ART. VIII – *Early-medieval hemp retting at Glasson Moss, Cumbria in the context of the use of* Cannabis sativa *during the historic period*

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AERIAL photography and field-work undertaken at Glasson Moss in Cumbria from 1996 to 1997 suggests that during the early medieval period, natural pools within the Moss were used for hemp retting. The exact number of pools used in this way remains uncertain but more than one seems likely. It appears that water levels within the pools were controlled by the construction of narrow ditches and possibly simple sluice systems. One pool was examined in detail. Probably used for retting from the seventh century A.D., it dried out during the late twelfth to mid-thirteenth centuries. Disruption to the mire hydrology, possibly combined with trampling activity around the pool and ditch, appears to have instigated vegetation succession which resulted ultimately in the colonisation of the edges of both pool and ditch by swathes of *Calluna vulgaris* (heather). The time-scale involved in these changes is unknown; however, the features in question were evident prior to and following a fire in 1976 which appears not to have influenced their long term survival as vegetation anomalies.

Introduction to the site

Glasson Moss (NGR NY 240590) (see Fig. 1), lies about 16 km west of Carlisle, Cumbria. It is one of four raised mires on the south Solway plain. The Moss covers some 200 hectares, 93 of which have been a National Nature Reserve (NNR) (Grade 1) since 1967, under the management of English Nature. During the last eight millennia the mire has developed into a hydrological system that is presently up to nine metres deep. Despite peat cutting during the historic and recent past, areas of intact or regenerated mire support a rich flora including the bog mosses, *Sphagnum cuspidatum. S. tenellum, S. pulcrum, S. macellanicum. S. rubellum. S. molle, S. papillosum* and *S. imbricatum*. Other species include the three sundews, *Drosera rotundifolia* (round-leaved sundew). *D. longifolia* (great sundew) and *D. intermedia* (oblong-leaved sundew) as well as *Eriophorum vaginatum* (hare's-tail cottongrass) and *E. angustifolium* (common cottongrass). Surface vegetation is dominated by *Sphagnum spp., E. angustifolium* and *E. vaginatum* with *Calluna vulgaris* (heather) on the drier hummocks. Common associated species are *Vaccinium oxycoccos* (cranberry) and *Erica tetralix* (cross-leaved heath). The vegetation history of Glasson Moss and the surrounding area has been established through pollen analysis.[1]

Until the early 1950s, Glasson Moss was considered to be one of the finest undamaged raised mires in England. However, between 1948 and 1951, the southern half of the Moss was subject to extensive drainage in order to facilitate peat extraction. This caused serious damage which subsequently began to affect the northern area as well. As a consequence, between 1956 and 1976, the moss suffered

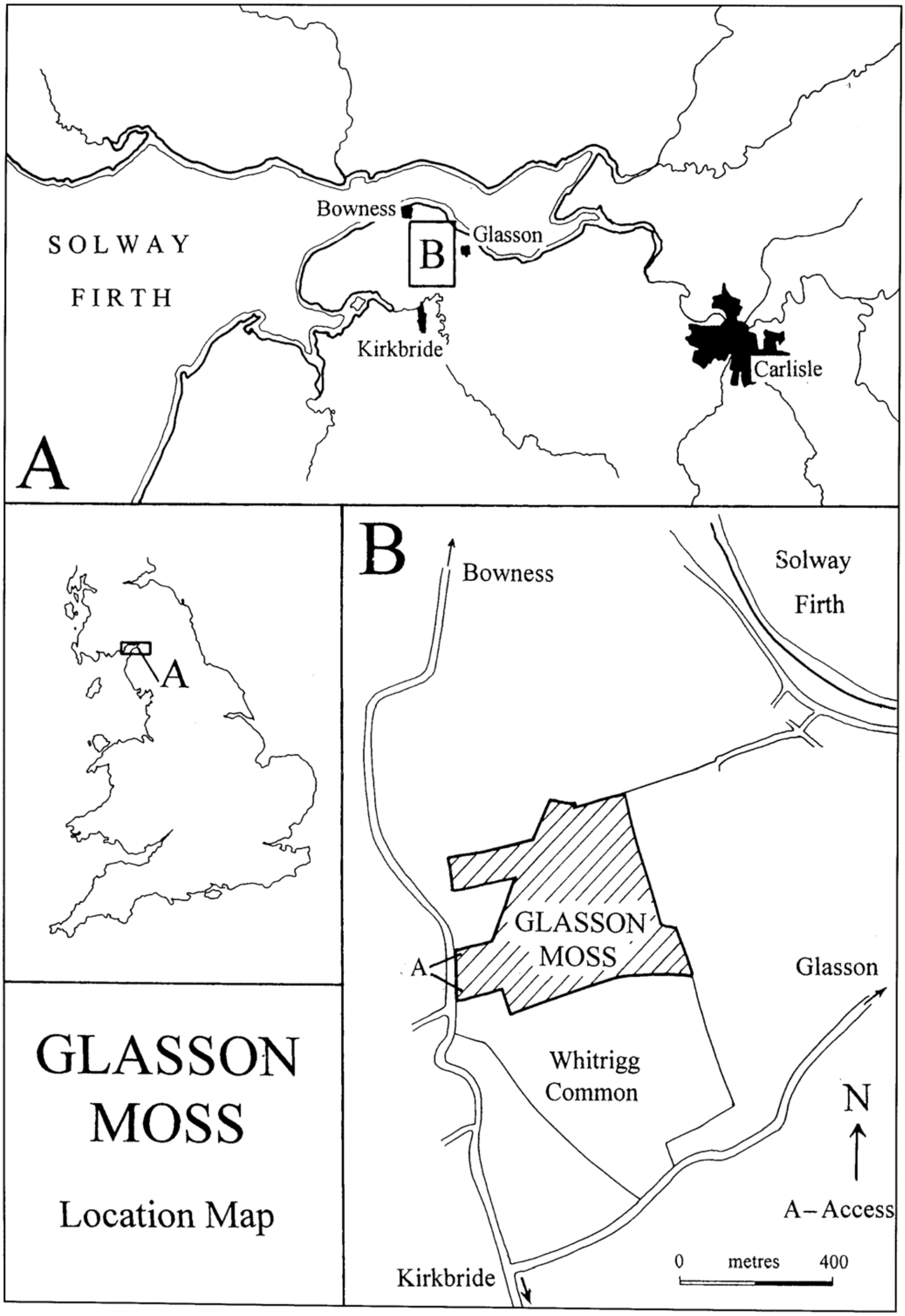

FIG. 1. Location map of Glasson Moss.

at least three serious fires.[2] Following the 1976 fire, the mire was surveyed to assess damage to the vegetation and eight years later, during routine monitoring by the Site Manager Frank Mawby, the anomalous presence of a series of linear and circular features was first noticed in the central area of the moss. These were characterised by vigorous growth of *Calluna vulgaris* (heather) along the length of the linear features and in a swathe around the outer edge of the circular features. In 1996 the School of Conservation Sciences, Bournemouth University, under the direction of Professor Margaret Cox, was invited to undertake a programme of investigative works to examine these features.

