ALTERNATIVE APPROACHES TO POLLEN ANALYSIS
AT TWO MIDLANDS SITES

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December 1995

CONTENTS

INTRODUCTION

In 1982-83 I enjoyed the opportunity of a sabbatical year of research and teaching at the University of Liverpool. My background in the study of pollen from archaeological site-context deposits in various New World districts focussed my interest on similar work undertaken in England -- particularly any done in the northwest. I quickly learned that conventional archeological wisdom held study of the pollen of mineral soil site-context deposits to be less than satisfactory, and not likely to produce sufficient archaeologically relevant information to repay the costs of investment. Collecting such samples for pollen study was, as a result, undertaken mainly at sites where successful analysis seemed highly likely -- or where prior research had demonstrated analysis might have particular archaeological value. Many sites excavated as aspects of rescue or salvage archaeology programmes were not sampled at all, or were sampled according to very selective standards.

As a professionally trained archaeologist, I view archaeological sites to be repositories of information for the study of prior cultural conditions. The body of information normally most intensively explored by archaeologists is that of the characteristics, quantities and spatial positioning of items of material culture, but other types of information are also regularly studied, including the varieties, quantities and associations of pollen records recovered from site-context deposits. It seemed to me that a great deal of the potential

archaeological value of palynological research was being ignored and, because so few sites were thoroughly sampled, was being discarded. I felt this was particularly unfortunate in the case of sites excavated for the express purpose of preservation of their information content prior to destruction.

I realized, though, that it was inappropriate that I simply champion a policy of recovery and study of site-context pollen samples for their archaeological value. I have no special expertise in either the archaeology or the palynology of the British Isles, so no special credentials for such action, and I hope I am not the sort of guest who would willfully embarrass his host. In any case, I have long believed that the most convincing way to identify the archaeological value of site-context sample pollen analysis is through case studies. I thus sought opportunities to sample and analyze the pollen of mineral soil site-context deposits at ostensibly unpromising sites, anticipating only that the result would turn out to be archaeologically significant. Such an effort would demonstrate that the information potential of such samples is greater than is normally supposed, and it might encourage modification of conventional wisdom on the matter and perhaps a change of policy.

The two case studies which follow allow demonstration of ways that alternative approaches to the study of mineral soil samples pollen records may allow discovery of archaeologically valuable information. Their significance lies not in what information was discovered nor even how it was discovered, but

4

rather that any was discovered at all. The sites were not selected to elucidate or resolve particular problems; I merely selected situations I could easily recognize as extreme challenges to conventional wisdom. In one case, analysis of equivalent samples had been attempted but had encountered difficulties that compromised analysis. In the second, conventional sampling and analytic strategies were so obviously inappropriate that pollen study would not normally have been seriously considered at all. Successful analysis of these cases argues that ostensible limitations of site-context deposit pollen studies may normally be overcome even under worst-case conditions. It seems appropriate, then, that the recovery and curation of site-context pollen samples be given far more sympathetic consideration in future efforts to recover the information content of archaeological sites in the British Isles.

THE FIRST STUDY: MARSDEN-SADDLEWORTH

BACKGROUND

Shortly before my arrival in England, Brown (1982) had published the results of pollen studies of three mesolithic sites in the Marsden-Saddleworth district of the Central Pennines. Her analysis was strongly compromised by the fact that at Warcock Hill South (hereafter, WHS), pollen was so poorly preserved in the mineral soil stratum that counts were reduced and identifications were affected. I collected fresh, larger,

samples from that site[1] to see if an alternative extraction technique would allow more confident analysis. For comparison, I also collected samples at a second site, Rocher Moss 2 (hereafter RM), where Brown's study of mineral soil deposits samples had been more productive.

Since Brown's excavations had been backfilled, my collections were recovered from profiles exposed through erosion of the margins of the sites. The stratigraphic relationships of the deposits revealed by erosion and by her excavation were identical, so determining the stratigraphic equivalency of the samples collected by Brown and myself was not problematical. The relationship of those samples to the mesolithic archaeological record of the sites was also clear. As noted by Barnes (1982:29), in situ microliths and other mesolithic cultural materials in the Central Pennines always occur below blanket peat near the top of the mineral soil unit. At WHS and RM the artifacts were encountered in and just below a peaty-gley podsol stratum (Brown's "transition zone" (1982:86)) which satisfies the definition of mor. According to Taylor and Smith (1980:112), mor evolves under the dominant control of soil formation process (in contrast to climatic or topographic factors) as plant communities of shallower rooting species gradually out-compete deeper rooted ones on wet substrates.

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[1] WHS, described by Buckley (1924), lies only 20 meters from the Turnpike site, recently described by Stonehouse (1992). The erosion profile I sampled actually lay between the two occupation areas.

According to Brown (1982:86) pollen was well preserved in the mor/transition zone samples directly associated with the mesolithic archaeological record at two of the three sites. Her study determined, however, that their pollen spectra did not reflect vegetation that existed at the time of mesolithic occupation. Study of the pollen sequences produced by samples from the sites suggested that pollen dating to the time of mesolithic occupation had been transported to some depth within the mineral soil (cf Dimbleby 1985:4-9).

THE ALTERNATIVE EXTRACTION TECHNIQUE

I collected two samples from Warcock Hill South (WHS1 and WHS2) approximately 3 meters distant from one another at the base of the mor/transition zone. This places them in the same stratigraphic position as the sample Brown collected at a depth of 25 cm. I also collected two samples (RM1 and RM2) at Rocher Moss 2 from the middle of the mor/transition zone. Though no mor layer was evident in the profile of her excavation, Brown encountered the contact between peaty soil and mineral soil at 37 cm depth. My samples, then, are stratigraphically equivalent to the sample she collected at that depth.

I was able to recover sufficient pollen for analysis from 30-50 cc of each of the four samples using swirl flotation to isolate the light fraction, HF and HCl treatments to reduce its inorganic content, and KOH and HClO treatments to reduce and bleach organic material in the extract. Acetolysis was not employed, to reduce the prospect of chemical damage to poorly

preserved pollen types. This result suggests that successful recovery of sufficient preserved pollen from site-context mineral soil deposits is primarily a technical problem which can be overcome by concentrating the pollen of larger samples. Pollen recovery, however, is not the significant issue. To justify the expense of sample recovery, curation and analysis, pollen records which might be recovered from site-context mineral soil deposits should be likely to aid the progress of archaeological research. At mesolithic sites, interest focusses on paleoenvironmental reconstruction.

PROBLEM RECOGNITION

The nature of the paleoenvironmental context of mesolithic occupations of the British Isles has been an issue of archaeological moment for many decades. It has long been clear that temporally and artifactually distinct expressions of mesolithic culture occurred, and that an earlier expression (broad blade mesolithic) existed at a time when regional vegetation patterns and climatic conditions were distinct from those that existed when a later one (narrow blade mesolithic) occurred. The bulk of palynological research that generated these understandings was developed from samples of lacustrine and peat contexts dated to the mesolithic horizon through radiocarbon assays, since mineral soil samples that are normally directly associated with the mesolithic archaeological records often (as here) contain the pollen of post-mesolithic floras.   Mineral soil samples are also viewed as poorer sources of pollen records

8

reflecting paleoenvironmental conditions for two other reasons. The pollen they contain tends to be less well preserved than the pollen of peat or lacustrine samples, creating some identification problems and the suspicion that differential preservation of taxa may skew paleoenvironmental interpretation. They also tend to contain pollen produced by the vegetation of more limited geographic areas, which may be responsive to local, non-representative, paleoenvironmental conditions.

These limitations, however, offer certain advantages to archaeological research. Poor preservation reduces the taxonomic variability normal to pollen records from other sources. But with fewer taxa in the record, smaller pollen counts can be defended on statistical grounds. More samples can thus be analyzed with the same investment of resources, and such palynological variability as a population of samples does express can be more confidently identified and interpreted. The tendency for site-context deposit samples to be more strongly influenced by highly localized ecosystem conditions allows prospect of more detailed reconstructions of the specific paleoenvironmental context of the site locale. Part of the archaeologist's interest in paleoenvironmental reconstructions lies in the question of the degree of natural resources variability in the territories exploited by the residents of different sites. This question is better addressed with the sort of site-specific information on paleoenvironmental context that site-context samples can provide.

The question here was whether such potential advantages of

TAXON	BROWN'S WHS 25	MY WHS 1	MY WHS 2	MY RM 1	MY RM 2	BROWN'S DC 39
Betula	4	1		1	4	3
Pinus	1			1	1	
Ulmus	1		1			
Quercus	4	5	7	4	15	3
Tilia		2		1	2	
Alnus	24	9	11	22	15	4
Salix	1	1			2	2
Corylus	15	60	55	63	46	47
Poaceae	22	8	8	4	8	30
Calluna	25	13	16	2	3	7
All others	4	1	1	1	4	6

Table 1. Pollen percentage values to the nearest whole
number (pollen sum = observed TLP)

site-context sample information could, in fact, be realized. That is, if reconstruction of the local paleoenvironments of the sites would aid understanding of their archaeological records or the cultural activity of the people so represented. At first blush, it seemed unlikely. In his 1982 synthesis, Barnes had developed detailed reconstructions of the characteristics of mesolithic paleoenvironments through consideration of information on the physical geography, geology, paleobotany, and archaeological records of the Central Pennines and pollen studies of adjacent areas. While it might be useful to have an independent test of this model, the small amount of information study of the few pollen records of these sites could add seemed unlikely to offer new insights.

AN ALTERNATIVE METHOD FOR IDENTIFYING THE POLLEN SEQUENCE

The task of developing a creditable data base for interpretation required two actions. First, I had to demonstrate that the pollen records of samples extracted by the technique I had used were comparable to those obtained by Brown using a more traditional technology. Second, if they were, I had to design a means of combining the data of my samples with those Brown had observed into a single pollen sequence in which horizons of earlier and later mesolithic occupation could be distinguished and site-specific temporal and spatial variability could be identified.

Table 1 provides the results of my analyses, compared against Brown's analyses of samples from the mor/transition zone

at Warcock Hill South (WHS) and Dean Clough (DC). My pollen counts of the samples from WHS turned out to be dissimilar to Brown's stratigraphically equivalent sample from that site in 4 major respects:

1. I observed significantly more Corylus pollen,

2. I observed significantly less Alnus pollen,

3. I observed significantly less Calluna pollen, and

4. I observed significantly less Poaceae pollen.

These differences could be due to distinctions in the extraction techniques employed. However, all but the last of those four differences also distinguish Brown's mor/transition zone pollen record at Dean Clough (DC 39) from her mor/transition zone pollen record at WHS 25.

Because my familiarity with British Isles pollen types has been structured by work with the pollen of related species in the Eastern Woodlands region of the United States, I was concerned that my analyses might incorporate misidentification errors. I thought it prudent to send the pollen extracts of three samples to Professor John Tallis, at Manchester University, for independent analysis. His results were not statistically identical to mine in all ways, but they also were more like the record Brown reports for DC 39 than that she reports for WHS 25, with significantly higher values for Corylus and Quercus pollen and significantly lower values for Alnus and Calluna (see Figure 1).

