

Chapter Title: The environmental evidence

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Book Title: The Dover Bronze Age Boat

Book Editor(s): Peter Clark

Published by: Liverpool University Press, Historic England. (2004)

Stable URL: <https://www.jstor.org/stable/j.ctvxbph7q.21>

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The environmental evidence

by Helen Keeley, Enid Allison, Nicholas Branch, Nigel Cameron, Simon Dobinson, Isabel Ellis, Peter Ellison, Andrew Fairbairn, Chris Green, Robin Hunter, Jerry Lee, Alison Locker, John Lowe, Adrian Palmer, Eric Robinson, John Stewart and Keith Wilkinson.

To set the Dover boat within its Bronze Age landscape, a number of environmental investigations have been carried out, focusing on the study of a range of sediments and biological remains that were found associated with the abandoned boat timbers. The specialists looked for evidence of where and how the boat was used; in the sea or in the lower reaches of the River Dour? What was it used for? Why was it abandoned where it was and how did it reach its final resting place? How far away was the sea at the time? Where was the dry land and how wide was the river channel? Were the people who might have used the boat living nearby at the time? What farming systems were in place and were suitable raw materials for boatbuilding or repair available locally? What was the significance of the boat to these Bronze Age people? And, finally, what factors led to the exceptional preservation of the boat?

Pollen, diatoms, molluscs, ostracods, insect and macroscopic plant remains, animal bones and the sediments themselves have been examined, with a view to addressing these questions. The stratigraphy was recorded in separate sections (Bates and Williamson 1996), rather than by single-context planning, and the samples were collected as columns or in bulk from individual sections. Cores were taken from deposits below the boat that were too deep to be exposed in the sections. Consequently, it was difficult to link deposits in one section to those in another in order to produce a site matrix, although this was attempted (Fig 12.1) and, ultimately, the attempt proved to be extremely useful for selecting samples for analysis and for interpretation of the results.

The individual specialist reports have been used as the basis for writing this chapter. All of these reports are available separately, in full, as archives held at Dover Museum.

The Dour valley at the time the boat was abandoned

Geology and geomorphology

The whole of the Dour catchment is situated on an outcrop of Cretaceous Chalk. Today, the active course of the river is only some 5–6km in length, and much of the valley network within the catchment comprises dry valleys occupying the dip slope of the Chalk, which here forms the eastern extremity of the North Downs. The plateau surface is largely covered with Clay-with-Flints. Intermittent overland water-flow during periods of high run-off occurs locally, producing streams known as 'winterbournes' (Barham and Bates 1990). Most of the dry valley network is aligned from south-west to north-east, parallel with the dip of the Chalk, but the lower course of the river cuts across this regional trend and is aligned from north-west to south-east. The down-valley gradient of the Dour in the 5–6km of the active course, averages about 7.5m/km. The valley sides in the immediate vicinity of where the boat was found rise steeply from the edge of the valley floor, reaching levels of over 70m OD within 0.5km of the site. The mouth of the Dour valley is flanked by chalk cliffs that rise to a level of over 100m OD. Soils in the area have been mapped by the Soil Survey of England and Wales as the Andover 1 Association and the Batcombe Association (Jarvis *et al* 1984).

Extensive tufa deposits (carbonate springs and algal growths) along the western side of the valley have often been found associated with peat (sometimes containing well-preserved wood and other plant macrofossils) and archaeological material (Bates and Barham 1993a). The remains of the boat lay at c 0m OD between the centre and western edge of the valley, about 30m from the course of the modern River Dour and about 150m from the modern sea front, at a point at which the

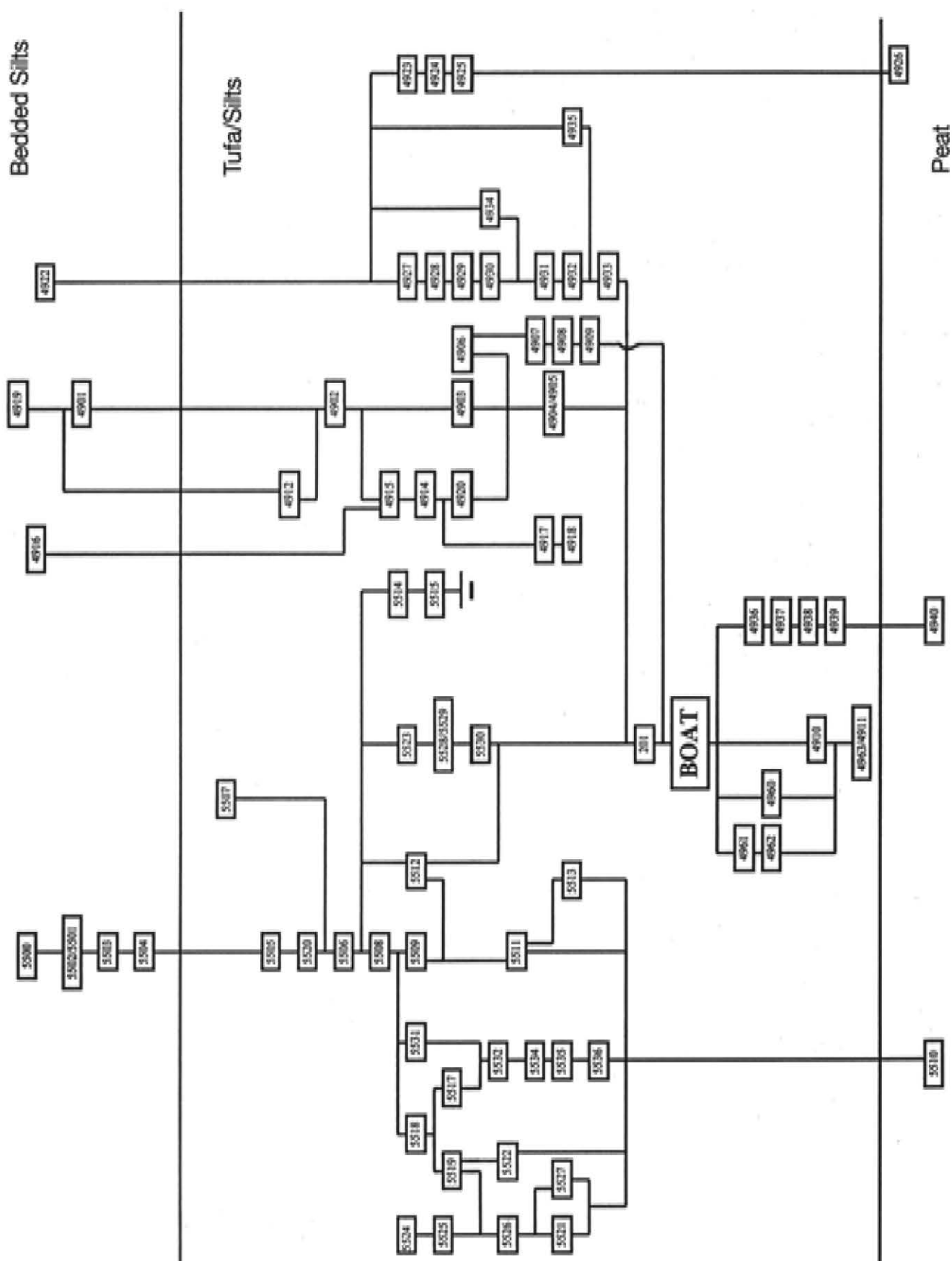


Figure 12.1 The six muscles.

valley is about 250m wide. Coastal erosion will have had the effect of progressively reducing the distance between the site and the sea throughout the period since the boat reached its final resting place.

Vegetation history

The vegetation history of Kent during the last 10,000 years (the Holocene) is still known only in outline, because few detailed pollen diagrams have been published from the area and there is no formally recognised type site. Our current knowledge, based on palynological investigations, has been summarised by Lowe, Branch and Ellis (1998). The scarcity of peat and sediment basins in south-east England, which contain continuous records of Holocene vegetation history, means that there is a dearth of knowledge about the pattern and timing of tree migrations, the nature of primary woodland and the localised effects of human activity in the region. This has resulted in recourse having to be made to sites that are not so suitable for pollen stratigraphy, such as buried soils and alluvial floodplain sediments, which have acute taphonomic problems, as discussed by Lowe *et al* (1998).

Lowe *et al* defined five broad palaeovegetation zones that summarise the temporal sequence of vegetation changes in south-east England, based upon a combination of Scaife's generalised scheme for south-east and southern England (1987) and new data for sites in south-east England. The pollen evidence from sediments closely associated with the boat suggests that it was abandoned in an area that had already been extensively modified by human activity, with widespread development of grassland on alluvial floodplain terraces. The mollusc evidence (Wilkinson 1998) indicates an open disturbed grassland environment, perhaps with longer stands of vegetation close to the channel side. There might have been standing pools of water in the vicinity, or periodic incursions of water over the nearby grassland surface. The local landscape appears to have been largely treeless with scattered hazel and perhaps sparse oak, birch and alder. The insect remains (Allison 1998) also indicate fairly open ground, with scrubby vegetation and poor-quality grazing. There are also suggestions from the plant macrofossil evidence (Fairbairn 1998) of arable land close to the site, although not immediately on the river bank, and chalk-grassland species were also found.

The phase of sedimentation that covered the boat appears to have occurred rapidly, within a landscape of heavily weed-infested grassland similar to that seen in newly abandoned, cultivated or pastoral land today (Lowe *et al* 1998).

Past agriculture

During excavation of the Buckland Anglo-Saxon cemetery (Parfitt, in preparation), a series of artificial terraces was revealed, cut into the natural chalk hillside of the Buckland tributary of the Dour valley. These were of several different dates, including this century, but some could be dated to the prehistoric period and appeared to be the product of agricultural activity. It seems likely that the prehistoric terraces formed part of a more extensive system of 'Celtic fields' occupying the side of Long Hill, which could have been in use between c 500 Cal BC (c 2500 BP) and Cal AD 500 (c 1500 BP). The evidence from Buckland indicates that the slopes of Long Hill were quite intensively cultivated both before and after the Anglo-Saxon cemetery phase. The nature of the soil infilling the terraces clearly implies that there was also extensive cultivation of the upper slopes of the hillside over a long period of time, which led to inundation with soil of the existing terraces of the middle slopes. The first ploughing of the slopes appears to have taken place in the Middle Iron Age, if not earlier (a Bronze Age barrow mound was located on the summit of the hill). Similar evidence for ploughing on the sides of the Dour valley has been recorded in Lousyberry Wood above Temple Ewell, some 2.3km north-west of Buckland, and at Lydden, towards the head of the valley. Agricultural activities within the Dour catchment are suggested by the environmental evidence, which would have resulted in the downwashed sediments identified in the bottom of the river valley. The steep, chalky slopes of the Dour valley, however, can never have been prime agricultural land, and their cultivation in both pre- and post-Anglo-Saxon times might indicate periods when there was considerable demand for agricultural produce.

