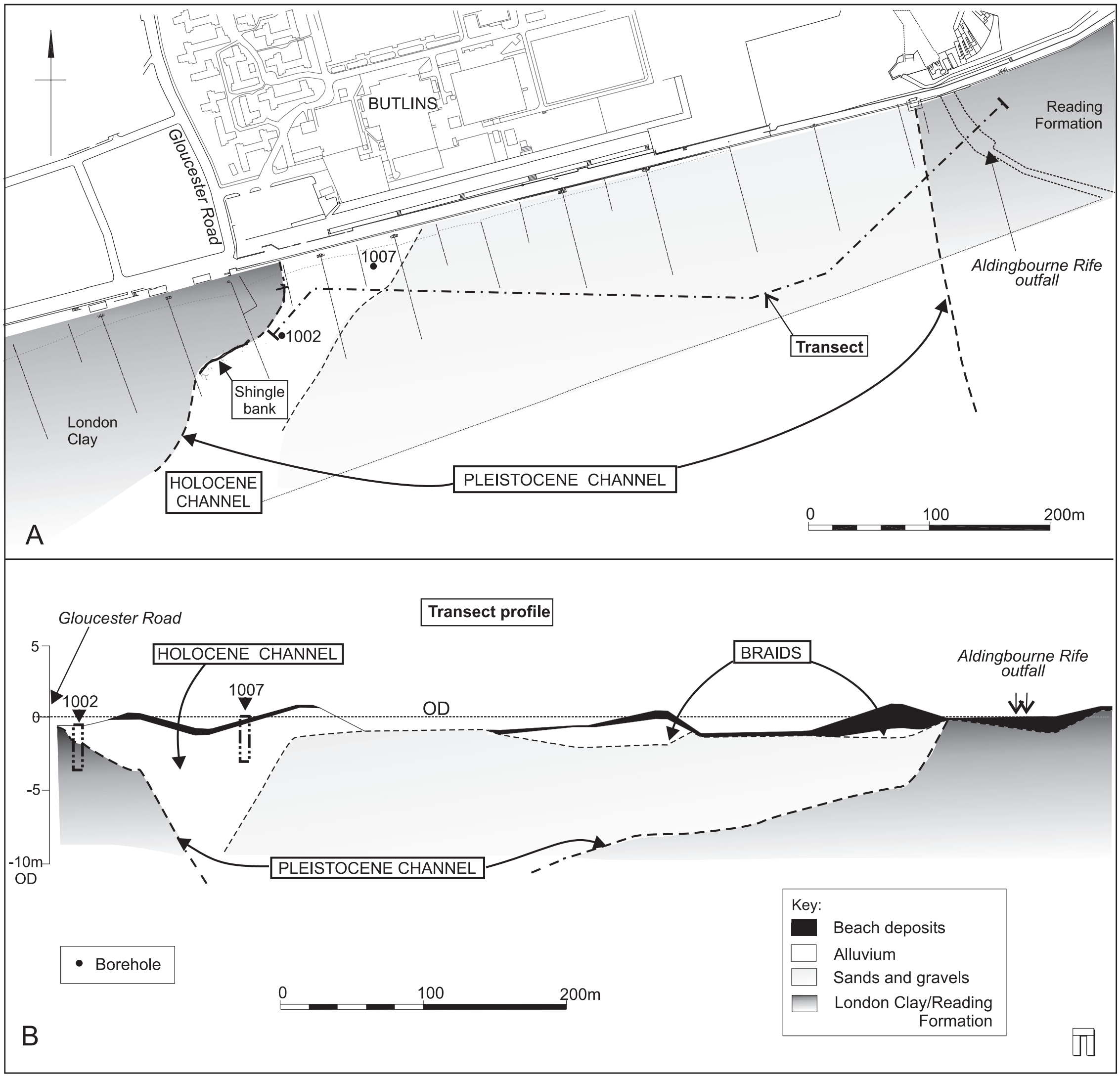


Fig. 2. A) Plan showing the Aldingbourne Rife and drift geology exposed on the foreshore, and B) Section of the Rife as defined by geotechnical examination, showing the location of the pollen cores and general stratigraphy.

strand-line of tree trunks and branches in and on alluvium which were surveyed with a Total Station Theodolite (Fig. 4). Samples for wood identification and radiocarbon dating were taken from most of the trunks and branches. Seven large timbers were sampled by the Dendrochronology Laboratory at the University of Sheffield.

Two test-pits (0.6 m²) were excavated to clarify specific deposit relationships. These were situated on or close to the 'shingle bank'. Neither exceeded a depth of 340 mm. Bulk samples were taken from exposed deposits within the test-pits for artefactual and environmental data. A trench measuring 5 m by 1.8 m (Trench 4) was mechanically excavated to a depth of 0.6 m to provide a section through the 'shingle bank' to the west of the area. Further observations were made during the construction groundworks.

A borehole survey was undertaken to determine the stratigraphy of the alluvium-filled channel, and to obtain undisturbed sediment samples (*see* boreholes 1002 and 1007 on Fig. 2). Eight window cores were drilled with a hand-held percussion corer by Geodrive Limited to a maximum depth of 3 m.

Undisturbed sediments were retained in sleeved liners, but where deposits were too soft for undisturbed recovery, they were recorded on site in a window sampler.

## THE ANCIENT CHANNEL OF THE ALDINGBOURNE RIFE

The exposures on the beach in conjunction with borehole and geotechnical trial pit data (Ground Explorations Limited 1997; Mouchel Consulting Limited 1997) have enabled the location and profile of the large palaeo-channel to be defined (Fig. 2). The infilled Pleistocene channel of the Aldingbourne Rife cuts through the London Clay to the west and the Reading Formation to the east, and appears to be about 550 m wide and more than 10 m deep. Its steep western side contrasts with the gentle slope of the eastern side.

Most of the Pleistocene channel is filled with sands and gravels, which are cut on the west side by a later, alluvium-filled channel. Two other shallower silty clay 'braids' occur to the east on the surface of the main palaeo-channel, and the current outfall of the Aldingbourne Rife lies to the east of the large ancient channel. Recent archaeological finds have largely been made within, or at the western edge of, the later alluvium-filled channel which is probably of Holocene date.

