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TOWARDS A MORE HOLISTIC VIEW OF BRITISH VEGETATION HISTORY

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1. INTRODUCTION

This paper will firstly indicate very broadly the way in which our interpretation of post-glacial vegetation records has been subject to adjustments since the end of the nineteenth century. It will then reveal how limited in perspective are our conventional criteria for detecting human influence on pollen diagrams and finally it will stress the importance of a consistent approach to the activities of man throughout the entire post-glacial period.

Changes of interpretation so far as vegetation history is concerned do, of course, arise from a growing body of knowledge but this is not confined to the records of vegetation themselves - equally important have been developments in contemporary ecology, archaeology and chronometric dating (Birks and Birks, 1980). This is a familiar situation in science, leading to the refinement or rejection of hypotheses or, depending on the extent and implications of the change, to the overturn of entire paradigms.

However, before considering the interpretation of vegetation records we ought to look briefly at the nature of the data we use and consider its status in relation to what we normally describe as fact. In the first place we are dealing essentially with stratified materials, the physical, chemical and biological nature of which tells us about the environment of deposition and the plants which grew on the site. The interpretation of these layers, be they lake sediments or peat, relies not only on the geological principle that the oldest is at the bottom but that by looking at modern equivalents we may gain insight into past environments and processes. Occasionally we can be misled and some deposits may have a truncated or inverted sequence due to erosion processes. Equally I have no doubt that modern ecological parallels for various types of former landscape simply do not exist. Fortunately however, the individual plants with which we are concerned are still to be found so their contemporary ecological requirements can at least be studied.

The most important source of data for developing ideas about vegetation history has been derived from pollen grains and spores (Fig.1). Unlike the deposits themselves, the pollen they contain comes from a wide territory around. This is at once a blessing and a curse - if it were not the case, then pollen would be of little use to us in predicting the nature of vegetation in the majority of the landscape which lies beyond the confines of the swamp environment. On the other hand in pure statistical terms pollen falls a good deal short of being an ideal indicator of former vegetation. Figure 2 illustrates factors which intervene between the original vegetation and the palynologist's microscope. Pollen is thus a substitute for, rather than a direct quantitative statement of the former vegetation - otherwise stated, it is merely a proxy or an index value. This will I am sure cause some disillusionment, yet the method does, at the very least, provide a standard of vegetational comparison from one time period to the next and from one place to another. Thought of in this way pollen analysis is no more reprehensible than, for example the whole range of soil analyses commonly conducted on denatured, dried soils which purport to represent real amounts of chemical elements available for plant growth.

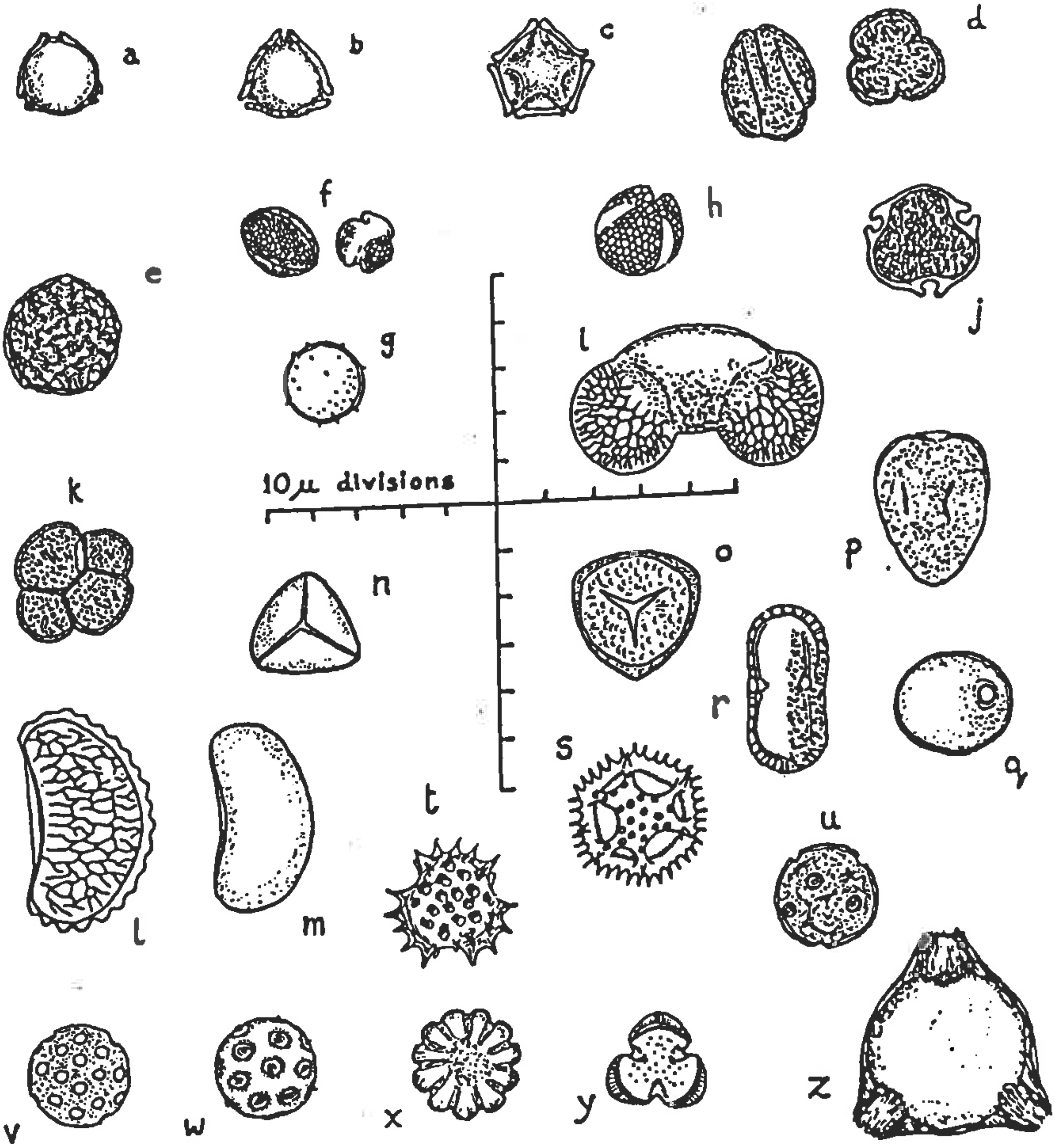

Figure 1 : A selection of pollen and spore types :

a, Betula pubescens *(birch tree)*; b, Corylus avellana *(hazel)*; c, Alnus glutinosa *(alder)*; d, Quercus *(oak)*; e, Ulmus *(elm)*; f, Salix *(willow)*; g, Juniperus *(juniper)*; h, Fraxinus *(ash)*; i, Pinus *(pine)*; j, Tilia *(lime)*; k, Ericaceae *(heaths)*; l, Polypodium *(polypody fern)*; m, Dryopteris-type *(male fern)*; n, Pteridium aquilinum *(bracken)*; o, Sphagnum *(bog moss)*; p, Cyperaceae *(sedges)*; q, Gramineae *(grasses)*; r, Umbelliferae:Heracleum-type *(hog weed)*; s, *Compositae-Liguliflorae:* Taraxacum-*type (dandelion)*; t,*Compositae-Tubuliflorae:* Bellis-*type (daisy)*; u, Plantago lanceolata *(ribwort plantain)*; v, Chenopodium album *(fat hen)*; w, *Caryophyllaceae e.g.* Lychnis flos-cuculi *(ragged robin)*; x, Polygala vulgaris *(milkwort)*; y, Artemisia *(wormwood)*; z, Chamaenerion angustifolium *(rosebay willowherb)*;

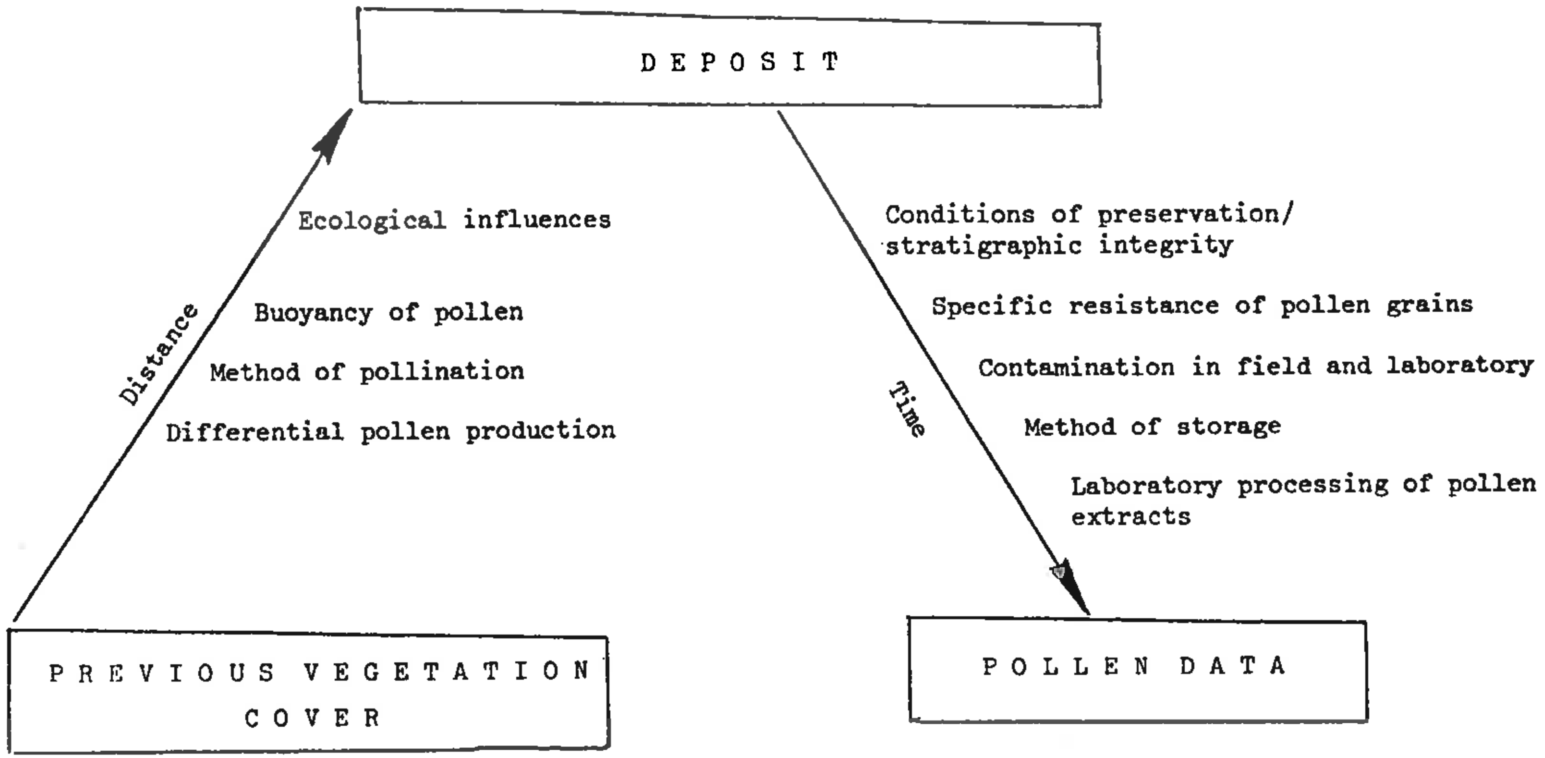

Figure 2 : <u>The factors intervening between former vegetation and pollen data</u>

2. MAJOR STEPS IN INTERPRETATION

The three steps which follow, do in a general way reflect a certain evolution in our thinking about the causes of vegetational changes but since each has its part to play in an overall interpretation of any interglacial series of floristic changes, they are presented here as the principle issues which underpin our interpretation of pollen diagrams.