Sea level

Estuaries are complex interfaces between the fluvial upland systems and the wave- and tide-dominated regimes of the open coast (Townend and Dun 1998). An estuary is,

therefore, subject to a wide range of natural variability, including changing climate, fluctuations in relative sea level and variations in the sediment supply and demand. In addition, an estuary might be subject to a variety of constraints that limit the way its shape can adjust to change, including the form of the catchment, the underlying geology and human developments (such as sea walls and navigation channels). Over the past 15,000 years, global sea-level rise appears to have been rapid between c 13000 Cal BC (c 12450 BP) and sometime between c 6000 to 4000 Cal BC (c 7100 – 5200 BP) – a result of climatic amelioration and release of melt waters from ice sheets and glaciers at the end of the Devensian glacial period (Bray *et al* 1992). As no single sea-level curve is valid globally (because no part of the Earth's crust can be regarded as stable), attention has been focused upon regional sea-level trends.

There are no detailed studies of the Dour estuary, but several areas of coastal lowland in Kent and East Sussex, and the lower reaches of several river valleys, have been investigated, and these are described by Green (1998). An important aim of these investigations has been to explore the evidence for sea-level change, and the data appear to show both that sea level had reached a position between approximately –2.0m OD and –5.0m OD by about c 2000 Cal BC (c 3600 BP), and that this level did not change significantly for a period of some 2,000 years (Long 1992). However, work carried out as part of the LOIS project (Shennan *et al* 1998) indicates that these levels might have been underestimated, and they are currently being revised. The main research on coastal geomorphology and sea level in Kent has centred on the East Kent Fens and Romney Marsh (Long 1992; Long and Shennan 1993; Long and Innes 1993; Long and Tooley 1995; Long *et al* 1996) and the Dour valley lies between these two areas. Although regional trends have been recognised, local processes have been shown to be operating, which makes extrapolation to the Dour valley somewhat problematic. This is exacerbated by the possible effects of the Variscan Thrust Fault, which can be traced across north-eastern France and the Strait of Dover, intercepting the coast of south-east England somewhere between Romney Marsh and the East Kent Fens. This fault appears to be still active today (Long and Tooley 1995). Different crustal movements associated with the front over this short length of coast provide one possible reason

for the differences in recorded sea-level histories between the two areas.

In general, however, regressive (falling) relative sea-level episodes are represented in the stratigraphic record by terrestrial peat and freshwater sediments, whereas transgressive (rising) relative sea-level episodes are characterised by marine sedimentation (shingle, sand, silt, clay). Interpretation of the stratigraphic record is complicated by the fact that, from time to time during the Holocene, coastal lowlands and the lower reaches of the river valleys have both been protected from marine influences by the development of natural coastal barriers. These barriers take the form of sand and single spits, developing across the mouths of river valleys, or more extensive shingle systems, such as Dungeness, protecting larger areas of coastland. Investigations at Midley Church Bank, Romney Marsh, by Long and Innes (1993), indicate that peat formation took place between c 2100 and 250 Cal BC (c 3600–2200 BP) and would have been encouraged by the probable existence of a shingle barrier to the south-west and south-east. Marine inundation, and the local deposition of marine sediment, might follow the breaching of coastal barriers, but it has no significance in terms of relative sea-level change. It seems most likely that, at the time the Dover boat was abandoned, a natural barrier was in place across the mouth of the River Dour (Green 1998).

Sediment deposition in the Dour valley

The most complete record of the Holocene stratigraphy of the lower reaches of the Dour valley comes from investigations associated with the A20 road and sewer scheme (Bates and Barham 1993a), which led to the discovery of the Dover boat. The earliest sediments encountered on the floor of the Dour valley were angular flint gravels, overlain by freshwater organic silts, peats, tufa and tufa-pellet gravels. Similar deposits have been found recently at the Northern Quay, Western Docks (Palmer *et al* 1998). The basal-flint gravel, tufa and silt deposits were also found during investigations at the Royal Victoria Hospital site, to the west of the modern Dour channel (Bates and Barham 1993b). The Dover boat was found to be entirely enclosed in freshwater sediments and lay beneath a Roman quay, above which all deposits contained evidence of marine conditions. This sedimentary

sequence appears to agree broadly with the general model for the lower reaches of river valleys in south-east England (Green 1998), that is, fluvial deposition has generally kept pace with rising sea level and, to a large extent, had excluded marine influences until quite late in the Holocene.

The sea might have been at a mean level of between 2m and 5m below the level at which the boat was emplaced, although the distance between the sea and the boat is not known. Marine influences might have been largely excluded, even from the lowermost reaches of the valley, by the development of a barrier structure across the rather narrow river mouth. This could have been continuous for much of the time, with a substantial part of fluvial discharge occurring by percolation through the barrier. However, a small component of marine and estuarine diatoms (Cameron and Dobinson 1998) suggests that the site might have been infrequently affected by very high tides (such as spring high tides). It seems likely, from the bulk of the environmental evidence, that the Dover boat was abandoned in a backwater area of the river valley subject to quiet water flooding, but was covered by sediments that quickly built up over the boat and led to its unusual preservation.

The mollusc evidence suggests there were probably relatively steep banks at the margin of the braided channels, with restricted areas of damp mud adjacent to the area of flow (Wilkinson 1998). Although the molluscs confirm that the boat was abandoned in a relatively shallow, freshwater environment, the species found indicated that the base of the channel would have consisted of a tufaceous gravel, not covered by mud or vegetation. The water would have been moderately fast-flowing, and there would have been no quieter water areas, zones of aquatic vegetation or mud exposure. Species present in sediments overlying the boat indicated that the southern end of the boat lay in an area of slower-moving water – the conditions for which might have been created by the placement of the boat itself. The insect remains also confirmed the freshwater nature of the aquatic environment and suggested shallow, well-oxygenated and unpolluted running water, perhaps with a gravely tufa substrate (Allison 1998). There were, however, indications of areas of slower-moving, or even still, well-vegetated water towards the channel margins or in backwaters. The insect remains also indicate that patches of

mud were present in places, and there appear to have been plants – including sedges, rushes and umbellifers – standing in the water, or on damp ground close to it, although parts of the river bank might have been gravely or stony and rather barren.

The ostracods were all of freshwater character and indicate that the tufa gravels were not true *in situ* calc-tufas, but valley sludge deposits containing species typical of muddy, silty sediment accumulation associated with temporary shallow pools and flooded water meadows (Robinson 1998).

Fish bones were found that represent the natural death assemblage of small fish living in freshwater conditions with an overall preference for flowing water and vegetation to provide cover (Locker 1998).

The plant macrofossils (Fairbairn 1998) indicate that a freshwater environment of permanent slow-flowing shallow water must have been present along the river at some point, with disturbed, open rush marsh or pasture nearby, and rushes perhaps persisting on the open, sandy river banks and bed. These shallows and marginal marshes might have been quite extensive. In the area of the Dover boat's abandonment there might have been a considerable groundwater flow, emerging locally as springs or as less-concentrated seepage, although the boat appears to have been close to dry land.

Human activity associated with the boat

Examination of sediments laid down both before and after the boat's abandonment reveal the presence of material associated with human occupation of the Dour valley throughout the period represented. The most common evidence occurred in the form of the waste from flint working, burnt flint, charcoal, mammal bones and (more infrequently) marine shell fragments. The artefacts recovered from around the boat included diagnostic material of Middle Bronze Age date. The state of the objects indicated that they had been washed very little or no distance. Marine shell fragments were also identified in the silt immediately overlying the bottom timbers of the boat, associated with unusually large amounts of quartz sand and common grains of glauconite. It seems most likely that this distinctive combination of components was introduced into the boat outside the Dour valley, possibly on a marine beach – thus providing strong evidence for maritime use of the boat.

The Lower Cretaceous Greensands are glauconite-rich sediments, which now reach the coast between Folkestone and Hythe, at a distance of less than 10km from Dover (Green 1998). Further unequivocal evidence for human activity local to the site of boat abandonment is provided by the presence of a charred hazelnut fragment and cereal grain, probably from dumped rubbish (Fairbairn 1998). Other plant taxa might have been introduced into the sediments as a result of sewage disposal.

Summary

The Dover boat appears to have been abandoned in a backwater area of the river valley subject to quiet water flooding, predominantly freshwater but perhaps infrequently affected by very high tides (such as high spring tides), most likely with a natural sand/shingle barrier in place across the mouth of the River Dour. The sea was probably at a mean level of between 2m and 5m below the level at which the boat was emplaced, but it is not clear how far away it was. Shallow, well-oxygenated, unpolluted, moderately fast-flowing water ran through braided channels among rather diminutive gravel bars and sandbanks, with probably relatively steep banks at the margin of the channel system. In other places, permanent slow-flowing, well-vegetated shallow water with marginal, disturbed open rush marshes, temporary shallow pools, flooded water meadows and pasture existed within the floodplain. The channels had gravel or stony bottoms but patches of mud were also present in places where water flow was slower. The surrounding vegetation appears to already have been extensively modified by human activity, with open, disturbed grassland (probably providing poor-quality grazing for herbivores) in a largely treeless landscape and arable land further afield (probably on the hill slopes and cultivated terraces on the valley sides).

The large mammal bones found in sediments closely associated with the boat (Stewart 1998) were of cattle, sheep/goat, pig, red deer and dog and indicated the presence of people nearby, perhaps a form of habitation or settlement. Four bones showed signs of cut marks thought to be the result of butchery – one of these was a sheep; the others belonged to cattle. Other types of surface alteration to the bones was also recorded, including water wear, gnawing by carnivores, marks that could be

attributable to trampling or similar mechanical processes, and evidence of weathering. These various marks signify that some bones were exposed for some time between death or disposal by man and eventual burial, and that others spent a relatively long period in the river prior to burial.

