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Recording and Reconstruction of Wood Macrofossils in Three-Dimensions

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Building on an upsurge of interest in European wetland archaeology, which has led to methodological advances in field techniques, a new palaeoecological technique is outlined to enable reconstruction of wood macrofossils in their original *in situ* positions within a peat deposit. Such three-dimensional reconstruction provides data on the temporal sequence and succession of mire woodland phases; these can be related to the fossil pollen record and to evidence of past human impact. Chronology building using tree ring-width series, is facilitated, and may assist in dating site records. The technique has wider application at sites where subfossiliferous peat is underlain by sand substrates, aiding palaeoenvironmental reconstruction and interpretation of the cultural landscape.

Keywords: WETLAND ARCHAEOLOGY, VEGETATION RECONSTRUCTION, PEAT, MACROFOSSILS, *PINUS SYLVESTRIS*, FIELDWORK METHODOLOGY.

Introduction

In European archaeology, a major growth area in the past decade has been the excavation and recording of wetland sites (Coles & Lawson, 1987; Coles, 1992). A parallel growth in interest in landscape archaeology (Berglund *et al.*, 1991), together with the increasing application of palaeoecological techniques in ''environmental archaeology'', has meant a change in emphasis in Europe from site-specific studies to reconstruction of the wider, natural or ''cultural'' landscape (Birks *et al.*, 1988), particularly of former forested landscapes (Berglund, 1991). In Britain, wood, including timber, is prominent amongst the macrofossils recorded from many wetland sites, and appears in various guises, from the trackways of the Somerset levels (Coles & Coles, 1986) to the structures at Flag Fen (Pryor, French & Taylor, 1986; Pryor & Taylor, 1992). Indeed, finds of subfossil wood can be interpreted to reconstruct forest structure and woodland management (see Baillie, 1993). However, although new techniques have been developed and refined for various aspects of wetland archaeology, the recording of prehistoric woodland landscapes, *in situ*, has hitherto been restricted to palaeoecology.

The importance of the stratigraphic position of subfossil wood has been recognized in palaeoecological research methodology (Munaut, 1986). However, emphasis has often been placed on the horizontal extent of individual layers of former mire-rooting woodlands (Birks, 1975), and rarely on the relative vertical and three-dimensional positions of the trees. Studies using subfossil wood have thus been limited in their scope owing to the restricted locations in which the wood was exposed. For example, pine stumps can be revealed in vertical peat faces as a result of building forestry access roads (Gear & Huntley, 1991), peat mining activities (Munaut & Casparie, 1971; McNally & Doyle, 1984), reservoir construction (Munaut, 1966) or upland peat erosion (Pears, 1975; Tallis, 1975). But studies in these locations suffer from initial sampling constraints and fail to allow for spatial and also possible temporal variations in the subfossil wood record. Indeed the majority of the above examples utilize a

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one-dimensional approach that in many more complex field locations is inadequate (cf. Lageard, 1992). In many peatland ecosystems a mosaic of surface hydrological conditions is apparent from present-day vegetation distributions and it is clear that similar patterns existed in prehistory, and led to selective encroachment of woodlands onto mires (cf. Lageard, Chambers & Grant, 1992, Lageard & Chambers 1993).

Studies of the three-dimensional nature of peat deposits were carried out by Stewart and Durno (1969) and by Smith and Cloutman (1988). These employed plant macrofossil and microfossil analyses in order to test the replicability of samples taken using conventional coring techniques, but did not provide a methodological framework that can be used in the detailed exhumation and reconstruction of subfossil wood.

This paper therefore aims to detail a new fieldwork methodology that permits three-dimensional reconstruction of macrofossils in their original positions. The limitations and advantages associated with this approach are discussed in relation to a specific fieldwork location, that of White Moss, Cheshire.

