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Postglacial Environmental History of the West Cumbrian Coastal Plain: New Palaeoecological Data from Gutterby

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This paper describes pollen and other environmental evidence from a sediment core taken from a wetland near the site of the former stone circle at Gutterby on the southern Cumbrian coastal plain. The vegetation during the early Mesolithic was relatively open with juniper but also with small amounts of pollen from various tree species. The tarn appears to have infilled to wetland by the late Mesolithic, which has implications for the landscape in which a nearby stone circle was constructed. Much of the later record appears to be missing (perhaps though subsequent peat cutting) but peat at the top of the core records a much more open landscape with probably some reedswamp. This is compatible with eighteenth-century descriptions of the site being used for collecting medical leeches.

THE Cumbrian coastal plain, south of the River Esk, has produced extensive evidence of prehistoric activity – including the Mesolithic sites at Eskmeals (Bonsall 2007) and Neolithic forest clearance at Barfield Tarn (Pennington 1970, 1995). In addition a range of coastal 'submerged forests' and various waterlogged valley sediments provide further evidence for environmental change and early agriculture in this area during the Mesolithic and Neolithic (Clare *et al.* 2001).

A number of stone circles are said to have existed south of Barfield Tarn with one at Gutterby (Fig. 1). Although no longer visible, antiquarian sources suggest that 30 stones previously formed two concentric circles (Clare 2007), presumably dating to the Neolithic or Bronze Age. The outer circle may have been between 20 and 28m in diameter and the inner circle one of 14m. There are also old records of a cairn 200m south of the circle, approximately 13.5m in diameter, which was described as being surrounded by large stones (Clare 2007). Both sites are in close proximity to a modern peatland surrounded by scrub, and Hutchinson (1794) records that the site of Gutterby contained a tarn formerly used for the collection of leeches. This wetland is particularly relevant to the archaeological context of the stone circle as Evans (2008) has suggested that the Gutterby site may have been situated on dry land, possibly prone to flooding at particular times of year so that it would have had the appearance of being on an island. Indeed several Cumbrian stone circles, which are not near open water in the present landscape, overlooked tarns at the time of construction (Clare *et al.* 2002, Clare & Wilkinson 2006), raising questions about the possible significance of such wetlands in the location of Neolithic and Bronze Age monuments. Here we report on the palaeoenvironmental analysis of a sediment core from the wetland deposits at Gutterby which provides further information on the environmental history of the area during the Postglacial period. Parts of the sediment record presented here are highly condensed, missing or truncated, and these issues are also discussed.