As to whether the Dover boat regularly worked the lower reaches of the River Dour, the environmental evidence clearly indicates that this was very unlikely. As Parfitt and Champion have concluded (Chapter 15), while the river would have been a valuable source of drinking water, it would never have been much use for water transport, certainly not for such a substantial vessel as the Dover boat. In fact, given the estimated dimensions of the boat, and despite its shallow unladen draft, it seems unlikely that it was emplaced as a result of floating unaided up the River Dour, which at most times probably comprised shallow streamlets flowing among rather diminutive gravel bars and sand banks. Also, the presence of quartz sand, glauconite and marine mollusc shells on the inboard surface of the boat provides strong evidence for its maritime use. There is no indication that the abandonment of the boat was associated with any sort of marine flooding event, but the River Dour in flood might have presented an opportunity for floating the boat into the position in which it was found. This would have involved propelling the boat against the flood flow – a difficult, but not impossible, task. Alternatively, the boat could have been hauled or carried into position.

The environmental evidence

The results from the individual specialist analyses have enabled us to build up a picture of the Dour valley at the time of boat's abandonment, and these are drawn upon below. Full analytical data and detailed interpretations can be found in the specialist archive reports held at Dover Museum.

The sediments

Investigations by Bates and Barham (1993a) associated with the Dover A20 road and sewer scheme recorded a sequence of angular flint gravels on the floor of the Dour valley (the earliest sediments), overlain by freshwater organic silts, peats, tufa and tufa-pellet gravels. Penetrating into this association of freshwater sediments were the

footings of a Roman quay, and the overlying deposits all contained evidence of marine conditions. The same basic stratigraphic sequence was recorded in the boat trench and has been reported upon by Green (1998). The three elements most closely associated with the boat (the underlying peat, the tufa/silts, sands and gravels and the overlying bedded silts) are shown in the site matrix (Fig 12.1). The position of the main sections in relation to the boat is shown in Fig 3.4. The relation of the boat to the tufa/silts, sands and gravels and the overlying bedded silts is illustrated in Section 134 (Fig 12.2), which clearly shows how the sediments overlying the boat were eroded and replaced by the bedded silts.

The peat

The peat forms a horizon that could be traced with reasonable confidence throughout the extent of the boat trench below the boat. The upper surface of the peat was uneven and had clearly been eroded. The bulk of the peat was well humified, with very little or no mineral material present, but there were partings in the peat formed by mineral grains, perhaps indicating episodes of sediment erosion upstream. Although the peat itself is known to be considerably older than the boat (Bates and Barham 1993a), only a thin veneer of tufa/silt was found between it and the base of the boat, indicating that the erosion event that truncated the peat had ended only a relatively short time before the boat was abandoned. The erosion of the peat, and its subsequent cessation, might have been caused by migration of the river channel within the floodplain.

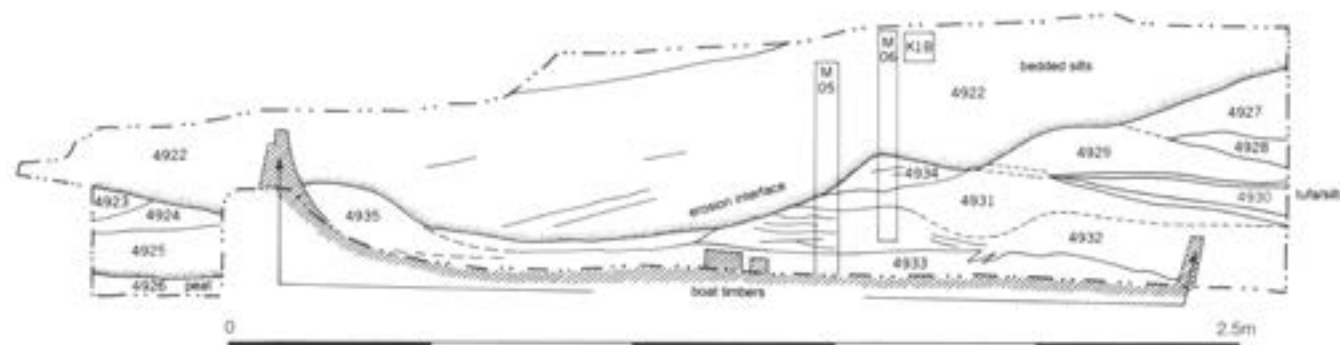
The tufa/silts, sands and gravels

The tufa/silts and tufa-rich sands and gravels were present immediately below and above the boat and overlain by the bedded silts. There was some indication of scour

beneath the eastern side of the boat, with subsequent infill with sands and gravels. The upper surface of the tufa/silts, sands and gravels was uneven, and the horizontal bedding appeared to be truncated in places, to the extent that one end of the boat had been exposed and then re-covered by bedded silts. The sediments surrounding the boat – which appear to have accumulated relatively rapidly – comprised mainly tufa debris but also included subround flint pebbles, subangular chips of flint, sharp flint flakes (including debitage) and pebbles of chalk. The mineral component was always accompanied by an organic component (including rolled peat clasts, twigs, pieces of wood, charcoal, moss fronds, seeds, bone, terrestrial and freshwater mollusc shells and shell debris, and ostracod valves). These organic components must have been derived from the erosion of the underlying peat, from sediments upstream and from material in the immediate contemporary environment. Marine shells were recorded in the immediate fill of the boat and sediment scraped off the outboard of the boat. Fine-grained sediment associated with the sands and gravels was generally silt-rich, formed in large part by tufa mixed with varying proportions of organic material, so that the silty sediments could be pale coloured and tufa-rich, or dark coloured and organic-rich (Fig 5.2).

Inside the boat, the bottom timbers were covered by a thin, distinctive, silty horizon, which contained marine-shell debris, relatively large amounts of quartz sand and common grains of glauconite. The silt is most likely to have built up immediately after the boat was abandoned, dropping out of water standing in or flowing slowly through the hulk. The sand and glauconite were probably trodden into the boat somewhere on a beach, before the abandonment of the boat, and this provides strong evidence for maritime use of the boat.

Figure 12.2
Section 134, showing
contexts and sample
locations.



The bedded silts

The tufa/silts, sands and gravels appear to have undergone a period of erosion after the boat was abandoned, after which they were overlain by silt-rich deposits, generally dark greyish brown in colour, containing plant debris and molluscs, and bedded or laminated in places. Evidence from the assessment indicated that the bedded silts had accumulated in an increasingly marine environment (Clark and Keeley 1997).

Pollen

The dispersal, preservation and interpretation of pollen and spores have been discussed in detail by Dimbleby (1978). The factors most conducive to pollen preservation in sediments are acidity (pH <5.5), anaerobic conditions (usually the result of waterlogging), extreme aridity (eg in desert environments) and extreme cold, all of which suppress the activity of bacteria and other organisms that destroy the pollen grains. The sediments associated with the boat were generally calcareous but also waterlogged, and thus the conditions for survival of pollen in an anaerobic environment appeared to be in place.

A generalised timescale of vegetation history, climatic change and archaeological periods in Britain during the Holocene is shown in Figure 12.3. Lowe *et al* (1998), who analysed the pollen from the deposits associated with the Dover boat, have produced a scheme for Kent that recognises five zones, slightly different from the general picture:

- Holocene I (c 8000 to 7500 Cal BC; c 8900–8400 BP) is characterised by birch (*Betula*) and juniper (*Juniperus*) and represents the expansion of woodland into south-east England during the earliest period of the present interglacial, after the end of the last cold stage (Devensian Glacial Stage).
- Holocene II (c 7500 to 5000 Cal BC; c 8400–6100 BP) is characterised by pine (*Pinus*), hazel (*Corylus*) and elm (*Ulmus*). The rise of *Corylus avellana* during this period was most likely the result of a climatic response owing to a drier and more continental climatic regime, which might have been facilitated by the possible higher incidence of fire, which allowed hazel to out-compete elm and oak (*Quercus*).

Years. BP.	Blytt-Serander climatic periods	Archaeological period	Pollen zone (Godwin, 1940)	Chrono- zone (Gibbert et al. 1971)	Generalised climatic change	
1000	Sub-Atlantic	Roman	VIII	F1-III	<i>Cold and wet</i>	Climatic deterioration
2000		Iron Age				
3000	Sub-Boreal	Bronze Age	VIIIb		<i>Warm and dry</i>	
4000		Neolithic				
5000						
6000	Atlantic	Mesolithic	VIIa	F1-II	<i>Warm and wet</i>	Climatic optimum
7000	Boreal		V/VI	F1-I	<i>Warm and dry</i>	
8000						
9000						
10000	Pre-Boreal		IV		<i>Cool and dry</i>	Climatic amelioration

Figure 12.3
Generalised chronology
(radiocarbon timescale) of
vegetation history, climatic
change and archaeological
periods in Britain during
the Holocene (adapted
from Roberts 1989;
Simmons and Tooley
1981).

- Holocene III (c 5500 to 3200 Cal BC; c 6100–4500 BP) is characterised by alder (*Alnus*) and lime (*Tilia*). Evidence suggests that the rise in alder is most likely to have been the result of human activity in inland areas, but it could be attributed to local natural succession in coastal or valley-bottom locations. *Tilia* appears to have expanded during this period into areas with base-rich soils.
- Holocene IV (c 3200 to 2500 Cal BC; c 4500–4000 BP) is characterised by hazel (*Corylus*), oak (*Quercus*) and birch (*Betula*) and also by the decline of *Ulmus* (the so-called 'Elm Decline') and a substantial change in the composition of vegetation communities. The 'Elm Decline' could be attributed to climatic change, human activity, factors affecting pollen distribution or survival, disease or competition, and, as strong cases have been made for all of them, the primary cause remains unresolved.
- Holocene V (from c 2500 Cal BC; c 4000 BP) is a deforestation phase, with reduction in deciduous woodland and increase in open grassland and heath associated with widespread human activity. Pollen evidence for human activity in the Bronze Age has been reported from sites in Sussex, Surrey and the Isle of Wight, often associated with peat initiation resulting from higher water tables following episodes of deforestation. There is also evidence for the decline of *Tilia* (lime) during the Bronze Age in south and south-east England, probably associated with human activity.