Methodology

Reflecting the Grade 1 NNR status of Glasson Moss, it was agreed that traditional survey of the mire was inappropriate as excessive trampling would be deleterious to both the fragile vegetation and the ground nesting birds. Consequently, it was decided to undertake an aerial photographic survey, followed by a limited programme of field verification and investigation. The latter involved undertaking a detailed survey of one circular feature with an associated linear feature and a programme of palaeoenvironmental sampling and analysis. This was followed by radiocarbon dating and a programme of historical research. The latter looked at a range of cartographic and historical sources.

Aerial Photographic and Field Survey

In early February 1996, an aerial photographic survey of Glasson Moss was undertaken, to record the location and extent of the features first noted on the ground. These photographs (Plate 1), together with library aerial photographic sources, were used as the basis for preliminary interpretation, and all visible features were plotted in detail to match base mapping supplied by English Nature. Subsequently, a field survey was undertaken. One of the linear features running for approximately 38 metres and averaging about 2.5 metres wide, and an adjacent circular feature, were chosen for detailed field study. This is visible in the centre of the aerial photograph (Plate 1) and was subject to a measured survey using triangulation. The circular feature has an inner diameter of approximately 19 metres, is 2.5 metres in width to the north-north-west, where it is narrowest, and about 14 metres wide at the opposite edge where it is at its widest and from where the linear feature extends (Plate 2). These *Calluna* demarked areas appeared to be raised above the surrounding mire surface, and the ground surface in these areas was relatively hard and dry as would be expected. While the height of this vegetation was undoubtedly greater than that around it, there was no evidence that the features themselves were in fact raised above their surroundings. The sediments beneath the features were examined by a programme of auguring using a Russian type peat borer along two transects; the location of the auger survey is shown in Fig. 2. On the basis of this initial stratigraphic survey, four sites were chosen for detailed analytical investigation (see Fig. 2):

1. Outside the circular feature (Core 2/5). It was assumed that this core would reveal undisturbed raised bog sediments and would therefore provide a datum

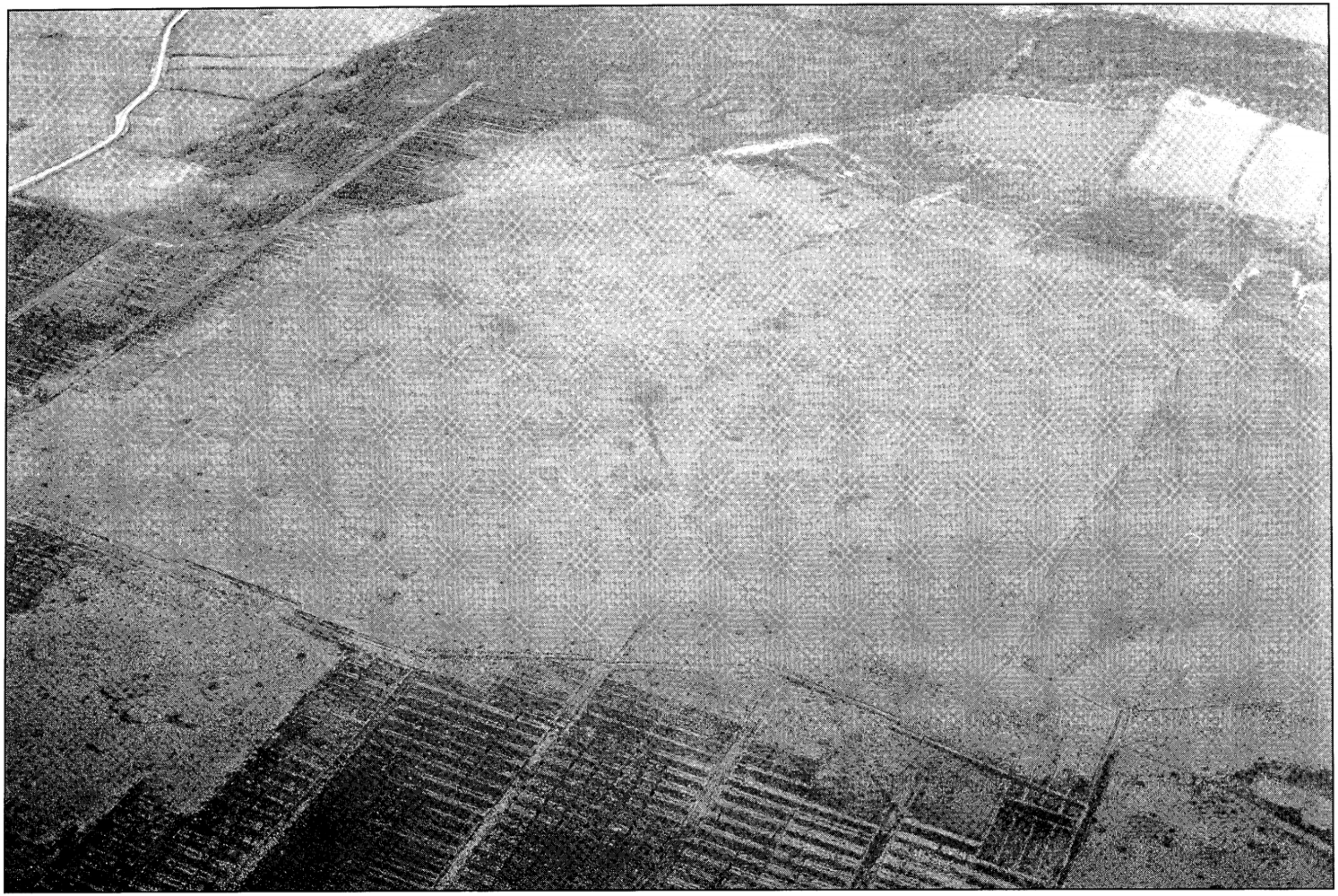

PLATE 1. Aerial photograph of Glasson Moss showing the circular and linear feature investigated in this study in the centre of the plate.

