Malham Tarn Moss

[SD 886 669]

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Introduction

Malham Tarn Moss, North Yorkshire, and its associated fens form the western part of the Malham Tarn National Nature Reserve (NNR) and is part of the 5000 ha Malham–Arncliffe SSSI, which is of great overall significance for wildlife and Earth science conservation (Figure 8.72). The NNR is a Ramsar site and falls within the Pennine Dales Environmentally Sensitive Area. Sinker (1960) gave a general account of the topography and character of the vegetation for the area immediately around the tarn, and the North Fen vegetation has been described by Proctor (1974), Adam *et al.* (1975) and Cooper and Proctor (1998). The geomorphology and glacial geology of the area has been discussed by O'Connor (1964), Clayton (1966, 1981) and Clark (1967). Malham Tarn is a shallow marl lake, at 375 m OD, which overlies an impermeable Silurian bedrock, which is mostly covered by calcareous glacial sediments (O'Connor, 1964; Clark, 1967). It is completely surrounded by Carboniferous Limestone and there is a marked escarpment of Great Scar Limestone just north of the North Craven Fault. Malham Tarn Moss is an ombrotrophic, raised bog, covering about 40 ha, some 700–800 m across, built up of acid *Sphagnum* and *Eriophorum vaginatum* peat, which overlie fen peats and lake sediments. Its domed surface rises some 5 m above the level of the adjacent calcareous drainage and tarn level. The surrounding calcareous fens, separating the bog from the surrounding drift-covered limestone, are fed by strongly calcareous water draining from springs that emerge from the limestone at its junction with the Silurian inlier, along the north edge of a broad but shallow drift-filled depression. This intervening belt of fen or lagg varies in width.

Malham Tarn Moss is important because it is one of few sites in the Craven limestone area that provides a continuous pollen and macrofossil sequence from the Late Devensian through to the present day, which allows information about the vegetational history of the limestone to be obtained and gives an understanding of how humans have influenced such vegetation development (Piggott and Piggott, 1959, 1963). Although some bog habitats are equalled or bettered elsewhere, it is considered by Cooper and Proctor (1998) that nowhere can such a range and so many of their characteristic species be seen within such a short distance. The whole Malham Tarn NNR is a remarkable microcosm of the mire habitats and species of upland Britain and it is the close proximity of such fen and raised bog habitats that is so interesting. Nevertheless there are rare bog species present and only in the last 20 years have species such as *Sphagnum riparium* and *Sphagnum warnstorfii* been found. There are other species at Malham Tarn that are rare in Britain as a whole, or that are at, or near to, the southern limit of their English range. Such species are discussed in Cooper and Proctor (1998) and Proctor (1974).

Description

Glacial landforms

Malham Tarn and Tarn Moss have formed in an area of lower ground that has allowed the focusing of mainly subglacial meltwater drainage from the north and west (Clark, 1967; Clayton, 1981). There has been some discussion and dispute as to the origin of some of the associated glacial landforms (Figure 8.73), such as the aligned drift forms of Spiggot Hill and the origin of the landforms in the drift belt to the south of the tarn. Raistrick and Illingworth (1949) called this drift a terminal moraine but Piggott and Piggott (1959) considered them to be drumlins. However, both Clark (1967) and Clayton (1981) consider them to be part of a glaciofluvial kame complex, with associated eskers. There has been similar dispute as to the origin of a 'delta' surface at 380 m behind Tarn Moss, as Clark (1967) suggested that this was subglacial in origin, whereas Piggott and Piggott (1959) suggested that from its relationship with the basal Late-glacial clays under Tarn Moss it was a delta formed earlier than pollen zone 1 from sediments fed from the West End channel. It seems possible, however, that there was an earlier post-glacial lake level at a higher level that overflowed through a channel at

379 m OD, which leads through to Great Close Mire (Clayton, 1981), although Clark (1967) considered this to be sub-glacial in origin. An even more likely origin is that a pro-glacial lake formed during deglaciation, which drained through this channel.