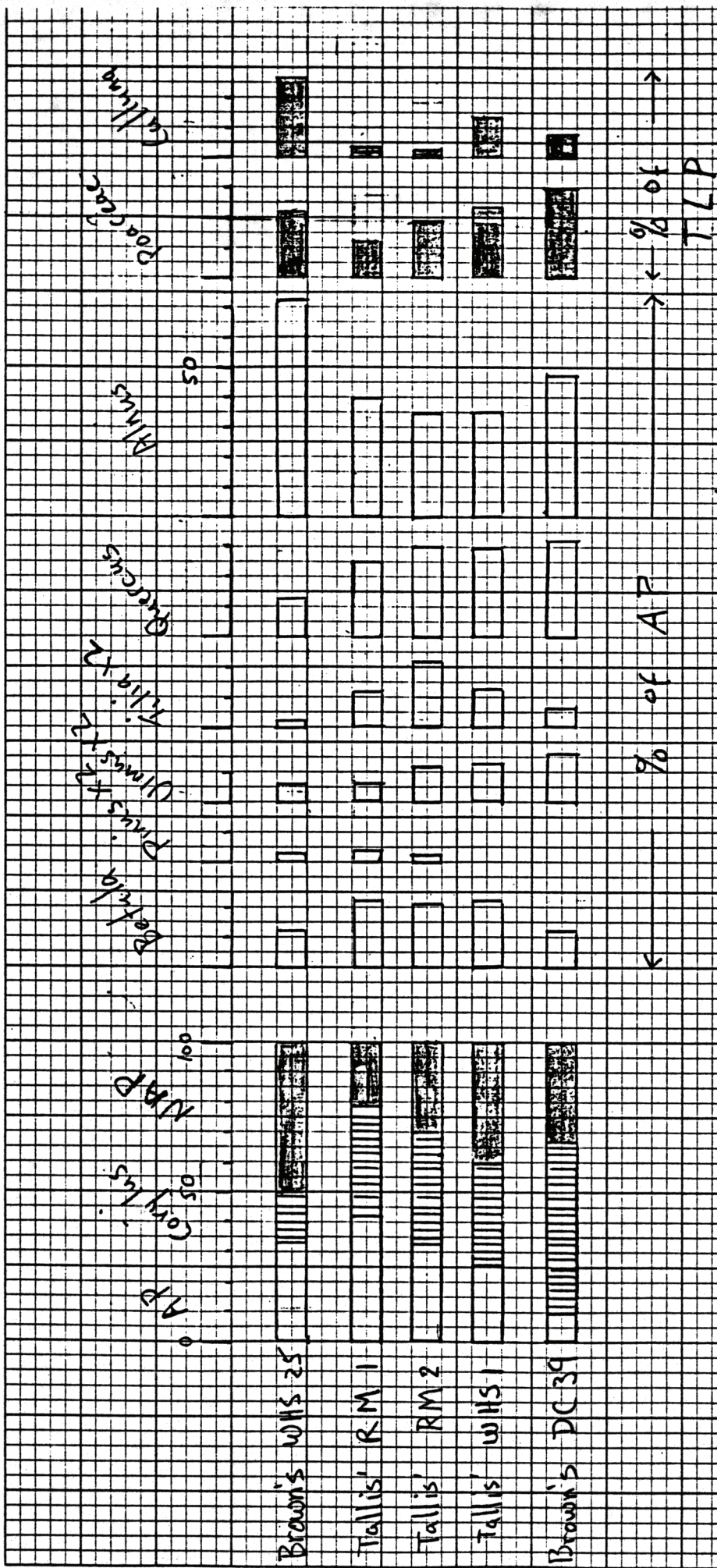This result suggests that it was not a difference in

11

Figure 1, Spectra of Mor/ Transition Zone Samples

extraction technique that produced the dissimilarity between Brown's and my pollen records of the mor/transition zone samples from WHS. Rather, it was that I had anticipated that my samples would produce pollen records of the same population represented in Brown's sample from that site at an equivalent depth, even though her sample came from a different profile. It appears, instead, that my samples contain the record of a different pollen population, which Brown had sampled in the mor/transition zone at DC.

Brown's two records from the mor/transition zone (WHS 25 and DC 39) could be distinct from each other because they represent spatially distinct floras whose pollen rains were trapped in the sites' deposits at the same time. But they also could be distinct because they represent pollen rains produced by different floras at different times. When both Brown's counts of her samples and Tallis' pollen counts of the samples I collected are considered (Fig.1), palynological evidence of both floras occurs in the transition zone record from WHS, while the mor/transition zone records from each of the other two sites present evidence of one of the two. The different kinds of floras, then, are not site-specific. The simplest explanation of the distinction is that each type of pollen record was dispersed and trapped at a different time, and each represents temporally distinct vegetation patterns present at all the site locations.

Pollen samples are usually collected in stratigraphically ordered sequences. Identification of the temporal order of

pollen spectra produced by such samples relies upon that sampling strategy. At any given site, earlier and later patterns of pollen records (pollen zones) may be confidently distinguished by their stratigraphic order, and interpreted in vegetational-climatic terms by reference to the British pollen zone sequence standard developed by Godwin (1975). I could not use this approach to assess the data of Figure 1 because I had sampled the same deposit at each site laterally. Lacking evidence that allowed relative positioning of their pollen spectra, the sequential relationships of the pollen samples I had collected could not be identified in the usual way.

I began construction of a sequence by noting that one of the two types of pollen records from the mor/transition zone contained more Calluna pollen than the other. Also, that the affects of pollen transport processes on pollen records from mor samples and from peat samples could be quite distinct. Mor represents a situation in which the water table in the mineral soil is too high for deeply rooted plants such as trees, but not so near the surface that peat can out-compete shallow rooted plants. Some downwash of pollen falling on the surface of a mor-producing vegetation can be anticipated. Pollen spectra representing vegetative conditions that existed during a period when the shallow-rooted plants grew on the mineral soil surface, then, might occur either within or below the mor/transition zone. Peat grows upon a substrate with a higher water table. Pollen spectra representing vegetative conditions that existed at a site

13

once it was invaded by blanket peat, then, would occur only in samples collected from the peat.

These understandings suggested that a type of pollen record observed within the mor/transition zone at one site might be observed below the mor/transition zone at another site. Similarly, if blanket peat invasion did not occur simultaneously at all sites, the pollen spectra representing that vegetation might be recovered from the base of the peat at one site but from an elevated mor/transition zone sample at another site. If any of Brown's data from samples demonstrably younger than those of Figure 1 were clearly comparable to that of sample WHS 25, and any of her data from samples demonstrably older that those of Figure 1 were clearly comparable to sample DC 39, an integrated pollen sequence could be constructed from the pollen spectra Brown had reported. This could occur because the relative age of each of the pollen spectra collected from the mineral soil deposit below the mor/transition zone at each site, and the relative age of each of the pollen spectra collected from the peat deposit above the mor/transition zone at each site, was known from their relative stratigraphic positions. So long as the integrated sequence granted that all samples from the mineral soil were older than any from the mor/transition zone, and all samples from the peat stratum were younger than any from the mor/transition zone, and so long as no sample was considered older or younger than others from the same site than was identified by its stratigraphic position, the pollen spectra of
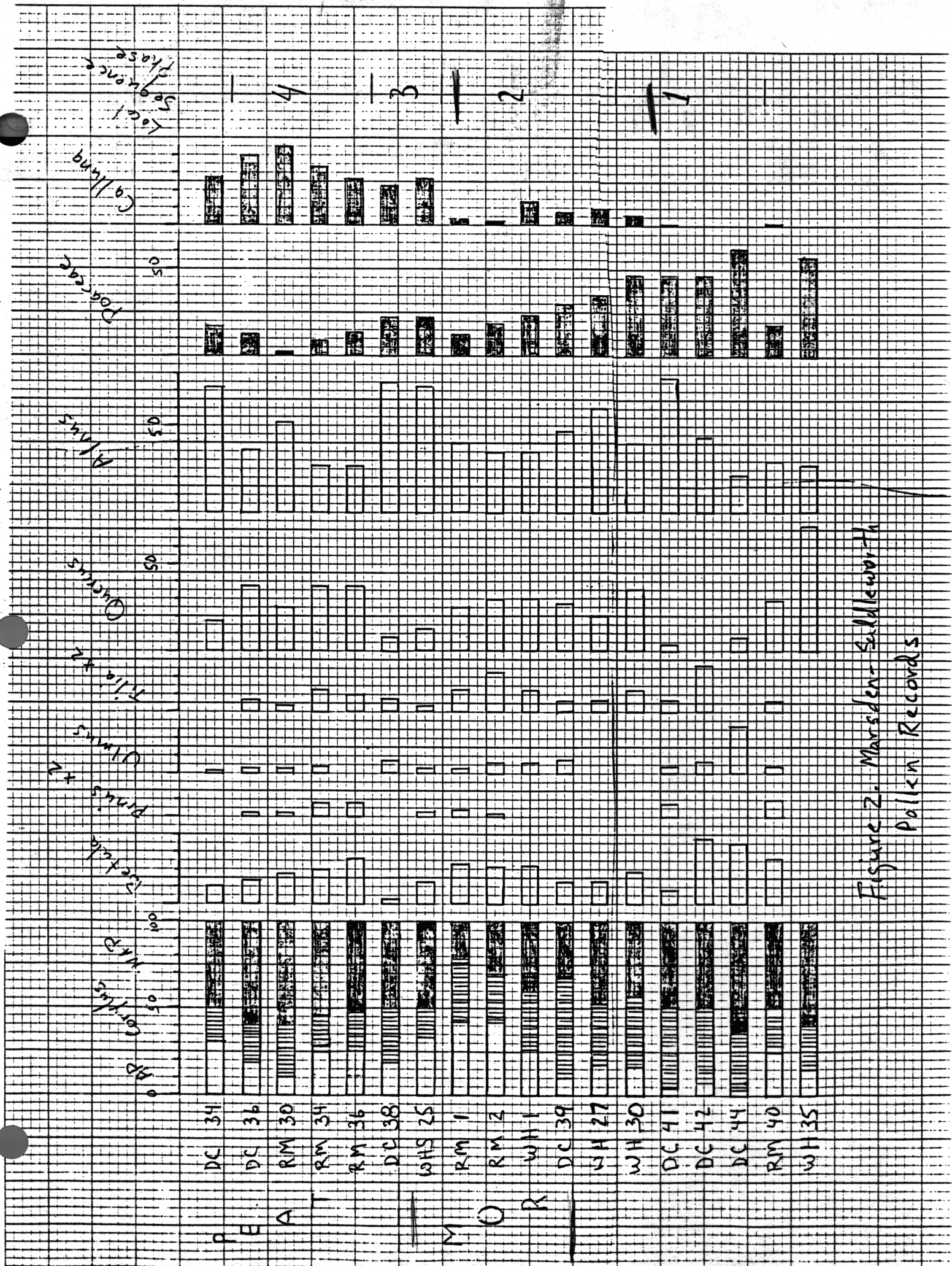
Figure 2. Marsden-Salkkewarth
Pollen Records

samples from all three sites could be integrated into a single sequence. Utilizing this principle, I organized the raw pollen data provided by Tallis's and Brown's (1989:91-96) analyses of into the probable stratigraphic order displayed on Figure 2.

Figure 2 is not a pollen diagram in the normal sense. The pollen sequence illustrated by Figure 2 is not as linear as those of pollen diagrams because the duration of unsampled intervals of time cannot be estimated from deposition rates calculated for the types of deposit. Also, because site-context sample pollen records identify variations in more localized vegetation, similarities between adjacent records may suggest _either_ very similar local vegetation patterns at a given site at different times _or_ similar local vegetation at different sites during a single episode of time. What appear to be fairly smooth trends of palynological change, then, may well have occurred at very uneven rates or may have been interrupted (perhaps even reversed) during unsampled intervals. Further, because each sample may reflect the vegetation of a restricted area, no individual pollen record, and no group of comparable samples taken together, can be interpreted in terms of regionally-scaled vegetation patterns. Thus even if they might have the same characteristic attributes, the pollen records of this sequence should not be correlated with the biostratigraphic pollen zone units of Godwin's British pollen sequence (1975).

INTERPRETATION

The two stratigraphically most ancient pollen samples (WHS

35 and RM 40) yielded spectra which are not comparable to each other nor to records of stratigraphically younger samples. I believe these pollen spectra from deep levels in the mineral soil have been significantly altered by the podsolization process, and I have assumed they do not identify one or more very ancient phases of the local pollen sequence.

The initial phase of the sequence is identified by three samples with very low Arboreal Pollen (AP) values, maximal Poaceae pollen values, a near-total lack of Calluna pollen, and a pattern of declining Betula, Ulmus and Tilia values. Quercus pollen is minimally represented, and Alnus pollen values increase as the phase proceeds. The probable vegetation pattern thus expressed is expansive grassland with scattered hazel copses and progressive alder development along watercourses. Heath seems to have been unable to establish itself as a component of either scrub vegetation or blanket bog. The forest tree pollen reaching the district (<15% of TLP) suggests the closest woodland or forest was quite distant and dominated by birch, with elm and basswood more common than oak until late in the period.

The second phase of the sequence is characterized by a trend of increasing AP values, a significant decrease in Poaceae pollen, a major increase in Quercus values and a gradual reduction in the frequency of Corylus and Alnus pollen. As Alnus, Corylus and Poaceae pollen values decline, Betula pollen becomes more prominent. Significant amounts of Calluna pollen appear early in this phase. It seems likely that the previously

16

grassy landscape changed to one in which occasional birches were embedded in a mosaic of grassy patches and hazel and heath scrubland, and the prominence of alder along drainages was reduced. The character of the less-distant forest also underwent significant change. Oak replaced birch as the dominant forest genus, and elm no longer held the status of a subdominant.