The cores/monoliths selected for pollen analysis were chosen to provide a sequence through the main deposits, concentrating on the tufa/silts, sands and gravels contemporary with the boat (Fig 12.4).

The peat

The junction between the upper peat and the overlying tufa/silts was best exposed in 4-inch Core 1, which had been taken close to the north-east side of the boat (Fig 3.4). The pollen assemblage from the upper peat suggested an open, herb-dominated community, a mixture of dry and damp grassland. The very low tree pollen totals, presence of *Fraxinus* (ash) and single occurrence of cereal grass pollen suggests clearance. The peat appears to date to the very end of the *Corylus* (hazel) decline and to post-date the elm decline and general loss of woodland in

southern England – that is, to around the end of Holocene IV or the start of Holocene V (Lowe *et al* 1998). This confirms the assessed evidence for the truncated upper peat being about 1,000 years (or more) older than the boat (Clark and Keeley 1997). Indications are that the local environment at this time was of dry-to-marshy meadow vegetation, largely treeless or with only scattered hazel and perhaps birch and oak, but mainly a herb-dominated vegetation cover.

The tufa/silts, sands and gravels

One of the most coherent of the pollen sequences investigated in the Dover boat analysis project was provided by Monolith M02 (Section 144; not illustrated) that was taken immediately adjacent to the south-east end of the boat (see Fig 3.4). The pollen diagram is shown in Fig 12.4 (Lowe *et al* 1998). The monolith sampled the upper, truncated peat and the tufa/silts and sands surrounding the boat. Pollen in the calcareous tufa/silts and sands indicated a non-wooded landscape, with an open herb-dominated vegetation cover. There is a diverse record of herb plants, all indicative of dry grassland or occurring as weeds of cultivated ground. The very high percentages of *Plantago lanceolata* and *Pteridium* indicate weed-infested grassland and woodland clearance by humans for pastoral activity. The records of *Chenopodium* and *Plantago maritima* suggest a marine influence. The nature of this is unclear but might reflect the proximity of salt marsh and/or vegetation on the adjacent cliffs. The records of *Mentha* (mint), *Hydrocotyle* (pennywort), *Sparganium* (bur-reeds) and *Typha* (great reedmace) indicate that the local soils were damp and that the site was close to the river's edge or that standing pools of water occurred in the vicinity.

Another monolith analysed (M10, Section 136) was located within the tufa/silts, sands and gravels filling the boat and probably resting directly on the inboard surface of the boat timbers. This contained sediments that were calcareous and with generally very low pollen concentrations and poor preservation, so the pollen data have been interpreted with some caution. However, there are clear similarities between this pollen assemblage and the tufa/silts in M02 – in particular, high percentages of *Plantago lanceolata* and *Pteridium*. Many of the other pollen types recorded were characteristic of grassland communities, although there was evidence

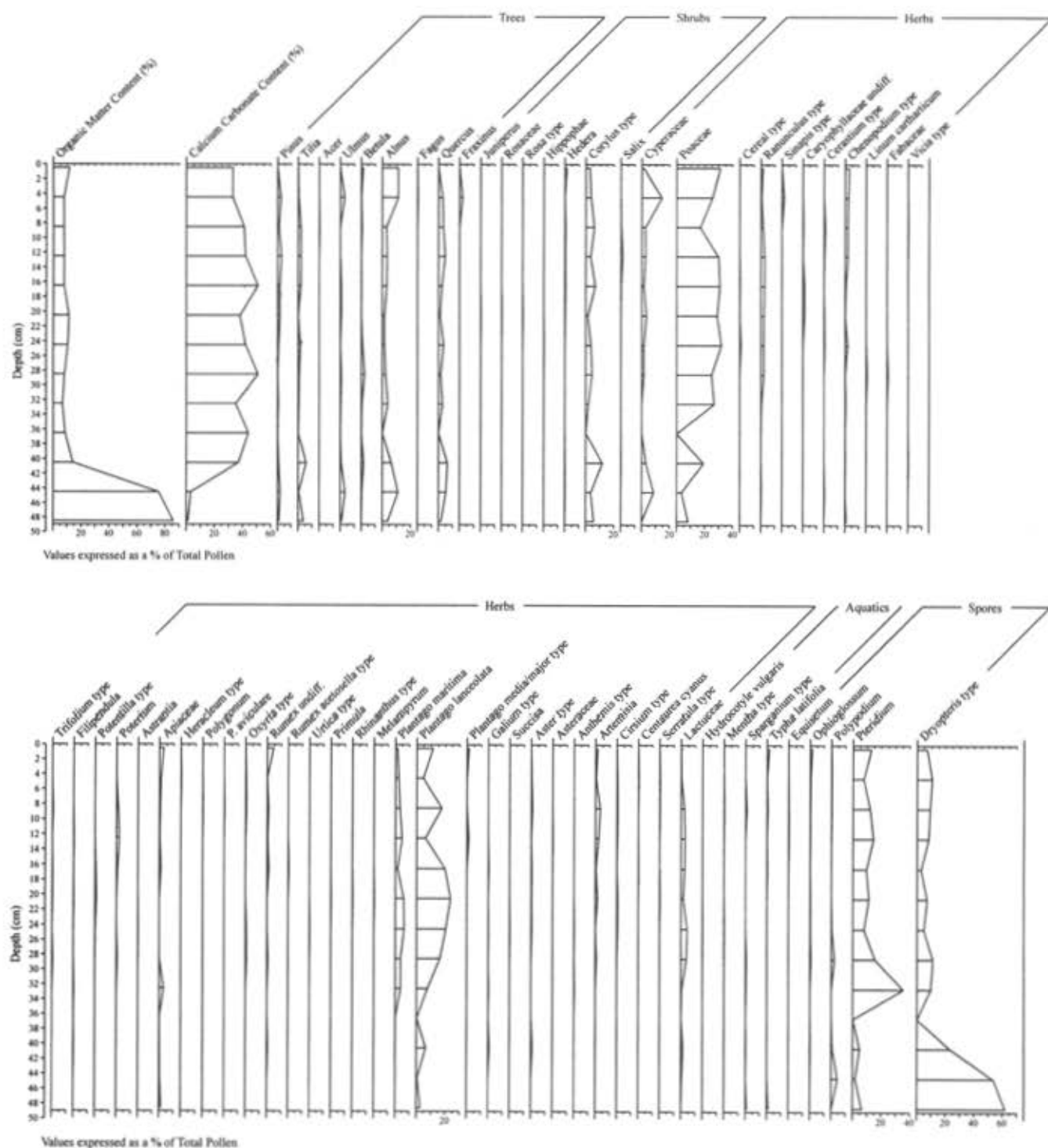
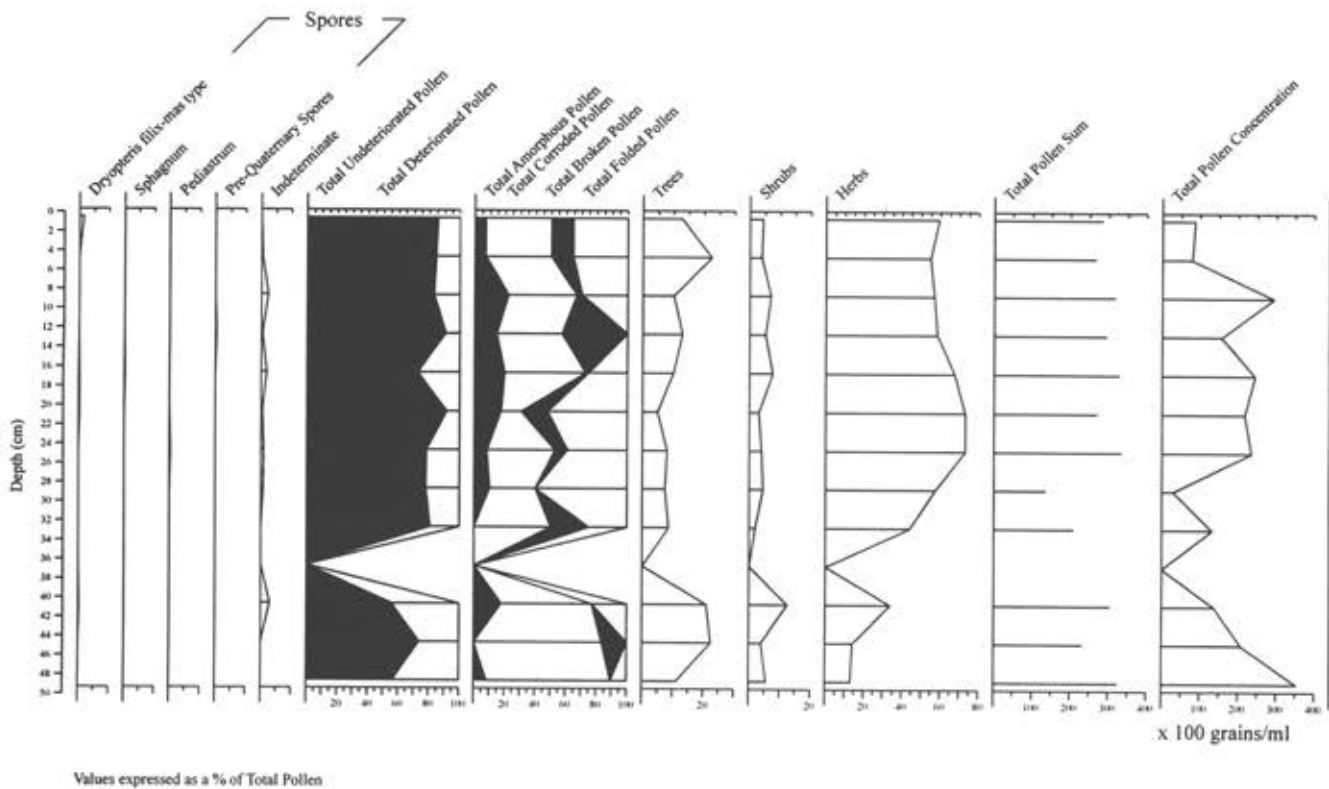


Figure 12.4
(above and opposite)
Composite pollen diagram.

in one level for quite a strong but short-lived recovery of woodland. This appears to be typical of records obtained for floodplain contexts and of human interference with floodplain vegetation from the Bronze Age to the Iron Age (Lowe *et al* 1998). There were also indications of pulses of sediment deposition, such as flooding events.