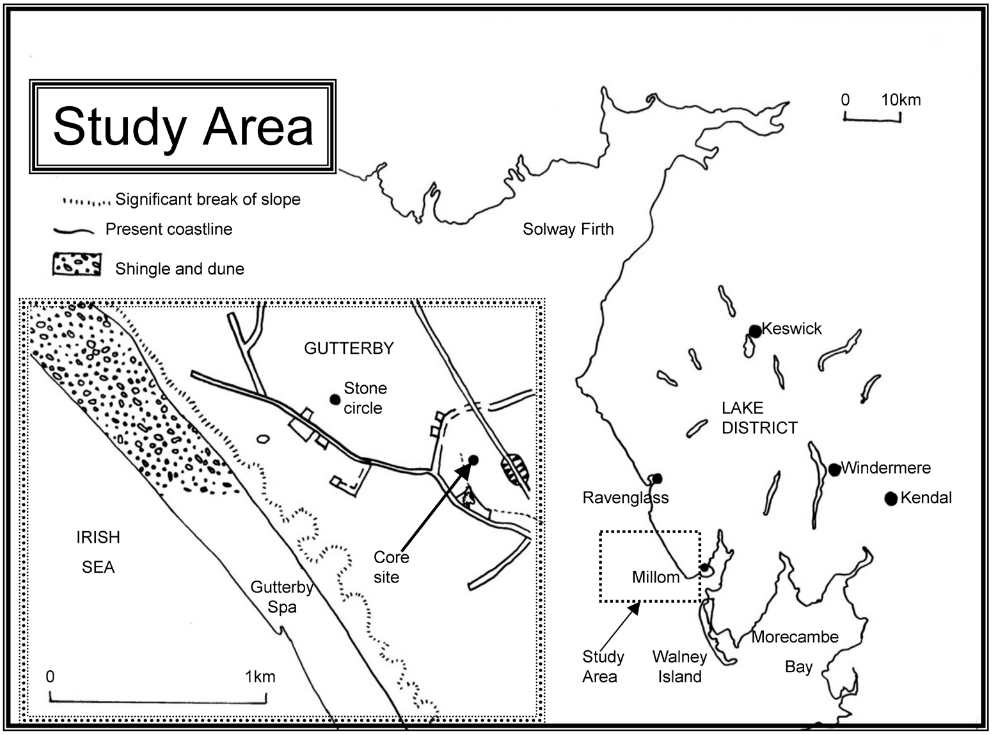

FIG 1. Location of study area – inset location of former stone circle at Gutterby, and the core site.

Field and laboratory methods

In order to provide data on the environmental history of the area around the former stone circle core samples were collected from the adjacent wetland (GR SD112842) on the 28th of July 2008. A 'Russian' type corer was used to retrieve a set of overlapping cores through peats and freshwater sediments to a depth of 1m.

The core was taken back to the lab and subsampled for palaeoecological analysis. All pollen samples were prepared following the standard procedures of Moore *et al.*(1991). Three hundred pollen and spores were counted from each level using an Olympus light microscope at 400x magnification; these were identified with the aid of Moore *et al.* (1991) and type slides from Liverpool John Moores University pollen reference collection. The pollen diagram was drawn using TILIA software (Grimm 1991) and pollen frequencies are expressed as per cent of Total Land Pollen (TLP) which includes *Cypereaceae* but excludes aquatics and spores. In addition samples were examined for the presence of testate amoebae, following Charman *et al.* (2000). These testate samples were also searched for the presence of diatoms. Macrofossils were extracted, by sieving (at 250μm), from the junction between the freshwater sediments and the peats for radiocarbon dating, in an attempt to establish the time at which open water was lost from the site.

FIG 2. Transition from peats to clay laid down in open water. Core from 50 – 100cm. The upper section of the core is to the right and shows dark peats which slowly change into the lighter coloured clays. The material for radiocarbon dating came from 60-61.5cm.

Results

Sediment stratigraphy and dating

A total core length of 100cm was collected consisting of peat and lake sediment (Fig. 2). The lowest unit recovered was a lacustrine clay. Between 66 and 60cm there was a transitional layer of organic clay with peat present above this extending to the modern surface. This shows a change from open water at the base of the core (depositing lacustrine clays) to a more recent peat-forming wetland environment. This sequence of sedimentary changes is easily explained in terms of classic ecological succession, whereby a small water body slowly infills due to autogenic processes, eventually progressing into semi-terrestrial fen environment (Walker 1970). In order to date this important transition, small plant macro-fossils were sieved out of the sediments between 60.0 – 61.5cm. These consisted mainly of sedge *Carex* spp fruits, along with one stonewort *Chara* sp oospore. Some animal fossils were also found namely one bryozoan statoblast and a small mineral caddis case. These macro-fossils confirm the presence of, at least shallow, open water at this depth in the core and gave a radiocarbon date of 8490 +/- 50 BP (Lab No. Beta 261635: Calibrated age = 9540-9440 BP with 95% probability calibrated using Intcal04 (Reimer *et al.* 2004)).

Palaeoecology

Testate amoebae preservation was extremely poor throughout the core and is not described further. However, diatoms were preserved across the transition from clay to peat – between 65-48cm. Four diatom taxa were identified: *Pinnularia*, *Gomphonema*, *Frustulia* and *Amphora*. The most common was Pinnularia, which is found in a wide range of water types, but many of the species in this genus are indicative of acid, oligotrophic freshwater (Van Dam *et al.* 1994). More interesting is Gomphonema (found between 65-55cm) as species within this genus are epiphytic, growing on submerged plants and other surfaces (Van Dam *et al.* 1994, Round *et al.* 2007) and therefore demonstrated that the water clarity was such that light could reach the bottom of the tarn or pools – although actual depth of water is unknown. Unfortunately diatoms were not preserved in the rest of the core.

