Bolton Fell Moss and Walton Moss

[NY 504 667] and [NY 495 695]

Potential GCR site

D. Huddart

Introduction

There are many classic ombrotrophic bogs in Cumbria, known locally as 'mosses', or 'flows' if they are particularly wet. These sites have been an important source for our knowledge of Holocene vegetation, climatic change and the impact of humans on the vegetation record. Barber's (1981) research into the relationship between peat stratigraphy and climatic change as a formal palaeoecological test of the theory of cyclic bog regeneration was centred at Bolton Fell Moss. Here undisturbed stratigraphical sections were analysed for macrofossils to characterize the changing assemblages of bog plants, dated and correlated by means of a master profile that was subject to pollen analysis at close intervals and ^{14}C dated. The close correlation between known climatic changes since the Middle Ages (Lamb, 1977) and the macrofossil and peat stratigraphy changes shown to have occurred across the bog as a whole, falsified the theory of autogenic cyclic regeneration (Barber, 1981). Barber thus demonstrated that the climatic signal was the overriding important factor. Work also has been undertaken on the human impact on the vegetation of the area using the pollen record (Dumayne, 1992) and detailed research has taken place into the sensitive, high-resolution record of Late Holocene climatic changes (Barber *et al.,* 1994b).

Work at Walton Moss [NY 504 667] has allowed a record of natural and cultural change to be made comparable with that at Bolton Fell Moss [NY 490 690] (Barber *et al.,* 1994a; Dumayne-Peaty and Barber, 1998; Hughes *et al.,* 2000), and has shown the conservation problems that beset this rare habitat (Barber, 1993). The work at these two locations forms part of an important overview of the role of climatic change and human impact on the landscape in northern Britain (e.g. Donaldson and Turner, 1977; Davies and Turner, 1979; Turner, 1979; Blackford and Chambers, 1991; Dumayne, 1992; Barber *et al.,* 1993; Stoneman, 1993; Barber, 1994; Tipping, 1995; Chambers *et al.,* 1997; Barber *et al.,* 1999; Mauquoy and Barber, 1999a, b).

Description

Walton Moss (altitude 95 m OD) is possibly the most intact ombrotrophic, raised mire in England and is 283 ha in extent. One kilometre to the south, and separated by a small valley, is Bolton Fell Moss, where peat resources have been worked extensively. It covers 365 ha at an altitude 110 m OD. The plant communities in both are dominated by *Sphagnum magellanicum,* which macrofossil analyses show as having only achieved dominance in the past 1000 years, replacing the former community dominated by *S. imbricatum.* The peat stratigraphy shows shallow lake muds succeeded by *Phragmites* reed, with varying amounts of woody material and moss remains. These deposits typically are only *c.* 1 m thick and are succeeded in turn by humified peats rich in cotton-grass and heather remains and then less humified *Sphagnum* peats, which often are very pure and contain thin, algal mud-rich bands. The pollen and macrofossil diagrams for these mosses are given in (Figure 8.76) and (Figure 8.77) but more detailed description is found in Barber (1981), Barber *et al.* (1994a, b) and Hughes *et al.* (2000).

Interpretation

The interpretation of the peat stratigraphy can be looked at in terms of the influence of climatic change, mire development and how much human impact there has been on the vegetation.

The proxy palaeoclimatic record

Bolton Fell Moss was used as a palaeoecological test site, whose evidence led to the rejection of the cyclic peat-bog regeneration model and established climatic phase theory (Barber, 1981). Barber conducted macrofossil and other analyses on seven peat faces. There are no lenticular structures that would be produced by cyclic regeneration and the dominant stratigraphy is layered, with only moderate relief. Relatively dry bog conditions, dominated by *S. imbricatum,* followed by an intermediate state (*S. cuspidatum–S. papillosum* phase) and then by very wet conditions, dominated by *S. magellanicum,* were found in 16 of the 21 monoliths analysed. These data were used to falsify the cyclic regeneration theory of Sernander (1908) and Osvald (1923) by relating the changes in stratigraphy and macrofossil assemblage to the known climatic variation of the last few centuries, and this was developed into the climatic phase theory, i.e. raised bog growth occurs in climatically forced phases. The curve of bog surface wetness derived from this work is related closely to Lamb's (1977) summer wetness index (see (Figure 8.78)).