Samples of sediment scraped off the underside (outboard) of the boat contained pollen that showed many features in common with the pollen assemblages obtained from the tufa/silts in M02, including indicators of open grassland (dry to damp). Cereal pollen was also noted in a few of these samples.



In general, the pollen evidence indicates that the boat was abandoned in an area already extensively modified by human activity. There is little change in the overall pollen percentage data from the tufa/silts, sands and gravels, suggesting that the boat was buried rapidly, as indicated by the sediment studies (Green 1998), probably as a result of agricultural activities upstream. There is little evidence for boatbuilding materials close to the site. No yew (*Taxus*) pollen was found, although it should be noted that this is produced in low abundance and rarely survives in countable numbers. Oaks (*Quercus*) might have been present in the vicinity, but do not appear to have been widespread at the time the boat was abandoned.

Diatoms

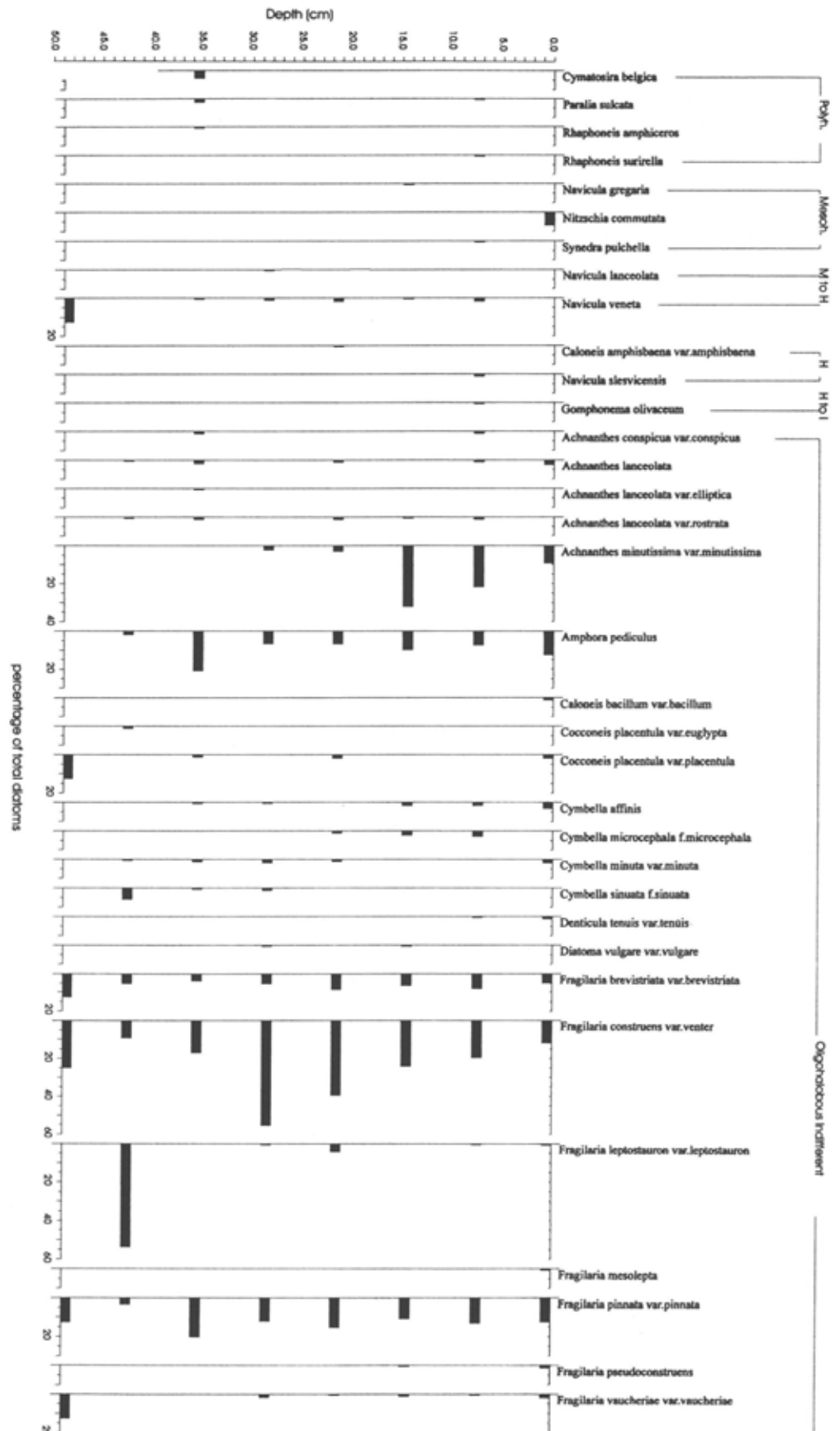
Diatoms are microscopic unicellular algae, which live in water and are characterised by their ornamented silica outer shell. They grow as single cells or colonies that might be free-living in water, attached to submerged surfaces or motile in and on underwater surfaces and comprise one of the most abundant algal groups, distributed worldwide and found in freshwater, brackish, marine and terrestrial habitats.

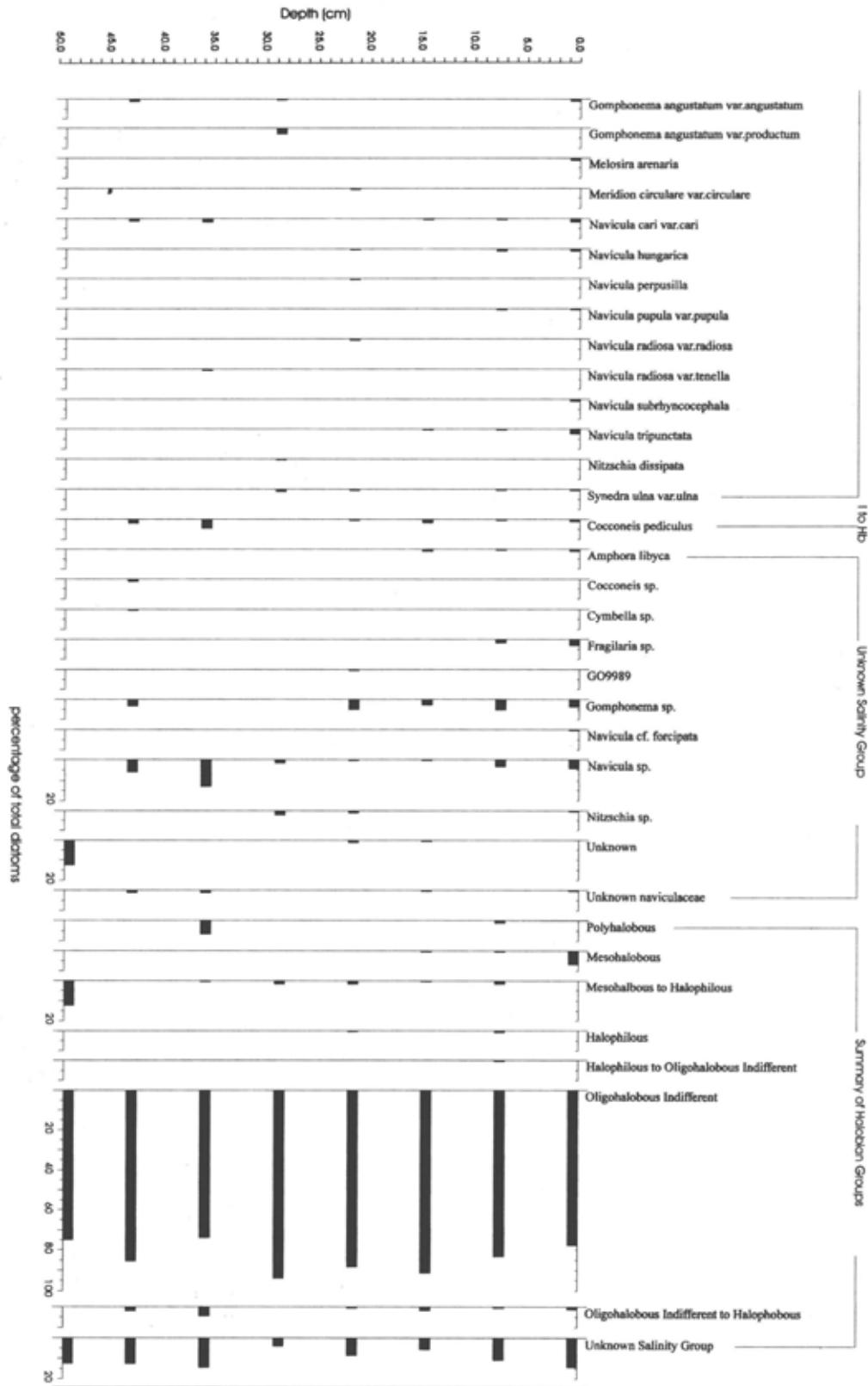
After the death of the diatom, the shells are often preserved in the sediments of ditches, ponds, lakes, rivers and in coastal or ocean sediments. The composition of species growing together is a sensitive indicator of water-quality factors, such as the level of acidity, phosphate and salinity. In view of the sensitivity of diatoms to salinity, the primary aim of analysis in the Dover-boat project was to determine the salinity conditions under which the sediments associated with the boat had accumulated (Fig 12.5). The samples studied were from the same suite analysed for pollen (excluding the peat) and these were reported on by Cameron and Dobinson (1998).

The tufa/silts, sands and gravels

The diatom assemblage from M10, Section 136, which sampled the tufa/silts filling the boat, was dominated by oligohalobous-indifferent (freshwater) taxa throughout the profile, although brackish and halophilous (slightly brackish) were more frequent in the lower part of the sediment column. Almost all the taxa were non-planktonic species (ie those that are associated with, or attached to, submerged surfaces), suggesting that the source of the diatoms is likely to be close by and the habitat represented is one of relatively shallow water.

Figure 12.5
Composite diatom
diagram.