Original study site

A large quantity of wood macrofossils was discovered at White Moss, a former raised mire located 2·5 km to the west of Alsager, southeast Cheshire (Grid reference: SJ 775 500). At this site, exhumation areas were dug down through peat thought to contain *in situ* subfossil wood, in order to reconstruct layers of former mire woodland (Lageard, 1992). Palaeoecological techniques that were employed included dendrochronology, to establish possible contemporaneity among individual timbers; radiocarbon dating of 20–30 year periods from the ring-width records of subfossil Scots pine (*Pinus sylvestris* L.), to establish the timing and minimum duration of the mire woodland; and palynology, to reconstruct the fossil pollen record of the subfossil woodland from peat stratigraphy. The stratigraphic position of *in situ* stumps was an important consideration in relating wood macrofossils to their fossil pollen record.

Although an electronic distance measurer might be used to obtain an accurate spatial record of uncovered subfossil wood, on unconsolidated peats there are problems with this approach owing to instability of the substrate. In addition, the messy process of peat digging is incompatible with sensitive equipment. With these considerations in mind, a new fieldwork methodology was developed that would (later) allow three-dimensional reconstruction of the subfossil timbers in their relative *in situ* positions at White Moss. This methodology owes much to the specific environmental conditions encountered at White Moss—that is, subfossiliferous peat overlying a relatively flat and firm sand substrate. (This substrate was levelled separately; see Lageard, 1992). These conditions are by no means unique and thus the authors feel that these techniques have wider application.

Defining exhumation areas

An exhumation area is defined as a specified area from which peat is removed in order to uncover wood macrofossils. In selecting exhumation areas, a systematic stratigraphic survey of the site is desirable in conjunction with field walking to establish the possible horizontal extent of any macrofossil layers. At White Moss, exhumation areas were positioned as an extension of a stratigraphic traverse that aimed to isolate possible edge effects/differences in subfossil woodland composition. The initial size chosen for the plan view of an exhumation area was an arbitrary 100 m^2. This area was later modified to 36 m^2 as practicalities became apparent in the field. Important factors in this decision were depth of peat deposit and quantity of subfossil wood contained therein.

Two different types of exhumation area may be envisaged:

(1) *Where one side of the area is exposed in cross-section by peat-cutting activities*. In the example of White Moss, this allowed one area to be worked from the exposed surface of the adjacent sand substrate. 1×6 m^3 sections were dug and removed systematically (in area 6×6I; Lageard, 1992), simplifying the process of sample collation in the laboratory.

(2) *An area that is worked down through blocks of peat where no side is exposed as a peat face*. In this case, peat removal becomes more difficult as the depth of the area increases. In order to facilitate access to such an area, stepped blocks of peat can be left, leading from the middle of the area to one of its sides. It is also advizable not to pile extracted peat adjoining the sides of the area. Despite the low hydraulic conductivity of peat, in the length of time involved in removing all the wood from an exhumation area, water seepage may become a significant problem when sampling the lower levels. Attempts to combat this using a petrol-driven water pump at White Moss (in area 6×6III; see Lageard, 1992) proved ineffective as unhumified plant remains from the peat caused rapid congestion of the pump despite the use of filters. A possible remedy for this is to dig a trench away from the exhumation area to a lower-lying area of substrate.

Recording subfossil wood

The recording procedure detailed in this paper bears some similarity to the archaeological excavation methodology of ''boxes and quadrants'' described in Coles (1972 pp. 143–148) where, in the case of large sites, selected squares are excavated by removing material in reverse order to its deposition, whilst leaving a vertical stratigraphic record in the sides of the square.