2.1 Establishment of the general sequence

This stage begins in the late 19th century with such names as James Geikie, Axel Blytt and Rutger Sernander and their pioneer studies of peat bogs (see Faegri, 1975). They found that where peat bogs occurred, forests had grown at an earlier period and from the remains of wood, leaves, seeds etc., it was possible to identify a very broad pattern of change since the Ice Age. Furthermore, from the tone or humification of the peat, inferences were made about moisture levels and accumulation rates and in this way a series of climatic substages were proposed, namely the Boreal, Atlantic, Sub-Boreal and Sub-Atlantic (Fig.3).

The first real pollen diagrams were those of Lennart von Post and in 1910 he proposed a threefold climatic division of the post-glacial period - amelioration, optimum and deterioration. Evidence for the amelioration was essentially based on the later arrival or later expansion of certain trees, then understood to require greater warmth. The next major achievements were those in the 1930's of Sir Harry Godwin who, in recognizing a parallelism or general consistency of pattern among pollen diagrams, attributed the vegetation changes to changes of climate (see e.g. Godwin 1956, 1975). Furthermore, he identified a sequence of pollen zones (Fig.3) or phases characterised by different combinations of trees. Figure 4 is an example of one of these earlier, and now classic, pollen diagrams. We ought to say now that the consistency on pollen diagrams which Godwin saw, was to become less as palynological studies became more widespread and as more detailed sampling was carried out. Consistency here, as elsewhere, is partly a matter of how generalised you wish to be.

GEOLOGICAL PERIODS (MITCHELL ET AL 1973)	CLIMATIC EPISODES		TIME SCALE	POLLEN ZONES	
	BLYTT/SERNANDER	GENERAL TREND		GODWIN (1940)	WEST (1970)
FLANDRIAN OR POST-GLACIAL (HOLOCENE)	SUB-ATLANTIC	DETERIORATION (Von Post) Cooling but fluctuating 'oceanic'	2000 1000 AD BC	VIII	F III
	SUB-BOREAL		1000 2000 3000	VIIb	
	ATLANTIC	OPTIMUM Milder 'oceanic'	4000 5000	VIIa	F II
	BOREAL	AMELIORATION Cool temperate, 'continental'	6000	VI	c
				V	F Ib
	PRE-BOREAL		7000 8000	IV	a
LATE-DEVENSIAN OR LATE-GLACIAL (PLEISTOCENE)	LATER DRYAS	GPS		III	L-D III
	ALLERØD INTERSTADIAL	Temperate	9000 10000	II	L-D II
	EARLIER DRYAS	Glacial, Periglacial and Sub-temperate (GPS)	11000 12000	I	L-D I

Figure 3 : Climatic divisions and pollen zones for the late-glacial and post-glacial periods

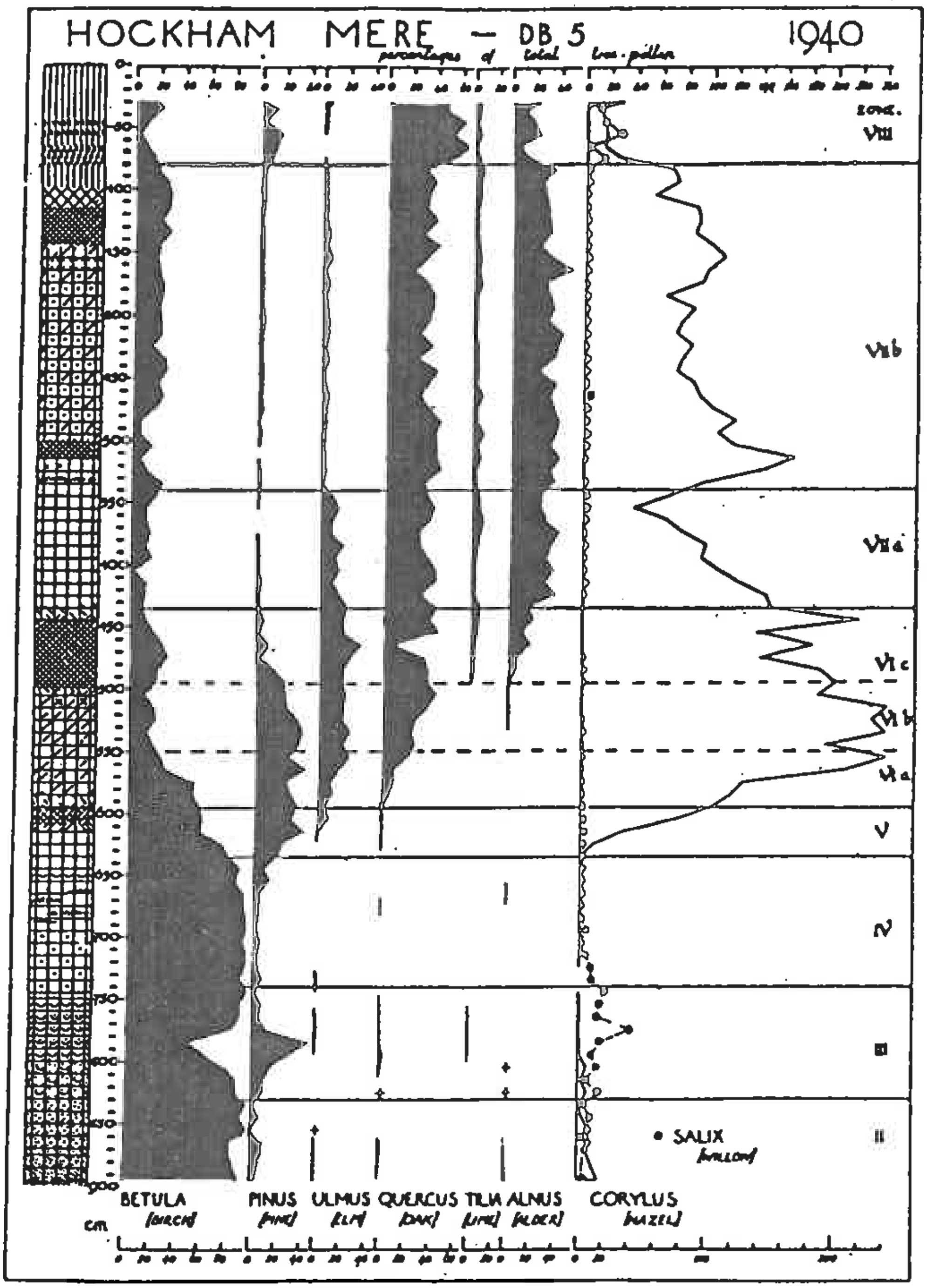

Figure 4 : Relative tree pollen diagram from the north of Breckland, East Anglia (from Godwin, 1975)

2.2 The principle of retardation

With the advent of radiocarbon dating (Libby, 1955) it was discovered that the pollen zones were not synchronous in all areas i.e. they did not represent the same slice of time - it was therefore not reasonable to argue that vegetational changes moved strictly in step with either real or supposed changes in climate (see e.g. West, 1963). Plants take time to migrate and they are faced with competition on the way so the sequence began to look more like a grand succession with pioneers leading the way. Looking at the apparent order of immigration of tree species we should not be surprised to see birch at an early stage in view of its climatic hardyness and extreme ease of dispersal. Pine similarly spreads rapidly by wind transport but the same is not true of oak whose heavy acorns ensure that a community of oaks will, given time, spread as an ecosystem complete with ground flora and fauna. Yet if we look at the biogeographical ranges of the two native British oaks (Jones, 1959) (Fig. 5), we see that on that basis there appears to be little reason why they should not, other things equal, have been able to cope with the continental conditions in Britain at the start of the post-glacial period. For the above reasons then, it is unwise to regard particular trees as signifying a particular climate.

It is necessary therefore to accept a lag or retardation period between climatic influences and adjustments in the vegetation (Smith, 1965). Environmental change since the last glacial maximum has in fact been synonymous with retardation since initial warming has led to melting of ice and rise of sea level. Rise of sea level in turn must have influenced the climate of adjacent land areas, perhaps accounting for part of the observed variations within the Flandrian. Again, the theoretically derived solar radiation curve for 60° north (Fig. 6, after Milankovitch) shows a maximum at the end of the Devensian rather than during the mid-Flandrian. At the extreme end of this complex chain of cause and effect is the soil profile, dependent as it is, on the existence and persistence of particular vegetation (see e.g. Dimbleby, 1965).

The European distribution of *Quercus robur* L.

The European distribution of *Quercus petraea* (Matt.) Liebl.

Figure 5 : Biogeographical ranges of British oaks
(from Jones, 1959)