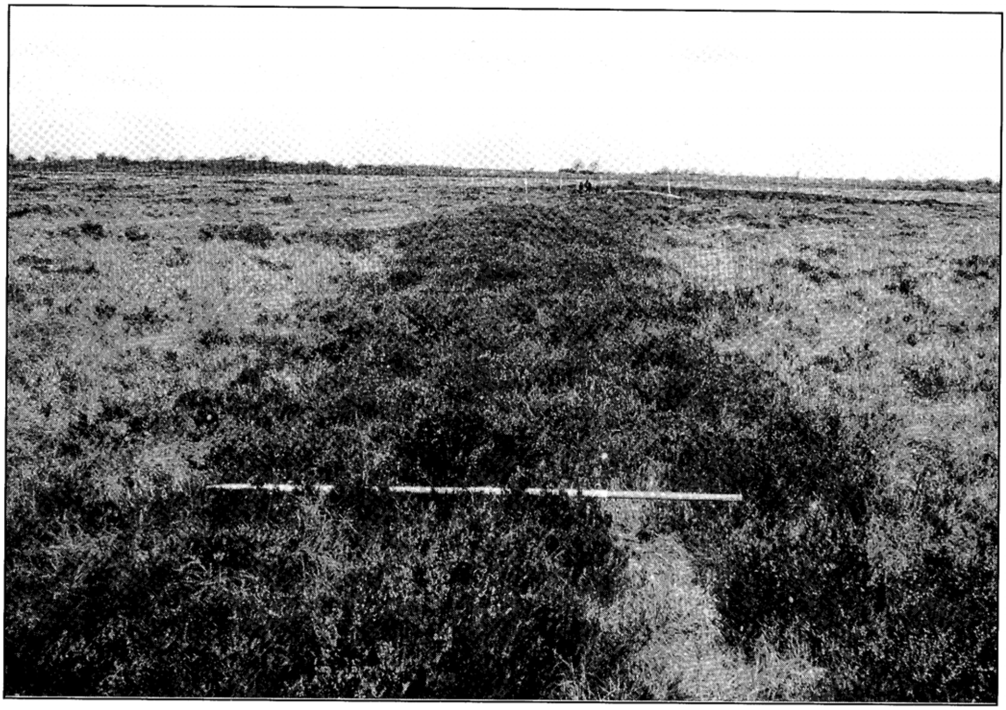

PLATE 2. The linear feature swathe of *Calluna vulgaris* extending towards the circular feature.

against which other cores could be assessed. It was also hoped that pollen analysis of spot samples from this core could be correlated with Dumayne and Barber's radiocarbon dated pollen diagram from Glasson Moss.[3]

2. Within the circular feature (Core 2/6).
3. On the bank of the circular feature (Core 2/1).
4. At the centre point of the linear feature approximately 26 metres from the inner diameter of the circular feature (Core 1/3).

It was assumed that only the upper bog sediments were likely to produce an effect on surface vegetation. Therefore each site was cored to a depth of only two metres.

Laboratory Methods

The stratigraphy of each core was described in detail in the laboratory and samples for pollen and macrofossil analysis and radiocarbon dating were taken. The aim was to assess whether there were any local differences in the pollen and macrofossil record from beneath the features, which might help to explain the vegetation anomalies of the bog surface. Samples were taken from the major stratigraphic units which were identified.

Pollen

In the pollen tables and outline pollen diagram (Fig. 3), taxa have been placed in ecological groups to help interpretation. However, these groupings must be treated

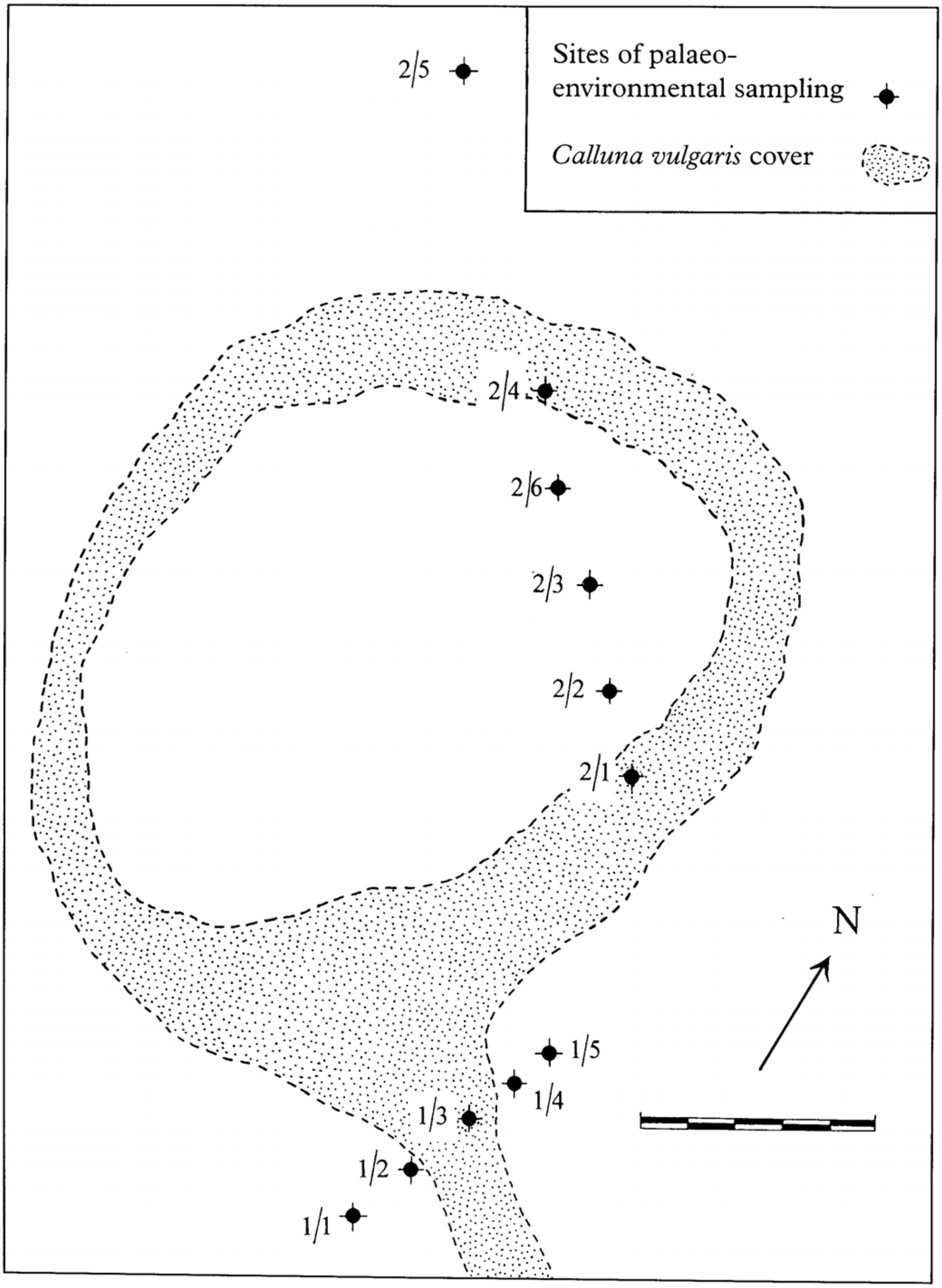

FIG. 2. Detail showing the feature assessed and the location of palaeoenvironmental sampling points.

with caution as they are not exclusive. Some taxa grow in a wide range of different habitats. For example the Ranunculaceae and the Rubiaceae contain many species which grow in water, on wet land or on dry land. In this case "mire types" include those taxa likely to have been growing on the raised bog itself.