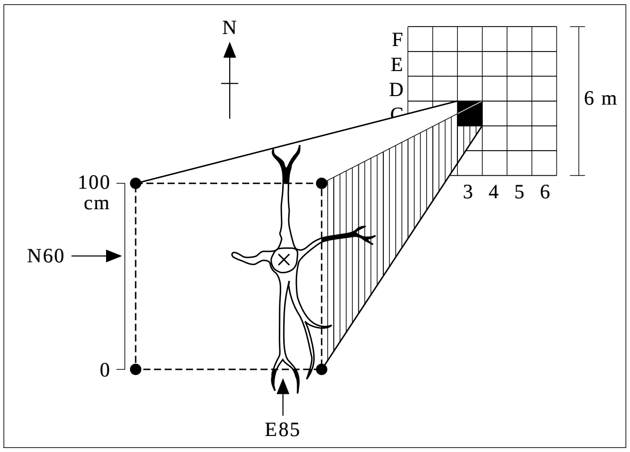

Figure 1. Plan location of a subfossil pine stump. (●): Bamboo cane; (×): centre of pine stump at root crown. Location record: pine stump in square C3 at North 60 East 85 (Pst. C3 N60 E85).

At White Moss each 36 m^2 exhumation area was divided into 1 m squares, in plan view. The compass orientation of the exhumation area was noted, but where its orientation deviated from a north–south axis, a hypothetical north was allocated to the side of the square with closest alignment to north. Macrofossils occurring in a particular grid square could then be given coordinates along north and east axes (see Figure 1).

It is important to clarify which particular classes of macrofossil (both type and size) are to be recorded. This will be largely dependent on the specific nature of the deposit. In subfossiliferous peat, macrofossils may range in size from pine cones, acorns and small twigs, to large fallen trunks. For the purposes of the research at White Moss, emphasis was placed on reconstructing basal areas of trees that comprised the subfossil woodland. Thus, *in situ* stumps were given priority, although the dimensions and spatial location of fallen trunks, large roots and root systems were also recorded. (Recording of the last two can be important when reconstructing basal areas or canopy spread of subfossil mire woodland, as root size and orientation can be used to estimate the location of other subfossil stumps outside the exhumation area.) An example of the minimum data required for the three-dimensional reconstruction of a subfossil tree stump is given in Table 1.

Table 1. An example of the data required for three-dimensional reconstruction of a subfossil pine stump

Grid square	Species/ macrofossil type	Grid coordinates	Height above substrate (cm)	Stump circumference (cm)
C3	Pine stump	N60 E85	107/162/80*	45

*Denotes three individual measurements made for the heights of the stump root crown, stump top and lowest stump root.

Recording procedure

Turf was removed from the surface of each exhumation area at White Moss using a stainless steel version of a traditional peat cutter (Lageard/Chambers Mk 1; see Lageard, Chambers & Grant, 1994). Peat was subsequently removed from the area by manual digging. This resulted in the uncovering of subfossil stumps and other large wood macrofossils. Once this point was reached, the following steps were followed to record the subfossil wood:

(1) Each square metre within the area was marked out using short (54 cm length) bamboo canes that were removed and subsequently replaced after further peat/subfossil wood removal.

(2) The 36 squares within the area were each given a number and a letter (see Figure 1).

(3) A peat probe (1·83 m long stainless steel rod) was employed to measure the heights of the subfossil wood above the sand substrate (see Figure 2).

(4) Trunk circumferences were measured just above the root crown. (Stumps of *Pinus sylvestris* are often well preserved, but in some cases where their incorporation into the peat deposit has been slow, stumps may lack discernable trunk owing to decomposition immediately after mortality. Girths however, can be estimated from the size of the stump's root crown.)

(5) A bow saw (chainsaw may be necessary in some cases) was used to cut a sample disc from the trunk (*c.* 5 cm vertical thickness), from above the root crown. Sample discs represent a horizontal section of the trunk that will allow ring-width measurements after careful preparation of the surface using a belt sander.

(6) Sample discs were enclosed in airtight bags in order to reduce sample desiccation and associated deformation of tree-ring patterns (cf. Munaut, 1986; Nayling, 1989; Coles, 1990). Sample bags were carefully labelled and a written record was made of the minimum data outlined in Table 1, together with additional ecological information important to palaeoenvironmental reconstruction, (see Munaut, 1986).

