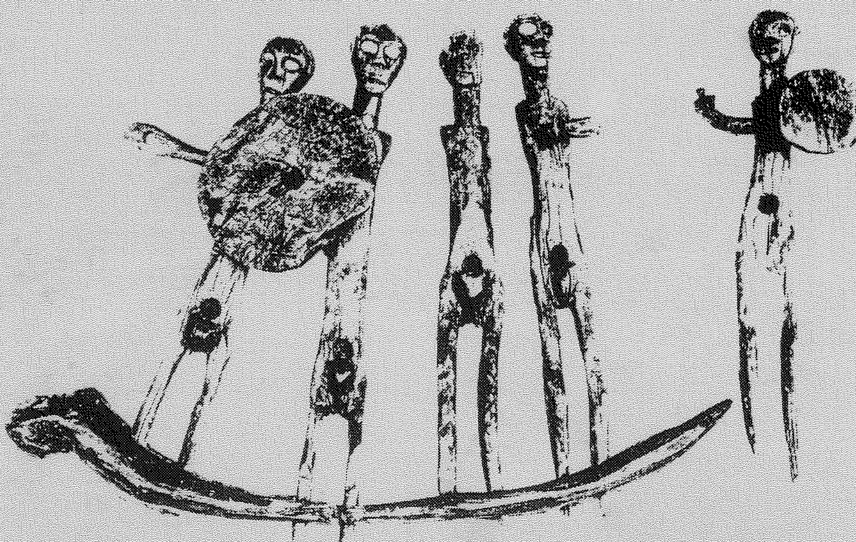
EAST YORKSHIRE

Field Guide

Edited by S. Ellis

Quaternary Research Association



1987

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Prepared to accompany the Short Field
Meeting held at Hull,
11-14 September 1987.

Quaternary Research Association
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Cover illustration: The Roos Carr Images, wooden idols c. 45 cm tall and probably all originally armed with shields on their left arms and clubs or other weapons in their right hands. They are made of Scots Pine, with eyes of hard limestone or quartzite pebbles. They were discovered in the wetlands between Roos and Halsham in 1836 beneath a reported 2 m of blue clay, and were originally attributed to the Viking period, although they were subsequently ascribed to the Late Bronze Age by T. Sheppard (1901), the first curator of Hull Municipal Museums.
Photograph by B. Fisher from an original by courtesy of Hull Museums and Art Galleries.

Acknowledgements: The editor is grateful to Pergamon Press for allowing the reproduction of Figures 3 and 6 (from Edwards, 1981), and to the Yorkshire Geological Society for allowing the reproduction of Figures 17 and 25 (from Catt and Penny, 1966). Sincere thanks are also due to John Catt for his valuable comments on many of the edited manuscripts. Brian Fisher, Keith Scurr and Mark Daddy have kindly assisted with the preparation of illustrative material and Stella Rhind typed the final version of the text.

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QUATERNARY RESEARCH ASSOCIATION

SHORT FIELD MEETING

September 11-14, 1987

EAST YORKSHIRE

FIELD GUIDE

EDITED AND COMPILED BY S. ELLIS

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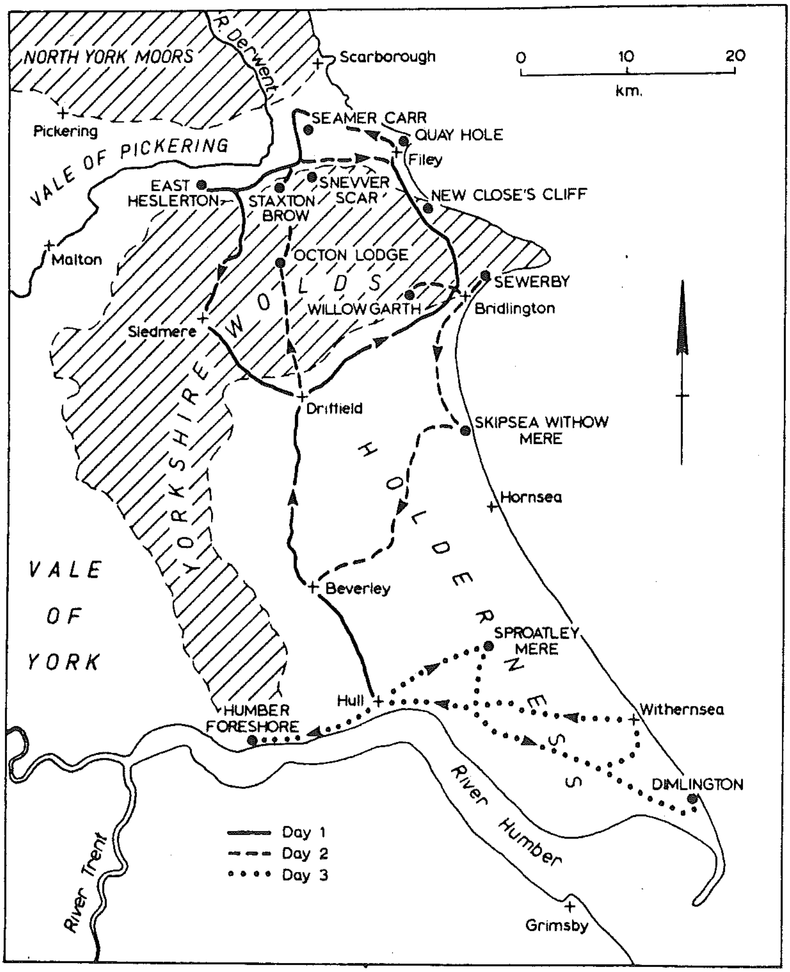

Figure 1. Field site locations and excursion routes.

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SITE ACCESS

Although the coastal sections all have free access, the following points should be noted with regard to the inland sites:

Seamer, Star and Flixton Carrs

These sites are on private farmland to which access is both restricted and discouraged. Good views of the sites may, however, be obtained from the scarp slope of the Wolds.

East Heslerton

Permission should be sought from the quarry owners: R. Cook & Son, The Sand Quarry, West Heslerton, North Yorkshire.

Octon Lodge, Staxton Brow and Snevver Scar

These sites are all on private farmland, but Octon Lodge and Snevver Scar can be viewed adequately from the roadside and Staxton Brow from the adjacent car park.

Willow Garth

This is a S.S.S.I. It is privately owned and on no account should it be visited without obtaining permission from: The Yorkshire Wildlife Trust, 10 Toft Green, York, YO1 1JT.

Holderness meres

Many of the former meres (including Sproatley Mere) are on private farmland, and the quality of sections varies according to the type and frequency of drainage activities. However, of those meres to which public access is available, Skipsea Withow Mere has constantly exposed sections as a result of coastal erosion, and Skipsea Bail Mere is the most interesting topographically.

THE QUATERNARY OF EAST YORKSHIRE AND ADJACENT AREAS

J. A. Catt

HISTORY OF RESEARCH

East Yorkshire, previously divided into the East Riding and eastern part of the North Riding, but now further fragmented into parts of the new counties of Humberside, North Yorkshire and Cleveland, has been a classic area for Quaternary studies since the 1820s (Buckland, 1822; Sedgwick, 1826; Phillips, 1827, 1829; Vernon Harcourt, 1829). John Phillips, who was a nephew of William Smith and often referred to affectionately as 'the father of Yorkshire geology', was probably the first British geologist to realise that the direction of 'diluvial currents' responsible for depositing clays like those on the Yorkshire coast could be determined from the sources of erratics found in the clays.

Stratigraphic investigations were begun by Wood and Rome (1868), who identified three boulder clays in Holderness, the Basement, Purple and Hessle (in ascending order). This subdivision formed the basis for all subsequent work, and the first of these names is still in use today, though with a slightly different meaning. Table 1 summarises the rather confusing changes in nomenclature of the Holderness glacial sequence since 1868.

The initial geological survey of the area by Reid, Dakyns and Fox-Strangways resulted in the publication in the 1880s of 1:63360 'Drift' sheets covering almost the whole area plus accompanying memoirs, notably by Reid (1885) and Dakyns (1886). It also stimulated great interest in the Quaternary among local naturalists and amateur geologists, and this continues even today within several local societies, such as the Yorkshire and Hull Geological Societies. Perhaps the most illustrious local amateur was G.W. Lamplugh, who lived for many years at Bridlington and recorded important sections nearby, many of which are now obscured (Lamplugh, 1878, 1879, 1881a, 1881b, 1881c, 1882, 1884, 1887, 1890, 1891a, 1892, 1903 and many other papers); he joined the Geological Survey in 1892 and eventually became Assistant Director. Other important early contributions were made by Sheppard (Curator of Hull Museums), Mortimer, whose descriptions of the drift deposits of the Yorkshire Wolds were based mainly on his excavations of numerous burial mounds (Mortimer, 1905), Stather, Harker, Kendall, Crofts and Raistrick. Between 1895 and 1938 Sheppard alone published almost 200 papers on the Quaternary of the East Riding.

Perhaps the most detailed and careful stratigraphic work was by the civil engineer and amateur Yorkshire geologist W.S. Bisat (1932, 1939, 1940), who used erratic suites and till matrix colours to distinguish numerous subdivisions of the coastal tills (Catt and Madgett, 1981). Long before the Munsell colour charts were invented, Bisat was aware of the need to standardise the colour descriptions of sediments, and used the chart of the British Colour Council, as adopted by the West Riding woollen trade. The names 'Drab' and 'Purple' (Table 1) probably originated in this way. Bisat was also the first to recognise silts with moss remains between the Basement and Drab Tills at Dimlington (Bisat and Dell, 1941; Bisat, 1948); these were subsequently ^{14}C-

Table 1. Changes in nomenclature of Holderness boulder clays since 1868.

Wood and Rome 1868	*Lamplugh* 1881b	*Reid* 1885	*Stather* 1929	*Raistrick* 1929	*Bisat* 1932	*Bisat* 1939	*Carruthers* 1948	*Bisat* 1954	*Catt and Penny* 1966	*Madgett and Catt* 1978
Hessle	Hessle	Hessle	Hessle	Hessle	Upper Hessle (inland)	Hessle (inland)	Hessle		Hessle	Holocene soil on Withernsea or Skipsea Till
					Lower Hessle (coast)	Upper Purple (coast)				
Purple	Upper Purple	Upper Purple	Purple or Middle Series	Purple	Purple	Lower Purple	Purple		Purple	Withernsea Till
Basement	Lower Purple	Lower Purple		Upper Basement	Drab and Grey	Drab	Till with Rafts		Drab	Skipsea Till
	Basement	Basement	Basement	Lower Basement	Basement	Basement		Basement	Basement Series (Basement Till plus rafts of Bridlington Crag)	Basement Till (with rafts of Bridlington Crag)
						Sub-Basement		Sub-Basement		
							Under Till	Under-till		

dated by Penny et al. (1969), the dates showing that the Late Devensian glacier deposited the Skipsea (=Drab) and Withernsea (=Purple) Tills in Holderness after 18000 B.P. (Table 2).

In the 1880s Reid (1885, p.48) and later Lamplugh (1887, 1890) excavated an important part of the cliff section at Sewerby near Bridlington, which exposes beach and other deposits associated with a cliff buried beneath the Skipsea Till. The buried beach was found to rest on chalk at approximately 2 m O.D., and the cliff was consequently referred to as 'preglacial'. However, Catt and Penny (1966) suggested that the associated vertebrate fauna is Ipswichian in age. They also discovered a calcreted equivalent of the beach deposit resting on weathered Basement Till a short distance seaward of the cliff. The Basement is therefore pre-Ipswichian in age (Table 2).

The uppermost member of the till sequence has been recognised by most workers as the Hessle Clay, named after a site near Hessle on the north bank of the Humber west of the Hull, which exposes reddish brown weathered till over Chalk. Wood and Rome (1868) stated that the Hessle Clay lies 'like a cloth' over the whole of Holderness and Lincolnshire, but in Holderness Bisat (1932) used erratics to distinguish the Hessle exposed on the coast (e.g. at Dimlington) from that inland (e.g. at Hessle itself). Madgett and Catt (1978) resolved this by showing from petrographic studies that the Hessle is actually a deeply oxidised soil formed during the Holocene on whichever of the two Late Devensian tills occurs at the surface. The Withernsea Till overlies Skipsea Till on the southeast Holderness coast, but extends inland no more than 10 km (Figure 2); elsewhere in Holderness the Skipsea is the uppermost till, and this extends through Lincolnshire to north Norfolk, where it has been termed the Hunstanton Brown Boulder Clay.

The irregular surface of the Devensian glacial deposits resulted in the formation of numerous lakes (meres), which attracted early man in the late Glacial and Holocene. The mere deposits have provided much palaeontological evidence for environmental changes since the ice disappeared, and also controversial evidence for human activities since the late Palaeolithic. For example, in 1902 B. Morfitt discovered a barbed bone point or harpoon in the basal deposits of Skipsea Withow Mere. This later became the subject of an acrimonious debate between Sheppard and Armstrong of Sheffield. Two scientific committees were appointed to verify its authenticity, and Armstrong later encouraged Harry and Margaret Godwin to date the horizon from which it came by the then novel technique of pollen analysis. Godwin and Godwin (1933) suggested that the harpoon was at least as old as pollen zone IV, and a recent detailed study of the site (Gilbertson, 1984) has shown, among many other things, that the harpoon horizon was deposited between 10000 and 10450 B.P. Early Mesolithic activities, including manufacture of barbed points, were also documented in the Vale of Pickering by the systematic excavations of Moore (1950) and Clark (1954).

In the last 20 years there have been several important studies of the late Glacial and Holocene vegetational history by Flenley, Beckett, Jones and others, often combined with archaeological investigations as at Skipsea Withow Mere (Gilbertson, 1984). The glacial and periglacial sequences of certain areas have also been restudied by Straw

Table 2. Main Quaternary deposits in East Yorkshire and nearby areas.

	Oceanic Stages	Lincolnshire	Holderness and Wolds	Vale of York	Filey Bay, Vale of Pickering
Holocene	1	Alluvium Peat	Warp Alluvium Peat Mere deposits	Warp Alluvium Peat	Alluvium Peat Mere deposits
Devensian: Loch Lomond Stadial Dimlington Stadial	2	Coversands Marsh Till	Coversands Mere deposits Withernsea Till Skipsea Till Dimlington moss silts Loess	Coversands Upper periglacial surface Lake Humber deposits York-Escrick advance Surge to Doncaster High-level Lake Humber ?Lower periglacial surface	Coversands Sherburn Sands Upper Till Lower Till
Devensian: Middle	3	Kirkby-on-Bain Tattershall		Oxbow	
Devensian: Early	4				
Devensian: Early	5a to 5d		Sewerby blown sand		
Ipswichian	5e	Tattershall	Sewerby beach	Wortley Armthorpe Austerfield Finningley Langham Older river gravel	Kirkdale Cave
Wolstonian	6	Welton Till	Basement Till (with shelly rafts)	Bielsbeck	Basement Till
	7				
	8				
Hoxnian	9	Kirmington			Speeton Shell Bed
Anglian	10 or 12	?Wragby, Calcethorpe and other tills	?Gravels and quartzite pebbles on Wolds	?Older till at Balby, Brayton Barff, etc.	

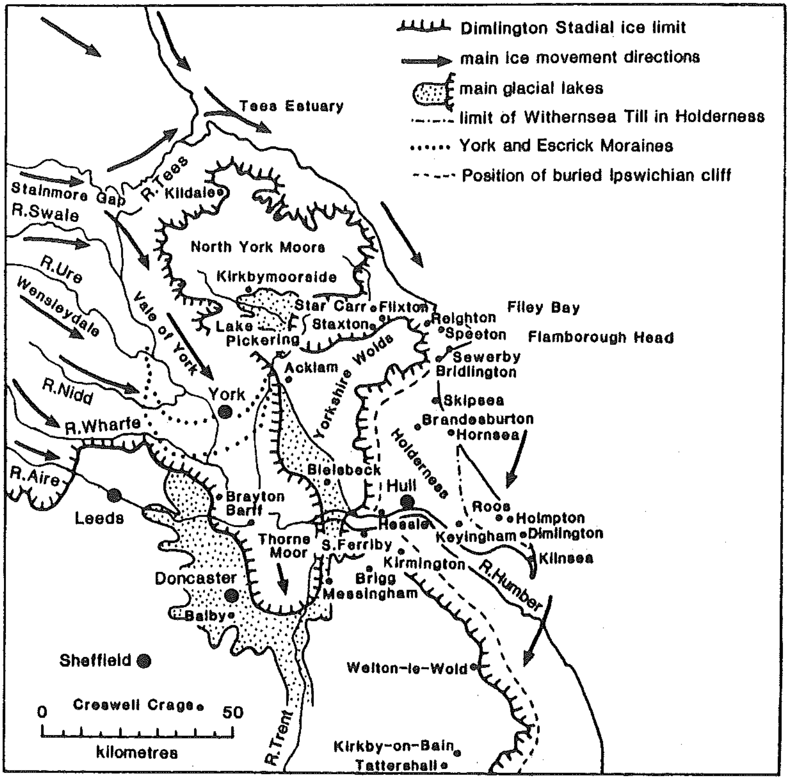

Figure 2. Devensian glacial features of East Yorkshire and nearby areas and localities mentioned in the text.

(1969), Edwards (1978), Gaunt (1981), Buckland (1982) and Foster (1985). The Soil Survey of England and Wales has recently mapped some areas in detail (e.g. Furness, 1985), and a geological resurvey of parts of the Vale of York and Humberside has been in progress for several years.

PRE-IPSWICHIAN DEPOSITS

The main pre-Ipswichian deposit in Humberside and east Yorkshire is the Basement Till, which is exposed sporadically beneath the Skipsea Till on various parts of the coast between Kilnsea and Holmpton, at Bridlington (Lamplugh, 1881c, 1882) and Sewerby, locally on Flamborough Head (Lamplugh, 1891a, 1892) and near Reighton in Filey Bay (Lamplugh, 1879). A lithologically similar till, known as the Welton Till, occurs at Welton-le-Wold near Louth, Lincolnshire (Alabaster and Straw, 1976), where it overlies gravels containing Lower Palaeolithic arte-facts and derived Hoxnian mammal remains. Assuming the Welton Till is equivalent to the Basement Till beneath the Ipswichian beach deposit at Sewerby, this places the till firmly in the Wolstonian Stage. However, no equivalent of the Basement Till is known offshore (Cameron et al., 1987), either because it was removed by Ipswichian marine erosion or because the till was deposited by a coastal glacier which moved southwards in the western part of the North Sea basin, and, like the late Devensian ice sheet, invaded the various coastal embayments.

The patchy coastal occurrence of the Basement Till is probably the result of Ipswichian erosion. The Ipswichian sea would have planed the surface of the till down to a maximum height of 2 m O.D. (the height of the interglacial beach at Sewerby), so it is somewhat surprising that the surface of the Basement rises to approximately 6 m O.D. at Dimlington, which is 20-30 km seaward of the Ipswichian cliff. However, a structural study of the Basement Till at Dimlington by Penny and Catt (1967) showed that it was extensively modified after deposition by a NNE-SSW compressive force. This is the same direction as the late Devensian ice advance, so it is likely that the surface of the Basement here was uplifted and contorted as part of a Devensian push-moraine, which was subsequently over-ridden by the Devensian glacier.

At Reighton a thin layer of Basement Till is separated from the Lower Cretaceous bedrock (Speeton Clay) by a shelly estuarine deposit termed the Speeton Shell Bed (Lamplugh, 1881a; Versey, 1938). Catt and Penny (1966) suggested that this bed is Hoxnian in age. According to West (1969), it contains Ipswichian pollen, but recent analyses by Flenley (unpublished) indicate closer affinities with Hoxnian pollen assemblages. Fold patterns in the shell bed and underlying Speeton Clay suggest that the bed was ice-rafted to its present position in the Wolstonian. The overlying Basement Till also may have been emplaced as a raft by the late Devensian glacier.

Other older drift deposits in Humberside, Yorkshire and Lincolnshire are much less clearly dated (Table 2) and often have obscure strati-graphic relationships to other deposits; some also have uncertain origins. The Calcethorpe, Belmont and Wragby Tills of the Lincoln-shire Wolds and areas immediately west have been attributed to both the Wolstonian (Straw, 1969) and the Anglian cold stages (Perrin et al., 1979). The northernmost outcrop of the Wragby Till is near Brigg, south Humberside (Straw, 1969, Figure 3), and at Kirmington (12 km east of Brigg) a British Association borehole (Stather, 1905) showed that interglacial deposits containing Hoxnian pollen assemblages (Watts, 1959) rest upon a lead-coloured clay resembling the Wragby Till. This suggests that at least the Wragby Till is Anglian rather than Wolstonian, but it is also possible that similar tills of two different ages occur in south Humberside and north Lincolnshire. At Welton-le-Wold Calcethorpe Till overlies the Welton Till, but it has probably been soliflucted downslope from higher levels on the Lincolnshire Wolds.

No equivalents of the Calcethorpe, Wragby or Belmont Tills occur north of the Humber. However, scattered quartzite pebbles and patches of sand or gravel with far-travelled erratics suggest that higher parts of the Yorkshire Wolds and North York Moors above the Devensian till margin were glaciated at some stage before the Devensian. Also patches of weathered till with Carboniferous and Permian erratics occurring at high levels further west in the Vale of York (e.g. at Balby and Brayton Barff) are thought to be pre-Ipswichian (Gaunt, 1981). However, neither these till patches nor the gravels on the Wolds and Moors can be dated as precisely as the Basement Till. The erratics on the Wolds have, for example, been attributed to cold periods ranging from the Baventian (Catt, 1982) to the Late Devensian (Foster, 1985).

Other deposits on the Yorkshire Wolds are of even less certain age and origin. The small patches of yellowish red Clay-with-flints occurring near Staxton and Acklam are probably old subsoil accumulations of illuvial clay, which invaded voids created by dissolution of chalk beneath a cover of loamy deposits. Matthews (1977) suggested that the loams, since removed by erosion, were either Tertiary sediments or pre-Devensian glacial deposits, but there are other possibilities, such as pre-Devensian aeolian sediments.

Borehole evidence from southeast Holderness (Lamplugh, 1919; Catt and Digby, in press) shows that the Basement Till extends down almost to the chalk bedrock surface at -30 to -35 m O.D. Consequently there is at present no direct evidence in Holderness for any glaciation older than the Wolstonian advance which deposited the Basement.

At Dimlington (Reid, 1885) and Bridlington (Lamplugh, 1878, 1884) the Basement Till contains rafts of shelly grey clay (Bisat's Sub-Basement Clay) and green glauconitic sand (the Bridlington Crag) respectively. These could have been torn from the floor of the North Sea by the Wolstonian glacier, or incorporated into the Basement when it was disturbed by the late Devensian glacier. The fauna is colder in aspect than any from the East Anglian Crags and therefore likely to be younger. Catt and Penny (1966) suggested a late Hoxnian age, but pollen and dinoflagellates from Bridlington suggest that at least part of the crag there is as old as Pastonian (Reid and Downie, 1973). Obviously the rafts might include mixed material of any age up to Late Devensian. At Dimlington the grey clay also contains erratics of igneous and metamorphic rocks, probably from Scotland and Scandinavia; the assemblage is more restricted than those in any of the Holderness tills, and probably consists mainly of stones dropped into the marine sediment from far-travelled floating ice before the sediment was incorporated into the Basement Till.

THE IPSWICHIAN INTERGLACIAL

Deposits assigned to the Ipswichian from various lines of evidence occur at several sites in and near east Yorkshire. They include the marine beach, best exposed at Sewerby near Bridlington but extending continuously along the eastern side of the Yorkshire and Lincolnshire Wolds, cave deposits at Kirkdale Cave near Kirkbymoorside (Buckland, 1822; Boylan, 1967a, 1972), and fluvial or marsh deposits at Langham, Armthorpe, Austerfield and Finningley in the Vale of York (Gaunt et al., 1972, 1974) and at Tattershall in south Lincolnshire. Palaeosol features, such as red mottles and clayey weathering of feldspathic Mesozoic sandstones in soils outside the Devensian ice limit on the North York Moors, have also been tentatively attributed to Ipswichian pedogenesis (Bullock et al., 1973).

The evidence at Sewerby for an Ipswichian maximum sea level little higher than present is supported by the fluvial and marsh sites in the Vale of York. At Langham and Tattershall, IpIIb deposits occur as low as -12 m O.D., but a base level close to O.D. in IpIII is indicated by deposits of a marshbound lake at 4 m O.D. over permeable substrata at Austerfield and by estuarine deposits at a similar level at Armthorpe. The Ipswichian age for the beach at Sewerby is indicated by the mammalian assemblage reported by Lamplugh (1890a), which was re-examined by Boylan (1967b). This includes *Palaeoloxodon antiquus*, *Didermocerus hemitoechus* and *Hippopotamus amphibius*, which are found together at several British Ipswichian sites, including Victoria Cave near Settle in northwest Yorkshire, where an age of 120000 yr (oceanic isotope stage 5e) or older is indicated by $^{230}Th/^{234}U$ dating of flowstones around the bones (Gascoyne et al., 1981). A typical Ipswichian (stage 5e) assemblage also occurs at Kirkdale Cave, which like Victoria Cave was probably a hyaena den, as many remains of cave hyaena (*Crocuta crocuta spelaea*) and gnawed bones were found there.

As *Hippopotamus* is known only from Ipswichian and Cromerian sites in Britain, the low terrace of the River Aire at Wortley near Leeds, which yielded *Hippopotamus* in the nineteenth century (Denny, 1854), is also likely to be Ipswichian. However, another site in the Vale of York with *P. antiquus* and *D. hemitoechus*, at Bielsbeck near Market Weighton, yielded no *Hippopotamus* (Vernon Harcourt, 1829; Stather, 1910; De Boer et al., 1958). Instead there were abundant horse remains, which are rare or absent from sites with *Hippopotamus*. In southern England and the south Midlands mammalian assemblages with *P. antiquus*, *D. hemitoechus* and horse, but lacking *Hippopotamus*, are associated with a pre-Ipswichian but post-Hoxnian interglacial dated to 140000-170000 yr ago at Marsworth (Green et al., 1984). It is therefore likely that the Bielsbeck assemblage dates from this earlier interglacial, which is probably equivalent to a mild episode within oceanic cold stage 6 (Table 2).

At Sewerby the eustatic rise of sea level in IpII led to formation of a platform transgressing a feather edge of Basement Till onto a shore and cliff incised in Upper Chalk. Following deposition of a beach shingle composed of rounded chalk pebbles with a few flints and derived erratics, the sea receded and the shingle and cliff face were covered by chalky colluvium with terrestrial molluscs. This deposit is in turn overlain by blown sand, which polished upper parts of the cliff face. The sand contains several members of the interglacial fauna, though not *Hippopotamus*. This was previously thought to indicate that the sand accumulated in a drier period late in the Ipswichian (Boylan, 1967b), but if the beach (with Hippopotamus) was formed in oceanic stage 5e, the colluvium and blown sand could have been deposited in 5d-5a.

THE DEVENSIAN COLD STAGE

Little is known about the Early and Middle Devensian (oceanic stages 4 and 3) in the area. At Sewerby the blown sand is overlain by a chalky solifluction deposit, which is probably Late Devensian (stage 2), because it contains loess similar in mineralogical composition to the Late Devensian Skipsea Till (Catt *et al.*, 1974). At Dimlington and other sites where the Basement Till is exposed, it is also directly overlain by Late Devensian deposits. However, in areas outside the Late Devensian ice limit, such as southeast Lincolnshire and the Vale of York, there is a little evidence for Early and Middle Devensian events. At Tattershall and Kirkby-on-Bain (south Lincolnshire), frost-disturbed fluvial sands and gravels overlying an Ipswichian peat contain bones of reindeer and bison and organic lenses with ^{14}C dates ranging from 34800 ± 1000 B.P. (Birm-250) at Kirkby-on-Bain to 44300 $\pm^{1600}_{1300}$ B.P. (Birm-408) at Tattershall. Beetle assemblages from dated lenses at two levels in the Tattershall sequence indicate a rapid climatic amelioration between 44000 and 43000 B.P. leading to the Upton Warren Interstadial (Girling, 1974). The later organic lens at Kirkby-on-Bain was deposited during a more stable cold phase, and has a beetle assemblage similar to other fluvial sites of about the same period, such as the Oxbow opencast coal site in the Aire Valley near Leeds (Gaunt *et al.*, 1970).