The following phase of the pollen sequence is characterized by dramatic elevation of Alnus pollen values, though the proportion of arboreal pollen declines. Increases in Poaceae and Calluna pollen occur, with (as a consequence of local Alnus pollen overrepresentation) reductions in Betula and Quercus pollen. The two pollen records of this phase seem to reflect replacement of birch by alder, with less hazel and heath scrub but patches of bog. The landscape was too open to identify as woodland.

The latest phase of the local pollen sequence, represented solely in pollen records recovered from peat samples, is characterized by a reduction in Poaceae and an increase in Quercus pollen values (the latter a consequence of lesser Alnus pollen production). Calluna pollen gradually increases to its maximum values in this phase and Corylus pollen gradually declines. This phase apparently reflects completion of the colonization of the district by the ombrogenous peat-producing flora. The youngest sample collected at DC yielded a pollen record unlike any others collected from peat context. It may represent a later phase of the district pollen sequence

17

characterized by an increase in _Alnus_ pollen values, but lack of comparable data from other sites weakens that interpretation. It is most conservatively interpreted as the product of local alder invasion of a nearby site of erosion of the blanket peat.

DISCUSSION

Synthesizing information on the character of the soils and sediments with information on macrofossil plant remains, radiocarbon dates for horizons of occupation, Brown's report, and pollen records from adjacent districts, Barnes (1982:21,28-9,35-8) presented a detailed model of vegetation change in the Central Pennines through the five millennia of mesolithic occupation: At the time of earliest mesolithic use, in the 8th millennium b.c. (Pollen Zone V), montane grassland and hazel scrub vegetation were probably prominent above 1200 feet on plateaux such as the Marsden-Saddleworth district. By the end of the Boreal Period (Pollen Zone VI), however, ca. 6,000 b.c., oak forests dominated lower portions of the Central Pennines. Though tree-line eventually reached 2,000 feet, the highest windswept and rocky areas of the Pennines were never wooded, and

> "in all likelihood the woodland of the Pennine uplands
> was not a closed canopy;... hazel... scrub was
> extensive under relatively open stands of birch, pine
> not being an important component of Central Pennine
> vegetation at the time (Brown 1982). The increased
> humidity at the end of Boreal times is marked by a
> sharp rise in alder [pollen], especially at lowland
> sites and on valley slopes, though alder, too, grew on
> parts of the summit areas as at Warcock Hill and Dean
> Clough...where it has been recorded as buried
> timber...(Barnes 1982:28)"

18

Climatic change at the time of the Boreal/Atlantic
Transition (BAT, also the Pollen Zone VI/VIIa transition) is
thought to have initiated blanket peat formation at the highest
altitudes (above 1,700 feet) very quickly, but open canopy
woodland was not replaced by moorland at lower elevations (ca.
1,400 feet) until about 3000 b.c. Later mesolithic populations
of the Central Pennines at the elevation of the Marsden-
Saddleworth district, then,

> "may have lived in an open forest and scrub environment
> dominated by hazel and birch with herbaceous
> communities -- perhaps dominated by Molina...-- on the
> shallow peats of flatter areas (Barnes 1982:29)"

In the pollen sequence illustrated as Figure 2, the alder
rise of the third phase is stratigraphically associated with mor
deposits. If this alder rise is taken to be chronologically
related to the period of alder pollen increase observed elsewhere
and the burial of alder timber within the district, the beginning
of the third phase of the district pollen sequence would be dated
to the end of the Boreal Period, sometime in the 7th millennium
b.c.

Two factors mitigate this interpretation, however. First, a
comparable rise in alder pollen at Broomhead Moor 5 (Radley et al
1974:11) is recognized to date to Zone VIIa because an
accompanying increase in oak pollen argues for increased
forestation. Second, the wetter conditions following the BAT are
a more probable cause for the onset of mor formation processes
than they are cause for colonization of the district by blanket

19

peat -- given that similarly elevated upland locales were not colonized until significantly after the BAT. The prior probability, then, is that the third phase of the Marsden-Saddleworth sequence reflects vegetative conditions in the area _subsequent_ to mesolithic occupation, in Zone VIIa times.

Presumably, then, the vegetation pattern occurring during the second phase of the district pollen sequence identifies the paleoenvironmental context of narrow blade mesolithic occupation, during Zone VI times, and the first phase of the sequence might then identify vegetative conditions during the district's broad blade mesolithic occupation.

This reconstruction is fully consistent with Brown's model of the vegetation pattern contexts of the broad- and narrow-blade occupations of Central Pennines sites. As it is specific to the Marsden-Saddleworth district, however, it invites assessment of vegetation pattern variations that may explain certain characteristics of the local archaeological record. There are two features of the Marsden-Saddleworth pollen sequence that seem particularly relevant. One is the character of changes in the vegetation mosaic that seem to have taken place during the course of the second phase. The second, related to the first, is the palynological evidence that identifies the relative degree of forestation of the district during the second and third phases of the sequence.

Differences among the six pollen records of the second phase of the sequence argue for progressive encroachment of forest or

woodland on the margins of the Marsden-Saddleworth district during the course of the Zone VI period. Though the vegetation retained its mosaic character, the territory of that mosaic seems not only to have shrunk over the course of later mesolithic occupation, but to have presented progressively fewer patches of the grassland and scrub habitats believed attractive to the prey and resources preferred by late mesolithic hunter-gatherers. The greater frequency of ostensibly earlier "March Hill" than ostensibly later "Rod Dominated" sites in the district might be related to this reduction.

The Marsden-Saddleworth pollen sequence also suggests that during the third phase (Zone VIIa) the upper canopy became more open as birch was replaced by alder, and wet heath (not blanket bog) replaced previous patches of scrub and meadow. The reduced AP values of this phase of the sequence occur despite a decline in the amount of hazel pollen. This suggests that forest and forest margin habitats were extinguished at the perimeters of the Marsden-Saddleworth district at just the time afforestation is evidenced at other upland Pennine locales in northern Britain (Simmons 1969, Jacobi et al 1976, Rowell and Turner 1985, Sturludottir and Turner 1985 and others). The issue is archaeologically relevant because it argues for consideration of greater variability in the vegetation change histories of upland districts than we are accustomed to recognize.

Archaeological literature has long recognized that the transition from the vegetation patterns represented by Zone VI

and VIIa pollen records are diachronous at upland sites, and the antiquity of the subsequent elm decline varies from place to place. There is, however, a general belief that the history of upland vegetation change in northern Britain is everywhere identified as the sequence montane grassland -> hazel scrub -> deciduous woodland -> blanket bog suggested by Radley et al (1974:13). Nor has there been debate over the conclusion that the decline in hazel pollen that accompanies the BAT at upland sites is best interpreted as either a product of suppression of flowering beneath a continuous tree canopy or a product of a reduction in human-induced fire or disturbance patterns. These understandings have contributed significantly to the influential model of man-land relationships during Pollen Zone VI championed by Simmons and Innes (1987).

The Marsden-Saddleworth pollen sequence is based on too little data to present serious challenges to these paleoenvironmental reconstructions or the models of man-land relationships that archaeologists have derived from them. It helps us recognize, however, that interpretive methods that relate the pollen sequences of individual locales to regional vegetation history (e.g. Godwin 1975) may not describe vegetation change events occurring at subregional geographic scales as effectively as methods of the sort used here. Since site-context pollen records are scaled more closely to the level of the territorial and resource requirements of cultural populations, I believe them likely to provide a better data base for
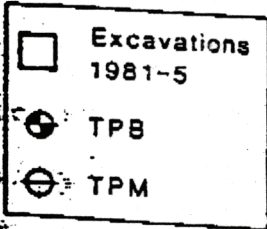
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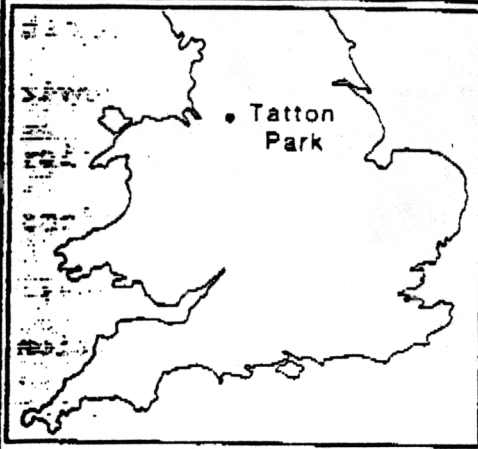
Mansion

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Old
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Excavations
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1 km

reconstructions of man:land relationships in districts of prehistoric occupation.

THE SECOND STUDY: TATTON MERE

BACKGROUND

Research initiated in 1982 at Tatton Park, Cheshire, near Knutsford, offered what seemed to be another opportunity to explore the archaeological potential of pollen records directly associated with mesolithic cultural remains. During the course of rescue archaeology excavations nearby at Old Tatton Hall, chance finds of microliths on the shore of Tatton Mere were brought to the attention of N.J. Higham and T. Cane. Survey of the environs of the finds and a trial excavation in November 1982 identified a concentration of broad blade mesolithic flints at 70-90 cm depth. They appeared to represent the _in situ_ remains of a chipping station or workshop on a surface that had been subsequently buried beneath a deposit of red aeolian sand (Higham, 1983).

Higham contacted me early in 1983, after hearing of my interest in mesolithic context pollen samples. He had not yet collected any at Tatton Mere, but intended to do so during the course of excavations planned for the summer of 1983. When I observed the situation some months before excavation was begun, I recognized that under normal circumstances there was little likelihood that samples collected at this site would be analyzed. The sandy context of the mesolithic horizon and overburden

offered poor prospects for well preserved pollen assemblages. In addition, sampling even one soil profile by standard procedures (cf. Dimbleby 1985: 20-22) would be difficult and -- if successful -- would generate more samples than it would be cost-effective to analyze.

I suggested a different approach to sampling. Instead of collecting small volume samples at one or two soil profiles at 1 inch or 2.5cm intervals, I suggested collection of large volume samples (ca. 150 cc) from vertical profiles at 10 cm intervals. The primary focus of the sampling strategy, however, would be on recovery of populations of "spot" samples associated with variations in cultural and non-cultural contexts the field archaeologists could recognize as excavation proceeded. One population, for example, might be recovered from proveniences where artifact concentrations occurred and another from proveniences where they did not; populations could be recovered from any features encountered, or associated with potential radiocarbon dates; and populations of samples could also be collected of ostensibly equivalent stratigraphic positions. The subtending logic was to provide samples which, if productive, would allow assessment of inter- and intra-population variations that might correspond with variability in the site's archaeological and geological records and possibly be responsive to the same causes.

If this were done, I agreed to analyze some of the collected samples through a phased research strategy. I first would

24

attempt to extract the pollen of a suite of eight samples. If
pollen was successfully recovered, I would undertake study of
another 32 samples.

Extension of the excavated area in 1983 and 1985 revealed a
good deal more about the site. The artifactual debris was
consistently located near the surface of a unit of silver gray,
leached, sand which overlay an older red sand unit. No traces of
fire or hearths were uncovered, but the density of mesolithic
remains increased as excavation proceeded southward until it
ceased abruptly at the northern margin of a pit-like feature
edged by stake holes. Though no flints were found within the
redeposited red sand that filled the pit, it had obviously been
let down from the surface upon which the mesolithic artifacts
rested, and the relationship of the pit to the distribution of
the artifacts suggested it dated to the same horizon.

