The sequences from Beccles, Hengrave and Ixworth were sub-sampled for pollen assessment at varying intervals, with 16 samples from each prepared using standard techniques including KOH digestion and acetylation (Moore *et al*., 1991). At least 125 total land pollen grains (TLP) excluding aquatics and spores were counted for each sample. However, where pollen preservation and concentration was found to be poor, then this was not always attained. In such instances, counting continued for one complete slide. Pollen nomenclature follows Moore *et al.* (1991), with the modifications suggested by Bennett *et al.* (1994). The pollen sum is based on TLP excluding obligate aquatics and spores. Percentages for these groups are calculated as percentage of the basic sum plus sum of the relevant group. The data are presented as skeleton pollen diagram produced using the computer programmes TILIA and TILIA*GRAPH. The diagrams have been divided into preliminary local pollen assemblage zones for the purposes of discussion.

Beccles

Interpretation

Pollen concentrations and preservation was found to be highly variable in the Beccles samples (Fig X), with evidence of a general deterioration in pollen preservation and associated reduction in concentration towards the top of the sequence. For this reason, pollen counts are very low above c. 2.9m in particular, and although the data are presented as percentages, these data should be regarded with caution and any interpretation must be very tentative.

The basal zone (BCC1) is dominated by *Pinus sylvestris* (Scots' pine), with few other taxa in any quantity other than Cyperaceae (sedges) and Pteropsida (ferns). Pine must have been growing on the floodplain itself at this time, with ferns and sedges on slightly damper soils near to the sampling site. BCC2 opens with a marked decline in Pinus and concomitant rise in *Alnus glutinosa* (alder) and other trees including *Quercus, Corylus, Salix* and *Tilia*. Poaceae also increases whilst Cyperaceae declines steadily across the zone and Pteropsida remain well represented. This zone therefore reflects both local and extra-local vegetation change, with alder, willow and perhaps oak replacing pine on the floodplain and with lime, hazel and oak becoming established in the wider landscape on drier soils. The Poaceae curve is likely to reflect local wetland grasses such as *Phragmites* (common reed), with few other herbs recorded at this time.

The final zone BCC3 sees an abrupt fall in *Tilia* and steady reductions in other trees and shrubs including *Alnus*, *Corylus* and *Pinus*. *Salix* and *Betula* are the only woody taxa to increase at this time. Herbs including Poaceae and Cyperaceae increase with other indicators of open ground including Lactuceae, *Galium*-type and towards the top of the zone, *Plantago lanceolata* and *Rumex*. *Sparganium emersum*-type also displays a steady increase. The data would therefore appear to reflect a general opening up of the woodland canopy both on the floodplain and on drier soils. The increase in bur reeds, sedges and willow may suggest that locally conditions had become wetter, favouring the expansion of willow over alder. The disappearance of lime and falls in the other arboreal components alongside rising grasses and other herbs suggest

significant changes on the dryland, with lime dominated woodland being replaced by open grassland.

Discussion

The very low counts for this sequence preclude any detailed discussion, with the associated lack of robust chronology **(see section? Tom)** also hindering interpretation. The poor pollen preservation and low concentrations may be a result of a relatively 'dry' environment on the floodplain for much of the period of sediment accumulation such that conditions for the preservation of pollen have frequently been marginal at this site (**see section?)** However, it is clear that the diagram reflects both local vegetation dynamics as well as changes in the wider landscape for much of the Holocene (BCC1 and 2), with evidence for human impact in the form of the lime decline and subsequent opening up of the landscape presumably during the later Holocene.

Hengrave

Pollen concentrations were assessed as moderate-good for most of the sample from this sequence, although counts for the samples at 2.40 and 2.64m are low due to poor preservation at these depths. Poacaeae, Cyperaceae dominate HEN1 with a range of other herbs including Lactuceae, Brassicaceae, *Cerealia*-type and *Plantago lanceolata* recorded. Arboreal taxa are very low. The data therefore reflect an open, damp grassland landscape, with evidence for the cultivation of cereals. Few trees can have been present in the near vicinity of the sampling site, although some alder is possible on damper soils of the floodplain.