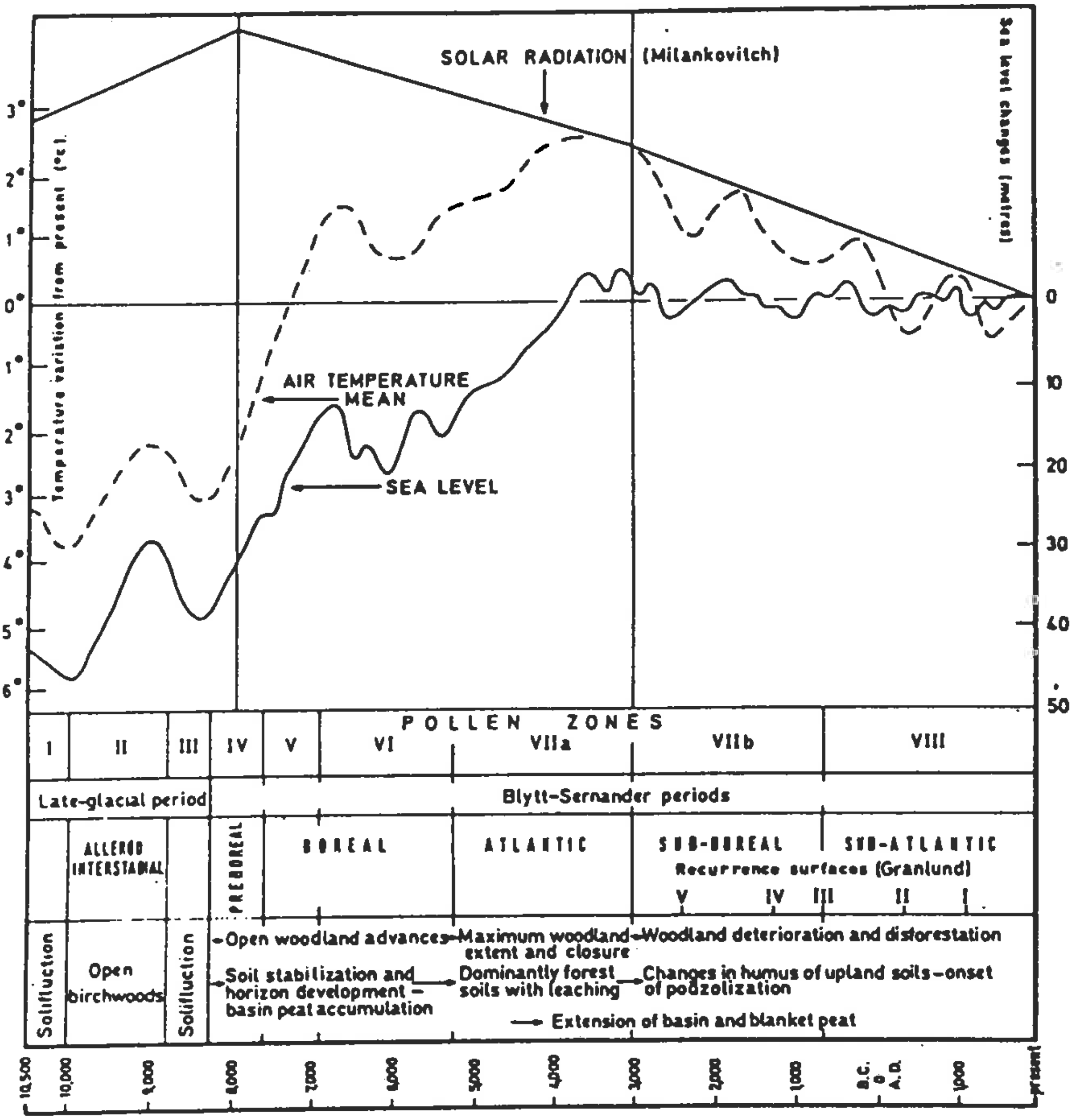

Figure 6 : Radiation, sea level and vegetation history in the
last 12,500 years

2.3 Human interference - the conventional evidence

It does not of course require a palaeoecologist to inform us that man has been altering the landscape since before Roman times. The existence of archaeological sites surviving in great numbers from the Bronze Age onwards is mute testimony to a modifying presence. Although it must have been patently obvious to early palynologists that man would have had an effect in later prehistory it was not until peats and sediments were subjected to closer sampling - 2 cm rather than 10 cm sampling intervals - that the evidence for clearance phases became apparent. This is because most earlier clearances were of such short duration in relation to peat accumulation that the evidence might only be contained within a 2-3 cm depth of peat and thus slip through the meshes of coarser sampling.

However, by the 1940s one feature on pollen diagrams which had become a contentious issue was the so-called elm decline (see e.g. Ten Hove, 1968). Seen by some as evidence of climatic change and by others as evidence of soil acidification, there were also reasons for associating this with man (Pennington, 1969). The view was expressed, based on historical and ethnographic research, that the elm leaves were used for fodder, possibly for the over-wintering of cattle (Troels-Smith, 1960). Cattle are known also to strip the bark off young elm trees and in this way elms may have been selectively reduced. Clearly also Dutch elm disease was a candidate, but what eventually settled the issue for most people was the radiocarbon dating for this event which placed it at the onset of the Neolithic (Godwin, 1970).

Also evident at the elm decline, together with a general fall of tree pollen, is an increased proportional representation of the pollen of grasses, bracken and certain weed species, together with occasional pollen grains of cereal grasses. A further idea which arose, therefore, was that clearance for arable farming of the better soils previously occupied by elm, led to its decline. Additionally it is of interest to note the former practice of using elm bark in the bread-making process which, one imagines, would have developed closely with the cultivation of grain crops.

While techniques have become more refined for the study of clearance phases, including the use of absolute pollen counts (Birks and Birks, 1980; Mannion, 1980) the above changes in relative frequency nevertheless remain as the accepted tell-tale evidence of man's influence in the pollen record (Fig. 7).

The last decade has witnessed increasing claims for pre-Neolithic clearances - much less distinct, but nevertheless identifiable by similar criteria (e.g. Jones, 1976; Simmons, 1969; 1975; Smith, 1970).

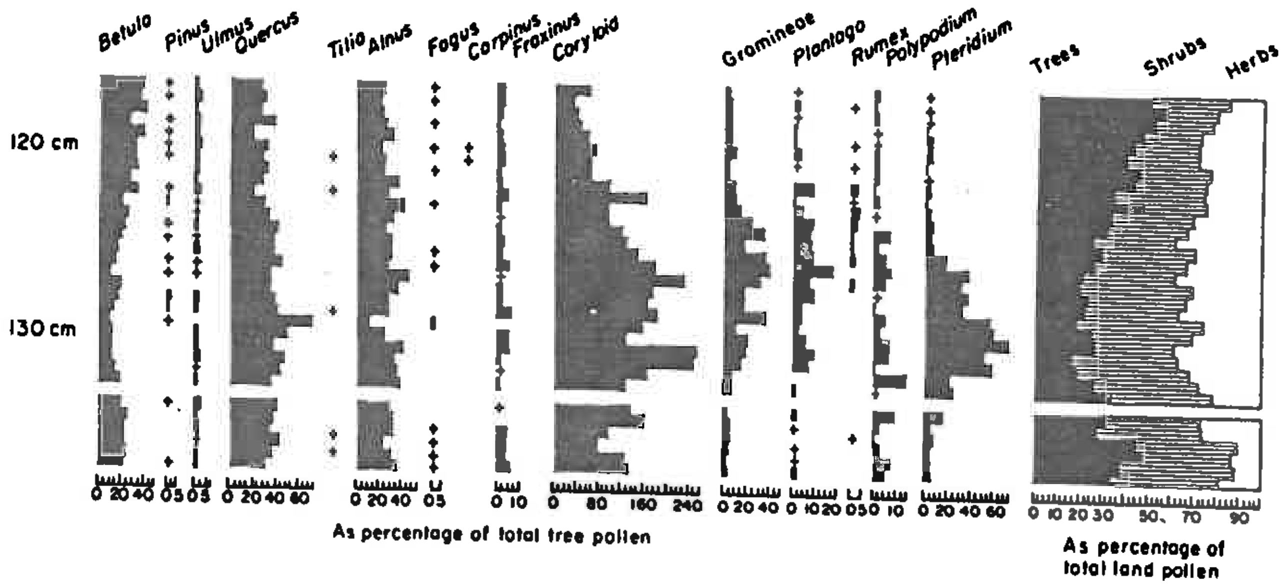

Figure 7 : A phase of Bronze Age forest clearance (from Turner, 1965)

3. PRE-NEOLITHIC HUMAN INFLUENCES - A PROBLEM OF DETECTION

There can be little doubt that Mesolithic man ranged widely across his territories as judged from the distribution and abundance of artefacts of the period and to aver that his hunting and habitations led to no significant change in the vegetation requires a considerable act of faith in the conventional model of Flandrian succession. Furthermore the context of Mesolithic man's activities was a broad continental margin subject to progressive inundation. It would therefore be a formidable argument which maintained that such physiographic changes led to no significant increases in human populations as sea level rose and drowned large tracts of the North Sea basin, Channel and Irish Sea (Morrison, 1976).

I therefore begin this section with an uneasy feeling that though there is little conventional palynological evidence for human interference in the long period associated with microlithic cultures, this may be a gross understatement of reality. This said, there are in fact a number of quite substantial reasons, some general and others very specific, as to why evidence from pollen diagrams of man's activities in the Mesolithic appears to be so limited or for why it has not been suspected before.

3.1 Problems of method and aims

We can firstly identify more general reasons for the limited data and progress in linking man with any of the vegetation changes in the early Flandrian.

(1) Emphasis was formerly placed upon establishment of the pollen zones and thus the identification of modal suites of pollen which gave a guide to the dating of pollen diagrams. The nature of the changes between major zones - often the most distinctive local and regional characteristics of pollen diagrams - tended to be neglected by contrast, although some authors fully recognised this problem (e.g. Smith, A.G. 1965). It can fairly be said then, that the initial orientation was towards the categorization of pollen assemblages rather than to the processes of change generating them. Indeed, since the changes were originally thought to be climatically induced this problem appeared to be solved.

(2) It also became standard practice to express the pollen data as percentages of the total tree pollen which enabled, as far as possible, an assessment of woodland composition to be made. However, without a diagram showing how relatively abundant was the pollen of trees and shrubs in relation to the total pollen, one could not easily assess the overall importance of the forest component in the total landscape.

Because of the lack of synchroneity of the original zones of Godwin (1940, 1956) local and regional pollen assemblage zones began to be used (West, 1970) but these still required use of the same basic statistic. Nearly all authors do now incorporate a summary diagram to meet the above criticism and may also employ diagrams where the pollen is expressed as percentages of the pollen sum. These are recognized to be better for indicating major ecological changes but suffer (as do tree pollen diagrams and all relative statistics) from the fact that a change induced in one component automatically affects all the rest to a proportionate extent (Faegri, 1966). In practice this theoretical worry is not fully justified, for real increases in some other component of the vegetation usually will take place but this cannot be known for palaeoenvironments without absolute pollen counting. Absolute and pollen influx statistics can thus help solve many such difficulties and, together with contiguous sampling of peat cores down to 0.25 cm intervals they constitute some of the palynologist's ultimate weaponry.(Birks and Birks, 1980; Mannion, 1980; Moore and Webb, 1978). One basic problem has often therefore been that of equivocal statistics.

(3) As a growing body of pollen data has been collected our expectations of Flandrian records have concentrated the majority of minds on the more recent periods in the search for evidence of man's activities. These are periods for which there is best archaeological calibration and from which visible field structures survive. In consequence it is common to find sampling intervals much coarser in the earlier periods than in the later ones to which attention is being focussed. There is therefore little possibility of early 'clearances' emerging by chance. It is, however, fair to

point out that while most investigators would argue strongly for a consistent, fairly small, sampling interval, the enormous amounts of research time which this represents normally dictate that the entire stratigraphy is studied in outline to provide a time frame within which the detailed study can be advanced. Often the latter, as postgraduate students and their supervisors are fully aware, is a function of the time constraints imposed by Ph.D. theses.

(4) For the purposes of establishing the original pollen zones and for obtaining regional i.e. generalised pollen data, field sites have commonly been selected towards the centre of large and deep mire systems. This particular research design is specifically aimed at avoiding local effects and bias from one side or other of the mire (Birks and Birks 1980; Moore and Webb, 1978 and see Turner 1975 for a practical application). It can be argued that the above sampling strategy, unless quite by chance associated with local prehistoric activities, is the least likely to yield evidence of man's activities, especially in the earlier periods of the Flandrian (see Section 3.2). Small bogs within forests and among a higher proportion of 'dry land' vegetation should *cet. par.* yield more intimate local information about human interference. It is, after all, unequivocal evidence of a clearing in one place at one time which is sought rather than generalised, overlapping events from a variety of sources (including of course natural catastrophes - see Section 3.3) which blur to become unrecognizable for what they are.

(5) Linked to the last point is, however, the sad fact that many of the smaller bogs originated at some stage within the Flandrian and may not therefore contain the early evidence of man which is sought. Much of the hill peat in Britain is in this category and represents an epoch largely without tree vegetation, giving us little idea of what preceded it. Underlining the frustrations of palaeoecologists is the occasional occurrence of Mesolithic flint flakes and worked artefacts on the sub-peat surfaces.

3.2 Anticipated responses from a Mesolithic landscape

Under this heading can be identified certain specific relationships between early Flandrian landscapes and the sedimentary record which frustrate the collection of conventional evidence for man's activities as outlined in Section 2.3. The problem largely centres on the way in which human activity is likely to be recorded on pollen diagrams at different times and in different places.

(1) If it is acceptable to maintain from pollen data that mainland forests were extensive and largely closed at an early stage of the Boreal period it then follows that forest pollen would have a tendency towards masking the small quantities of herbaceous pollen generated in cleared areas.