Three-dimensional drawing

The peat exhumation area was delimited by horizontal, diagonal and vertical construction lines. The area was further sub-divided into six 1 × 6 m rows; each was drawn separately in order to differentiate stump positions clearly (see Figure 4). The pre-recorded coordinates (see Table 1) were used to locate wood samples in plan view within each individual grid square, and the heights above the underlying sand substrate were used to give each wood sample a vertical orientation, as illustrated in Figure 3(a). In the case of the pine stump recorded in Table 1, a cross was used to mark the vertical position of the root crown above the sand substrate (Figure 3(a)). This mark was then used as a basis to recreate the stump (Figure 3(b)). Although the trunk component of the stump can then

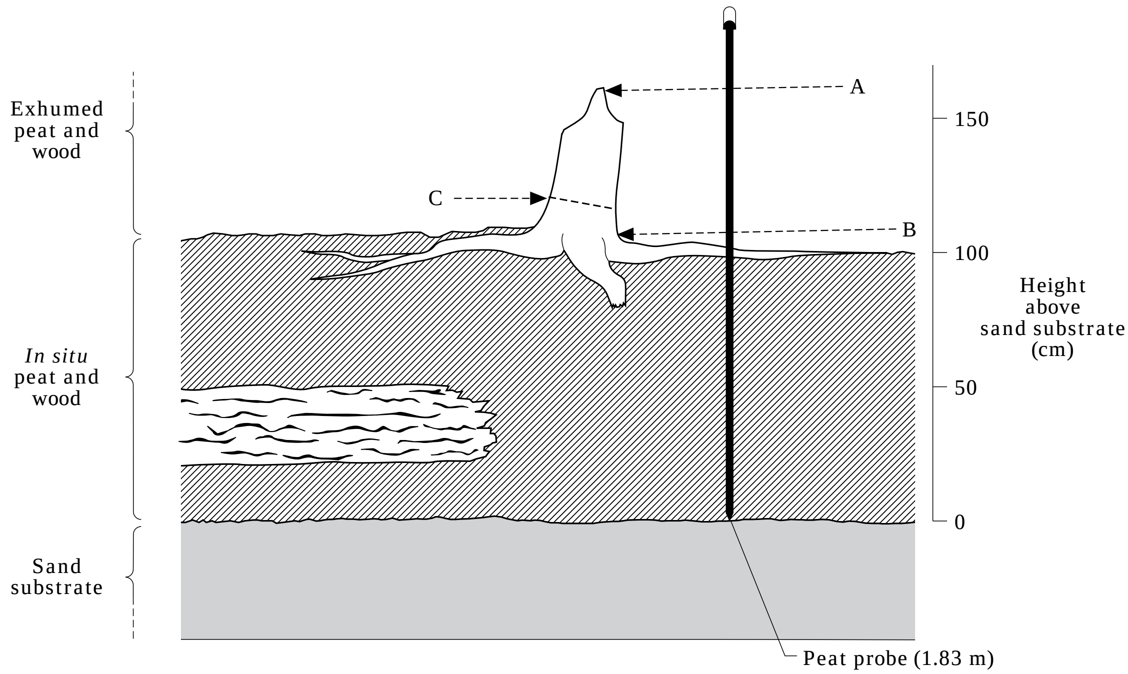

Figure 2. Cross-sectional measurements of an *in situ* pine stump. A: height of stump top above sand; B: height of root crown above sand; C: stump circumference (20 cm maximum above root crown).

be accurately drawn, a certain artistic licence was employed in drawing the stump top and stump root system (Figure 3(c)). Recording of the type of stump top and type of root system (i.e. plate, tap root etc.) can improve the accuracy of this reconstruction.