Changes at the opening of the subsequent zone (HEN2) are fairly subtle, consisting of increases in *Plantago* and other herbs including *Chenopodium*, *Filipendula*, *Rumex*, *Urtica*, *Polygonum* and *Cerealia*-type. The impression is of an open agricultural landscape with an expansion in arable plots and associated weed floras (eg. mugwort and fat hen), as well as herbs suggesting a range of other semi-natural vegetation communities such as tall herbs (meadowsweet and the carrot family) and disturbed grassy places (knotweed), pasture/meadow (ribwort plantain, dandelions, meadow-rue, docks and nettles). Vegetation on damper soils near to the sampling site and probably also on the edge of the floodplain included sedges, *Equisetum* (horsetails), *Typha latifolia* (reedmace), which expands towards the top of the zone, whilst aquatic vegetation is evidenced by *Potamogeton* (pondweeds). As with the previous zone, no substantial woodland cover is indicated, with perhaps some alder and scattered oak-hazel scrub possible.

The final zone, HEN3, is mainly defined on the basis of the virtual disappearance of tree and shrub taxa from the record, with only *Corylus* recorded as a continuous curve at very low percentages. Changes in the ground flora consist of an initial spike in Poacaeae, followed by reductions in *Rumex*, *Polygonum* cf. *aviculare*-type and *Filipendula*. Other herbs including *Plantago* and Lactuceae remain well represented, whilst there are slight increases in *Artemisia*-type and *Urtica*. The spectra therefore indicate the demise of any remaining woodland communities in the pollen source area at this time, with hazel the only woody component that might have persisted after the

opening of the zone. This as well as the changes in the representation of herbaceous taxa is probably a reflection of a shift in the nature of the local agricultural regime at this time (see below).

Discussion

Discussion of the Hengrave sequence is also hindered by the lack of a robust chronology. However, the biostratigraphy is evidently conformable, pollen concentrations are adequate and preservation is good to moderate for most of the samples. The sequence obviously reflects later Holocene environmental change as the vegetation in the pollen source area is clearly an open, agricultural landscape with very few trees and both arable and pastoral agriculture indicated. The suite of herb pollen in all three zones includes relatively high percentages of cereal-type pollen, as well as weeds of cereal plots and those suggesting grazed swards and disturbed habitats. The final zone (HEN3) would appear to reflect an intensification/change in the nature of local farming activity, leading to the demise of certain herb communities including knotweed, docks and tall herbs, and the expansion of taxa typical of heavily disturbed habitats such as nettles and mugwort. It might be speculated that the maintenance of a steady hazel curve in the context of an open, farmed landscape at this time suggests some form of woodland management.

Ixworth

Both pollen concentration and preservation were assessed as good-moderate for this sequence. The basal zone (IX1) records a peak in Betula with lower values for *Pinus*, *Salix* and *Quercus*. Cyperaceae is well represented with other herbs including Poaceae, *Thalictrum*, *P.lanceolata* and *Saxifraga* spp. The impression is therefore of an open birch-willow scrub dominated environment, with herbs such as sedges, meadowrue, ribwort plantain and saxifrage suggesting disturbed/skeletal soils.

IX2 is marked by a reduction in *Betula* and *Salix* and increases in the other arboreal taxa including *Alnus, Ulmus, Tilia* and *Corylus*. *Pinus* also increases to a marked peak at 2.28m prior to falling to low values. Indicators of open habitats are reduced and in the case of certain of the herbs in the previous zone, disappear from the record. Other than Poaceae and Cyperaceae, herbs tend to be recorded in low and sporadic quantities in IX2, whilst Pteropsida rises towards the top of the zone. The pollen spectra reflect the development of alder carr on and around the wetter soils of the sampling site and the spread of mixed woodland in the wider landscape. Lime and hazel appear to have been the major components of the tree/shrub cover, with oak and elm less significant. Birch was clearly out competed following the spread of the other trees, but pine appears to have remained present on some areas of the floodplain, and even expanded perhaps as a result of a dry phase which favoured this tree over alder. This was clearly a relatively brief event, as pine is subsequently reduced whilst alder re-expands. The nature of the understorey on the drier soils beyond the floodplain is unclear, but it seems probable that the canopy was closed with few clearings or naturally open areas away from those where high soil moisture favoured wetland vegetation. Is possible that some of the Poaceae derive from dryland communities rather than wetland grasses on the floodplain, but it is likely that the pollen spectra are