Stratigraphy in Tarn Moss

The main expanse of Tarn Moss is the result of a coalescence of three raised bog domes (northeast, north-west and south of Spiggot Hill), each initiated on a different part of the undulating drift surface. The stratigraphy was investigated by borings by Piggott and Piggott (1959), and is shown in (Figure 8.74). On the drift in the lowest part of the basin there is a grey, silty clay with occasional lines of angular limestone or slate fragments, succeeded by a dark blue, compact clay, with occasional fruits of the aquatic plant *Potamogeton praelongus.* Above this is a layer of laminated silts and clays 20–30 cm thick, with lines of small stones and plant fragments, followed by a thin deposit of blue clay. These sediments grade into a deposit of almost pure calcium carbonate with abundant shell fragments, as well as undamaged molluscs (Stratton, 1956). This sediment is still being deposited in the Tarn, but under the Moss it is succeeded by fen peat. Over the central part of the basin *Sphagnum* appears and increases in abundance until the peat becomes almost pure *S. imbricatum.* Piggott and Piggott (1959, 1963) describe overlapping lens-shaped peat masses that represent compressed hummocks, whereas the uppermost layer of bog peat is composed largely of *Eriophorum vaginatum.*

Pollen analysis in the cores

The pollen diagram is illustrated in (Figure 8.75). In the lower grey clay there are only traces of organic matter and occasional damaged pine pollen grains and pre-Quaternary spores. The pollen of various herbs appear in the blue clays, with pine and birch exceeding the total herb pollen. Juniper is plentiful but never reaches over 60%. By contrast the ratio of tree to herb pollen is reversed in the overlying laminated layer, in which grasses, *Artemisia, Rumex, Plantago* and *Helianthemum* are well represented and juniper and willow become abundant. Above the laminated clay birch remains the only abundant tree pollen, but hazel is now also present, and juniper, willow and herbs decline. Pollen of water plants becomes more frequent and the character of deposition changes to calcium carbonate precipitation. About halfway through the marl deposition the proportion of hazel rises rapidly and becomes about five times more abundant than birch. Pine begins to increase again and then elm and oak. Pine then becomes dominant and is associated with abun dant hazel and frequent elm. There is then the change to peat accumulation and the appearance of *Sphagnum* and heather. There also are small and temporary rises in pollen frequency of Chenopodiaceae, Ranunculaceae, *Plantago lanceolata* and *Urtica dioica.* In the upper part of the marl in the tarn and in the upper peat of the moss, ash and birch begin to rise, alder declines and occasional grains of beech and hornbeam appear. In the last phase there is an enormous rise in herb pollen.

Vegetation of Tarn Moss

This has been described in detail by Proctor (1974) and Cooper and Proctor (1998). The raised acid peat supports predominantly Erico-Sphagnion mire of the *Erica tetralix* sub-community of the *Calluna vulgaris–Eriophorium vaginatum* mire (M19a, National Vegetation Classification). It is found across the three domes of the main raised bog and on isolated lenses of peat that occur within the North Fen. The vegetation is dominated by an uneven tussocky growth of *E. vaginatum,* with *Deschampsia flexuosa,* ericoid sub-shrubs and patches of sphagna and hypnoid mosses. The *Vaccinium–Hylacomium* sub-community of the *Calluna–Eriophorum* mire occurs fragmentarily along the steep margin of Tarn Moss at its northern and eastern edge. Here the vegetation is dominated by *Calluna vulgaris* and *Vaccinium myrtillus,* with locally frequent *Vaccinium vitisidaea* and *Rubus chamaemorus.* Bog pools are poorly developed, but where they do occur, they are of the *Sphagnum cuspidatum/recurvum* type (M2). Around the margins of the bog and where the surface of the peat has been disturbed by peat digging, *Molinia caerulea* often becomes predominant, forming the *Erica tetralix* sub-community of the *Molinia caerulea–Potentilla erecta* mire. Cooper and Proctor (1998) describe poor fens, where wet acidic peat close to the influence of mildly base-rich water is occupied by the *Carex echinata* sub-community of the *Carex echinata–Sphagnum recurvum* mire (M6a), rich in *Carex carta.* The pH of such areas is often little higher than the raised bog communities but cation content is slightly greater and mineralization of nutrients, especially N and P, is probably more rapid. The hydrochemistry is described further in Proctor (1995) and the rich fens and fen-carr are described in detail in Proctor (1974) and Cooper and Proctor (1998).

Around the margins of the Tarn thin (*c.* 5 mm), spongy encrustations of tufa or Krusten-stein (Kann, 1941) cover the rocks, which provides a harbour for many protozoa, invertebrates and algae (Lund, 1961; Holmes, 1965). The most conspicuous tufa-forming species, but not the most abundant, is *Rivularia haematites* (Pentecost, 1981).