In the Vale of York a lower periglacial land surface, occurring on the Ipswichian 'Older River Gravel' and older deposits, but underlying Late Devensian glacial and glaciolacustrine sediments, could be Early, Middle or early Late Devensian. It is marked by deep ice-wedge casts and possible thermokarst features (Gaunt, 1981) as well as by a widespread ventifact horizon (Bisat, 1946; Gaunt, 1970, 1974, 1981).

The most important Devensian event in east Yorkshire and Lincolnshire was the glacial advance of the Dimlington Stadial (Rose, 1985), between 18000 and 13000 B.P. Before the ice actually arrived, a thin layer of loess was deposited over much of the area; this was probably derived from proglacial outwash deposits in the North Sea basin (Catt *et al.*, 1974). At the same time, exposed chalk surfaces were affected by frost action, and on the Wolds the loess was incorporated into a head or gelifluction deposit composed mainly of frost-shattered chalk and flint. Wintle and Catt (1985) obtained a thermoluminescence date of 17.5 ± 1.6 x 10^3 yr for this deposit at Eppleworth. At Sewerby the head deposit contains molluscs indicating a moderately severe periglacial climate (Lamplugh, 1903), and at Hessle, where the deposit again overlies the Ipswichian beach deposits, it has yielded reindeer, red deer and abundant horse remains (Boylan, 1967b). Where it was unprotected by the later till cover, the head was decalcified in the Holocene to produce the thin flinty, silty soils widespread on higher parts of the Wolds (Catt *et al.*, 1974).

Shortly before the ice reached southern Holderness, silts accumulated in a shallow freshwater lake at Dimlington. Remains of an arctic moss from these deposits gave the ^{14}C dates which show that the ice arrived there as late as 18000 B.P. (Penny et al., 1969); beetles indicate an extremely harsh climate and little vegetation other than aquatic plants in the lake. The silts pass up by alternation into windblown sands, indicating progressive desiccation of the lake. Both deposits were subsequently disturbed and folded by the Late Devensian glacier. As the surface of the Basement Till beneath the silts was lifted during formation of the push-moraine, the single basin in which the silts had accumulated was folded and divided into a series of small glacio-tectonic basins, which were truncated and further contorted when the ice overrode the push-moraine.

Figure 2 shows the Late Devensian ice limit and directions of ice movement. In the northern part of the Vale of York a single till was deposited by ice that had principally come from northwest England via the Stainmore Gap, though confluent valley glaciers emerging from Swaledale, Wensleydale, Nidderdale and Wharfedale brought small contributions of essentially Carboniferous material from Pennine areas. A similar valley glacier occupied upper Airedale, but terminated northwest of Leeds before reaching the Vale of York. Originally the Vale of York glacier was thought to have terminated at the Escrick Moraine, an arcuate ridge marking the till limit, but Gaunt (1976) showed that gravels rich in Carboniferous and Permian erratics overlie the lower periglacial land surface as far south as Wroot, near Doncaster; he suggested that these were deposited by an initial surge of ice into the waters of Lake Humber, a proglacial lake impounded by the ice to the north, by higher ground to the south and east, and by coastal ice blocking the Humber Gap (Figure 2).

On the east coast from the Tees Estuary southwards there are two Late Devensian tills, the Skipsea Till below and the Withernsea Till above. The Skipsea Till overlies the Ipswichian deposits at Sewerby and the ^{14}C-dated silts at Dimlington, and extends inland further than the Withernsea Till (Figure 2). In Holderness these two tills are distinguished from each other and from the Basement Till by consistent differences of matrix colour, carbonate content, particle size distribution, coarse silt mineralogy, fine sand mineralogy and composition of 6-16 mm stones (Madgett and Catt, 1978). These lithological characteristics show that only one Late Devensian till (the Skipsea) occurs in western Holderness, Lincolnshire and north Norfolk, despite the conclusion of Straw (1969) that there are two 'Marsh Tills' (an Early Devensian and a Late Devensian) in Lincolnshire. However, there is a progressive southward increase of chalk and flint in the Skipsea Till, presumably resulting from incorporation of glacially eroded bedrock material. In contrast, the amounts of chalk + flint in the Withernsea Till decrease southwards along the Holderness coast, suggesting that these constituents came from a single point source to the north. Devensian till (mainly Withernsea Till) extends as a lobe across the floor of the North Sea as far east as 3°E and southwards to approximately 53°N; there was no connection with the Scandinavian ice (Cameron et al., 1987).

Carruthers (1953) suggested that all the coastal tills of east Yorkshire were deposited by melting in situ of a single multi-tiered ice sheet, which originated by valley glaciers from the Tyne and Tees valleys overriding Scandinavian ice off the east coast. In its entirety this theory is untenable, because we now know that the Basement Till was deposited by a much earlier advance than the Devensian tills. However, Madgett and Catt (1978) and Edwards (1981) retained the concept of a two-tiered glacier for deposition of the Skipsea and Withernsea Tills and their equivalents in Filey Bay, because it explains the following:

(a) The lack of a weathered horizon between the two Devensian tills.

(b) The short period of time (5000 yr or less) available for two completely separate ice advances from the Tees southwards.

(c) Where Skipsea Till is locally incorporated into the base of the Withernsea Till, it is along low-angle shear planes at sites where bedrock obstructions retarded basal ice movement; as the shear planes extend from the lower till into the upper, the ice from which both were deposited was present when the deformation occurred.

(d) The British Devensian ice sheet model of Boulton et al. (1977), based on known ice thicknesses and gradients, fails to explain why ice extended south of the Tees Estuary, unless there was some instability and surging. Overriding of coastal ice from southern Scotland and Northumberland (which eventually deposited Skipsea Till) by a Tees valley ice stream (which deposited the Withernsea Till) could have caused this instability, as the additional weight would have increased basal melting, thus lubricating the postulated surge lobe.

(e) The existence of a high level (33 m O.D.) Lake Humber, which is dated to 21835 ± 1600 B.P. or later (Gaunt, 1974), depended upon the presence of ice in both the Humber Gap and the northern part of the Vale of York. The ice in the Humber Gap deposited Skipsea Till, whereas that in the Vale of York was part of the same Stainmore ice stream which deposited the Withernsea Till (Figure 2), so the two tills were deposited almost contemporaneously.

The early 33 m level of Lake Humber produced only thin patches of sand and gravel and was probably short-lived, its level perhaps being determined by the waterproof ice dam in the Humber Gap (Gaunt, 1981). At a lower (8 m O.D.) level, possibly determined after the ice had melted by the height of a morainic ridge crossing the Humber Gap between North Ferriby and South Ferriby, the lake persisted for much longer, and resulted in the accumulation of up to 20 m of laminated clays overlying the older periglacial land surface. A minimum age for disappearance of the lake is provided by the ^{14}C date of 11100 ± 200 B.P. for a buried soil formed on the surface of the laminated '25-foot drift' at West Moor near Doncaster (Gaunt et al., 1971).

In addition to Lake Humber, many other lakes were impounded by the coastal ice in eastward draining valleys (Kendall, 1902). The largest of these was Lake Pickering in the western end of the Vale of Pickering (Figure 2), though Edwards (1978) and Foster (1985) have shown that ice penetrated much further into this depression than Kendall thought, and that the lake was correspondingly smaller. Foster's evidence consisted partly of outwash deposits (the Sherburn Sands) extending along the southern side of the Vale and also on the Wolds in Warren Slack and Cotton Dale, and of glacial drainage channels on the northern Wolds escarpment. He suggested that the ice surmounted much of the northern escarpment and spread some distance down the dipslope, but never completely covered the whole of the eastern Wolds.

Other bodies of Devensian glaciofluvial sands and gravels are common throughout the region. In Holderness the largest overlie the Skipsea Till and often seem to have been deposited by outwash streams emerging approximately from the boundary between the two tiers of the Devensian ice sheet. The most interesting of these gravels, though by no means the largest, are the Kelsey Hill Gravels near Keyingham in southern Holderness, which have yielded a very rich, but mixed and derived assemblage of molluscs and vertebrates (Catt and Penny, 1966).

The earliest dates indicating that coastal areas had become free of ice are 13042 ± 140 B.P. (Jones, 1976) and 13045 ± 270 B.P. (Beckett, 1981). Jones (1977) obtained the much earlier ^{14}C date of 16713 ± 340 B.P. for moss from the base of a kettle hole at Kildale in Cleveland, but this may include a hardwater error, and the site could have emerged from between stagnant ice lobes on the valley floor long before a major climatic improvement made the whole region ice-free.

Several workers (e.g. Valentin, 1957; Straw, 1969) have drawn attention to topographic differences within those parts of eastern England covered by the Devensian tills; for example, in Holderness constructional features characteristic of 'young morainic topography' (morainic ridges parallel to the ice margin, mounds, kettle-holes and eskers) are more evident in the east than the west. This has often been interpreted as indicating two or more separate ice advances during the Devensian, or even that some areas were not invaded at all in the Devensian. However, there is no stratigraphic support for repeated advances with erosive episodes between; even the margin of the Withernsea Till in southeast Holderness does not coincide with any morainic ridge or change in the topography. To some extent the weaker relief in western Holderness resulted from extensive Holocene flooding along the Humber and Hull Valleys and deposition of alluvium and peat in low-lying areas. Other differences can be attributed to natural variation in the surface relief of deposits left by a single Late Devensian ice advance.

Once Lake Humber was dry, streams developed courses across its floor towards the present River Humber. These did not incise into the lake deposits but built up sandy levees. This indication of a high base level, despite a sea level that must have been much lower than present, suggests that the knickpoint of the Humber had not yet moved back from the coast into the Vale of York (Gaunt, 1981). Levee formation was soon followed by extensive deposition of coversands in the Loch Lomond Stadial (approximately 11000-10200 B.P.). These sands often form low dunes (Matthews, 1970), and have yielded insect remains indicating very cold, dry conditions (Buckland, 1982). Localised aeolian reworking of outwash sands may also have occurred at this time in central Holderness (Furness, 1985) and the Vale of Pickering (Foster, 1985). Some sand was perhaps deposited on the northeastern Wolds, where the thin soils over chalk are often sandy, rather than silty (loessial) as on the high Wolds further west and south. Ventifacts, ice-wedge casts, and patches of desert pavement on the upper surface of the Devensian glacial deposits and high level (33 m O.D.) lake marginal sands constitute the upper periglacial land surface of the Vale of York (Gaunt, 1981), which was probably also formed in the Loch Lomond Stadial.

Late Devensian lacustrine sequences have been studied at several sites in Holderness (e.g. Beckett, 1981), the Vale of York (e.g. Bartley, 1962) and the Vale of Pickering (e.g. Walker and Godwin, 1954). They are dominantly inorganic deposits, often grey or pinkish grey calcareous clays derived by erosion of the unweathered till surface. Within these clays the Windermere Interstadial is usually represented by a darker organic mud, and at The Bog, Roos (Beckett, 1981) and a few other sites there is also a thin lower organic mud dating from about 13000 B.P. Pollen from this lower organic deposit includes Helianthemum (indicating that soils on the till were not yet decalcified), numerous other herbs and some shrubs (Juniperus, Hippophae, Betula nana and Salix) but very few trees. In contrast, tree birches were abundant during the Windermere Interstadial (approximately 12000-11000 B.P.). Pollen assemblages from the intervening cold period and the succeeding Loch Lomond Stadial deposits are dominated by Cyperaceae and Gramineae, often with small amounts of juniper, tree birch, dwarf birch, pine and willow. This four-fold division of the late Glacial resembles that of the European mainland, but contrasts with the late Glacial sequences at more oceanic sites in western Britain, where there was a steady, uninterrupted improvement of climate leading to the Windermere Interstadial.

During the late Glacial man migrated northwards to inhabit several cave and open sites in the area. The earliest (Upper Palaeolithic) sites, dating from just before 12000 B.P. to after 11000 B.P., are mainly in caves such as Victoria Cave (Settle) and Creswell Crags (Nottinghamshire), which have yielded assemblages of artefacts collectively referred to the 'Creswellian' tradition. However, an open site with a stone-lined hearth, dating from the Windermere Interstadial and overlain by coversand of Loch Lomond Stadial age, has recently been discovered at Seamer Carr in the Vale of Pickering. Isolated late Glacial finds are also fairly common. These include a flint blade discovered in 1978 in deposits older than the Windermere Interstadial at Skipsea Withow Mere in Holderness (Mellars, 1984), two flint artefacts associated with a concentration of horse bones in Windermere Interstadial deposits at Flixton in the Vale of Pickering (Moore, 1954), and an end-scraper found by Buckland at Messingham (Lincolnshire) in cold climate deposits predating 10550 ± 250 B.P. (Birm-707).

Many other artefacts date from the very end of the Devensian or earliest part of the Holocene. The most interesting of these are the 'Maglemosian' barbed bone points or harpoons from Skipsea Withow, Hornsea and Brandesburton in Holderness. The Skipsea harpoon, which probably came from deposits dated by Gilbertson (1984) to between 10000 and 10450 B.P., was associated, according to Armstrong (1922), with remains of reindeer and giant elk. It is very similar to a harpoon from Sproughton (Suffolk), which is older than 9880 ± 120 B.P. (Wymer et al., 1975), but differs from early Mesolithic barbed points found at Star Carr in the Vale of Pickering (Clark, 1954; Clark and Godwin, 1956), which are early Holocene (Zone IV) in age, and are made from red deer antler instead of bone.

THE HOLOCENE

After the Loch Lomond Stadial, birch woodland reappeared in Holderness by 10120 ± 180 B.P. (Beckett, 1981), accompanied by some pine. By about 9000 B.P. this had been replaced by hazel-elm forest, and thereafter the vegetational history of the region to approximately 5000 B.P. is generally similar to that of other parts of eastern England. The exception is the Yorkshire Wolds, where there is pollen evidence for the survival of chalk grassland from Late Devensian times, and forest pollen may never have exceeded 75% (Bush, 1986). Pollen sequences suggest that human effects on the vegetation began at various times, even as early as 8800 B.P.; the earliest clearances seem to have been on the Wolds, and are associated with possible cereal pollen as well as chalk grassland species (Bush, 1986). Later, in lowland areas such as Holderness cereal pollen becomes increasingly abundant but pollen of pasture weeds less common (Beckett, 1981), indicating a progressive increase in arable farming. However, in upland areas the reverse is true, often because medieval landscapes under monastic control were dominated by pasture (Jones, 1976). In Holderness there is some evidence for Neolithic or Bronze Age woodland management, and at Skipsea a roughly pointed alder rod, dated to 4500 ± 50 B.P. (SRR-1942) was probably used as a stake to support an early Neolithic lakeside platform or trackway (Gilbertson, 1984). Two large meres nearby (Skipsea Low Mere and Skipsea Bail Mere) are the only British Holocene sites for in situ records of water chestnut (<u>Trapa natans</u>); this was possibly introduced (Flenley <u>et al</u>., 1975), and platforms may have been associated with its cultivation. However, worked timbers of the Bronze Age and later periods from other Holderness meres have also been interpreted as evidence for piled lakeside dwellings or crannogs (Smith, 1911; Varley, 1968).

When the knickpoint of the River Humber eventually eroded back through the glacial deposits in the Humber Gap, sea level was still quite low, and the rivers in the Vale of York consequently incised their courses into the soft Devensian deposits to approximately -20 m O.D. (Gaunt, 1981). This must have occurred before 7000 B.P., when sea level in the Humber Estuary had risen to -9 m O.D. (Gaunt and Tooley, 1974). As the sea rose further, the rivers began to deposit fine calcareous alluvium, and rising groundwater encouraged formation of peat in areas such as Thorne and Hatfield Moors, the Hull Valley and Vale of Pickering. In the Humber Gap rising river level resulted in deposition of alluvium over peat some time after the 'elm decline' (approximately 5000 B.P.). At North Ferriby, Bronze Age boats have been recovered from this alluvium (Wright, 1976), suggesting that the Humber has been navigated for at least 2500 years. Nearby at Redcliff an Iron Age port of the 1st century A.D. imported pottery and other goods from the Roman Empire, but was probably abandoned when Brough (Petuaria) developed from a military camp into an important Roman town. Low-lying areas along the Humber and in the Vale of York have been reclaimed during the last six centuries or so by artificial drainage schemes and by warping, a procedure for raising the land level by encouraging deposition of silt; muddy floodwater was impounded at each high tide, then allowed to drain away slowly through sluice-gates at low tide (Heathcote, 1951).

THE QUATERNARY DEPOSITS OF FILEY BAY

C. A. Edwards

INTRODUCTION

The coastal glacial succession in Filey Bay is broadly similar to that of Holderness (Catt and Penny, 1966), and can be correlated with it. Each of the coastal tills of Holderness is fairly uniform, probably because the surface of the underlying chalk bedrock is even. North of Flamborough Head, however, the sub-drift topography is much more varied, with many barriers to ice advance, which resulted in more variation within the tills. Because of this greater variation the coastal tills of Filey Bay are named the Lower and Upper Till Series. The Lower is correlated with the Skipsea and the Upper with the Withernsea till of Holderness. Filey Bay exhibits both narrow-band and lodgement till sequences, the former overlying the Speeton Shell Bed at the southern end of the bay.

NEW CLOSE'S CLIFF

Narrow-band tills

At New Close's Cliff (TA 14707585) an extremely hard, compact till about 7 m thick (T1) rests on angular chalk gravel above the Speeton Shell Bed and contains streaks of greenish till (5Y 3/1) characterised by numerous well-rounded secondarily derived igneous erratics (Figure 3). This basal till unit is overlain by englacial sands and gravels which in turn are overlain by 4 m of silty till (T2) which has lithological affinities to that below. The next till unit (T3) is 1.3 m thick and compact, with a fine sand/silt matrix and infrequent erratics. The series of thin layers of till and gravel around 47 m O.D. (T4) represents the contact between the Lower and Upper Till series. They are interpreted as thrust slices of meltout till formed by englacial shearing which occurred between the lower and upper ice layers in the compound North Sea glacier. The topmost till (Upper Till Series) is reddish brown (5YR 3/4) with a clay-rich matrix (T5). It contains many northeast English erratics and is less well consolidated than the Lower Till Series. Carbonate analysis of the sequence (Figure 3) shows there are no weathered horizons in the succession.

The long axis orientation of erratics with an a-axis:b-axis ratio of at least 2:1 shows great within-till variation at this site. The base of the lowest till unit (T1) displays no strong directional evidence, probably because of reorientation of erratics as the ice met the rising ground of Flamborough Head. The second till unit (T2) shows a strong NNE-SSW maximum, and the overlying unit (T3) has a NE-SW maximum. The lack of unified directional data illustrates how shearing processes have subdivided the Lower Till Series into a sequence of narrow-band tills, some of which have been internally disturbed more than others. The Upper Till Series (T5) displays NNW-SSE movement over the Lower Till Series which was perhaps responsible for creating some of the shear observed between the two till series.

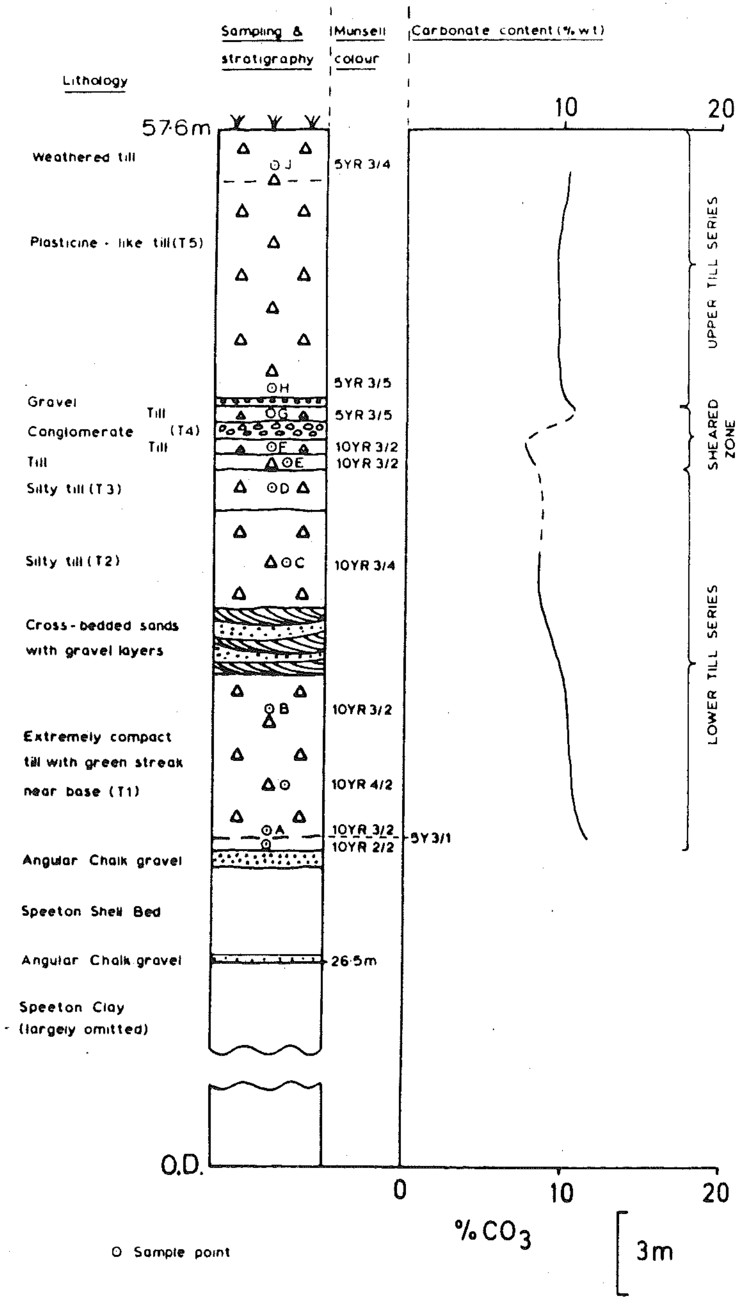

Figure 3. Section at New Close's Cliff (after Edwards, 1981).

The Speeton Shell Bed

The Speeton Shell Bed is exposed in New Close's Cliff (TA 14707585) at 32 m O.D. and is 3 m thick. The lowest 1 m is blue-black silty clay and the uppermost 1 m brownish silt and fine sand; between the two is 1 m of blue-brown silty clay (Figure 4). The Shell Bed is underlain by 0.6 m of angular chalk gravel with quartzite erratics, which rests on Speeton Clay C and D beds; it is overlain by 0.6 m of angular chalk gravel beneath the Devensian Lower Till Series (Figure 3).

The lower chalk gravel and Speeton Clay are very tightly folded. The lowest zone of the Speeton Shell Bed exhibits current bedding and is closely faulted. Monoclinal folding associated with dislocational thrust planes has also developed. The uppermost zone of the Shell Bed shows only a small amount of minor flexuring. Some lowest zone folds appear to have been rotated by a later tectonic event. In this zone, valves of Cardium edule are not united and are filled with material derived from higher beds, whereas in the uppermost zone C. edule valves are joined at the umbo and infilled with the enclosing sediment. Folding in the Speeton Clay indicates outcrop compression of approximately 2:1 by ice advancing from the north. This advance also uplifted the overlying Speeton Shell Bed by 28 m above the estimated height of the chalk base in this region (Figure 5).

The Shell Bed macrofauna indicates deposition in a tidal estuary, but it has no age significance. Common species include Cardium edule, Macoma balthica and Scrobicularia piperata. Other recorded species include Utriculus obtusus, Hydrobia ulvae, Littorina littorea, L. rudis and Mytilus edulis. The microfauna indicates deposition in shallow brackish water such as a tidal estuarine environment, which was fairly cold but not arctic. Conditions were colder than the present southern North Sea, perhaps similar to those currently found in the Norwegian Skaggerak (Edwards, 1978).

The isoclinal folding within the Shell Bed indicates that it has been ice-rafted to its present height, and the anomalous height of the Speeton Clay (Figure 5), plus the isoclinal folds and subsequent compression of its outcrop, also testify to strong glacial disturbance. If uplift of the Shell Bed had been accomplished by late Devensian ice, the early Devensian soliflucted chalk gravel which overlies the Shell Bed would display folding similar to that in the Shell Bed beneath. However, the gravel is undisturbed and has been deposited on the Shell Bed after uplift, thus indicating that the Shell Bed was transported by pre-Devensian, probably Wolstonian, ice and is therefore perhaps as old as Hoxnian. The soliflucted chalk gravel beneath the Shell Bed is then late Anglian or older. There is no Wolstonian till directly overlying the Shell Bed, although a thin streak of it has been incorporated into the basal beds of the Devensian Lower Till Series (Figure 3).

The Shell Bed was also attributed to the Hoxnian interglacial by Catt and Penny (1966) on the basis of stratigraphic, altimetric and mineralogical evidence. This is further supported by the predominant fold orientation within the deposit, which is not compatible with the known direction of Devensian ice advance into the Filey Bay area. Instead the folding of both the Shell Bed and Speeton Clay can be attributed to the more southerly flow of the Wolstonian ice,

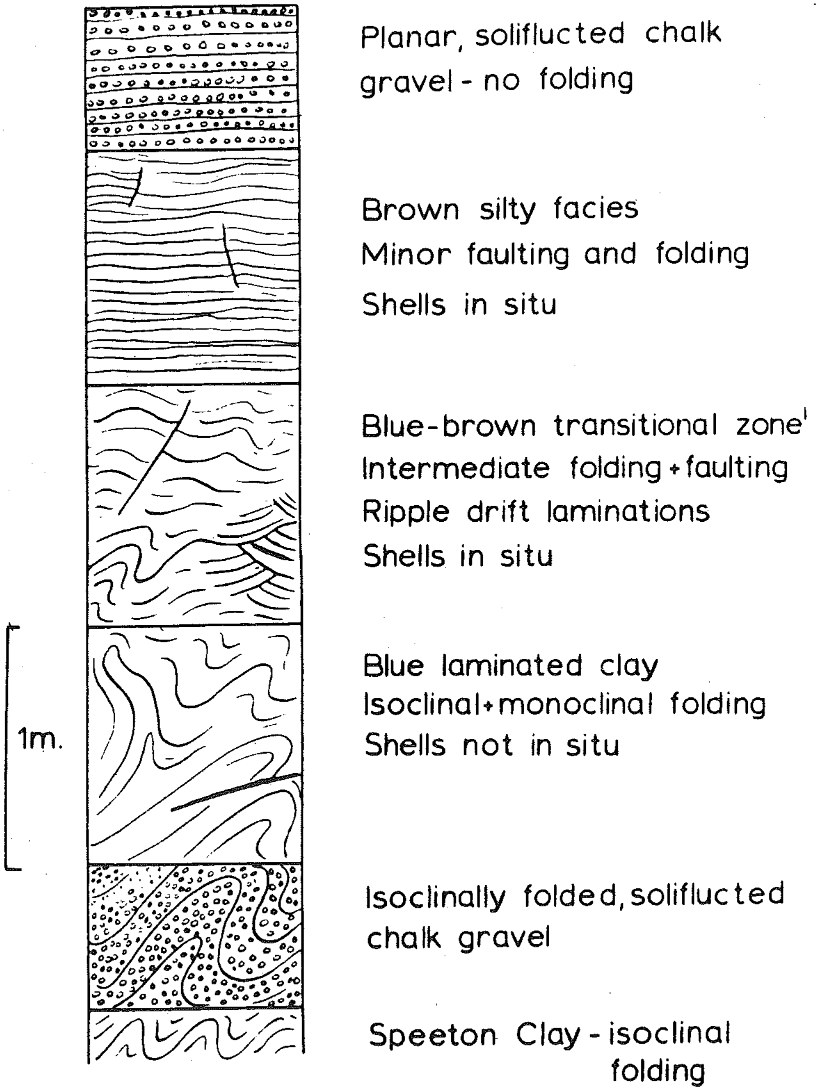

Figure 4. Tectonic and stratigraphic features of the Speeton Shell Bed at New Close's Cliff.