biased towards on-site vegetation in any case with ferns and sedges probably forming the alder carr understorey.

The final zone IX4 is marked by an abrupt decline in *Tilia* with *Alnus* and *Ulmus* also reduced at this time. Other trees including *Corylus* and *Quercus* initially display small increases but subsequently decline across the zone. Marked rises in Poaceae and Cyperaceae are accompanied by the record of other herbs such as Lactuceae, Apiaceae, Asteraceae undiff., Caryophyllaceae, *Chenopodium* with *Cerealia*-type and *Plantago lanceolata* towards the top of the zone. These events can be interpreted as indicating a significant opening up of the lime woodland followed some point after this by disturbance to the alder carr on and around the sampling site. The initial enhanced values for hazel and oak are probably a result of the increased representation of extra-local vegetation following the reduction in alder rather than an actual areal expansion of these taxa. The subsequent drops in all the arboreal components and the rise in *Cerealia*-type and indicators of disturbed habitats and grassy places towards the top of the diagram reflect the demise of much of the woodland on both dry and wetland soils as a result of the expansion of arable cultivation.

Discussion

As for the other two sequences, discussion and interpretation is hindered by the lack of a reliable chronology. However, once again, the biostratigraphy is as far as can be established from these data, conformable. The Ixworth sequence would appear to reflect an almost complete Holocene sequence of environmental change. The basal zone reflects a very early Holocene landscape with open birch scrub prior to the subsequent expansion of the main Holocene tree taxa recorded in IX-2. Alder carr dominated the floodplain with wetter, more open areas probable whilst the dryland tree communities consisted of lime and hazel. Whilst elm and oak appear to have been less significant, it is possible that this is in part a result of a taphonomic bias towards local on-site vegetation, but the good representation of *Tilia*, usually an under-represented taxon, might suggest that this is not the case. Likewise, the paucity of herbaceous taxa indicative of understorey vegetation in the wider landscape might also be a result of taphonomic factors, but it appears likely that the canopy was generally closed and dense. There is no clear evidence for human disturbance to the vegetation until the final zone, when what appears to have been an abrupt and landscape-scale clearance of lime woodland seems to have been followed shortly after by the clearance of other components of the arboreal vegetation. Initially, the pollen spectra suggest predominantly pastoral activity (dandelions, docks) in the vicinity of the sampling site but with the relatively high values for cereal pollen subsequently indicating arable agriculture, presumably relatively close to the sampling site. By the close of the diagram, then, an open, agricultural landscape with few trees other than perhaps oak and hazel present is inferred.

Summary

The pollen assessments demonstrate that whilst preservation and concentration at Beccles is poor, at Hengrave and Ixworth preservation is generally good. Despite the problems connected to radiocarbon dating of the deposits, it is clear that the biostratigraphy at these sites is conformable; the pollen curves from both diagrams make ecological sense, with no evidence for any form of significant disturbance to the sequences of sediment deposition. The absence of detailed, radiocarbon dated pollen diagrams from Suffolk makes it difficult to establish even a relative chronology for the two sequences. Nevertheless, some general comments may be made.

It is clear that sediment deposition began at both Ixworth and Beccles during the early Holocene (supported by the basal radiocarbon dates from these sites), although at Hengrave accumulation did not begin until the later Holocene. Whilst the Ixworth sequence would seem to record much of the Holocene, the later part of the record is resolved in some detail at Ixworth.