Interpretation

Late-glacial vegetational history

Piggott and Piggott (1959, 1963) interpreted the lowermost succession in the pollen diagram as showing the Late-Glacial stages. In this period open-water extended over almost the whole area of the present tarn and the Tarn Moss and fens. The absence of organic matter in the zone I clays suggests that vegetation was sparse both in the tarn and in the surrounding uplands. In the Allerød (Windermere Interstadial), fruits of a pondweed in the clay and the proportional increase in birch pollen suggest that the tree may have been present locally, although a high proportion of the pollen grains are of the type characteristic of the dwarf species (*Betula nana*)*.* The abundance of juniper pollen during zones II and III suggests that this was present on the limestone pavements, but the vegetation must have been open because of the high frequencies of grasses, sedges, *Artemisia, Rumex* and *Helianthemum* and the occurrence of *Armeria maritima, Alchemilla, Campanula rotundifolia* and *Poterium sanguisorba.* Rare grains of *Hippophäe rhamnoides* and *Ephedra distachya,* both plants restricted to the coast in western Europe today, are present. *Ephedra* is no longer found farther north than the south coast of Brittany and also has been found in Late-glacial deposits of the limestone pavements of Öland in the Baltic (Iversen, 1954). The Loch Lomond Stadial part of the Late-glacial succession is indicated by 20 cm of laminated clay and silt with occasional stones. The Late-glacial sequence can be compared with similar deposits at Thieves Moss on the slopes of Ingleborough (Gosden, 1968), where there is no pollen in the lowest clay but in the succeeding Windermere Interstadial birch pollen rises to about 35% of the total pollen, with juniper about 20% and the rest willow and non-arboreal pollen. No birch fruits were found at either locality and it is possible that birch was absent from the limestone uplands.

Flandrian vegetational history

The change to a predominantly calcareous sediment at the opening of the Flandrian is accompanied by increasing numbers of *Potamogeton praelongus* fruits, a high frequency of *Potamogeton* pollen and abundant *Chara* remains, deposited in clear, shallow, open water. Tree birches became plentiful but the decline and almost complete disappearance of juniper and herb pollen was delayed until the rise of hazel in zone V. This disappearance seems likely to have been caused by a dense hazel cover on the pavements. The well-defined pine–hazel phase is unusual in the northern and western uplands, although it was found by Raistrick and Blackburn (1938) from Linton Mires (Wharfedale). Piggott and Piggott (1959) suggest that pine became established on the shallow, well-drained soils of the scars and pavements.

During zone VI by 8000–9000 years ago, sedges were able to spread over the Tarn Moss basin but only the basal part of the fen peat is free of birch and willow, so the spread of carr woodland was rapid. The presence of *Phragmites communis,* at close to its altitudinal limit in the Pennines, and *Lycopus europeus,* well above its limit at Malham, suggest that summer temperatures were warmer than at present. Before the end of zone VI there is a marked increase in *Sphagnum* and *Calluna.* Thin charcoal layers and the small rise in weed pollen (plantain, nettle and Chenopodiaceae) were thought likely to be associated with Mesolithic habitation (Piggott and Piggott, 1959), and microliths have been found around the tarn. Alder became established in the wet hollows surrounding the tarn and in the fen at the opening of zone VI, and hazel, elm and oak still occupied the limestone. Despite the evidence that woodland covered most of the limestone uplands during zone Vila, the rare *Helianthemum* pollen shows that natural open habitats persisted, as does the presence of *Polemonium caeruleum,* present as a characteristic species of the Late-Glacial and still occurring on Craven cliffs and screes today.