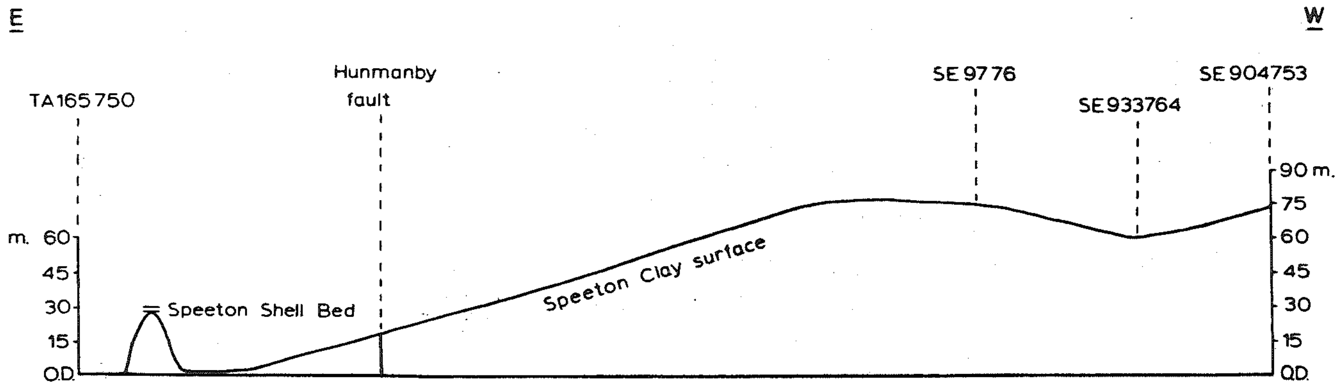

Figure 5. Variation in height of the Speeton Clay along the scarp of the chalk Wolds.

though the Wolstonian folds within the Shell Bed were probably reorientated by the overriding advance of the Devensian ice. On this evidence, the Shell Bed is therefore considered to predate the Wolstonian glacial period and is probably of Hoxnian age. The weathering of the deposit resulting in discoloration and oxidised microfauna may have occurred in the Ipswichian, when strong oxidation of soils is thought to have occurred elsewhere in northern England (Bullock *et al.*, 1973).

QUAY HOLE

The lodgement tills at Quay Hole (TA 125816) at the northern end of Filey Bay (Figure 6) show a complete Devensian depositional sequence, which contrasts with the sequence described above but resembles sequences exposed in Holderness. The Lower Till Series (T1) overlies Corallian Limestone, which has been incorporated into the basal 15 cm of till, changing its colour from 10YR 3/2 to 10YR 5/3. Narrow-band tills are not developed at this site. Between the Lower and Upper Till Series is 2.7 m of gravel, sand, silt and clay with fluvial structures indicating flow towards the southwest. The overlying Upper Till Series (T2) is compact with a clay-rich matrix and Munsell colour of 5YR 3/4.

Directional data have been obtained from striations on the Corallian Limestone platform (Lamplugh, 1891a; Stather, 1897). These were clearly visible in 1975 and gave a mean true bearing of 034°. Macrofabric analysis of the overlying Lower Till Series displays a north-south longitudinal maximum with a minor transverse maximum normal to the mean trend of the basal striations. 20 m south of TA 125816 a lens of overfolded gravel contains platy pebbles with long axes orientated normal to the fold axis. This indicates compression from north to south, suggesting that the basal till was either subject to flow after deposition or disturbed by overriding pressure from the overlying Lower Till Series ice. There is no sign of shear between the Lower and Upper Till Series.

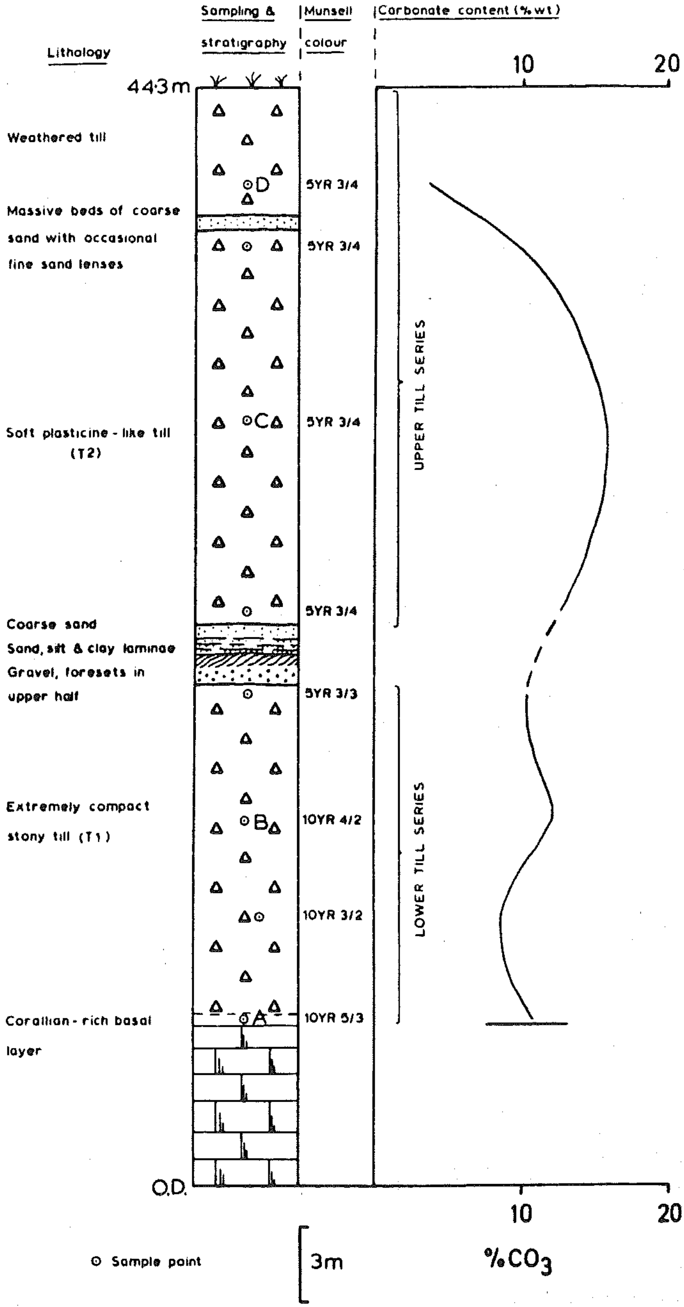

Figure 6. Section at Quay Hole (after Edwards, 1981).

EARLY MAN IN THE EASTERN VALE OF PICKERING

R. T. Schadla-Hall

INTRODUCTION

Since the later part of the nineteenth century, when the first systematic attempts at drainage in the Vale of Pickering were made by a network of hand-cut ditches, there has been an increase in ploughing along the peat margins of the Vale and increased development of the pasture land. In the 1940s J. W. Moore of Scarborough began a systematic investigation of the peat deposits exposed by these ditches, concentrating largely on the areas of Flixton, Star and Seamer Carrs (Moore, 1950). At least ten sites were located which produced flints and faunal remains of Early Mesolithic (Zone IV/V) date (Figure 7), and these findings attracted pioneering work on the palaeobotany of the Vale (Walker and Godwin, 1954). Moore subsequently carried out excavations on two of these sites. The first, Flixton 2, produced evidence of a Zone II deposit just south of the River Hertford, which was apparently sealed by a possible solifluction deposit representing Zone III (Moore, 1954). From a deep water-logged trench he recovered the remains of at least two horses, and one piece of worked flint. The second site, Flixton 1, was the subject of a much larger excavation covering some 3 x 20 m and producing approximately 8000 pieces of worked flint and several fragments of worked bone and faunal material. From slightly to the west of this site a possible Zone II deposit was identified (Walker and Godwin, 1954).

Most significantly, however, at Site 4 a limited excavation had recovered a large quantity of flint just south of the River Hertford. This site (Star Carr) was subsequently excavated in a four-season campaign by J. G. D. Clark (1954), and has become the best known Early Mesolithic site in Europe, producing over 13000 pieces of worked flint, over 100 bone points and, among other artefacts, remarkable stag antler frontlets. The site, considered to have been on the edge of an area of open water, was suggested to have been a seasonally-occupied hunting camp (Clark, 1954). Clark later reviewed the results of Star Carr, and attempted to place his original interpretation in a wider context by suggesting a relationship between the Early Mesolithic sites on the North York Moors and Star Carr in terms of a seasonally-based activity pattern (Clark, 1972). However, a number of alternative hypotheses have been offered as to the exact nature of the site; Pitts (1979) suggested that it may have been occupied all the year round and was used as a 'specialised industrial activity zone, where the working of deer antler and the processing of animal hides was carried out'. Andreson _et al_. (1981) accepted an all year round occupation but considered this to be only intermittent, and suggested the site represented a 'hunting and butchering site occupied frequently for very short periods at various times of the year'. Caulfield (1978) suggested that _Bos primigenius_ formed a more significant element, at least in terms of meat, than red deer, and indicated that the importance attached to red deer hunting, or even herding, had been much over emphasised. More recent analysis of the faunal remains from Star Carr by A. J. Legge and P. Rowly-Conwy now suggests that

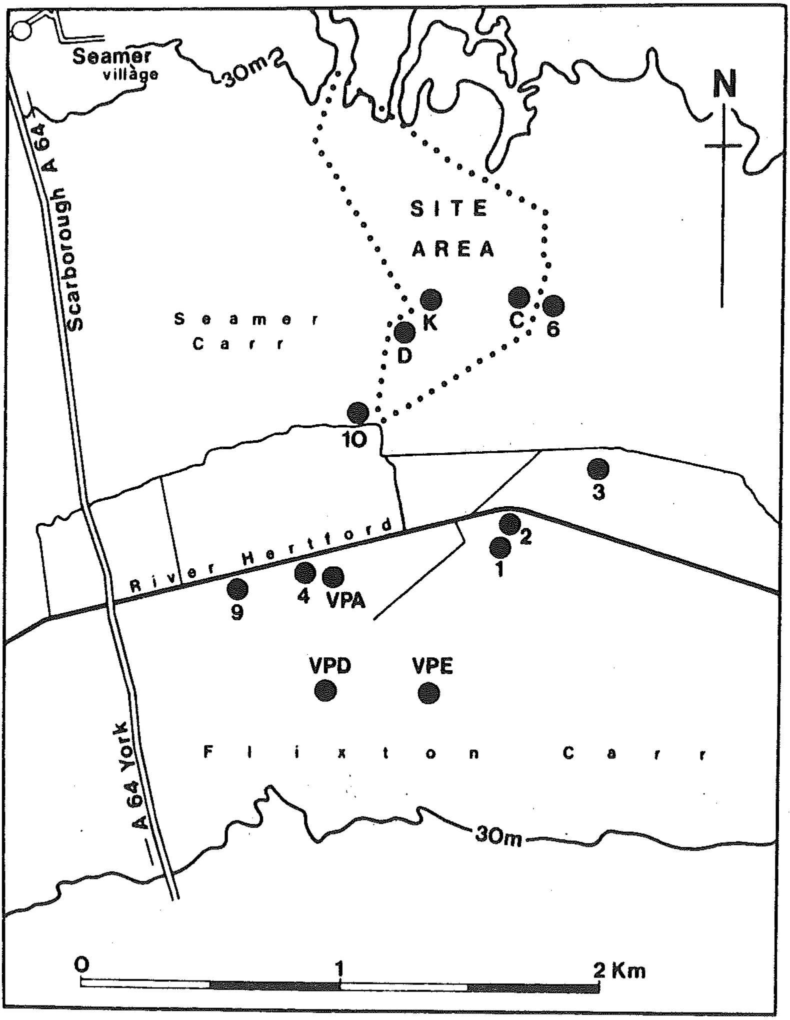

Figure 7. Late Upper Palaeolithic and Early Mesolithic sites in the eastern Vale of Pickering. Numbered sites are those located by Moore (1950); lettered sites are those found during more recent excavations outlined in this paper. The margin of the Seamer Carr Waste Disposal Area is indicated by a dotted line.

activity occurred all year round, including the summer period, rather than the autumn/spring period originally suggested by Clark (1972).

After the archaeological activity of 1945-54, no further sustained investigations took place in the Vale until 1976. Since the 1970s drainage of the peat deposits has proceeded rapidly as a result of the New Cut being lowered and arable cultivation spreading from the marginal to the deeper peat deposits. It seems likely that this is causing large areas with a high potential for Early Mesolithic archaeology to be extensively damaged (Schadla-Hall and Cloutman, 1985).

RECENT WORK AT SEAMER CARR

Background

In 1974/5 North Yorkshire County Council designated some 40 hectares on the north side of the Vale as an area for waste disposal (Figure 7). The southern margins of this area (some 15 hectares) largely comprised a peat deposit, and it became clear that the development of the Seamer Carr Waste Disposal Plant would result in the complete dislocation of any archaeological material within the peat, and also on the dry-land deposits adjacent. An initial palaeo-stratigraphic and palaeobotanical survey, conducted by E. W. Cloutman and F. M. Chambers, indicated that there were extensive deposits of Zone IV/V date immediately adjacent to the dry land (Figure 8), and as a result excavations to examine areas threatened with destruction were funded by the Historic Buildings and Monuments Commission for England (formerly the Directorate of Ancient Monuments and Historic Buildings, Department of the Environment) and assisted by North Yorkshire County Council.

The first area to be investigated (Site C) lay on the northeast side of the designated area (Figure 8). Here a clayey till produced evidence of Neolithic and Early Bronze Age occupation, but immediately south of this and adjacent to a kame deposit, trial trenching into the peat margins indicated a scatter of Early Mesolithic flint. Investigations on the northwest side of the site showed that the subsoil was gravelly, and produced some evidence for a peat-sealed Late Mesolithic occupation site. The same area also produced a Late La Tene sword, but no other evidence for Iron Age occupation.

The discovery of Site C indicated that the peat margin constituted a prime zone for investigation, and as a result a subterranean contour plan of the buried landsurface along this margin (some 2 km in extent) was built up by a series of bored transects carried out over a period of two years. As the initial finds at Site C had been made around 24.5-25 m O.D., it was decided to sample excavate, using 2 x 2 m trenches, as much as possible of this 'shoreline'. Well over half the 80 trenches excavated produced evidence of Early Mesolithic activity and pointed to the presence of a further site (Site K) within the threatened area, represented by considerable recoveries of flint. A Late Mesolithic occupation site was also identified on the top of Rabbit Hill (60 m northeast of Site K) at some 27 m O.D. Presumably this site was on the edge of peat deposits as they existed around 7500 B.P.

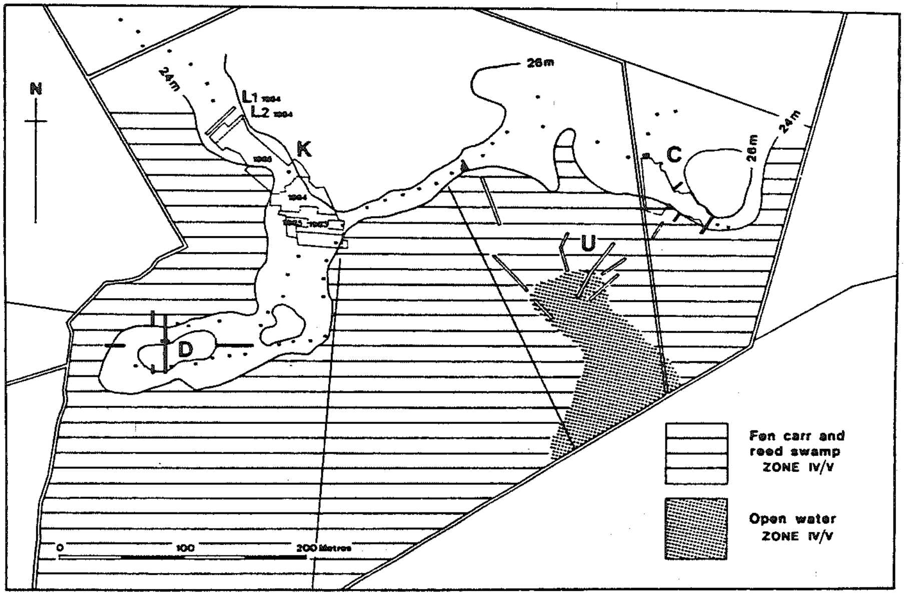

Figure 8. The southern part of the Seamer Carr site indicating the location of excavations carried out between 1977 and 1986.

Site C

Site C (TA 036820) ultimately covered an area of 1400 m^2 and produced c. 8500 pieces of worked flint, distributed in a series of clusters running along a shelf 24-26 m O.D. formed by a kame deposit (Figure 9). Only one stone-lined hearth was located, but the flint distributions also related to other areas of burning. The site seems to have been situated on the edge of fen carr/reed swamp sheltered by the kame behind, and some 50 m from open water to the south (Figure 8). The bulk of the faunal material recovered (c. 100 fragments) was located towards the southern edge of the site and included material representing wild horse, wild pig, ox, roe deer and red deer. Most of the material consisted of small fragments of bone rather than large complete pieces such as those recovered from Star Carr. The present interpretation of the site would suggest an intermittently occupied area visited over a long period. The ^{14}C dates give a mean date of c. 9200 B.P., firmly in the Early Mesolithic.

It was clear that the rest of the peat to the south of Site C would be severely disturbed as a result of future waste dumping in the area, therefore an attempt was made in 1983 to examine the edge of the open water zone closest to Site C (Figure 8, Site U). In view of the depth of peat and its waterlogged condition at the time of excavation, the only way to achieve this was to machine-cut a series of sections into the peat and examine the deposits by hand. Sufficient faunal material was recovered to suggest some form of activity on the edge of open water in the fen carr/reed swamp area some time during the Early Mesolithic.

Site K

Site K (TA 034820) ultimately covered an area of some 1800 m^2, although not all of this area was fully excavated. This Early Mesolithic site produced c. 9000 pieces of worked flint, distributed in a series of clusters relating to at least three stone-lined hearths. As in the case of Site C, the faunal material was fragmentary with some exceptions including part of a dog skeleton, two horse jaws and a large grooved and splintered red deer antler fragment. A small number of pits was also recovered, but there was no sign of any structures. The site lay on the edge of a 'lagoon' cut off from the main area of open water in the Vale, apparently on the edge of a fen carr/reed swamp. The occupation again lay on the edge of the kame formation (Figure 8). The ^{14}C dates centre around 9300 B.P., and at this stage it seems reasonable to offer a similar interpretation for the occupation of this site as for Site C.

Further excavation showed that the peat-sealed Early Mesolithic site lay on top of an aeolian sand, presumably derived from the kame deposit. This sand layer, varying from 10-20 cm in thickness, had been clearly dislocated by frost action and had been affected by at least one extensive frost wedge; the deposit is thought to date to Zone III. Beneath the sand a thin layer of peat 10-20 cm thick contained flint of a Late Upper Palaeolithic character, and also produced a stone-lined hearth and some very poorly preserved bone fragments. The 700 or so pieces of flint from this deposit, the bulk of which clustered around the stone-lined hearth, indicate one of the first open Upper Palaeolithic sites to be recorded in northern England. Four ^{14}C dates from the peat range from 10200-11300 B.P. and the site is stratigraphically in Zone II. It is now clear that the Early

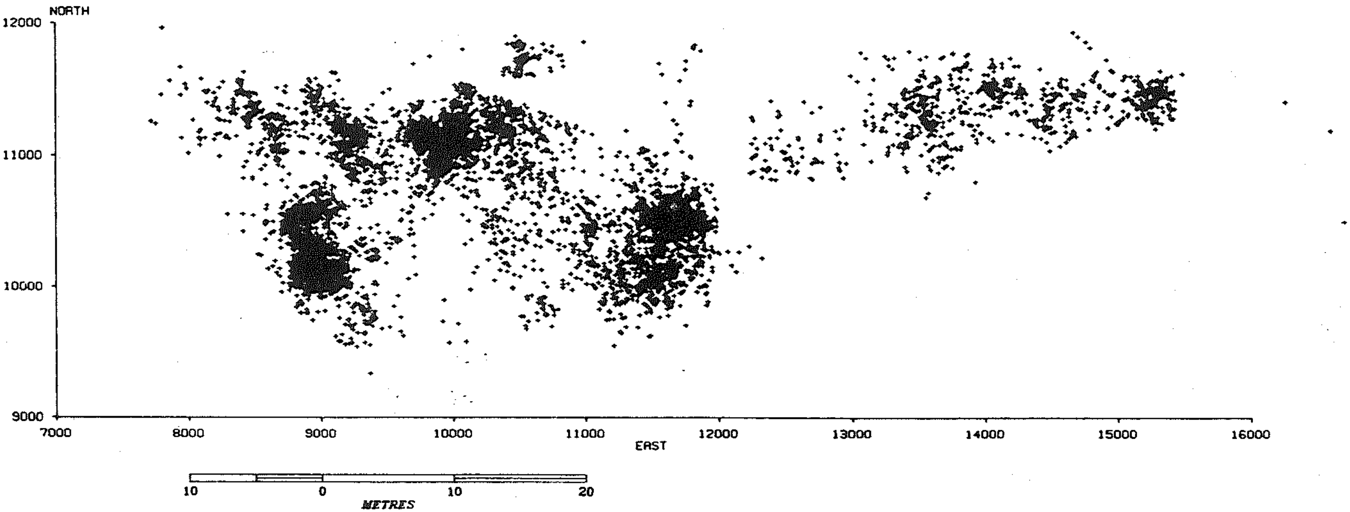

Figure 9. Flint distribution at Site C, Seamer Carr.

Mesolithic site contaminated part of the Zone II deposits, and it is likely that ultimately a higher number of Upper Palaeolithic worked flints will be recognised when analysis of the flint is complete.

RECENT WORK ELSEWHERE

Initial investigations

In 1984/6 E. W. Cloutman of Cardiff University undertook a major survey of the palaeostratigraphy of the peats in the area shown in Figure 7. This enabled a reconstruction of the subsurface topography of a large area of the eastern Vale, and thus created the possibility of sampling and examining this landscape with a high degree of accuracy. The identification of areas of likely open water in Zone IV and also the 'shoreline' margins, provided the possibility, for the first time, of being able to look for further Early Mesolithic sites with a minimum of effort.

In order to provide further palaeoenvironmental information for the survey, and also to assess the likely drainage effects on the area, in 1985 a section (TA 027810) some 20 x 2 m was cut north-south some 15 m east of Clark's (1954) original excavations at Star Carr (Site 4 as originally identified by Moore, 1950). This clearly illustrated that the peat had become extensively desiccated, but in addition it produced some 200 pieces of worked flint and 35 fragments of bone including a bone point. The faunal material was in extremely poor condition as a result of the effects of drainage. This therefore established that there was a drainage threat to the Zone IV deposits in at least part of the Vale, and also indicated that there was more Early Mesolithic material in the region of Star Carr itself.

The 1986 excavations

In 1986 the Vale of Pickering Research Trust was formed to investigate further the Early Mesolithic landscape, in view of a clear threat to the surviving archaeological material. The Trust has received grants from North Yorkshire County Council, the Royal Archaeological Institute and other charitable institutions and interested individuals. The strategy in the 1986 season was to investigate sites which had already been identified or excavated, in an attempt to assess their condition, and at the same time, using the information derived from Cloutman's survey, to test whether it would be possible to locate hitherto undiscovered sites. The group of sites consists of Flixton 1 and 2, both of which were excavated by Moore, and also Sites 3 and 6, which were indicated as likely Early Mesolithic sites (Moore, 1950, 1954). In all cases 2 x 2 m sample holes were used to examine the sites, as previous experience had suggested that these were ideal (Schadla-Hall and Cloutman, 1985).

When Flixton 1 (TA 035810) was originally excavated, a 2 m wide section 25 m long was cut across the western end of Flixton Island (Moore, 1950). The site produced some 8000 worked flints and large quantities of faunal material. Later palaeobotanical work seems to suggest the possibility of a Zone II deposit further to the east (Walker and Godwin, 1954). The 1986 excavations consisted of three sample holes to the west of Moore's original trench, and produced over 900 pieces of worked flint and some 15 fragments of bone, including 3 horse jaws; the jaws were in poor condition and had to be frozen before lifting. It was clear that there was considerable Early Mesolithic material under the peat, and that the faunal material had suffered from peat drainage over the last 35 years.

Flixton 2 (TA 035811) had originally produced horse remains and one worked flint, which was stratigraphically dated to Zone II. This site lay on the northern edge of Flixton Island. Here three sections were cut into the deeper peat and Moore's (1954) original excavation area was identified. His original stratigraphy was confirmed, but the site had become entirely dried out. A minute fragment of bone was recovered but no artefacts were found; it seems likely that the whole of this deposit has been badly damaged.

Site 3 (TA 040813) lies on a larger island to the northeast of Flixton Island. One of the four sections excavated produced over 150 pieces of worked flint and poorly preserved faunal material. The island almost certainly contains a more extensive Early Mesolithic site, but again the peat has suffered from drainage.

Site 6 (TA 037820) lies immediately east of Site C on Manham Hill. Seven sections were excavated around the edge of the hill, but only 20 pieces of worked flint were recovered. It is obvious that there is an Early Mesolithic site in this area and that the peat has suffered from drainage, but it is difficult to assess the severity of the damage in the absence of any faunal material.

Nineteen 2 x 2 m sample holes were excavated on the southern side of the Vale some 300 m south of Star Carr, which would have been separated from this area by open water in Zone IV. Two significant concentrations of flint and faunal material were located; Site VPD (TA 028806) produced nearly 1000 pieces of worked flint and at least 10 fragments of bone from three sections 15 m apart, while Site VPE, some 200 m east, produced 200 pieces of worked flint, and strongly suggested the presence of another Early Mesolithic site in this area.

CONCLUSIONS

The work at Seamer Carr underlines the potential variation in site types within the Vale; in terms of location, Site C is at least 50 m from open water and Site K even further, lying outside the main basin. By contrast, Clark's site at Star Carr was less than 5 m from open water. Another contrast is underlined by the difference in the size and quantity of faunal material recovered; at Clark's site not only was the quantity far greater, but much of the bone was complete. The total quantity of worked flint recovered from Sites C and K was less than from the much smaller excavated area of Clark's site, and the distribution much less uniform. The number of finished forms at the Seamer Carr sites is also much lower than at Star Carr. It is clear that only by establishing the range of types of site which existed in the Early Mesolithic will it be possible to achieve a detailed insight into the variable and complex activities of early Flandrian society (Schadla-Hall, 1987). In addition, the recognition of an Upper Palaeolithic site demonstrates the importance which the Vale holds, at least in isolated areas, in terms of understanding the nature of even earlier human activity. The work at Seamer also indicates that drainage in the last 30 years is having a profound effect on the fragile archaeological deposits.

The most recent work, especially in Flixton parish, has continued to emphasize the importance of palaeostratigraphic survey in advance of any archaeological work, and it is now clear that there are potentially considerably more Early Mesolithic and Upper Palaeolithic occupation sites available for recovery within the area. The most worrying aspect of these discoveries, however, is clearly the fact that large parts of the Vale have suffered from considerable drainage, and the resulting degradation of the peat poses a threat to survival of the faunal fraction of the archaeological material.

THE SHERBURN SANDS OF THE SOUTHERN VALE OF PICKERING

S. W. Foster

LOCATION

These sands and gravels form part of a large outwash train extending for approximately 25 km along the south side of the Vale of Pickering from the Hovingham area in the west to Flotmanby in the east. It was subdivided by Fox-Strangways (1880, 1881) into the Slingsby Sands (west of Malton) and the Sherburn Sands (east of Malton).

The Sherburn Sands are mixed fine and coarse quartzose sands with large lenses of chalk and flint gravels and thin seams of finely comminuted coal and shale fragments. The bulk of the deposit outcrops between the alluvial sediments of the Rivers Derwent and Hertford to the north and the foot of the Wolds escarpment to the south (Figure 10). Scattered patches of Sherburn Sands also occur on the Wolds scarp slope and at scattered sites on the dip slope.

SITE DESCRIPTION

At East Heslerton (SE 918767) 8 m of sediments have been recorded at the southern end of the sand pit without the base having been reached. In the northern end of the pit 4-5 m of sediments have been exposed. The lower sands show abundant sedimentary structures, especially laminar bedding and small-scale trough cross-bedding (Figure 11, unit 3). Trough units vary in size from 10-12 cm deep x 35-40 cm wide to 20 cm deep x 70-80 cm wide. Grading of the sands from coarse at the base of a trough-bedded unit to fine at the top is common. Occasionally coal and/or shale fragments are also found at the bottom of the trough infill. Similar fining-upward sequences and coal and shale fragments occur in the laminar bed structures. Ripple-drift lamination was found in some parts of the sands at the northern end of the pit; this showed current flows in a west to northwest direction. The upper sand is structureless as it has been reworked by wind action (Figure 11, unit 1); at the northern end of the pit a Saxon age cemetery was discovered in 1976, buried beneath 1-1.5 m of this sand.