Bolton Fell Moss also was used to characterize and date the main humification change in a transect of bogs across Europe. The quadrat and leaf count method (Haslam, 1987) was used to produce relative hydroclimatic curves. At Bolton Fell Moss the division between the upper and lower peats was characterized in many places by a horizontal layer of green pool muds indicative of widespread surface flooding, and it was one of several changes akin to recurrence surfaces and hence major humification changes. The summary macrofossil diagram and hydroclimatic curve derived from Dupont's method (1986) are shown in (Figure 8.79), where wetter and drier phases are indicated (see Haslam, 1987; Barber *et al.,* 1994a, b). A detailed palaeoecological and multivariate analysis of the Bolton Fell Moss profile was undertaken by Barber *et al.* (1994a) and this has shown that the data possess a coherent and robust structure and that the variations in the data are related to the bog water table and hence through that to climate.

(Table 8.14) shows the timing of the main wet shifts in the peat stratigraphy at both mosses (Hughes *et al.,* 2000). There seems to be a reasonable degree of correspondence between the two climate archives, but some significant differences are present. Both mires preserve records of four wet shifts between *c.* 4300 and *c.* 2200 calibrated (cal.) years BP that appear to be broadly in phase and this section of the climate reconstruction has been independently radiocarbon dated. The differences are discussed in Hughes *et al.* (2000).

Mire development

In Walton Moss a brief fen phase began shortly before *c.* 10 200 cal. years BP, with the transition to oligotrophic, Eriophorum-dominated bog occurring at *c.* 9900 cal. years BP. There also is a significant increase in the frequency of macroscopic charcoal in the pioneer raised-bog phases, which suggests that the dry hummocky surface was burnt periodically. This highly humified peat layer represents a phase when the pioneer raised mire lacked a stable water table. The almost universal occurrence of such a bed of highly degraded *Eriophorum–Calluna* peat lying above the fen levels and below fresher *Sphagnum* peats lends support to the hypothesis that one or more phases of peat surface desiccation and humification favour raised water-mound formation as a consequence of the production of a relatively impermeable, finely comminuted peat layer (Hughes *et at.,* 2000). At Walton Moss the macrofossil remains suggest that 2000 years elapsed before the first near-surface water tables were established, as indicated by the arrival of *Sphagnum subnitens* at *c.* 7800 cal. years BP. This 2000 year interval may reflect either a prolonged phase of low effective precipitation in the early Holocene and a major switch to wetter climates at *c.* 7800 cal. years BP, or the time taken for sufficient well-humified ombrotrophic, catotelmic peat to develop to maintain a high water table. A third possibility is that the climatically insensitive phase naturally would be shorter than 2000 years but at the point at which the mire could potentially respond to wet shifts by forming pools, effective precipitation levels were low. It seems, however, that this first wet shift at Walton Moss was a dramatic response to increased effective precipitation. This very wet interval occurred between *c.* 7800 and *c.* 6800 cal. years BP. The marginal development of the mire was different and fen conditions lasted longer than in the main basin and dry, *Eriophorum–Calluna* mire developed here whereas the main mire centre had a *Sphagnum*-rich flora indicative of pool, lawn and hummock microforms. At *c.* 2800 cal. years BP the first appearance of *Sphagnum imbricatum* marked the point at which the water table stabilized at the marginal core site and correlates with a significant increase in surface wetness in the main mire basin.