The Ixworth diagram suggests that following the growth of birch scrub during the earlier Holocene, the migration of trees led to the development of lime dominated woodland, at least on the better-drained, base-rich soils. It is also possible that lime was growing on 'poorer' soils as well. Alder probably formed dense carr on the more stable river floodplains, as is the case for many other English lowland river systems at this time (eg. Gearey and Lillie 1999). Other trees such as hazel, oak and elm were components of the woodland, with exact species composition no doubt dependent on local edaphic conditions. At Ixworth, pine was also present on the floodplain and apparently expanded at one stage perhaps as a result of dry conditions. The woodland appears to have been dense with few natural openings; lime woodland tends to create deep shade, although the precise structure of the vegetation in the wider landscape is difficult to establish on the basis of these data.

Perhaps curiously, there is no evidence for a clear Neolithic 'elm decline' in the Ixworth diagram. The reduction in elm at the opening of the final zone is concomitant with an abrupt decline in lime, and may reflect this event, although similar 'lime declines' are recorded in other diagrams from eastern England during the early-Middle Bronze Age. The lime decline at Scole in Suffolk appears to be equally abrupt and is probably a result of human activity during this period (Wiltshire in prep) which also led to the spread of open grassland. There is evidence that lime was virtually eliminated from the uplands adjacent to the Fenland within what may have been only a few hundred years (Waller 1994) whilst pollen diagrams from other areas of lowland England also display a similarly rapid decline in *Tilia* during the Bronze Age-Iron Age (eg. Grieg 1982).

The impression is of both arable and pastoral farming activity during IX-3. The relatively high values for Cereal-type pollen suggest that cultivation was taking place reasonably close to the sampling site. Again, the absence of secure dating control makes further comment difficult but it seems likely on stratigraphic grounds that this dates to the later Holocene period. The Hengrave diagram likewise dates entirely to the later Holocene, but further meaningful comment regarding the chronology of this sequence is not possible.

