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BRECKLAND ARCHAEOLOGICAL SURVEY. AN OUTLINE OF THE ENVIRONMENTAL ARCHAEOLOGY OF BRECKLAND, WITH AN EVALUATION OF POTENTIALLY WATERLOGGED DEPOSITS AT FIVE SITES.

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Summary

An outline of the Environmental Archaeology of Breckland is presented. The Breckland Archaeological Survey was designed to enhance the SMR record and thereby to aid implementation of stipulations related to the ESA status of the area. To aid future decisions on site management, investigations of potentially waterlogged deposits at five sites were made. The stratigraphy, pH and % dry weight of deposits were determined, and small samples were assessed for macrofossil preservation. Only a Cavenham Mere, adjacent to a known Neolithic site, were deep sequences of well-structured waterlogged peats found. It was recommended that any future proposals affecting the hydrology of this site should be carefully considered: if these are unavoidable, archaeological intervention and palaeoecological study would be necessary.

Author's address :-

Mr P Murphy
UNIVERSITY OF EAST ANGLIA
Norwich
NORF
NR3 7TJ

Introduction

The Breckland of Norfolk and Suffolk was designated as an Environmentally Sensitive Area (ESA) in 1987 by the Ministry of Agriculture. ESA guidelines stipulate to land-owners and tenants that " You will be expected to farm the land so that scheduled ancient monuments and other features of historic interest that you know of are not damaged". Implementing this stipulation effectively depends upon having good data on archaeological sites and their current state of preservation, and making this information available to appropriate parties. The Breckland Archaeological Survey was established in 1994 by Norfolk and Suffolk County Councils and English Heritage to supplement and enhance information already available on the County SMRs, and thereby to aid this process. Kate Sussams was appointed Project Officer.

The project involved both desk-top studies and field survey and, in the course of the latter, Ms. Sussams identified a group of sites (archaeological sites and sequences of natural sediments adjacent to them) where waterlogged deposits with the potential for yielding environmental data where thought to be present. At this stage, the writer was asked to undertake stratigraphic studies, to determine the character of the extant deposits and sediments and to evaluate preservation of organic materials, so as to provide data relevant to future site management. This was thought to be of particular value when determining the possible impacts of any future proposals affecting groundwater levels, and is presented and discussed in this report.

The aim of the study was not primarily to provide environmental information *per se*, though some information has incidentally been obtained. An outline of the Environmental Archaeology of Breckland was requested by Ms. Sussams for inclusion in the full Survey Report, and prefaces the account of the evaluation work, to place it in context.

Environmental Archaeology and landscape history of the Breckland

1. Introduction

Breckland is an area of predominantly sandy soils occupying a gap in the Cretaceous escarpment of west Norfolk and Suffolk between Newmarket and Swaffham. It is contiguous with the peat fens to the west and is bounded to the east, north-east and south by chalky till, whilst to the south-west sand cover thins onto the Suffolk and Cambridgeshire chalklands. The combination of very freely-draining sand soils with low mean annual rainfall, together with the long-term effects of human activity, resulted in the development of highly distinctive heathland plant communities. However, though forming a discrete landscape region, Breckland shows considerable internal diversity. Corbett (1973) distinguishes five main 'landscape' facets:

1. Uplands. On the higher areas of Breckland, around 30-45m OD, soils are well-drained acid brownearths and podzols formed on sands over the chalk-sand drift and on high-level Pleistocene gravels. On the deeper acid sands *Calluna vulgaris* (ling) heath locally dominated by *Pteridium aquilinum* (bracken), grassland of *Agrostis* (bent grass) and areas of *Carex arenaria* (sand sedge) are nowadays the main semi-natural plant communities (Watt 1940,

1955).

2. Slopes. Fossil periglacial features - stripes and polygons (Watt *et al* 1966) - have resulted in complex and locally very variable patterns of soil types on slope sites, including rendzinas, calcareous brownearths and brownearths with surface sandy horizons. The main 'natural' vegetation is grass-heath of *Agrostis* and *Festuca* (sheep's fescue) with varying proportions of calcicolous (chalk-loving) herbs (Watt 1940).

3. Dry valleys. These are infilled with soliflucted sands and gravels, and soils are deep and coarse-textured.

4. River terraces. Terrace gravels flanking the main rivers have a superficial cover of blown sand. Soils are well-drained stony brown-earths and humus podzols with immature soils on recent blown sand. Vegetation includes *Calluna* and grass heath, with *Carex arenaria* on blown sand.

5. Valley floors. Deep eutrophic (base-rich) peats cover the valley floors, with ground water gley soils and organic soils developed on them. Fen woods, carr and wetland herbaceous communities occur.