Pollen nomenclature follows Bennett.[4] The pollen of *Cannabis sativa* is morphologically similar to that of *Humulus lupulus* (hop). In this case identification of *Cannabis* pollen was made following reference to the type material and to the criteria of Andrew[5] and Whittingdon and Gordon.[6]

Samples were processed according to standard procedures.[7] Total pollen counted ranged from 400-600 grains. A pollen sum of at least 250 grains of non-mire pollen types (NMP) was used (i.e. excluding from the sum plants such as Cyperaceae (sedges), Ericaceae (heaths), other mire types and aquatics). Spores of pteridophytes (ferns) and bryophytes (mosses and liverworts) were also counted outside the sum. This pollen sum was chosen in order to make a direct comparison between the samples examined in this study and Dumayne and Barber's[8] radiocarbon dated pollen diagram. The samples from Cores 2/5, 2/1 and 1/3 were widely spaced and were treated as spot samples with the results shown in table form (Tables 1 to 3). The resolution of the sampling from Core 2/6 was higher and these results are therefore shown as an outline pollen diagram (Figure 3).

Plant macrofossils

A constant volume of material, 3 x 3 x 1 cm, was extracted from immediately below the pollen spot samples for analysis of the plant macrofossil remains. This was washed on a 250 micron sieve and assessed on a five point scale as indicated in Table 3. The overall presence of *Sphagnum*, which formed the bulk of most samples was also indicated in this way. Random collections of at least 50 individual *Sphagnum* leaves were also made and then mounted on microscope slides. These were identified by John Daniell of the University of Durham. Identification was made at up to x 400 magnification to section level in all cases and to species level where possible. It was hoped this would be representative of the total Sphagna estimated in the preliminary scanning. Identification, with the use of reference material, was based mainly on Smith[9] with additional use of keys advocated by the Institute of Terrestrial Ecology[10] and Watson.[11] Other plant macrofossils identified refer to seeds and fruits unless otherwise indicated on the table. Nomenclature and habitat information follows Stace.[12]

Results and Interpretation

The peat stratigraphy

It was clear from the examination of the stratigraphy of the four sampling sites that, despite their close proximity on the surface of the moss, there were marked differences between them. The control core (2/5) showed a sequence typical of an undisturbed raised bog with horizons of *Sphagnum/Eriophorum* peat varying in degree of humification. In contrast, the stratigraphy of the core from the centre of the circular feature showed a marked discontinuity at 119 cm below the surface where an upper layer of *Sphagnum/Eriophorum* peat gave way to a water deposited gyttja below. This suggested that the feature had once been a pool which had dried out and become colonised by peat-forming plants typical of the surrounding raised bog. The core from the bank of the circular feature revealed a sequence of raised bog peats which were disturbed towards the surface. In particular there was a marked band of charcoal 4 cm thick, 73 cm below the surface. Field survey of the linear feature identified it as a narrow ditch of indeterminate depth. Given limited resources, and the extremely high water level, it was not possible to investigate the ditch in detail. Observation of extant ditches relating to demarcation of boundaries associated with tithes, suggested that ditches need not be more that 25cm in width to act as effective drains. The course and exact location of the ditch beneath the two metre wide *Calluna* swathe was determined by "bouncing" across the feature. Unorthodox as this may seem, the ditch itself was in marked contrast to the hard and dry area alongside it. The core from this ditch revealed a surface layer of coarse fibrous *Sphagnum/Eriophorum* sealing an horizon of very wet gyttja. Beneath the gyttja, at 81 cm below the surface, the auger penetrated what appeared to be undisturbed *Sphagnum/Eriophorum* raised bog peat into which the ditch had been cut.

The palynological and macrofossil data

The control core: Core 2/5 (Table 1)

The pollen and plant macrofossil assemblages from the control core 2/5 indicate the changing nature of the vegetation of Glasson Moss and its region for the period when the uppermost two metres of peat were accumulating.

The plant macrofossil assemblages show a typical raised bog sequence of *Sphagnum/Eriophorum* peat especially towards the base, with *Sphagnum* and *Calluna/Erica* more dominant towards the top of the sequence. *Sphagnum*, in the form of individual and branched leaves, capsules and capsule lids, is abundant throughout all the samples. *Sphagnum imbricatum* and *S.* sect. *Cuspidata* are the most abundant towards the base. Both are common species of wet lowland oligotrophic mires; *Sphagnum cuspidatum* often forming pure stands floating or submerged in pools.[13] Stems of *Eriophorum* and root fragments of *E. angustifolium* occur below one metre, and both *Calluna* and *Erica tetralix* are consistently present but not in such abundance as higher in the sequence. These macrofossils are typical of *Sphagnum* dominated, species poor, bog pool communities, with *E. angustifolium* perhaps forming small stands on some of the barer exposures of peat with the *Calluna* and *Erica tetralix* on the drier hummocks. Notably at 106-109 cm, remains of *Empetrum nigrum* (cranberry, crow-berry), *Andromeda polifolia* (bog rosemary) and *Drosera intermedia* (oblong-leaved sundew) occur, all characteristic species of wet heaths and mires. *Sphagnum* continues to dominate the samples and *S. imbricatum* still forms a major part of the assemblage. The presence of *S.* sect. *Acutifolia*. at 27-30 cm, may suggest some drying of the bog surface, possibly the result of recent peat cutting. This section includes eleven species, but the leaves identified here are thought to be *S. capillifolium* which often forms small hummocks or more extensive mats on the drier parts of acid peatlands.[14]

TABLE 1: Pollen and plant macrofossil spot samples from Core 2/5, the control core.