(2) Following from this, it is possible, depending on the nature of the disturbances, that early openings in woodland actually increased the amount of pollen produced by the remaining trees. It is well attested that trees growing singly or with open spaces flower more profusely than those in a closed stand (see e.g. Faegri, 1975). In the event of clearance a buffering mechanism may therefore originally have existed to reduce the perceived level of tree pollen reduction on relative pollen diagrams. Absolute counts would give insight into just such a problem.

(3) With or without the above considerations it will always have been true that the further away is the sampled site from areas formerly subject to disturbance, the less the likelihood of tell-tale evidence being recorded. Inspection of the general pollen transfer model (Figure 8) allows one to appreciate the filtering effects of woodlands between an open area and the site of the sedimentary record. Therefore on theoretical grounds demonstrated in studies of pollen transfer (e.g. Tauber, 1967; Tinsley and Smith, 1974) there would have been a tendency for changes in the proportions of tree pollen to be recorded rather than pollen from localized areas of herbaceous vegetation enclosed and insulated

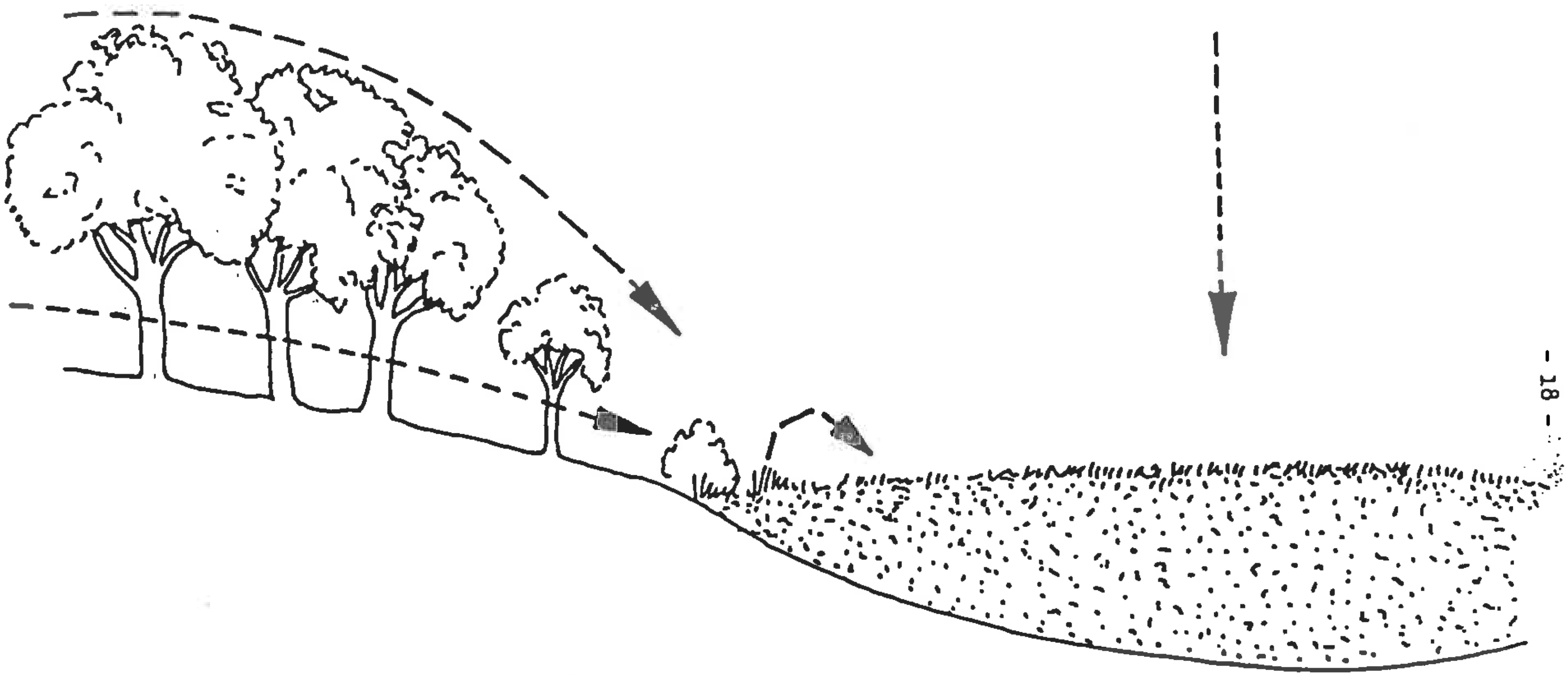

Figure 8 : A representation of pollen transfer to a bog or lake surface (adapted from Tauber, 1967)

by woodland. This question again comes back to the problematic location of sample cores within extensive bogs and the generalized pollen rain which is normally associated with such sites (vide Section 3.1(4)). Again it has to be said, that in the majority of locations previously studied, even with all sampling problems satisfied, it will be a matter of chance as to whether early clearances are recognizable as such. A superior research design appropriate to the early Flandrian would be to first locate the Mesolithic sites, as in the case of the Vale of Pickering and then devise appropriate sampling strategies. Rankine and Dimbleby (1960) for example in their examinations of Mesolithic sites saw evidence of considerable clearance with even a possibility that forest cover was never again fully established.

(4) A further problem is posed by duration. Our understanding of Mesolithic peoples, whether correct or not, is that they moved around a great deal between areas which favoured them in the different seasons of the year. This might have meant wholesale migrations with the passage of the seasons - a model more appropriate to the reindeer and caribou hunters or an upland-lowland rhythm within a given area which would not necessitate the existence of more than one major settlement site for each group of people. Apart therefore from the chance of a core being relatively near to such a major dwelling site the other disturbances would, we imagine, be fairly short lived. In other words, scarcely had gramineous vegetation begun to increase in the ground flora when the area became overgrown again by trees. This, as we have already observed, places the ultimate strain on detection by palynological means.

(5). Following from a consideration of the movements and lifestyle of Mesolithic peoples it would appear that certain types of locality might commend themselves more than others for major settlement. We assume that factors of importance were water supply, hunting or fishing potential, fuel and strategic location. Hunting communities may therefore have selected coastal, riverine and lacustrine sites as major centres and while some such sites doubtless existed within areas now peat covered, the open hills probably always were a place where the summer huntsman displayed his prowess and where temporary accommodation was therefore sought. We are all capable of judging to what extent the above habitats are represented by available sedimentary records and the picture is not particularly encouraging except to say that many previous lake sites, since evolved into bogs, are now candidates for accessible palaeoecological work.

In general terms then, unless a clearance took place near the sedimentary record, lasted several decades at least and was several hectares in extent there would be little chance of anyone recording it. Clearance phases are therefore likely to be about as reliable a guide to the real energies of Mesolithic man as, for example, is the distribution of surviving Bronze Age sites, of the total land settlement of that period.

The conclusion from the foregoing is that we may often be wasting our time looking for periodic increases in herb pollen in the Boreal and Atlantic periods except in conjunction with known archaeological sites. But have we necessarily been asking the right questions?

Let us for a start consider the first *Ulmus* fall which, as we have said, accords with the dates of onset of the Neolithic culture in north western Europe. Here we have a feature which is clearly recorded in the majority of pollen diagrams from England and Wales despite elm pollen often being only a minor component of the tree pollen. One therefore wonders whether there could have been former activities in far antiquity which led to changes in the composition of vegetation, notably of arboreal species, without being protracted enough to lead to large and therefore detectable increases in ground flora. This question will be fully explored in the next major section of this paper but it is worth recognizing at this stage that in a largely forested environment, for reasons of tree pollen concentration and pollen filtration, changes in composition of arboreal vegetation would be more readily communicated to the palynologist than increases in low growing herbaceous plants.

3.3 A note concerning non-arboreal pollen (NAP) and the separation of pollen classes

Since human interference is usually associated with changes in the AP/NAP ratio (trees and shrubs vs. herbs) it is perhaps worth noting a few general points about pollen of non-arboreal origin. Pollen records always contain a small and fluctuating amount of NAP even in the periods of maximum forest cover, presumably because in addition to bog surfaces and woodland ground flora, natural processes tended to perpetuate a proportion of open habitat, such as wild fires, wind throw and the building of beaver dams. These sources of disturbance would contribute fairly evenly in time to the production of NAP, as would the existence of river banks, coasts and estuaries, mountain screes, bogs and other habitats. Indeed at higher level sites, the former tree pollen values are normally well below those of lowland sites. Pollen diagrams from the Western Isles of Scotland display exceptionally low tree pollen levels (Birks, 1973) as do those from the Isles of Scilly (Dimbleby *et al.*, 1981) and from the western coast of Wales (Smith and Taylor, 1969). Additionally, and of minor importance, is the fact that certain tree pollen types are either difficult to assign or are not preserved, a source of imprecision which is always difficult to assess. In the latter category is included *Populus* (poplar), while *Sorbus* (rowan) and *Crataegus* (hawthorn) (both *Rosaceae)* are only distinguishable in modern specimens. Still others are poorly dispersed, including *Fagus* (beech), *Taxus* (yew) and *Tilia* (lime). On the other hand little should be made of this problem for there are similar frustrations encountered with the NAP such as the non-appearance of Juncaceae pollen.

There is a further problem connected with the traditional division into trees, shrubs and herbs. Ideally one would like to be able to guarantee that pollen in given classes signified plants of a certain stature. A tree thus suggests tall woody vegetation, a shrub rather less so, etc. The botanical distinction between trees and shrubs is concerned with the production of the stem and in this respect shrubs differ from trees in that they produce multiple stems from ground level. These distinctions are in practice somewhat frought and many apparent inconsistencies arise. In particular since hazel is regarded palynologically as a shrub and alder as a tree it is worth pointing out that in many cases the two can exhibit very similar life forms along with willow, which is also classed as a shrub. The separation of hazel from the tree pollen class had been emphatically approved at an early date due to its prolific pollen production. There is also some danger of confusing its pollen with that of myrtle. As far as the distinction between shrubs and herbs is concerned, the Ericaceae, which comprise mainly dwarf shrubs, are conventionally grouped with herbs despite the woody character of the dominant heathers.

Thus we return to the point made in the introduction to this paper, that the use of pollen has unavoidable limits of resolution as a tool for reconstructing former vegetation and in view of the limited parallels available to us today we may easily come to wrong conclusions about the type of growth and the range of habitats that particular genera represent.

4. A REINTERPRETATION OF EARLY HOLOCENE VEGETATION CHANGES

4.1 The spread of birch

When birch spread west and north across Britain after the final cold period it was not merely a 'space invader'. The landscapes it encountered were not barren at this time but vegetated with a low growth of willow, dwarf birch, juniper, mosses, sedges and a rich variety of flowering plants, all of which had probably been present throughout much of the latter part of the Devensian (West, 1977). This is a typical association for an arctic or alpine environment. On these steppe-like landscapes roamed many large herbivores and their carnivorous predators together with the most formidable of all - Palaeolithic man. It is likely therefore, that in addition to established vegetation, the advancing birch woods had to contend with grazing animals and their human tormenters. On the whole, we might assume that any disadvantages of terrain would probably have been offset by the protection afforded to birch seedlings by the existing plant cover which, of course, would eventually be overshadowed and eliminated as the forest advanced.