Human impact on the vegetation

Pollen analysis by Barber (1981), Dumayne (1993) and Dumayne-Peaty and Barber (1998) indicate the human impact on the landscape. In zones a and b at Bolton Fell Moss (Figure 8.76) the indications are of a late prehistoric period of subdued agriculture. A date of *c.* 580 cal. years BC at BFMa and the low level of clearance implies low population densities. This was followed by a major expansion of cleared land in Romano-British times (zone c) indicated by grass and plantain pollen reaching levels not seen again until medieval times. After the Roman withdrawal (zone d) there was some increase in woodland and the marked expansion of clearance and evidence of agriculture (zone e) is dated to the 12th century. There is a steep decline in human impact indicators in zone f, correlated with the Black Death and Anglo-Scottish wars. There is a revival of agriculture in zones g–j, including events such as the decline in tree pollen at *c.* AD 1800 to levels lower than the present day, which is in accord with the Napoleonic 'plough-up' campaign and the planting of Scot's pine, dated to about AD 1800, which was accompanied by increased tree species such as beech, elm and ash, which were planted on country estates at that time.

(Table 8.14) Comparison of the timing of wet shifts from Bolton Fell Moss and Walton Moss (data from Hughes *et al.,* 2000). All ages are approximate and are years BP

Bolton Fell Moss	**Bolton Fell Moss**	**Bolton Fell Moss**	**Bolton Fell Moss**
(Barber, 1981)	(Stoneman, 1993)	(core BFMJ)(Barber *et al.,* 1994b)	(core WLM11)
c. 200			*c.* 100
c. 500	*c.* 350		*c.* 300–350
c. 1000		*c.* 1300	*c.* 1450
			c. 1650–1750
	c. 2400	*c.* 1900–2200	*c.* 2100 to 2040–2320
	c. 3100	*c.* 2650–2900	*c.* 2600 to 2680–3170
	c. 3550	*c.* 3300–3600	*c.* 3500
		c. 4000–4350	*c.* 3800 to 3990–4410
			c. 4900–5300
			c. 6800–7800