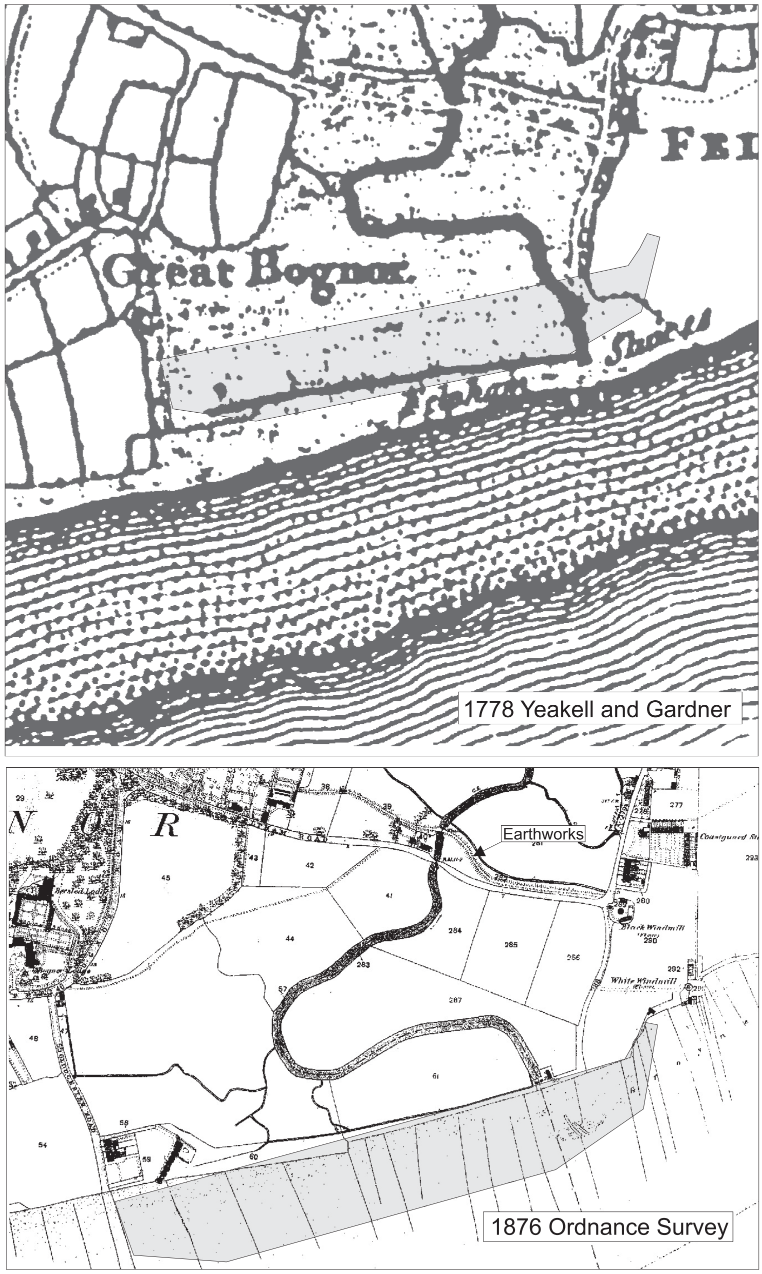

Fig. 3. 1778 map by Thomas Yeakell and William Gardner, 1876 Ordnance Survey map with the position of the site indicated.

The upper alluvial deposits of the Holocene channel were excavated in the two test-pits and Trench 4. Soft mid-bluish/grey, fine sandy silty clay with frequent organic material overlies the 'shingle bank' (Fig. 4). From trenches cut for the rock groynes the surface deposits of the Pleistocene channel comprising sand and gravel were observed to extend across much of the foreshore to the east of the Holocene alluvium-filled channel.

The western edge of the channel was clearly defined by the 'shingle bank' and the eastern edge

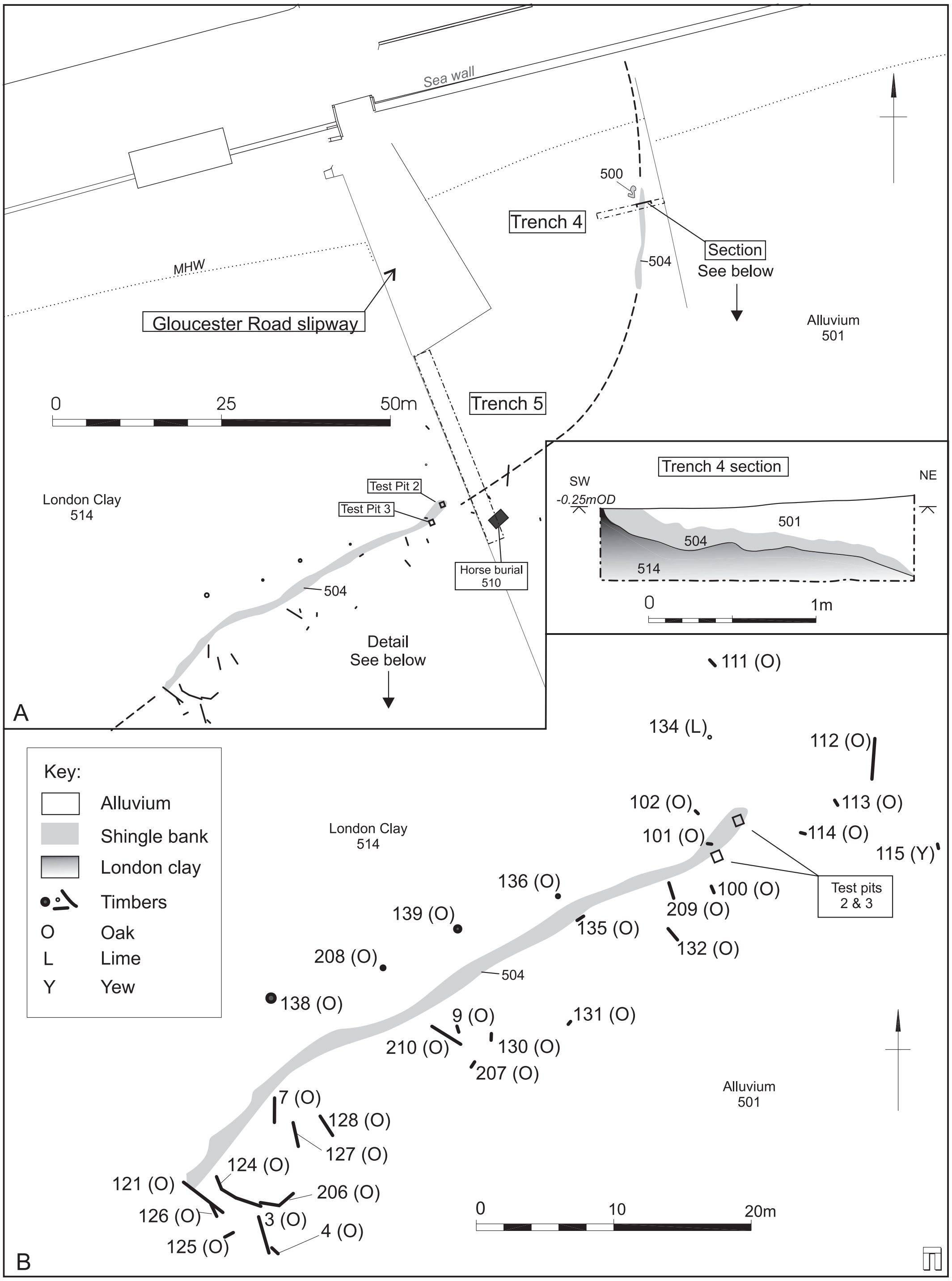


Fig. 4. A) Plan of the edge of the Holocene channel and 'shingle bank' showing test-pits and trenches, and the general distribution of trunks and branches (inset showing section across the 'shingle bank'), and B) detail of the distribution of timbers along the strand-line and Bronze Age stake fence-line.