2. Pollen analysis at Hockham Mere

The overall vegetational history of the area has been reconstructed from pollen analyses of sediments at Hockham Mere, Norfolk (Godwin 1944; Sims 1973, 1978; Bennett 1983a,b). Pollen studies show that in Breckland, as elsewhere in lowland Britain, from the end of the latest (Devensian) glaciation the landscape was colonised by herbaceous vegetation and then by trees: at first *Betula* (birch) woodland developed, and successive colonists included *Pinus* (pine), *Corylus* (hazel), *Quercus* (oak), *Ulmus* (elm), *Tilia* (lime) and *Fraxinus* (ash), with *Alnus* (alder) in low-lying wet locations. The earliest major human impact on woodland vegetation was associated with a marked decline in elm pollen, now thought to be a consequence of early clearance and/or coppicing and pollarding, which placed trees under stress and made them vulnerable to disease (Peglar 1993), though earlier disease outbreaks not related to human activity may have occurred.

The most recent work by Bennett (ibid) shows that just prior to the elm decline *Tilia* was the dominant forest tree on dry soils, and that *Corylus* was being replaced by *Fraxinus*. The elm decline occurred in two phases, at 6000 BP ('before present', in uncalibrated radiocarbon years) and, after a slight recovery, there was a secondary decline at 4500 BP. However, there was no very substantial woodland clearance until after 2500 BP (in the Iron Age), followed by a marked increase in pollen percentages of *Calluna* from about 2250BP. Bennett concluded that "the effects of Neolithic man around Hockham Mere were limited".

However, it should be noted that in the area to the north and north-east of Thetford, around Hockham Mere, there are extensive areas of 'upland' gravel-based soils (Corbett 1973, 65) and the pollen data therefore relate predominantly to the first of the 'landscape facets' distinguished above. Healy (1984, 126-7) has reviewed the distribution of settlement sites and lithic finds and concludes that they are, in general, riverine in distribution and that settlement was sparse in the Neolithic. On archaeological evidence the opening up of the more drought-prone sand soils on the interfluves between the main rivers does not seem to have pre-dated the Late Neolithic or Early Bronze Age, when these areas were used primarily for grazing, rather than permanent settlement.

The notion that the Breckland was an area of large-scale permanent clearance in the earlier part of the Neolithic may now be rejected. There is, however, palaeoecological information from prehistoric and later sites suggesting that the scale and intensity of exploitation differed markedly between the 'landscape facets', and this will now be reviewed.

3. Uplands.

The principal upland site so far investigated was north of Thetford at Fison Way (Gregory 1991). There was a scatter of Late Neolithic and Bronze Age flintwork, some Beaker pottery and Middle Bronze Age cremations, but the main phase of activity was in the Late Iron Age/Early Roman period, when a large and complex rectangular enclosure with large round-houses, clearly of high status and perhaps a religious cult centre, was constructed.

Environmental information came primarily from charred plant material. Cereal remains were sparse; the predominance of cleaned and semi-cleaned grain, with no crop processing waste, was thought to indicate that cereals were being brought to the site from farms elsewhere rather than representing local production (Murphy 1991). Pre-Iron Age contexts produced no *Calluna* charcoal: only oak was identified. However, charred stems of ling/heather were frequent in Iron Age and Roman contexts, and several large deposits of charred *Calluna* remains came from Late Roman features. Nearby, on Gallows Hill, a turf-stack mound sealing an immature soil formed on blown sand (MacPhail 1986) had previously been excavated (Lawson and Le Hagerat 1986). Charred *Calluna* remains on the surface of the soil were dated by radiocarbon to 1600 $\pm$ 70BP (HAR-2905) (Murphy 1986).

The results indicate that by the Iron Age this hilltop site had been cleared of woodland and was covered with *Calluna* heath, whilst the Gallows Hill buried soil indicates that there were areas of unstable soil surfaces prone to wind-erosion.

4. Slopes.

Several sites have been investigated on the more calcareous soils of the slopes. Shells of land snails from Bronze Age barrow ditches at Little Cressingham, Norfolk (Murphy 1986a) and Risby, Suffolk (Murphy, unpublished) and from an Iron Age enclosure ditch at Barnham, Suffolk (Murphy 1993) have been studied. At all three sites snails typical of dry, unshaded grassland habitats (*Truncatellina cylindrica, Vertigo pygmaea, Pupilla muscorum, Vallonia costata, V. excentrica, Helicella itala*) vastly predominated: *P.muscorum* accounted for up to 60% of some assemblages. Snails characteristic of less extreme habitats were sparse (the normally common *Trichia hispida* group was apparently absent at Barnham) and shade-requiring species typical of woodland very rare. Extremely open environments and intensive grazing appear to be indicated.

Middle Bronze Age settlement midden deposits at Grimes Graves, Norfolk produced charred cereals and pulses and a collection of animal bones with a high proportion of cattle, thought to indicate an emphasis on dairying (Legge 1981). Grimes Graves is, however, an atypical site. Neolithic flint mining pre-dating the Bronze Age site had resulted in surface deposition of dumped chalk, which would have improved soil conditions for arable farming; and the site is relatively close to the Little Ouse valley where pasture and water would have been available. It is likely that farm sites of this type were located mainly in a belt following the river valleys, rather than further up the slopes (see Healy, above).