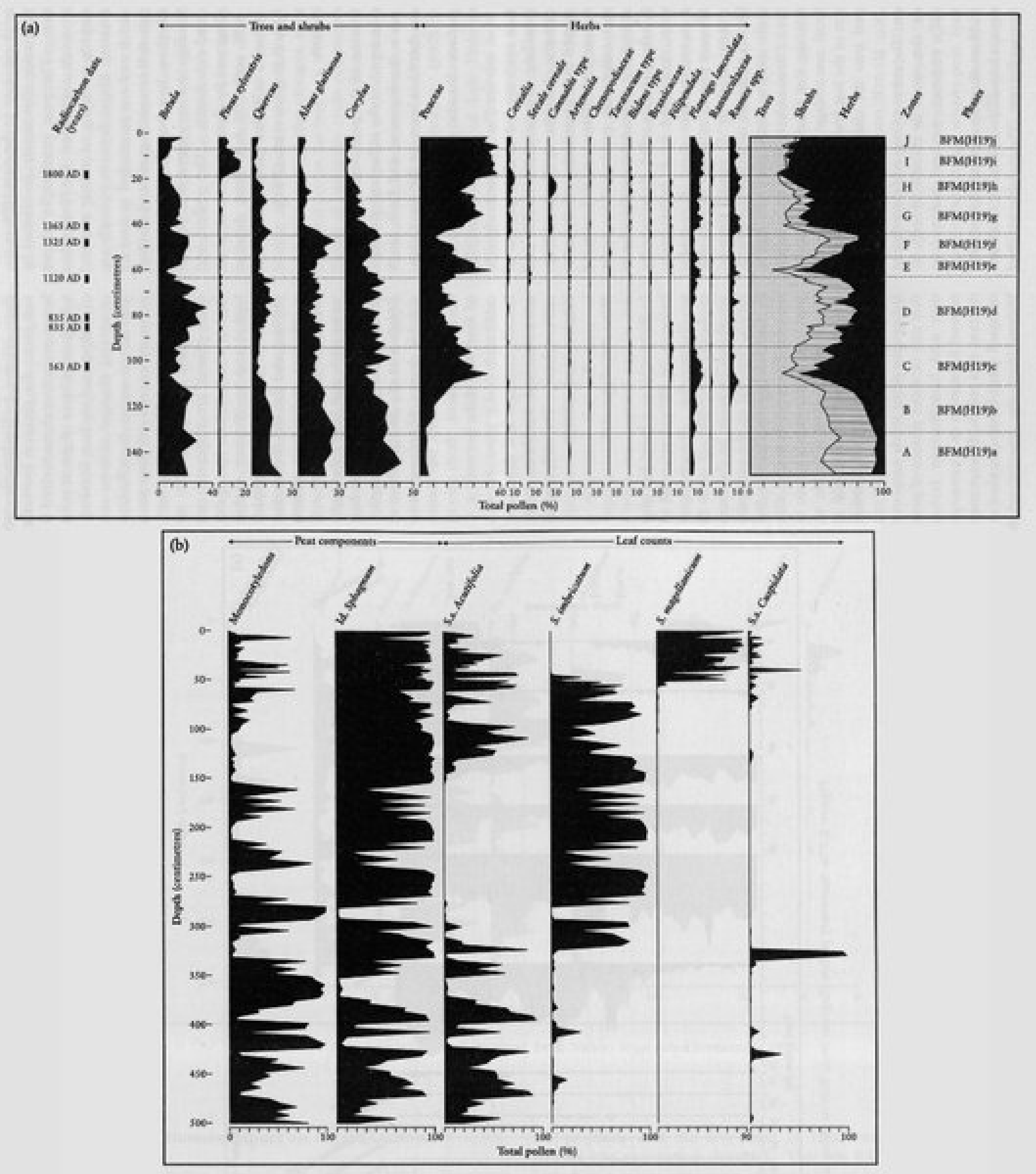
Work at Walton Moss by Dumayne (1992) and Dumayne-Peaty and Barber (1998) is summarized in (Figure 8.77). In the earliest phases, the Bronze Age and Early Iron Age landscape was largely forested and typified by small, temporary clearances. Pastoral and/or arable agriculture may have been practiced and affected mainly hazel, which may indicate that secondary woodland and the understorey were being cleared. The Late Iron Age landscape was characterized by a sudden, major forest clearance (WLMc), which is indicated by a fall in tree pollen, a significant rise in grass (Poaceae) and other open-ground indicators, such as *Plantago* and *Rumex.* The mid-point calibrated date is 45 cal. years BC. Cereals indicate arable agriculture, and population and settlement may have been increasing in the area. However, there was little change in the pollen spectra at Bolton Fell Moss at this time and a lack of archaeological evidence. A discussion of the problems related to what this pollen record is likely to mean is given in Barber *et al.* (1994a), Dumayne (1992) and Dumayne-Peaty and Barber (1998). Significant changes are indicated at a time that is correlated with the Roman invasion of northern Britain, with fluctuations in tree and non-tree pollen indicating possible tree felling by Roman troops and regeneration, because Cumbria was in open rebellion. In zone e there is a phase of rapid and major clearance, where grasses increase by 60%. There is a parallel decrease in trees and an increase in taxa indicative of pastoral and arable agriculture. This is correlated with the Romano-British period and the beginning of this phase has been dated to *c.