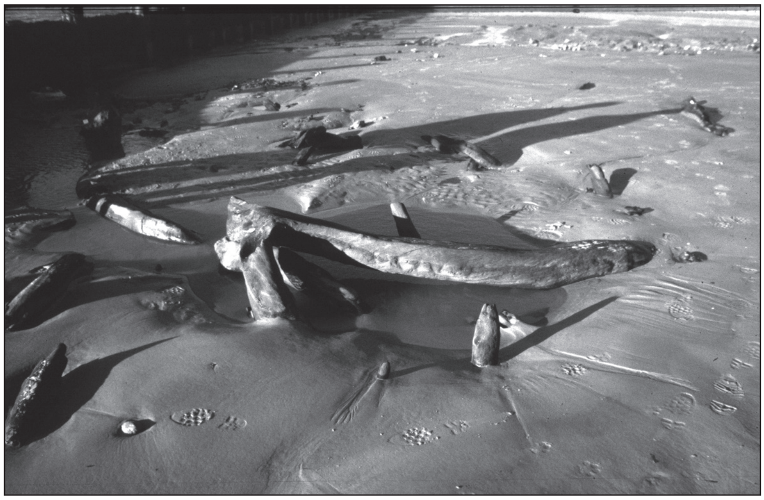

Fig. 5. Branches around trunk 210, exposed in the Holocene channel to the south of the 'shingle bank'.

of the Pleistocene channel was shown in aerial photographs taken between 20th March and 22nd May 1998 and held by Arun District Council. The photographs agree with the line identified and planned by both David Bone and Roger Cordiner (pers. obs.).

## THE RIVER BANK AND ASSOCIATED ARCHAEOLOGY

The western bank of the ancient channel of the Aldingbourne Rife was clearly demarcated on the exposed foreshore by a snaking line of flint gravel (504, the 'shingle bank'). It varied from 400 mm to 1.6 m wide and was largely composed of subangular and water-worn river flint gravel within a dark sandy clay to silty clay matrix. London Clay was visible to the north and west of this line and alluvium of the channel fill to the south and east. The 'shingle bank' had been obscured in front of the Gloucester Road slipway by vehicular access to the ramp (Fig. 4). Trench 4 showed that the shingle flint deposit overlaid the London Clay and appeared to line the edge of the alluvium-filled channel (Fig. 4, inset). Hand excavation of test-pits 2 and 3 showed that the 'shingle bank' was only 50 mm deep. In test-pit 2, it directly overlaid London Clay whereas in test-pit 3, it sat on a layer 100 mm thick of dark greyish yellow sandy clay with occasional rounded flints which overlaid London Clay.

The brown, weathered London Clay adjacent to the 'shingle bank' was perforated by masses of root remains, indicating that the area had been wooded at some time in the past.

Fifty-two burnt flints and 193 struck flints were recovered from the 'shingle bank'. The struck flints, comprising flakes and cores, although lacking any diagnostic tool types, have been broadly dated to the Bronze Age (*c.* 2400–700 BC). Their fresh condition suggests that this was an *in-situ* assemblage.

A single sherd of Middle/Late Bronze Age pottery was found lying on top of the alluvium (501) on the exposed foreshore, just to the south of Trench 4. During the watching brief, a small fragment of human skull was found in an area that had been heavily disturbed by construction traffic. It appeared to have come from the surface of the alluvium (501) rather than from the 'shingle bank'. No cut for an inhumation burial was observed. The fragment came from the left side of the skull above the ear and was not particularly abraded.

### TREES AND TREE TRUNKS

Within and lying on the blue-grey silty clay of the Holocene channel were numerous large branches and larger waterlogged tree trunks (Figs 5 & 6), forming a strand-line just to the east and south of the western bank of the alluvium-filled channel of the Rife (Fig. 3). Samples from the tree trunks and large branches were identified by Rowena Gale (Table 1). Most were oak, a few were yew, one was alder. Small wood fragments of woody and twiggy material lying in the alluvium (501) above the 'shingle bank' included Pomoideae/*Prunus* family, which includes hawthorn, apple, pear, rowan, wild service, whitebeam and blackthorn. The trunks and branches, most with bark intact, ranged from 320 mm to 4.4 m in length and 100 mm to 340 mm in breadth. None was found *in situ* as no tree stumps were present.

A section was cut beneath trunk 124, which revealed that about 180 mm of modern beach sand and alluvium overlaid a dark peaty-rich layer, which contained moss and twigs. The peat overlaid and merged into the 'shingle bank'. Although it was not present in Trench 4 or the two test-pits, it may represent the base of a former soil or land surface

Fig. 6. Drifted tree trunks in the strand-line at the western end of the 'shingle bank', with timbers adjacent to 127 in the foreground and 124 behind.

that overlaid the 'shingle bank'. It was sampled for pollen analysis (*see* below).

**STAKES**

Grey silty London Clay was exposed on the foreshore at the extreme west end of the site. It was visible to the north and west of the 'shingle bank'. Five vertical timbers with only their upper end exposed (134, 136, 138, 139 & 208) and another timber 0.6 m long (111) lying prone were recorded in the London Clay to the north-west of the 'shingle bank' (Fig. 2). Five were oak and one (134) was possibly lime.

It was originally thought that the five vertical timbers might represent *in-situ* tap roots. However, identification has shown that with the exception of 134, they are heartwood rather than roots. The possible lime timber (134) was very degraded and although it was probably roundwood (i.e. branch), it is impossible to rule out that it may have been a root. It seems likely that these were stakes of an ancient fence line aligned along the bank (i.e. along the landward edge of the 'shingle bank') of the Holocene channel of the Aldingbourne Rife (Fig. 4).

**DENDROCHRONOLOGY** by Jennifer Hillam

Six oak trunks or branches (113, 124, 206, 207, 209 & 210) and one stake (208) were selected for dendrochronological analysis. Although each of the samples contained 95 or more rings, dating was not possible owing to the very narrow growth rings. This suggests that the trees were under substantial stress during their lifetime, but were able to survive. The narrow annual growth rings suggest that the stress was both ecological and physiological. It may have been due to a high water table. Narrow rings are usually associated with drought but a surplus of water can produce the same effect and is known as 'physiological drought'. Oak trees are able to survive waterlogged conditions, even immersion in salt water, for considerable periods as long as they have a short period with a low water table (Heyworth 1978; Clapham 1999). It appears that these trees had grown on banks further upstream and had drifted downstream to this location. It is likely that they would have drifted and become caught in the strand-line soon after they fell and before they had become totally waterlogged. It is probable that there was an extensive wood along the western bank of the tidal Aldingbourne Rife.