5. River terraces.

Investigated sites ranging in date from the Iron Age to Middle Saxon on the gravel terraces of the Rivers Lark and Little Ouse and nearby areas in Norfolk and Suffolk: these include West Stow, Icklingham, Staunch Meadow, Brandon and Fengate Farm, Weeting (Carr, Tester and Murphy 1988; Murphy 1985 and unpublished). They have produced useful information on early farm sites, from charred crop remains and animal bones.

In summary, the results indicate crop production on terrace soils based on spelt wheat, emmer wheat and hulled barley in the Iron Age-Roman periods and persistence of spelt into the Early Saxon period, together with barley, free-threshing wheat, rye and cultivated oats. By the Middle Saxon period, at Staunch Meadow, Brandon, rye seems to have been the main cereal crop. It has a very extensive root system, and gives good yields compared to other cereals on nutrient-poor, excessively drained soils. Iron Age animal bones from West Stow were mainly of cattle and sheep/goat with few pigs (Crabtree 1989). Pigs in the past were allowed to forage in woods in a semi-wild state for nuts, fruits, roots and tubers (pannage), and their rarity at West Stow probably reflects the scarcity of pannage in the largely treeless Breckland. In the early Saxon period at West Stow, sheep and goat predominated (almost 50% of the total) with some cattle and again, relatively small numbers of pigs (Crabtree 1994). It is known from historical sources, from the Domesday Survey onwards, that sheep-grazing was the main element of Breckland farming in later times, and this form of land-use clearly had very early origins.

There is little information relating to vegetation from terrace sites, though charred *Calluna* remains came from Iron Age and later contexts.

6. Valley floors.

The earliest evidence for human activity in the Lark Valley came from Lackford Bridge, Suffolk, where a 20cm thick layer of heat-shattered flint and charcoal was recorded within peat. The charcoal was largely of alder with some hazel and oak. Overlying brushwood peat contained abundant alder remains with some oak wood and seeds of wetland plants. A radiocarbon date of 3940 $\pm$ 80 BP (HAR-2484) was obtained on charcoal (Murphy, unpublished data). Bronze Age burnt flint sites in peat, of this type, are widespread around the eastern fen-edge and in East Anglian river valleys elsewhere, though their function(s) are still not understood.

Valley peats have been most extensively investigated at Staunch Meadow, Brandon, adjacent to the Middle Saxon settlement (Carr, Tester and Murphy 1988; Murphy 1994, 31-35; Wiltshire 1990). The site was located on a sand ridge on the floodplain of the Little Ouse, and peat sections were examined at four locations. In each case the peat overlay a basal grey or greyish brown sand. In a 2m section adjacent to the river, the base of the peat was radiocarbon-dated to 1950 $\pm$ 70 BP (HAR-6475) and 1920 $\pm$ 60 BP (HAR-6474), whilst further back from the river, the base was dated to 1810 $\pm$ 80 BP (HAR-4087). Plough-marks in the basal sand indicate agriculture, presumably of Iron Age date, before the inception of peat development.

Within the peat were layers of charcoal and white sand, eroded from the ridge, dated to 1350 ± 70, 1330 ± 80 and 1390 ± 80 BP (HAR-4086, 6605, 5072: calibrated date range AD 605-660 *i.e.* relating to the earliest phases of the Middle Saxon site). These included *Calluna* charcoal with hazel, oak and ash charcoal (some showing cuts made prior to charring), charred macrofossils of wetland plants, cereals and crop weeds. A major fire on the ridge which burnt areas of heath vegetation and also perhaps artificial wooden structures seems to be indicated. Artificial sand mounds within the peat were associated with charred cereals, seeds, capsules and stem waste of flax (*Linum usitatissimum*), dense deposits of elder (*Sambucus nigra*) seeds and seeds of *Reseda luteola* (dyer's rocket). Evidently these related to textile processing.

Pollen analysis of the peat at Staunch Meadow by Patricia Wiltshire (1990) has provided information on vegetation changes and farming from the Late Iron Age to Middle Saxon periods. At first there was a local dominance of grassland and weed vegetation, followed by increases in pollen from tall herb/swamp communities as peat development began. Pollen from trees and shrubs (mainly hazel-type, alder and ash) never accounted for more than 10% of total pollen. *Calluna* pollen was represented throughout the sequence, pointing to proximity of heathland vegetation, but from the Middle Saxon period showed an increase. Pollen of cereals similarly occurred at all levels, with peaks in deposits of probable Roman and Middle Saxon date, together pollen of *Cannabis* (hemp), *Linum* (flax) and *Reseda luteola* (dyer's rocket). The lower pollen percentages of cereals and other crops between these two peaks may indicate a reduction in arable farming in the post-Roman period.