Selected pollen types only, all expressed as percentages of non-mire type

	Sample depth (cm)	**180-181**	**157-158**	**133-134**	**105-106**	**64-65**	**26-27**
Trees and shrubs	*Betula* (birch)	22	16	4	15	11	2
	Pinus (pine)	1		1		5	
	Quercus (oak)	8	8	18	9	7	6
	Alnus (alder)	10	13	11	15	2	5
	Coryloid (hazel)	26	28	18	27	20	1
	Total arboreal pollen	**67**	**65**	**52**	**66**	**45**	**14**
Herbaceous types	Poaceae undiff. (grass)	22	23	22	22	29	43
	Cereal type	3	3	8	2	2	8
	Cannabis sativa		1	0.5		4	2
	Plantago lanceolata	1	3	3	4	7	5
	Rumex acetosella type		1	4		1	5
Mire types	Cyperaceae	12	11	62	7	51	20
	Calluna vulgaris	10	14	69	9	169	30
	Vaccinium type			3		13	5
Fern spores	Undifferentiated	1	1	3	2	8	5
	Pteridium aquilinum		2	8	1	8	4
Moss	*Spagnum*	45	188	62	23	57	82
Plant macrofossils (assessed on scale of abundance)							
	Depth (cm)	**181-184**	**158-161**	**134-137**	**106-109**	**65-68**	**27-30**
Drosera intermedia Hayne	Oblong-leaved Sundew				1		
Empetrum nigrum L.	Crowberry				3		
Andromeda polifolia L. (leaves)	Bog-rosemary				2		
Calluna vulgaris (L.) Hull	Heather	2			2		
C. vulgaris (leaf)		2	1		2	3	2
C. vulgaris (flower)		3				3	1
Calluna/Erica (stem)				2		3	
Calluna/Erica (roots/rootlets)		3			3	4	4
Erica tetralix L. (leaf)	Cross-leaved Heath	1	2		2		2
Ericaceae indet (flower)					1		
Vaccinium oxycoccos L. (leaf)	Cranberry				2		
Eriophorum angustifolium Honck (roots)	Common Cottongrass		2		2		
Eriophorum sp. (stem frags)	Cottongrass	2	4				
Rhynchospora alba (L.) Vahl	White Beak-sedge	1	1				
Moss							
Polytrichum commune		2					
Sphagnum sp. (individual leaves)		5	5	5	5	4	5
Sphagnum sp. (capsules)			3		3		
Sphagnum sp. (capsules lids)		2	3		2		
Identification of individual *Sphagnum* leaves (actual numbers)							
Sphagnum imbricatum		63	5	52	33	56	24
Sphagnum papillosum			8				
Sphagnum section *Acutifolia*		3		1	22		35
Sphagnum section *Cuspidata*		13	90		16		
Sphagnum section *Sphagnum*		1	1				
Undetermined		7					5
Total		**87**	**104**	**53**	**71**	**56**	**64**

The pollen data (Table 1) suggest that changes were taking place in the vegetation of the wider region around Glasson Moss during the period in which the upper two metres of raised bog peat accumulated. The lower samples are dominated by arboreal (tree and shrub type) pollen forming more than 50% of NMP, mainly Coryloid type (hazel/bog myrtle) and *Betula* (birch), with some *Alnus* (alder) and *Quercus* (oak). Poaceae (grass family) are consistently around 20% NMP with fluctuating values for cereal type pollen and pollen of agricultural indicators such as *Plantago lanceolata* (ribwort plantain) and *Rumex* (dock). Low frequencies (less than 1%) of *Cannabis* (hemp) pollen occur in some samples. Between 105 cm and 64 cm, the arboreal pollen declines and the *Poaceae* start to increase, reaching more than 40% NMP at 26 cm, the uppermost sample. The mire types, *Calluna* and the Cyperaceae also increase markedly in the upper peat, and *Cannabis* values rise to between 2% and 4% NMP. It appears that in the period represented by the lower metre or so of peat from this core, the landscape around the moss was occupied by mixed deciduous woodland which had been partly cleared for agriculture. Cereal crops and hemp were grown and pastoral agriculture was also taking place in the region. The type and frequencies of the arboreal pollen taxa suggest that this woodland was largely secondary and that the balance between wooded and open land varied during the period. As time went on the woodland declined, the surrounding landscape probably becoming more open as fields and pasture extended.

In order to establish a chronology for these changes, it is helpful to refer to the radiocarbon dated pollen diagram from Glasson Moss[15] and to the zonation scheme for Glasson proposed by Dumayne.[16] It is not appropriate to attempt precise correlation as the spot samples from Core 2/5 are widely spaced and the resolution of Dumayne and Barber's pollen diagram[17] is not high in the post-Roman period. However, the overall patterns appear to correspond. The fluctuating arboreal pollen and agricultural indicators found in the spot samples below 105 cm, follow the pattern Dumayne[18] described for her Phases GLMb$_2$ to GLMg which span the period from the Roman invasion to around A.D. 1220. According to Dumayne,[19] woodland clearance in the Glasson area was associated with the building of Hadrian's Wall when timber was required for constructing both the Wall and its forts. A period of regeneration was associated with the abandonment of the Wall, with renewed bursts of clearance activity around A.D. 635, A.D. 890 and A.D. 1230 (Dumayne's dates are presented as cited). The upper two samples from Core 2/5, where arboreal pollen frequencies fall markedly, can probably be equated with the upper part of Dumayne and Barber's[20] diagram where arboreal pollen is consistently below 50% NMP. This first occurred at a horizon radiocarbon dated to 990-1185 cal A.D. (SRR 4532). Sample 26-27 cm is probably equivalent to Dumayne's[21] phase GLMj in which arboreal pollen values fall to less than 20%. This phase was interpreted as representing the period of agricultural improvement from A.D. 1600 onwards. The high frequency of cereal pollen in this sample, and the wide range of indicators of both arable and pastoral activity, support this view.

All the evidence therefore suggests that the two metres of peat from Core 2/5 accumulated in the post Roman period; the palynological data give a picture of the changing environment against which evidence from the adjacent cores can be assessed.

Inside the circular feature: Core 2/6. (Figure 3 and Table 3)

The sediments from Core 2/6 are in marked contrast to the raised mire peats, although the sites are less than 20 metres apart. In this core the gyttja, which occurred below 119 cm, is an organic mud, typical of a pool deposit. The marked discontinuity at 119 cm, where the gyttja gave way to poorly humified *Sphagnum/ Eriophorum* peat, indicates a change in the local environment. The pool must have drained or dried out, the resulting depression filling with mire deposits. Pollen concentrations suggest that the upper peat accumulated quickly.

In the gyttja, pollen and fruits of the aquatics *Nymphaea alba* (white water-lily) and *Potamogeton* (pond-weed) are present and confirm the interpretation of this feature as a pool. Both these plants occur in open still water conditions. The presence of *Juncus* seeds, although not identified to species, may represent rushes which would have grown at the pool's edge. The macrofossil samples continue to be dominated by *Sphagnum* with *S. imbricatum, papillosum* and sect. *Sphagnum. S. papillosum* is often extremely abundant in the zone intermediate between bog pool and hummock top.[22] There is limited evidence of *Calluna* and *Erica tetralix* lower in the pool sequence indicating its continued growth on the pool periphery.