The results of the pollen analysis are given in Fig 3. Pollen assemblage zones were defined using statistical cluster analysis (CONISS) which confirmed the distinction of five different pollen assemblage zones as summarised below:

GUTB-I (90-55cm):

This zone is dominated by pollen of grasses (*Poaceae*) and sedges (*Cyperaceae*) which along with limited evidence for trees (mostly birch – *Betula*) and some scrub vegetation such as willow (*Salix*) and heathers (*Ericaceae*) indicates a largely open landscape. A defining pollen species of this zone is juniper (*Juniperus communis*). This species is common in the Late glacial and early part of the Holocene in much of Britain (Godwin 1975) and then becomes much more restricted in its distribution due to climatic amelioration and increased competition from other tree species. The presence of juniper is consistent with the early Mesolithic radiocarbon date. This predates the earliest date from the Mesolithic pollen core from Williamson's Moss at Eskmeals (Tipping 1994). There juniper pollen is found until around 5000 BP whereas at Gutterby it disappears from the pollen record soon after the Mesolithic date. Juniper is still found in the area today but on the hills above the coastal plain (Halliday 1997). This location is downwind of the core site at Gutterby so this juniper community is unlikely to be recorded in the pollen record, even if it survived on the hills for the full duration of the Holocene. The diatom and plant macrofossils provide clear evidence of open shallow water at the site.

GUTB-II (55-44cm):

The start of this zone is marked by large amounts of bulrush (*Typha latifolia*) pollen along with the disappearance of the green algae *Pediastrum* from the record. This coincides with a major stratigraphic change from lacustrine clay to peat suggesting progressive shallowing of water in the tarn due to infilling, and ultimately the growth of semi-terrestrial fen wetland vegetation on the site. In this context, the increase in grass pollen is likely to be due to increased recruitment of local pollen from reeds (*Phragmites*) growing in the fen. In addition to shifts in the local vegetation, there are changes in the regional vegetation too with juniper pollen no longer recorded and an increase in frequency of birch pollen. These changes, and the transition from GUTB-II to GUTB-III, are discussed below.

GUTB-III (44-25cm)

In this zone there is an increase in pollen of several tree species, especially birch (*Betula*), alder (*Alnus*) and hazel (*Corylus*). Other, potentially larger trees, such as oak (*Quercus*) and elm (*Ulmus*) also occur but their pollen attains lower frequencies. The presence of these pollen taxa, particularly the rise and abundance of alder, is typical of the mid-

