Tadcaster

[SE 499 430]

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Introduction

This site in North Yorkshire is important for preserving lake deposits with a full Late-glacial and early to mid-Holocene record of lithostratigraphical and vegetational history from the Vale of York, a region from which relatively few long environmental records are available. Sediments occurring within a hollow in the Escrick Moraine near Tadcaster have been investigated using pollen and plant macrofossil analysis (Bartley, 1962), and more recently using insect remains, to study Late-glacial climate change (Lowe *et al.,* 1994a, b). The Late-glacial sediments have been classified within the Bingley Bog Formation by Thomas (1999). The site has been discussed during a recent wetland survey of the Vale of York (Van de Noort and Davies, 1993; Gearey and Lillie, 1999; Lillie and Gearey, 1999), and has been important for studies of Late Devensian deglaciation in this area (Gaunt, 1981). Tadcaster is one of the first sites in Britain from which pollen evidence for early Late-glacial climate change was reported.

Description

The site lies 1 km to the south-east of Tadcaster in the southern Vale of York, and 0.5 km north of the River Wharfe. It comprises a hollow up to 6.5 m deep containing lake sediments within the Escrick Moraine, an arcuate till ridge that extends from west of Tadcaster to beyond the River Derwent at the foot of the Yorkshire Wolds, at the eastern edge of the Vale of York (Catt, 1977d, 1991b). The moraine is composed mainly of till (Gaunt, 1970a), with some glacial sands and gravels on its north-westerly side. The small lake basin has been drained in recent times by a tunnel through the glacial sediments to the River Wharfe (Edwards *et al.,* 1950) and it today forms an area of flat meadowland with a dry, silty surface soil.

Bartley (1962) examined the stratigraphical succession in the basin by a lateral transect of twenty-five hand cores, which proved a sequence of mainly limnic sediments, overlying the undulating surface of the basal pebble-rich sandy clay diamicton (Figure 6.20). Across most of the transect a calcareous blue lake clay up to 2 m thick formed the lowest deposit above the basal material, although at the edges of the basin, in places, it lay upon thin sand layers. The southern half of the stratigraphical transect contains a highly disturbed sequence of layers which makes it difficult to record, other than a generalized section, and it is not used in this description. In contrast, the northern section exhibits a clear sediment succession. Here the blue lake clay contains near its top a discrete layer of light brown calcareous mud with *Chara* and *Betula pubescens* macrofossils. The blue lake clay above this mud also contains these plant macrofossils, with the addition of *Phragmites* and *Potamogeton praelongus.* A second thin layer of brown mud, this time highly calcareous, lies upon the upper surface of the lake clay, and includes *Cladium, Scirpus lacustris, Phragmites, Chara, Betula pubescens, Nymphaea* and *Hypnum* macrofossils. This lower blue clay and mud couplet sequence is sealed by a thin layer of detritus mud.

Above this lower clay and mud sequence there are three organic elements that characterize the mid-profile lithostratigraphy. To the north of the section there is a layer of peat that contains abundant bark, twigs and wood in its central part but which includes an increasing proportion of detrital mud towards its lower and upper contacts. *Pinus* wood occurs in the central peat, whereas *Populus* is recorded in the lower muddy levels and *Alnus* and *Betula* in the upper muddy zone. Macrofossil remains of aquatic herbaceous plants *Cladium, Carex, Potamogeton, Phragmites, Scirpus* and *Nymphaea* are very common in various levels of this peat. In the centre of the basin this peat is not present, and instead there are two contrasting limnic mud layers at this depth in the sequence. A dark brown, highly amorphous mud is the lower and thicker of these two, and it contains very few plant remains. Fruits and seeds of *Alnus, Betula pubescens, Betula verrucosa, Nymphaea, Carex, Ceratophyllum demersum* and *Najas marina* do occur. This dark amorphous mud overlaps the peat. The third element is a much thinner layer of light brown mud, which rests upon the amorphous mud and overlaps the woody peat nearer the margins of the basin, where the amorphous mud is absent. This upper mud contains abundant plant macrofossils, including *Alnus, Carex,* various *Potamogeton* species, *Cicuta virosa* and *Nymphaea alba.*