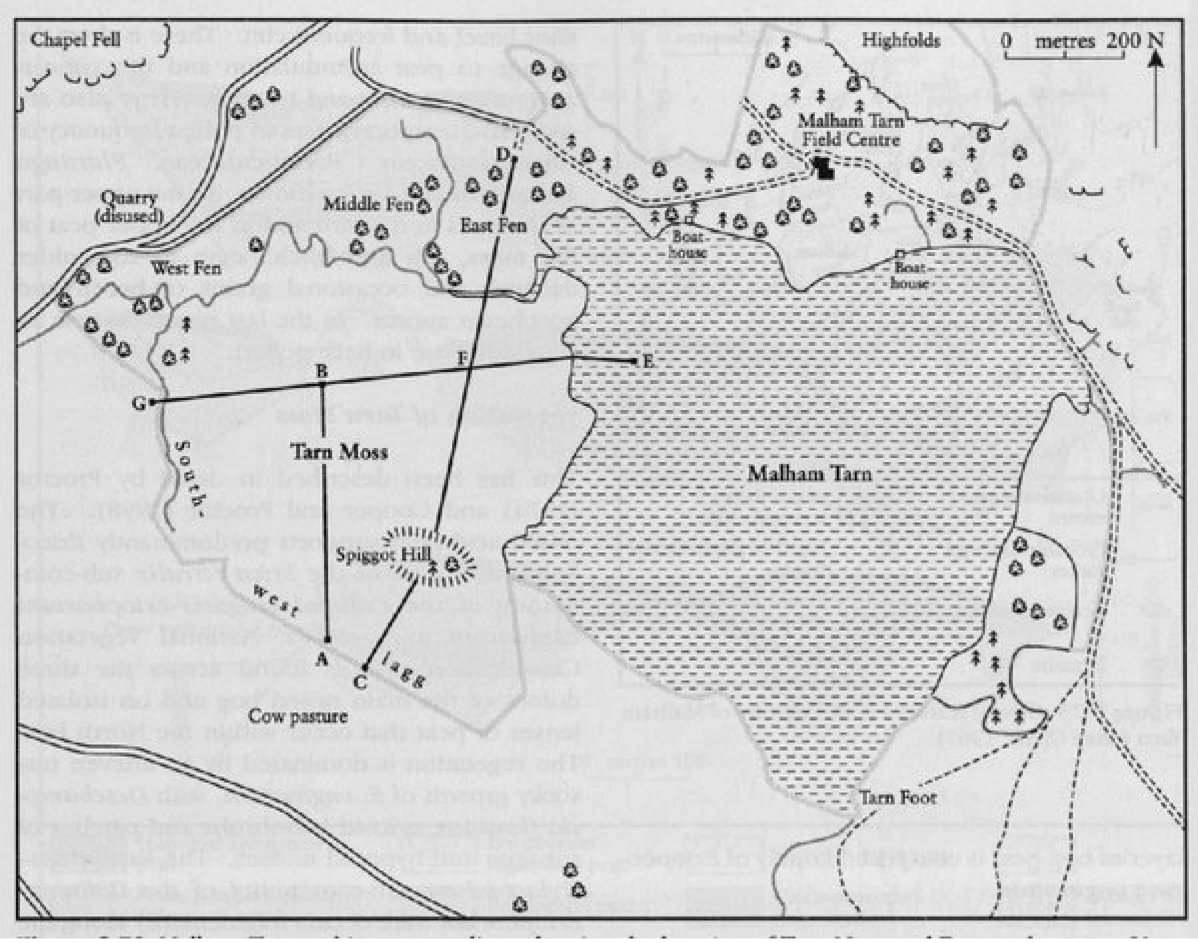
The abrupt rise of herb pollen and particularly plantain during zone VIIb must be associated with a Late Neolithic forest clearance, and polished hand axes have been found close to Malham Tarn. This first increase of herb pollen is sustained and culminates during zone VIII in a much greater rise, which is associated with the Iron Age (Piggott and Piggott, 1959). This seems probable, as archaeological evidence, such as hut circles attributed to this period, are found on Malham Moor (Raistrick, 1947). A rise in frequency of ash pollen is associated with each increase in herb pollen, so that the spread of ash seems to be related to forest clearance and is an example of secondary, rather than primary, woodland. It is likely that the present treeless limestone pavement areas arose because of Iron Age tree clearances and that regeneration has been prevented largely by grazing. Malham Moor was settled and farmed by the Vikings and during the medieval period was part of the monastic estates that maintained large sheep flocks on the limestone uplands (Raistrick, 1947). By this period the limestone uplands were probably as open as today. Grazing by farm stock must have had some influence on Tarn Moss and fens since early times, tending to suppress tree growth and the fen-carr sallows and to increase the area of open fen (Cooper and Proctor, 1998). In 1791 the level of the Tarn was raised by about a metre by a weir construction and sluice (Holmes, 1965) and this inundated the lakeward edge of Tarn Moss, causing the erosion of a peat cliff and flooding of some old peat cuttings, and brought some ombrogenous peat within the influence of calcareous water. Tarn Moss probably has been used for rough grazing and was no doubt sporadically burnt, but the 1785–1786 map from Thomas Lister's estate book (Anon., 1785–1786; Cooper and Proctor, 1998) shows Tarn Moss divided into three compartments, which may have had different management histories. From the latter part of the 19th century onwards grip drains were put in radially across the main raised bog. In the late 1940s the vegetation was dominated by *Eriophorum vaginatum* with abundant *Deschampsia flexuosa,* with little heather, very little *Sphagnum,* except in flooded peat pits, and profuse growth of the mosses *Pohlia nutans* and *Tetrophis pellucida* reflecting recent severe burning (Cooper and Proctor, 1998).