Diatoms associated with full marine conditions were completely absent and taxa that grow in marine-to-brackish salinities occurred at cumulative abundances of less than 5 per cent, suggesting that, even during its most saline phase, the sedimentary environment was not in a fully tidal location.

Another monolith (M01, Section 132) taken along the north-south axis of the boat (see Fig 3.4) sampled the tufa/silts above the boat structure and the overlying bedded silts. The picture for the former was essentially similar to that for M10, being dominated by freshwater diatoms, including various *Fragilaria* taxa (*F. leptostauron*, *F. brevistriata*, *F. constuens* var. *venter* and *F. pinnata*).

As for M10 and M01, the diatom assemblages in all samples from the tufa/silts above the boat in M02 Section 144 (the main pollen sequence; not illustrated) were dominated by the oligohalobous-indifferent (freshwater) halobian group and almost all were non-planktonic life forms, probably from a nearby source, indicating that the environment was one of shallow water (see Fig 12.5). As in M10, marine and brackish water species were rare, suggesting that the site was not regularly affected by tides but might have been reached infrequently, for example by high spring tides. The dominance of a species such as *Fragilaria leptostauron* (which is often associated with shallow-water mud habitats) might indicate a large area of mud surface for diatom colonisation, but, as the species is robust (heavily silicified), its dominance in one sample might be the result of differential preservation. The common occurrence of a number of 'opportunistic' *Fragilaria* taxa suggests that the aquatic habitat available was, to some degree, ephemeral – such as shallow pools that were subject to drying out.

The bedded silts

The uppermost sample from M01, Section 132, came from the overlying bedded silts and contained a mesohalobous (brackish) diatom *Nitzschia acuminata* and a semi-planktonic marine species (*Cymatosira belgica*), indicating a degree of direct contact with the marine environment. This confirms the results of previous assessment work on other biological remains from the bedded silts (Clark and Keeley 1997).

Ostracods

Ostracods are a diverse group of small bivalved crustaceans that occur in almost all aquatic environments. The animals themselves are essentially shrimp-like, but with a bivalved, calcareous shell (carapace). Many species occur in fresh waters, almost 100 of which are known from modern Britain and British Pleistocene and Holocene deposits, and are recognised as valuable indicators of hydrological and climatic conditions (Griffiths *et al* 1993). Ostracod valves preserve well in a wide variety of depositional environments, sometimes in very large numbers, and assemblages can provide quite specific information on the nature of the environment from which they derive. Ostracods might be expected to occur in almost any non-acidic, water-lain deposit, but, as ostracod shells are calcareous, optimal preservation occurs in calcareous deposits such as tufas and marls, although they also occur in other fine sediments. Thus it was expected that the tufa/silts, sands and gravels associated with the Dover boat could provide suitable conditions for ostracod preservation and useful information about the depositional environment of these deposits.

Analysis was carried out by Robinson (1998) but of the twenty samples examined only eight from the tufa/silts surrounding the boat provided an adequate ostracod fauna for study. All shared a relationship to calc-tufa sequences, although none represented a normal *in situ* calc spring deposit. Most seemed to testify to muddy, silty sediment and all were of a freshwater character. All contained specimens of *Prionocypris serrata* (some samples were dominated by it), which frequently occurs in temporary pools and flooded water meadows, where it survives successfully in wet grass. The species *Potamocypris fulva* and the entire genus is another ostracod which signifies temporary wetlands, often associated with spring emissions or spring-fed pools. The suggestion that part of the aquatic habitat at the time of boat abandonment might be temporary in nature ties in with the results of the diatom analysis (Cameron and Dobinson 1998).

Molluscs

In palaeoenvironmental reconstruction, molluscs share with beetles the advantage of occurring in a great variety of deposits – terrestrial, freshwater and marine –

although they are unusual in non-calcareous sediments from which the exoskeletons – formed predominantly of calcium carbonate – are leached. However, if preservation is good, molluscs can be identified to species level and the composition of assemblages can be used as an indicator of past environments. Molluscs are influenced by the microclimate (rather than the macroclimate) of the local site, and changes in the species composition of the assemblage are likely to reflect ecological change rather than climatic change. Thus, although molluscs cannot be used with any confidence in establishing the magnitude of climatic change, a strength of molluscan analysis lies in the detail with which local site conditions can be reconstructed. Molluscs can also be used to indicate changes in water quality and water depth (Simmons and Tooley 1981).

In view of the calcareous nature of the deposits surrounding the boat, molluscan analysis appeared to have considerable potential to provide a picture of the local environment and water conditions and was carried out by Wilkinson (1998), who examined both gastropods and bivalves.

A series of samples was studied that provided a complete sequence from the eroded top of the peat, through the tufa/silts, sands and gravels immediately underlying, within and directly overlying the boat and into the overlying alluvial-bedded silts, thus providing a 'master sequence' with which other assemblages could be compared. The results are shown in Figure 12.6. The relationship between the contexts and the boat is shown in the site matrix (see Fig 12.1) and the samples came from three sections (134, see Fig 12.2; 135, not illustrated; 131, not illustrated), all running at right angles to the length of the boat (see Fig 3.4).

The peat

Mollusc preservation in Context 4963/4911 (Section 131, not illustrated) was surprisingly good and more mollusc shells were recovered from this horizon than from any other. However, despite the large number of shells recovered, the diversity of the assemblage was low. The main species were indicative of a slow-flowing stream or river rich in vegetation and a bed of plant debris. The sample came from where the base of the tufa/silts overlay the eroded peat surface and it seems likely that this molluscan assemblage post-dates the peat formation and has subsequently been incorporated in

the upper part of the peat, along with the tufa granules. The small terrestrial component indicated that the 'dry' land was some distance from the sample site and was probably shaded.

A sample was analysed from Context 4926 (Section 134) in a pit adjacent to the boat, which probably pre-dated 4963/4911 (Section 131, not illustrated) and was related to the peat accumulation. The assemblage was diverse but consisted largely of several species characteristic of marshland and other wet, muddy areas such as *Carychium minimum*, *Lymnaea truncatula*, Succineidae and *Vertigo angustior*. The fully aquatic species were either tolerant of all conditions (*Pisidium nitidum* and *Lymnaea peregra*) or preferred highly vegetated aquatic environments (*Valvata cristata*). The terrestrial species (c 35 per cent) were overwhelmingly dominated by shade-loving species – such as *Discus rotundatus*, *Aegopinella* sp. and *Oxychilus* sp. – indicating there was a great deal of tall vegetation. These data tie in closely with the pollen and sediment results, suggesting that the peat developed at the margin of a stream channel as a 'backswamp' or a cut-off channel still exposed to occasional flooding, possibly in a relatively calcareous environment. The peat would have been characterised by areas of exposed mud, zones of pools or rivulets containing aquatic vegetation and drier areas on which plants, including trees, could grow.

The tufa/silts, sands and gravels

Below the boat

Samples from tufa/silts, sands and gravels immediately underlying the boat contained mollusc assemblages of a broadly similar nature to that in the underlying peat but with fewer shells of species preferring moving water. Shell preservation was generally poor. The earliest assemblage (Context 4938, Section 135, not illustrated) was dominated by *Pisidium nitidum* (which inhabits most aquatic environments) and to a lesser extent *Valvata piscinalis* (which generally inhabits moderate to large size bodies of moving water). The less numerous component included species and families (*Lymnaea peregra*, *Lymnaea truncatula*, Succineidae) indicative of rather quieter water conditions than before, with reduced flow and limited areas of mud. The proportion of fully terrestrial species was higher than in Context 4963/4911 and the

dry-land component mostly consisted of shade-loving species, suggesting that the dry land was closer to the sample site than before. The shade could have been the result of the development of long grassland rather than woodland, as no compulsive arbophiles were noted. The change of environment from before could have been the result of local changes to the river-bed morphology. The braid of the river in which the boat was abandoned might have become marginalised from the main area of flow, or there might have been a broader reduction to the flow of the Dour.

In Contexts 4937 and 4936 (Section 135, not illustrated) there was a major change in the assemblages from earlier deposits, with species indicative of large bodies of water declining further and being replaced by another species indicative of moving water, *Ancylus fluviatilis*. The latter requires a hard substrate, which is likely to have been provided by the tufa that had accumulated above the peat, and fast-to-moderate moving water. The species indicative of marsh and mud-rich environments rapidly declined and the shade-loving terrestrial species were replaced by species indicative of open-country conditions, such as *Pupilla muscorum* (a significant proportion of which, however, might have been derived from sediments of late glacial age) and *Vallonia costata*. The impression given is that a sharp divide was forming between the aquatic and terrestrial environments.

Accumulation of tufa was the main factor in the change in aquatic conditions, including accretion on the muddy channel margins previously occupied by mud banks. The increase in open-country species might have been the result of human clearance of the longer vegetation for agricultural purposes. The environment immediately prior to the abandonment of the boat (Context 4936, Section 135, not illustrated) seems to have been within a freshwater, highly calcareous, braided channel system surrounded – perhaps on individual bars between channels – by areas of open country – probably grazed grassland.

Above the boat

The first sample that post-dates the abandonment of the boat was from Context 4933 (Section 134, see Fig 12.2), which represents the primary fill of the boat. This had a very unusual mollusc assemblage, overwhelmingly dominated (98 per cent or more) by *Lymnaea peregra* – a species that can tolerate

a wide variety of different aquatic conditions and, thus, an extremely efficient coloniser of newly created environments. It is most likely that, following the abandonment of the boat, sediment-rich pools developed within the interior. These were colonised by *Lymnaea peregra*, which might have entered in water seeping through the decaying structure.

In Contexts 4932 to 4929 (Section 134, see Fig 12.2) the mollusc assemblages were similar both to each other and to those from 4936 and 4937 (Section 135, not illustrated). These lay beneath the boat, being dominated by *Ancylus fluviatilis*, *Lymnaea peregra* and terrestrial open-country taxa, indicating that the environment following the boat's abandonment remained much as before. There are some notable changes, however, which might indicate subtle alterations to the local environment. The reduction in *Ancylus fluviatilis* (and freshwater species in general) towards the top of the tufa/silts, sands and gravels, accompanied by an increase in marsh dwellers and fully terrestrial species, might indicate further marginalisation of the area around the boat from the zone of predominant water flow.