The uppermost sequence of deposits is present in the centre of the basin only, where the surface of the limnic mud layers is concave in shape and upon which firstly fresher brown *Sphagnum,* and then more humified *Sphagnum* and *Eriophorum* peats have accumulated, both containing wood remains of *Alnus, Betula* and *Calluna.* The fresher *Sphagnum* peat is composed mainly of *S. cuspidatum* and contains fruits and seeds of *Nymphaea* and *Potamogeton.* The upper, more humified, peats contain abundant *Eriophorum vaginatum* cuticles, and *Sphagnum plumulosum* remains. A peaty, silty mineral soil seals the sequence across the whole of the basin.

Pollen analysis

Bartley (1962) constructed pollen diagrams through the northern part of the transect at core 14, where a fully representative sequence of sediments was preserved. These diagrams are shown as Figure 6.21 and Figure 6.22. (Figure 6.21) is calculated as percentages of total land pollen and is restricted to the Late-glacial succession, showing a more complete range of herb pollen taxa. (Figure 6.22) covers the Holocene succession and is calculated as percentages of total tree pollen to reflect the dominant post-glacial vege tation type, only the major non-tree pollen types being shown. The following pollen zones are recognized:

Late-glacial

Ia Low *Betula* values, with *B. nana* consistent at around 10% of total pollen. Cyperaceae and Gramineae contribute more than 50%. Some thermophilous pollen, such as *Corylus,* is present in low numbers. Many open-ground herbaceous taxa occur, most commonly *Artemisia, Rumex acetosa*-type *,* Rubiaceae and a range of aquatic types. *Lycopodium selago* is prominent.

Ib *Betula* pollen rises to about 25%, and Gramineae pollen falls in proportion. *Juniperus* and *Thalictrum,* more thermophilous types, become consistently recorded.

Ic *Betula* frequencies fall again to a minimum of 6%, whereas Gramineae values are almost restored to their previous abundance. Other herbs such as *Helianthemum* increase, but percentages of most taxas remain steady. *Juniperus* frequencies increase in this sub-zone, and rise to a sharp peak of 44% near the top.

II This zone, which corresponds stratigraphically to the lower calcareous mud layer, includes the disappearance *of Juniperus* pollen and a rise in *Betula* to almost 50% of total pollen. *Pinus* also becomes significant. *Betula nana* is not always present and herb pollen taxa, in general, are much reduced. *Filipendula* is an exception, and has high values throughout the zone.

III *Betula* values decline to about 20%, but *B. nana* increases. There is a sharp increase in Cyperaceae percentages, not mirrored in the Gramineae curve. *Artemisia, Thalictrum* and *Rumex acetosa*-type are present in high values, and *Lycopodium selago* reappears.

Holocene

IV Characterized by a great increase in *Betula* frequencies to almost 80% of total pollen (over 90% of total tree pollen). *Betula nana* is no longer recorded and Cyperaceae almost disappears. *Filipendula* rises sharply and aquatics also increase. Other herb pollen types are reduced to only sporadic counts.

The Holocene pollen record above zone IV initially is confused and perhaps reflects some contamination by later sediment as small peaks of *Alnus, Ulmus* and *Quercus* occur prior to the rise in *Corylus* pollen, which usually delimits the start of Boreal assemblage zone V Typical mid-Holocene tree pollen changes do occur above this confused zone, however, with *Corylus, Pinus, Ulmus, Quercus, Alnus* and *Tilia* rising to high values in turn, and *Betula* gradually declining to very low frequencies by the top of the profile. *Pinus* also falls to low values after the *Alnus* rise. Herb pollen taxa are almost absent after the *Corylus* rise.