Studies on the important tufa deposits around the shores of Malham Tarn (Pentecost, 1981) indicate that the deposit is continuously disturbed, broken up and redeposited. Its distribution is dependent on the distribution of littoral rocks and stable peat surfaces. Narrow grooves may be seen on the rocks beneath the tufa, giving the surface a gnawed appearance. Similar structures, called galets sculptes, have been ascribed to limestone corrosion caused by respiring algae and bacteria (Le Roux, 1908), however, these features at Malham appear to result from the burrowing activities of the caddis *Tinodes waeneri* (Holmes, 1965).

Conclusions

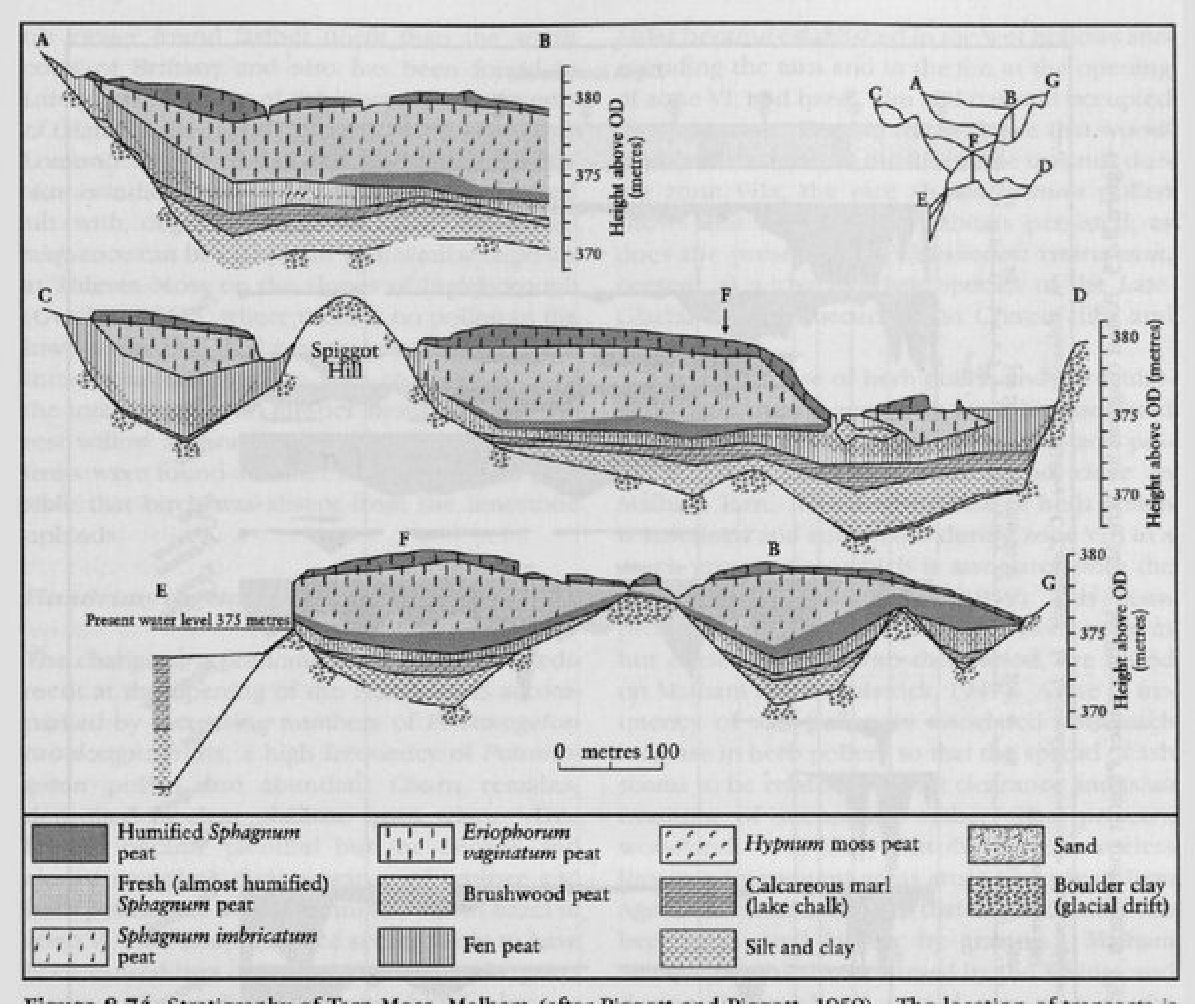
Tarn Moss is the best site in the Craven limestone uplands illustrating the vegetation development of the area from the Late-glacial to the present day and helps to provide a picture of the development of that landscape throughout this period. It also illustrates the influence of humans in such vegetational change. Unfortunately the pollen work was carried out in the 1950s and the site is important enough to benefit from a modern re-analysis of the succession. The location is important too, because of the contrast between closely associated, modern raised bog vegetation and fens, successional changes in such ecosystems, its complex groundwater development and the development of tufa around the margins of the modern tarn.