* AD 165 cal. years. The clearance was the result of all or some of the following factors: Roman occupation and native, civilian settlement; the construction of Hadrian's Wall and its related structures needed timber, although originally it was built of turf, indicating an already open landscape; open ground was needed for visibility and intercepting of raiders as well as signalling across the wall and to the forts in front and behind, and for agriculture. There has been a lively debate generated by the reconciliation of the archaeological and environmental evidence for the Roman impact in Dumayne and Barber (1994), McCarthy (1995, 1997) and Dumayne-Peaty and Barber (1997). After Roman troop withdrawal some tree regeneration took place and intensfied in zone f, when tree pollen rises to 53%. This, plus the subdued agriculture, suggests a decline in population and settlement in the area after the breakdown of Roman control. The change to a cooler and wetter climate at this period (Barber *et al.,* 1994a) would not have encouraged settlement but woodland regeneration. The later phases of the pollen diagram from Walton Moss are similar to Bolton Fell Moss and are discussed in detail in Dumayne-Peaty and Barber (1998). The decline of *Sphagnum imbricatum* from both mosses, dated to AD 1030–1400 m cal. years may have resulted from interspecific competition between *Sphagnum* species during the 'Early Medieval Warm period' and the 'Little Ice Age' (Mauquoy and Barber, 1999b), as first suggested by Barber (1981). At Walton Moss the decline also may have been the result of climatic change, as its disappearance is associated with large fluctuations of water tables, followed by a phase of increased mire surface wetness (Stoneman, 1993).