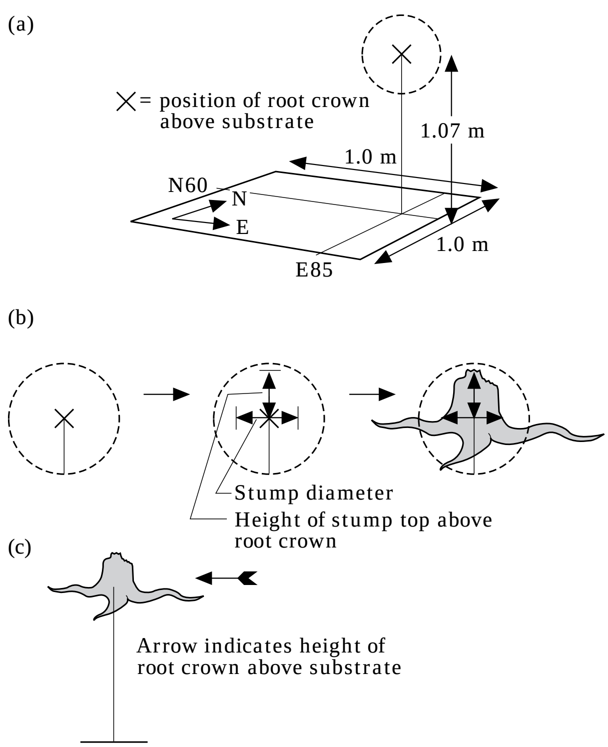

Figure 3. Reconstructing a subfossil pine stump.

Figure 4 illustrates the potential for this method of macrofossil reconstruction. Pine stumps were shaded black to facilitate visual comparison of the predominant macrofossil type. Non-pine macrofossils (*Betula* spp.), were shaded with vertical hatching. Apart from the subfossil stumps, other important subfossil wood (including pine trunks, branches and large roots) were reconstructed using measurements of their size and three-dimensional location within the area.

Although this method was entirely manual, computer graphics could be used instead. For example, as the data were recorded with coordinates in three-dimensions, it would be possible to import the data from a spread sheet to a CAD/CAM drawing package.

Implications of results

(1) According to Coles and Coles (1992), there has been a rapid development at the field stages of survey and excavation and also in the quality of chronology in wetland archaeology. The latter is offered by the increasing availability of absolute (calendrical) dating through dendrochronology. Yet even at extensive sites such as Flag Fen, the dating of floating master chronologies (up to 206 years in length) can still be problematic (Pryor & Taylor, 1992). This and examples from White Moss, highlight the need for stratigraphic awareness when dealing with tree-ring series that form several individual site chronologies. The