Hitherto, what has not been accorded much attention is the probable role of both steppe and woodland herbivores in vegetation history. It seems reasonable to point out that the presence of such animals ahead of an advancing birch forest - and indeed within it - would undoubtedly have retarded or even locally prevented woodland establishment. From the evidence of previous Interglacial episodes we may assume that animals did not, generally speaking, prevent sequences of forest development although it should be acknowledged that neither did the previous extensions of forest cause the steppe fauna to become extinct! Although there are difficult problems of timing, the advance of birch may thus have been associated as much with the overkill by man of large numbers of predominantly steppe herbivores as it was with questions of climatic amelioration, adaptability and speed of immigration (Cornwall, 1968; Dorst, 1972; Martin, 1974).

Professor Burkhard Frenzel (1981, private communication) has indicated that in northern Europe certain areas which are now rated as high quality pasture seem to have experienced a delayed arrival of post-glacial forest as shown by generally higher levels of heliophilous vegetation. This would appear to indicate that terrain factors are also potentially important for the spread of forest particularly if they formerly led to high concentrations of animals (see also Mellars, 1975).

What is therefore offered here, is not an alternative to an orthodox succession-based hypothesis for birch expansion, but a possible mechanism affecting the timing of the extension of forest in given localities. It is therefore considered that the control, let alone decimation of early herbivore populations, would have accelerated the advance of woodland.

4.2 The expansion of pine and hazel

If one can accept the probability of man's impacts in the early Flandrian based on archaeological evidence, mainly of charcoal and scattered artefacts - occasionally settlements (e.g. Rankine and Dimbleby, 1960) it seems not inappropriate to enquire what might have taken place when people began to open up the early birch woods either with or without the use of fire. Contemporary observations after forest felling or coppicing practices, show us that undershrubs in particular grow up rapidly and flower profusely without suppression by taller trees. This will affect a variety of plants such as elder, brambles, various thorns and notably hazel. The regrowth of hazel was particularly noticeable in the Drayed forest experiments in Denmark begun by the late Professor Iversen. Fire also encourages the regeneration and spread of certain species, the rosebay willowherb is a well known example, while fire is also endemic to many areas and is a recognized ecological factor (Cwynar, 1978; Groves, 1981; Heinselman and Wright, 1973; Swain, 1973). Of all the trees represented in the post-glacial records pine is the most closely associated with fire in the sense that it regenerates particularly well in mineral terrain cleared by fire yet is itself particularly vulnerable to fires. Sharp increases of pine pollen have been associated with disturbance of mixed forests by Algonkian indians in Ontario in the 18th century, for example at Crawford Lake (J.H. McAndrews, personal communication). Sites in the English Pennines (Smith, unpublished) also apparently began to form peat in the Boreal period with charcoal and high pine pollen frequencies at the base and in the sub-peat soil. It is also recognized that hazel sends up suckers rapidly after fire and these may flower virtually the following season. Far from constituting a member of the shrub stratum as normally visualized, it thus seems a possibility that some of the hazel pollen recorded in the Boreal period could have been derived from a partially herbaceous growth.

It will be of interest therefore to note that the first decline of birch pollen - sometimes a dramatic fall - is associated with a rise of either pine and hazel together or one or other individually. Thus the two are very clearly linked at the Threshfield site (Jones, 1977) at around 160 cm and again around 120 cm (Figure 9). They are also seen in association on the Hockham Mere record (Figure 4) from the base of zone V. A variation is seen in the Flixton diagram (Figure 10) where hazel rises after the zone IV/V boundary - the estimated date of occupation of the nearby Mesolithic settlement at Seamer. While a sharp relative fall in birch pollen is to be seen coinciding with the main rise in hazel, in this formerly extensive swamp land pine does not rise until later, in fact not until after the presumed establishment of mixed oak woodland in the area. The rise of pine, when it occurs, coincides with a major fall of hazel which may even be symptomatic of persistent burning and land clearance in this later period. What is important about this particular record, apart from the element of archaeological calibration, is the fact that we have a site in an extensive lowland area which cannot have been conducive to pine early on even if it developed to be so at a later stage of the Flandrian. In this area therefore, pine would not have been able to exercise the unrestrained influence which it could have done in many other localities. Such minor, early rises as are evident in pine at this site clearly took place some distance away or are simply not significant in view of the type of data base used. The fact that there appears to be some evidence here of species selectivity certainly supports the present arguments

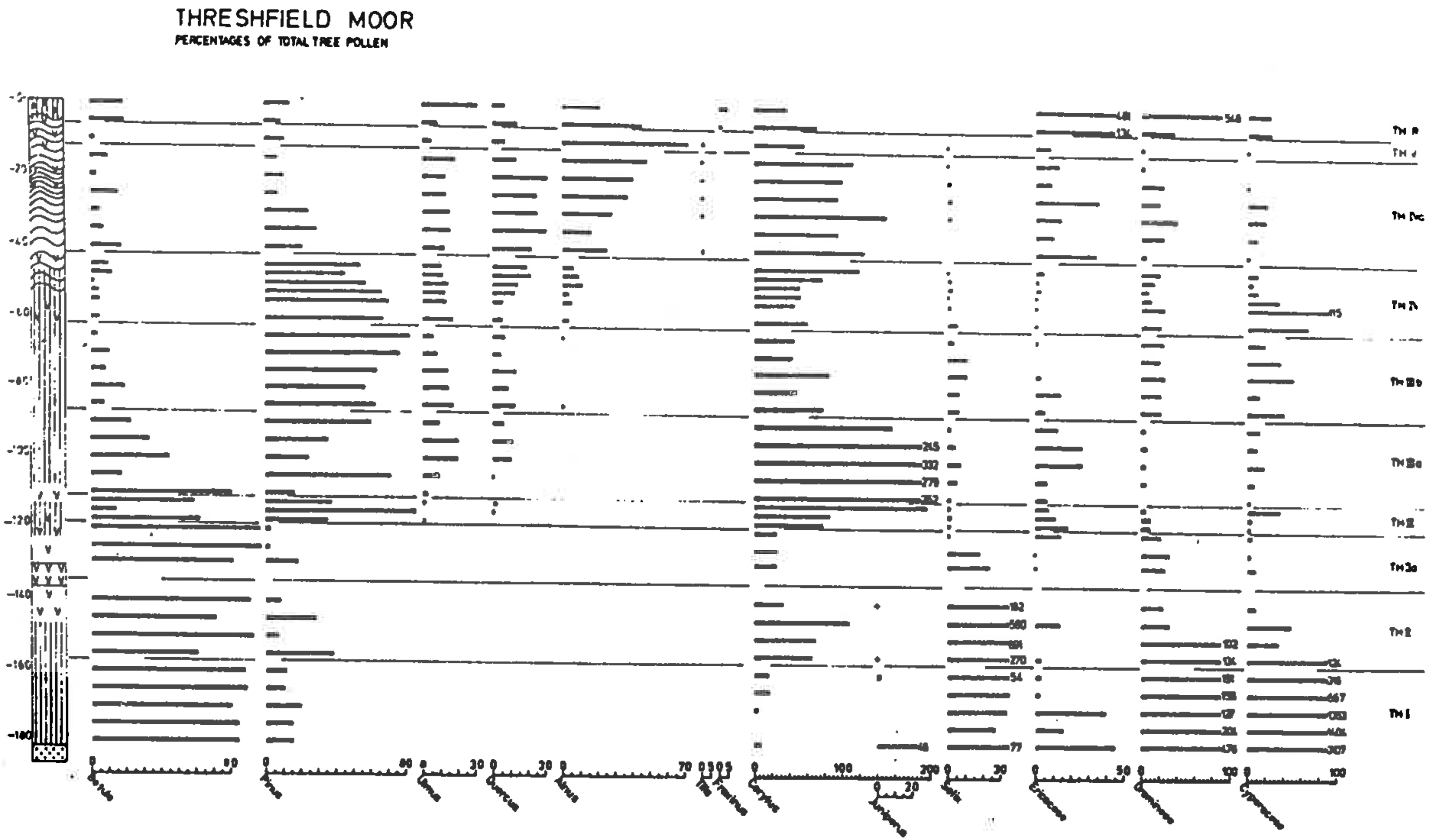

Figure 9 : A pollen diagram from the Craven district of Yorkshire
(from Jones, 1977)

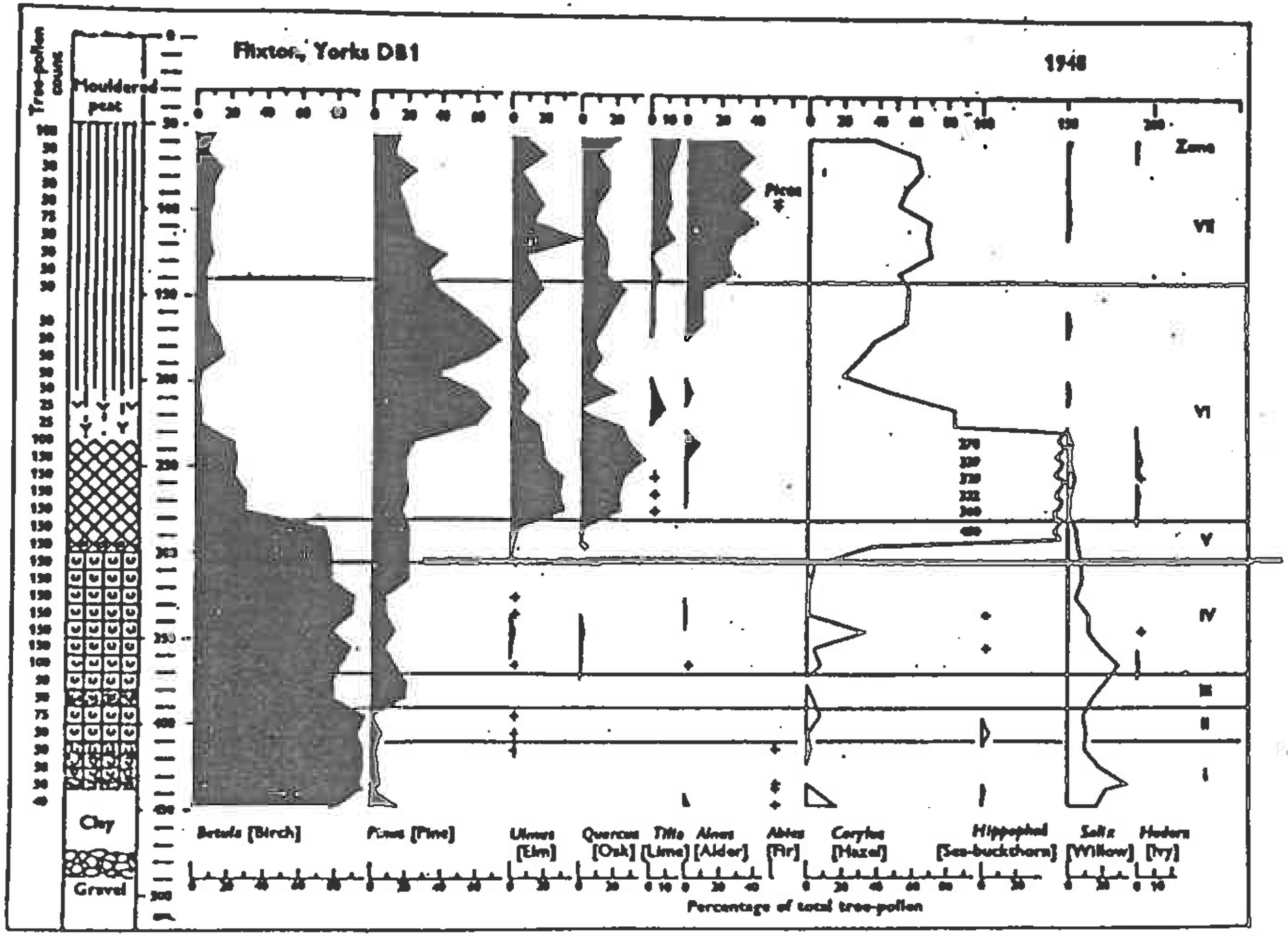

Figure 10 : A pollen diagram through the deposits of Lake Pickering in north-east Yorkshire (from Godwin, 1975)

but in particular argues against the notion that the general pine pollen increase in the Boreal is merely an artefact of reducing birch at a time when the pine pollen flux was increasing across a broad continental area. In fact, in the north of Britain as a whole, the rise of pine at this time is far less consistent than the increase in hazel.