The most significant feature of the outline pollen diagram from the pool gyttja (Figure 3) is the very high frequency of *Cannabis* pollen found below 118 cm. Values range between 56% and 75% NMP for the three samples between 145 cm and 118 cm. These values are far higher than would be expected if they were derived from hemp fields around the edge of the moss. Such high values do not occur in the control core less than 20 metres away, or in Dumayne and Barber's[23] Glasson Moss diagram. These figures only appear to be explicable if hemp was actually being placed in the pool. Similar *Cannabis* values have been recorded from other lake and pool sites in this country and in Europe and have been attributed to hemp retting.[24] Interestingly, no evidence for hemp was found in the plant macrofossil record in the pool sediments. Despite this it appears that the circular feature represents the remains of a natural pool on the moss which was used for retting hemp fibre or possibly soaking ropes. In the upper peat above 118cm, which accumulated after the pool dried out, *Cannabis* pollen is present at around 4% NMP. This figure is compatible with *Cannabis* in the regional pollen rain, as shown by the evidence from Core 2/5.

Radiocarbon assay from the pool gyttja, at the base of the two metre core, gave a date of 660-970 cal 2 sigma A.D. (1220±60BP: WK–5479) and it appears that prior to this date hemp retting was taking place in the pool. Peat sealing the gyttja, which marks the end of the retting phase, produced a radiocarbon date of 1050-1290 cal 2 sigma AD (790+60BP: WK-5478). Dumayne[25] noted that the pollen record for *Cannabis* in her diagram from Glasson Moss started around A.D. 635, and ceased in Phase GLMj, which she believed post-dated A.D. 1630. This pool therefore appears to have been used for retting for the early part of the period during which hemp was being cultivated locally.

The linear feature: Core 1/3 (Table 2)

Examination of the sediments from this core revealed the presence of a thin deposit of gyttja, similar to that in the pool, below a surface layer of *Sphagnum/Eriophorum*

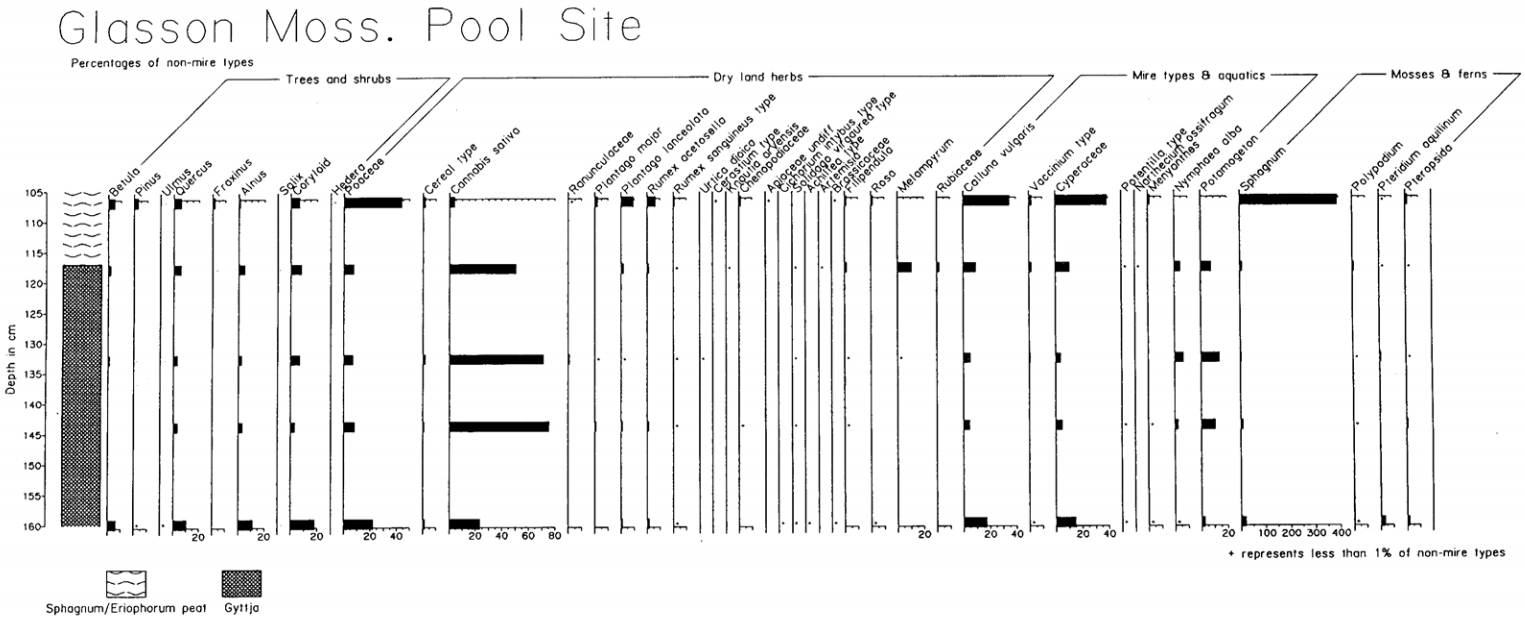

FIG. 3. Pollen diagram from Core 2/6, the circular feature.

TABLE 2: Pollen and plant macrofossil spot samples from Core 1/3, the linear feature, and from Core 2/1, bank of the circular feature.

Selected pollen types only, all expressed as percentages of non-mire type

		Linear feature				Bank		
	Sample depth (cm)	**160-161**	**127-128**	**81-81**	**74-75**	**83-84**		**65-66**
Trees and shrubs	*Betula* (birch)	11	7	3	2	2		1
	Pinus (pine)		1	1				
	Quercus (oak)	8	7	2	1	3		1
	Alnus (alder)	8	5	1	3	4		2
	Coryloid (hazel)	33	11	4	2	12		6
Total arboreal pollen		**60**	**31**	**11**	**8**	**21**		**10**
Herbaceous types	Poaceae undiff. (grass)	20	39	32	22	19		55
	Cereal type	4	5	4	1	3		5
	Cannabis sativa		4	46	66	47		20
	Plantago lanceolata	4	6	3		3		2
	Rumex acetosella type	3	1			2		1
Mire types	Cyperaceae	9	33	9	5	10		54
	Calluna vulgaris	26	59	44	7	70		55
	Vaccinium type			1		4		2
Fern spores	Undifferentiated	5	2		2	2		1
	Pteridium aquilinum	14	1		1	3		1
Moss	*Spagnum*	9	536	12	5	52		11
Plant macrofossils (assessed on scale of abundance)								
	Depth (cm)	**161-164**	**128-131**	**82-85**	**75-78**	**84-87**	**74-77**	**66-69**
Andromeda polifolia L. (leaves)	Bog-rosemary		2	2	2			
Calluna vulgaria (L.) Hull (seed)	Heather			2	2	3	1	2
C. vulgaris (leaf)					3	1		2
C. vulgaris (leaf-charred)							2	
C. vulgaris (flower)				1	2	3		
Calluna/Erica (roots/rootlets)		3	2			4	4	3
Ericaceae indet (flower)							1	1
Vaccinium oxycoccos L. (leaf)	Cranberry		2	2				
Juncus sp.	Rush			2	2			1
Luzula multiflora (Ehrh) Lej	Heath Wood-rush						2	
Carex echinata (Murray)	Star Sedge						2	
Eriophorum angustifolium Honck (roots)	Common Cottongrass							3
E. vaginatum L. (roots)	Hare's tail Cottongrass			5				
E. vaginatum (sclerenchymatous spindles)				4	2			
E. vaginatum – charred (sclerenchymatous spindles)							3	
Eripphorum sp. (stem frags)	Cotton-grass	3			3			
Rhynchospora alba (L.) Vahl	White Beak-sedge							
Charcoal fragments						2	5	
Charred twigs							2	
Moss								
Aulocommnium palustre				2				
Polytrichum commune					1			
Sphagnum sp. (individual leaves)		2	5	3	5	5	2	2
Sphagnum sp. (capsules)			2					
Sphagnum sp. (capsules lids)			2				1	
Identification of individual *Sphagnum* leaves (actual numbers)								
Sphagnum imbricatum		28			1		23	1
Sphagnum papillosum		16	23	24	16			
Sphagnum section *Acutifolia*						57	2	5
Sphagnum section *Cuspidata*		3	4	6	16	22		42
Sphagnum section *Sphagnum*		1	28	50	59		3	5
Undetermined			3		5	4		4
Total		**48**	**58**	**80**	**97**	**83**	**28**	**57**