**RADIOCARBON DATING**

| | | |
|---|---|---|
| Oak trunk 124 | NZA-10805, 3642±60 BP | 2200–1870 cal BC |
| Oak stake 208 | NZA-10804, 3623±60 BP | 2140–1770 cal BC |

The results are calibrated using INTCAL98_14C, which uses 1998 atmospheric delta 14C and radiocarbon ages quoted by Stuiver *et al.* (1998). The results are expressed at the 95% confidence level and the end points rounded outwards to the nearest 10 years following the form recommended by Mook (1986).

The two results are statistically indistinguishable at the 95% confidence limit (Ward & Wilson 1978), and date the growth of trees to the Early Bronze Age. The similarity of the two results indicates that the vertical timber (fence post, 208) was probably constructed at the same time as trees fell down and were washed up in the strand-line at the channel edge. It probably came from the same population of trees.

**FORMER SUBSOIL OR TOPSOIL**

A small expanse of brown silty clay (500) was found overlying the London Clay within the northern end of the survey area. It may have been the remains of a former subsoil or topsoil. Map evidence shows that the current foreshore was a low-lying marsh up to the 19th century (Fig. 3) and therefore topsoil probably existed extensively over the London Clay in the past.

Table 1. Record of major waterlogged timbers on the foreshore.

| Timber | Context | Length/breadth (m) | Species | Comment |
|---|---|---|---|---|
| ***Stakes in London Clay adjacent to 'shingle bank' and channel*** | | | | |
| 136 | 514 | –0.1 | *Quercus* | Heartwood, not root |
| 138 | 514 | –0.3 | *Quercus* | Heartwood, not root |
| 139 | 514 | –0.22 | *Quercus* | Heartwood & sapwood, not root |
| 208 | 514 | –0.13 | *Quercus* | Heartwood, not root, 95 rings, 3623±60 BP |
| ***Timbers on London Clay or 'shingle bank'*** | | | | |
| 101 | 504 | >0.32/0.13 | *Quercus* | Heartwood |
| 102 | 514 | | *Quercus* | Heartwood |
| 111 | 514 | 0.6/0.29 | *Quercus* | Heartwood |
| 134 | 514 | >0.05/0.12 | cf. *Tilia* | Stake very degraded, probably narrow roundwood, cannot rule out root |
| ***Timbers in strand-line*** | | | | |
| 7 | 501 | | | |
| 100 | 501 | >0.53/0.12 | *Quercus* | Heartwood |
| 112 | 501 | 3.11/0.27 | *Quercus* | Trunk, heartwood |
| 113 | 501 | 0.33/0.18 | *Quercus* | 72 rings |
| 114 | 501 | –0.1 | *Quercus* | Heartwood |
| 121 | 501 | >4.4/0.26 | *Quercus*<br>*Taxus baccata* | Trunk, mostly oak |
| 124 | 501 | >2.25/0.29 | *Quercus* | Trunk with branch, 215 rings, 3642±60 BP |
| 126 | 501 | >1/0.34 | *Quercus* | Heartwood |
| 127 | 501 | 1.84/0.21 | *Quercus* | Heartwood |
| 128 | 501 | >1.73/0.2 | *Quercus* | Heartwood |
| 132 | 501 | >1.1/0.16 | *Quercus* | Trunk, heartwood |
| 133 | 501 | 2.47/0.22 | *Quercus* | Trunk, 57 rings |
| 135 | 501 | 0.62/0.105 | *Quercus* | Heartwood |
| 206 | 501 | >2.5/0.22 | *Quercus* | Large branch, 145 rings |
| 210 | 501 | >2.41/0.21 | *Quercus* | Trunk, 207 rings |
| 213 | 501 | Diameters to 20 mm | *Alnus* | ?roots in alluvium nr timber 124, prob. roundwood, very degraded, impossible to rule out root |
| 214 | 501 | | *Quercus* | Round wood stake, very slow grown in test-pit 3 |
| ***Timbers in Channel*** | | | | |
| 3 | 501 | | | Trunk |
| 4 | 501 | | | Timber |
| 115 | 501 | >0.35/0.18 | *Taxus baccata* | Slivers of wood |
| 125 | 501 | >0.73/0.14 | *Quercus* | Sapwood |
| 130 | 501 | >0.5/0.17 | *Quercus* | Sapwood, also bark |
| 131 | 501 | >0.28/0.23 | *Quercus* | Timber |
| 207 | 501 | | *Quercus* | 118 rings |
| ***Woody twigs*** | | | | |
| 103 | 501 | | *Quercus* | Twigs + bark from larger wood in alluvium test-pit 2 |
| 104 | 514 | | *Taxus baccata* | Wood slivers + 1 twig, very degraded in London Clay, test-pit 2 |
| 106 | 501 | | *Quercus*<br>*Taxus baccata* | Mostly oak twigs + round-wood, 1 yew twig, also bark in alluvium, test-pit 3 |
| 118 | 501 | | *Pomoideae/ Prunus* | Roundwood diameter 8 mm, very degraded, ?toolmark woody fragments in alluvium above 'shingle bank' |

**LATER FEATURES**

A series of earlier groynes was observed during the watching brief. During the excavation of Trench 5 a horse burial (510) was found by the groundworks contractors at the west end of the site near the base of the Gloucester Road slipway (Fig. 4). The adult male horse was lying in a shallow rectangular grave cut into the alluvium between the high and low water mark. The condition of the bones suggests that the burial is modern. Two other probably modern horse burials have been found on the foreshore: one in 1965 from a site between Clarence Road and Albert Road (Venables 1956–65) and the other just to the east of the Rife outfall in 1982 (recorded by D. Bone).

## FINDS

### by Phil Harding (worked flints) and Lorraine Mepham (other finds)

The quantities of finds recovered during the recent fieldwork are presented in Table 2. Worked flint was the most common material type. Most derived from the 'shingle bank' with some from the alluvium. Flint from both contexts is of a similar nature.

The raw material utilized is exclusively from the 'shingle bank' or flint layer, where large nodules, originally deriving from the South Downs, would have been available. This flint is of relatively good quality for knapping but is prone to thermal fracture. The cortex, where it survives, is heavily battered and eroded.

The assemblage comprises flake and core material, with no tools or retouched pieces. In general there is a low level of attrition and the flint does not seem to have been subject to much post-depositional movement. The technology employed is consistent with a later prehistoric date, probably Bronze Age and may represent a single knapping episode. One or two cores are more carefully prepared and could be earlier. Bulk samples from the two test-pits were sieved through 2-mm and 4-mm mesh producing a few undiagnostic flint chips.