Scattered throughout the sands are rare gritstone pebbles (probably of Jurassic origin, although some may be Carboniferous) together with very rare dreikanter pebbles. These, and the occasional thin lenticles of angular flints and subangular chalk fragments, probably indicate lag deposits in former stream channels.

Overlying the sands in the northern part of the pit are 2-3 m of gravels composed of subangular to angular chalk (85-90% of total), angular grey and white flints and rare gritstone pebbles (Figure 11, unit 2). The gravel is loosely packed and has a sand matrix comprising up to 60% of the total. Lenses of pure sand (up to 30 cm long x 6 cm thick) are common. The junction between the sands and overlying gravels is generally very sharp and is nearly horizontal over most of the exposure. However, in places the junction is disturbed by load

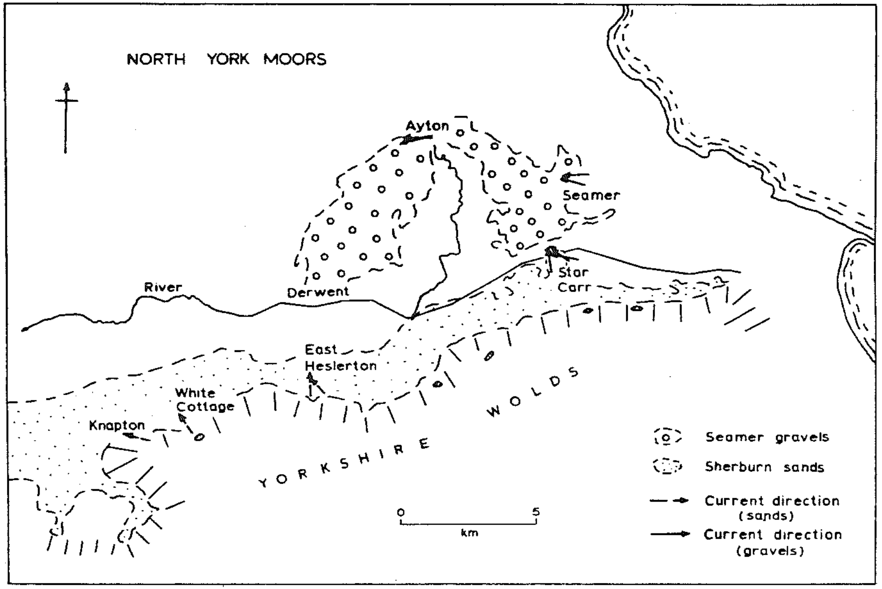

Figure 10. Outcrop and current directions of the Sherburn Sands in the southern Vale of Pickering.

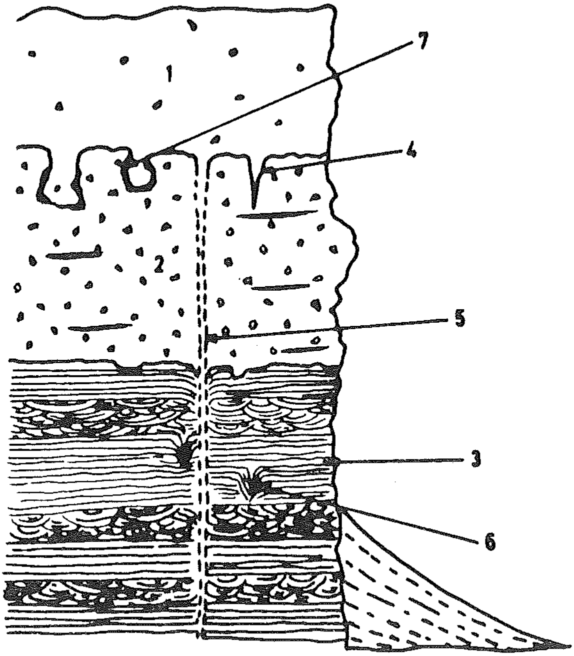

Figure 11. Schematic diagram of the sandur deposit exposed at East Heslerton Sand Pit (SE 918767). See text for explanation of numbers.

structures up to 10 cm deep. The gravels are almost devoid of sedimentary structures, except for the sand lenses mentioned above, which are often distorted. Lenses of similar gravels have been reported from boreholes on the south side of the Vale of Pickering. The boundary between the gravel facies in the northern part of the pit and the sand facies which replaces it to the south has been obscured by slippage and growth over the quarry faces. However, it seems that the gravels thin out into interdigitating seams and lenses as the sand matrix becomes more dominant.

The sand is in places disturbed by small ice-wedge pseudomorphs (Figure 11, feature 6). The overlying gravels have larger ice-wedge pseudomorphs which tend to be narrow (<20 cm) but deep, some extending as much as 5 m through the gravel and underlying sands to the base of the exposure (Figure 11, features 4 and 5). Wider ice-wedge pseudomorphs were recorded from the southern end of the pit in the mid-1970s; these were up to 95 cm deep x 30 cm wide at the top. The upper layers of the gravels also show signs of cryoturbation with occasional festoons and pockets of blown sand (Figure 11, feature 7). This was sufficient to destroy any former imbrication in the gravels, but did not severely disrupt the sand lenses within them.

DISCUSSION

The Sherburn Sands form a discrete body of outwash along the foot of the Wolds escarpment, and appear to pass laterally into the Slingsby Sands in the west. To the north they interdigitate with the Seamer gravels (Figure 10), as in the banks of the River Hertford near Star Carr footbridge (TA 028810). The height and position of the deposit strongly indicate that it was laid down along the margins of the late Devensian glacier which had filled the Vale of Pickering and which was melting down in situ, but its exact source is difficult to determine. It may originally have been blown sand banked against the Wolds escarpment in late Ipswichian or early Devensian times; similar sands occur at Sewerby on the coast (Catt and Penny, 1966). Alternatively it could have been derived from sediments within the North Sea glacier which had blocked and then invaded the Vale of Pickering.

The sands were deposited in braided streams with shallow channels which changed course frequently, causing local non-conformities and erosion surfaces. Velocities were fairly low for much of the time, so that little or no coarse material was carried, and as the streams gradually dried up, progressively finer material was deposited to give local graded sequences. The streams were perhaps supplied by seasonal meltwater because the repeated fining-upward sequences indicate falling velocities and probably discharges, and the ice-wedge pseudomorphs show that the climate was still very cold.

In view of the above, previous suggestions that the sands represent the beach deposits of former Lake Pickering (Kendall, 1902; Clark, 1954; Sheppard, 1956) are considered incorrect. The lack of a silt/clay component also suggests that the sands were not deposited at a lake margin, since some settling of fine sediment would be expected during the winter freeze-up. The 'laminations' recorded by Clark

(1954) at Staxton were found on close inspection to be iron-rich layers thought to be of pedological origin; similar features were found by the author at East Heslerton in 1975, where they were observed to cut across the current bed structures in the sands.

The influx of gravels was sudden and reflects either a sudden change in environmental conditions, or a new source area. Edwards (1978) described these gravels as reworked Wolstonian soliflucted material derived from the Chalk scarp, but there is no firm evidence for a Wolstonian age. They could represent material eroded from the meltwater channels on the scarp, deposited within the body of stagnant ice and later reworked, or may be bodies of solifluction gravel which started to form when the Wolds escarpment became ice-free. Their rapid influx and wide lateral extent could be explained by meltwater streams spreading them over an almost flat sandur-like plain. On the slightly higher levels to the south, the gravels interdigitate with Sherburn Sands without gravels, perhaps indicating that these areas of smaller grain size were affected only by flood overflow from the main gravel-bearing channels to the north.

The ice-wedge pseudomorphs and cryoturbation structures in the gravels, along with cryoturbation of the overlying blown sands, indicate a continuation of the cold environment after deposition. However, movement and deposition of the blown sands has continued into historical times, perhaps as a response to vegetation clearance by man.

THE DRY DRAINAGE SYSTEM ON THE NORTHERN YORKSHIRE WOLDS

S. W. Foster

INTRODUCTION

Dry valleys are a characteristic feature of chalk landscapes in Britain and some of the best, though least studied, examples are found in Yorkshire. The origin of these features has long been controversial, and there are several theories which attempt to explain their origin:

(a) Spring sapping, whereby a higher water table in the past allowed springs to rise in valley floors and by a process of headward erosion cause the valleys to lengthen (Small, 1965; Lewin, 1969). Progressive desiccation of the chalk, either by solution widening of the joints (Ineson, 1962), or by climatic change (Lewin, 1969), led to subsequent disappearance of the streams.

(b) During periods of Quaternary periglacial activity the ground was frozen and impermeable, causing spring meltwaters to remove loosened, frost-shattered debris (Kerney _et al_., 1965; Paterson, 1976).

(c) If ice did completely cover the Wolds, excavation or modification of the valleys by subglacial meltwater is a possibility (Lewin, 1969). In particular the deep dip-slope valleys which head very close to the escarpment could be explained in this way.

DRY VALLEY DEVELOPMENT

It is highly probable that the dry valleys on the Yorkshire Wolds have a complex history of evolution during the Quaternary. Direct erosion by ice or subglacial meltwater would probably have occurred in a pre-Devensian, probably pre-Anglian, glaciation (Catt, 1982). During the Devensian, ice in the Vale of Pickering overtopped the northern Wolds escarpment so that meltwater drained into the dip-slope dry valleys, probably contributing to their erosion. Outwash sands recorded from two sites on the Wolds dip slope, Warren Slack (SE 986751 and SE 98857460) and Cotton Dale (TA 025768), indicate that ice meltwater passed down these valleys from the Vale of Pickering glacier. The presence of shallow cols and channels at the heads of all the dry valleys which drain southwards from the northern escarpment, and in some cases their apparent links with lateral drainage channels (especially Merry Dale and other valleys in the northeast corner of the Wolds, Cooper's Bottom linking with Sked Dale above Sherburn in the more central area, and Old Dale in the east), further supports this hypothesis.

GULLY DEVELOPMENT

Towards the end of the Devensian period, probably during Zone I and Zone III times, snow meltwater drained from interfluves into the dry valleys, cutting gullies into the valley sides and heads. These gullies are a widespread and important local element of the landscape. Examples can be seen in the upper part of the valley northwest of Octon Lodge (TA 0070), where they lead northwards from the interfluve, and also at the head of the valley immediately to the east (TA 0170), where they form a dendritic pattern (Figure 12).

They are, however, unevenly distributed, being concentrated along some valley sides and yet almost absent on others. Many are found on the Wolds scarp slope. Their presence seems to be controlled by a number of factors:

(a) Slope angle and length. Short slopes (<100 m) have to be steep (>10°) before gullies appear, while gentler slopes (6–7°) need to be longer (>250 m).

(b) Angle and size of interfluve catchment. Where the catchment is large and gently sloping (<3°), but surrounded by deep valleys with steep slopes, large numbers of gullies occur on the valley sides. In valleys surrounding other catchments, channels are rare or absent.

(c) The nature of the subsoils. Generally the low-angle catchments are underlain by less permeable silty and sandy clay subsoils which increased and favoured formation of valley-side gullies. Where those subsoils are extremely thin or absent (usually on slopes >5°), valley-side gullies are few or absent.

The gullies appear to form a disproportionately high number of first and second order channels relative to the third and fourth order channels of the trunk dry valley systems (Figure 12), indicating a low degree of integration of the drainage system. This suggests that the gully system has been superimposed at a relatively late stage in the history of the valleys. A recent origin for the gullies also explains the observations that (a) they cut across the lateral drainage channels of the northern escarpment and thus post-date the late Devensian deglaciation of the Vale of Pickering, and (b) they cut into solifluction gravels of Devensian age on the sides of many of the dip-slope dry valleys (e.g. Camp Dale and Old Dale).

The prevailing conditions when the gully system formed were probably arctic or sub-arctic, when winter snows accumulated on the interfluve areas, and rapid spring thaws led to high runoff conditions. Gravels in the floor of some of the dry valleys (e.g. the Great Wold Valley at Boythorpe, and at Garton Slack near Wetwang) are water-laid, yet the surface horizons have been disturbed by cryoturbation, indicating a cold phase after deposition. If the considerable runoff and erosion in the gully systems contributed to deposition of the gravels, the gullies were probably active up to, but not after, Zone III, as this is the latest period of known cryoturbation in this part of Britain.

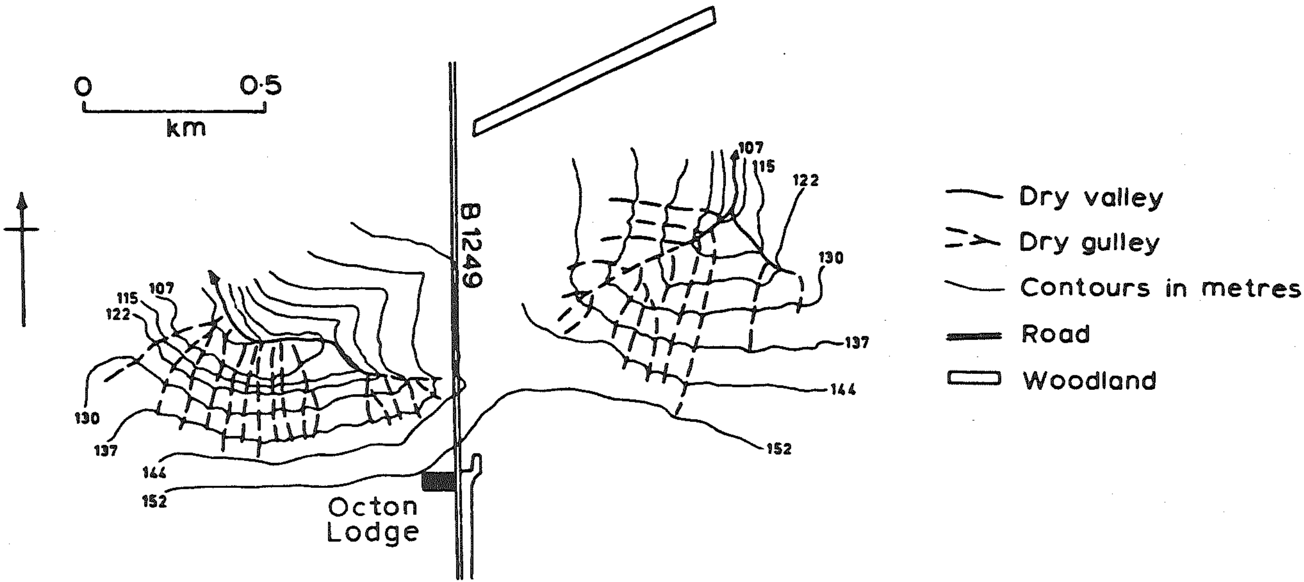

Figure 12. Dry gullies in the vicinity of Octon Lodge.

FEATURES OF GLACIAL DRAINAGE ON THE NORTHERN WOLDS ESCARPMENT

S. W. Foster

DESCRIPTION

Glacial lateral drainage channels occur at a variety of locations on the northern Wolds escarpment. One of these is well displayed at Staxton Brow (TA 009780). This is an asymmetrical channel with a southern edge much longer and higher than the northern. The Wolds scarp forms the southern edge of the channel, and the northern side rises 1-1.5 m and is topped by a prehistoric earthwork embankment. The slightly meandering channel is c. 500 m long and runs from east to west with a variable gradient (1 in 70 to 1 in 80) before passing at its western end into a deep gully (probably a subglacial chute), which runs perpendicular to the scarp. The latter feature is, however, almost totally obscured by trees. Augering in the bottom of the lateral drainage channel revealed 0.5 m of coarse, angular chalk/flint gravel with a matrix of blown sand; the base of the channel was probably not reached. Excavations in other similar channels elsewhere on the scarp have shown that 1.5-2 m of gravel with a sandy matrix may be present on the floors. No glacial sediments have been found in or near this channel, but outwash sand (Sherburn Sand) occurs on Flixton Brow and West Heslerton Brow; at the latter site till-like material has also been recorded.

On Flixton Brow is Snevver Scar (TA 032788), a deep (up to 5 m), narrow, steep-sided (up to 42°) V-shaped channel, which runs perpendicularly to the scarp slope and opens out above the base of the scarp, leaving no trace of any continuation (Figure 13). No glacial deposits have been found within or at either end of this channel. The upper end is approximately 6-8 m below the crest of the scarp and heads into a nearly blind 'wall'. Two small channels enter it, a short one from the west and a longer one from the east. The latter may connect with the head of a dip-slope dry valley (Merry Dale). From its position on the scarp, relation to the lateral drainage channels and its depth, Snevver Scar is considered to be a subglacial chute.

DISCUSSION

The lateral drainage channel on Staxton Brow and the chute at Snevver Scar are parts of a more complex and continuous system of glacial drainage channels which run along the Wolds escarpment from Muston in the east to Thorpe Basset Brow in the west. On some parts of the scarp a continuous sequence of channels extends from the crest of the scarp to the foot. The channels are generally well preserved and free from thick infills of soliflual or aeolian sediments. The freshness of these features is very similar to channels of Devensian age found in other parts of Britain (Sissons, 1960, 1961; Gregory, 1962, 1965) and also in Sweden (Mannerfelt, 1949, 1960). They are often found where the dip of the rocks is into the local slope, thus allowing the channels to be cut down-dip; indeed, some of the channels found on the scarp show strong signs of structural control (Foster, 1985).

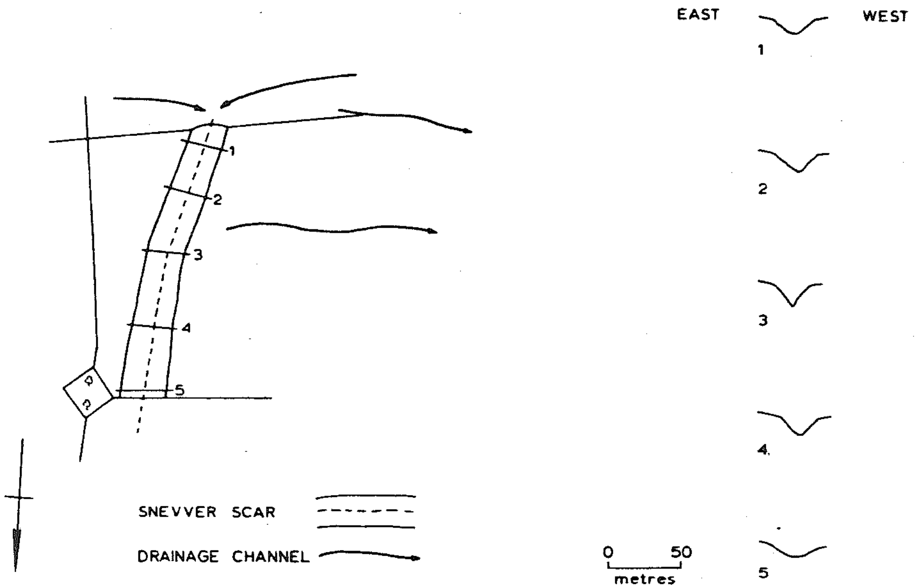

Figure 13. Plan and cross-sections of Snevver Scar, Flixton Brow.

On some parts of the scarp (at Flixton Brow, Binnington Brow and Luttons Lane, West Heslerton), glacial and glaciofluvial sediments (Sherburn Sands) occur close to, or within, the channels. Sherburn Sands have also been found at scattered sites on the dip slope, showing that ice from the Vale of Pickering almost certainly overtopped the escarpment during the late Devensian. In the Vale of Pickering ice advanced at least as far west as Thornton-le-Dale on the north side (Edwards, 1978) and probably even further west (Foster, 1985). Therefore the channels described here are probably Devensian in age. They probably formed during deglaciation as the glacier in the Vale of Pickering gradually thinned and ice and snow meltwater streams flowed along the margin of the ice where it was frozen to the bedrock. The chutes were probably cut where a crevasse or other form of weakness allowed the meltwater to flow down the steep slopes under the ice. If the chutes passed into englacial tubes, it would explain why the bases of the chutes end rather abruptly near the base of the scarp, leaving no further trace of their course or evidence of sediments deposited at the foot of the slope.

THE SEDIMENTOLOGICAL AND VEGETATIONAL HISTORY OF WILLOW GARTH

M. B. Bush and S. Ellis

INTRODUCTION

With the exception of Winchester (Waton, 1982), the only palaeoecological evidence relating to British chalklands has either been from sites peripheral to the main body of the chalk, for example Wingham, Frogholt (Godwin, 1962) and Lewes (Thorley, 1971), or from mollusc death assemblages. Molluscs have frequently supported Tansley's (1939) hypothesis of woodland on the chalk, but there are sufficient discrepancies in the mollusc records to warrant further investigation of the past vegetation communities of the British chalklands. Willow Garth has provided an exceptionally detailed palaeoecological record dating back to the late Glacial. This offers new evidence regarding the history of the chalk grasslands, and has also provided a useful temporal framework for a sedimentological examination of the site.

SITE STRATIGRAPHY AND SAMPLING

Willow Garth (TA 126676; 18 m O.D.) is an ancient carr lying in the Great Wold Valley, the largest catchment on the Yorkshire Wolds, drained by the Gypsey Race. The chalk bedrock is mantled upslope by Devensian till; the site lies just inside the Devensian ice limit. Sediments are exposed in two drainage ditches, one running east-west, parallel to the axis of the Great Wold Valley, the other running north-south along the western margin of the woodland. From these sections, and 63 boreholes, the stratigraphy of the site was determined (Figure 14). Over most of the site an organic-rich soil developed in gyttja overlies either gravel, gravelly sand or peat occurring in hollows on the gravelly sand. In the southwest corner of the site, the gyttja grades laterally into sand, and the underlying gravel and gravelly sand overlie silty clay.

Bulk samples were collected from the sediments for analysis of grain size, organic carbon and $CaCO_3$ content, and the deepest peat-filled hollow was cored and sampled for palynological, macrofossil and ^{14}C analysis (Figure 14).

A further moss peat at the southern end of the north-south drainage ditch was also sampled for palynological analysis. This is only 10 cm thick and c. 10 cm wide, but is significant in that it occurs at the base of the gravelly sand, unlike the peat at the coring site. At the time of writing 3 subsamples of this peat fragment are being ^{14}C dated.

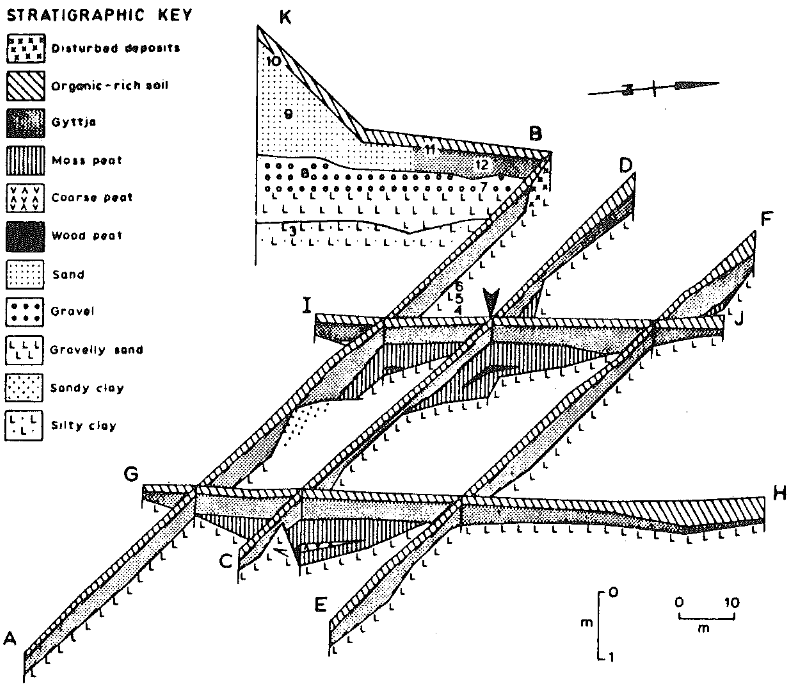

Figure 14. Stratigraphic diagram of Willow Garth. Arrow shows coring site and numbers relate to bulk sampling locations (see Table 3). AB and BK represent east-west and north-south ditch sections respectively.

RADIOCARBON DATING

Ten ^{14}C dates, based on the 'organic' carbon fraction in the sediment, were obtained for the pollen core (Figure 15). As obligate submerged aquatic taxa were poorly represented in this sediment, the error due to incorporation of dissolved carbonates was probably small. The basal date of the organic deposit (115-118 cm) was 9460 ± 80 B.P. (SRR-2674). Other dates obtained suggest that there have been one, or possibly two breaks in deposition, one from c. 7980-4150 B.P. and the other (less certainly) from c. 3300-2200 B.P. These are thought to correspond to drier periods with organic matter oxidation rather than to peat growth and subsequent erosion.

SEDIMENT ANALYSIS

Silty clay

This is an inorganic, structureless sediment with a moderate $CaCO_3$ content and very little sand and gravel (Table 3, sample 3). The grain size characteristics are quite unlike those of the till, sampled some 500 m upslope in Sands Wood (Table 3, samples 1 and 2), so the deposit is not a downslope extension of the till. Its predominant size range indicates a low energy environment of deposition, probably related to lacustrine conditions. As the sediment is not overlain by till, it probably post-dates the glaciation, but is late Devensian in age rather than Flandrian because the peat fragment above it at the southern end of the north-south ditch contains pollen indicating a Zone II/III age (see later for details). A lake could have resulted from ponding up of drainage waters by the retreating ice margin or on an irregular till surface. The deposit may extend northwards beneath the remainder of the site, but if so, it lies below the limit of augering.

Gravel and gravelly sand

This possesses very little organic matter, variable $CaCO_3$ and abundant chalk and flint mixed with some erratic components (Table 3, samples 4 to 8). The gravel and gravelly sand as a whole are fluvial because of (a) a fining upwards sequence in the east-west ditch section (samples 4 to 6), (b) the inclusion of sandy lenses within the gravel (sample 8) and (c) the gravel showing a longest axis preferred orientation parallel to the axis of the valley with an up-valley dip (Figure 16a), indicating deposition by water flowing down-valley. However, at the southern end of the north-south ditch section the upper 20 cm of the gravel deposit comprises densely packed angular chalk fragments, suggesting a soliflual origin. The deposits are therefore thought to be derived by solifluction from till and chalk on the valley sides and reworked in part by fluvial activity, a sediment type similar to that reported in other dip-slope valleys of the Wolds (Catt, 1982; Foster, 1985). The peat fragment is probably derived from a more extensive peat accumulation which suffered fluvial erosion.

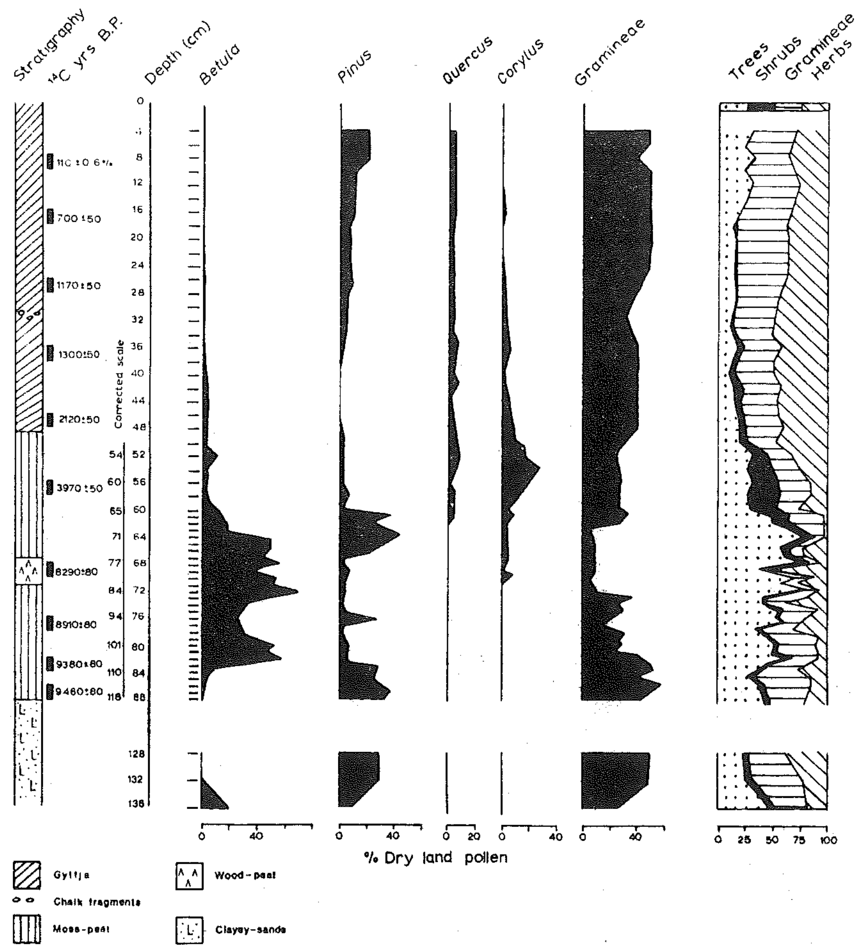

Figure 15. Willow Garth radiocarbon dates and pollen diagram showing selected taxa. The corrected depth scale adjusts for compression of the 50–118 cm section of the core by the Livingstone Piston Sampler.