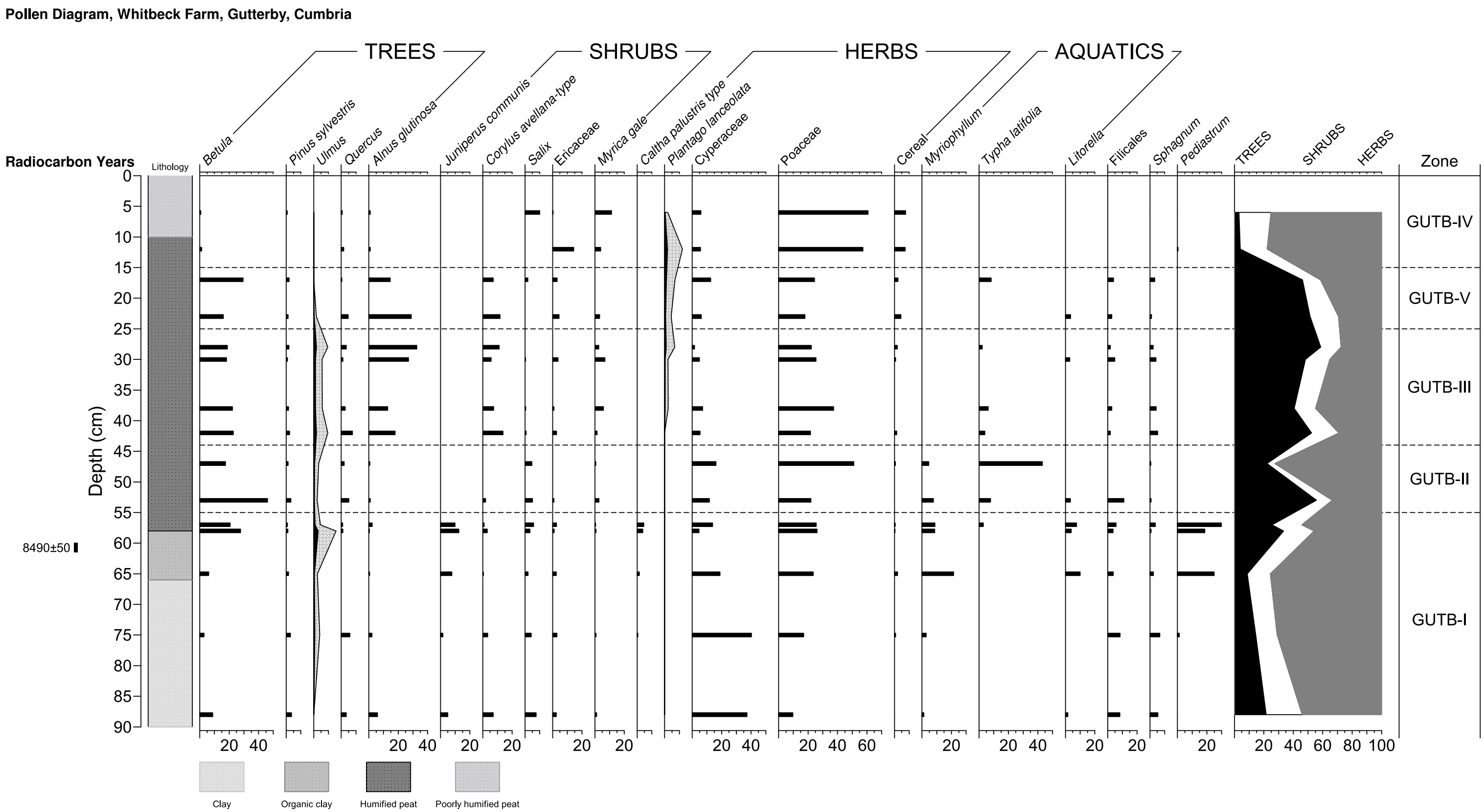

FIG 3. Summary pollen diagram for Gutterby, SW Cumbria. Only main taxa are shown. Data are percentage frequencies expressed as a sum of total land pollen excluding aquatics and spores. The curve for *Ulmus* and *Plantago lanceolata* have been exaggerated as important pollen markers of the elm decline and human impact respectively.

Holocene (late Mesolithic times) in Britain. The characteristic rise in alder pollen is a classic feature of pollen diagrams in Britain and was thought to be associated with the thermophilous, maritime conditions which Godwin (1940) used as a biostratigraphic marker to define an approximate age of 7000 BP. Later work has shown that the alder rise is asynchronous between sites by up to 2500 years (Smith & Pilcher 1973) and that alder generally increases later in the north and west of Britain (Smith 1984). A date of 7000 BP for this transition must therefore be treated with caution.

Alder is a profuse producer of pollen and is generally considered as one of the most over-represented taxa in pollen diagrams (Andersen 1970). Values of greater than 25 per cent TLP are usually taken to indicate a local presence of alder growing in the wetland basin (Huntley & Birks 1983) and so the decline in bulrush pollen in this zone is likely to be attributed to an expansion of fen carr at the site consisting of alder and probably birch and hazel in the drier parts.

GUTB-IV (25-15cm)

The transition to this zone is marked by a decline and disappearance of elm pollen from the record. This is most likely to reflect the classic mid-Holocene elm decline that marks the onset of the Neolithic period. Also evident are increases in cereal pollen. Whilst pollen in this category may also include natural wild grasses such as Elymus which grow in wet fen environments (which may also explain its presence in GUTB-III), the consistent appearance of the herb ribwort plantain (*Plantago lanceolata*) in this zone strongly suggests human activity and agriculture. The Elm Decline has been attributed to a variety of causes, with disease often cited as the most likely (Parker *et al.* 2002). The common association of human activity with the Elm Decline in this context is perhaps opportunistic, and it has been suggested that people perhaps cleared areas of wildwood (which would have included lots of dead elm trees) to create open space for farming.

GUTB-V (15-0cm)

The most recent part of the core is marked by the scarcity of tree and shrub pollen in the record. The previously high pollen frequencies of birch, alder and hazel in GUTB-IV decline abruptly and there is a slight increase in the pollen of dwarf shrubs such as heathers (*Ericaceae*) and bog myrtle *Myrica gale*. This suggests a largely open landscape with heath, much like the present-day environment. The presence of ribwort plantain and cereal pollen is consistent with pastoral and arable farming or other human disturbance in the landscape (Grime *et al.* 1990). *Poaceae* is the most frequent pollen taxa, attaining frequencies of up to 70 per cent. Whilst this pollen is likely to be recruited from multiple sources including upland areas and anthropogenic landscapes, it is also possible that some of this pollen may be locally derived from the common reed *Phragmites* growing in the wetland basin. An abrupt shift away from alder dominated fen carr into reedswamp suggests increased wetness at the site.