Interpretation

Much of the importance of the deposits at Tadcaster lies in their location atop the Escrick Moraine, which is a key stage in the process of the southerly advance of the main ice lobe down the Vale of York. Some initial ice advance to the south of this moraine into glacial Lake Humber took place (Gaunt, 1981), perhaps as far as the Doncaster area (Catt, 1991b). It deposited glacial gravels upon a periglacial land surface, which extends northwards beneath the Escrick Moraine itself (Gaunt, 1976; Catt, 1991b), before ice-sheet retreat to the Escrick line. It therefore is unlikely that the Escrick Moraine represents a true terminal moraine and static ice front (Catt, 1977d; 1991b). It does, however, mark an important stage in the Vale of York deglaciation. The start of sediment accumulation within the Tadcaster hollow must have been of an age only slightly younger than the beginning of ice withdrawal from the Escrick Moraine and so could provide a limiting date for retreat from this depositional limit. Dating must be relative, however, based upon pollen assemblages, a deficiency that applies to the rest of the profile also, including the later organic sediments. The site is unique in the southern Vale of York in preserving a complete Late-glacial sequence, and historically was one of the first sites where a very early Late-glacial zone I vegetation history was recognized. Only a few sites in northern England have since yielded a comparable record.

Pollen zones Ia and Ib represent an amelioration of climate after deglaciation, at first gradual then more rapid. Initial pioneer colonizing vegetation of grasses, sedges, dwarf birch and abundant ruderal herbs, such as *Artemisia,* reflect tundra-type conditions and dominate zone Ia. The site is undated, but the grass–sedge tundra environments of the earliest zone, Ia, must date prior to the general onset of rapid climatic warming at the start of the main Late-glacial Interstadial, which can be correlated with zone Ib. Gradually these early cold-tolerant tundra-type communities gave way in zone Ib to an open birch woodland, with a rich ground flora of tall herbs with some, such as *Thalictrum,* indicating a warmer climate and more developed soil conditions. This vegetation succession towards woodland communities is reversed in zone Ic, with the return of grass, sedge and open-ground herb taxa to dominance and the major reduction of tree birch cover. A climatic 'reversion' and a return to colder conditions, although probably not as cold as in early zone Ia, may well have been responsible, although as Tipping (1991a) has pointed out, the Tadcaster pollen data remain equivocal as evidence of vegetational, and therefore actual climatic, reversion. The Tadcaster pollen assemblages are not easy to interpret and possibly could result from taphonomic and other factors, representing a unidirectional vegetation succession. There is no supporting signal in the lithostratigraphy of changed conditions in the catchment. Recent work on Greenland (GRIP) ice cores and other proxy data, however, has recorded a short-lived episode of colder temperatures in the Late-glacial Interstadial about 12 000 years BP, which supports the climate 'reversion' theory (Walker *et al.,* 1994; Bjork *et al.,* 1998). Although birch trees probably did not disappear from the area during this zone Ic colder phase at Tadcaster, conditions for their existence must have been marginal at best. The great expansion *of jumperus* towards the end of this phase, however, shows that although this short climatic deterioration was significant enough to suppress tree growth, it was not severe enough to prevent colonization by juniper-dominated shrub communities and the rapid re-establishment of tree birch woodland when amelioration ensued.

Tadcaster zone II is a typical main Late-glacial Interstadial (cf. Allerød) warm climate environmental record, with the rapid spread of birch trees to cover the landscape and shade *outJuniperus* virtually entirely. *Filipendula* is the only herb to be favoured during this phase, reflecting its thermophilous character, and the major decline of all other herb taxa demonstrates the closed nature of the woodland on the drier lands around the site. Most surviving herb types probably had wetland associations. Dates of between 13 000 and 11 000 years BP are inferred for this interstadial, which incorporates the traditional Bolling and Allerød continental warm periods, from many dated sequences elsewhere (e.g. Walker *et al.,* 1993, 1994). The sharp fall in *Betula* tree pollen in zone III and its replacement by a cold-tolerant, sedge tundra-type, herbaceous flora in which grasses, sedges and *Artemisia* are prominent, correlates with the Younger Dryas (Loch Lomond Stadial) arid period of severe cold between 11 000 and 10 000 years BP (Walker *et al.,* 1993). Sparse vegetation cover encouraged soil instability and erosion and in most sites sedimentation at this time is clastic in nature. In this respect the lithostratigraphy at Tadcaster supports the pollen stratigraphy in that the periods of conspicuously warmer climate and more developed vegetation of zones II and N correlate with more organic mud layers, whereas the colder phases are times of blue lake clay deposition. The end of the zone III cold phase and the start of the Holocene (zone IV) is defined by the very rapid expansion of full *Betula* woodland, with very few open-ground indicators. This transition was achieved without any intervening transitional *Juniperus* phase, unlike several sites farther to the north, such as those in east Durham (Bartley *et al.,* 1976), but similar to nearby Bingley Bog (Keen *et al.*, 1988).