To act as further illustration of the possible role of man at the birch/pine transition, figure 11 from a site in north east Finland (reproduced in Hicks, 1975) shows a remarkable phase in which grass pollen rises selectively with the drop in birch. Were pine simply moving in to an area of birch forest it is difficult to visualise why an increase of grass pollen should occur. The available date K-771 is 10,210 ± 150 BP. On the old climatic hypothesis the rise of pine and hazel is seen as evidence of a warming and drying of the climate. It is difficult though, to see how an undershrub, notwithstanding its relatively high pollen production, could experience such a dramatic rise in pollen output without major disturbance to these early forests. Pine also, though adapted to drier terrain - even to the drier areas on bog surfaces - would not necessarily have competed easily. It may have been capable, after establishment, of out-competing birch in selected areas but its requirement for light in the seedling stage makes it ill-adapted to the straightforward invasion of birchwoods. Far more likely is it that pine got into birch woods in the first place by colonizing blocks of disturbed ground, whether burned or not. The rate at which this took place would depend on the proximity of a pine seed source and the intensity of contemporary settlement. This may be a suitable model for explaining the north-south contrasts of the pine pollen record in Britain.

Of interest to this present discussion are the chemical investigations of lake sediments reported by Mackereth (1965). Figure 12 shows a composite set of carbon values for these sediments and Mackereth comments on the remarkable similarity of form of the data irrespective of the trophic status of the lake water. He observes that this latter fact 'lends support to the supposition that the important factors influencing the composition of the sediment are to be sought regionally rather than in individual

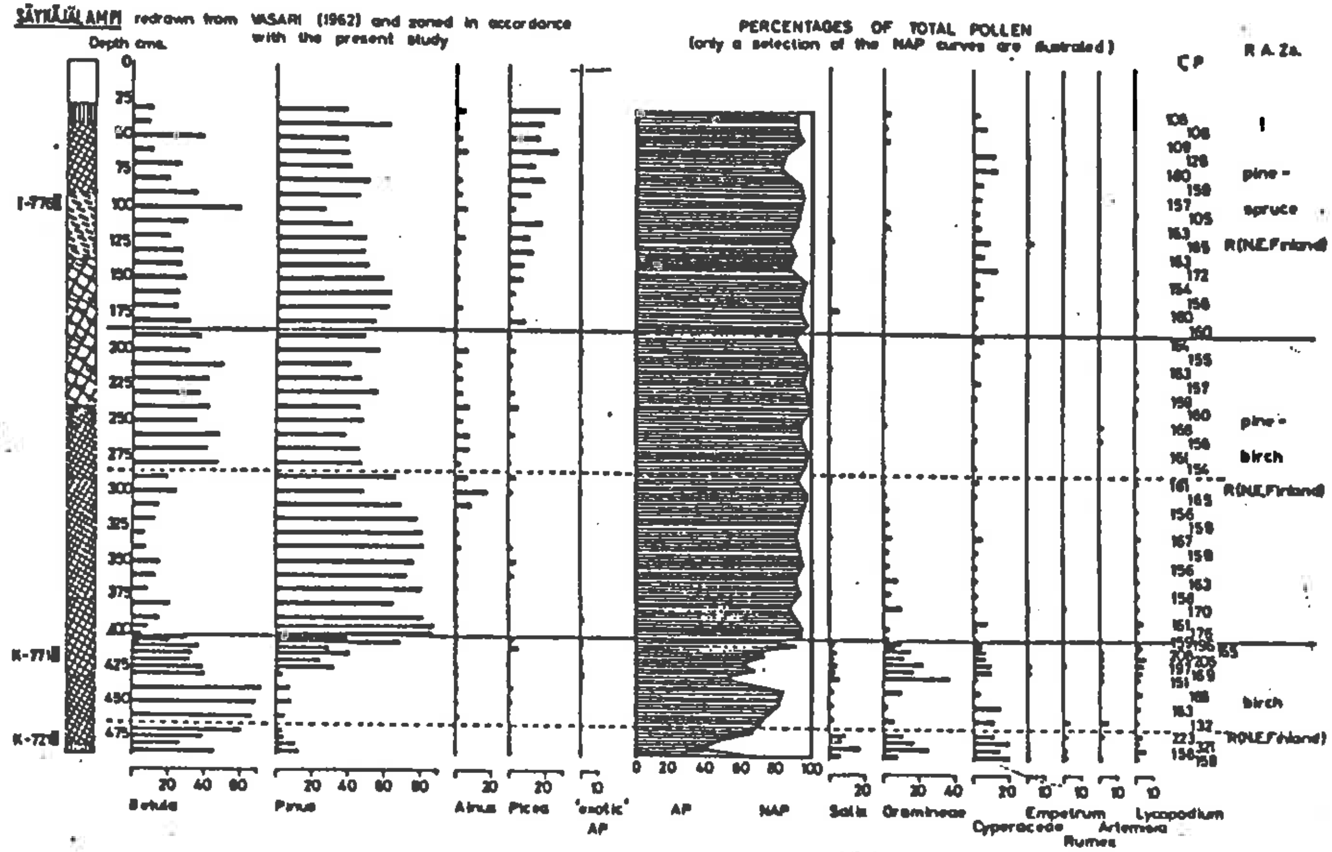

Figure 11 : Relative pollen diagram showing percentages of total pollen, Säynäjälampi, Finland

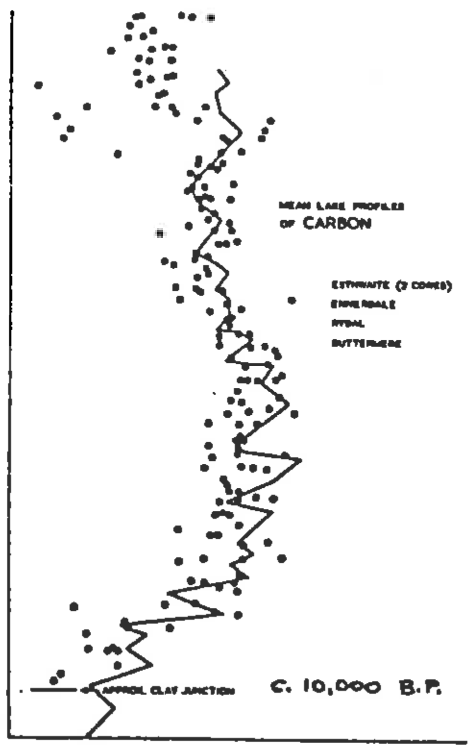

Figure 12 : Composite set of carbon content values for Lake District lake sediments. Continuous line is carbon profile for Linsley Pond, U.S.A. (from Mackereth, 1965)

lake basins'. Although lake sediments will tend to contain higher proportional carbon content under conditions of forest cover and therefore landscape stability, there must nevertheless remain the possibility that atmospheric carbon from forest fires has contributed to the high carbon values in the first half of the post-glacial period. Later on, man began to clear plots for agriculture and make more permanent changes, leading to increased sediment input into the lakes and tarns.

As already stated, fires can occur in many areas quite naturally, often by lightning strike but it is in continental, drier, hotter conditions where such fires are most likely to occur. Whether in the 'drier' Boreal episode conditions in Britain became more suitable for such occurrences we will never know, for charcoal unfortunately is never labelled with the culprit's name. The existence of Mesolithic man does however more than make up for any uncertainty concerning the suitability of the climate. Mesolithic man must have maintained fires for long periods which, on occasion may have got out of control for any number of reasons, from a change of wind direction to flying sparks. Mesolithic man may also have used fire for various purposes such as in hunting. Controlled and contained fires of no more than a hectare could still lead to ecological changes of the kind discussed, particularly if the areas affected were abandoned after short periods but we should also accept that the havoc wrought by accidental spread of fire would be several orders of magnitude greater given a closed and virtually continuous forest. A consequence of the later isolation and fragmentation of woodlands may therefore have been a commensurate protection from fire. These principles are of course central to forest planning and fire protection today.

Whatever the pattern of occurrence of forest fires may have been in Mesolithic times it is inconceivable that their effects would not have impressed themselves on contemporary society. Thus the lush regrowth and the irresistability of this to deer and other animals of open country such as the aurochs would surely have been apparent (Mellars, 1976; Simmons, 1975). The use of fire in any other way connected with hunting would thus seem to be unnecessary. The greatly improved quality of herbage in such cleared areas and its greater 'carrying capacity' should thus have had considerable benefits to man at this time (Cohen, 1977). It should also be said that the benefits of burning are largely lost after more than about 10 years (Cowan, 1956) so that either regular burning or selection of a fresh swidden might have occurred. Were such occurrences commonplace, the genetic link between them and both animal domestication and swidden agriculture will be clearly apparent. Further advantages of the clearance of woodland, with or without fire, would probably have been the rich growth of hazel which could be cut for slender poles or utilized for the crop of nuts in season. Again, the step between this and woodland management can readily be visualised (Mellars, 1975).

These remarks may appear to totally misjudge the real activities of the period - we have after all slender evidence and much conjecture, the latter however, being at least partly based on modern experience and experiments. It is for this reason worth reminding ourselves that just as 30 years ago the discovery of Neolithic trackways in Somerset was sensational, so today is the realisation that these same trackways were a standard wood product and were probably derived from coppiced trees (Rackham, 1976). It is then not unreasonable to enquire whether the evidence for ceremonial sites, land divisions, arable farming and woodland management in Neolithic times betokens a more organized and less savage image for Mesolithic people (Clarke, 1978; Clark 1980). The impact of Mesolithic people has I think been consistently underestimated. The argument that stone tools would have rendered tree felling difficult and that it was not until the advent of iron that increases in the rate of tree removal could be effected must be regarded as suspect. Furthermore, to maintain that populations were small at this time and that for this reason we do not have any obvious evidence of woodland clearance is to miss the essential point about the effects of fire. Populations may well have been low and scattered by contrast with later periods and various factors may therefore have helped the regrowth of woodland over a prolonged period but the fact is that, using fire, the ecological changes under discussion could have been effected by a mere handful of people, so the population argument is as irrelevant as the technological one concerned with the chopping of trees.