7. Land use: general conclusions.

The evidence currently available indicates that Neolithic-Bronze Age settlement and farming in Breckland was largely confined to the river valleys and calcareous soils on slopes. Areas of poorer sandy soils were evidently exploited, but apparently not intensively. Pollen results from Hockham Mere indicate no substantial clearance on these soils before about 2500 BP. This seems to indicate an Iron Age expansion onto land which was marginal for agriculture The major site at Fison Way, Thetford was associated with this expansion. From the Iron Age onwards there is good evidence from charred cereals at settlement sites for continuous crop production on the river terraces; and pollen results from Brandon clearly indicate continued arable and pastoral farming between the Iron Age and Middle Saxon periods, with some reduction in production in the post-Roman period. At all periods it may be suspected that the river valleys and adjacent areas were the core areas for agriculture: the 'heathland nuclei' (Limbrey 1978, 25) of the uplands rarely justified the effort of manuring and marling for arable farming, but were used principally as low-grade grazing land for sheep.

8. Future archaeological research

Although the results available for the Breckland were not the product of a research project planned in advance, relatively intense archaeological and palaeoecological research for many years has resulted in a model of land use from the Neolithic to the Middle Saxon period. This model is, to some extent, predictive: for example, Bronze Age barrow ditches on the chalk/sand drift of the slopes would be expected to produce snail shell assemblages consistently composed of open country species. Sampling at archaeological sites in the

Breckland should therefore be geared primarily towards testing the proposed model of land use. This will help to provide a framework for investigation when soil samples from future excavations are being assessed, and will also aid the devising of detailed programmes of sample analysis.

Since it has been suggested that the river valleys were the main areas of settlement and agriculture, opportunities to examine sections through floodplain peats and sediments filling extinct water-courses (palaeochannels) should be given a high priority. Deposits adjacent to archaeological sites are likely (as at Brandon) to yield detailed information on changes in vegetation, land-use and agriculture, relating to particular sites.

Stratigraphic, palynological and macrofossil investigations at Hockham Mere have been conducted by Quaternary Ecologists, who have a different research agenda to archaeologists: they have been concerned with long-term reconstruction of vegetation change from the late glacial onwards. This does, of course, give a background, gross picture of ecological change which is archaeologically relevant. However, future environmental studies of sediments as part of archaeological projects need to be much more focused. It will not always be necessary, or indeed possible, to analyse fully complete sequences. Instead parts of sequences contemporary with specific archaeological sites should be characterised (by radiocarbon dating) and then studied in great detail. Only by this means will it be possible to integrate on- and off-site data in any detail.

9. Site management

Strictly in terms of Environmental Archaeology, two categories of deposits stand out as being potentially very informative, but also very vulnerable to destruction: wet/waterlogged deposits and buried soils (the latter not, so far, extensively investigated).

9.1. Wet/waterlogged deposits

As part of the Breckland Archaeological Survey, a small-scale study of sediments and archaeological deposits at selected sites was undertaken, focusing attention on several sites where preservation of organic materials by waterlogging was expected. The results are discussed below, but in summary it is clear that many of these deposits were de-watered so that organic preservation was often not good. Only at Cavenham Mere were deep organic deposits with well-preserved macrofossils encountered.

This study serves to highlight the importance of permanently waterlogged peats and other deposits in the river valleys and some of the Breckland meres, where organic preservation is still very good, particularly those close to known archaeological sites. Proposals affecting the hydrology of these deposits, particularly lowering ground-water levels would cause degradation. Wholesale removal or disturbance of such deposits by quarrying, road construction etc. would obviously destroy them completely. Appraisal and assessment prior to any such developments will be essential, leading to the development of mitigation strategies where appropriate. This would involve preliminary site investigation by augering or coring to evaluate the depth and character of deposits, their hydrological status and relationship to archaeological layers, as well as laboratory assessment of the preservation of macro- and micro-fossils.

9.2. Buried soils sealed beneath earthworks.

These have the potential for yielding detailed information from studies of soil pollen, molluscs and soil micromorphology. However, the surviving areas of ancient buried soils are a limited resource, subject to long-term degradation and destruction. Any proposal involving removal of archaeological deposits overlying buried soils will demand an archaeological response in terms of appraisal, assessment and mitigation. Buried soils preserved under Scheduled Ancient Monuments and other protected sites should be safe from damage by construction, but are vulnerable to biological re-working and disturbance, especially by tree roots and burrowing animals, which in the long run will result in homogenisation of soil profiles. Site management to reduce damage from these sources is clearly necessary.

However, preliminary vegetation survey would be necessary before any clearance of vegetation so as not to overlook plants which are themselves an integral part of the historic landscape. These would clearly include rare Breckland species (Petch and Swann 1968, 31), but also more common plants relating to former land-use. An example of the latter would be the old coppiced willows on the bank of site BAS/ENV 1 - the only trees in an otherwise open landscape.

9.3. Other sites in dry locations.

No active management seems necessary for ploughed-out dry sites surviving only as negative features, though obviously archaeological recording and environmental sampling would be necessary in advance of destruction by construction work, forestry and other developments.