In 1983, Higham and Cane collected two stratigraphically
superimposed suites of pollen samples from standing profiles and
samples from the excavation area as they were uncovered. When
the pit feature was discovered in 1985, its fill, the fill of its
stakeholes and the surface of its origin were all thoroughly
sampled for pollen analysis. In total, nine samples were
collected from each of two profiles and forty-three from the area
of the flints and the pit feature. All of the collected samples
were not submitted for analysis and, upon reflection, the field
observers decided that the samples from one of the profile series
were unsuitable for study. Ultimately, the nine samples

25
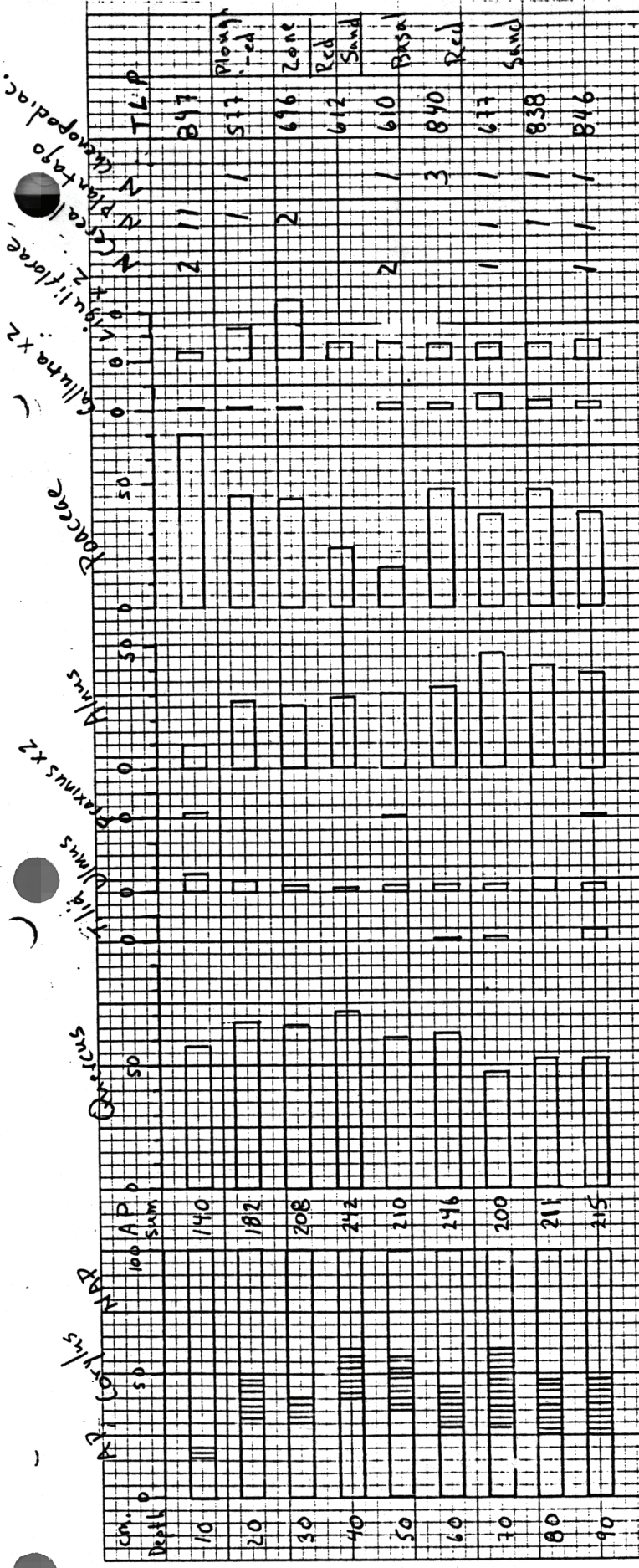
Figure 3: Pollen Sequence at Locus 155

Figure 4. Site-Context Pollen Spectra

Sample No.	Spit	AP Sum	TLP	Context
5	1A	259	519	Redeposited
7	2A	200	625	Redeposited
11	3A	201	936	Red
9	3A	212	581	Sand
16	3B	202	610	
14	3B	210	782	Pit
40	3	263	695	Feature
41	3	207	574	Fill
42	4	201	550	
22	4B	201	324	
26	4	187	748	
31	5	202	368	Gray
32	5	103	555	Stand
33	5	197	439	Mottled
29	5	216	482	
36	6	80	277	Zone
37	6	118	350	

collected from the profile at locus 155 and 25 samples collected
from provenance units related to the archaeological record were
prepared for analysis (Figures 3 and 4).

The pilot study performed in 1984 demonstrated the
applicability of extraction techniques designed for large-volume
samples, and documented the occurrence of cereal pollen grains
directly associated with the ostensibly 9000 year old mesolithic
feature and artifacts. This information, and reconsideration of
the geomorphological history of the site suggested by field
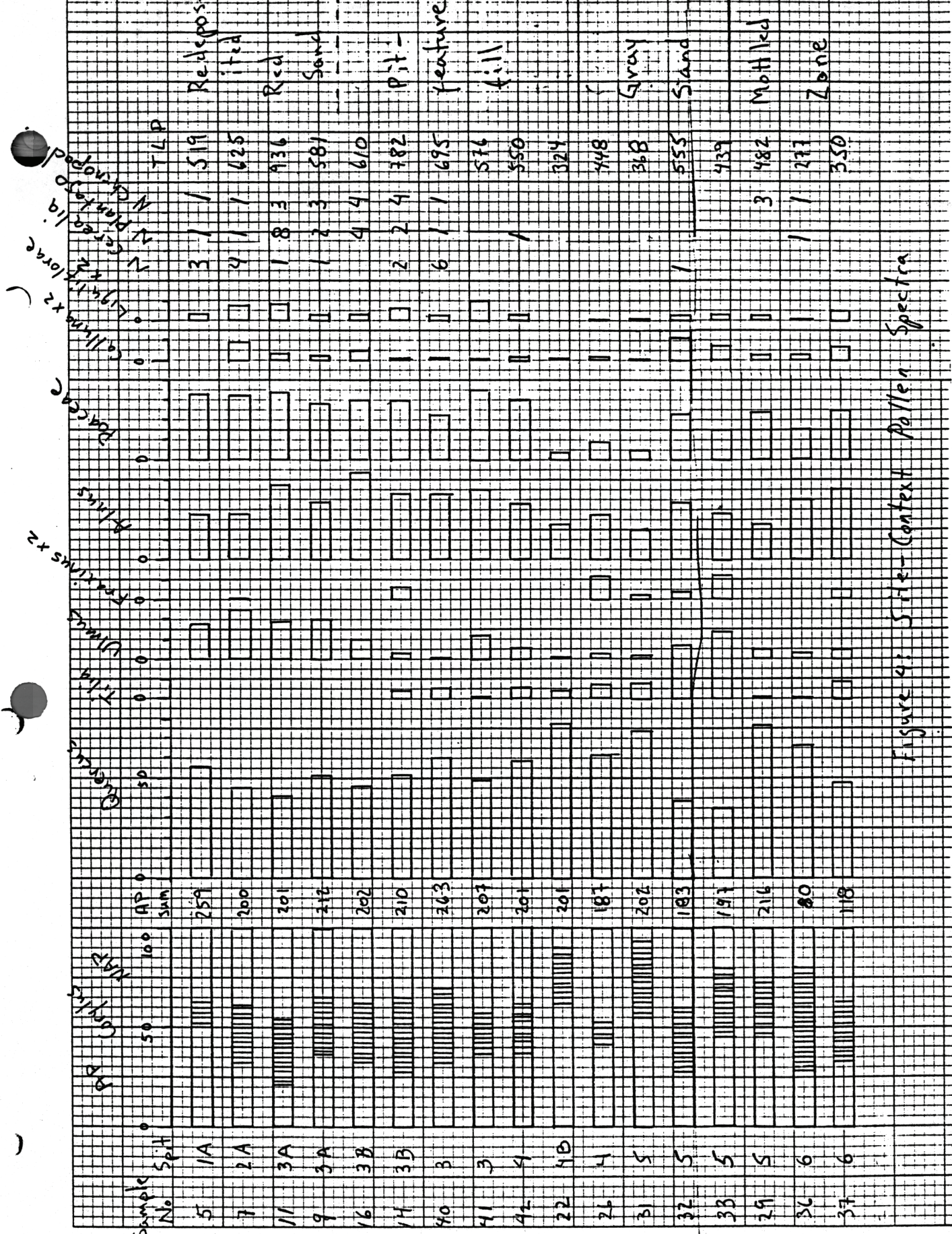observations, convinced Higham and Cane that the mesolithic
materials were not in situ, and their association with the pit
feature was fortuitous. This conclusion was confirmed when two
small fragments of charcoal collected in close association with
the flints provided a radiocarbon date (HAR 9206) of 3270 ± 90
bp.

Pollen study proved of significant archaeological value at
this site, then, even before the principle phase of the analysis
was performed, since the pilot study's results compelled
reinterpretation of field evidence. I was curious to know,
however, if data patterns occurring amongst the samples would act
to confirm the results of the pilot study and/or offer other
information of archaeological significance. When opportunity
arose in 1987, then, pollen was extracted from the samples
submitted for the second phase of the study, and counts were
undertaken in 1988.

CONTEXT AND STRATIGRAPHY

Historical research by Higham (1986) suggests that Tatton Mere was simply a brook known as the River Lilley running along the faulted edge of the Cheshire salsiferous beds until the medieval period, when subsurface collapse caused a small body of water to form. The pumping of wild brine during the late 19th and 20th centuries encouraged further collapse, increasing the size of the lake, which was subsequently dammed to provide convenient bathing facilities in modern Tatton Park.

Erosion of the sandbank above the existing beach brought mesolithic material to the bathing area. Higham and Cane's systematic beach survey identified the area of the bank where flints were to be found in highest density, and the 1982 test exposed over 900 pieces in undisturbed context (Higham 1983). 6805 pieces were ultimately recovered from the entire 10 x 5 meter excavation, 1744 from a 2 square meter area within the roughly oval 9 x 3 meter area interpreted as a knapping locus (Higham, in press).

> [The lithic materials] represent a balanced assemblage, rather than one dominated by one tool type. Excluding characteristically late types, microliths represent 35.96% and scrapers 36.59% of the total retouched pieces. The scarcity of complex retouching on obliquely-blunted points is characteristic of a site in occupation early in the broad-blade mesolithic...(Higham, personal communication, 27 Oct 88).

The basal "natural" semi-indurated red sand deposit (field notes describe it as "crisp") and the unit of grey silvery sand

superimposed above it are separated by a mottled zone with root casts rather than an unconformable contact. The surface of the silver sand unit, however, is an unconformable contact with the base of the superimposed unit of redeposited red sand. The silver

> sand surface...exhibited extraordinary
> surface irregularity which suggests that it
> had once been no more stable than a modern
> beach (Higham, personal communication, 27 Feb
> 95).

Further, the silver sand unit is not continuous across the whole of the excavated area; where it pinches out, as at locus 155, redeposited red sand rests unconformably on the surface of the older red sand.

The redeposited red sand unit continues to the modern surface, which supports the grassy landscape of the Tatton Park recreation area. A series of humus lines lie immediately below the roots of the turf, within a ploughed zone that extends from 10 cm to an uneven base between 30 and 35 cm below the present surface.

The geomorphological processes responsible for the color, texture and other lithological attributes of the deposits can be reconstructed with a high degree of confidence. The basal red sand and silver sand units of this series clearly formed as a single outwash deposit upon local glacial retreat. The silvery color of its upper portion is a function of the reduction of iron oxide through eluviation consequent upon formation of the A zone of a soil on its original surface, while the mottled coloration

and root casts of the lower, illuviated, portion is a function of the transport of humates and iron minerals to the base of the B zone. Soil profiles with these characteristics form under dense vegetation which casts very acid leaf litter (heath or boreal forest) or where the brownearth soil profile that develops under deciduous forest has been degraded through exposure. Culturally induced forest clearance can be held responsible for the latter condition in a number of English locales (Dimbleby 1985:101-2).

The markedly irregular surface of the silver sand, the unconformable contact at the surface of the older unit where the silver sand is missing, and the lack of any color or structure indicative of a buried paleosol, provide strong evidence of interruption of the depositional sequence. During this interval, the A zone of the soil was stripped from the site, and both the A and B zones were eroded from locus 155. Since the mesolithic cultural material must originally have been deposited on the then-existing surface of the glacio-fluvial deposit, and its limited distribution suggests it remained at or near the place of deposition, deflation of an exposed and disturbed surface through wind erosion is more likely than overbank flooding or sheetwash. It seems fairly certain, then, that the pitfeature was let down from the eroded surface upon which the mesolithic artifacts came finally to rest, before red sand wind-transported from a nearby source buried them both.

Soil profile characteristics that might offer evidence for a reconstruction of the vegetation that stabilized the surface of

the redeposited red sand unit were, unfortunately, obliterated by ploughing. Documentary evidence suggests the site area was commonly owned woodland from the 11th until the mid 13th century, when it became part of a deer park that lasted to the 15th century. An estate map of 1733 shows it within an area of banked and hedged fields with place names suggesting the significance of local coppicing. About 1760, the Edgerton family caused emparkment of the whole of Tatton township. The site area was then given over to pasture until modern Tatton Park was established.