4.3 The expansion of oak

The rise of oak in the late Boreal period in England and Wales is considered to represent the consolidation of deciduous woodlands. Elm usually precedes the oak in its apparent arrival but does not normally reach its highest values until the expansion of oak (see Figure 4). Other deciduous trees, notably alder and lime follow with the onset of the Atlantic period. There seems every justification for regarding the climate of Atlantic times as being both mild and moist with sea levels approaching their ultimate datum (Jelgersma, 1966) but the label 'climatic optimum' is somewhat enigmatic. This was certainly the period when tree growth reached its furthest northward extent but it could seriously be doubted whether it was optimal in every respect for tree growth in all British habitats. Treelines were certainly higher (Pears, 1968, 1969) but the onset of peat accumulation on many upland locations at the Boreal-Atlantic transition suggests that on certain terrain the moisture balance was unfavourable to tree growth (we will return to this question in Section 4.4). Nevertheless the notion of a climatic optimum coinciding with mixed deciduous woodlands led many to regard the Atlantic phase as exhibiting climatic climax vegetation following the teachings of Clements and Tansley. This then, was the type of vegetation which followed the early periods in which birch, pine and hazel were so abundant.

As already stated a factor of undoubted importance in the comparatively late arrival of oak was its slow rate of immigration from its glacial refugia in Mediterranean latitudes. Not only this, but the refugia were probably montane and therefore fragmented so that it took a considerable period for oak-dominated ecosystems to establish themselves on a broad front.

The general assumption regarding oak's successful infiltration of birch and pine woods is that it will regenerate successfully in shaded conditions and is of a greater stature than most of the pre-existing vegetation and so will eventually overtop it and cause suppression. Furthermore the longevity of oak has undoubtedly helped it to survive through periods when its regeneration was threatened and it is probably for this reason that the species has been so enduring and become the forest dominant in Britain and much of the west European mainland during the later Holocene (Jones, 1959; Morris and Perring, 1974).

But to argue that such oak colonization occurred in an atmosphere of primeval innocence would appear to be requesting a virtual amnesty from man. For this reason we must be consistent and again ask the question, could there have been human factors which affected the timing of the establishment of this new kind of woodland? The most obvious issue to concentrate attention on is fire since this was assumed to have played an important role in the expansion and maintenance of pine. Oak, by contrast, almost certainly could not have coped with fires for it is a comparatively slow growing, slow maturing tree. A reduction in the extent and frequency of fires could have helped its colonization considerably. In this respect an increasingly moist climate or greater fragmentation of forests may have significantly reduced fire frequency but one also has to consider the amount of his habitat that man had by this time opened up. There is evidence (e.g. Simmons, 1969, 1975) that large upland areas had been cleared of their original forests and peat had already begun forming over charcoal layers as well as occasionally, Mesolithic flint artefacts. The fact that, once cleared, many parts of our uplands did not return to the original forest meant that Mesolithic man had for his duration gained the open ground he required which may have taken the pressure off the lowland and valley woods. It would be mainly the latter avenues through which oak migration could take place.

Then again, there is that other matter which seems so often to have been overlooked, animal grazing. It is possible in addition that forest animals such as the wild boar had become hunted to the point where they no longer presented a restraint on the advance of oak. It must here be acknowledged that the wild boar does not simply graze but (as with the later practice of pannage) will remove small plants and shows a marked preference for acorns. Under intense pressure from woodland fauna, including the bear and red deer, it would tend to be fast-growing species such as birch, pine and hazel which would hold their ground. We should note that any reduction in animal populations leading to oak expansion would do so without leaving any palynological clues other than changes in relative proportions of tree pollen.

It is possible that through excessive hunting Mesolithic peoples did in fact run desparately short of food (Cohen, 1977). Cohen also argues that this would have provided an incentive for domestication and a transition to the Neolithic.

There remains one problem worth commenting on before moving to consider the expansion of alder. In the north of Britain oak appears to arrive with or even after alder, while in Scotland, oak is very poorly represented. To explain this phenomenon probably requires an explanation embodying colonization time and the nature of the terrain. That oak is later in its spread in the north is not of itself difficult to understand but its relationship with the alder expansion may indicate that with the wetter conditions of the Atlantic period and the physical barriers of hills and lowland swamps, alder was able to penetrate more rapidly. Also, by the time that oak had reached the Scottish border the impact of man may have become a sufficiently potent force to prevent its effective spread.

4.4 The expansion of alder

It is intriguing as to why the red alder in North America is a recognized pioneer on the retreat of ice (e.g. Morrison, 1970) whereas the English alder, though present to a limited extent in the Boreal, only expanded at the commencement of the Atlantic period. Both species of alder have actinomycete root modules and might therefore be expected to exploit similar niches so one cannot discount 'accidents of biogeography' for this notable feature of the British Holocene.

Various explanations either have been or will now be advanced to explain the expansion of alder at this particular stage.

(1) Climatic control : It was originally, and indeed still is fairly widely held (Godwin, 1940, 1975) that the expansion of alder took place on account of the moist and mild climate which characterised the mid-Holocene. Certainly one could not argue that alder was particularly slow in migration and colonization so a climatic explanation seems the more reasonable. Furthermore, the tree which appeared to be most reduced at the time of the alder rise was pine, which might again be taken to indicate an increase in soil moisture and even waterlogging. There seems little doubt then, that the conditions of the time must have favoured alder though whether the new habitats exploited by alder necessarily were dependent on climate change, seems more doubtful.

(2) Expansion within Quercetum Mixtum : The establishment of a stable, mixed deciduous oak-dominated ecosystem may possibly have helped to generate conditions of shelter and humidity which were conducive to alder, a view previously expressed by Dimbleby (1970). This is a most realistic conception because it attempts to link the expansion with the existing vegetation and postulates an actual niche for alder which had not existed hitherto. However it is doubtful whether the alder would have been so well represented in pollen diagrams were this habitat alone to have been exploited. Supporting this latter view is the apparent detachment of the alder record from that of oak in the north of Britain, already mentioned in 4.3. The main problems of the oakwood thesis are that while oakwoods might provide more even conditions of humidity and while naturally wet spots might be available for exploitation, given a reasonable amount of forest closure at the time one might argue that alder would be heavily suppressed. One wonders therefore how alder suddenly expands within oakwoods except by way of openings. The other problem concerns soil moisture. One would normally associate lower levels of soil moisture with woodland soils than with their non-wooded counterparts. Thus, the only ways of

significantly increasing soil moisture levels (as a possible basis for alder expansion) would be via the climate or the removal of a proportion of the forest trees.

(3) Evolution of mire systems : In view of the timing of the alder rise it seems only reasonable to search for possible sites of alder expansion which were not in existence hitherto, the same basic approach as that adopted for the proposed expansion within oakwoods. It is of course possible that many of the basin sites which are so often used for palynological studies were evolving from open water bodies and reed swamp to a fen or carr at about this time. This is pure supposition and of course no-one supposes that all such sites would be synchronized to produce alder trees in this way. There may however be elements of truth about this view which particularly relate to the over representation on pollen diagrams, of wetland vegetation. Indeed alder is also a prolific pollen producer which should warn us about attaching too much importance to the absolute amounts of pollen in the deposits.

(4) Rise of sea level : As the sea approached its present level one may suppose that a considerable amount of alluviation took place within valleys, the rivers of which were grading to an ever rising sea. This would have converted the cross profiles of the lower courses of many valleys to broader, flatter features. The general trend would also have given rise to higher water tables, the latter assisted by any increased climatic wetness. Clearly such a process would have made its impact very largely in coastal and estuarine areas and alder might have been best adapted to colonizing this new terrain.

Although this particular mechanism cannot possibly account for the consistent nature of the alder rise on pollen diagrams well inland it is included here on the grounds that there is no necessity of having to favour one particular mechanism for all areas so long as the general timing is correct. In this case the final stages of eustatic rise may have been responsible for such ecological changes, just as they destroyed and buried some of the extensive Boreal woods which now remain as submerged forest beds (see for example Taylor, 1975).

(5) Wetlands created or abandoned by man : Another possible solution to the alder rise is that it relates directly or indirectly to man. However, it will be apparent that any explanation along these lines has to account for why this event did not occur earlier or indeed later in the Holocene and why it should have been so widespread.

Several examples of human activities coincident with or slightly preceding the alder rise can be quoted. There is the data from Newferry, Northern Ireland (Smith, 1975; Smith and Collins, 1971) remarkable for showing consistently higher grass pollen valuesbefore the alder rise than after and that from Seamer Carr, Yorkshire (Pilcher and Smith, 1981) both of which are associated with archaeological remains as well as charcoal. There is also the much earlier work from Danish bogs reviewed by Jessen (1935) which is appropriate to mention here because it consistently shows cultural remains predating those of alder trees which grew over the bog surfaces. But because there is an association of evidence at some sites does not of course mean that this was everywhere the case and even where the evidence is available it cannot prove conclusively a cause and effect relationship as one might hope to achieve in a contemporary study (see Birks and Birks, 1980). On the other hand neither is it reasonable in every pollen record or every locality to expect to find the localised human evidence connecting with the vegetation change in question. Furthermore it is doubtful whether palynologists have always taken careful note of small charcoal fragments in peat cores - very minute fragments easily evade detection. Therefore, given the suggestion that human activities may be implicated, it is worth considering what are the possible mechanisms by which the alder rise could have occurred.

For a start we will assume that alder, in being especially adapted to wetland is therefore a good indicator of such conditions. This idea has already been discussed under several other headings. We also assume this would be land too wet for birch and hazel and certainly too wet for pine, all of which at different sites and to differing degrees show a decline on pollen diagrams coincident with the rise of alder. Oak, on the majority of pollen diagrams, remains fairly steady which may again be a useful clue regarding the nature of the ecological changes taking place. A possible scenario therefore is that deforesting activities in the context of the ruling climate led to swamp conditions in low lying areas and to mire conditions in upland areas. In both cases alder alone may have been capable of recolonizing these areas. Removal of trees may thus have led to many flushed sites in hill areas while so long as alder remained effectively nodulated it could also spread into nitrogen-poor areas of swamp and peat accumulation. Unhappily the lack of modern parallels is limiting to the development of this view, yet the high levels of alder pollen in upland areas strongly indicate an important former role for alder as well as birch and hazel in the prehistoric past (Moore, 1969; Smith, R.T., 1970; Smith and Taylor, 1969). Moore (1973) and Merryfield and Moore (1974) consider that blanket peats began to form through just such a series of man-induced changes.

An actual example from the Nidderdale Moors in Yorkshire (Tinsley, 1975 and see Figure 13) will illustrate the trend envisaged. Here, the rise of alder *(Alnus)* is associated with the decline of hazel, pine and birch and the existence of actual alder trees is proven by the wood remains in the peat, which is that of an alder carr. That such a woodland development took place on the site must indicate a lack of human interference throughout the duration of the zone N-B (Broadly speaking the Atlantic) but the end of this phase coincides with a sharp reduction of tree pollen which, together with a rise in certain non-tree pollens and *Fraxinus* (ash) would seem to strongly implicate man. This is in fact the Atlantic - Sub-Boreal transition which, as previously stated, is associated with the onset of Neolithic cultural expansion. A progressive decline of tree pollen can thus be seen in Figure 13 above about 300 cm. It is therefore tentatively suggested that human influence accounts for the rise as well as the fall of alder at this site.

There is then some limited evidence not only to link man with the changes at the so-called Boreal/Atlantic transition but that these changes created a more hostile environment such that he moved away to drier sites leaving alder to take over. Such is the conclusion to be drawn from the Danish material and is strongly

Figure 13 : Total pollen diagram (part) from Fountains Earth Moor near Pateley Bridge, Yorkshire (from Tinsley, 1975)

indicated in Northern Ireland. It must therefore be tempting to view the increasing evidence for Mesolithic impact on areas such as the North Yorkshire Moors in terms of the abandonment of wetter sites at lower levels. This provides a model or backcloth for the observed concentrations of prehistoric sites in upland areas despite the strong argument that the latter is merely a function of site survival (see e.g. Stevenson, 1975).