Table 3. Sediment analytical data.*

Sediment	Sample number	% Gravel >2000 um	% Sand 2000-600 um	% Sand 600 - 200 um	% Sand 200 - 60 um	% Silt 60 - 20 um	% Silt 20 - 6 um	% Silt 6 - 2 um	% Clay <2 um	% Organic C	% $CaCO_3$
Gyttja	12	2.5	1.2	20.2	44.8	13.3	4.5	2.8	13.2	14.0	0.1
	11	5.5	3.8	25.3	36.0	14.9	4.7	3.9	11.5	6.3	5.0
Sand	10	1.4	1.9	28.4	45.5	9.8	3.2	1.4	9.8	1.8	0.1
	9	0.3	1.3	28.9	46.9	10.3	2.5	1.3	8.6	0.5	0.1
Gravel	8	22.3	5.6	62.7	18.7	4.6	1.8	3.3	3.3	0.1	6.1
	7	41.5	6.6	34.2	27.4	7.8	5.0	11.5	7.4	0.7	22.1
Gravelly Sand	6	3.8	3.3	25.6	20.7	15.4	11.3	14.0	9.7	1.4	43.5
	5	12.4	5.6	40.8	20.4	11.6	5.3	9.9	6.4	0.1	24.4
	4	16.3	6.1	49.1	18.6	10.9	3.6	8.5	3.1	0.6	17.0
Silty Clay	3	0.9	1.5	1.9	3.0	9.9	21.2	29.8	32.7	0.8	25.9
Sands Wood till	2	22.1	2.6	15.4	35.5	22.3	5.5	2.7	16.0	4.1	1.4
	1	10.0	3.0	12.5	34.8	22.6	6.9	2.7	17.5	3.5	0.6

* Gravel (>2000 um) is shown as a percentage of the total bulk sample. Sand, silt and clay percentages are calculated on a gravel-free basis.

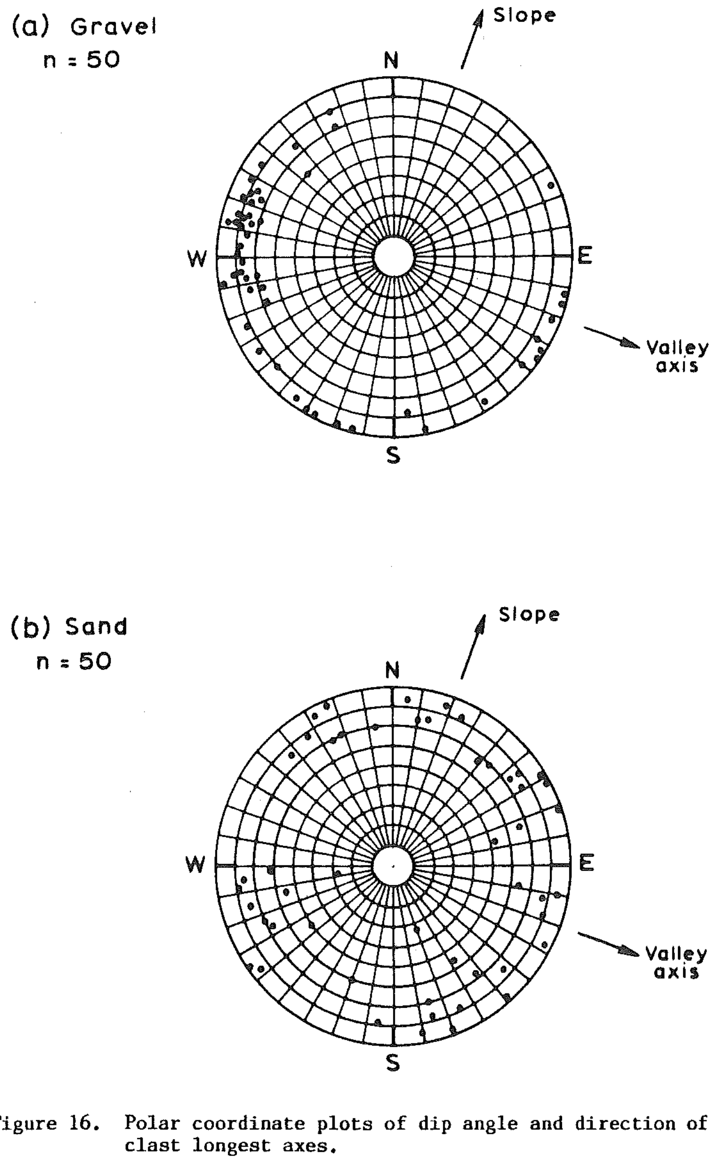

Figure 16. Polar coordinate plots of dip angle and direction of clast longest axes.

Sand

This is a well-sorted, structureless sediment of low organic and $CaCO_3$ content (Table 3, samples 9 and 10), containing randomly distributed chalk, flint and erratic clasts of up to c.5 cm longest axis. The absence of any observable bedding, either in the field or in thin section, suggests that it is unlikely to be a fluvial or slopewash deposit, as does the random clast distribution and the lack of preferred orientation (Figure 16b). With the exception of the larger clasts, these characteristics could, however, result from a periglacial aeolian origin, the material being banked against the valley side footslope. Sandy aeolian deposits are known to occur on both the Yorkshire and Lincolnshire Wolds (Straw, 1963; Bray et al., 1981), and Foster (1985) reported that many of the soils on the northern Yorkshire Wolds contain a major sand component which may be aeolian; the sand at Willow Garth possesses grain size characteristics similar to these soils and also to aeolian sands in the Vale of York (Matthews, 1970) and the Netherlands (Maarleveld, 1960). It is unlikely that the larger clasts within the sand have been transported by wind action, and these were probably incorporated from the till and weathered chalk bedrock upslope by colluviation. This process is likely to have been confined to the cold conditions of the late Devensian because the sand contains little organic matter and no macrofossils, palaeosolic layers or pedorelicts.

Gyttja

Although peaty in appearance, the organic content of this sediment is not very great, and its $CaCO_3$ content is low (Table 3, samples 11 and 12). At the coring site its base has yielded a date of 2120 ± 50 B.P. (SRR-2669) (Figure 15). The mineral component of the gyttja was probably derived largely from the sand, since the sediments merge laterally and have similar sand contents. However, the slightly higher silt and clay content of the gyttja (Table 3, cf. samples 11 and 12 with 9 and 10) may indicate that some of the sediment was derived from the Gypsey Race. This depositional episode could result from soil erosion caused by ploughing, as arable farming at this time is indicated in the palaeobotanical record (Bush, 1986). Evidence for soil erosion within the last 2000 years or so is also provided by palaeosol observations at archaeological sites elsewhere on the Wolds. For example, at Paddock Hill and Hutton's Plantation (TA 0270) some 10 km further up the Great Wold Valley, brown earths are buried in situ beneath Bronze Age and slightly younger earthworks, whereas adjacent modern soils are thinner brown rendzinas (Avery, 1980), indicating the loss of 20-30 cm of topsoil since earthwork construction.

There is a gap of several millenia between deposition of the late Devensian gravel and gravelly sand and the overlying gyttja. This may represent either the removal of any sediments which may have accumulated prior to the gyttja, or the prevention of such an accumulation. The former situation could have resulted from fluvial erosion, although the coring site, which is close to the central axis of the valley, shows no evidence of fluvial disturbance. If erosion occurred elsewhere, the coring site might have been protected by an upstream barrier; perhaps the flow of water through the

Willow Garth fenland was ill-defined and irregular, giving rise to erosion in some areas and not others. The prevention of sediment accumulation could have occurred due to the oxidation of organic matter during drier climatic conditions if the sediments were exclusively organic. Indeed, two such phases are indicated at the coring site by hiatuses in the moss and wood peat section of the core, as noted earlier.

POLLEN AND MACROFOSSIL ANALYSIS

The late Glacial

Fossil evidence of this period is contained in the peat fragment in the north-south ditch and the sediment at the base of the coring location (Figure 15). Preservation within the peat fragment was extremely good and its fossils suggest that deposition took place during a period of extreme cold. The lower 5 cm of the deposit, thought to have been laid down in Zone II/III, is made up of Drepanocladus revolvens, Calliergon giganteum, Calliergon giganteum/sarmentosum and Amblystegium spp., and above this there is a sudden change to a moss flora dominated by Scorpidium scorpidioides. The paucity of macrofossils and pollen suggests an environment in which there was a high proportion of bare ground. Cyperaceae dominate fruit and pollen spectra although there are strong peaks of other taxa, for example Selaginella selaginoides and Sanguisorba officinalis. There is evidence of a progressive diversification of habitat, but little to suggest a strong climatic amelioration. Notaris aethiops, Otiorynchus nodosus and Olophrum fusca, typical 'cold' species, give way to Siphon spp. and the groundbeetle Petrobus cf. assimilis, although the continuing presence of the stenothermic species Arpedium brachypterum shows that this might represent a change in habitat rather than a significant climatic amelioration. Unusual features of this assemblage are the presence of the pollen of Gentiana verna and Gentiana pneumonanthe, and the first macrofossil of Diphasium alpinum from the British Quaternary.

The base of the core (118-136 cm) probably represents the same period as the peat fragment in the recolonisation of this site, since a rich tundra flora is also indicated, including Gentiana spp., Saxifraga spp., Helianthemum and Campanula. The sediment contains fragments of Alnus stemwood, the largest of these being 7 x 2 x 1 cm. This is the earliest macrofossil record of Alnus from the British late Quaternary and supports Godwin's (1975) view that Alnus probably survived throughout the late Glacial and early Flandrian periods. Leaves, fruits, male catkin fragments and female catkin scales of Betula nana are among the macrofossils, and tree birch reaches a peak at 120-116 cm with 78% of the total propagule sum.

The early Flandrian

The earliest ^{14}C date is from a moss peat with some timber (Alnus) fragments at 118-115 cm (9460 ± 80 B.P.) (Figure 15). Preservation of the mosses is generally good, with many fragments identifiable to species, including Calliergon giganteum, C. cuspidatum and Amblystegium riparium. The initiation of peat accumulation indicates a change in the local hydrological regime;

the stream which had deposited the underlying sediment ceased to flow and hollows in the valley floor started to develop a moss flora. The abundance of arctic-alpine species represented in the pollen and propagule records declines gradually and they are replaced by Betula pubescens and holarctic grassland taxa, for example Helianthemum and Campanula. The presence of Cladium mariscus (10 fruits) at 116-112 cm, a known thermophile (Conway, 1938), marks the climatic amelioration heralding the start of Zone IV, probably c. 9400 B.P.

At c. 8800 B.P. there is evidence of the transition from Pre-Boreal to Boreal forests. Pinus pollen increases to a peak of 30%, which may represent the peak of Pinus commonly associated with Zone V (Godwin, 1975). Quercus and Corylus pollen begin to occur regularly as Betula pollen decreases (24% at 93 cm). This is the expected rise of temperate forest taxa, but the succession is interrupted; Pinus suddenly falls to its 'background' count of 3%, the temperate forest trees all but disappear and there is an irregular resurgence of Betula to a maximum of 68%. Betula therefore appears to have re-asserted dominance in the forests of the Wolds at a time when Corylus and Pinus were dominant in most other parts of lowland Britain. Throughout this period there is strong evidence of not only a rich fen flora but also the continued survival of chalk grassland, evidenced by Lotus, Bellis, Plantago media/major, Centaurea nigra, Teucrium botrys and Gramineae. Four consecutive samples contained Gramineae pollen larger than 44 um (annuli up to 11.5 um), which are probably Avena or Hordeum types (R. Scaife, pers.comm.). In addition, there is pollen and propagule evidence suggesting disturbance. Chenopodium album occurs regularly, and Atriplex patula, Stellaria media, Aphanes microcarpa, Polygonum lapathifolium and Plantago lanceolata are also present. Further evidence of forest disturbance is provided by the insects Cantharis rustica, Serrica brunea and Philopertha horticola, all of which are dry grassland species.

One explanation of these data would be that Mesolithic man was utilising the Great Wold Valley as a hunting ground. There were several Mesolithic camps in the vicinity (Earnshaw, 1973) and Willow Garth would have been ideal for their needs. The juxtaposition of a string of valley fens and pools, and light woodland on the surrounding slopes would have provided ample opportunity for hunting, a setting in many ways similar to that of Star Carr in the Vale of Pickering. The sand deposit on the valley side footslope was probably the area colonised by the Pinus, and may have provided the preferred soil conditions for Mesolithic camp sites. The arrival of Mesolithic hunters might therefore coincide with the sudden decrease of Pinus. The forest disturbance may have been through felling, though probably not burning as there is no evidence of charcoal. Salix timber is present but so is that of Quercus, a tree which is unlikely to have grown on the fen surface. Chippings and debris, produced by felling trees, may therefore have been carried downslope into the fen. The irregularity of the Betula regrowth suggests that there were two clearance phases, one from c. 8800-8600 B.P. and the other from c. 8400-8250 B.P., between which the site may have been temporarily abandoned, or the regrowth was not sufficiently dense to interfere with hunting.

Between 8200 and 7980 B.P. there is a decline in Betula pollen and propagules, and a rise of Pinus pollen to 43% at 70 cm. This could represent regrowth of Pinus on the sandy soils of the abandoned Mesolithic camp. The decline of Betula during this period may represent successional change as Quercus, Alnus and Corylus expanded. It is important to note that throughout this period there is an increasing diversity of pollen and spores, and that the indicators of unshaded dry grassland habitats and disturbance mentioned above are present in all the samples. Late Mesolithic activity is well documented from Bessingby, a few kilometres to the east, and it is possible that, although forest disturbance continued at Willow Garth, the camp had been abandoned in favour of this site nearer the coast. Between c. 7980 and 4150 B.P. (67 cm) there appears to have been a period of no net peat accumulation.

The late Flandrian

This period has evidence for the expected open landscape with remnant woodlands containing Tilia, Quercus and Corylus. Evidence of arable farming and chalk grassland is present throughout. Tilia never exceeds 2.5% of the total dryland pollen count and has all but disappeared by 3400 B.P. Between c. 3300 and 2200 B.P. there is a second hiatus, although there is no change in the pollen or macrofossil record at this point. At c. 2200 B.P. there is a change in the sedimentary environment as the moss peat gives way to moss-rich gyttja. This might be the result of soil erosion following ploughing of the valley sides, as suggested earlier.

From c. 1300 B.P. onwards there is evidence of a progressive drying of the site. Carychium minimum replaces a rich aquatic mollusc fauna, and there is a progressive change in the bryophyte flora from a fen to a woodland community, the latter including Aulocomnium androgynum, Eurynchium spp. and Hypnum cupressiforme. At the same time Salix pollen increases in abundance. It is suggested that the site was managed as an osier bed from c. 1100 B.P. Osiers were important for a variety of trades in medieval times and there would have been very few suitable locations for their cultivation on the Wolds. This would confer an importance on this wetland which might explain why it was never drained. One piece of circumstantial evidence for a long-standing osier bed is that this is the only known location of Salix purpurea in East Yorkshire and Humberside, such disjunct distributions often suggesting antiquity.

SUMMARY

The proposed sedimentological and vegetational history of Willow Garth may be summarized as follows:

(a) Deposition of Devensian till followed by accumulation of silty clay, probably under lacustrine conditions shortly after ice retreat.

(b) Late Devensian solifluction and fluvial activity depositing and reworking the gravel and gravelly sand in an environment

supporting a rich tundra flora, followed by aeolian deposition and colluvial reworking of sand under periglacial conditions.

(c) Accumulation of moss and wood peat from Zone II/III to c. 2200 B.P. accompanied by varying degrees of removal due to oxidation and/or fluvial erosion. There may have been a Mesolithic settlement in the vicinity of Willow Garth, with felling of the local early Flandrian woodland, which regenerated c. 8000 B.P. following abandonment of the site. The Pre-Boreal and Boreal forests failed to exclude the heliophilous plant and animal taxa of the Great Wold Valley, and it is suggested that chalk grasslands were continuously present throughout these periods and have been anthropogenically maintained thereafter. This confers a considerably greater antiquity on this community than has been previously supposed.

(d) Mineral-organic sedimentation commencing around 2200 B.P., probably as a result of soil erosion caused by arable farming. Progressive drying of the fen from c. 1300 B.P. onwards, accompanied by a change to a woodland community, and management of the site as an osier bed from c. 1100 B.P.

SEWERBY

J. A. Catt

INTRODUCTION

The cliff section between the northeast end of Bridlington sea wall and Sewerby steps (Figure 17) provides an oblique section through the Ipswichian cliff and beach deposits, which are buried by late Devensian solifluction deposits and Skipsea Till. The fossiliferous interglacial deposits were investigated in the 1880s by the British Association (Lamplugh, 1891a, b) and the Geological Survey (Reid, 1885). Foreshore exposures in May 1963, which are projected onto the cliff section (Figure 17), clarified the relationship of the interglacial beach deposits to the Basement Till (Catt and Penny, 1966).

THE INTERGLACIAL SUCCESSION

The excavations of the 1880s revealed the following sequence of deposits banked against the cliff and resting on the beach platform cut in Upper Chalk at approximately 2 m O.D. (Lamplugh, 1891b):

c) Yellow aeolian sand, up to 8 m thick near the cliff

b) Chalky rainwash or colluvium, 1.5 m thick, which partly interdigitates with:

a) Beach shingle of chalk cobbles and erratics, 1.5 m thick

The mammal remains found by the British Association Committee were revised by Boylan (1967b) and are listed together with molluscs in Table 4.

The succession records a declining sea level, from the time when waves reached the cliff foot, cutting a cliff notch and depositing the shingle (bed a), to a later period when rain washed chalky colluvium down the cliff face but the sea was too low to clean it completely (bed b), and finally to a dry period also of low sea level when sand was blown against the cliff (bed c), polishing the chalk face. Typical interglacial mammals occur in all three beds, so the climate was warm throughout, despite the declining sea level, unless the remains in the colluvium and aeolian sand were derived by mass movement from earlier deposits slightly inland. The mammalian assemblage is similar to other Ipswichian deposits in Britain, including Victoria Cave near Settle, West Yorkshire, where an age of 120000 yr (oceanic stage 5e) or older is indicated by $^{230}Th/^{234}U$ dating of flowstones around the bones (Gascoyne <u>et al</u>., 1981).

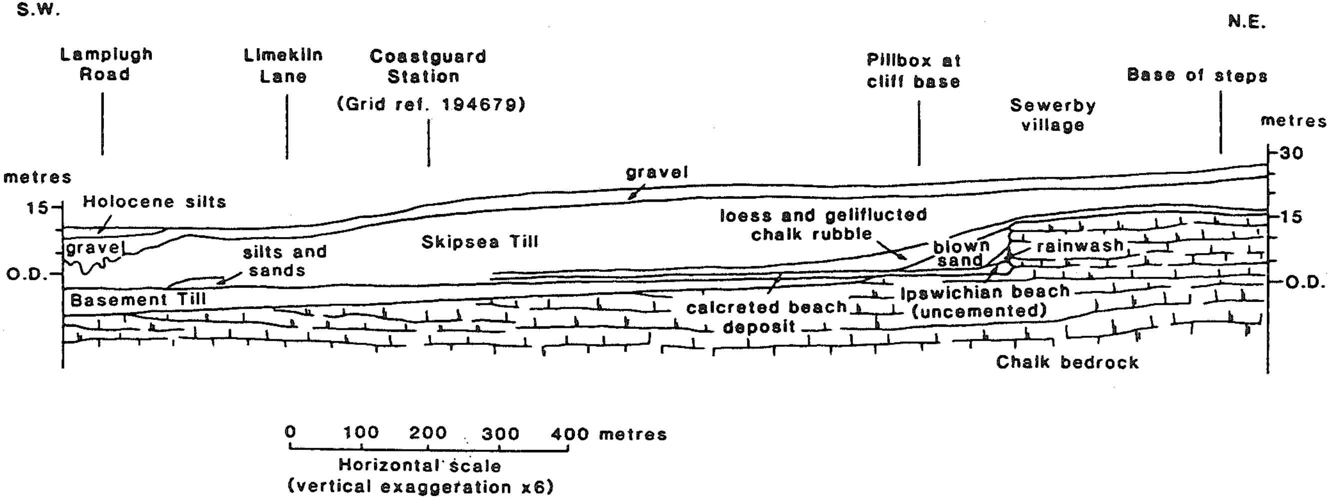

Figure 17. Cliff section at Sewerby, sketched from periodic cliff and foreshore observations 1960–64 (from Catt and Penny, 1966).

Table 4. **Fauna of the Ipswichian interglacial deposits at Sewerby.**

MAMMALIA	Beach shingle	Colluvium	Aeolian sand
Hyaena, Crocuta crocuta (Erx.) (an ulna and gnawings on other bones)	*		*
Bear, Ursus sp. (a lower jaw)		*	
Straight-tusked elephant, Palaeoloxodon antiquus (Falc. & Caut.) (4 tusk fragments and many molars)	*		*
Narrow-nosed rhinoceros, Didermocerus hemitoechus (Falc.) (16 cheek teeth)	*		*
Hippopotamus, Hippopotamus amphibius L. (fragment of canine tooth and a molar)	*		
?Giant deer, Megaceros giganteus (Blum.) (antler fragments)		*	
Bison, Bison cf. priscus (Boj.) (left metatarsal, left metacarpal, calcaneum)	*	*	*
Water vole, Arvicola terrestris L. (cheek tooth and two incisors)		*	
MOLLUSCA			
Littorina littorea L.	*		
Ostrea edulis L.	*		
Mytilus edulis L.	*		
Purpura lapillus L.	*		
Pholas sp. (borings)	*		
Saxicava sp. (borings)	*		
Helix hispida L.		*	
Helix pulchella Müll		*	
Pupa marginata Drap.		*	
Zua subcylindrica L.		*	

LATE DEVENSIAN DEPOSITS

Confusion arose over the relationship of the interglacial beach deposits to the Holderness till succession, because Lamplugh originally (1887) identified the till above as the 'Lower Purple' (= Skipsea of modern nomenclature) but later (1890b) as the Basement. Bisat (1939) and later workers have felt that Lamplugh's first opinion was correct, and Catt and Penny (1966) showed that this till resembles the Skipsea Till in matrix colour, erratics and heavy minerals. Its macrofabric indicates an E-W ice movement, but this is probably a local vector caused by eddying in the lee of Flamborough Head (Penny and Catt, 1967). The overlying gravels, which cap the modern cliff, are probably outwash from the same ice sheet. They contain occasional ice-wedge casts, and in sections now obscured by Bridlington sea wall they were overlain by late Glacial and Holocene freshwater silts (Lamplugh, 1881c).

Between the interglacial sand and the Skipsea Till is a rubbly gelifluction deposit composed of angular, frost-shattered chalk and flint fragments in a mixed and rather variable matrix of white crushed chalk and yellowish silt (loess) with some sandy layers possibly derived from the aeolian sand. This deposit is thin (<30 cm) over the cliff itself, but thickens southwestwards to 6 m. It contains terrestrial molluscs (Lamplugh, 1903), such as *Pupilla muscorum* (L.), *Trichia hispida* (L.) and *Deroceras* sp., which suggest a moderately severe periglacial climate; Lamplugh (1891a) also reported a limb bone of *Bos* or *Bison*, though this could have been derived from older deposits. Because the loess component is mineralogically similar to silt from the Skipsea Till, and was probably blown from outwash of the late Devensian ice sheet, Catt *et al*. (1974) suggested that the chalk rubble was deposited shortly before the late Devensian glacier arrived. This is supported by a thermoluminescence date of $17.5 \pm 1.6 \times 10^3$ years obtained on loess from a similar deposit beneath the Skipsea till at Eppleworth, near Hull (Wintle and Catt, 1985). It is therefore likely that there was a time gap of about 100000 years between deposition of the aeolian sand and the chalk rubble.

RELATIONSHIP TO THE BASEMENT TILL

Foreshore exposures in May 1963 showed that the Basement Till occurs at approximately -3 m O.D. south of the buried cliff, and is there overlain usually by the late Devensian gelifluction deposit (chalk rubble). In some of these exposures, however, a thin calcreted beach deposit occurred between the gelifluction deposit and a reddish weathered surface of the Basement Till. This beach deposit contained rounded erratics as well as chalk and flint pebbles, and also fragments of the same marine molluscs as Lamplugh recorded from the interglacial beach deposit in the excavations at the foot of the buried cliff. The pebbles were much smaller than those in the beach at the foot of the buried cliff, and the deposit was cemented into calcrete because it rested on impermeable till, whereas at the cliff it is not cemented because it rests on Chalk. Catt and Penny (1966) suggested that as the sea level fell towards the end of the Ipswichian, a regressional beach was deposited at successively lower levels and greater distances from the cliff;

near the cliff it was deposited on a chalk platform, but further south it regressed onto a weathered surface of Basement Till, indicating that the Basement is pre-Ipswichian. These exposures have never been visible again. As a till resembling the Basement overlies gravels containing derived Hoxnian artefacts and mammalian remains at Welton-le-wold, Lincolnshire (Alabaster and Straw, 1976), the Basement must have been deposited during the Wolstonian stage as defined by Mitchell *et al*. (1973).

THE LATE QUATERNARY LAKE MARGIN SEQUENCE AT SKIPSEA WITHOW MERE

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INTRODUCTION

The deposits of the former Skipsea Withow Mere are exposed in cliff sections at the Withow Gap (TA 184547). The eroding cliff has produced a series of exposures showing the complexity and importance of lake margin deposits at this site. The site played an important role in (a) Sheppard's (1912) study of coastal erosion (b) Sheppard's (1956, 1957) historical geography of Holderness meres and (c) a heated discussion on the antiquity of flints and Maglemosian harpoons, giant elks and worked flints, which later involved a misattribution of late Devensian sequences to the early-mid Flandrian. The site was one of the earliest in Britain at which archaeological remains were dated by pollen analysis (Godwin and Godwin, 1933). This and neighbouring sites were the subject of inter-disciplinary studies reported in Gilbertson (1984).