THE PALYNOLOGICAL RECORD

Though sandy deposits are often considered poor contexts for pollen preservation, preservation was not so affected that much pollen was damaged beyond the point of confident identification. Eight subsamples of the sediment collected for pollen study were sent for independent analysis to Dr. James Innes, now at the University of Durham, along with slides prepared from the extracts done in my laboratory. His results parallel my own (Appendix A). Both Innes and I recognized large graminoid grains we attributed to Cerealia. To provide a conservative estimate, none of the pollen I classified as Cerealia was smaller than 47.5mu (ranging to 56mu, mean = 51.9mu). Unfortunately, exotic marker pollen was not added to the samples so pollen concentration values and absolute pollen frequency data is not available.

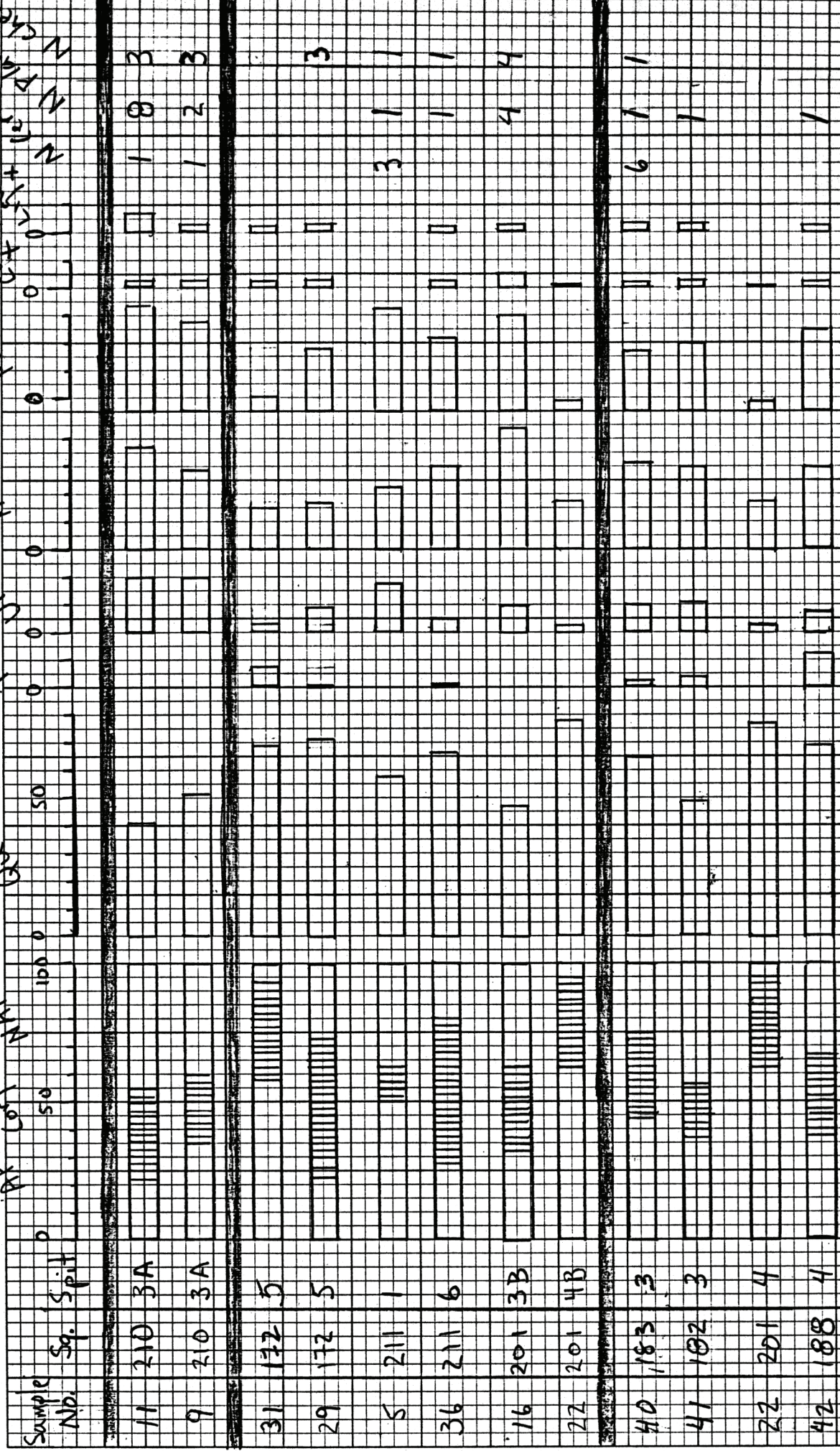The redeposited red sand and silver sand units are quite

Figure 5: Paired Comparisons

friable and allow free drainage; though more compact, the older red sand unit is also well drained. Downwash transport of pollen is thus likely, but it cannot be expected to be uniform over the extent of the excavated area. Indeed, the pollen spectra both demonstrate that this is the case and allow some perspective on the degree of difficulty the situation imposes upon interpretation of the pollen record.

Excavation was controlled by 1-meter squares and 4-inch spits ("levels", in American parlance). The top part of Figure 5 illustrates the pollen spectra of two samples collected from the same deposit in the same spit of the same square. There is no statistically significant difference between them. The middle part of this figure graphs the pollen spectra of three pairs of stratigraphically separated samples from the same square. In all cases, statistically significant distinctions in the AP:Corylus:NAP ratios preclude assignment of stratigraphically older spectra to the same pollen assemblage as the spectra of stratigraphically younger samples. The lowest part of the figure illustrates the spectra of samples collected at the same depth in different squares. Samples 40 and 41 are statistically comparable though they were collected from different stakeholes marginal to the feature. Alternatively, samples 22 and 42 were collected within the pithouse feature at the same depth but are significantly distinct with respect to their AP:Corylus:NAP ratios and their Alnus and Poaceae pollen frequencies.

Pollen samples collected from the same depth and sedimentary

context in different parts of the site, then, are not always assignable to the same pollen assemblage, though relatively deeper samples are likely to be assignable to older assemblages than relatively more elevated ones. Samples from a particular type of deposit at locus 155 (e.g. redeposited red sand), then, may be older or younger than samples from the same deposit in other parts of the site, though the relative antiquity of superimposed spectra will be identifiable by their relative depth. These data also suggest that temporal variations reflecting local vegetation changes would be most effectively distinguished by contrasts in AP:Corylus:NAP ratios, by frequency variations calculated on the TLP pollen sum, and by consistent patterns of presence/absence data.

Geological evidence that the surface of the site was stabilized by vegetation twice during its Holocene history raises the question of the antiquity of the most ancient pollen records. Pollen recovered from the silver sand and older red sand deposits could, theoretically, represent vegetation of either of these episodes, or some mixture of the pollen of both. The clue to resolution of this problem lies in the distribution of Tilia and Fraxinus pollen. Both of these pollen types normally occur in significant frequency in the pollen spectra of samples of the younger, elluviated, portion of the B zone (Fig. 4). If these pollen records identified vegetation that occupied the site prior to the erosive episode, a similar data pattern should be evidenced in the pollen spectra recovered from samples of the

32

basal red sand deposit at locus 155 (Fig. 3). That is not the case. Instead, *Tilia* and *Fraxinus* pollen only occur together in the oldest sample at locus 155, while *Tilia* recovery in younger samples of the basal red sand is minor and sporadic -- paralleling the pattern of its recovery in samples from the redeposited red sand unit elsewhere (Fig. 4).

A pattern of continuing decline in the distribution of *Tilia* pollen thus transcends the unconformable boundary between deeper deposits and the redeposited red sand, even though that boundary identifies an erosive interval. The simplest explanation for the observed distributions of *Tilia* and *Fraxinus* pollen is that pollen assemblages containing these taxa were progressively downwashed from the most recently stabilized surface, and any pollen representing vegetation of periods prior to the erosion interval has been winnowed from the gray sand and basal red sand deposits over the course of time.

The fairly large intervals between the superimposed samples collected at locus 155 allows the possibility that some types of pollen records have not been sampled at all, and others may be represented in statistically unreliable sample populations. Formal identification of a pollen zone sequence for the site, then, is not a trustworthy exercise from the available data. However, a sequence of temporally ordered variations in pollen assemblages can be recognized which is evidenced by the mean frequency values of the pollen records of the analyzed samples and their relative stratigraphic positions. The assemblages of

	TLP OBSERVED	AP:Corylus:NAP	QUERCUS	ULMUS	TILIA	FRAX-INUS	ALNUS	SALIX	CYPER-ACEAE	POACEAE	CALLUNA	CEREALIA	DISTURBED GROUND	NAP VARIA	TARAX-ICUM
A1	847	16.5: 03.3: 80.2	12.7	1.4		0.1	1.2			69.4	0.1	0.2		8.1	1.8
A2	1273	30.6: 11.1: 58.3	21.4	1.3			7.8		0.1	43.0	0.5		0.3	2.1	11.1
A3	2062	33.9: 18.8: 47.3	22.2	0.9	P	P	10.6			40.4	0.6	0.1	0.2	1.8	3.4
A4	1515	27.1: 23.3: 49.6	13.7	1.1	0.1		12.1			42.2	2.0	0.1	0.3	1.6	3.0
A5	3271	32.8: 26.9: 40.3	16.2	6.0			10.0	0.2	P	31.6	2.1	0.3	0.8	2.2	2.4
A6	3449	31.8: 29.4: 38.8	17.6	1.5	1.5	0.2	10.6	0.1		31.1	0.8	0.3	0.3	3.0	3.1
A7	1140	51.8: 40.0: 8.2	36.8	1.0	3.3	1.0	9.8			6.2	0.6			0.2	0.4
A8	994	38.2: 33.5: 28.3	14.1	0.4	11.6	1.5	9.9	0.3		19.3	6.0		0.1	0.8	1.7
A9	1109	37.3: 33.2: 29.5	24.3	1.6	1.2	0.3	9.3	0.1		23.6	1.9		0.5	1.0	1.4

Table 2. Mean pollen frequency values for the assembleges.

this sequence ("pollen groups" of Schoenwetter 1990) cannot be
interpreted as successive pollen zones of the sort that lend
themselves to biostratigraphic correlation, and there is some
prospect that study of other samples collected from the site and
still being curated might suggest modifications. However,
changes in the pollen statistics of sequent assemblages are open
to interpretation as indices of changes in the vegetation that
distributed pollen to the site since the redeposited red sand
unit became stabilized.

THE POLLEN ASSEMBLAGES (TABLE 2)

The most ancient pollen assemblage, A(ssemblage)9, was
recovered from samples 37 and 36, collected at the base of the
illuviated portion of the B zone, within root casts, and sample
29 from the mottled sand. The assemblage is best characterized by
the ways in which it contrasts strongly with Assemblage 8,-
represented by the spectra of samples 32 and 33, which were
collected from a higher level in the illuviated zone. Samples 32
and 33 contain significantly more Tilia and Calluna pollen and
significantly less Quercus pollen.

The succeeding assemblage (A7), represented in samples 31
and 26 from the eluviated portion of the silver sand unit and
sample 22, from pitfeature fill, is characterized by very low NAP
values, by reduced values for Tilia, and an increase in the
Quercus frequency.   Because of the emphasis of the sampling
strategy, the next youngest assemblage (A6) is represented by a
larger number of pollen records: the uppermost sample recovered

34

from the silver sand, the 90cm depth sample from locus 155, pitfeature fill sample 42, and stakehole samples 40 and 41. Increased NAP, the consistent occurrence of small quantities of Tilia, Fraxinus and Cerealia pollen, and significant increases in Taraxicum-type and various herbaceous pollen types characterize this pollen assemblage.

The next youngest pollen assemblage (A5) is identified from the records of samples 16,9,11,7 and 5 from the redeposited red sand deposit, which are distinguished by a major increase in the Ulmus pollen frequency and an increase in Calluna pollen. Pollen records of the 70 and 80cm depth samples from locus 155 identify the subsequent assemblage (A4). It is distinguished from that which immediately precedes it by lower frequencies of Ulmus pollen, loss of Salix pollen from the record, and higher frequencies of Alnus pollen. It is distinguished from the succeeding assemblage (A3) by lower frequencies for Quercus and Corylus pollen and a higher value for Calluna pollen. Pollen assemblage 3 is identified from the spectra of the 60, 50 and 40cm levels at locus 155.