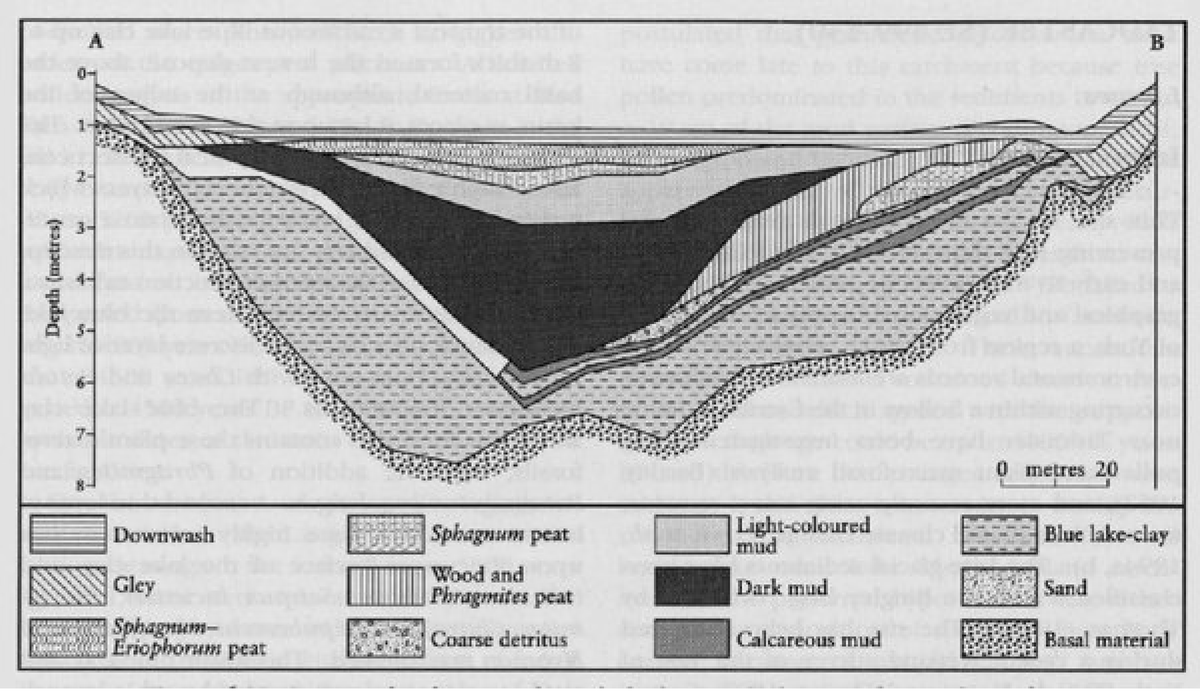
Tadcaster is highly significant in that it contains the dual *Betula* maximum in the Late-glacial succession, with the earlier *Betula* peak allowing the subdivision of Late Devensian zone I at the site. Dating of this earlier of the Late Devensian *Betula* peaks at Tadcaster is still uncertain, but correlation with the start of the main Late-glacial Interstadial would mean that it is almost certainly in the order of 13 000 years BP indicated by radiocarbon evidence from sites in the region, such as Gransmoor (Walker *et al.,* 1993). At Tadcaster, as in northern England in general, a birch woodland became established in this earlier interstadial phase, which was lighter than that of the later, zone II, woodland biozone. A dual Late-glacial *Betula* peak subsequently has been recognized at other sites in the area, such as The Bog, Roos in Holderness (Beckett, 1981), Seamer Carrs and Kildale Hall on the western edge of the North York Moors (Jones, 1976a, 1977b) and Thorpe Bulmer in east Durham (Bartley *et al.,* 1976). Surprisingly, thermophilous pollen grains occur throughout the Late-glacial record at Tadcaster, explained by Bartley (1962) as the result of reworking. This probably is the case, but Keen *et al.* (1988) have recorded similar thermophilous pollen in Late-glacial contexts, which they ascribe to long-distance transport from refugia to the south. Growth of these taxa, for example *Corylus,* near to Tadcaster in the early Late Devensian seems very unlikely, although Late-glacial *Alnus* macro-fossils from Willow Garth in east Yorkshire (Bush and Hall, 1987) suggest such records cannot be dismissed.