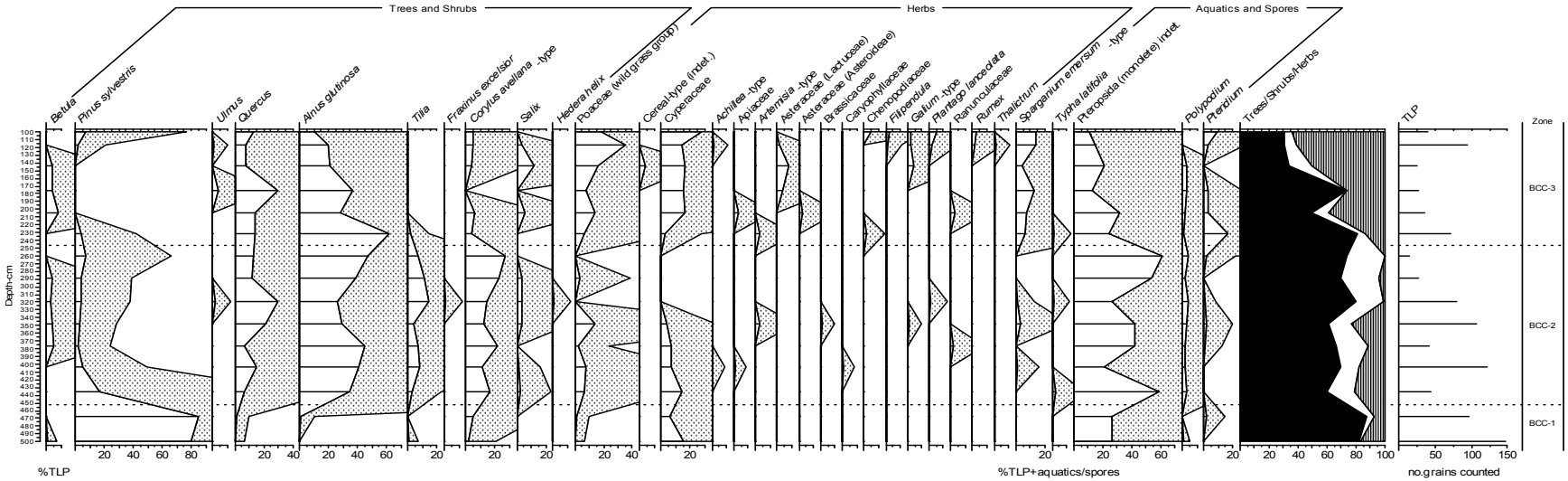
References

Gearey, B.R. and Lillie, M.C. 1999. Aspects of Holocene vegetational change in the Vale of York: palaeoenvironmental investigations at Askham Bog. In R.van de Noort and S.Ellis Wetland Heritage of the Vale of York: 109-125. Hull, Humber Wetlands Project, University of Hull.

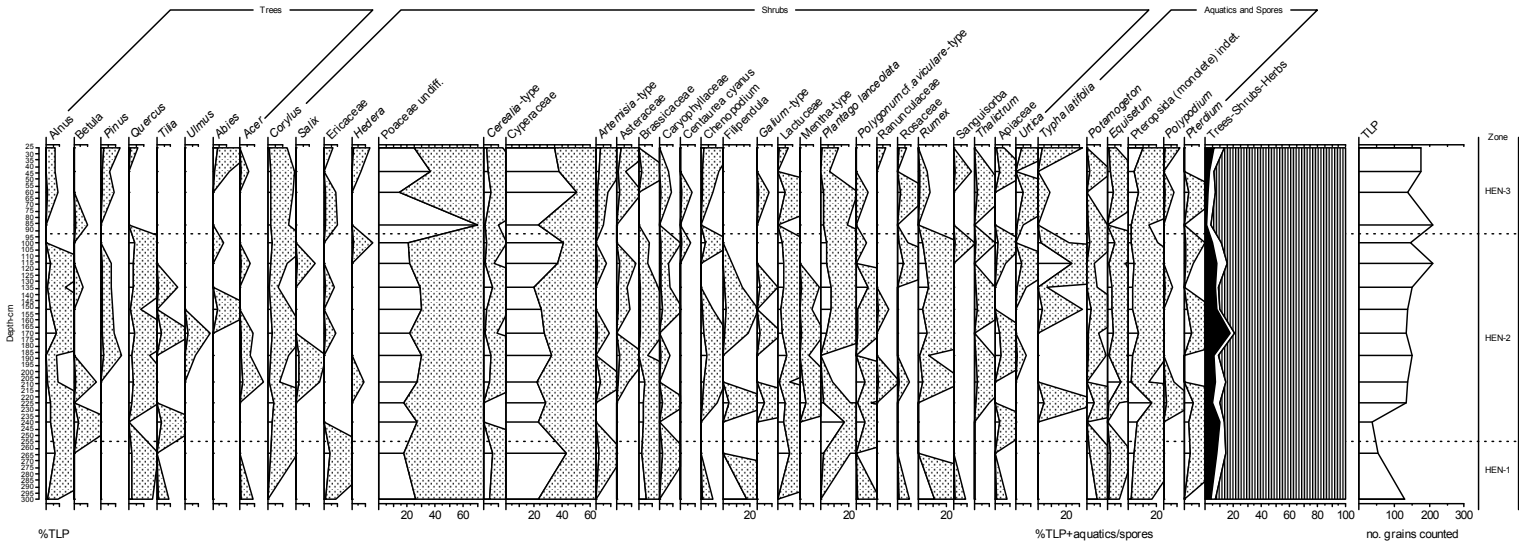
Waller, M. 1994. *The Fenland Project No. 9: Flandrian Environmental Change in Fenland.* Cambridge, East Anglian Archaeology Report no. 70, Cambs. Archaeological Committee.

Grieg, J.R.A. 1982. Forest clearance and the barrow builders at Butterbump, Lincs. *Lincolnshire History and Archaeology* 17, 11-14.

Beccles Skeleton Pollen Diagram (exagerration x10)



Hengrave Skeleton Pollen Diagram. Exagerration x10



Ixworth: Skeleton Pollen Diagram. Exagerration x10