Other finds include a small quantity of burnt, unworked flint, probably also of prehistoric date. A sherd of Middle/Late Bronze Age flint-tempered pottery and a fragment of human skull (identified by J. McKinley) were recovered from the alluvium. Pottery from the alluvium in the personal collection of David Bone comprises one Middle Bronze Age sherd of Deverel-Rimbury urn and a single sherd of Early Iron Age flint-tempered jar.

## ENVIRONMENTAL EVIDENCE

The undisturbed sediment cores from the Holocene channel enabled pollen analysis and sediment description. In addition, 16 bulk samples from several contexts, mainly the alluvium and 'shingle bank', provided the opportunity for the controlled recovery of waterlogged plant remains (twigs or roots), land snails, shells and artefacts. Fifteen of these samples (between *c.* 5–10 litres) were examined for waterlogged remains and produced between 5 ml and 250 ml of organic matter. The larger items in these samples comprised twigs and small roundwood fragments. In addition, David Bone has found that acorns and catkins are particularly common in the drifts of organic debris close to the 'shingle bank', as well as quantities of other seeds (including *Iris pseudoacoris* or Yellow Flag) and unidentified vegetation.

No charred plant remains or charcoal were found in any of the samples, not even those from

Table 2. All finds by context (number/weight in grammes).

| Context | Description | Struck flint | Burnt flint | Pottery | Animal bone | Human bone |
|---|---|---|---|---|---|---|
| test-pit 2, 200 | Alluvium (sieved sample) | 1/32 | - | - | - | - |
| test-pit 2, 201 | 'Shingle bank' (sieved sample) | 15/26 | - | - | - | - |
| test-pit 3, 301 | 'Shingle bank' (sieved sample) | 7/23 | - | - | - | - |
| test-pit 3, 303 | Layer beneath 'shingle bank' (sieved sample) | 1/1 | - | - | - | - |
| 501 | Alluvium | 5/339 | 2/48 | 1/8 | - | 1/28 |
| 504 | 'Shingle bank' | 171/6150 | 52/1493 | - | 2/6 | - |
| 508 | Horse burial | - | - | - | 85/9893* | - |
| 509 | Horse bone in alluvium | | - | - | 2/726* | - |
| **Total** | | **200/6571** | **54/1541** | **1/8** | **89/10625** | **1/28** |

* indicates finds not retained

the 'shingle bank' which contained burnt flint. Charred remains and charcoal are unlikely to survive in exposed contexts, as they are commonly washed away by the tide (*see* Allen & Gardiner 2000).

**SHELL**

A few fragmentary marine shells were recovered from five of the samples. Only two species were noted (identification by Sarah Wyles). *Scrobicularia plana* (peppery furrow shell) came from the 'shingle bank' and has previously been recorded from the alluvium (Venables 1931; Bone pers. obs.). *Ostrea edulis* (oyster) came from the alluvium and has not previously been recorded from this context.

David Bone reports that shellfish frequently occur in current-aligned drifts within the alluvium. The fauna is dominated by deposit-feeding animals, which include *Scrobicularia plana* and *Macoma balthica*, and the shallow-burrowing suspension feeder *Cerastoderma edule*. The algae-grazing winkle, *Littorina littorea,* is the most abundant of the larger gastropods, but the tiny gastropod *Hydrobia* spp., which lives in large numbers on the sediment surface, is also common. The range of species present suggests that the alluvium was deposited in an intertidal, estuarine environment. A full list of the molluscs that have been recorded from the alluvium is given below.

| **Bivalves** | | **Gastropods** | |
|---|---|---|---|
| *Scrobicularia plana* (da Costa) | a | *Littorina littorea* (Linné) | c |
| *Cerastoderma edule* (Linné) | c | *Littorina littoralis* (Linné) | o |
| *Parvicardium exiguum* (Gmelin) | o | *Littorina saxatilis* (Olivi) | c |
| *Macoma balthica* (Linné) | o | *Hydrobia ventrosa* (Montagu) | a |
| *Solen marginatus* Montagu | o | *Lymnaea peregra* (Müller) | c |
| | | *Hydrobia ulvae* (Pennant) | c |
| | | *Nucella lapillus* (Linné) | o |
| | | *Rissoa membranacea* (Adams) | o |
| | | *Planorbis crista* (Linné) | c |

KEY: a = abundant, c = common, o = occasional

**ANIMAL BONE**

Wessex Archaeology recovered two fragments of animal bone, both pig skull (identified by Pippa Smith), from the 'shingle bank'. David Bone has found that animal bones are not uncommon in the alluvium. These are often associated with the woody debris immediately adjacent to the 'shingle bank', as if the bones had washed in with the driftwood along a strand-line. Cattle, pig, sheep/goat and deer, possibly fallow deer, have been identified. Fallow deer and red deer antler fragments have previously been recorded by Guermonprez (1915). Butchery marks were visible on two cattle bones (an ulna and a radius) and a sheep/goat rib, and the cattle ulna was also gnawed (James Kenny pers. comm.).

**THE VEGETATION HISTORY: POLLEN ANALYSIS**

by Robert Scaife

The realization that many of the Sussex valleys, such as those of the rivers Ouse, Cuckmere and Rother, were filled with deep minerogenic deposits (Burrin 1985) prompted stratigraphical and palynological investigation of the floodplain alluvial sediments of these valleys. These studies demonstrated that useful palaeo-environmental information could be obtained from this previously unworked pollen resource (Burrin & Scaife 1984; Scaife & Burrin 1983; 1985; 1987; 1992; Scaife 1988) producing evidence of valley development, vegetation and prehistoric land-use changes. The alluvial sediments from the Holocene channel of the Aldingbourne Rife offered the potential for environmental examination of valley sediments in the lower valley and coastal zone.

Two cores (borehole 1002 & 1007; Fig. 2) were subsampled from the Holocene channel and analysed for pollen (Figs 7 & 8). A spot sample from the peat over the 'shingle bank' and under the alluvium beneath trunk 124 was also examined. The full results are presented in the archive. Borehole 1007 appears to represent the longer time span of the two cores and whilst profile 1002 fits within the broader temporal span of 1007, there are some differences between the two sequences.