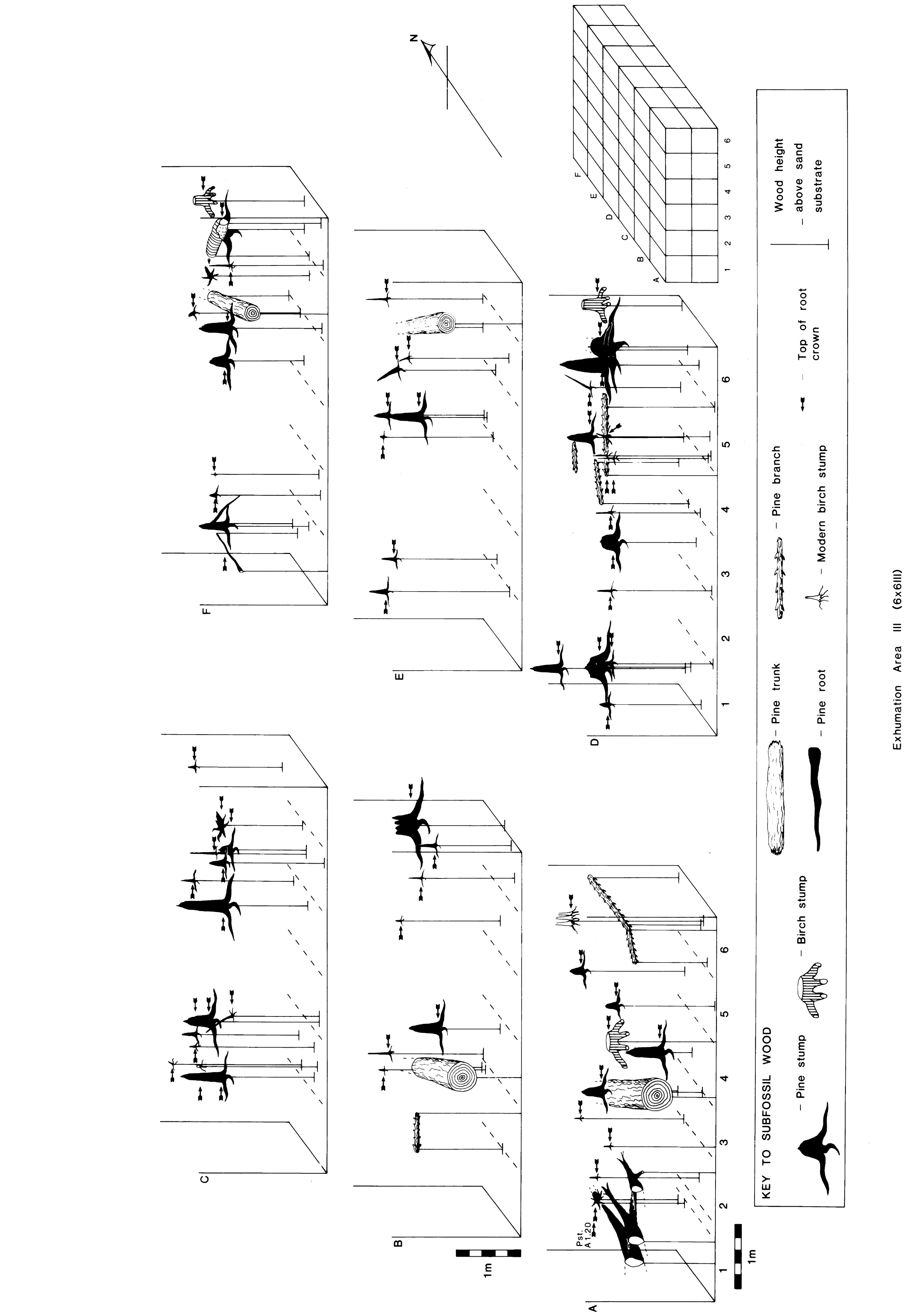

Figure 4. Three-dimensional reconstruction of exhumation area 6 × 6III at White Moss, Cheshire, including 66 subfossil tree stumps.

methodology outlined in this paper gives a degree of precision to the often haphazard art of searching for ''missing'' pieces of wood that might link apparently disparate chronologies constructed in both archaeological and palaeoecological investigations. This would lead to chronology extension and better possibilities of achieving calendrical ''dendrodates''.

(2) Many palaeoecological studies refer to single ''layers'' of subfossil pine trees that have been discovered in peat deposits. These interpretations may be over-simplistic (see Lageard & Chambers, 1993). At White Moss the initial assumption of one single subfossil pine layer was tested by this new field methodology and subsequent palaeoforest reconstruction (using the additional techniques of palynology and dendrochronology). Three distinct phases of mire pine woodland were identified, indicating a protracted decline or marginalization of the taxon at the site (Lageard, in prep.). This record differs significantly from other palaeoecological studies in the British Isles where a sudden ''pine decline'' has been noted at *c.* 4000 BP (Bennett, 1984; Bradshaw & Browne, 1987; Blackford, Edwards, Dugmore, Cook & Buckland, 1992).

(3) The method permits comparison of macrofossil and fossil pollen records from the same site, and can help to refine percentage criteria used to indicate the presence of woodland in the vicinity of the pollen depositional environment. At White Moss, new percentage criteria were suggested for the local presence of pine (cf. Bennett, 1984).

Conclusion

Detailed three-dimensional reconstruction of prehistoric woodland landscapes has been possible using a new field recording technique, developed during palaeoecological investigations at White Moss, a former raised mire in southeast Cheshire. The stratigraphic prerequisites, those of subfossiliferous peat underlain by sand substrates, are encountered in many other localities throughout north west Europe, giving the technique a broad base for its wider application in palaeoenvironmental and in wetland archaeological reconstructions.

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