The sequent pollen assemblage (A2) was recognized from the samples collected at 30 and 20 cm depths at locus 155. It is characterized by further reduction in the Corylus pollen frequency and a surge in the frequency value for Taraxicum-type pollen. The final pollen assemblage of the sequence (A1) is represented in the 10cm sample from locus 155. Severe reductions in both AP and Corylus values characterize this assemblage along

with a major increase in Poaceae pollen and reduced Taraxicum-type pollen values.

DISCUSSION

There are two questions of archaeological moment the palynological record from the site at Tatton Mere may address: First, what relationship exists between these data and those of the study that examined pollen samples recovered from cores in nearby mire and bog habitats (Chambers and Wilshaw 1991). Chambers and Wilshaw established a local pollen sequence for the postglacial period from three profiles. The oldest (profile TPM2) commences in the PreBoreal and continues through the Boreal to the late Subatlantic period. However, much of the Boreal record seems to be missing because deposition was interrupted at the coring locus. Companion profile TPM does not begin until the PreBoreal/Boreal boundary was already transgressed, but includes segments of the Boreal period record that do no occur in the TP2 sequence. Most of the pollen records attributable to the SubBoreal and SubAtlantic periods were recovered from the TPB core in a bog context roughly 450 meters downstream from TPM and approximately 1.5 km downstream of the mereside site.

Second, what might these data suggest to be the character of cultural activities evidenced at the site. In addition to the assemblege of mesolithic artifacts, cultural behavior is evidenced by the existence of the ploughed zone and, if it were the ultimate result of clearence and crop cultivation, evidenced by the existence of the unconformable contact between the gray

and the redeposited red sand strata. Though the attributes of
pollen grains are products of wholly biological processes
(except, perhaps, certain attributes of the pollen of obligate
cultivars), and the numbers and distributions of pollen grains in
sediment samples may be wholly controlled by non-cultural
processes, the observed characteristics of pollen records can be
(and often are) parsimoniously interpreted as products of
man:plant relationships of various sorts. Abundant
archaeological and historical evidence (Higham in press)
documents human occupation and landuse at Tatton Park
continuously since late mesolithic times. It would be more
surprising if the pollen assembleges from the mereside site did
reflect cultural activity than if they did.

Chambers and Wilshaw's analysis of the Boreal period pollen
record from TPM suggests an open woodland environment dominated
by pine supporting a hazel-dominated understory. Though the
mesolithic occupation evidenced at the mereside site doubtless
dates to this time, none of the pollen records associated with
the artifacts representing that occupation are comparable to
those of this period from TPM or TPM2, and none lend themselves
to interpretation as evidence of a different habitat existing
under similar climatic conditions. Similarly, those pollen
records from TPM and TPM2 expressing the classic attributes of
Atlantic and SubBoreal period spectra have sufficiently higher
alder and hazel pollen frequency values, and lower values for
oak, to reference paleoclimatic and paleoenvironmental conditions

quite different from the ones expressed in any of the pollen
assembleges from the mereside site.

Pollen records attributable to the SubBoreal and SubAtlantic
periods at TPM

> "indicate the mire was dominated by alder for millenia.
> Pollen records of *Plantago lanceolata* (ribwort plantain) and
> Cerealia...imply some human-induced disturbance,
> particularly from the Early Bronze Age. However, the pollen
> spectra are too coarsely spaced for further interpretation.
> Further data on SubAtlantic environments come from the
> northern mire site, TPB (Chambers and Wilshaw 1991:23)."

The oldest phase of the pollen sequence at TPB, just below a
radiocarbon date of 1860 ± 90 bp (HAR 8411), evidences a largely
open, disturbed, environment in which cereal production and
pasturage occur. Chambers and Wilshaw consider the Iron Age date
too recent, and suggest the pollen record and the depth of peat
support interpretation of this environment as appropriate to
Bronze Age or Neolithic conditions. Higham (*in press*: III-4)
considers it probable that the date is appropriate, because the
paleoenvironmental conditions identified imply the substantial
level of human settlement indicated by the buildings, other
features and radiocarbon dates ranging from 390 ± 120 b.c. to 250
± 100 a.d. (HAR 5174, 4496, 5150, 5715) evidenced at the Old
Village site. I concur, and suggest the erosive episode
evidenced at the mereside site dates to this period as well.

Study of the magnetic minerals trapped in the sediments of
Bar and Peckforton Meres (Schoenwetter 1982a, 1982b; Twigger
1983; Olfield *et al.* 1985) suggests significant amounts of soil
erosion on the western margin of the Cheshire Plain in Romano-

British times. Though erosion at the mereside site could have been the result of earlier or later ploughing, short-term large-amplitude variance in weather patterns, or population increases acting to reduce fallowing or increase development of areas with thinner soils, I am inclined to interpret the erosion as a product of intensified agricultural production during Romano-British times. In part, this interpretation is based on recognition of the Cheshire Plain's potential to serve Rome's interest as a granary, and the belief that over-exploitation would not have been inconsistent with Roman administrative policy. Mostly, though, it is based on the probability that the site lay within the landuse catchment area of a known site of Romano-British occupation, and the radiocarbon evidence that the landuse practises reflected in the earliest phase of the TBP pollen sequence date to that period.

The second phase of the TPB pollen sequence is marked by a substantial rise in AP values, suggesting "a general woodland regeneration (Chambers and Wilshaw 1991:25)." Though no radiocarbon dates are associated with pollen spectra of this phase, a date associated with records of the subsequent phase, characterized by lower AP values and significant increases in grass and cereal pollen, is 1460 ± 70 bp (HAR 8408). The spectrum of the sample recovered at the same depth as the C14 sample includes rye (Secale). Chambers and Wilshaw believe this horizon of the sequence probably dates subsequent to the mid-7th century A.D., after the period of major expansion of rye

cultivation in the British Isles in Saxon times (Chambers 1989).
Citing the archaeological and radiocarbon evidence of woodland
exploitation at the nearby Old Village site, they suggest the
woodland evidenced by the second phase of the TPB sequence was
established when the site was abandoned following its Roman
period occupation. By their reckoning this woodland was cleared
less than 500 years later.

Though the youngest phase of the TPB pollen sequence is
characterized by significantly reduced values of alder and hazel
pollen, Chambers and Wilshaw suggest (1991:27) that alder carr
persisted at TPB subsequent to the 16th century -- the antiquity
they assign to the pollen sample from 64 cm depth because it
evidences cultivation of hemp. The youngest sample of the
sequence, recovered ca. 35 cm below the surface of the bog, is
not discussed or dated in Chambers and Wilshaw's analysis.
Assuming a constant deposition rate since deposition of the 64cm
sample at 1550 A.D., this sample might be estimated to represent
environmental conditions in the last quarter of the 18th century.
The relatively high grass and increased Liguliflorae pollen
frequencies and the reduced values for alder and hazel suggest an
open landscape exploited by grazing. The relatively high values
for cereal and ribwort plantain pollen, on the other hand,
suggest little abatement in cultivation and crop production
practices.

Comparison of the pollen frequency values of Figure 7 with

40

those of Chambers and Wilshaw's Figure 4 (1991:5) makes it
abundantly clear that there is no correspondence between any of
the pollen assemblages from the mereside site and the spectra of
the earliest phase (a) of the TPB sequence. The AP:Corylus:NAP
ratios are wholly distinct, neither the frequency of cereal
pollen nor those of disturbed ground indicators is comparable,
and the relative significance of oak and alder pollen is
reversed. Further, birch pollen characteristically occurs in
phase a pollen spectra in statistically significant amounts, but
was extremely infrequent in pollen spectra from the mereside
site.

Though the mean AP value for Assemblege 7 at the mereside
site is only about 10% lower than the mean AP value for the phase
(b) samples from TPB, the characteristic pollen values of the
spectra are quite different. Yet woodland development is clearly
suggested in both cases and, since highly localized conditions
are probably expressed in both pollen sequences, it is necessary
seriously to consider the hypothesis of temporal coincidence
resulting from human abandonment of Tatton township. This
hypothesis is strengthened by pollen diagrams from the Southern
Pennines (Tallis and Switzur 1973; Bartley 1975) that suggest
widespread woodland development during or shortly after the Roman
period that lasted until the late centuries of the first
millenium A.D. The event seems to be a consequence of population
decline, and Higham (nd: IV-1) suggests population recovery in
Cheshire may have been delayed until the 12th century. The

41

archaeological record of Old Village occupation at Tatton Park does, indeed, cease with the abandonment of a longhouse that was probably occupied in the A.D. 300-600 interval.

Three contrasts between the A7 and phase b pollen records, however, convince me this hypothesis should be dismissed. First, the differences in the oak:alder ratios are too extreme. Both taxa are wind pollinated and distribute quantities of their pollen widely. Coincident forest development would expectably produce pollen rains at each location that were very strongly influenced by vegetation of the local habitat, as seems to be the case. But the influence of arboreal and shrub vegetation flourishing in areas surrounding these habitats in response to reduced land use should also be expressed in both pollen records. More oak pollen and, particularly, more birch, hazel and heather pollen should occur in the TPB record and more alder, birch and heather pollen should occur in the mereside site spectra if all these records reflected the vegetation of a single episode of time. Second, despite the dramatic decrease in ribwort plantain values which accompanies the increases in alder and sedge pollen at TPB, the values for sorrel pollen remain constant and those for nettle increase. Taken together, the average value for disturbed ground indicator pollen types is not much different in the phase b and the phase a record at TPB; the major distinction is that taxa reflecting disturbed cropland conditions occur less frequently. While it is true that no cereal pollen occurs in the A7 pollen spectra, that assemblage also lacks any of the

palynological indices of disturbed ground conditions. This
contrast should not exist if human use of the district had ceased
altogether. It is more explicable if one hypothesizes that human
disturbance was severely curtailed in the pollen catchement area
of the mereside site but crop production was replaced by pastoral
activity in the pollen catchement area of the bog. Third, I note
the contrast in recovery of willow, elm, ash and lime pollen.
Abandonment, or even severely reduced human activity, would
expectably allow regeneration of willow at the margin of the
carr, and allow more ash, elm and lime to colonize the less well
drained soils surrounding the bog than the sandier soil of the
mereside site. Yet pollen of the latter taxa occurs at the less
appropriate location and willow pollen never occurs in the TPB
record.

Woodland regeneration seems well evidenced at both locales,
and the woodlands involved were evidently habitat-specific.
There seems reason to believe, however, that these woodlands did
not regenerate at approximately the same time, and that neither
woodland was a response to the suspension of human landuse
activities.

Over the course of the third phase of the TPB pollen
sequence, NAP values increase from roughly 40% to roughly 80%, as
is true over the course of time from the deposition of A5 to A1
at the mereside site. In the latter case, however, almost all of
this increase is accounted for by successive elevation of grass
pollen frequencies; in the TPB sequence grass pollen increases by

only 10%, and the difference is produced mainly by increases in the cereal, sedge and disturbed ground pollen values. It is difficult to support an argument that either the similarity or the difference is relevant to interpretation of the palynological relationship between the two locations. I think it somewhat more likely than not, however, that much of the record from the mereside site falls within the range of time identified by the phase (c) records from TPB. It seems rather unlikely that any of the pollen assembleges of the mereside site are specific temporal correlates of any of the individual spectra of the phase (c) record from TPB, however. It also seems unlikely that any of the characteristic features of the mereside site pollen assembleges reflect any of the same paleoenvironmental conditions as those reflected in the phase (c) pollen spectra, with one exception. Both the phase (c) records at TPB and the records of Assembleges A1-A6 offer palynological evidence for the presence of open, disturbed, environments near to, or used for, cereal cultivation.

From the perspective of interpretation of Tatton Park's archaeology, assessment of the relationship of the mereside pollen records to those of the nearby cores yields three significant inferences: First, the analysis supports the geologically-based argument that those pollen records directly associated with the broadblade mesolithic artifacts are significantly younger, and they post-date the erosional period identified by the unconformity between the silver sand and redeposited red sand strata. Second, that the episode of

44

woodland rgeneration represented in the TPB core is not the temporal equivalent of Assemblege A7, and neither episode of woodland regeneration seems to have been responsive to a period of reduced land use. Third, that the younger pollen assemblages of the mereside site probably correspond in time to those of the most recent phase of the TPB core pollen sequence, but most identify rather different sorts of local open, disturbed, environments.