Conclusions

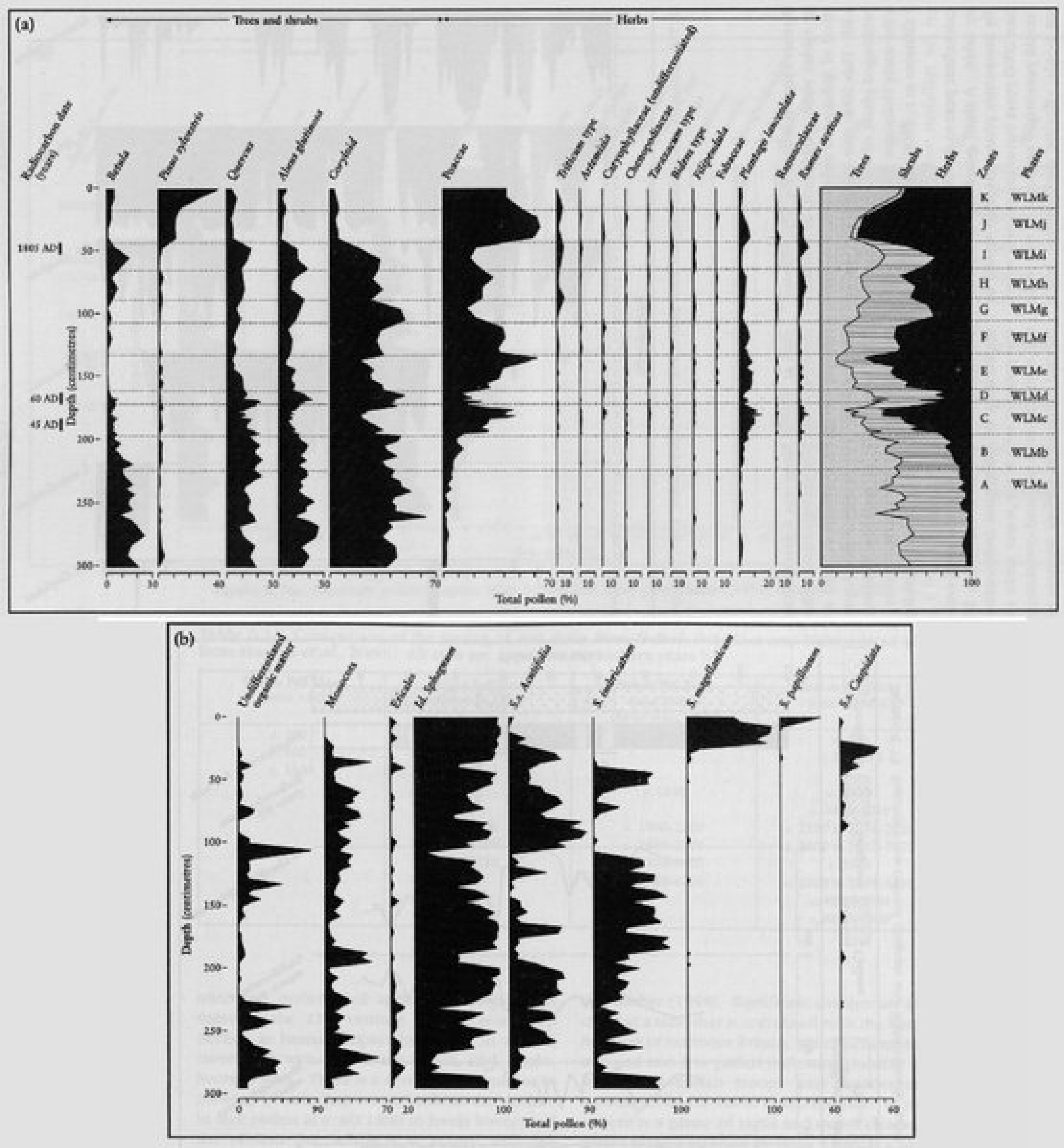
Bolton Fell Moss and Walton Moss are important sites in northern England, where a wealth of detailed palaeoecological and palaeoclimatic information has been obtained from a major programme of pollen, macrofossil and dating work. This has allowed the theory of cyclic peat bog regeneration to be disproven and established the climatic phase theory of bog development, controlled by climatic change. The impact of humans on the landscape also has been deduced in detail and the links with the archaeological and documentary records established. The conservation of Walton Moss is important because this raised mire habitat is extremely rare in England.