peat. The base of the gyttja appeared to lie at 81 cm where there was a clear junction with *Sphagnum/Eriophorum* peat below. The ditch gyttja contained the same pollen of aquatic taxa as the pool, but no aquatic macrofossils were found. High *Cannabis* pollen values, similar to those in the pool gyttja, also occurred in the ditch, although again no macrofossil evidence was found. It appears that pollen of white water lily and pond-weed growing in the pool, together with the *Cannabis* pollen from the retting hemp plants, must have been washed into the ditch from the adjacent pool.

Below the base of the ditch, a *Sphagnum/Eriophorum* peat occurred with the tussock-forming *E. vaginatum* particularly abundant at 82-85 cm. The latter is an important tussock-builder and often becomes dominant, forming a typically uneven ground surface. Ericoid sub-shrubs have a more patchy occurrence.[26] *Sphagnum* becomes more abundant at 128-131 cm where the sediment description recorded a golden brown partly humified *Sphagnum* peat. This peat represents the raised bog sediments into which the ditch was cut. The pollen assemblages from the two spot samples taken from these sediments have arboreal pollen values of 62% and 37% respectively. They are similar to those in samples from the control core below 105 cm and probably represent the same general period, post-Roman to early-medieval. Given the use to which the pool was put, it seems that the ditch must have been dug in order to regulate the water level in the pool, or to drain away the foul water from the retting process (see below).

The bank of the circular feature: Core 2/1 (Table 2)

The bank core showed a similar stratigraphic sequence to the control core, with typical raised mire peat of varying degrees of humification. The discrete charcoal band at 73-77 cm was found only at this site. The thickness of the band, and the coarse gritty nature of the charcoal, suggests a small, localised fire site at the edge of the pool rather than general burning of the bog surface. There have been well-documented and widespread fires on the bog in recent years but the charcoal from these fires is likely to be confined to the surface peat.

Three samples were analysed from the bank core, above, at and below the charcoal band. Macrofossil evidence of *Calluna/Erica* occurs at all levels sampled. *Sphagnum* leaves are abundant at 84-87 cm, below the charcoal band with *S.* sect *Acutifolia* most common together with sect. *Cuspidata*. This may again represent the hummock/hollow relief with *S. cuspidatum* in the wet pools and *S. capillifolium* colonising the drier hummocks. The charcoal band contains an abundance of charcoal fragments, charred twigs, *Calluna* leaves and the diagnostic sclerenchymatous spindles of *E. vaginatum*. Pollen was not counted from this level in view of the overwhelming presence of charcoal on the pollen slide.

The pollen samples from above and below the charcoal band both had high *Cannabis* values (46.5% NMP at 83-84 cm and 19.5% NMP at 65-66 cm). This would be explained if hemp was being brought to the pool for retting and was piled up on the bank, leaving its pollen to accumulate in the peat.

Cannabis sativa and hemp retting

Cannabis sativa is a plant of western Asia and India; it has a long history of cultivation for its bast fibres and oily fruits and there is documentary evidence for its

TABLE 3: Plant macrofossil spot samples from Core 2/6, the circular feature and scale of abundance used in macrofossil assessment.

Plant macrofossils (assessed on scale of abundance)

	Depth (cm)	**161-164**	**145-148**	**134-137**	**119-122**	**108-111**
Nymphaea alba L.	White Water-lily			1		
Drosera intermedia Hayne	Oblong-leaved Sundew				1	
Andromeda polifolia L. (leaves)	Bog-rosemary	1	1			
Calluna vulgaris (L.) Hull (seed)	Heather	1		2	2	
C. vulgaris (leaf)		2				
C. vulgaris (flower)					2	
Calluna/*Erica* (stem)					2	
Calluna/*Erica* (roots/rootlets)					5	
Erica tetralix L. (leaf)	Cross-leaved Heath	2			2	
Erica spp (flower)					2	
Ericaceae indet (flower)						
Vaccinium oxycoccos L. (leaf)	Cranberry			1		
Potamogeton sp.	Pondweed		2	2	1	
Juncus sp.	Rush	1	2	2	3	
Carex sp.	Sedge				1	1
Eriophorum sp. (stem frags)	Cotton-grass					3
Rhynchospora alba (L.) Vahl	White Beak-sedge	1	1	2		
Moss						
Polytrichum commune		1			2	
Sphagnum sp. (individual leaves)		5	5	5	5	5
Sphagnum sp. (capsules)						1
Sphagnum sp. (capsules lids)			1		2	2
Identification of individual *Sphagnum* leaves (actual numbers)						
Sphagnum imbricatum		35	18	22	15	
Sphagnum papillosum		9	20	18	18	
Sphagnum section *Acutifolia*		1				
Sphagnum section *Cuspidata*		5	1	11	7	76
Sphagnum section *Sphagnum*		6	20	7	20	2
Undetermined		1	2	2	1	
Total		**57**	**61**	**60**	**61**	**78**

Scale of abundance used in plant macrofossil assessment

1:	rare	Vegetative material occurring only once or one seed.
2:	occasional	Vegetative material occurring only a few times or 2-5 seeds.
3:	frequent	Vegetative material occurring regularly or 5-20 seeds.
4:	very frequent	Vegetative material occurring in every portion of the sample examined or 20+ seeds.
5:	abundant	Vegetative material occurring in field of view all the time and dominating the sample or 40+ seeds.

cultivation in Britain from the early medieval period.[27] The fibres of the stem produce the hemp used for canvas, ropes and paper, the oily seeds for cooking, fuel and poultry food, and the foliage for medicinal purposes.[28] The plant is dioecious, so male and female flowers grow upon separate plants. The male plants tend to grow faster than the female and their stem fibres are finer and more elastic. In cultivation, the male plants are usually pulled at the beginning of July, whereas the female plants are allowed a longer growth period for the seeds to ripen.[29] If the male plants (which are the pollen producers), were used for hemp retting at Glasson, this may account for the lack of *Cannabis* macrofossils in the pool deposits.