THE LATE QUATERNARY SEQUENCE

The sequence as understood in 1984 is illustrated in Figure 18 and described below:

Unit No.	Maximum thickness in m	Description
11	0.15	Man-made ground and structures.
10	0.10	Modern soil; grey clay/silt beneath a thin, compacted turf line. ?Colluvium: ploughwash? Unconformably resting on:
9	0.20	Grey sandy silt; occasional peaty inclusions. Colluvium-hillwash? Unconformably resting on:
8d	2.50	Detrital and in situ moderately humified marsh and carr peats; includes sandy partings in strongly laminated, quasi-horizontally bedded layers. Cut-and-fill stratification present near stream. Dense packing of brushwood, with larger flat-lying trunks of *Alnus*, *Fraxinus*, *Quercus* and *Corylus*; abundant hazel nuts.
8e	0.10	Well-sorted sand lens, thins into lake

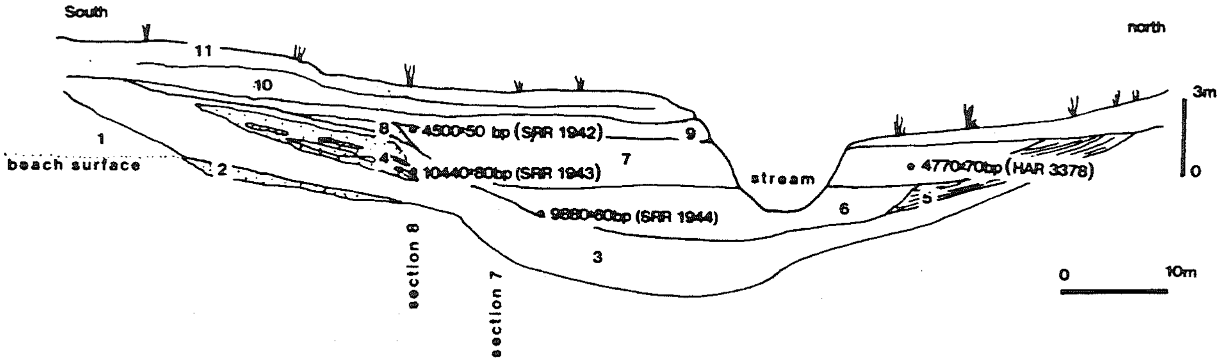

Figure 18. Outline of the stratigraphy at Skipsea Withow Gap.

		deposit: ?beach (lake) sand derived by erosion and sorting of till or Unit 4.
8b	0.05	Silt; blue, pebbly in parts: ?reworked from Unit 3.
8a	0.05	Poorly sorted pebbles and silt: ?slump or inwash from Unit 4? Erosional surface below 8a with flint and chalk fragments; acorns and hazel nuts.
		The in situ and reworked alder carr is also associated with early Neolithic wooden rods and pegs. One carved wooden stake at this level was radiocarbon dated at 4770 ± 70 B.P. (HAR-3378). This was at the same level as a stake with the characteristic 'heel of coppicing' and poles that had bent into 'zig-zags' as a result of being pushed when 'green' into the underlying peat surface. The uppermost 0.05 m of Unit 8 was radiocarbon dated at 4500 ± 50 B.P. (SRR-1942). This unit continues below without apparent break into:
7	1.70	Brown silty peat; strongly laminated, with abundant flat-bedded brushwood and numerous substantial horizontal branches and tree trunks up to 0.3 m diameter of <u>Quercus</u>, <u>Pinus</u>, <u>Alnus</u>, <u>?Fraxinus</u> and <u>?Corylus</u>. Lacustrine shallow water deposits. Apparently conformable transition below to:
6	1.25	Dark brown silty peat; occasionally horizontally-bedded trunks and branches up to 0.2 m diameter of <u>Alnus</u> and <u>Betula</u>. The basal 0.05 m of this deposit was radiocarbon dated at 9880 ± 60 B.P. (SRR-1944).
6b	0.05	Occasionally separated from the deposits below by a lag deposit of angular to rounded flints. Unit 6 rests unconformably upon:
5a (north exposure)	0.10	Orange-brown sandy silt, often strongly weathered.
5b (south exposure)	0.16	As 5a; thinly downslope-bedded; occasional small rounded pebbles; apparently cross-laminated, but may be infill of root holes. In the central exposure, the layer is distorted by slumps, minor folds and erosional hiatuses, pre-dating the peats of Unit 6.
4vii	0.02	Reworked detrital peat pellets on clear erosional surface developed upon Unit 4vi. It is uncertain whether this surface extends above or below Unit 5b.

4vi	0.15	Sandy gravel; poorly sorted, often structureless: ?slump or reworked gravel? Underlain by:
4v		Erosional surface developed across Unit 4d; it is uncertain whether this surface extends above or below Unit 5b.
4d	1.4	Coarse gravels and pebbles; poorly sorted; interfingers with alternating layers of silts/clays, often pebbly and dipping northeast; frequent graded bedding fining upwards in and between layers. Unit coarsens to the southwest and former lake margin. Lobes due to slumping introduce both younger deposits and macrofossils into this layer. ?Slump reworked in lake at lake margin? Apparently conformable relationships below with:
4iii	0.15	Sandy silt; poorly sorted; occasional small rounded gravel; twigs of <u>Betula</u> at base; thickens to the east to form a depression 0.3 m thick, possibly a slump into a slump scour hollow. The layer rests unconformably upon:
4ii	0.06	Detrital <u>Carex</u> peaty silt with plant and molluscan remains; occasionally disturbed by folds/slumps; yielded a tree birch log radiocarbon dated at 10440 ± 80 B.P. (SRR-1943). Downward penetrating lobes of sediment caused by slumping and load casting bring both superjacent deposits and macro-fossils down into this layer. The tree birch sample may have been introduced in this manner. In situ and reworked marsh/lake margin soil/ sediment surface. This layer rests unconformably upon an erosional surface truncating:
4c	0.45	Coarse gravel; poorly sorted, downslope-bedded, alternating with, and fining upwards into, intrusive layers of laminated dark blue/ grey silts of Unit 3; often weathered, blue to orange/brown.
4b	0.5	Gravels as 4c, but divided from 4c by the plane of a major lateral slide which appears to have an eastward component of 1-2 m lateral displacement.
4a	1.6	Gravels and pebbles; poorly sorted; thins rapidly to the east/northeast. Throughout sections 7 and 8 (Figure 18), the deposits of Unit 4 are affected by slumps and a complex sequence of faults, which are often further displaced by a later lateral slide, and:

3 B/C/D	2+	Silt and clay; thinly laminated, occasional discontinuous, thin (1 mm) detrital peat/soil? layers and pebble bands, both at former lake margin; sticky-plastic textures; grey/blue with occasional blue crystals of vivianite; the unit interdigitates with the gravels of Unit 4. Fragmented plant debris and molluscan remains common in some locations, especially the decomposing/rotten shells of large fresh-water bivalves (?Anodonta sp.). A compressed log of tree birch in 'blue' clay stratigraphically equivalent to or slightly below the gravels of Unit 4, was found in situ exposed on the beach 100 m southeast of the Withow gap. This was radiocarbon dated at 10710 ± 70 B.P. (Q-3035). It is uncertain whether or not the blue clays of Units 3 B/C/D are separated by an erosional surface from the underlying clays/silts of:
3a	1+	Pale grey/white/brown clay and silt. Lowest 0.4 m contains textural varves at northern exposure. These are overlain by 0.4 m of silts with thin layers of white precipitated carbonates in 2-3 mm layers, alternating with grey silts. Mottles and brown discoloration suggest minor episodes of weathering and the former development of gley soils. Occasional discontinuous, 1-2 mm thick layers of compacted in situ and detrital peats. Flint blade found in association with a thin detritus, silty peat. Sporadic fragmented plant macrofossils; rich in molluscan remains, especially Valvata piscinalis. In the northern and central exposures Unit 3 deposits are affected by a complex sequence of normal faults and a lateral slide.
2b	0.1+	Sands; well sorted; downslope-bedded; occasional pebbles: ?lag deposit?
2a	0.2+	Sandy clay; poorly sorted; quasi-bedded downslope, elsewhere showing slump structures and folds. Includes striated cobbles from tills below. Weathered on upper surface; mottled. Mudflow, slumps and downslope hillwash weathered and ?affected by later development of gley soils?
1	>1.5	Skipsea till. Brown sandy weathered zone around 0.2 m deep; 2 mm wide fissures: ?tension cracks?

PALYNOLOGICAL RESULTS

A pollen diagram from Skipsea Withow Mere is shown in Figure 19. It is located near section 7 (Figure 18) and extends from Unit 3 to the upper surface of Unit 7, passing into Unit 6 at the position from where the radiocarbon date of 9880 ± 60 B.P. (SRR-1944) was obtained. This site has been lost to the sea since 1982. The diagram has been divided into six local pollen assemblage zones as follows:

Zone WM1 — (2.65 m) Dominated by *Betula* pollen. Small values for *Pinus*, *Salix* and Gramineae. Possible date: late Devensian (before 10000 B.P.).

Zone WM2 — (1.65 m) High values for *Betula*, Gramineae and Cyperaceae. Possible date: late Devensian/early Flandrian.

Zone WM3 — (1.62-1.22 m) Dominated by *Betula* and *Corylus* pollen. *Quercus* and *Alnus* appear at the end of the zone. Possible date: early Flandrian (c. 10000-7000 B.P.).

Zone WM4 — (1.22-0.67 m) *Alnus* is dominant. *Quercus*, *Ulmus* and *Tilia* are also present. *Fraxinus* appears and *Pinus* disappears during the zone. Possible date: Flandrian (c. 7000-5000 B.P.).

Zone WM5 — (0.67-0.42 m) There is a reduction in total tree pollen percentage, followed by a recovery. The trees most affected are *Alnus*, *Ulmus* and to a lesser extent *Tilia*. Gramineae pollen reaches a peak. Cereal and *Plantago* pollen is present. Possible date: Flandrian (after c. 5000 B.P.).

Zone WM6 — (0.42-0.02 m) There is another reduction in total tree pollen percentage, and recovery this time is only partial. The trees chiefly affected are *Alnus* and *Ulmus*. Cereal and *Plantago* pollen are continuously present. Possible date: Flandrian (after c. 5000 B.P.). The ^{14}C date of 4500 ± 50 B.P. (SRR-1942) at 0.02 m does not conflict with this, but seems rather old.

Details of plant macrofossils and molluscan assemblage zones are given in Gilbertson (1984).

THE LATE DEVENSIAN

Deglaciation

The early post-depositional history of the till (Unit 1) is known in more detail than is commonly the case. Initially weathering features and tension cracks developed, presumably reflecting a partial drying out of the till surface; gleying suggests that the immature, skeletal soils were subject to periodic waterlogging. Mudflows and slumps occurred, followed by shallow faulting of the surface materials (Unit 2a). This episode was followed by the deposition of

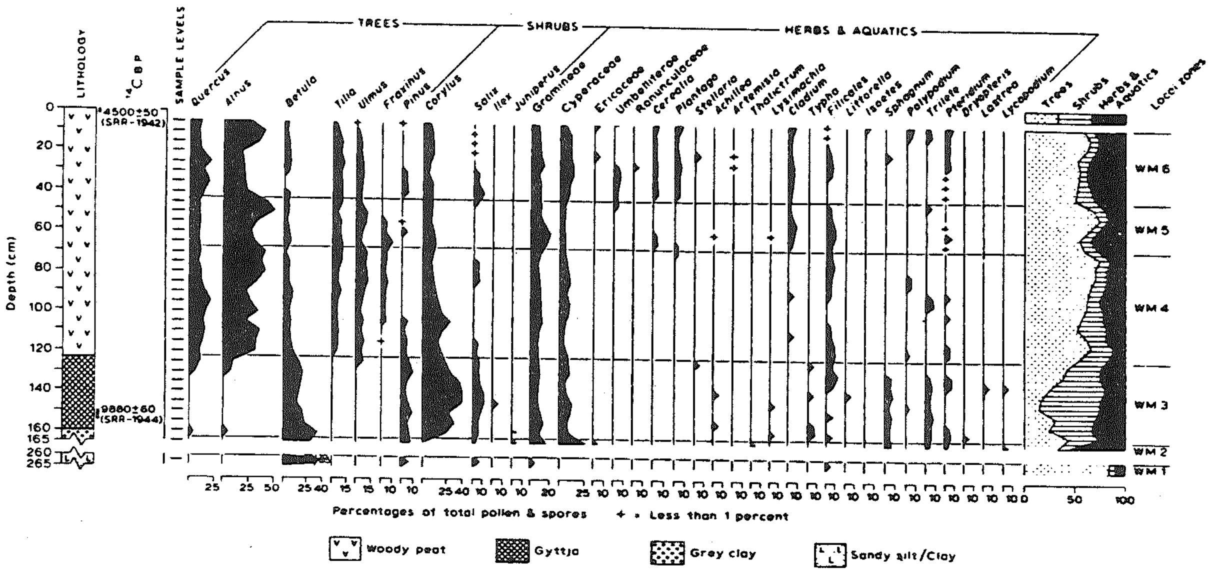

Figure 19. Pollen diagram from Skipsea Withow Mere (analysis by A.M. Blackham). Values are shown as percentages of total pollen and spores.

a hillwash deposit and then by the inundation of the existing sequence by the waters of a lake which reached 8+ m above the present beach, almost to the highest point reached by the present cliff face. Elutriation by waves or shallow currents appears to have removed the fine fraction from the lake margin deposit, leaving a pebble-rich lag deposit (Unit 2b).

Ameliorating conditions

The next phase of deposition is recorded only at the highest margins of the former lake. Varved sediments (Unit 3a) indicate repeated freezing of the lake, deposition of clays within this unit occurring at times of ice cover. Pioneer plant and animal species are shown to have colonised both the lake and the surrounding catchment at this time. *Chara* and pondweeds grew in the deeper water while the lake margins were colonised by *Hippuris* and *Eleocharis*. The adjacent hillslope soils were immature, contained little organic matter, and were covered in a mosaic of mosses, light-demanding herbs and shrubs, and eroding open ground. The lake was rapidly colonised by freshwater molluscs, especially bivalves. Water conditions were improving. The input of organic detritus was rapidly increasing, and water hardness increased from very low to moderately high levels as carbonates were washed from the chalk-rich soils into the lake. The 'textural' varves were replaced by layers of carbonate precipitates suggesting notably hard water. On several occasions the lake margin was sufficiently stable for fringing reedswamp to spread onto its sediments, eventually forming thin layers of peaty silt. The rate of erosion of the catchment soils was declining, causing fewer re-cycled palynomorphs to be deposited in the lake.

The vegetation of the catchment was still open in aspect, but was now starting to reflect milder, stable conditions. Thickets or a parkland of birch and poplar-aspen developed within a widespread ground cover of light-demanding and, increasingly, warmth-demanding herbs. Dwarf birch was present, as was *Filipendula*, which has a present northern limit coinciding with the 14 °C July Isotherm in northwest Europe (Seddon, 1962). The accumulating lake margin deposits were disrupted by local, small-scale faulting. Lake levels fluctuated, causing erosion of the lake margin and truncation of its sediments. It is likely that these events reflect the general climatic improvement, thawing and dewatering of the slope and marginal deposits. The Mesolithic blade (the 'Skipsea blade') found in these deposits indicates human activity in this early deglacial landscape. The generally high lake levels were probably caused by climatic factors.

Fluctuations in an improving environment

The next major event is indicated by the erosional surface which is marked by the base of Unit 4vi. This surface extends below modern beach level (Figure 18). It represents a substantial drop in lake level, and caused erosion of the abandoned lake margin deposits. Several possible factors might have been responsible. Higher temperatures may have increased evaporation and/or precipitation input may have declined. The spreading tree/shrub cover 'pumping' water from the ground through evapotranspiration may have reduced surface and soil water. Alternatively, the final melting of large, incorporated ice-blocks nearby in the till may have caused breaching and draining of the lake.

After this lowering, the ameliorating trend noted earlier was re-established, and the lake level returned to within 2-3 m of its former level. The dominant deposit was the sticky-plastic grey/blue silt (Unit 3 B/C/D). The lake and its margin now supported a relatively rich flora of vascular plants, as well as desmids, Zygnemataceae, Pediastrum, and dinoflagellates (Hunt et al., 1985). The rich and abundant molluscan fauna included several taxa requiring summer warmth. Erosion of the surrounding hillslope soils decreased further in intensity, because there are fewer microfossils derived from the till. There was a relatively complete ground cover with grasses, herbs and dwarf shrubs.

Macrofossils of tree birch and juniper occur, demonstrating the increasing diversity of the ground cover, and suggesting the presence of a birch-poplar/aspen-juniper parkland. At several points in the central areas of the exposure, Unit 3a strata are overlain unconformably by peats. It is possible that some of the artefacts and vertebrate remains recorded by Armstrong (1923a, b) derived from this deposit. However, no evidence of the 'punt-holes' inferred by Armstrong was detected. The resource potential of the lake and its catchment must have been high at this time.

Deterioration

In Unit 4a both the molluscan and palaeobotanical studies record an environmental deterioration. The content of recycled pollen increases, suggesting accelerated soil erosion in the catchment. Juniper and tree birch become much less frequent, and more cold-tolerant taxa such as Betula nana continue. The molluscan fauna declines rapidly in both diversity and numerical abundance.

Stability and instability

At or shortly after this deterioration, the history of the mere becomes more complex. Notably very coarse clastic sediments started to come into the lake at the southwest margins of the present exposure (Unit 4) from pockets of coarse glacial sands and gravels enclosed in the till at this location. The mass movement process responsible was localised, as these gravels do not occur on the northern face of the modern exposure and thin rapidly to the south. Graded bedding and interdigitating blue/grey silts, which indicate an aquatic depositional environment, are restricted to the lower half of the complex gravel member (Unit 4c). Their absence in the upper part of these deposits suggests that they are subaerial in origin. The cause of the mass movement/instability is obscure, but the climatic deterioration associated with Unit 4a may have served as a trigger.

This period of geomorphic instability was followed by limnological and biological stability. Molluscs indicate a biologically mature lake fringed with well developed hyroseral successions, and a mild summer climate. The palaeobotanical data suggest that only limited soil erosion was occurring in the catchment. Once again, the vegetation appears to have been a birch and poplar-aspen parkland with juniper and a ground cover of grasses, herbs and shrubs, including some thermophiles. The climatic amelioration continued until the base of Units 4v/4vi, when a sudden and marked deterioration is indicated. Although it cannot be rigorously demonstrated, it is likely that some of the more recent episodes of faulting and slides affecting these gravels were induced during and after this change. All lines of palaeontological evidence point to a sudden and distinct climatic decline. The palynological indications of soil erosion in the catchment increase markedly, the lake fauna declines in species diversity and overall numerical abundance, and the vegetation of the lake becomes extremely poor. The landscape changed from a parkland with herbs and grasses to a sedge-grass tundra with exposed soil patches and a few tree birch surviving in favoured locations.

THE FLANDRIAN

Amelioration

The landscape was progressively recolonised by more thermophilous tree taxa which were associated with a diverse shrub-herb flora. Tree birch replaced dwarf birch, only subsequently to decline in abundance due to competition. There were two notable local events in the history of the lake. First, a marked lowering of lake level due to climatic change resulted in the exposure, erosion and, on the northern side, weathering of the late Devensian lake silts; lake levels fell below modern beach level. The 'buff-silts' produced by weathering of the late Devensian lake margin deposits (Unit 5a) may have been the equivalent of those noted by Godwin and Godwin (1933). Mixed cold/warm plant-animal assemblages and archaeological remains occur at this level. Second, the lake level returned almost to its late Devensian level (c. 3-4 m above modern beach level) and organic muds accumulated, indicating a nutrient-rich, biologically active lake (Unit 6). This change occurred at or before 9880 ± 60 B.P. It is possible that the 'peat-stained' or immediately 'sub-peat' artefacts of Armstrong (1923a, b) came from these early Flandrian deposits.

At about 7000 B.P. the catchment was dominated by a mixed forest assemblage of oak, alder, elm and lime. The lake was now sufficiently infilled (Unit 7) to allow alder carr to extend away from the lake margin across the site, although some open water still prevailed. The climate might have been slightly milder than at present, with the dominant wind direction being from the SSW rather than W or SW.

Forest clearance and management

There is abundant evidence of forest clearance and early agriculture dating from c. 5000 B.P. Elm, alder and lime were the main trees felled, with plantains and grasses common in the grazed pastures. Cereal cultivation was also practised. The site is interesting because of the clear evidence of deliberate woodland management (the coppicing of alder carr) and of structures requiring piles and pegs at the lake margin (Unit 8). Presumably these were intended to aid exploitation of other biological resources in and around the lake. Further episodes of clearance and agriculture are recorded before the site was buried by the hillwash resulting from soil erosion sometime after c. 4500 B.P. (Unit 9). Historical data indicate that the mere continued to be important into late medieval times, when it was presumably breached and drained by coastal erosion.

CONCLUSION

The pattern of climatic change revealed at Skipsea Withow is similar to that of other late Devensian lake sites in Britain (Coope, 1977; Pennington, 1977; Flenley, this volume) and to the emerging sequence at Creswell Crags (Jenkinson and Gilbertson, 1984). Four divisions of the late Devensian are clear at Skipsea. An initial phase of rapid warming following deglaciation reached a peak, with mild or even warm summers; this corresponds fairly precisely to the pre-interstadial and Windermere interstadial of Coope (1977). This was succeeded at Skipsea by a short climatic deterioration. Many sites elsewhere record this episode, which is dated to c. 12000 B.P. (Coope, 1977). A period of fairly stable, mild climate followed. This corresponds to the milder part of the Windermere interstadial. The severe, sudden climatic deterioration of the subsequent Loch Lomond stadial stands out clearly in the impoverished floras and faunas of the Withow mere and other British sites. Consequently, the detailed palaeoclimatic and palaeontological information from the Withow site provides an important link between the more 'oceanic' sites of western Britain and those of the European mainland. In many ways the Flandrian history of the area is conventional, except for the evidence of very early woodland management.

THE ARCHAEOLOGY COLLECTION OF HULL CITY MUSEUMS AND ART GALLERIES

D. R. Crowther

INTRODUCTION

Displayed in the old Corn Exchange at 36 High Street, the Archaeology Collection of Hull Museums is among the finest of any provincial museum in Britain. The 'collection area' of the museum comprises the Vale of York, Yorkshire Wolds and Holderness (Figure 20); each landscape forms a distinctive component and offers a certain kind of archaeological resource be it wet, dry, buried or exposed.

The collections owe their importance primarily to J. R. Mortimer who, with his brother Robert, was a prodigious antiquary unmatched by any of his contemporaries. Throughout the latter half of the 19th century he excavated the barrow mounds that dotted the Wolds landscape around his Driffield home. Many of these structures, together with their contents, have long since been ploughed away, and exist today only as buried remnants. Mortimer's energy and, by the standards of his day, exemplary recording of no less than 365 barrow excavations (Mortimer, 1905) produced one of the great antiquarian collections of its time, so great indeed that he built a private museum in Driffield in which to house it. This also included tens of thousands of surface finds and an important collection of geological specimens.

From the turn of the century, Hull's first municipal museum curator, Tom Sheppard, had taken up Mortimer's own cause of trying to ensure the collection remained in Yorkshire. In 1916 it came to Hull, having been presented to the City by one Colonel Clarke who provided the £1000 necessary for its purchase after Mortimer's death. Today it offers invaluable insights into the technology, taste and ideology of generations of Neolithic, Bronze Age and Anglo-Saxon inhabitants of the region. Since the acquisition of the Mortimer Collection, the archaeology collection has expanded to include material from throughout the periods for which evidence of local human habitation can be found.

THE DISPLAYS

Hunter-gatherer communities of the Mesolithic were, in all probability, widespread in the region by 7000 B.C., and a collection of bone and antler serrated points or harpoons from Brandesburton in Holderness may, like Seamer Carr and Star Carr in the Vale of Pickering, indicate a focus of activity where fishing and hunting resources were available (Clark, 1954; Clark and Godwin, 1956; Schadla-Hall, this volume).

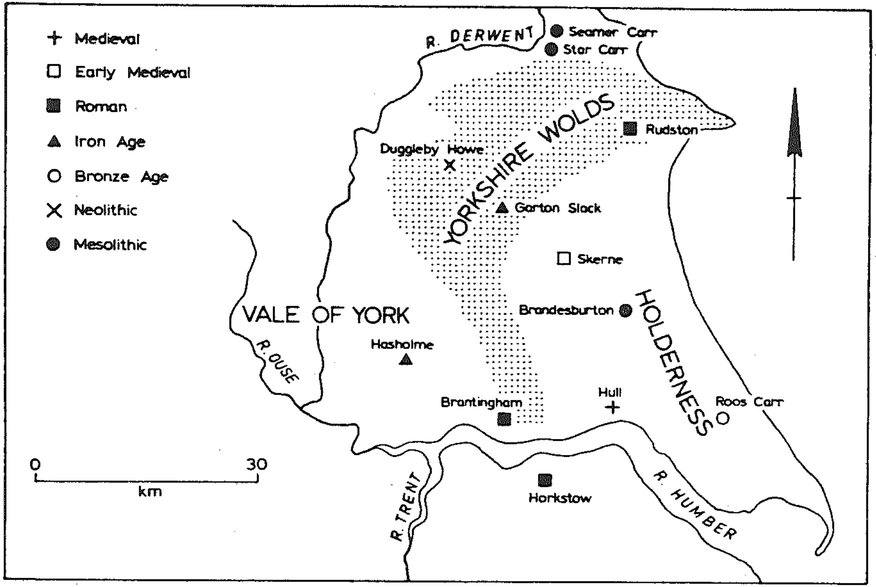

Figure 20. Location of archaeological sites.

After the first farmers settled in the 5th and 4th millennia B.C., the establishment of social hierarchy and order manifested itself in the archaeological record with the construction of great ceremonial or funerary monuments such as Duggleby Howe (Kinnes et al., 1983). Some of the spectacular Neolithic grave goods from the site are displayed.

Population growth, economic change, technological advances and new ideologies are all reflected in changing burial practices. Individual burials under round barrows came to dominate, further setting apart those individuals within an elite group of society. The wealth of some of these burials with jet necklaces, buttons, bronze implements and finely decorated beaker pottery are on display. By the Bronze Age, metal technology was entering the funerary and other rituals; axe hoards, rapiers and swords were now surviving. The enigmatic Roos Carr Images, wooden idols from a peat bog in Holderness (see cover photograph), are ascribed to this period (Sheppard, 1901).

The age of the warrior-aristocrat extends beyond the Bronze Age and into the distinctive local Iron Age 'Arras Culture'. The Garton Slack chariot burial (Brewster, 1971) is one of many; the lack of weapons in the displayed example may be misleading.

Under Roman rule, the indigenous aristocracy seem to have settled into a 'Romanised' way of life. Villas at Brantingham, Rudston and Horkstow have all produced that great indicator of Classical taste, the mosaic (Stead et al., 1973; Stead, 1980). The examples displayed evoke something of the refinement to which a privileged few aspired. Domestic life, industry, the Army and religion are all explored in the Roman displays in the Horkstow Gallery.

The departure of the Roman administration, and the hectic market economy which it supported, led to radical changes in popular culture as systems of production and distribution altered. In the centuries that followed, new populations of immigrants brought with them many new ideas, fashions and laws. Settlement sites from this period tend to be rare. For the 10th century, recent excavations at Skerne have given us important evidence for a bridge or jetty on the River Hull (Dent, 1984). Beneath and around the supporting piles, debris accumulated, including a very fine sword with a hilt inlaid with copper and silver. The Skerne Sword is displayed along with other material from the site.

It is only in the late 13th century that Hull itself was established by Royal Charter. Through the 14th, 15th and 16th centuries, the town grew as the port assumed increasing significance. Excavations in the Old Town in the 1970s helped to add three-dimensional shape to the black-and-white history of one of England's best documented medieval towns (Armstrong, 1977, 1980; Ayres, 1979). Some of the material from these excavations, domestic utensils, trinkets, adornments and tools, is displayed.

It is impossible to do justice here to the quality and range of even the small fraction of the collections that are actually displayed. The year 1987 is in many ways a critical one for the collection. A new Transport Museum, now under construction, will see the removal of the transport collection before the end of the decade, resulting in a new museum of archaeology, geology and natural history in the Corn Exchange. The centrepiece will be the 13 m long Hasholme Boat, our latest and greatest single acquisition. This is the largest surviving prehistoric logboat in Britain. Excavated near Holme on Spalding Moor in 1984 (McGrail and Millett, 1985), the 2300 year old vessel requires impregnation with polyethylene glycol if it is to be stabilised. This will necessitate a spraying programme over 8-10 years, carried out on display in the museum gallery. The technical difficulties are daunting, but the rewards should be matchless.

THE MERES OF HOLDERNESS*

J. R. Flenley

INTRODUCTION

The uneven surface of the Devensian till in Holderness formerly bore numerous meres of which the only survivor is Hornsea Mere. The former existence of many other meres (Figure 21) is clear from historical records, place names, topography, vegetation and sedimentology (Sheppard, 1912, 1956), and the history of the drainage of all but Hornsea Mere has been assembled by Sheppard (1956, 1957).