Discussion

Pollen zone GUTB-I describes the vegetation at the start of the Mesolithic which is at least 2500 years earlier than the earliest pollen from Williamson's Moss (Tipping

1994). It also predates all the Mesolithic environmental samples described from the area by Clare *et al.* (2001). The area at this time appears to have been reasonably open with juniper and birch being the most common trees. During this time the site at Gutterby was open water rather than fen or bog, as shown by the presence of the diatom *Gomphonema* and other aquatic species. This diatom taxon is only present in samples which also contain juniper pollen (so presumably restricted to Mesolithic sediments at this site) and suggests that a clear water tarn survived to at the end of GUTB-I. Pollen evidence for the end of the late glacial and early Mesolithic is relatively scarce in the area, so these data help describe the environment of postglacial human populations – this is of some archaeological interest as some of the earliest evidence for post-glacial humans in north west England comes from the cave sites on the northern shores of Morecambe Bay south of the Gutterby site, apparently utilizing this coastal plain (Barrowclough 2008).

Whilst the pollen of birch, hazel and juniper might be expected at this date, there are small amounts of oak, elm and alder pollen also consistently recorded. The presence of such tree species in this area is slightly earlier than expected, based on general summaries of the postglacial tree colonisation of Britain (Birks 1989). Alder is more surprising as it is generally thought to not appear in any abundance in the area until around 7500 BP (as discussed above); however, there are records of alder from around 10,000 BP from some parts of northern England (Barrowclough 2008). All the apparently 'early' trees only occur at a low pollen frequency. Because pollen can be dispersed over very long distances (Franzén *et al.* 1991), it is difficult to interpret such occurrences. In addition there is the possibility of reworking of pollen grains eroded out of earlier sediments. It is therefore impossible to claim, with confidence that these tree species were growing in the region. However, the fact that pollen grains are recorded in each level does suggest some local growth and there is a growing realisation that the colonisation of northern Europe by trees at the end of that last glaciations is more complex than previously thought with some populations apparently surviving further north than previously assumed (for a possible UK example see Kelly *et al.* 2010). In this context more pollen evidence of this date from the Cumbrian coastal plain would be very interesting.

The transition from pollen zone GUTB-1 to GUTB-II presents some difficulties in interpretation which may at least in part be due to changes in the local depositional environment (from open water to wetland), basin vegetation and pollen source area which also occur at this time. Without further radiocarbon dates it is not possible to be sure of the date of the start of zone GUTB-II. However, the absence of juniper above 55cm suggests it could be later than the radiocarbon date of 9,500 BP from only a few cm below. Tipping (1994) found juniper in the pollen diagram at Williamson's Moss until around 5000 BP, which might suggest GUTB-II post-dates this and is of a late prehistoric age. However, the conformable pollen changes above this (alder rise, elm decline etc) suggest otherwise. If we accept that the main postglacial vegetation changes described above are recorded in the sequence, either the sedimentation rate is extremely slow, or the sequence probably contains hiatuses and/or periods of non-deposition (or both). In an extensive study of data from similar sites in NE America, Webb and Webb (1998) found a mean sediment accumulation rate of 91cm per thousand years. In the light of such figures it would be unusual if the top 60cm of the Gutterby core contains an unbroken record of the last 9500 years. Similar studies conducted in Cumbria, namely Walton Moss (Hughes *et al.* 2000), report accumulation rates of between 6.4 years per cm in fen peats, similar to those sampled at Gutterby.

There are two parts of the core where a break in sedimentation is a possibility. The first of these is the transition from pollen zone GUTB-I to GUTB-II. The tarn at Gutterby appears to have largely infilled by the end of the Mesolithic, and thereafter, sedimentation proceeded at a very slow pace. There simply appears to be insufficient vertical space for sedimentation to proceed at rates recorded at other sites as reported by Webb and Webb (1998). The peat in the sequence is very well-humified with few identifiable plant macroscopic remains which also suggests slow peat accumulation. It is unlikely that peat accumulated at a linearly consistent rate, therefore it is inevitable that within the peat sequence there will be variations in accumulation rate, and perhaps periods of non-deposition and possibly erosion. Variations in the nature of deposition can be related to local site conditions as described above, but also to climate. The radiocarbon date suggests that the transition to pollen zone GUTB-II probably occurred sometime during the early Holocene. The climates of Britain (and other parts of northern Europe) are known to have been particularly dry and continental during this time (Huntley & Prentice 1993) which would have led to much lower wetland productivity and slow sediment accumulation. The abrupt disappearance of juniper pollen and the generally lower frequencies of pollen from elm and oak than one might expect, in GUTB-II can both be explained by a pause in peat accumulation as a result of local and regional hydrological changes. The alder rise and elm decline might therefore be recorded in the sequence as peat accumulates during the wetter and more maritime conditions of the late Mesolithic and Neolithic period.