**Sampled peat**

The peat over the 'shingle bank' and under the alluvium beneath trunk 124 was bryophytic (derived from mosses and liverworts), which suggests that it was a woodland soil. It contained high values of oak, hazel and alder pollen. This clearly suggests local dominance of these trees. The on-site ecology was a dry fen carr woodland and is comparable with similar habitats noted by Clement Reid from near shore and intertidal peats along the south coast as long ago as 1892. The coastal margins at both Langstone Harbour (*see* Scaife, in Allen & Gardiner 2000) and in the Isle of Wight (Scaife, in Tomalin *et*

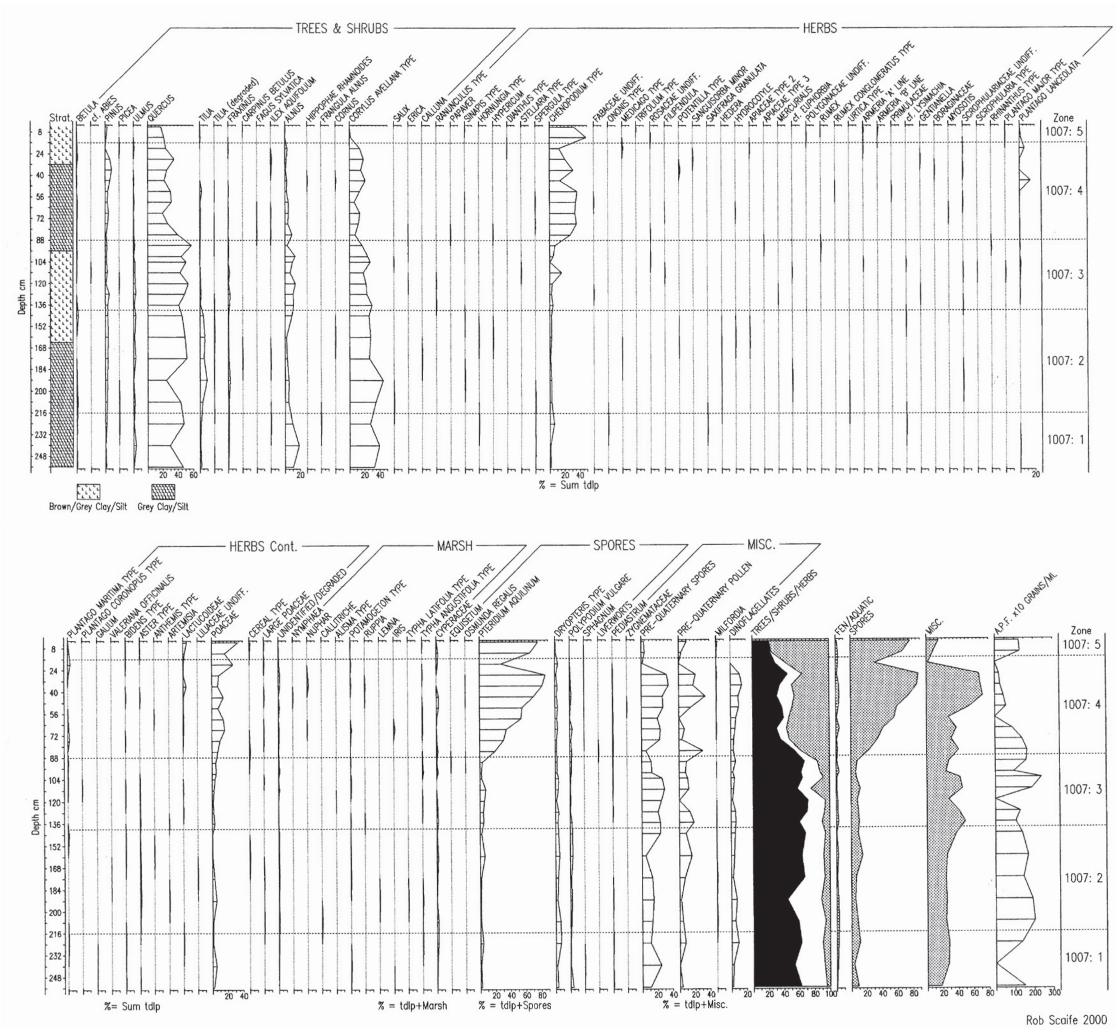


Fig. 7. Pollen diagram from core 1007.

*al.* forthcoming) have produced similar peat deposits and pollen assemblages. These have been dated, or attributed, to the Neolithic–Early Bronze Age period, accumulating prior to final marine inundation (Long *et al.* 2000). The pollen in the peat at Bognor Regis suggests that this peat is of a similar age and may be contemporary with the oak trunk 124, which has been dated to 2200–1870 cal BC (3642±60 BP). If this is the case, it is likely that peat accumulation under a dry carr woodland occurred at a time when there was a critical balance between a stationary or slowly rising relative sea level.

**Aldingborne Rife Holocene channel fill**

Pollen and spores present in alluvial sediments may have a complex taphonomy (Hall 1981; Grichuk 1967). Unlike the pollen in peat sequences where pollen transfer from the catchment is largely via airborne means from the surrounding area (Tauber 1965; 1967), pollen in alluvial sediments may contain pollen which has been fluvially transported. Although the deposits are minerogenic, indicating autochthonous ('on site' rather than transported) derivation and the possible reworking of older pollen, alluvial sediments do contain a useful temporal record of vegetation and environmental changes (Burrin & Scaife 1984; Scaife & Burrin 1992). As alluviation may be related largely to periods of instability and change within the environment of the river basin, it may have particular relevance to landscape changes

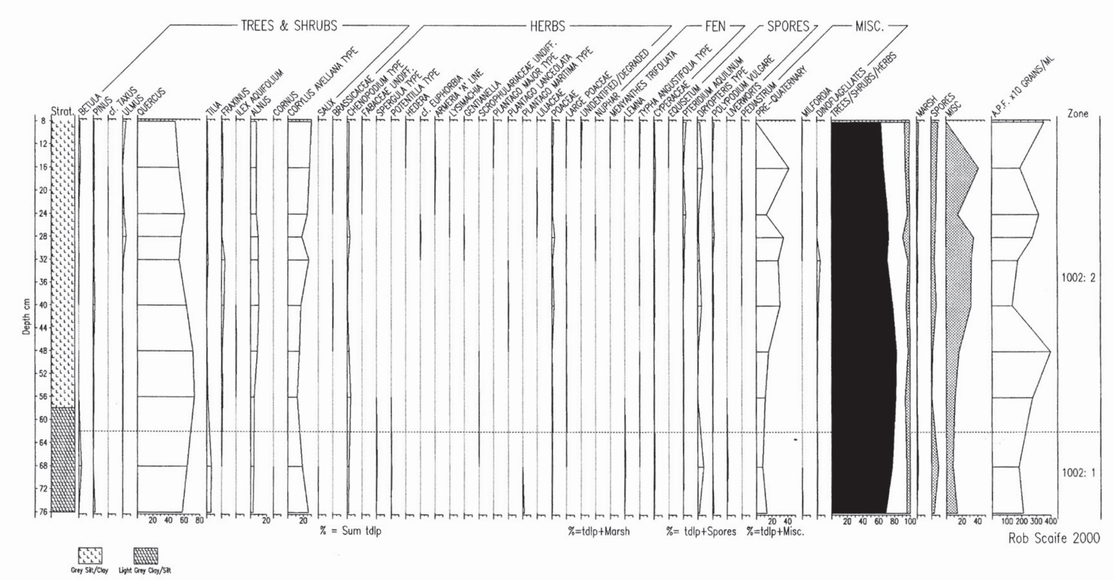


Fig. 8. Pollen diagram from core 1002.

brought about by human agencies such as forest clearance but also by external controlling factors such as relative sea-level change. Earlier pollen studies of Sussex floodplain sediments were in the middle and upper catchments away from direct marine influence (Scaife & Burrin 1992), whereas the sediment studied here is from the coastal zone. This adds the further effect of changing sea level with marine and brackish water incursion. Thus, the pollen spectra can be viewed in terms of (a) the vegetation attributed to the surrounding interfluves and river catchment and (b) to freshwater and marine sedimentation.