These last two inferences direct the discussion to consideration of locality-specific interpretations of the mereside site pollen assembleges, most or all of which post-date 1460 ± 70 bp or, following Chambers and Wilshaw, the mid-seventh century A.D. Historical information about the district (Higham, 1986, in press), while not overly abundant, identifies some events which might have had sufficient impact on local conditions to effect vegetation pattern changes, such as the development of the mere itself in medieval times and the establishment, and subsequent breaching, of a mill dam on the drainageway. But the historic record also identifies land use modifications that occurred in Tatton Township (Higham 1986). The inferences suggested from comparison of the mereside and mire pollen records direct our attention specifically to those changes.

Palynologically-based interpretations of the character of prior landuse, or landuse change, are normally controlled by knowledge of the affects of man:land or man:plant interactions on the processes of pollen production, pollen dispersal and pollen

45

preservation (Behere 1986; Tauber 1965). I have argued
(Schoenwetter 1990) that they also may be controlled by evidenced
correspondence with historically documented events. I accept
that argument here, for historic documentation has provided an
interpretation of the sequence of landuse changes occurring since
the 11th century (Higham 1986). In addition, there are two forms
of physical evidence that serve to link the mereside site pollen
sequence with that history: the ploughed zone of the sedimentary
profile and the radiocarbon date recovered from the top of the
gray sand stratum.

The radiocarbon date provides assurance that the ploughed
zone represents agricultural activity at the site long after
deposition of Iron Age charcoal in the sedimentary column. The
character of the ploughed zone is also informative. Both its
depth and surface indications of narrow ridge and furrow plowing
(Higham in press:I-3) suggest it was created before 1750 A.D.
These archaeological data are inadequate to control inferences of
the temporal span of the pollen assemblege sequence. They are
not inconsistent, however, with the inference that much if not
all of the mereside pollen record post-dates the 5th, and perhaps
the 7th, century A.D.

Another relevant fact is that the most recent pollen sample
from the mereside site was recovered from the deposit that post-
dates plowing activities at the location. This dates the A1
assemblege, and perhaps others responsive to downwash, subsequent
to the last quarter of the 18th century, when emparkment of

46

Tatton township occurred. In all, what we know of the depositional history of the mereside site, the use of the locality demonstrated by the existence of its ploughed zone, and the relationship of its pollen sequence to that developed from cores recovered from the nearby mire all suggests an effort to interpret the pollen assemblege sequence that is informed by historical evidence of landuse modifications since the 11th century could well prove successful.

While landuse and landuse change interpretations of pollen records are fairly common, interpretation of the landuses evidenced by the mereside site pollen records is not as straightforward as is usually the case. The problem is that landuse interpretation is normally based on the evidence of pollen sequence data. In those cases, the temporal position of each pollen record is revealed by its stratigraphic position, so variability in the frequency value of a pollen taxon indexing landuse can be attributed to landuse change over the course of time. In this case, most of the palynological data derives from populations (assemblages) of samples whose similarities have argued for their being grouped togeter to represent the pollen rain of an episode of unknown duration. Differences in taxon frequency between these groups can be attributed to landuse change over the course of time. But what of differences in taxon frequency values that occur within the groups? They might represent nothing more than expectable stochastic variability. However, they might represent the effects of other sorts of

47

culturally institutionalized or idiosyncratic behavior; they might represent observer errors or inter-observer variability of the sort noted in the appendix to this paper; or they might represent non-behaviorally induced variations in pollen production, dispersal, deposition or preservation that occurred during the duration of the episode.

Though the number of observed pollen grains in an assemblege may be large, the number of samples is normally too small to allow confident statistical assessment of the hypothesis that the observed variability is stochastic. In any case, demonstration that the hypothesis was not rejectable would not mean that a stochastic explanation was valid, and rejection of the hypothesis would not demonstrate any of the other plausible explanations.

Recognizing these problems, I have proposed (Schoenwetter 1990) that when the objective of the analysis of site-context pollen assemblages is the reconstruction of landuse changes -- and particularly in cases where such reconstructions can be related to Historic Period documentation -- it is appropriate to suppress the affect of intra-assemblage variability on the analysis. After all, inter-population differences are those most directly relevant to that objective. One could eliminate the effect of intra-population variability altogether by selecting one pollen spectrum as a characteristic representative of the population for interpretive purposes, but I think it both more conservative and more appropriate to recognize some degree of such intra-population variability as exists. I have suggested

(1990:288-203) that landuse reconstructions should be based on the pooled data of the pollen assemblages expressed by __average__ frequency values for each taxon. The information of Figure 7 has thus been re-expressed as Table 2 for reconstructing landuse changes occurring through time at the mereside site.

Archaeological analysis normally proceeds from discussion of reconstructions of more ancient events to discussion of the reconstructions of more recent events. Here, however, because of the control offered by the historic record, it is appropriate to undertake the analysis in reverse order.

INTERPRETATION

The site at Tatton Mere is presently within the bounds of a recreational park, close to bathing facilities; immediately prior to the park's development it was within the pastureland created by emparkment in the late 18th century; prior to that date it was cultivated (Higham __in press__: I-1). The excavation area lies

> "athwart a pre-emparkment field boundary which had divided a higher from a lower field (in 1733 known as the Marliff Meadow and the Mare Coppy, respectively), most of the latter ...has been lost to the Mere since emparcment [sic]. Surface indications of narrow ridge and furrow suggest that both fields had been cultivated prior to c. 1750 (Higham __in press__: I-3)."

The place names and the historical record suggest landuses for the site consistent with the characteristic features of the late pollen assemblages. The sorts of palynological changes that distinguish Assemblages 3 and 2 (reductions in the quantities of __Corylus__ and Cerealia pollen) are ecologically consistent with cessation of crop production at the site and the affects of

emparkment on woodland edge and woodland habitat. The sorts of
palynological changes that distinguish Assemblages 2 and 1
(further reduction in Corylus, declines in Quercus and Salix,
less pollen of taxa adapted to disturbed ground habitat, and
major increases in Poaceae and herbaceous plants pollen) are
consistent with the release of the site area from grazing
pressure, loss of streamside woodland, and modifications of the
district landscape that occurred as its pastures became park
property and the bathing beach area was improved. This
interpretation of these changes in the pollen sequence suggests
another: that the significant increase in Taraxicum-type pollen
that characterizes A2 constitutes palynological evidence of use
of the site area as pasture, and minimization of grazing at the
site more recently (A1) is indexed by significant reduction in
the value for Taraxicum-type pollen as well as by increase in the
Poaceae pollen frequency.

The principle distinctions between Assemblages A3 and A4 are
the reduced Quercus value and the increased Corylus, Calluna and
Cerealia values in the latter. Assemblage A4 is consistent with
mixed farming landuse: sometimes cultivated and sometimes used as
fallow and/or pasture. In assemblage A5, total NAP is
significantly reduced as a consequence of relative increases in
AP and Corylus despite an increase in Poaceae pollen. It would
appear the site was subject to mixed farming at this time also,
but its pollen rain catchement area was significantly influenced
by the presence of producers of hazel and elm pollen. I suggest

50

the boundary between the upper and lower fields was marked by a hedgerow at the time pollen assemblege A5 was deposited, suggesting a date no younger than 1733 A.D.

The contrasts between Assemblages A5 and A6 suggest that prior to the construction of the hedgerow, no physical boundary separated the parcel that would be called Marliff Meadow from that to be called Mare Coppy, and both were subject to mixed farming landuse. However, the mereside reach of the lower field would have supported a band of mixed woodland. Mare Coppy would have been an appropriate place name for a field adjacent to the mereside source of coppiced wood and fuel resources, and the name might have been applied to both parcels if Marliff Meadow was not delineated until the hedgerow was built to contain it.

Assemblage A7 identifies an episode in the landuse sequence when the site was located in mature oak woodland, with a mix of other deciduous trees nearer the mere and an open hazel shrub understory. The site seems to have been significantly distant from either pasture or cultivated land, or even from a road or other source of disturbed ground weeds. It is this wood, apparantly, that was cleared to provide land for the mixed farming activities represented by Assemblages A6, A5 and A4. Such a woodland would not normally be recognized as a form of deliberate landuse, but historic records document that it was. Also, they suggest this use of the mereside site dates from the late 13th to the 15th century A.D.

In the second quarter of the 13th century, interests in the

lands of Tatton township passed to Richard Massey

> "[Richard] was personally known to the king [Edward I], a
> competent and successful administrator, whose position gave
> him the power and resources to purchase most of Tatton
> Hall...[Several purchases] in the 1280's established Richard
> and his wife in Tatton...They set about arranging matters in
> a manner consistent with a household amongst the most
> influential and fashionable in the country (Higham in press:
> IV-10).

> Land which was the subject of several grants to Mobberley
> Priory early in the 13th century came into Sir Richard's
> hands in 1286. Included therein was a large block...on both
> sides of the then Portstrete...It was this land which Sir
> Richard converted to a [deer] park...Richard sought and was
> granted royal permission under a writ of quo damnum to
> enclose Portstrete where it ran through his new park to
> Knutsford, rerouting it nearer the edge of the mere (Higham
> in press: IV-13).

> Parks were probably rare in the county before this
> date...Richard's park, small though it was, was the height
> of ostentation (Higham in press: IV-14).

An agreement between Richard de Massey, lord of Tatton, and

William de Tabley, lord of Knutsford suggests the need to

regulate use of woodland along their common border about 1300.

> "...the need to regulate the use of both by the pigs of the
> two communities implies that woodland was already a scarce
> resource, under some economic pressure, and probably visibly
> shrinking...In Tatton, therefore, the same process of
> defining boundaries and of 'defending' woodland and pasture
> from the commoners can be identified as occurred elsewhere
> locally, for example at Hale Barns and Ringway (for the
> former see the Altrincham Borough Charter) (Higham 1986:6)."

The characteristics of pollen assembleges A8 and A9 are fully

consistent with a reconstruction of common woodland used for

pannage and exploited for fuel and raw materials. Further, the

contrasts between assemblage A9 and A8 suggest selective

harvesting of mature oaks, and possibly a degree of grazing

pressure in the grass:heath ratio, in the more recent episode.

OVERVIEW

Some years ago, I felt it evident that the archaeological potential of site-context sample pollen analysis was not being well explored in United Kingdom research. My experience as an archaeologist who undertakes palynological studies for the same reasons other archaeologists undertake studies of pottery or stone artifacts suggested the need for alternative approaches to exploit certain opportunities offered by site-context pollen study. Three such alternatives have been employed in the two case studies described above.

The first is an alternative approach to the technical problem of recovery of sufficient pollen to accommodate analytical needs. By concentrating the pollen of larger mineral soil samples one may obtain larger numbers of pollen grains. But the principle issue to be addressed by alternative approaches to site-context sample pollen study is one of quality not quantity. The pollen of mineral soil samples is normally less well preserved as well as more sparsely distributed, and it tends to have been dispersed by the vegetation of more limited areas. Alternative approaches must also overcome these constraints of site-context sample pollen data.

The second alternative approach I have applied, therefore, is an alternative to the strategy normally used for collecting pollen from archaeological sites in Britain. Samples are usually

recovered at close intervals in stratigraphic order from one or two profiles within or marginal to the site. If possible, the profiles are sampled at exposures that express the depositional/geomorphological history of the locale, including the deposits related to its prior human occupation. This sampling strategy is obviously derived from sampling designs which have proven effective for bog and lacustrine deposits and is designed to effect the same objective. Its underlying assumption is that the principle objective of palynological research is determination of the character of vegetation that grew at the locale, and how it changed over the course of time. This strategy treats archaeological sites, like other sites, as sources of sequentially organized palynological records that may be used to fulfill this objective.

However, archaeologists do not view sites as sources of information about paleovegetation patterns and paleovegetation change, normally, though they are well aware that a site's potential to generate such information may have a great deal of archaeological relevance. Archaeological theory identifies sites as loci of the material products of cultural activity, normally artifacts, which occur in contexts that suggest the nature of culturally conditioned patterns of human behavior. Archaeological field strategies thus recognize an archaeological site as a suite of cultural and non-cultural contexts of many sorts. Most of a site's contexts cannot be identified until they are revealed through excavation. Scientific field methods thus require

excavation to be controlled in such a way that any and all contexts which become exposed will be identified as fully as possible, and their positions, their contents and their material attributes will all be carefully recorded.