<u>The survey</u>

1. Methods

Augering was undertaken using a 6cm Edelman combination auger (for soils and archaeological deposits) and a 3cm gouge auger (for peats and other organic sediments). Samples were taken of the main units, sub-divided where these were thick.

pH estimations were made on homogenised samples from the main sedimentary units distinguished, to give a crude impression of pH variability in the deposits. For each estimation a 0.5ml spoon spatula-full of sediment was suspended in 10ml of distilled water and, following calibration, pH was estimated using an Eijkelkamp meter. Estimations were done in the laboratory as soon as possible after sampling, though inevitably pH ranges are likely to have been reduced after sampling. This should, however, not have affected relative pH between deposits.

% dry weight of sediments was determined where it was thought that data relevant to site management would be obtained. Sediment samples (*c.* 5g) were weighed and dried overnight at 105°C before re-weighing to determine % dry weight and hence water content.

Small sub-samples, (amounts specified below), were assessed for plant and animal macrofossils. These samples were disaggregated in hot water with manual agitation, though pre-soaking in NaOH solution was needed to disaggregate clay samples. They were then wetsieved on a 0.5mm mesh and the retent was scanned under a binocular microscope at low power, noting taxa present and their state of preservation.

2. Site BAS/ENV 1, East Wretham Heath. TL 9129 8814.

This small circular enclosure, defined by two concentric ditches and banks, was investigated on 19th January 1996. The site lay within a topographic hollow, within an area of open grass heath: a few old coppiced willows along the outer bank were the only trees in the immediate vicinity.

Augering at the centre of the enclosure showed the following deposits:

0-10cm.	A_o. Dark brown peat loam; sharp boundary.
10-35cm.	Greyish-brown clay loam, mottled reddish-brown; slightly stony, with sub-angular and angular flints up to 10mm.

In the outer ditch deposits were;

0-30cm.	Dark brown slightly sandy peat loam with subangular flints up to 10mm; sharp boundary.
30-35cm.	Brown sand.

Results

A 250g sample from the base of the outer ditch (20-35cm: pH 5.7) included *Salix* (willow) leaf fragments, abundant 'seeds' of *Ranunculus* subg. *Batrachium* (water crowfoot) with *Potamogeton* (pondweed), *Eleocharis palustris/uniglumis* (spike-rush), *Lapsana communis* (nipplewort) and *Potentilla anserina* (silverweed), as well as cladoceran (water-flea) ephippia, caddis larval cases and beetle remains. All were well-preserved.

Conclusions

The basal clay loam deposit in the central area of the site differs very markedly from the natural sub-soil in the vicinity, which has a sand matrix. It seems highly likely that the area within the inner bank was lined with intentionally-emplaced clay, so as to retain surface drainage water naturally intercepted. In other words, it is thought that the site was a pond for watering stock. The very well defined profiles of the banks and shallow infilling of the outer ditch suggest that the site is of post-medieval or later date.

3. Site BAS/ENV 2, Langmere, (Parish of East Wretham). TL 9053 5977.

Investigations at this site were intended to evaluate the potential preservation of wooden structures and organic deposits at the margins of a circular outlying basin of Langmere, and to determine the depth and character of sediments infilling the basin. When the site was inspected, on 19th January 1996, the basin was entirely dry, with no standing water. The very marked fluctuations in water-levels within the smaller Breckland Meres are well known.

Successive zones of desiccation, reflected by living vegetation cover and dead remains of the recent aquatic flora and fauna, were clearly visible. It seemed possible that the zones might have related to past cyclical local environmental change, and augering was therefore undertaken at three locations within these zones. Positions of the auger holes were measured from an arbitrary point at the outer edge of the basin ('0'), where grass heath with sporadic bushes of *Cytisus scoparius* was replaced by grass heath with tussocks of *Molinia caerulea*. Progressively towards the centre of the basin, continuous living vegetation cover was replaced: (1) by a zone largely masked by a near-continuous mat of dead filamentous algae with young colonising seedlings; and (2) by a central zone of peaty surface sediment, littered with shells of freshwater molluscs (*Sphaerium* spp, *Lymnaea* spp.) with dead remains of aquatic plants and a few seedlings. The small-hummocky surface of the ground in all but the central zone appeared to indicate rabbit burrowing in areas which were at least seasonally dry.

Stratigraphy

Auger hole 1. 29m from '0'.

0-11cm.	Greyish-brown sand, slightly organic in top 2cm; sharp boundary.
11-22cm.	Yellowish-brown sand.

Auger hole 2. 40m from '0'.

0-8cm.	Reddish-brown sand; sharp boundary (probable rabbit-scrape).
8-20cm.	Light greyish-brown sand with peaty laminations up to 10mm; sharp boundary.
20-22cm.	Reddish-brown sand.

Auger hole 3. 82m from '0', at centre of basin.