Other samples from the tufa/silts, sands and gravels were comparable with those from the 'master sequence', indicating an environment characterised by moderately fast-flowing water on a tufa substrate with the area around the stream largely occupied by short grassland. Context 4932 (Section 134, see Fig 12.2) appeared to be primarily derived from dry-land material, possibly including cultural debris, and could have accumulated on the margin of one of the braided channels. It contained two shells of the marine species *Littorina littorea*, which are likely to have been introduced onto the contemporary ground surface by man.

Samples from tufa/silts, sands and gravels at the southern end of the boat showed some differences from the 'master sequence', indicating that conditions in the former were more marginal to the main area of water flow, although there was still a relatively sharp divide between dry land and the channel. Samples taken from sediment attached to the underside (outboard) of the boat contained species that indicated slow-moving water in the watercourse in which the boat was abandoned and there do not appear to have been areas of semi-flooded, mud-rich marsh. The terrestrial component was dominated by open-country species and indicated that the area immediately surrounding the river most likely comprised

grazed grassland with occasional stands of longer vegetation (but no trees) and damp grassland at the water's edge.

The bedded silts

Mollusc preservation in the overlying bedded silts (Context 4922, Section 134, Fig 12.2) was highly variable, but the results indicate, as do the sediment data (Green 1998), an alteration in stream behaviour to deeper, slower-flowing water, which probably took the form of a change from a braided to a single channel bedform (or at least to fewer, larger channel bedforms). Terrestrial molluscs are overwhelmingly dominated by open-country and catholic species and the lack of shade-loving species in the upper deposits suggests that the area surrounding the stream channel was almost totally devoid of vegetation.

Plant macrofossils

The remains of plants of economic importance, such as cereals, vegetables and fruits, can provide evidence of agriculture, social organisation and diet. Plant remains from natural or human-influenced ecosystems can point to local vegetation history and, by proxy, local environmental conditions in river systems. Plant macrofossils are those remains that can be seen with the naked eye (although species identification usually requires microscopy) – such as seeds, fruits and vegetative structures – as opposed to microfossils, which can be viewed only under magnification – such as pollen, spores and diatoms. Preservation usually requires an anaerobic environment (commonly waterlogging) or charring of the material, although extreme dryness or cold can also result in excellent resistance to decay. Remains might also be silicified in ash or preserved by mineralisation – usually in deposits extremely rich in calcium and phosphates.

Plant macrofossil assemblages reflect mainly the local flora, with several important caveats. For example, in channel and channel-bank deposits, plant remains are derived mainly from the vegetation of the river banks, but these deposits can also preserve macrofossils from more distant sources, especially taxa with buoyant seeds. Most vegetative matter is damaged in these environments, limiting identifiable fossils to fruits and seeds. Raised sediments accumulated on levees and around tree hummocks preserve few remains owing to

oxidising conditions, and preservation in overbank sediments depends upon maintained water levels.

The waterlogged conditions of the boat sediments indicated good conditions for the preservation of plant macrofossils (Fairbairn 1998). Samples were examined from deposits scraped off the underside (outboard) of the boat and from tufa/silt, sand and gravel contexts associated with the boat. No samples from the peat or the overlying bedded silts were analysed. Seeds and fruits constituted the most diverse and abundant group of plant macrofossils. A small number of mosses was recovered (probably including small fragments of caulking used in the boat construction) and rare leaf fragments and epidermis (with the exception of bracken pinnules, which were common), bud scales, thorns and prickles were noted. The identified macrofossils were from plants of several distinct habitats: wetland trees (alder); submerged and floating aquatics; emergent aquatics; herbaceous riparian (river bank), marsh and mire taxa; dryland trees, shrubs and woody scrub taxa; dryland ferns and climbers; grassland taxa of wide distribution; chalk-grassland taxa; mesotrophic grassland taxa; domestic plants; and species indicative of arable and disturbed ground, waysides and wasteland.

The plant macrofossil assemblages, and the pattern of habitat representation, were generally similar throughout the deposits within which the boat was preserved. Taxa of arable, wetland and aquatic habitats dominated the assemblages in terms of numbers of taxa and numbers of macrofossils. Characeae (stonewort) oospores and the seeds of *Juncus bufonius* (toad rush) were occasionally very abundant, otherwise being present throughout the sample set in small numbers. Regularly abundant taxa included *Ranunculus acris* (buttercup), *Ranunculus* sub-genus *Batrachium* (water crowfoot), *Juncus acutiflorus* (rush) and *Chenopodium album* (fat hen). Many other taxa were less abundant but regularly present, including *Neckera crispa* (moss fragments), *Rubus fruticosus* (bramble), *Potentilla reptans* (creeping cinquefoil), *Mentha* (mint), *Eupatorium cannabinum* (hemp agrimony), Rosaceae (sloe/hawthorn type; thorns) and *Pteridium aquilinum* (bracken; pinnules). Rare taxa included *Zannichellia palustris* (horned pondweed) and *Clematis vitalba* (traveller's joy). The variation in taxon occurrence in individual samples did not affect the overall

interpretation, suggesting that plant macrofossil assemblages were largely deposited in a similar range of depositional environments, with inputs from an identical range of source habitats throughout the period of deposition.

Two samples from the fill of the boat (Context 4933, Section 134, Fig 12.2; Context 5512, Section 144, not illustrated) contained macrofossil assemblages significantly different to those of the surrounding sediments, including low-diversity, abundant assemblages dominated by aquatic and wetland taxa. The dominant remains were small seeds and oospores, which do not float and are dispersed by wind, overland flow or in suspension in moving water. These concentrations might suggest that conditions inside the boat were of standing water, which allowed suspended macrofossils and fine-grained sediment to fall out of suspension and accumulate in the boat's hull, which ties in closely with the mollusc evidence (Wilkinson 1998) described previously.

All of the aquatic, riparian and wetland taxa identified grow in freshwater habitats. Although most of the remains were probably derived from local plants, the seeds of non-floating taxa might not be of local origin and the flora along the whole river course might also be represented. Permanent slow-flowing shallow water must have been present along the river at some point, indicated by the presence of *Callitriche* (starwort) and *Nymphaea* (water lily). The presence of *Juncus bufonius* (toad-rush) suggests that disturbed open-rush marsh or pasture existed nearby and this plant might have persisted on the open sandy river banks and bed, as it frequently colonises such areas today. Seeds of *Montia fontana* (blinks) and *Chrysosplenium oppositifolium* (golden saxifrage), which are not easily distributed in water, might indicate that there was a considerable groundwater flow emerging locally as springs or as less-concentrated seepage, as indicated by the ostracod evidence (Robinson 1998).

The presence of the aquatic and wetland taxa mentioned above, and of dryland taxa throughout the sample set, indicates that the river might have had extensive shallows and marginal marshes directly adjacent to dryland habitats. Seeds of some important and abundant taxa, however, such as goosefoots (*Chenopodium* sp.), which are well dispersed in water, might have come from upstream. It is unclear how close to the site

the marshes would have been, as the mollusc evidence (Wilkinson 1998) suggests the lack of a local, developed bank-side habitat. Direct evidence for human activity included a charred hazelnut shell fragment identified in Context 5528, and a cereal grain recovered from Context 5512 (both specimens post-date the boat). These are most likely to have been incorporated through dumping of rubbish locally into the river, as evidenced by the large quantity of burnt flint, charcoal and animal bones in the deposits. This might also explain the presence of other taxa, such as the seeds of strawberry (*Fragaria vesca*) and blackberry (*Rubus fruticosus*), which might have been introduced as a result of sewage disposal. Less direct evidence comes from the range of disturbed and possible grassland habitats present around the site, all of which require human action to be maintained. Primary woodland taxa are almost totally lacking in the assemblages, the dryland flora being composed of open or scrub/secondary woodland species with an abundance of open-country taxa, indicating a cleared local environment, consistent with the site pollen record (Lowe *et al* 1998).

A developed Bronze Age weed flora was present which, with the waterlogged cereal grain, might indicate open arable land close to the site, if not on the river bank. The presence of *Chenopodium* (goosefoots), *Urtica dioica* (nettle) and *Glechoma hederacea* (ground ivy) indicate that some of the surrounding habitats were enriched with nitrogen, possibly because of human activity. Open-country and grassland species were present throughout. Chalk-grassland species were present, as well as taxa of more neutral or acidic soils and one possible source of these (as well as the river flow) could be animal dung, which the insect remains suggested was entering the river (Allison 1998). The common occurrence of *Thymus* (wild thyme) in the assemblages almost certainly indicates the presence of grazed or mown grassland in the vicinity of the site. The non-calcareous taxa might have grown on the alluvium.

Insect remains

Beetles (Coleoptera) and bugs (Hemiptera) are found in most terrestrial and freshwater habitats, including coastal ecosystems such as sand dunes and salt marshes. Although the beetle fauna of Britain is impoverished compared with that of the rest of Europe,

there are about 3,700 species, and these are widely spread. Those species that have narrow ecological ranges are of particular value in environmental reconstruction (Simmons and Tooley 1981). For instance, some beetles are phytophages and live exclusively on particular plants, and others are carnivores. Beetle analyses have also made significant contributions to climatic interpretation. The remains of insects are best preserved under waterlogged conditions. Thus the sediments associated with the Dover boat appeared to offer suitable conditions for finding them, and samples from the tufa/silts, sands and gravels were analysed by Allison (1998). In practice, preservation varied somewhat between samples, but, generally, fragmentation was very high and some samples contained specimens showing a degree of chemical erosion, so that many small fragments could not easily be identified.

Tufa/silts, sands and gravels from below the boat

The two earliest samples came from the underside (outboard) of the boat. The deposits were clearly laid down in fresh water and aquatic taxa accounted for between 21 per cent and 35 per cent of the total. The most numerous beetles were running-water taxa, in particular the elmids *Elmis aenea*, *Limnius volckmari* and *Normandia nitens*, which require well-aerated water with a high oxygen content. All three of these species live under stones on the bottom of rivers and streams, and the tufa gravel might have provided a suitable substrate here. The presence of *Coelostoma orbiculare* and *Chaetarthria seminulum* suggest that slower moving, or stagnant, well-vegetated water might have been present in places.