Not too surprisingly, the focus of archaeological interest during field studies at a site are those contexts whose characteristics reveal them to be direct products of human behavior (usually features) or effects of human activity (e.g. artifact concentrations). Thus the fullest range of information generated by archaeological field research is information about the cultural and non-cultural contexts that were exposed, with special attention paid to those of cultural character. Field reports stress what has been learned of the variety of such contexts, their distributions in space and time, their relationships to the contexts of other sites, what their further study might reveal of the history and the lifeways of the site's occupants, etc.

The monolith sampling strategy normally used to recover pollen samples obviously has yielded archaeologically significant information in many instances. But it gives no serious consideration to an archaeological view of the structural character of sites, and it ignores the principle kinds of information archaeologists expect studies of sites to reveal. Other sampling strategies seem needed to capitalize on the information potential of sites and to maximize opportunities to discover what the pollen record may reveal about the culture and

activities of a site's occupants.

Since sites are seen as consisting of contexts which become exposed (and partially or wholly destroyed) as excavation proceeds, it seems to me rational to recover samples of depositional contexts (e.g. strata, middens, feature fills) and samples associated with archaeologically significant contexts (e.g. artifact concentrations, house floors, radiocarbon samples), as they are revealed during archaeological work. Since archaeologists discover information about the culture and activities of a site's occupants through comparative analysis of the characteristics and contents of the contexts revealed by excavation, it seems to me likely that palynological study will discover them through comparative analysis of the pollen associated with those contexts.

Both archaeological methodology and palynological experience support this view of an appropriate strategy for site-context deposits pollen sampling. Most cultural contexts cannot be fully identified until sufficient exposure allows adequate observation of diagnostic characteristics and attributes. Care must be exercised, however, to control excavation activities in such a way that potentially significant characteristics and attributes of a context will not be ignored or discarded prior to exposure of its diagnostic features. Control is exercised through continuous application of the assumption that any patterns that can be observed in site-context deposits are products of cultural activity unless evidence exists to the contrary, and through

imposition of a continuous responsibility to seek and recognize any evidence to the contrary exposed as excavation proceeds. Thus patterns in the distributions, varieties or numbers of faunal remains, or patterns in the distributions of soil colors or textures, are noted and assessed as excavation proceeds. Evidence often is identified to convince the field archaeologist that human behavior is not responsible for the observed pattern, and it has no potential archaeological significance. Until that evidence appears or is noted, though, the assumption continues to affect the excavator's data recovery strategies.

Lacking evidence to the contrary, there is no reason to treat patterns in the varieties and/or frequencies of pollen grains recovered from site-context deposits samples differently from patterns in the varieties and distributions of macroscopic floral or faunal remains in those deposits. Basic principles of the methodology of scientific archaeology require patterns of any form of data from site-context deposits to be granted the status of products of human behavior until evidence exists to the contrary. Those same principles also require the analyst of such data to search for and recognize evidence to the contrary that may exist.

Palynological practice recognizes the problem in a different way, but demands the same solution. Palynological theory recognizes that the varieties and numbers of pollen grains of any sample are products of the range of interactive physical and biological processes which control pollen production, dispersal,

deposition and preservation. Human behavior may affect any and all of those processes, creating the situation in which the varieties and numbers of grains in a given pollen record are products of both "natural" and "cultural" conditions. Because human behavior has occurred at sites, palynologists are aware that the varieties and numbers of pollen grains in site-context deposit samples are more likely to be influenced by such behavior than is true for samples of non-site context deposits. Indeed, conservative interpretation requires the assumption that behavioral patterns have a prior probability in explaining the data of site-context pollen samples. Unlike archaeological practice, palynological practice does not require the investigator to seek such evidence to the contrary as may exist. But analysis of control samples that illustrate the ways in which non-cultural processes affect pollen records is normally encouraged, as a way of identifying the distinctive ways "natural" and "cultural" conditions are expressed palynologically.

The third alternative approach applied in these studies has been to organize the site-context deposit pollen records into populations of equivalent context for purposes of analysis and interpretation.

Pollen records recovered in stratigraphic sequence are normally organized into pollen zone populations for these purposes. The relative temporal position of each of the samples of a pollen zone sequence, however, is securely known by virtue

of its stratigraphic relationship to the other samples. This
allows variations among the pollen records of members of a pollen
zone population to be confidently interpreted as a function of
the passage of time. Though the temporal relationships of some
of a site's contexts to others may be clear from their
stratigraphic positions, it may not be possible to identify which
members of a population of samples of equivalent context are
older or younger than others. And it may not be wise to
attribute variability among the pollen records of members of such
populations to the passage of time in any case, since site-
context sample pollen records are at least as likely to vary
because of cultural effects or because they reflect the
vegetation of limited areas.

Organizing the pollen records of site-context deposits
samples by the characteristics of the contexts of their
association, however, allows what is known of those contexts and
the ways they have been interpreted to inform interpretation of
the palynological data base. Thus, in the Marsden-Saddleworth
case it was possible to recognize that the two subpopulations of
pollen records discovered in the population of mor/transition
zone samples could not have been influenced by cultural activity,
even though they were directly associated with the mesolithic
archaeological record recovered from those sites. The pollen
trapped in mor/transition zone samples had to post-date
mesolithic occupation of the sites because that sort of context
could not have yet evolved at the locale when occupation took

place. Alternatively, the pollen produced at the locale during the horizon of mesolithic occupation was probably subject to soil formation processes which would have downwashed it to the mineral soil stratum below the artifact-bearing surface.

As matters turned out, application of these alternative sampling and data organization strategies were not archaeologically significant for reasons I had anticipated when the samples were collected.

I collected the small population of samples from the Marsden-Saddleworth sites with two objectives in mind: to provide controlled evidence of the value of the alternative approach to pollen extraction, and to sample the deposit directly associated with the archaeological record of mesolithic occupation. Though that context turned out to incorporate pollen that was younger than the artifacts, reorganization of the pollen records. previously recovered from those sites by the sample populations approach proved archaeologically relevant. The resulting Marsden-Saddleworth pollen sequence provides useful details about the character of quite local mesolithic vegetation pattern conditions and resources. The information suggests certain long-held views on mesolithic cultural ecology may require revision.

I intiated study of the samples from Tatton Mere because of my conviction that even those site-context deposits that seem poor prospects for archaeological pollen analysis will normally yield informative pollen records. I assumed the pollen records associated with the mesolithic artifacts would prove useful to

the archaeological interpretation of the mesolithic occupation. No one was more surprised than I when it turned out to be the character of those pollen records that precipitated recognition that the site's mesolithic archaeological record was not actually in situ. I certainly did not anticipate the interpretation of the mereside site samples would suggest relationships to the pollen phases evidenced in cores from the nearby mire, and to Higham's historically documented analysis of changes in landuse practises. I am not sure whether or not it is appropriate to say that the pollen work actually supports the historical research. But that any parallels occur at all is amazing, given all the errors that can accumulate and compound to confuse interpretation of pollen spectra.

I contend that the Marsden-Saddleworth and Tatton Mere case studies indicate that site-context deposits samples pollen analysis can generate information relevant to archaeological research from even the most unlikely sites. They suggest, however, that exploitation of the information potential of such samples may demand alternative approaches to pollen extraction, pollen sampling and the organization of palynological data. Further, they suggest that the sorts of information such samples may seem likely to produce when they are collected may turn out not to be the sorts of information they in fact yield.

More significantly, however, these case studies indicate that recovery and curation of site-context samples is likely to be as relevant to archaeological research as recovery and

curation of material culture, faunal or floral remains, or information on the geological characteristics of a site. Pollen sampling should thus been seen as a normal operation of professional archaeological fieldwork. Analysis of those samples to exploit their potential need not occur immediately. Indeed, it may be more cost-effective to delay that effort until cultural analysis of sampled contexts identifies appropriate problem orientations. Curated collections of pollen samples, however, like curated collections of material culture, offer opportunity for their potential ultimately to be realized. Failure to collect samples simply because immediate analysis cannot be supported constitutes poor appreciation of the information potential sites provide. It is especially inappropriate in the context of rescue or salvage archaeology programmes, since they are predicated on the position that the information content of sites should be preserved even if the site itself must be destroyed.

TAXON	SAMPLE 41		SAMPLE 42		SAMPLE 14		SAMPLE 32		50cm SAMPLE		90cm SAMPLE	
	Innes	Schoen.	Innes	Schoen.	Innes	Schoen.	Innes	Schoen.	Innes	Schoen.	Innes	Schoen.
Betula	3.3	3.9	0.7	0.5	2.3	0.1	2.8	0.4	7.0	0.2	2.5	
Pinus	0.9	4.2		0.2		0.9	0.9	0.2	0.3	0.8		0.7
Ulmus											3.8	13.0
Quercus	5.3	17.5	5.6	21.6	6.3	15.1	6.8	12.8	3.2	21.1	1.3	0.7
Tilia	0.7	0.5	3.0	0.2	1.1	1.2	8.3	8.6		0.2		0.1
Fraxinus						0.8						
Alnus	10.5	12.5	10.3	10.4	11.9	8.8	9.6	9.5	18.6	12.5	10.1	10.0
Salix	2.0	0.3	1.9		1.1	1.1	2.5	0.2	1.5		3.8	0.4
Corylus	28.3	20.1	46.3	29.1	47.7	38.2	23.1	32.6	23.3	20.8	17.7	21.5
Calluna	1.3	0.5		1.4	1.7	0.4	11.4	8.1	3.2	0.5	2.5	1.2
Poaceae	26.3	34.7	25.6	29.8	24.4	29.3	26.9	22.5	24.7	37.3	58.2	39.2
Cerealia			1.1			0.3	1.2	0.2	2.3	0.4		0.1
Cyperaceae	3.3		0.7		1.1		1.5		4.6			
Senecio-type	1.3		0.3				0.6		0.3			
Cirsium-type									0.3			
Tubuliflorae	9.2	3.0	3.3	0.7	0.6	1.0	0.2	1.6	4.6	2.0	2.6	4.5
Taraxicum-type		5.2		1.6		2.8	1.5			4.3		
Ranunculus-type							0.3					
Silene-type	0.7						0.6		0.6			
Stellaria-type									0.3			
Rosaceae	1.3							0.5	0.3			0.7
Potentillia-type									0.3			
Sanguisorba									0.3			
Artemisia	0.7							0.5	0.3			1.2
Umbelliferae								0.4				
Geraniaceae						0.5			0.3			
Cruciferae		0.3	0.3		0.6	0.1		0.2				
Caryophyllaceae							0.3			0.2		0.5
Chenopodiaceae							0.3			0.2		0.1
Rumex		0.3	0.3						0.9	0.3		
Mentha-type				0.2		0.3			0.3			0.4
Plantago				0.2					0.3			
Plantago major+media												
P. lanceolata	2.0			1.1					2.0			
Rubiaceae							0.3					
Succisa				0.2		0.3	0.3		0.3			
Typha angustifolia												
Unknowns	0.3			0.4		0.3	0.3	0.7				3.2
TLP	152	576	270	550	176	782	324	555	344	610	79	846

Table 4. Comparison of pollen frequency values. For each pair, Innes's count left, Schoenwetter's right.

APPENDIX

Table 3 presents the frequency values for pollen observed by Dr. James Innes (left column of pair) and myself (right column of pair) for six of the samples of the Tatton Mere study. Low pollen counts for samples 41, 44 and 90cm occurred because some of the slides prepared from my extracts had dried out. Some persistent contrasts in the counts are best explained by differences in decisions made by the observers. I include partial grains if I believe identification can be made of the fragment. Thus I consistently recorded more observations of Quercus, Ulmus and Caryophyllaceae pollen, and usually recorded more Poaceae pollen. Other contrasts are due to differing levels of familiarity with the British pollen flora. Thus I recorded more Unknowns pollen while Innes identified more pollen taxa; I collapsed all Tubuliflorae into one taxon while Innes distinguished two types of Tubuliflorae; and I collapsed all Plantago while Innes distinguished two types. The data table suggests I probably misidentified some Betula as Corylus and some Poaceae as Cyperaceae.

The cumulative affect of all these differences is insufficient to affect the vegetation change interpretations presented in the text. For example, even if the true percentage values for Quercus were actually only half those of my analysis, relative changes in AP and Quercus values would occur in the same samples over the course of the pollen sequence. Horizons of the

Tatton Mere pollen sequence identified as woodland might then have been less densely wooded, but yet would have supported more arboreal cover than other horizons.

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