The Holocene environmental record at Tadcaster is unexceptional and also truncated, finishing in mid-Holocene post Alnus rise, pre-*Ulmus* decline (Flandrian II) times (Lillie and Gearey, 1999). The successive immigration of thermophilous trees *Corylus, Pinus, Ulmus, Quercus, Alnus* and *Tilia* follows a pattern repeated in the other sites in the Vale of York, varying according to local environmental factors. Nearby analogous records are Burton Salmon (Norris *et al.,* 1971) and Askham Bog (Gearey and Lillie, 1999). The demise of *Pinus* at Tadcaster after the *Alnus* rise suggests that these two factors are linked, and this supports the view of Bartley (1962) that the macrofossil content and lithostratigraphy of the upper sediments record a major change from a zone VI dry depositional surface to its replacement in zone Vila by flooding and deeper water. The peats of zone VI age carried pine trees in the upper layers and the contemporaneous dark oxidized limnic mud in mid-basin also points to low water tables. After the *Alnus* rise, however, the light brown mud with abundant aquatic plant-remains reflects deep water, followed by a succession to wet *Sphagnum* swamp peat. This appears to be a very clear record of mid-Holocene climate change.

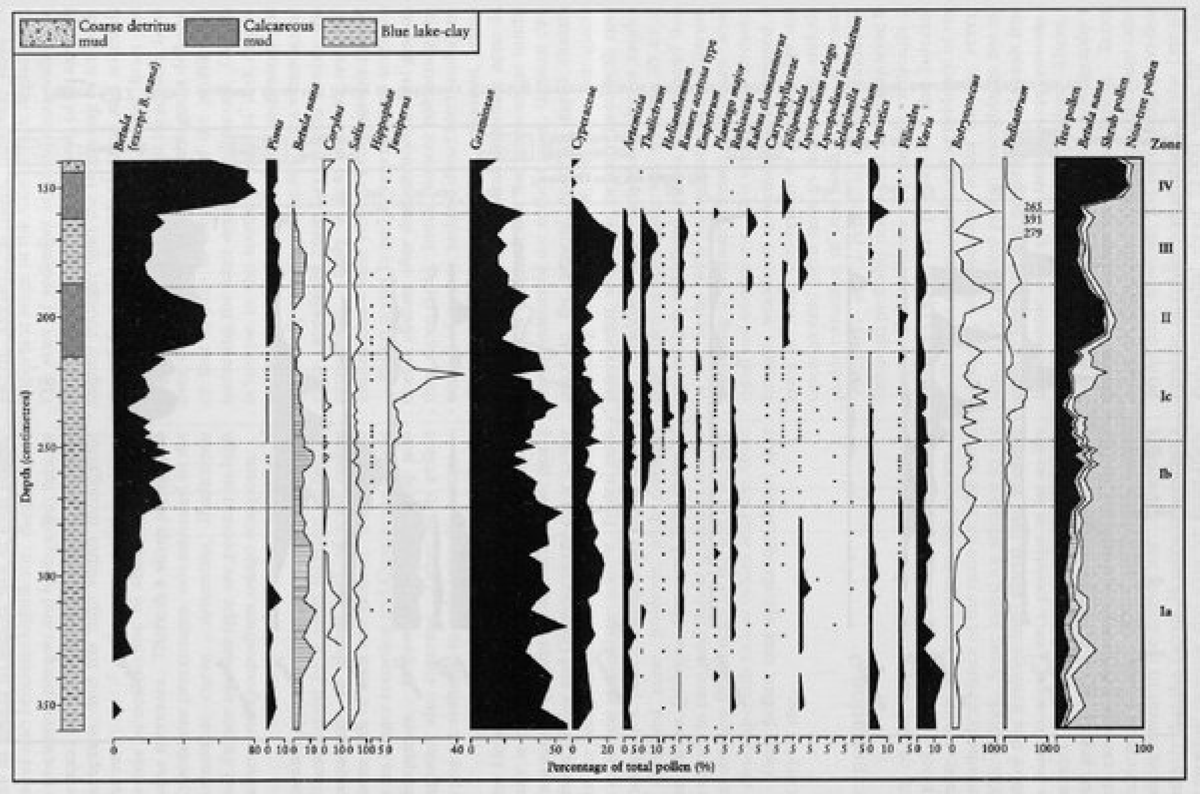
Conclusions

Tadcaster is a classic site in the early study of Late-glacial vegetation and climate change in Britain, providing the earliest analysed, full, pollen record for the tripartite stadial-interstadial-stadial succession. Its evidence of two warm phases encouraged further subdivision of this succession and the recognition that more than one, or at least one complex, Late-glacial Interstadial existed in Britain. This allowed correlation with the data from continental northwest Europe and with its system of classification. Much more detailed research is now available for the history of climate and vegetation change in the British Late-glacial, and the Tadcaster site requires renewed and detailed examination to fulfil its clear potential.

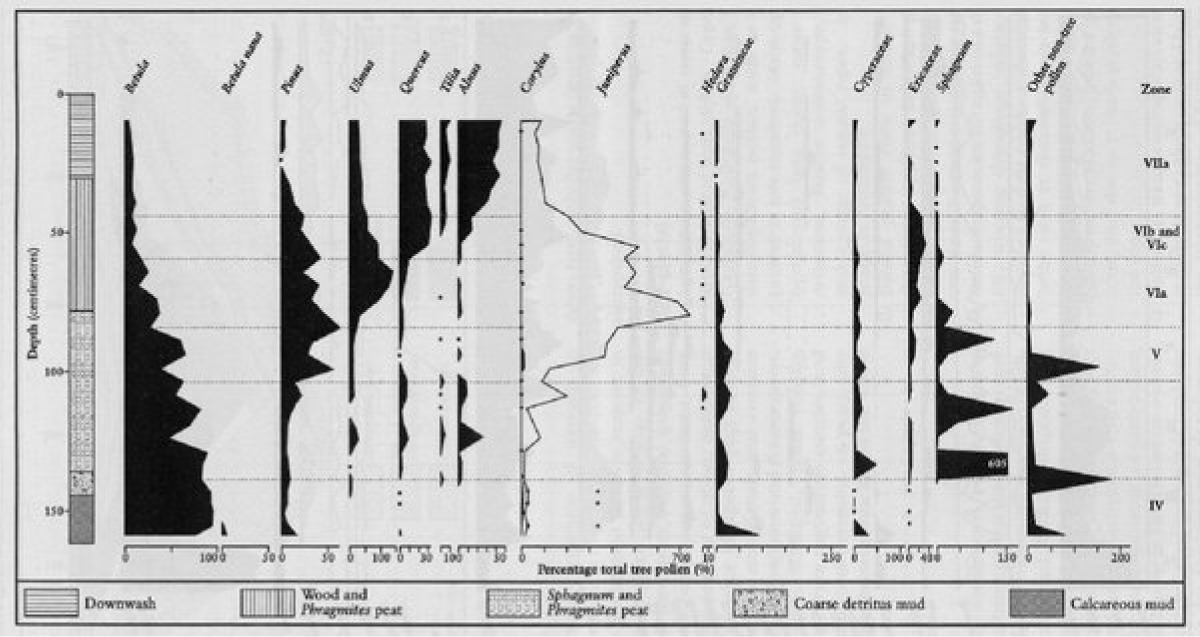
References



(Figure 6.20) Stratigraphical section through the basin at Tadcaster (after Bartley 1962).



(Figure 6.21) Pollen diagram from the basin at Tadcaster showing percentages of total land pollen for the Late-glacial succession (after Bartley 1962).



(Figure 6.22) Pollen diagram from the basin at Tadcaster showing percentages of total tree pollen for the Holocene succession (after Bartley 1962).