The Holderness meres appear to have been of two types. Larger meres, typically elongated and at least 1 km long by 200 m wide, include Hornsea Mere (TA 190470), Hornsea Old Mere (TA 210475), Lambwath Mere (TA 190395), Skipsea Bail Mere (TA 163550) and Skipsea Low Mere (TA 155564). These occupy major depressions in the till surface, and the fact that three of them run in a west-east direction suggests that they could mark the sites of former valleys in the underlying chalk (Valentin, 1957), which would presumably have drained to the east. The smaller meres, typically about 100 m or less across and often circular or oval in shape, are probably features of till deposition. Some deep ones are possibly kettle holes, for example, The Bog at Roos (TA 274289). Others, generally shallower, may result simply from uneven deposition of till, for example, Sproatley Mere (TA 205344) and Gilderson Marr (TA 299331). Skipsea Withow Mere (TA 185545) is also probably of this latter type, although it may have extended considerably further inland, and its former extent seaward is unknown, so it could be a remnant of one of the larger meres.

The meres seem to have been of some archaeological significance. Mesolithic fish spears have been found at Skipsea Withow Mere and also at Hornsea Old Mere before its coastal exposure was covered by a sea wall (Armstrong, 1923). A Neolithic dwelling platform was excavated in Skipsea Low Mere, and Bronze Age dwelling platforms have been excavated at several sites, for example Skipsea Low Mere and the passage between Skipsea Low Mere and Skipsea Bail Mere (Smith, 1911). In Norman times, Skipsea Bail Mere provided a natural moat for the keep of Skipsea Brough, and there is documentation of the importance of fisheries in at least the larger meres in monastic times (Sheppard, 1956, 1957). The following discussion applies to the Holderness meres in general; the example to be visited is Sproatley Mere. At this site an oak trunk from a depth of c. 5 m showed evidence of chopping and gave a ^{14}C date of 6310 ± 80 B.P. (HAR-6626). An outline pollen record also suggests possible early forest disturbance.

* This contribution is based on that made by the author to Gilbertson (1984, pp. 165-175).

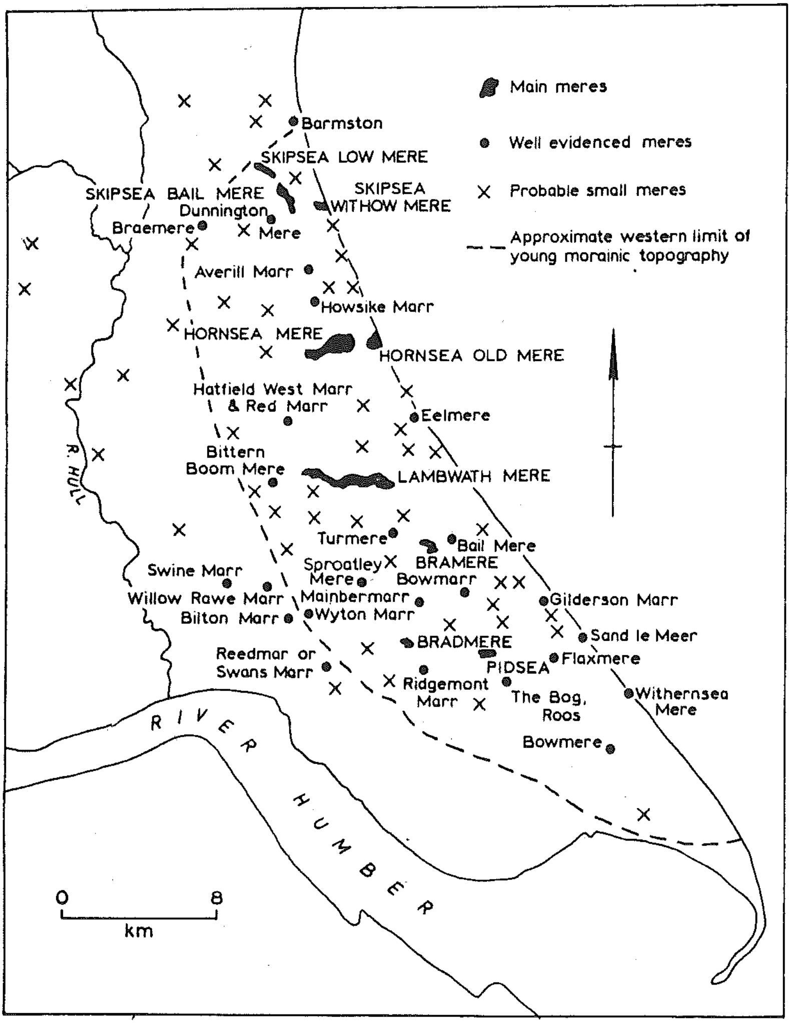

Figure 21. The ancient meres of Holderness (after Sheppard, 1956).

STRATIGRAPHIC AND POLLEN DATA

The main detailed stratigraphic and pollen diagrams published from Holderness meres are those from The Bog at Roos (Figure 22) and from Hornsea Old Mere (Beckett, 1981). Other diagrams available include those for Skipsea Withow Mere (Figure 19, this volume), Skipsea Bail Mere (Figure 23) and Skipsea Low Mere (Figure 24). Deposits of both late Devensian and Flandrian type have also been recorded at Bittern Boom Mere (TA 157398), Flaxmere (TA 305302) and Gilderson Marr, and pollen diagrams from the last two sites have confirmed this.

DISCUSSION

Stratigraphy

All the meres, if they have been bored sufficiently deeply, show a similar succession at the base, the late Devensian being largely represented by inorganic deposits. Usually these are grey or pink clays, presumably the result of solifluction. In the deepest (and perhaps formerly largest) mere investigated, the Old Mere at Hornsea, a coarse chalky gravel was found in addition to clay (Beckett, 1981). The late Devensian clay is interrupted by a darker, more organic clay-mud, c. 20-50 cm in thickness, which appears to represent the Windermere Interstadial (Pennington, 1977). In at least three sites, however (Roos, Skipsea Bail Mere and Flaxmere), there is also a lower band of darker, more organic clay-mud, usually c. 2-5 cm in thickness. At Roos this gave a ^{14}C date of 13045 ± 270 B.P. (Birm-317). Although there is a possibility of such early deposits being contaminated by older carbon derived from the till, this seems a reasonable minimum age for the deglaciation of Holderness. Taken with the date of 18240 ± 250 B.P. for the Dimlington Moss Silts (Penny et al., 1969), it brackets the deposition of the Skipsea and Withernsea tills.

The Flandrian began everywhere with deposition of an organic lake mud (gyttja). In the larger meres, this extends almost to the sediment surface, but the smaller meres soon changed to peat formation as their basins were more rapidly infilled. Trees probably grew on peat at some sites, as they do now (aided by drainage) at Roos. In all sites except Roos, the uppermost part of the sediment shows a return to mineral deposition. This is probably the result of soil erosion on the surrounding slopes, following deforestation. It is also possible that mineral material was actually dumped on some sites to aid reclamation. Drainage of the meres was sometimes conducted by means of new surface ditches, for example at Flaxmere, or perhaps by canalization of existing streams, as may have occurred at Skipsea Bail Mere and Skipsea Low Mere. Alternatively, underground pipes leading to one of the major drainage channels were installed, for example at Roos and Bittern Boom Mere.

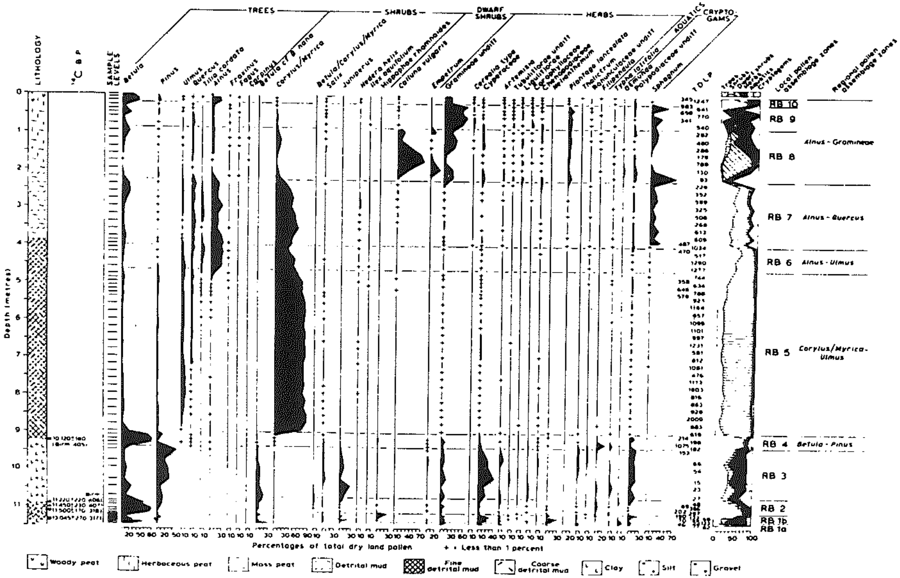

Figure 22. Pollen diagram from The Bog, Roos. Only selected pollen taxa are shown. Recalculated and redrawn from Beckett (1981).

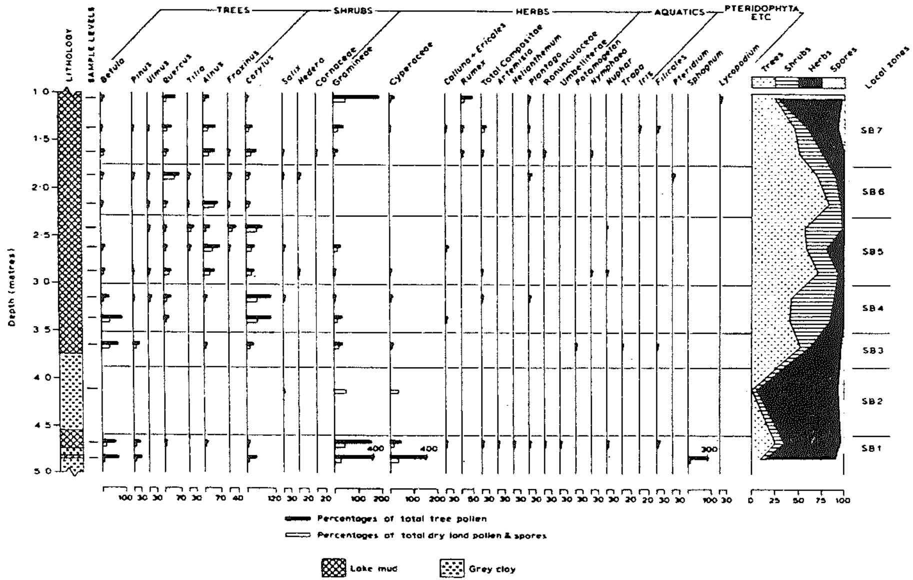

Figure 23. Outline pollen diagram from Skipsea Bail Mere (analysis by Hull University 2nd year Palynology Class, 1982).

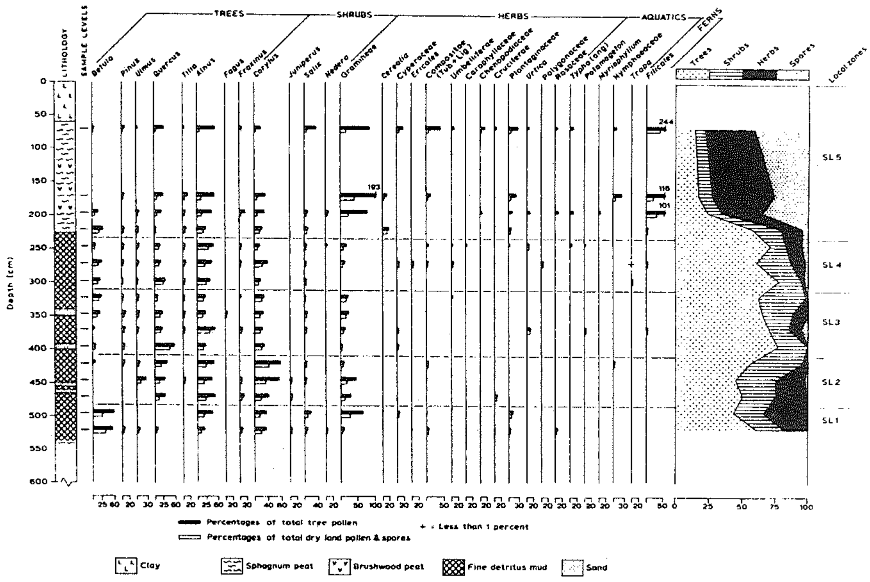

Figure 24. Outline pollen diagram from Skipsea Low Mere (analysis by Hull University 2nd year Palynology Class, 1974).

Pollen assemblages

Each diagram has been zoned according to its own pollen assemblages. In addition, an attempt has been made to correlate the diagrams with each other and with the regional pollen assemblage zones of Beckett (1981) (Table 5). The earliest zone recorded (from c. 13000 B.P.) is present only at The Bog, Roos, and is designated the Helianthemum-herbs Regional Pollen Assemblage Zone (RPAZ). At Roos this is subdivided, but further evidence would be needed to substantiate a division at the regional level. The landscape was open, with few trees (Beckett, 1981). Shrubs (Salix, Juniperus, Hippophae rhamnoides and Betula nana) were present but did not exclude numerous herbs. The regular presence of Helianthemum, which is now typical of chalk grassland, testifies to the unleached, chalky nature of the soil newly developed on the till.

The Betula-herbs RPAZ covers the period c. 12000-11000 B.P. (Beckett, 1981), and is represented at Roos, Skipsea Withow Mere and Skipsea Bail Mere. Pollen of tree birches is abundant (>50% of total dry land pollen and spores) at the small meres but less so (c. 20%) at Skipsea Bail Mere. It seems clear, however, that birch woodland was present, although this may have been patchy. Other tree pollen is probably derived or wind blown. The climate may well have been similar to that of the present day.

The Cyperaceae-herbs RPAZ, roughly 11000 B.P. to c. 10200 B.P., seems to represent a distinctly colder phase. Tree birches were not eliminated altogether at Roos, although they are absent in the single sample from Skipsea Bail Mere. Pinus pollen, present at Roos, is probably wind blown from much further south. The vegetation may have been a sparse tundra.

Birch woodland reappeared in Holderness before 10120 ± 180 B.P. (Betula-Pinus RPAZ). This zone is represented at all five sites. Pinus is now sufficiently abundant to suggest it grew locally, although other tree and Corylus pollen was probably wind derived. The climate could have been as warm as at present, the low tree diversity being due simply to slow migration from southern refugia. A single grain of Trapa at this level in Skipsea Bail Mere is probably the result of contamination during sampling.

The next RPAZ is designated Corylus/Myrica-Ulmus. It is unsatisfactorily dated in Holderness, but probably extends from c. 9000-7000 B.P. Pollen grains of Corylus and Myrica are not readily distinguishable, but in Holderness it is likely that the pollen is nearly all derived from Corylus. Ulmus and Quercus arrive early in this zone at Roos and Hornsea but later at Skipsea Withow. At the other sites the diagrams are too sketchy to permit close correlation at this time. It is likely, however, that immigration proceeded irregularly if it was not closely controlled by climatic change.

The maximum development of forest in Holderness coincided with the ensuing Alnus-Ulmus RPAZ. This is undated in Holderness, but is at c. 7000-5000 B.P. elsewhere in England. Non-tree pollen is usually at a minimum, and forest tree diversity increases with the rise of Alnus and Tilia, both previously present but in smaller quantities in most areas. Again it is unnecessary to invoke

Table 5. A correlation of pollen diagrams from Holderness.

^{14}C date B.P.*	Regional Pollen Assemblage Zone	The Bog, Roos	Old Mere, Hornsea	Skipsea Withow Mere	Skipsea Bail Mere	Skipsea Low Mere
	Alnus-Gramineae	RB 10 RB 9 RB 8	HO 5	WM 6	SB 7	SL 5
	Alnus-Quercus	RB 7	HO 4	WM 5	SB 6	SL 4
	Alnus-Ulmus	RB 6	HO 3	WM 4	SB 5	SL 3
	Corylus/Myrica-Ulmus	RB 5	HO 2	WM 3	SB 4	SL 2
10120 ± 180 (Birm-405)	Betula-Pinus	RB 4	HO 1	WM 2	SB 3	SL 1
	Cyperaceae-herbs	RB 3			SB 2	
11220 ± 220 (Birm-406)						
	Betula-herbs	RB 2		WM 1	SB 1	
11500 ± 170 (Birm-318)						
13045 ± 270 (Birm-317)	Helianthemum-herbs	RB 1b RB 1a				

* All dates are from The Bog, Roos.

climatic change; delayed immigration may be the explanation.

The well-known elm decline (usually dated to about 5000 B.P.) ushers in the succeeding Alnus-Quercus RPAZ. The first clear evidence of human influence on the vegetation is present, in the form of cereal and weed pollen. Trapa natans is present at Skipsea Low Mere (Figure 24), and was also found in this zone at Skipsea Bail Mere (Flenley et al., 1975), although it is not recorded in Figure 23. Its presence in Skipsea Bail Mere over a long period within this zone was also confirmed by Smith (1978), who found both pollen and fruit spines. The presence of Trapa has usually been taken to indicate summers warmer than at present in Britain (Godwin, 1956), but cultivation is also possible; it is therefore interesting that Bronze Age dwelling platforms occur in both meres where Trapa has been found (Flenley and Maloney, 1976).

The uppermost parts of the diagrams differ widely, and all have been lumped in a rather unsatisfactory Alnus-Gramineae RPAZ, probably dating from around 2500-0 B.P. Forest clearance, doubtless occurring in different ways and at different times, is evidenced in all the diagrams. Tree pollen is reduced spectacularly at Roos, then shows a recovery, a further clearance and a later recovery (perhaps due to tree growth on The Bog itself after drainage). At Hornsea and Skipsea Bail Mere clearance seems to have been progressive, although the evidence from the latter site is scanty, and both are incomplete at the top. At Skipsea Withow Mere the record is again incomplete and the date of 4500 ± 50 B.P. (SRR-1942) appears rather old; it is possible that here the zone is not represented, although there is evidence of forest reduction at 40 cm. At Skipsea Low Mere the record is exiguous but suggests a rather complete clearance early in the zone. In the best record, at Roos, the herbs present suggest the initial clearance was for mixed farming. For instance, Plantago lanceolata suggests pastoral land, while Chenopodiaceae suggests arable. Cereal pollen is regularly present later in the zone, and Plantago lanceolata is reduced in amount, which accords with the present day importance of arable farming.

CONCLUSION

It is clear that the meres of Holderness provide a series of records through the last 13000 years which display considerable variations on a basic theme; the pattern of late Devensian oscillation, Flandrian forestation and later deforestation is everywhere present, but the details differ. This is particularly so during the last 5000 years, in which the forests have been removed. It seems that the abundance of sites would make possible a remarkably detailed reconstruction of the impact of man on the vegetation of Holderness.

DIMLINGTON

J. A. Catt

INTRODUCTION

The cliffs between Easington (TA 399205) and Out Newton (TA 386224) provide a section through the highest part of Holderness, rising to 38 m O.D. at Dimlington High Land (TA 391217). Exposures depend very much on wave and tidal conditions, which control the movement of modern beach sediment and erosion of the cliffs (Pringle, 1985), but at their best show the full succession of tills known in Humberside and east Yorkshire. Beneath the Devensian tills the Dimlington Silts have given ^{14}C dates of 18500 and 18240 B.P., and large rafts of shelly marine clay incorporated into the oldest till (the Wolstonian Basement Till) are also usually visible. Figure 25 shows the cliff section as surveyed between 1956 and 1964, but it should be realized that the cliffs have retreated approximately 50 m since this was drawn.

THE BASEMENT TILL

This uniform dark grey (5Y 3/1) till is usually seen in the foreshore and cliff base to about 6 m O.D. It occurs on the shore as far south as Kilnsea (TA 412176) and as far north as Holmpton (TA 376237), also in the Bridlington-Flamborough area, but nowhere else in Holderness. The records of boreholes put down near Kilnsea (TA 415163) in 1916-17 (Lamplugh, 1919) and on the foreshore north of Easington (TA 399205) in 1985 (Catt and Digby, in press) indicate that the Basement Till extends down to the bedrock (Chalk) surface, which is fairly flat at -30 to -35 m O.D.

The Basement Till contains erratics of Chalk (mainly quite small), flint, Magnesian Limestone, Carboniferous Limestone, various sandstones, and numerous igneous and metamorphic rocks from Scotland and Scandinavia (including larvikite and rhomb porphyry). The fine matrix ($<$2 mm) contains 35-50% clay ($<$2 um) and approximately equal amounts of silt (2-63 um) and sand (63-2000 um). The stone orientation is usually NE-SW, but upper parts of the till often have a NW-SE macrofabric associated with folds trending NW-SE, which probably result from deformation of the till by the Devensian glacier (Penny and Catt, 1967).

RAFTS OF MARINE CLAY WITHIN UPPER PARTS OF THE BASEMENT TILL

The largest of the rafts of shelly dark bluish grey (5B 4/1) marine clay is usually visible on the foreshore near Dimlington High Land (Figure 25), but smaller masses are known elsewhere, and similar clay may be incorporated into the matrix of the Basement Till, as occasional shell fragments and marine microfossils occur in upper parts of the till. The rafts have a rich fauna (Table 6), similar to that of masses of greenish, glauconitic sand (the Bridlington Crag of Reid, 1885) which are occasionally exposed in the Basement Till on

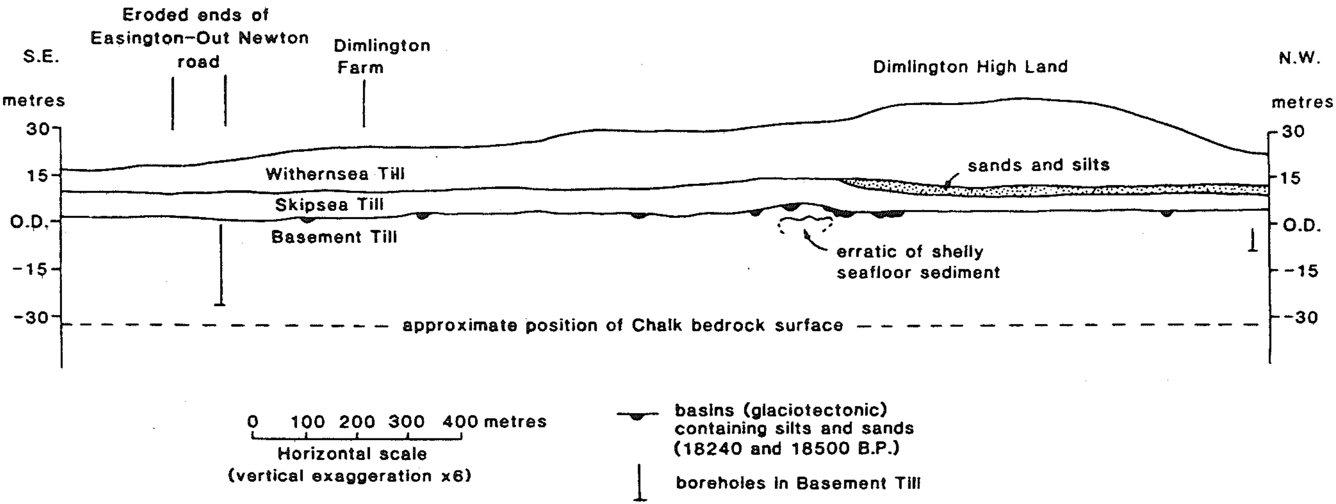

Figure 25. Measured cliff section near Dimlington Farm, based mainly on observations 1956–64 (from Catt and Penny, 1966).

Bridlington foreshore (de Boer et al., 1965). The fauna is predominantly boreal, much colder in aspect than any of the East Anglian Crags, and has been attributed to the 'early glacial' i.e. Anglian (Baden-Powell, 1956) and late Hoxnian (Catt and Penny, 1966). However, pollen and dinoflagellate cysts from Bridlington suggest a Pastonian age (Reid and Downie, 1973), so it is likely that the rafts are derived from North Sea sediments of various ages. The faunal list (Table 6) has been partially revised by various workers, but the Gastropoda and Lamellibranchiata in particular need further work; P. Cambridge comments that it is very unlikely that there are so many different species of Oenopota and Astarte.

The rafts at Dimlington have been termed the Bridlington Crag of Dimlington (Reid, 1885; Catt and Penny, 1966) and the Sub-Basement Clay (Bisat, 1939). They contain erratic rocks, mainly igneous and metamorphic types from Scotland and Scandinavia, which were probably dropped into the marine clay from floating ice. The rafts could have been picked up by the Wolstonian glacier which deposited the Basement Till, or may have been folded into upper layers of the Basement when this was pushed and disturbed by the Late Devensian ice sheet.

THE DIMLINGTON SILTS AND SANDS

The surface of the Basement Till is locally discoloured and weakly decalcified by weathering, and hollows in its surface (Figure 25) are filled with laminated silts containing fine strands of moss. In the deeper basins the silts pass upwards by alternation into yellow sands, probably aeolian coversand. Samples of moss provided ^{14}C dates of 18500 ± 400 B.P. (I-3372) and 18240 ± 250 B.P. (Birm-108) (Penny et al., 1969), which show that the overlying Skipsea and Withernsea Tills were deposited quite late in the Devensian, during the period of time that Rose (1985) termed the Dimlington Stadial.

The moss is mainly Pohlia wahlenbergii var. glacialis, which lives in meltwater from snowbeds and glaciers. It is a calcifuge, so the risk of hard-water error in the ^{14}C dates is small. Insects and freshwater ostracods (Table 7) indicate that the silts were deposited in a shallow lake with only a little aquatic vegetation, and that surrounding areas were devoid of vegetation other than moss patches, because the climate was extremely harsh. The lake must have existed shortly before the Devensian glacier arrived.

The bedding within each of the basins is parallel to the curved basin floor, and in some basins upper parts of the silts just beneath the Skipsea Till have been folded isoclinally by a NE-SW compression. This is similar to the direction of movement of the Devensian glacier. Therefore it is likely that the silts were originally deposited in a single lake, and that the Devensian glacier deformed both the silts and upper layers of the Basement Till to produce a push-moraine, which was subsequently over-ridden by the ice. The small basins were formed glacio-tectonically, and the sediments within them have probably been lifted as part of the push-moraine to heights well above their level of deposition.

Table 6. Fauna of the Bridlington Crag (rafts of marine clay and sand) in the Basement Till.