**Floodplain/alluvial development**

The cores only sampled the upper 2.4 m of the Holocene channel alluvium, which may have been about 10 m deep. The effects of marine sedimentation were clearly visible in the pollen record and were a result of regionally increasing relative sea level causing the inundation of the freshwater Aldingbourne Rife. In the lower profile of core 1007 (pollen zones 1007:1 and 1007:2; Fig. 7) there is little evidence of marine/salt marsh conditions, with only small percentages of *Chenopodium* (goosefoot, oraches and glassworts) and a single occurrence of *Plantago maritima* (sea plantain). There are, however, some typical marginal/aquatic elements, albeit in small numbers, including *Alnus* (alder), Cyperaceae (sedges), *Iris, Callitriche* (water-starwort), *Lemna* (duckweed), *Typha latifolia* (bullrush) and *T. angustifolia* (lesser bullrush and bur-reed) and algal *Pediastrum*. It is considered that the lower portion of the sampled sequence consists of freshwater alluvial sediments containing pollen derived directly from both airborne sources and alluvial sediments washed from the interfluves. The small numbers of *Chenopodium* and *Plantago maritima* imply that coastal vegetation was present but at some distance or that there were very rare brackish water incursions into the Rife.

In the middle of the profile (pollen zone 1007:3) there is a change which suggests progressive marine invasion into the Rife. The numbers of halophytes (plants that tolerate very salty soil) start to increase, notably with *Chenopodium* type. *Plantago maritima*, and large Poaceae (some halophytic grasses) and *Armeria* 'A' line (thrift and sea lavender) are also present. The expansion of other types may relate to taphonomic changes. These include *Plantago lanceolata* (ribwort plantain) and *P. coronopus* (hoary plantain) which are typical of coastal grasslands. *Pteridium* (bracken) also remains important (and in the upper profile (pollen zone 1007:4) becomes very important.) Zone 1007:3 clearly suggests that there were some marine influences in the lower reaches of the Rife with brackish water and development of salt marsh.

By the upper profile (pollen zone 1007:4), marine, salt marsh conditions became dominant, as shown by the importance of *Chenopodium* (*Atriplex, Salicornia,* *Suaede* etc.) with increases of *Plantago maritima*, *Armeria* 'A' and 'B' line, Poaceae (grasses) and large Poaceae. This change is also seen in the stratigraphy with a change to typical grey salt marsh sediments. The dramatic expansion of *Pteridium* is somewhat enigmatic since expansion is also clearly associated with this final salt marsh. High spore contents in freshwater alluvial and lake sediments during periods of high discharge are discussed by Peck (1973). It appears that here its importance is derived not from the river catchment but from that carried in the coastal water/brackish levels.

**The terrestrial vegetation**

Diagnostic features in pollen sequences that are used as temporal markers and evidence of human impact and environmental change include the Neolithic elm decline, the lime decline which is asynchronous but frequently dated to the Late Bronze Age and the historic anthropogenic pine rise (Long *et al.* 1999). The *Ulmus* (elm) decline (Smith 1970; Scaife 1987) is not present and the percentage values here suggest a date after about 4250–3750 cal BC (5000–5500 BP) for the base of these pollen profiles. Although the tops of the pollen profiles are at the present-day land surface, there is no evidence that sedimentation had continued to the present.

Lime is important in zone 1007:2 suggesting that it was an important constituent of the local woodland. This taxon is poorly represented in pollen spectra because it is insect-pollinated. It also flowers during the summer when other trees are in full leaf which further inhibits pollen dispersion (Andersen 1970; 1973). Its demise, the 'lime decline', has frequently been dated to the Late Bronze Age period as a result of human clearance, although Neolithic through to Saxon dates have been reported (Scaife 1980). The lime decline is seen in both profiles; in 1002 at *c.* 64 cm (zone 1002:1/2, Fig. 8) and in 1007 at 140 cm (zone 1007:3/4, Fig. 7) and allows tentative correlation between the two. Whilst this phenomenon is widely interpreted as anthropogenic (Turner 1962), it is also a possible consequence of locally rising water table expanding the wetland and killing local growth of lime (Waller 1994). Here, there is evidence of both factors. Typical weeds of human disturbance and cultivation indicating dry land are present including *Plantago lanceolata*, occasional cereals and other weeds. There is also some expansion of wetland (alder) and salt marsh vegetation (Chenopodiaceae) which also implies expansion of wetland habitats.

The base of core 1007 (zone 1007:1) is somewhat enigmatic in that *Tilia* values are low. It is possible that the lower values are associated with an earlier phase of woodland clearance as evidenced by sporadic occurrences of *Plantago lanceolata*, cereals and a peak of grasses. It may be postulated that this represents a Neolithic clearance, followed by secondary, woodland expansion (lime and ash).

*Quercus* (oak) and *Corylus avellana* (hazel) type are the dominant vegetation elements throughout the time period represented in both profiles. This is commensurate with the presence, and radiocarbon date, of timbers found on the edge of the alluvium-filled channel. Reduction of these tree pollens in the upper profile (zones 1007:3 & 4) is considered to be a statistical function of the expansion of *Chenopodium* rather than of changing conditions to salt marsh. Such importance of oak and hazel woodland during the later prehistoric period until the present is characteristic of southern Britain and is seen in the majority of pollen sequences cited from this region.

To sum up, the pollen data present in both profiles indicate a late prehistoric date for the sediments, that is spanning the Neolithic and Bronze Age periods.

## DISCUSSION

### THE SUBMERGED TREES

The tree stumps and large horizontal tree trunks recorded by Dixon (1850) and Venables (1931) on the beach were interpreted as the remains of a submerged forest. Acorns and hazelnuts were also reported.

Submerged forests or evidence of them, along the south coast of England are extremely rare, and there are relatively few in England as a whole (Bradley *et al.* 1997; Clapham 1999). Those associated with human activity are clearly of archaeological significance as the waterlogged trees and associated peat provide categories of evidence missing from dry land sites. In addition, they extend the overall distribution of sites beyond the coastline and more significantly can be crucial in aiding the determination of past local relative sea level.