However, it would be a simplification to suggest that the Holocene proxy climate record is composed solely of a series of coherent, synchronous and far-reaching events. Distinct regional climatic gradients have been identified across Europe during the Holocene Epoch and the relationship between climate and peat stratigraphy may be more complex than was recognized previously. Future goals for peat-based palaeoclimatic research must be to identify the relative importance of the temperature and precipitation elements of the effective precipitation signal and to couple these records to improved tephra-based chronologies (Hughes *et al.,* 2000). Further work also is required to confirm the millennial-scale cycle of wet shifts at Walton Moss and to verify the striking level of agreement with the occurrence of ice-rafted debris events found in ocean cores, which may represent evidence of ocean-driven forcing of the regional climate.

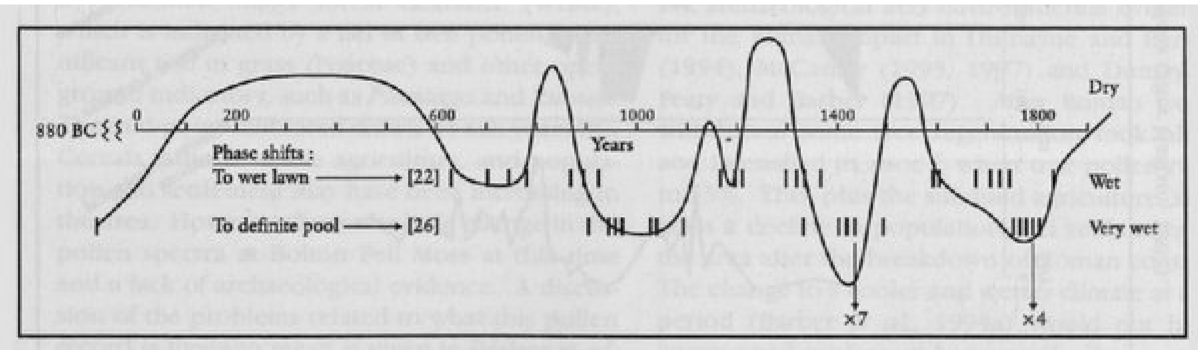
References



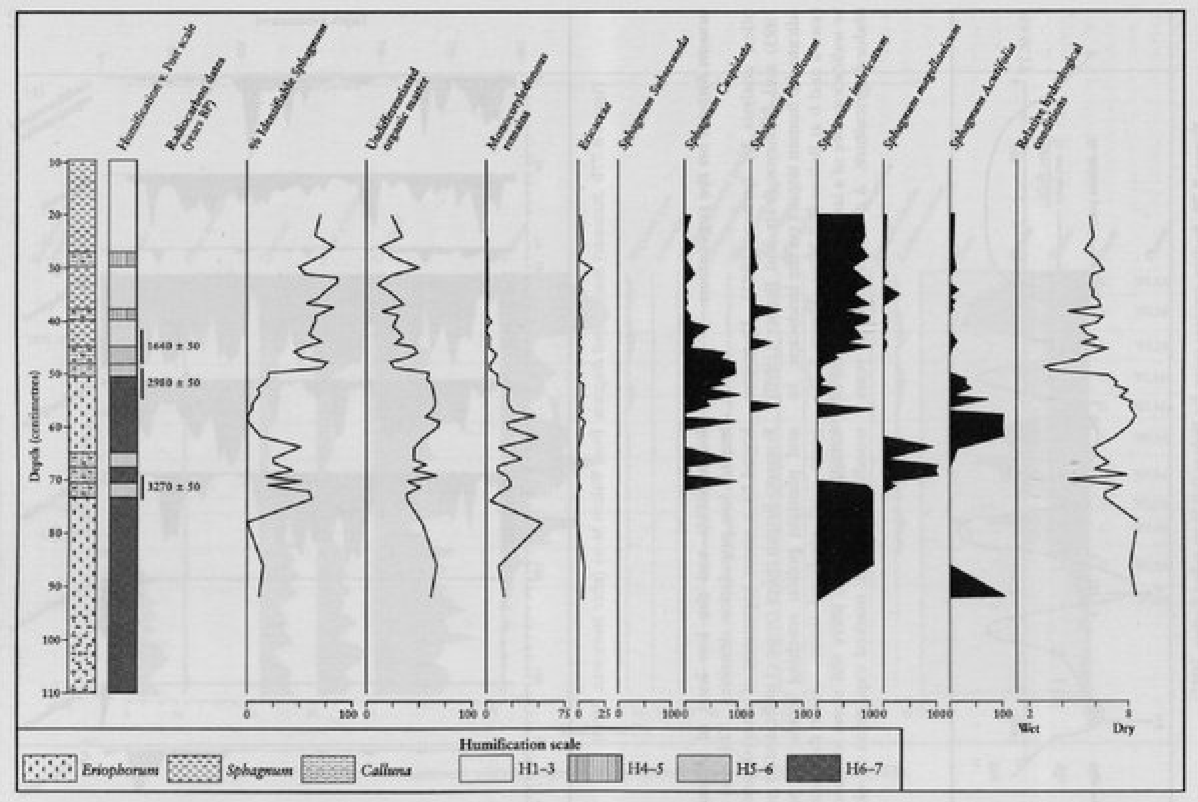
(Figure 8.76) a Summary pollen diagram from Bolton Fell Moss (after Barber, 1981; Dumayne, 1992). b. Summary macrofossil diagram from Bolton Fell Moss (after Barber, 1981; Dumayne, 1992).



(Figure 8.77) a. Summary pollen diagram from Walton Moss (after Stoneman, 1993). b. Summary macrofossil diagram from Walton Moss (after Stoneman, 1993).



(Figure 8.78) Surface wetness curve for Bolton Fell Moss (after Bather, 1981).



(Figure 8.79) Summary macrofossil diagram and hydroclimatic curve for a major humification change at Bolton Fell Moss (after Haslam, 1987).

Bolton Fell Moss (Barber, 1981)	Bolton Fell Moss (Stoneman, 1993)	Bolton Fell Moss (core BFMJ) (Barber *et al.*, 1994b)	Bolton Fell Moss (core WLM11)
c. 200			*c.* 100
c. 500	*c.* 350		*c.* 300–350
c. 1000			
		c. 1300	*c.* 1450
			c. 1650–1750
	c. 2400	*c.* 1900–2200	*c.* 2100 to 2040–2320
	c. 3100	*c.* 2650–2900	*c.* 2600 to 2680–3170
	c. 3550	*c.* 3300–3600	*c.* 3500
		c. 4000–4350	*c.* 3800 to 3990–4410
			c. 4900–5300
			c. 6800–7800

(Table 8.14) Comparison of the timing of wet shifts from Bolton Fell Moss and Walton Moss (data from Hughes et al., 2000). All ages are approximate and are years BP