The process of hemp retting for the extraction of the fibres is described by Bradshaw *et al.*:[30]

> Bundles of mature stems are deposited in small deep ponds of standing water and weighted down with blocks and logs of wood. The hemp is then left to rot or "ret" for periods of six or more weeks, leaving the residual fibres free to be dried and twisted to make rope.

Retting systems are pools often linked to small water channels used to control the water supply to the pool[31] by means of sluices. Thomas Tusser[32] writing in 1557 indicates that: "the retting of Hemp is commonly done in standing Plashes, or small pools . . . It leaves a loathsome Smell in the Water" (*sic*). A further description concerns the gathering of winter hemp:[33]

> Now pluck up thy hempe, and go beat out the seed,
> and afterward water it as ye see need:
> But not in the river where cattle should drinke,
> for poisoning them and the people with stinke. (*sic*)

A medieval treatise on agriculture referred to hemp, "sown on the manor to make ropes for carts, harnesses and other necessary items".[34] Its economic importance was recognised by a statute of 1532,[35] which ordered that: "every person having in his occupation threescore acres of land apt for tillage, shall sow one rood with flax or hemp-seed upon pain to forfeit 3s. 4d. for every 40 acres". Legislation was also introduced in 1541 to control the nuisance caused by hemp retting:[36]

> . . . it shall not be lawful . . . to water any manner of hemp or flax in any river, running water, stream, brook, or other common pond, where beasts be used to be watered, but only on the grounds or pits for the same ordained . . . or else in other their own several ponds . . . .

These provisions were repealed in 1593.[37] Shortly afterwards, in 1620, the virtues of hemp cultivation were extolled in a long poem by John Taylor, the "water-poet". In contrast to the pollution caused by retting, Taylor[38] praises hemp as an enricher of the soil on which it is sown: "It fats the earth, and makes it to excell, No dung, or marle, or mucke can do't so well . . ." (*sic*).

Hemp retting in Cumbria

If, as appears to have been the case in other regions, the growing and processing of hemp (and flax) in medieval Cumbria was widely practised and rather taken for granted, it is not likely to have been extensively documented (given the nature of most written records). The only securely datable reference to hemp in Cumbria which has been discovered comes at the latter extremity of the radiocarbon date range of 1050-1250 cal A.D. This is from the cartulary of Lanercost Priory[39] which lists: "*decimis garbarum bladi crescentis in ortis' lini et canabi ubicunque crescat in parochia . . .*" ("tithes of sheaves of corn growing in gardens, and of flax and hemp wherever it may grow in the parish").

Medieval field-names in Cumbria demonstrate the importance of both hemp and flax, from the sixteenth century onwards. At this period is found the first instance of "Hemp" in a field name near Glasson: "Hemskin Howe" in Dalston (1560). Elsewhere in Cumbria "Hempgarth Plantation" occurs in 1589 at Dacre near Penrith. Later references are to "Hemble Lands" (1675) and "Hempsgillhow" (1886) in Dalston, and "Hemp Croft" (1794) in Wigton.

Discussion

It is clear from the aerial photographic and field survey that the pool and ditch which has been examined in detail in this study is only a small part of a larger system of natural pools and man-made ditches which once extended over the central dome of Glasson Moss. Despite continued peat deposition, these have subsequently dried out and been colonised by *Calluna* on their margins, forming the anomalous patterns of vegetation visible today. It seems reasonable to assume that all the former pools, which have linear features leading from them, were once used for hemp retting. These ditches were probably constructed to control the supply of water to and from the pools (which were all situated towards the centre and dome of the Moss), possibly in conjunction with simple sluices.[40] No evidence for sluices was recovered, but it is unlikely to have been, given the limited and localised nature of this assessment.

The first records of *Cannabis* pollen in the regional pollen rain at Glasson come from the early medieval period.[41] Similar values for *Cannabis* pollen have been interpreted as indicating hemp cultivation in the general area at a range of other sites in Britain including, for example, Old Buckenham, Norfolk,[42] Hockham Mere and Sea Mere, Norfolk,[43] and Chat Moss, Greater Manchester.[44]

There are some sites where very high concentrations of hemp pollen similar to those from the Glasson pool have been recorded. Thompson Common, Norfolk had *Cannabis* pollen values of nearly 50% of total dry land pollen, Bugg's Hole, Suffolk 15-52% and Askham Bog, North Yorkshire 13%.[45] These three sites also had evidence of *Cannabis* macrofossils (not found at Glasson) and this led Bradshaw *et al.*[46] to the conclusion that hemp retting was taking place at all of them. In their review of Cannabaceae pollen records, Whittingdon and Edwards[47] agree with this interpretation.

At Askham Bog, hemp achenes were found in a poorly humified *Scorpidium scorpioides-Sphagnum* peat associated with macrofossils of aquatic species indicative of areas of open water. It was suggested that at this site hemp retting was being carried out in abandoned peat pools, a similar situation to that postulated for Glasson. However, in the case of Askham, Bradshaw *et al.*[48] believed that the pools may have been an artefact created by peat cutting, whereas the Glasson pools are certainly natural. The absence of *Cannabis* achenes from Glasson can perhaps be explained. It is possible that only the male plant with its more elastic fibres was used in this area. Alternatively, if Tusser's comments of "beating out the seed"[49] are correct, these could have been removed before retting took place, as they were known to be a valuable commodity. Seed removal was likely to have taken place on dry land convenient to its point of processing rather than in the middle of a raised mire, hence the hemp stems brought to the Glasson pool may have been already de-seeded. At Thompson Common, trampled ground herbs nearby were taken to indicate human and draught animal activity in bringing hemp to and from the retting site.[50] The dates for hemp retting at the three sites discussed by Bradshaw *et al.*[51] are more recent than those suggested for the Glasson pool. Only Askham, with a possible date-span from Roman to Tudor, could have been in use in the early medieval period.

One question which remains unanswered, regarding hemp retting at Glasson, relates to the use of pools in such an isolated and potentially dangerous part of the mire. The documentary evidence clearly shows that hemp retting polluted waters for humans and cattle and this may provide an explanation. It is possible that the mire pools were the only available sources of open water in this area which were isolated from the general ground water table and that any effects resulting from the retting pollutants were thus contained. This provides an example, perhaps, of careful environmental management in early medieval times.

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