The assemblages include part of a rich terrestrial fauna but many remains were very fragmentary and the plant-associated species, therefore, only hint at the terrestrial vegetation. The presence of fairly open, drier ground in the vicinity is suggested by the presence of the ground beetle *Calathus fuscipes* and the bug *Syromastus rhombeus*. The latter occurs in dry sandy habitats of all types and its foodplants are spurries (*Spergularia*), sandworts and other Caryophyllaceae. Other indications of plant life included the *Phyllotreta nemorum* group found on crucifers, and two species of leaf weevils (*Phyllobius* or *Polydrusus*) found on various trees and bushes. Two chafers were recorded – the larvae of *Phyllopertha horticola*

feed on the roots of turf and usually infest poor-quality pasture on light soil, preferring chalky soil in south-east England. *Cetonia aurata*, a larger species known as the rose chafer, has larvae that develop in rotten wood and humus. Scarabeid beetles usually associated with herbivore dung were common in the samples. Several species of *Aphodius* were represented, most commonly *Aphodius sphaelatus*, which occurs in dung of all kinds and also in rotting vegetable matter. Three species of *Onthophagus* were recorded, of which *Onthophagus ovatus* is found in horse or sheep dung, especially on chalky and sandy soils and *O. coenobita* feeds on corpses and fungi in addition to dung. No synanthropic insects were noted, which could have indicated human activity in the vicinity of the site.

Tufa/silts, sands and gravels from above the boat

Nine samples were examined from deposits post-dating the abandonment of the boat. Only a small sample was available from the thin silt layer lying on the timbers inside the boat (Context 4933), which contained *Normandia nitens* (a running-water species) and appeared to be a small extract of the fauna represented in the other, larger samples. The rest of the assemblages were all so strikingly similar that they can be treated together and they were also very similar to the samples from the underside of the boat. All indicated deposition in a fresh-water environment. Aquatic beetles and bugs made up a major component of all the insect assemblages. Ehippia (resting eggs) of a water flea (Cladocera: *Ceriodaphnia*) were noted in two of the samples and, as with the earlier deposits, the most numerous beetles among the aquatic group were running water taxa, notably the elmids *Elmis aenea*, *Limnius volckmari* and *Normandia nitens*. Members of the genus *Ochthebius* provided further indications of water conditions: *O. exsculptus* lives in shallow running water and *O. bicolon* is found in rivers and streams mainly among vegetation in more slowly flowing water at the edges and also on muddy banks. Remains of *Hydraena* were also recorded, most of which are found in clear, unpolluted water.

The ground beetles (Caribidae) were a mixture of species found close to water and others typical of rather dry and open ground. Parts of the river bank might have been gravelly or stony and rather barren – *Bembidion saxatile* is predominantly found in

such situations. *Calathus fuscipes* was the most common ground beetle, which is mainly found in open country on rather dry soil. The range of waterside taxa suggested that slow-moving or still, well-vegetated waters were present in places, with areas of waterside mud indicated by *Chaetarthria seminulum*, *Platystethus cornutus* group and *Dryops* sp. A greater range of plant feeders could be identified, with emergent or floating vegetation indicated by at least two species of Donaciinae. *Prasocuris phellandrii* is a leaf beetle found in damp localities on umbelliferous plants standing in or by water, duckweed (*Lemna*) is indicated by the tiny weevil *Tanysphyrus lemnae*, and the frog hopper *Conometus anceps*, *Kateretes* sp. and the weevil *Limnobaris* sp. all indicate that rushes (*Juncus*) and sedges (*Carex*) grew at the water margins or on nearby damp ground.

Remains of four chafers were present, the most common being *Phyllopertha horticola*, whose larvae usually infest poor-quality pasture on light soil. A range of plant-associated taxa suggestive of scrubby vegetation were represented, including *Gymnetron flabile* whose larvae develop in the heads of ribwort plantain (*Plantago lanceolata*) which was common in the pollen record (Lowe *et al* 1998), *Apion craccae* group found on vetches and vetchlings (*Lathyrus* or *Vicia*) and *Phyllotreta nemorum* group found on Cruciferae. Little evidence was obtained for the presence of trees, although fragments of leaf weevils were recorded from several samples and *Ramphus pulicarius* from two – this small weevil is associated with birch (*Betula*), willow (*Salix*), poplar (*Populus*) and sweet gale (*Myrica gale*).

In all samples, remains of scarabeid beetles usually associated with herbivore dung were common, the most numerous being *Aphodius sphacelatus*, a rather generalised dung feeder that also exploits foul decomposing vegetable matter. *Aphodius scrofa* was recorded from one sample. This species is now thought to be extinct in Britain. In the 19th century it was recorded in association with the dung of sheep, cows and horses. Several other *Aphodius* species, *Colobopterus erraticus* (most often found in sheep, pig or horse dung), possibly two *Geotrupes* spp. and two *Onthophagus* spp. were represented. *O. ovatus*, which is found in association with horse and sheep dung, was recovered from four samples. Again there were no synanthropic species that could have indicated human occupation or activity nearby.

Animal bones

Fish bones were recovered from thirty-one samples of tufa/silt, sand and gravel deposits both surrounding and adhering to the boat, and these were identified by Locker (1998). The following species were present: eel (*Anguilla anguilla*), Salmonidae, stickleback (*Gasterosteus aculeatus*), bullhead (*Cottus gobio*) and possibly thin-lipped grey mullet (*Liza namada*). The bones were generally in good condition and represented the natural death assemblage of small fish inhabiting fresh water.

The eel remains included many small individuals, which might have been elvers migrating upstream from the sea during the late winter to spring. Two salmonid caudal vertebrae and a fragment of operculum were identified from the underside (outboard) of the boat. The vertebrae were from an individual of approximately 40cm in length and were the largest fish bones from the entire assemblage. Nevertheless, it was not possible to distinguish between salmon (*Salmo salar*) and brown trout (*Salmo trutta*) on morphological grounds, but on the evidence of current distribution this specimen is more likely to be the latter. Of the stickleback bones, those with distinctive features were closest to the three-spined stickleback (*Gasterosteus aculeatus*). The bullhead is a wholly freshwater species and is a bottom-living fish, hiding among stones and among weeds, and usually preferring a fast current and a stony bottom. A single, small precaudal vertebra has been very tentatively attributed to the thin-lipped grey mullet, a marine, shallow-water fish that will enter fresh water but could have entered this deposit as the remains of the meal of a seabird.

The rest of the vertebrate remains (Stewart 1998) comprised forty-five large mammal bones that were retrieved by hand during the excavation of the boat, and bones from sieved bulk samples. The large mammal bones were found in sediments immediately above and below the boat and inside the boat itself. Only a small number of bones came from the bulk samples, including those of a slow worm (*Anguis fragilis*), some frog or toad (*Rana* sp./*Bufo* sp.), a mouse (*Mus musculus*/*Apodemus sylvaticus*) that could not be identified to species, and a passerine bird. The large mammals comprised cattle, sheep/goat, pig,

red deer and dog. The amphibian remains (frog/toad) are not out of place in a fluvial deposit, but the slow worm is not aquatic and its remains must have been introduced into the river sediment. Similarly, the small mammals are likely to have been introduced into the sediment as a result of bank collapse or seasonal flooding.

Four of the large mammal bones showed signs of cut marks, one of which belonged to a sheep, while the others belonged to cattle. They were:

- *Bos taurus*, right scapula, showing marks from disarticulation of the scapula from the humerus and a second set of filleting marks, removing muscle from the scapula;
- *Bos taurus*, proximal left metatarsus, with cut marks around the circumference of the bone that appear to be the result of skinning the carcass;
- *Bos taurus*, distal right humerus, with cut marks on the medial side of the condyle appearing to represent the disarticulation of the humerus from the radius and ulna; and
- *Ovis aries*, distal left humerus, with possible cut marks on the trochlea that might have been made during the disjuncting of the humerus from the radius and ulna.

In addition to the cut marks, there were clear signs of water wear on three specimens, gnawing by carnivores on three (possibly four) specimens, marks that could be attributable to trampling or similar mechanical processes on two specimens, and evidence of weathering on nine (possibly thirteen) specimens. These marks signify that some bones were subject to a delay between death or disposal by man and eventual burial (the gnawing, trampling and weathering) and that others spent a relatively long period in the river prior to burial (the water wear).

The large mammal bones are mostly domesticated species, suggesting the presence of people in the area at the time of boat abandonment. As animal bones and human artefacts were only found immediately above, in and below the boat, it seems reasonable to suggest that habitation lay nearby, as some of the bones showed signs of being fresh and possessed cut marks, which ties in with evidence from the plant macrofossil analysis and the finds evidence (Chapter 11).

Summary

The environmental investigations described here have allowed us to address most of the questions originally posed in the introduction. It seems most likely that the boat was used in the sea, as the lower reaches of the Dour valley would hardly have been navigable at the time, although it is not possible to say how far away the sea was. This, and other general information about the Dour estuary, should emerge from study of the samples from the Dover A20 road and sewer scheme and more recent excavations in Dover. It is still not clear why the boat was abandoned where it was in the Dour valley, although some effort was evidently involved in getting it to its final resting place in a backwater area of the river, as the braided channels were shallow and probably quite narrow. It might even have been carried or dragged across the banks and shoals. The sea was probably at a mean level of 2m to 5m below the level at which the boat was emplaced. The edges of the channel system had steep banks and there might have been a main river channel as well as the braided channels, although its location and width are not known for certain. It appears, however, that, not long before the boat was abandoned, and then some time after it was covered by the tufa/silts, sands and gravels, a river channel passed through this area of the valley, first eroding the surface of the peat and later the tufa/silts overlying the boat. The boat was abandoned in freshwater, perhaps infrequently affected by very high tides, and there might have been a protective sand/shingle barrier across the mouth of the Dour at the time.

There seems to have been a settlement nearby at the time the boat was abandoned and the people appear to have been grazing animals on the valley floor, with arable agriculture further afield that resulted in considerable soil erosion and alluviation. Trees seem to have been sparse and it is unlikely that suitable timber for boatbuilding was available nearby, although there might have been wood for small repair work. There is no evidence for yew but this is not surprising as it rarely survives in the environmental record. The preservation of the boat was the result of rapid sediment deposition following its abandonment, probably caused by extensive soil erosion in the river catchment. We do not know how long this took, but it is likely to have been a matter of a few years rather than decades.