References

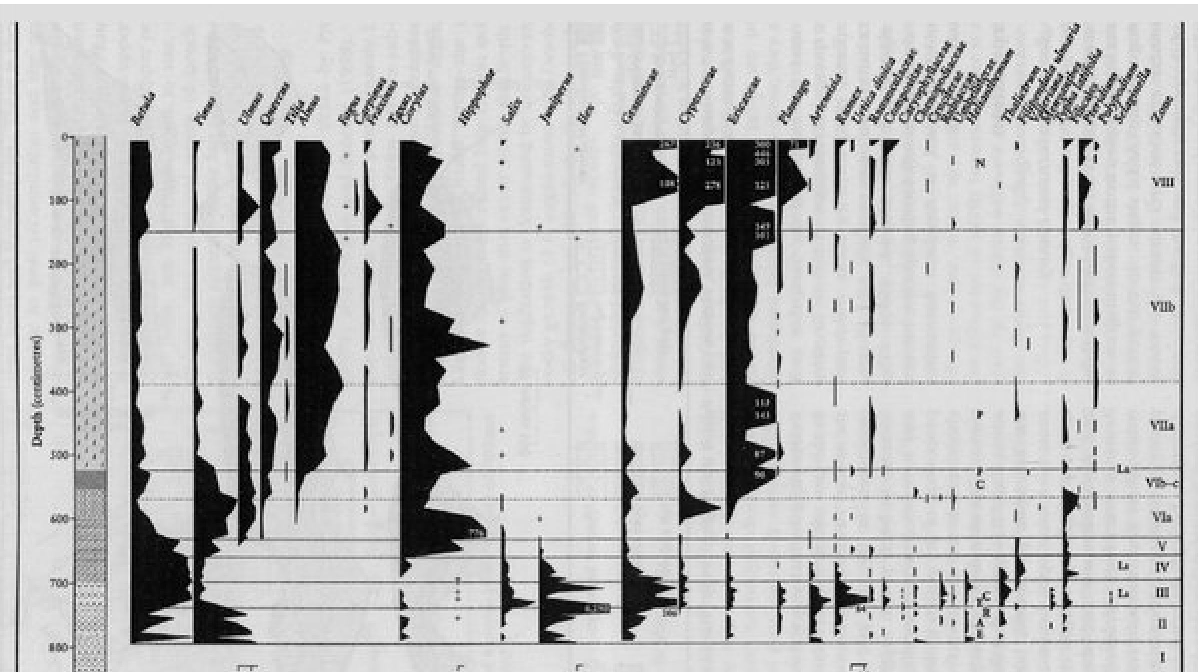


(Figure 8.72) Malham Tarn and its surroundings showing the location of Tarn Moss and Fens and transect Lines shown in (Figure 8.74) (after Cooper and Proctor, 1998).

(Figure 8.73) Glacial features in the vicinity of Malham Tarn (after Clark, 1967).



(Figure 8.74) Stratigraphy of Tam Moss, Malham (after Piggott and Piggott, 1959). The location of transects is shown in (Figure 8.72).



(Figure 8.75) Pollen diagram for Tarn Moss, Malham (after Piggott and Piggott, 1959). See (Figure 8.74) for key to the stratigraphical log.