0-18cm.	Dark greyish-brown peaty/organic mud; sharp boundary.
18-123cm.	Light greyish-brown minerogenic mud; sharp boundary.
123-127cm.	Yellowish-brown sand.

Results

Auger hole 3.

0-20cm.	pH 6.7	% dry wt.	43.1
20-50cm.	pH 7.3		57.5
50-75cm.	pH 7.6		66.1
75-100cm.	pH 7.7		72.2
100-123cm.	pH 7.6		69.2
123-127cm.	pH 8.0		85.9

Macrofossils from 50g sediment samples at 0-20, 20-50, 50-75, 75-100 and 100-123cm included a very small organic fraction, comprising degraded scraps of monocotyledonous stem, fruits and seeds of *Cerastium* sp (mouse-ear), *Chenopodium rubrum/glaucum* (goosefoot), *Ranunculus* subg. *Batrachium* (water crowfoot), *R. sceleratus* (celery-leaved crowfoot) and *Urtica dioica* (stinging nettle) with cladoceran (water flea) ephippia. These were relatively well-preserved. The basal sample (123-127cm) was devoid of macrofossils.

Conclusions

The sediments infilling this arm of the mere are predominantly minerogenic, representing in-wash from of fine sediment from eroded soils in the catchment. The small organic component includes some quite well-preserved fruits and seeds, mainly of weeds favouring nutrient enriched soils with some aquatic species. The low input of biogenic material suggests that vegetation was sparse around the mere throughout the period of sediment accumulation examined. As is argued below for Rymer Point, this may indicate that livestock, driven to the mere for watering, trampled and grazed fringing vegetation almost completely, so that only bare soil surfaces with patches of weed plants were left. This is not implausible, for water sources for stock were limited in this area of Breckland, and large numbers of stock would periodically have been present at the mere.

In the absence of peats or other organic deposits, the sediments are not datable by means of radiocarbon. pH was generally >7 and water content relatively low, except in the topmost deposits. In these conditions pollen preservation is unlikely to be good. Wood is highly unlikely to survive. The sequence is therefore of little or no archaeological or palaeoenvironmental interest.

4. Site BAS/ENV 3, Santon Downham, (Parish of Lynford). TL 8275 8727.

This medieval moated site (County No. 5688) adjacent to the river Little Ouse was examined on 8th March 1996. Vegetation at the base of the moat comprised grasses, *Galium* and dead *Conium* (hemlock) plants: specifically wetland plants were not present, implying the fills were not permanently wet. The central platform was largely grass-covered, with some hawthorn and *Mahonia* bushes, of no great age.

Stratigraphy

Auger holes were sunk at several locations at the base of the moat, but it was generally not possible to penetrate sub-surface deposits of mortar, flint and occasional brick fragments. However, one hole in the south-east corner of the moat provided an apparently complete sequence through the moat fills.

0-37cm.	Dark brown sandy peat topsoil.
37-50cm.	Humified dark brown peaty sand with mortar fragments; modern roots.
50-90cm.	Humified dark brown peaty sand.
90cm+	Coarse orange-brown sand.

Samples were collected from the basal fills.

In the north-east corner, the deposits were.

0-25cm.	Dark brown sandy peat topsoil.
25-50cm.	Humified dark brown sandy peat with small flints and a single brick fragment.
50-75cm.	Brown organic sand, stony.

At neither location was there a substantial depth of fill, and those deposits present were moist but not waterlogged.

Augering in a depression which has been considered to represent a 'leat' connecting the moat to the river showed that impenetrable sandy deposits directly underlay the modern organic topsoil. Either this depression has been misinterpreted, or else it was infilled during one of the massive sand-storms which occurred in this area in the post-medieval period.

Results

South-east corner of the moat:

60-75cm.	pH 8.0	% dry weight	51.7
75-90cm.	pH 7.9		65.2

A 100g sample from the basal fill (75-90cm) at this point included monocotyledonous stem/leaf fragments, wood and twig fragments, budscales and fruits/seeds of *Ranunculus* subg. *Batrachium* (water crowfoot), *R. sceleratus* (celery-leaved crowfoot), *Apium* sp (wild celery) and *Urtica dioica* (stinging nettle), with caddis larval cases, beetle remains and shells of the terrestrial snails *Cochlicopa* sp and *Vallonia* sp. All were well preserved.

Conclusions

A trial trench would strictly be necessary to confirm that the impenetrable basal sand deposits are 'natural' rather than a fill with further organic deposits below. Assuming, however, that this sand is 'natural', the shallowness of the basal organic ditch fills implies that the ditch was regularly cleaned-out whilst the site was occupied (and perhaps even after). The basal organic fills appear base-rich with a relatively low water content: although the base of the ditch may be seasonally waterlogged, the fills were partly de-watered when sampled. Plant and animal macrofossils would not be expected to survive for long periods in such conditions and this, together with the excellent state of preservation of biological remains in the basal fill, implies that they are not of great antiquity. The deposits encountered during augering are therefore of no archaeological significance.