The second part of the sequence where a hiatus is apparent is between pollen zone GUTB-IV and GUTB-V. Here tree pollen declines suddenly to values less than five per cent of total land pollen and the pollen diagram is strongly suggestive of an open cultural landscape similar to the present day. Whilst this part of the sequence lacks any chronology, it seems highly likely that much of the Bronze Age, Iron Age and later cultural periods are missing. A plausible explanation is that the start of GUTB-V represents the recent historical period with all the intervening peat removed. This could be due to erosion or possibly due to anthropogenic disturbance such as peat cutting, leaving a partly flooded surface suitable for colonisation by reeds and abrupt changes as evident in the pollen record. Certainly we know from archival sources (Hutchinson 1794) that *'In a tarn, close by Gutterby, there is a great quantity of leeches, to procure which, a woman comes every year from the neighbourhood of Edinburgh i.'*. A *Phragmites* dominated reedswamp with some areas of standing water would have provided a good habitat for the medical leech (*Hirudo medicinalis*), which like both shallow water and emergent vegetation (Clegg 1974, Porter 1997, Ausden *et al.* 2002).

Conclusion

This paper presents new palaeoecological information from the former tarn at Gutterby. During the early Mesolithic, the site was open water and the surrounding landscape was dominated by birch and juniper, at least until 8490 BP. After this, the character of the site changed, and the tarn infilled to become a fen. It is likely that peat deposition proceeded very slowly at this time and appears to have stopped completely until the later Mesolithic when alder increased and the site became a fen carr. The Elm Decline marks the transition to the Neolithic and it was accompanied by a range of anthropogenic pollen indicators of landscape disturbance and cultivation. The pollen evidence for the post Elm Decline period is limited and it appears likely that the Bronze Age, Iron Age and later periods are missing from the sequence either due to erosion or anthropogenic disturbance (possibly peat cutting). The upper part of the pollen sequence resembles the contemporary landscape. The pollen evidence for a wet, reedswamp environment during this time is consistent with historical archival descriptions of the site which was apparently utilised for the collection of medicinal leeches in the eighteenth century.

If this interpretation and chronological sequence of events is accepted, then this site does not offer any direct evidence about the environment at the time when the stone circle may have been in use/constructed. All that can be said is that the circle was near a wetland and that prior to the circle, in the early Mesolithic, this consisted of open water rather than fen or bog which most likely had largely infilled by the late Mesolithic (especially if our identification of the Elm Decline is correct). Therefore the context for the stone circle would have been nearby wetland but probably not an open water tarn. This is relevant to Evans (2008) interpretation of a very wet environment for the stone circle; however, the timing of the transition from tarn to fen is difficult to estimate as it appears that sediment accumulated very slowly with some hiatuses. Whilst the authors agree an increase in resolution of the pollen diagram and additional radiocarbon dates would potentially aid in refining our interpretation of the Gutterby environment, given the cost of such work – and the fact that we have established low rates of sedimentation and/or a truncated sequence at this site – it would probably be more cost effective to use such resources at other sites on the Cumbrian coastal plain.

Footnote

i. It should be noted that the journey from Edinburgh to collect leeches must have been quite difficult in the eighteenth century. However, at this time Edinburgh was the location of one of the major European medical schools (Porter 1997), with a large market for leeches. These were so widely used in medicine that by the early nineteenth century both the UK and France were experiencing shortages and having to import large quantities of leeches from other countries (Clegg 1974, Porter 1997, Ausden 2002). Despite the large market, leech gathering was not a lucrative trade and Wordsworth's 1807 poem 'The Leech Gatherer' portrays Lake District leech collecting as a hard occupation being both 'hazardous and wearisome!'. It is worth noting that Southern Cumbria is still a hot spot for medical leech abundance (Clegg 1974).

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