GASTROPODA (revised by P. Cambridge and P.E. Long)	Bridlington	Dimlington
Admete viridula Fabr.	*	
Admete viridula couthouyi Jay		
Admete viridula sheppardi Bell		
Alvania crassa (Kanmacher)		
Alvania wyville-thompsoni (Jeffr.)	*	
Amaura sulcosa Leche		
Amauropsis islandica Gmel.	*	*
Astyris rosacea Gould.	*	
Boreoscala groenlandicum (Perry)	*	*
Boreoscala groenlandicum crebristriatum Sars		
Boreotrophon clathratus (L.)	*	
Boreotrophon gunneri (L.)	*	
Boreotrophon truncatus Ström		
Buccinum inexhaustum Verk.		
Buccinum groenlandicum Chem.	*	
Buccinum undatum L.	*	*
Buccinum undatum crassum King		
Calliostoma zizyphinus L.	*	
Cingula semistriata (Mont.)		
Colus attenuatus Jeffr.		
Colus curtus Jeffr.	*	
Colus exiguus Harmer		
Colus gracilis Da Costa		
Colus latericeus Möll	*	
Colus leckenbyi S.V. Wood	*	

Colus propinquus Alder	*	
Colus pygmaeus Gould		
Colus sabini (= c. exiguus?)		
Colus sarsii Jeffr.	*	
Colus tenuistriatus Harmer		
Cylichna alba (Brown)	*	
Cylichna scalpta (Reeve)	*	
Gibbula cinereus Couth.	*	
Gibbula cinerarius L.	*	
Haedropleura rufa Mont.		
Helcion pellucidum L.		
Lacuna crassior Mont.	*	
Lacuna vincta (Mont.)	*	
Lepeta caeca MÜll.	*	
Littorina globosa Jeffr.	*	
Littorina headleyi Bell		
Littorina littorea L.	*	*
Littorina obtusata (L.)	*	
Littorina rudis (Maton)	*	
Littorina saxatilis (Olivi)		
Margarites groenlandica (Gmelin)	*	
Menestho albula Fabr.	*	
Menestho derivata (S.V. Wood)		
Menestho sulcosa Mighels		
Molleria costulata (MÖll.)		
Natica affinis Gmel.	*	*
Natica pallida (Brod. and Sow.)	*	
Natica islandica Gmel.	*	*
Natica montagui Forbes	*	

Natica nana Möll		
Natica occlusa Wood	*	
Natica tenuistriata Dautz & Fisch.		
Neptunea contraria typica L.		
Neptunea contraria carinata Wood		
Neptunea despecta L.		*
Neptunea despecta carinata Penn.		
Neptunea despecta subantiquata (M&R)		*
Neptunea spitzbergensis Reeve		
Nucella incrassata (Sow.)		*
Nucella lapillus (L.)	*	*
Ocenebra erinacea (L.)		
Odostomia conspicua Alder.	*	
Oenopta angulosa Sars		
Oenopta bicarinata Couth.	*	
Oenopta borealis (Reeve)		*
Oenopta cinerea Möll.		
Oenopta decussata Couth.	*	
Oenopta decussata inflata Posselt.		
Oenopta dowsoni S.V. Wood	*	
Oenopta elegans Möll.	*	
Oenopta elegantior S.V. Wood		
Oenopta exarata Möll.	*	
Oenopta harpularia Couth.	*	
Oenopta multistriata Jeff.	*	
Oenopta nobilis Möll.		*
Oenopta plicifera S.V. Wood		
Oenopta pyramidalis Ström	*	*
Oenopta pyramidalis semiplicata Sars		

Oenopta robusta S.V. Wood		
Oenopta scalaris Möll.		
Oenopta trevelyana Turt.	*	
Oenopta turricula Mont.	*	*
Oenopta violacea Couth.	*	
Oenopta viridula Möll.		
Onobu striata Adams		
Piliscus commodus Middendorff		
Pleurotoma simplex Middendorff	*	
Plicifusus kroyeri Möll.	*	
Puncturella noachina L.	*	
Purpura elongata (Wood)		*
Rissoa parva Da Costa	*	
Rissoa parva interrupta Adams		
Rissoa subperforata Jeffr.	*	
Solariella cinerea (Couth.)		
Solariella obscura (Couth.)		
Solariella obscura bella Verk.		
Solariella varicosa Mighels		
Tachyrhynchus erosus (Couthouy)	*	*
Trichotropis borealis B&S	*	
Trichotropis insignis Middendorff		
Trochus varicosus M&A.	*	
Trophon truncatus (Strom.)	*	
Trophon fabricii Beck	*	
Trophon fabricii reticulata Harmer		
Trophon truncatus Ström.		
Turritella communis Risso	*	*
Turritella tricarinata (Brocchi)		*

Utriculus constrictus Jeffr.	*	
Utriculus crebristriatus (Jeffr.)	*	
Utriculus pertenuis (Mighels)	*	

LAMELLIBRANCHIATA (revised by P. Cambridge and P.E. Long)

Acila cobboldiae (Leathes)	*	*
Altenaeum dawsoni (Jeffr.)		
Anomia ephippium L.	*	
Arctica islandica (L.)	*	*
Astarte apiculata Bell		
Astarte arctica Gray		
Astarte banksii warhami Hanc.		
Astarte bennettii Dall.		
Astarte borealis mutabile	*	
Astarte borealis withami Smith	*	*
Astarte compressa globosa Möll.		
Astarte compressa latior King		
Astarte compressa nana Jeffreys		
Astarte compressa striata Leach	*	
Astarte crenata Gray		
Astarte depressa Brown	*	*
Astarte elliptica (Brown)	*	*
Astarte elliptica ovata Brown		
Astarte elliptica crassa Leche		
Astarte montagui (Dillwyn)	*	*
Astarte nana Jeffreys		
Astarte placenta Mörch.		
Astarte richardsoni Reeve		

Astarte semisulcata lactea B&S			
Astarte sericea Posselt			
Astarte soror Dall			
Astarte sulcata (Da Costa)	*	*	
Axinopsis orbiculata Sars	*		
Cardium echinatum L.		*	
Cerastoderma edule (L.)	*	*	
Chlamys islandica (Müll.)	*	*	
Chlamys opercularis (L.)	*		
Chlamys pes-lutrae (L.)	*		
Chlamys pusio Penn.			
Corbula gibba Olivi	*		
Corbula pusilla Philippi	*		
Crenella decussata Mont.	*		
Cyclocardia borealis (Conr.)			
Donax vittatus Da Costa	*		
Dosinia exoleta L.			
Dosinia lupinus (L.)			
Ensis ensis (L.)			
Glycymeris glycymeris (L.)	*		
Heteronomia squamula (L.)	*		
Hiatella arctica L.	*	*	
Lima excavata Fabr.			
Lutraria elliptica Lam.			Filey Bay
Macoma balthica (L.)	*	*	
Macoma calcarea (Gmel.)	*	*	
Macoma obliqua Sow.	*	*	
Mactra subtruncata			

Modiola modiolus L.	*	*
Musella bidentata (Mont.)		
Mya arenaria L.	*	
Mya truncata L.	*	*
Mya truncata uddevallensis Hancock	*	*
Mytilus edulis L.	*	
Nucula insignis Gould		
Nucula nucleus L.	*	
Nucula tenuis Mont.	*	
Nucula tenuis inflata	*	
Nuculana caudata buccata Steem		
Nuculana minuta Müll.	*	
Nuculana minuta buccata	*	
Nuculana pernula Müll.	*	*
Ostrea celtica Bell		
Panomya norvegica (Spengler)	*	*
Pecten maximus L.		
Pecten septem-radiatus Müll.		
Pholas crispata L.	*	*
Portlandia intermedia (Sars)	*	
Portlandia lenticula (Müll.)	*	
Portlandia tenuis (Philippi)	*	
Serripes groenlandicum (Chemn.)	*	*
Spisula solida (L.)		
Spisula elliptica Brown	*	*
Spisula subtruncata (Da Costa)		
Tellina pusilla Philippi	*	
Thracia praetenuis Pult.	*	
Thracia pubescens Pult.	*	*

Timoclea ovata (Pennant)	*	
Tridonta borealis (Schumacher)	*	*
Venus fluctuosa Gould.	*	
Yoldia limatula Say	*	
Yoldia myalis Couthouy		

SCAPHOPODA

Dentalium entalis L.	*	*
Dentalium striolatum Stimpson	*	*
Dentalium tarentinum Lam.		

CIRRIPEDIA

Balanus concavus Bronn.		*
Balanus crenatus Brug.	*	*
Balanus hameri (Asc.)	*	*
Balanus porcatus Da Costa	*	*
Verruca strömia Müll	*	

BRACHIOPODA

Hemithyris psittacea (Chemn.)	*	

BRYOZOA

Undetermined	*	*

OSTRACODA (revised by E. A. Robinson and R. C. Whatley)

Rabilimis mirabilis (Brady)	*	*
Sarsicytheridea punctillata (Brady)	*	*
Finmarchinella angulata (Sars)	*	
Finmarchinella finmarchica (Sars)		*
Baffinicythere costata (Brady)	*	
Cytheromorpha cribrosa (Brady, Crosskey & Robertson)	*	
Baffinicythere emarginata (Sars)	*	*
Baffinicythere howei Hazel	*	
Pterygocythereis fimbriata Norman	*	
Roundstonia globulifera (Brady)	*	*
Pterygocythereis jonesii Baird ceratoptera		*
Cytheromorpha mcChesneyi (Brady & Crosskey)	*	
Robertsonites tuberculata (Sars)	*	*
Cluthia cluthae (Brady, Crosskey & Robertson)		*
Hemicythere villosa (Sars)	*	*
Pontocythere elongata (Brady)	*	
Sarsicytheridea bradii (Norman)	*	*
Cytheropteron angulatum Brady & Robertson	*	
Cytheropteron arcticum Neale & Howe		*
Cytheropteron dimlingtonensis Neale & Howe		*
Cytheropteron arcuatum Brady, Crosskey & Robertson		*
Cytheropteron excavoalatum Whatley & Masson	*	
Cytheropteron inflatum Lev	*	*
Cytheropteron latissimum (Norman)	*	*
Cytheropteron cf. pipistrella Brady		*
Cytheropteron montrosiense Brady, Crosskey & Robertson		*
Cytheropteron nodosum Brady	*	*
Hemicytherura clathrata (Sars)	*	*

Elofsonella concinna (Jones)	*	*
Eucythere argus Sars	*	
Heterocyprideis sorbyana (Jones)	*	*
Krithe glacialis Brady, Crosskey & Robertson	*	*
Normanicythere leioderma (Norman)	*	*
Paradoxostoma ensiforme Brady	*	
Paradoxostoma pyriforme Brady, Crosskey & Robertson	*	
Sclerochilus contortus (Norman)	*	
Acanthocythereis dunelmensis (Norman)	*	*

FORAMINIFERA (revised by J. Haynes)

Trifarina fluens (Todd)		*
Biloculina elongata D'Orbigny	*	*
Biloculinella ringens (Lam).	*	*
Buccella karsteni (Reuss.)	*	
Bulimina aculeata D'Orbigny		*
Bulimina elegans D'Orbigny marginata Fornasini		*
Bulimina marginata D'Orbigny		*
Cassidulina crassa D'Orbigny	*	*
Cassidulina laevigata D'Orbigny	*	*
Cassidulina laevigata carinata Silvestri		*
Cassidulina teretis Tappan		*
Cibicides lobatulus (Walker & Jacob)	*	*
Cornuspira foliacea Ph.	*	
Lenticulina cultrata (Mont).	*	
Lenticulina acutauricularis (F&M)		*
Dentalina baggi Galloway & Wissler		*
Dentalina brevis D'Orbigny	*	

Dentalina communis D'Orbigny	*	*
Dentalina frobisherensis Loeblich & Tappan		*
Dentalina pauperata D'Orbigny	*	*
Elphidiella arctica (Parker & Jones)		*
Elphidium bartletti Cushman		*
Elphidium crispum (L.)		*
Haynesina orbiculare (Brady)		*
Elphidium subarcticum (Cushman)		*
Gaudyrina pupoides D'Orbigny	*	
Glandulina laevigata D'Orbigny	*	*
Glandulina laevigata rotunda	*	
Glandulina laevigata aequalis	*	
Globigerina bulloides D'Orbigny		*
Globigerina bulloides borealis Brady		*
Lagena apiopleura Loeblich & Tappan		*
Lagena globosa (Montagu)	*	*
Lagena isabella (D'Orbigny)		*
Lagena laevigata Reuss.	*	
Lagena laevis (Montagu)	*	*
Lagena pseudocatenulata Chapman & Parr		*
Lagena squamosa Montagu	*	
Lagena sulcata Walker & Jacob	*	*
Miliolinella oblonga (Montagu)	*	*
Miliolinella subrotunda (Montagu)		*
Nonionella auricula Heron-Allen & Earland		*
Haynesina depressula (Walker & Jacob)	*	*
Nonion scapha (F&M)	*	
Guttulina lactea (Walker & Jacob)	*	*
Guttulina lactea novangliae (Cushman)		*

Guttulina dawsoni (Cushman & Ozawa)	*	
Pseudopolymorphina cylindroides (Roemer)		*
Elphidium striato-punctata F&M	*	*
Pseudopolymorphina ligua (Roemer)	*	
Pulvinulina karsteni Reuss.	*	
Pyrgo williamsoni (Silvestri)		*
Quinqueloculina agglutinata Cushman		*
Quinqueloculina seminula (L.)	*	*
Quinqueloculina triangularis D'Orbigny	*	
Robulus cultratus Denys de Montfort		*
Rotalia beccarii (L.)		*
Trichohyalus bartletti (Cushman)		*
Uvigerina angulosa Williamson		*
Vaginulina laevigata Roemer	*	
Vaginulina legumen L.	*	
ECHINODERMATA		
Undetermined spines (broken)	*	*
FISHES		
Gadus aeglifinus		
Gadus merlangus		
Gadus morrhua		
Gadus minutus		
Notidanus serratisimus		
Odontaspis subulata		
Platax woodwardii (Cleithra?)	*	
Raja batis		

Table 7. Fauna and flora of the Dimlington Silts.

COLEOPTERA	
Agabus bipustulatus L.	
Aleocharinae indet.	
Amara alpina Paykull	
Amara quenseli Sch.	
Aphodius sp.	
Arpedium brachypterum Gr.	
Bembidion sp. (lunatum group)	
Bledius fuscipes Rye	
Byrrhus sp.	
Cercyon sp.	
Feronia blandulus Mill.	
Hydrobius sp.	
Notaris aethiops F.	
OSTRACODA	
Candona neglecta Sars	
Cypridopsis vidua (Mull.)	
Cyprinotus salinus (Brady)	
Eucypris gemella Bodina	
Ilocypyris gibba (Ramdohr)	
PLANTS	
Daphnia ephippia	
Eleocharis palustris (L.)	
Menyanthes trifoliata L.	
Pohlia wahlenbergii (Web. & Mohr) glacialis (Schleich.)	
Potamogeton alpinus	
Potamogeton filiformis	
Pinus and Betula pollen (sparse)	

THE LATE DEVENSIAN GLACIAL SEQUENCE

The Skipsea Till is mainly very dark greyish brown (10YR 3/2), but is more variable in colour and erratic suite than the overlying Withernsea Till, which is uniform dark brown (7.5YR 3/2). Both have about 15% more silt (2-63 um) than the Basement Till, and the Skipsea is generally more sandy and less clayey than the Withernsea Till (Madgett and Catt, 1978). The two Devensian tills can also be distinguished using the relative amounts of resistant heavy minerals in the fine sand (63-250 um) and coarse silt (16-63 um) fractions; the Skipsea Till contains more garnet, hornblende, staurolite and kyanite, but less zircon, tourmaline, rutile, anatase and brookite in both these fractions than does the Withernsea Till. Erratics in the 6-16 mm fraction are also different (Madgett and Catt, 1978); the Skipsea Till has more chalk and flint, but less shale, siltstone and other limestones than the Withernsea.

Bisat (1939) referred to the Skipsea and Withernsea Tills as the Drab and Purple Clays respectively, and divided the Drab at Dimlington into two beds distinguished by colour and erratic suites. Postwar refinement of this work led Bisat to divide the Drab into five beds (Catt and Madgett, 1981), but these are difficult to trace, especially as the cliff section Bisat worked on was some distance seaward of the present cliff line. In addition to Triassic sandstone and marl (which increase in abundance upwards), chalk and black and grey flints (which increase southwards) and grey Carboniferous and Jurassic shales, the Skipsea Till contains rarer erratics of larvikite, rhomb porphyries, amygdaloidal porphyries, granites, Carboniferous and Magnesian Limestones, greywackes, coal and metamorphic rocks. The Withernsea Till has more Triassic, Liassic and Carboniferous material than the Skipsea, but fewer igneous and metamorphic rocks; its chalk and flint (mainly grey) contents increase northwards.

Catt and Penny (1966) and most earlier workers except Bisat recognized a third Devensian till (the Hessle), forming the top 3-5 m of Dimlington cliff and lying 'like a cloth' over the whole of Holderness. However, this is a Holocene soil formed in southeast Holderness on the Withernsea Till, and elsewhere on the Skipsea Till (Madgett and Catt, 1978). The characteristics by which it was distinguished from the Skipsea and Withernsea Tills, namely fewer weatherable erratics and heavy minerals, redder colour (usually 5YR 4/3), and grey (gleyed) fissures, all result from pedogenesis.

The Skipsea and Withernsea Tills are separated in northern parts of the cliff section by bedded glaciofluvial sands and silts (Figure 25), but elsewhere the junction is sharp with no evidence of an ice-free interval between (e.g. weathering of the Skipsea Till, or disturbance of it by a later ice advance). This and other aspects of the Devensian glacial sequence in Yorkshire suggest that both tills were deposited by a single two-tiered glacier.

SEDIMENTS AND ARCHAEOLOGY OF THE HUMBER FORESHORE

D. R. Crowther

INTRODUCTION

Since autumn 1984 a programme of fieldwork on the north bank of the River Humber has been conducted by Hull City Museums and Art Galleries as part of a long-term exercise in assessing the archaeological importance of the area and the rate at which it is suffering destruction by tidal erosion and human causes. The study area lies to the west of North Ferriby, in an area of great archaeological significance (Corder and Davies-Price, 1938; Corder et al., 1939; Wright, 1976). There are two distinct but complementary contexts: at Melton (SE 974247) a water-logged strand of foreshore below high water mark, and at Redcliff (SE 980249) a more accessible dryland context on higher ground behind.

MELTON

At Melton the Humber foreshore slopes gently down from a revetted bank, with an abrupt change of level visible only at low tide where an exposure of peat forms a step (Figure 26). The peat has accumulated in a depression in the underlying till and has subsequently become buried by estuarine clay as a result of Flandrian sea level change (Gaunt and Tooley, 1974). A similar peat exposure at North Ferriby has been tentatively dated to the late Neolithic-Early Bronze Age (Wright, 1976), a date not at variance with palynological results for Melton (Figure 27). These are derived from two cores (A and B) taken from the estuarine clay and a further core (C) from the underlying peat (Figure 26). All three cores show low values for Ulmus, and are therefore younger than c. 5000 B.P. Tree and shrub values remain high, however, suggesting that forest clearance was not well advanced, indicating a date before c. 2500 B.P. This places the deposits within the Alnus-Quercus Regional Pollen Assemblage Zone for Holderness (Flenley, this volume). The consistent presence of Gramineae and Chenopodiaceae in the clay is compatible with a salt marsh environment succeeding the fresh water conditions under which the peat accumulated.

At North Ferriby no less than three Bronze Age boats have been discovered and salvaged since the Second World War (Wright, 1976). These occurred within estuarine clay overlying the peat, and at Melton it may therefore be the same clay which has produced broadly contemporary material. Here, within 150 m of foreshore, 32 wooden features have been identified (Figure 26). Several tree boles have been recorded, emerging from the peat, and dating presumably to the period of peat accumulation, leading to their death and preservation in situ. Of the 18 wooden features which are man-made, some are single timbers, a post for example, but others comprise multiple components of posts, rails and roundwood including horizontal hurdles. Although the post-only structures could be of quite recent origin, the examples including rails and other horizontal elements must predate the overlying sediment.

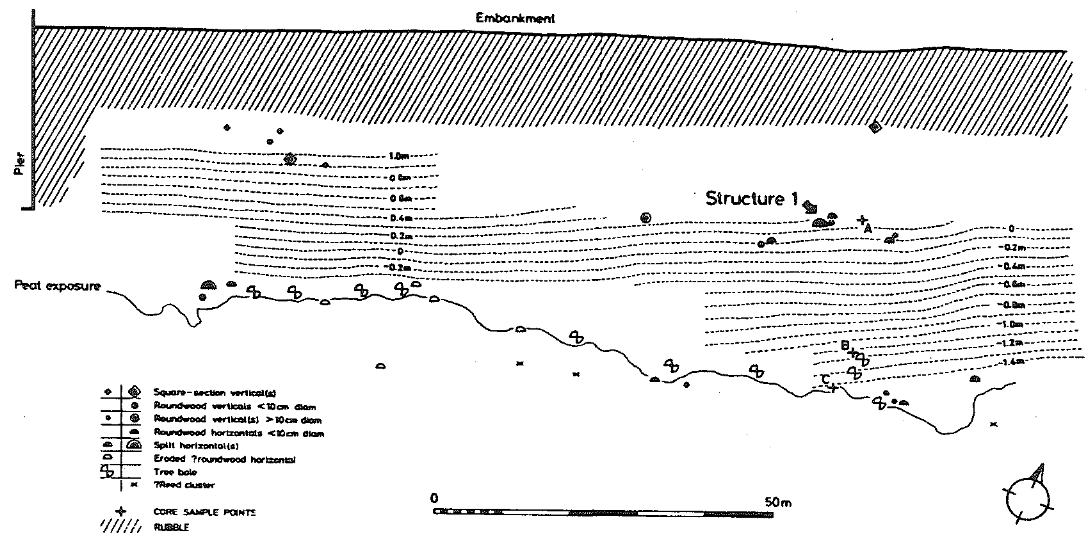

Figure 26. Plan of the Melton foreshore.

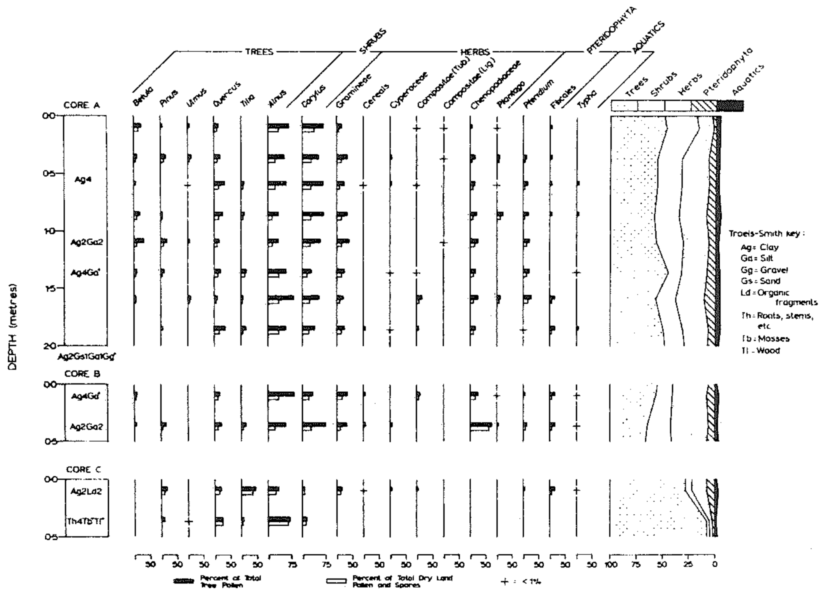

Figure 27. Outline pollen diagram for the Melton foreshore (analysis by A.G. Dickson).

To provide information about preservation, extent, construction and date, one of two elaborate structures was excavated (Figure 26, Structure 1). This revealed a series of rails held in position by pegs covered in hurdles or bundles of roundwood (Figure 28). The depth of the constructional sequence pointed to the possibility of repair during the structure's life. Radiocarbon dates from two of the rails gave 960 ± 90 B.C. (HAR-6367) and 1040 ± 70 B.C. (HAR-6368). Any understanding of the purpose of this structure must await further excavation, although a trackway, platform or 'hard' for hauling up boats are all obvious possibilities.

REDCLIFF

Two hundred metres downstream of the previous site, glacial deposits rise above the shoreline to approximately 10 m O.D. and are exposed in a rapidly eroding cliff known as Redcliff. This is a cross-section through a morainic ridge, which probably extended across the Humber Gap to impound glacial Lake Humber at the 8 m level in the Vale of York in the Late Devensian. A similar section occurs near South Ferriby on the opposite side of the river. The Redcliff section (Figure 29) shows Skipsea Till overlain by locally disturbed, laminated glaciolacustrine silts and fine sands, which are in turn overlain by sands and cross-bedded gravels. The glaciolacustrine deposits resemble the '25-foot drift' deposited in Lake Humber, but are on the eastern side of the main till ridge that impounded Lake Humber, so they were probably deposited in the slightly earlier, high-level (33 m) lake impounded by the ice sheet. The gravels were deposited by water flowing eastwards, possibly early overflow from Lake Humber.

The morainic ridge at Redcliff was of great strategic significance, for it dominates the low-lying marginal land up and downstream for several kilometres, and affords access to the Yorkshire Wolds inland. Wetlands have only comparatively recently been recognised by archaeologists as areas of often intense exploitation in prehistoric and later periods, and Redcliff offers a highly favourable settlement location for such exploitation. Its coastal aspect, with access to the North Sea and the river systems feeding the Humber, add to its potential significance in social and economic terms.

As yet, only scattered flint debris has been found which might relate chronologically to the Bronze Age structural material on the Melton foreshore, although investigations are at a comparatively early stage. For now, work at Redcliff is concentrating on the excavation of later material; features visible in the cliff edge have been examined by excavation in the field behind, revealing a complex arrangement of ditches, pits and possible structures, all apparently associated with the commercial traffic centred here in the 1st century A.D. At this time the site appears to have supported a native Iron Age port-of-trade attracting exotic imported pottery and other goods from a Roman Empire which, until 70 A.D., extended no further north than the Humber itself.

Mapping by the Soil Survey of England and Wales and recent work by Durham University Department of Archaeology suggests the drainage

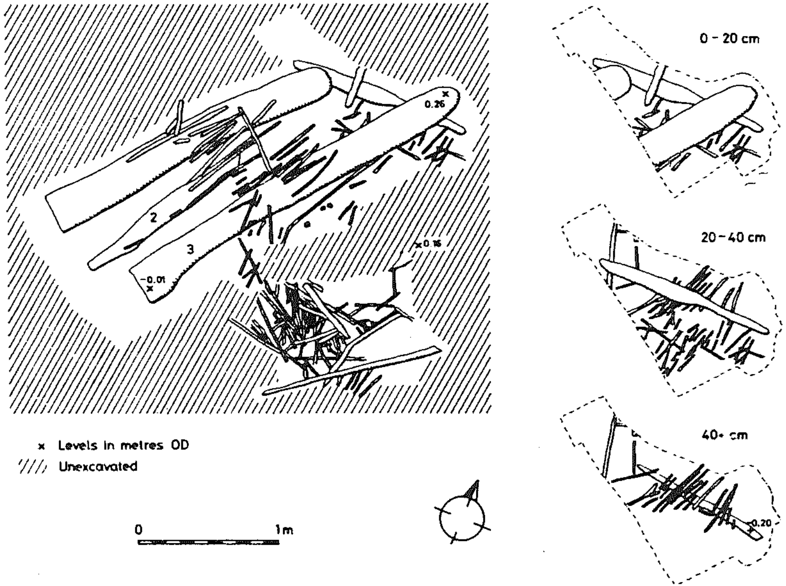

Figure 28. Excavation details of Structure 1.

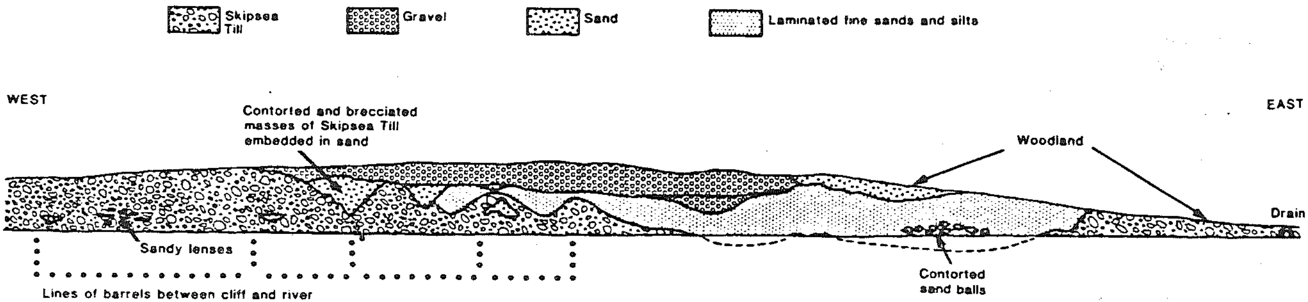

Figure 29. Redcliff section as seen in 1963 (redrawn from Catt, 1963).

outfall of that part of the Vale of York now served by the embanked River Foulness and Market Weighton Canal system might have been served by a tidal creek with a mouth running from Brough to Faxfleet during the Roman period. At present the relationship between Redcliff and Brough is uncertain for this period, although the apparently sudden termination of activity at Redcliff seems to coincide with the Roman advance northwards in 70 A.D. and the establishment of a military bridgehead at Brough (Petuaria), ultimately a major Roman town. If Redcliff was eclipsed by the establishment of Brough, perhaps reasons other than Roman military expediency must be sought. Natural constraints such as changes in drainage may have been critical factors in Redcliff's dominance and decline, although there may be social, political or economic factors that were yet more critical.

CONCLUSION

The shaping and modification of this landscape during the late Quaternary has created special circumstances and generated distinctive stimuli to which the indigenous population and newcomers alike have responded since at least the Bronze Age. Whilst only limited aspects of the region's exploitation are yet appreciated, it is hoped that in time a picture will emerge to show a coherent pattern of development and adaptation at a critical location along one of the great estuaries of England.

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