More than 27 tree trunks or large branches have recently been recorded. The trees have no root balls and comprise entirely recumbent trunks and large branches with no stumps (*contra* Langstone, Allen & Gardiner 2000, and Wootton Quarr, Isle of Wight, Tomalin *et al.* forthcoming). There is no obvious land surface in which they were growing, although a patch of bryrophytic peat, probably a remnant of a woodland floor, was recorded beneath trunk 124. The position and orientation of the trunks suggest that they had drifted downstream before coming to rest in a strand-line, rather than the result of a single-event wind fall or natural decay fall (cf. Clapham 1999; Clapham *et al.* 1997). It is likely that they would have drifted and become caught in the strand-line soon after they fell and before they had become totally waterlogged.

All the oak trunks and branches examined had very narrow growth rings, with the early and late wood being very close together, indicating that the trees were under substantial stress during their lifetime. This can be related to rising relative sea level in the Early Bronze Age and saltwater inundation of the Rife.

### SEA LEVEL AND ENVIRONMENT

Maps show that in the 18th century the site was low-lying marsh (Fig. 3) which only became foreshore in the 19th century, at least partly as a result of coastal retreat. The pollen analysis confirms that in the Neolithic–Bronze Age period, the site lay in a dry, albeit low-lying, area within the coastal plain. The analysis provided clear evidence of rising relative sea levels and saltwater ingression into the former freshwater Rife, giving rise to the development of salt marsh along the open river margin.

None of the data recorded are, however, relevant to relative sea level indices as they do not relate to *in-situ* land surfaces. The trees and branches were in a river strand-line, which relates to local tidal heights, rather than to absolute sea level. The dated stake was driven into the underlying firm London Clay. It is uncertain how much higher the Bronze Age land surface through which it was driven would have been. Only intermittent, relict patches of soil survived over the London Clay. Truncation may have been as great as 0.5 m, and again this land surface only relates to tidal regimes in the Rife and not to absolute sea level.

Hints of yew in prehistoric coastal wetlands in southern England are becoming more common (*see* Langstone Harbour: Clapham, in Allen & Gardiner 2000; Thames estuary, J. Sidell pers. comm.). In the wider landscape, the lack of elm and the indication of the lime decline confirm that the pollen sequences broadly cover the period of the dated trunks in the alluvium, and stakes on its margins. There is evidence of cultivation on the drier soils beyond the salt marsh. In the wider landscape open woodland of oak and hazel, characteristic of southern England, was present.

### BRONZE AGE ACTIVITY ON THE COASTAL PLAIN

The pollen evidence tentatively indicates local clearance episodes prior to the Bronze Age. Few artefacts of this date have been found in the vicinity, although two Neolithic axes have been found some 2 km to the north-west of the site. No further evidence of the previously reported Mesolithic artefacts was encountered, nor were the original finds available for re-examination. Limited human activity indicated by plants of disturbed ground is present in the Bronze Age pollen sequence. Evidence for Bronze Age activity related to the palaeo-environmental evidence is sparse. Certainly the area was visited and the 'shingle bank' scoured for useful flint and knapping episodes occurred. The 'fence line' is the only hint of more permanent activities and structures. This ephemeral activity is typical of that recorded along much of the Sussex and Hampshire Coastal Plain. This zone was an important resource-rich area exploited throughout the Bronze Age for its flint and clay; it provided ideal summer grazing for cattle and freshwater for watering them. A few metal hoards and isolated metal objects are known as well as evidence for flat urnfield burials (*see* Allen & Gardiner 2000, 206–15).

Perhaps worthy of mention is the isolated find of a human skull fragment. Although undated this may have been of Bronze Age date. This is unlikely to have been a casual disposal. Ritual and symbolic associations with wetlands, rivers and pools are common throughout later prehistory. The deposition of human skulls is particularly common in wetlands and especially in the mid- to Late Bronze Age. Numerous skulls or skull fragments were found in isolated locations along the Goldcliff intertidal muds (Bell *et al.* 2000, fig. 5.1), and those that were radiocarbon dated were Bronze Age to Iron Age in date (Bell *et al.* 2000, appendix 2). Several defleshed Bronze Age skulls are recorded from rivers, four of which were recovered from the Thames (Bradley & Gordon 1988; Bradley 1990). The single human cranial fragment recovered from Bognor Regis probably forms a part of this Bronze Age tradition and may, in part, be allied to the use of these lowland rivers and wetlands for burial and funerary practices such as those reported from the Coastal Plain at Langstone, Hampshire (Allen & Gardiner 2000).

## CONCLUSIONS

The collective investigations recently undertaken at Bognor Regis have amplified antiquarian records and provide a more secure temporal, spatial and interpretative framework for the trees and human activity. It is clear that the trees recorded over the past 10 years were not part of a submerged forest, in contrast to those previously reported by Dixon (1850) and Venables (1931), but drifted logs which had floated down stream and come to rest against the muddy edges of the river. The Rife at Bognor Regis was a part of the coastal plain, rather than the coastal foreshore, in the Bronze Age. The evidence of Bronze Age activity here indicates the use of resources rather than settlement. As such, the environmental and archaeological data provide an important addition to our understanding of the Sussex coastal plain in prehistory and, especially, of the Bronze Age landscape.

## THE ARCHIVE

The project archive, is currently held at the offices of Wessex Archaeology, Old Sarum Park, Salisbury, Wiltshire (site code 44266), and will be deposited in due course at Littlehampton Museum.

**Acknowledgements**
Wessex Archaeology would like to acknowledge the assistance provided by Mouchel International Consultants, in particular Tracey Bulley and Zoë Hutchison, on behalf of their client the Environment Agency. Tim Kersley of the Environment Agency is also thanked for his assistance. The brief for archaeological fieldwork was provided by Mouchel International, in consultation with Mark Taylor, the County Archaeologist of West Sussex County Council, Department of Leisure and Arts, whose collaborative role is also acknowledged. Wessex Archaeology would like to acknowledge the contribution of David Bone, geologist and amateur archaeologist, who provided a great deal of information from his own research and contributed so much to the text. Roger Cordiner, a local geologist, is also thanked for his help and for supplying extremely useful information on the local geology. Wessex Archaeology would also like to thank Dean and Dyball, the groundworks contractors, for their co-operation during the watching brief, in particular for the assistance of Brian Heskins.

The project was managed for Wessex Archaeology by Kit Watson and Charlotte Matthews. The fieldwork was undertaken by Mark Dunkley, Gemma Smith and Kit Watson. Identification of the human and animal bone was by Jacqueline McKinley and Pippa Smith, respectively. The environmental analysis was assisted by Sarah Wyles who also identified the marine shells. Tree ring dating was undertaken by the University of Sheffield Dendrochronological Laboratory, and pollen analysis by Robert Scaife was conducted in the palaeoecology laboratory at Southampton University. The illustrations were prepared by S. E. James.

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