5. Site BAS/ENV 4, Rymer Point, (Parish of Little Livermere). TL 8667 7577.

Investigation took place on 8th March 1996. The site was an isolated small mere, one of a group known to have been present at this point on the high Breckland. The convergence of parish boundaries at this point indicates the importance of these meres for watering stock. Field-walking around the mere has indicated a dense concentration of Romano-British artefacts and burnt flint, the latter perhaps relating to prehistoric activity (Kate Sussams, pers. comm.). The aim of the investigation was to establish whether peat deposits suitable for palaeoecological investigation were present. The site was fringed by a dense cover of *Salix* sp(p) around open water.

Stratigraphy

An auger hole, approximately 10m from the edge of the arable field surrounding the mere, and at the water's edge showed the following deposits.

0-30cm.	Dark brown organic peaty loam with abundant *Salix* leaves.
30-110cm.	Greyish-brown sandy clay, mottled reddish-brown; merging into yellowish-

	brown clayey coarse sand.
110cm+	Yellowish-brown clay with chalk fragments.

Auger holes were sunk at other locations all around the mere, but encountered impenetrable sandy and clayey deposits at depths of about 30cm. The clayey matrix of the deposits accounts for the persistence of standing water, though whether this is purely derived from precipitation or from springs is uncertain. The apparent absence of any peats fringing the mere was unexpected. Possibly intensive use for watering animals in the medieval and post-medieval periods resulted, first, in the removal of fringing wetland and aquatic vegetation by trampling and grazing and, secondly, disruption and erosion of any organic deposits which had previously accumulated.

There remains the possibility that sediments still survive at the centre of the mere. If so, use of a piston corer would be necessary to recover cores.

6. Site BAS/ENV 5 (Cavenham Mere).

Stratigraphic investigations were undertaken on 29th April 1996 at the drained lake basin of Cavenham Mere. Bennett *et. al.* (1991) make no mention of this site, though observations by the Suffolk Archaeological Unit on the line of the Anglian Water pipeline crossing it indicated substantial peat depths (K. Sussams, *pers. comm.*).

Stratigraphy

The area studied was in the northern part of the mere, adjacent to a known Neolithic site occupying a spur of sand and gravel to the east of the mere. Two auger holes were sunk: Hole 1 was approximately 70m to the west of break in slope marking the former margin of the mere; Hole 2 was about 10m to the west of the former mere margin, and thus very close to the lithic scatter. The site was under pasture, crossed by drainage ditches lined by reeds. A simple gouge auger was used.

Hole 1. TL 7635 7055.

0-25 cm.	Topsoil with abundant grass roots.
25-63 cm.	Soft light greyish-brown clay; merging boundary.
63-83 cm.	Dark greyish brown organic clay, mottled reddish-brown; merging boundary.
83-100 cm.	Very dark brown well-humified peat; merging boundary.
100-165 cm.	Brown fibrous peat, relatively unhumified; merging boundary.
165-180 cm.	Very dark brown well-humified peat; sharp boundary.
180-184 cm.	Greyish-brown mud with mollusc shells; sharp boundary.
184-225 cm.	Very dark brown well-humified peat; merging boundary.
225-237 cm.	Very dark greyish-brown peat, relatively unhumified; some twigs; merging boundary.
237-250 cm.	Very dark greyish-brown organic mud; merging boundary.
250-263 cm.	Brown, relatively unhumified peat; narrow boundary.
263-268 cm.	Dark brown well-humified peat; narrow boundary.
268-271 cm.	Brown, relatively unhumified peat; narrow boundary.
271-285 cm.	Dark brown well-humified peat; merging boundary.

285-340 cm.	Brown, relatively unhumified peat; narrow boundary.
340-350 cm.	Dark greyish-brown organic mud with shell fragments.

Sediments below 350cm were impenetrable with the equipment available, and may represent the sand base of the mere.

Hole 2. TL 7640 7056.

0-40 cm.	Topsoil with abundant grass roots.
40-60 cm.	Light greyish brown firm clay, becoming darker and more organic at base; merging boundary.
60-129 cm.	Dark brown well-humified peat, becoming very dark brown with depth; occasional white sand patches/laminations; merging boundary.
129-141 cm.	Dark brown less humified peat; sharp boundary.
141-145 cm.	Greyish-brown sand.

This preliminary investigation has thus shown that sediments *c.* 350 cm. thick are present 70m from the presumed mere edge, thinning to *c.* 140 cm. 10m from its edge. Apart from the topmost 'alluvial' clay correlation between the two auger holes would not be possible without more detailed work

Results

% dry weight determinations were made only on the top 150cm of deposits, to evaluate whether there was any de-watering of peripheral peats around the mere edge.

Hole 1.

25-50cm.	pH 8.0	% dry wt.	69.8
50-63cm.	pH 8.0		68.5
63-83cm.	pH 7.8		53.7
83-100cm.	pH 7.6		23.8
100-125cm.	pH 7.4		17.4
125-150cm.	pH 7.7		15.8
150-165cm.	pH 7.3		
165-180cm.	pH 7.2		
180-184cm.	pH 7.7		
184-200cm.	pH 7.3		
200-225cm.	pH 7.0		
225-237cm.	pH 7.0		
237-250cm.	pH 6.8		
250-263cm.	pH 7.3		
263-268cm.	pH 7.1		
268-271cm.	pH 7.1		
271-285cm.	pH 7.1		
285-300cm.	pH 6.8		
300-320cm.	pH 6.5		
320-340cm.	pH 7.0		
340-350cm.	pH 7.3		

Hole number		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2
Depth (cm)		320-340	300-320	285-300	271-285	268-271	263-268	250-263	237-250	225-237	184-225	180-184	165-180	100-165	83-100	63-83	25-63	141+	129-141	80-100	60-80
Trees, shrubs etc																					
Betula sp	Birch		xx							x											
Solanum dulcamara	Woody nightshade	x																			
Terrestrial herbs																					
Papaver argemone	Long-headed poppy													x							
Potentilla sp.	Cinquefoil														x						
Rumex acetosella	Sheeps sorrel															x					
Urtica dioica	Nettle																				x
Wetland plants																					
Carex spp.	Sedges		x	x				x					x	x	x						x
Cladium mariscus	Saw-sedge		x		x	xx	x		x												
Eleocharis sp	Spike-rush											x									
Eupatorium cannabinum	Hemp agrimony	x																			
Hydrocotyle vulgaris	Pennywort										x										
Lycopus europaeus	Gipsywort	x																			
Menyanthes trifoliata	Bogbean								x		x										x
Ranunculus flammula	Lesser spearwort														x					x	
Ranunculus sceleratus	Celery-leaved crowfoot																			x	
Aquatics																					
Chara sp.	Stonewort											x		x	x	x	x				
Potamogeton spp.	Pondweed		x									x									
Ranunculus subg. Batrachium	Water crowfoot											x				x				x	
Zannichellia palustris	Horned pondweed																x				
Vegetative plant material																					
Charcoal			x			x												x	x		
Monocot stem/leaf/rhizome		x	x	x	x	x	x	x	x				x	x	x	x	x	x	x	x	x
Mosses				xx	x	xx	x	xx	x		x		x	xx	x	x					x
Phragmites rhizome	Reed																	x	x		
Twigs		x	x	x	x	x			x	xx	x		x					x	x		
Molluscs																					
Armiger crista												xx									
Hippeutis complanatus												x									
Lymnaea spp												x									
Lymnaea truncatula												x									
Pisidium spp.												x				x					
Arthropods																					
Beetles		x	x	x	x	x		x	x		x	x		x	x	x		x		x	
Cladocera																x					
Ostracods												x			x	x					

Table 1: Macrofossils from sediment samples. Plant taxa are represented by fruits or seeds except where indicated.

In Hole 2 estimations were:

60-80cm.	pH 7.4	% dry wt.	29.5
80-100cm.	pH 7.9		25.8
100-129cm.	pH 6.4		20.3
129-141cm.	pH 6.6		18.4
141-146cm.	pH 7.1		75.6

Small samples (*c.* 3 cm^3) were disaggregated and scanned under a binocular microscope at low power (Table 1). Macrofossils were preserved in all sediments examined: preservation was good or adequate for analysis throughout.

Conclusions

Highly organic sediments, including peats, were shown to extend to a depth of 3.5m. The circumneutral pH and waterlogging of these sediments has resulted in good preservation of plant and animal macrofossils, and pollen preservation may be inferred to be similarly adequate for analysis. Numbers of macrofossils retrieved in this study were obviously far too small for any overall environmental reconstruction. However it appears that the site remained open fen for much of its history, with no evidence for alder or willow carr development, though birch was represented at some levels. On macrofossil evidence, the shelly mud at 180-184cm in Hole 1, and the topmost organic clays in both boreholes, were deposited under standing water and may relate to human effects on hydrology and soil erosion in the catchment.

Peats at the margins of the mere (60-141cm) had percentage dry weights of 18-29%, increasing towards the top. This compares with 16-24% for peats in Hole 1 at equivalent depths (83-150cm). Allowing for the slightly higher minerogenic component of the peripheral peats, these results give no grounds for thinking that drainage ditches in the mere have resulted, yet, in any significant de-watering at the edge of the mere.

Any proposals to improve drainage further at this site would undoubtedly have deleterious effects on deposits which at present are excellently well preserved, and eminently suitable for detailed palaeoecological analysis. The site offers the potential to relate human activity, evidenced by artefact scatters around the mere edge, directly to changes in vegetation, soils and hydrology. Palaeoecological studies at this site would therefore make a valuable contribution to our understanding of landscape and vegetational change in the Breckland, which hitherto has been based to a large extent on studies at one site - Hockham Mere (see above).

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