5. HUMAN INFLUENCE AND NATURAL SUCCESSION - ARE THEY INCOMPATIBLE?

5.1 General discussion

It could well be imagined that there are insuperable problems in trying to explain vegetation changes throughout the entire Holocene in terms of man's activities and in this section some, if not all, of the real or imagined difficulties will be discussed.

Probably the most acute difficulty is one of association, namely how we demonstrate that certain changes are due to man's influence as distinct from examining the changes and reading into them a possible human connotation. As has been discussed already and as is well recognized in palaeoecology, evidence on matters of cause and effect has to be largely circumstantial. Evidence, if such it may be called, will be more or less convincing depending on how closely associated are the human remains with the floristic records. Equally, the link is the stronger the more species (ideally an assemblage) appear to be telling the same story. It must also be recognized that we gain considerable insights into the effects of man's activities by contemporary observation and experimentation as in the cases of Draved and Butser. This problem of association is of course not unique to man's effects. How, for example, given the complex interactions within the landscape do we argue convincingly for vegetational changes responding clearly to climatic change? (see Section 2.2).

There is thus an inevitable tendency in palaeoecological studies, as with archaeology, for whole structures of reasoning to be based on a consistency of evidence rather than knowing that certain process relationships actually applied. This probably accounts for why a current trend in archaeology is towards ethnographic enquiries. The problem is of course that hypotheses concerning former processes of change are only rarely susceptible to testing (e.g. field experiments) so that ideas which are thrown up along the way take a long while to either be fully accepted or respectfully buried.

For a variety of reasons, covered in previous sections, it is not until the Neolithic, in general terms, that evidence for human interference in a palynologically acceptable form becomes recognizable.

Equally it is after this period that it becomes virtually impossible to assign climatic or successional significance to the records thanks to man's over-riding influence. Figure 14a is a representation of this traditional view of man's influence on vegetation as being of almost no consequence prior to the Neolithic but gaining ascendancy thereafter. But by the Neolithic the archaeological evidence suggests a landscape already fundamentally modified, not merely emerging from forest cover. The argument which has therefore been sustained throughout the later part of this paper is that man has been active throughout the entire Holocene and that evidence for his actions is of a different kind in different periods because of changes in the landscape itself and the way in which man's activities interacted with both the vegetation and the ruling climate. Figure 14b is therefore designed to represent the present view of man's role in the Holocene. It should be stressed that the diagrams are not intended to be a portrayal of cleared versus forest land but of the proportional influence of man in bringing about vegetation change.

It can also be said that such vegetation sequences have all happened before (in previous interglacials) and that there is no need to have man explain it this time. Furthermore similar sequences took place in other parts of the world and is the same anthropocentric explanation to be applied elsewhere? This is equivalent to assuming that man and natural succession provide two mutually exclusive hypotheses which of course they do not. To start with, processes of climatic change which were initiated during the last phase of the Devensian provided the stage on which a whole sequence of environmental changes could take place, only minor oscillations of climate occurring within the Holocene. Both plants and man responded to these changes. We have long considered that the Holocene forest changes signified distinct waves of vegetation. But from pollen diagrams it is evident that the first records of certain species often long precede their rise, suggesting that the climate was quite suitable for them but that an appropriate trigger mechanism had not yet been provided for their expansion. One can visualise therefore that at particular times the expansion of certain species may take place from within the existing diversity of flora rather than as freshly acquired elements.

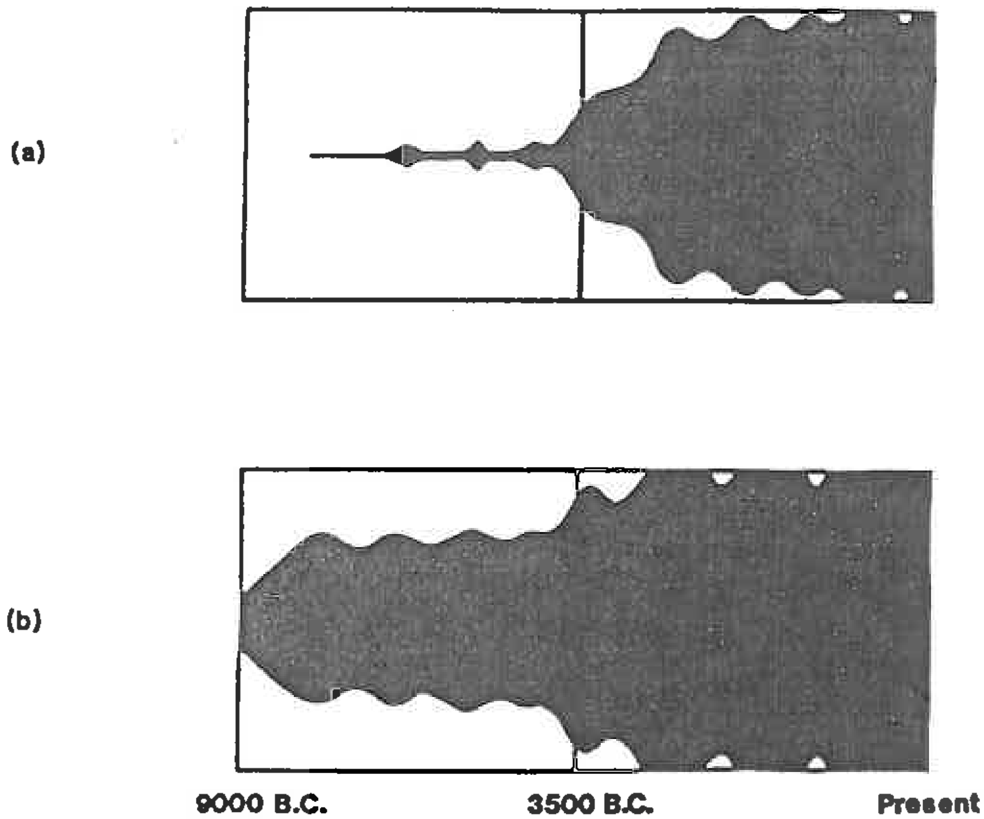

Figure 14 : Two conceptions of man's role in the British Holocene

This is a principle reason for considering that man's actions could lead to consistent changes in the vegetation within a limited period of time. Furthermore there is little justification for supposing that man's actions in the past were random and inconsistent (see the previous discussion about fire). Indeed the elm decline is a remarkable case in favour of consistency. Types of impact should therefore be expected to be consistent within a given cultural context.

What we are saying therefore in the first instance is that within the context of climate and available species, man is capable of altering the timing, intensity and rapidity of floristic changes; in other words of accelerating some processes, retarding, distorting or preventing others. These kinds of issue were uppermost in Dimbleby's mind (e.g. Dimbleby, 1962) regarding the origin of heathlands and consequent widespread changes in soils. In this respect we must bear in mind that the great variety of changes in our present interglacial have so far occupied a mere 10,000 years, a remarkably short period within which progressive and retrogressive trends have been completed compared to previous interglacial periods.

Whether man has also led to changes taking place which were not destined to occur anyway should provide scope for future debate but since selective processes often accompany man's activities, favouring particular plant and animal species, it would be unreasonable to maintain that man was not capable of influencing the course of vegetation history and the composition of the vegetation as well (see figure 15).

To return to the interglacial issue once more, it must be stated that the species mix, palaeogeography, climate and lengths of time which are being compared are all different so that any comparisons can only be made on the most general features. Interglacial records are also frequently rather condensed and therefore in the Holocene we not only have a shorter period but greatly increased resolution of floristic changes within it. Similarities certainly exist (see West, 1977) but there are some differences. One of the most interesting has been reported by Deacon (1974) namely that the rise of hazel occurs progressively earlier in each interglacial episode. Might not this be evidence of an increasing ability of man to adapt to changes on retreat of ice and possibly also for successively larger human

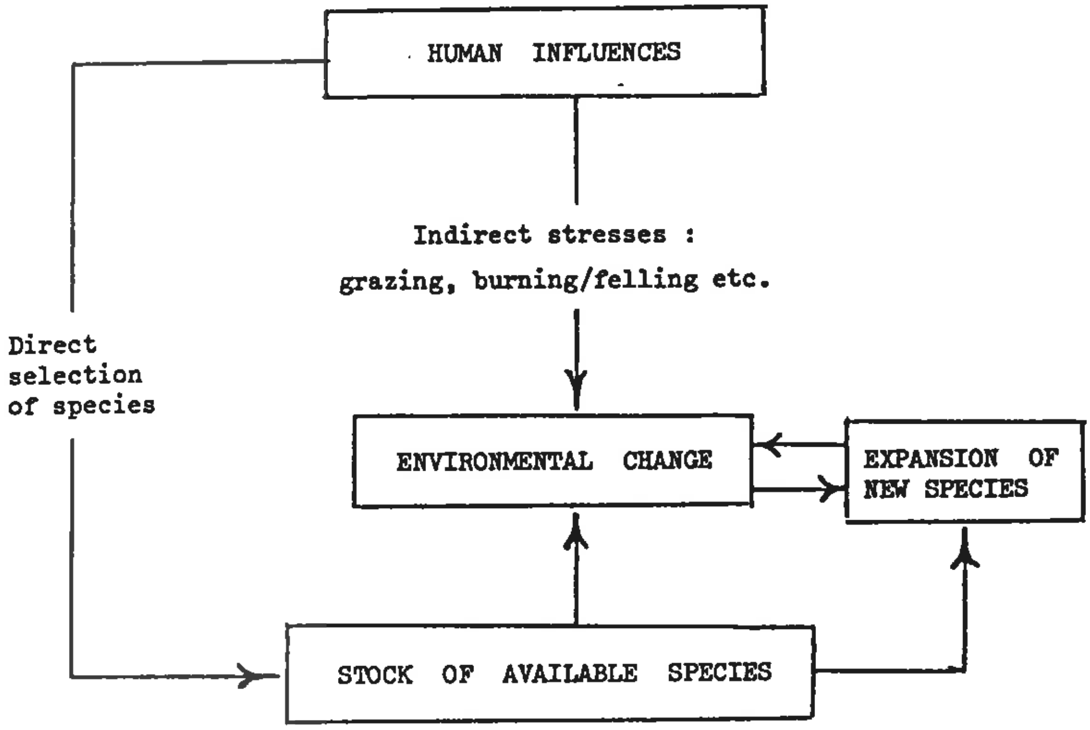

Figure 15. Man's influence on expansion of new species

populations? In any case one should not fall into the trap of assuming that man was not arcund at the time for the archaeological record extends back through several glaciations. Indeed there are two definite examples of Acheulian forest clearance known to the present writer (West 1957; Turner, C., 1970) which display all the required tell-tale reductions of tree pollen and rises in the pollen of herbaceous species. The answer then, to the initial statement, is that it may indeed all have happened before, but so has man - maybe not to develop iron tools and nuclear physics but possessing an inventory of deadly weapons against the forest including fire and the axe and we may also suppose that his relationship to animal populations was not far removed from that during the early Holocene.

As regards other parts of the world, the fact that Holocene vegetation sequences take place and may possibly do so substantially without man's assistance (as seems likely in Chile for example) does not prove that man cannot exert such influence. A climatic viewpoint is generally adopted in North America as explaining the vegetation changes. On a continental scale with a vastly greater climatic spectrum, climatic changes may be easier to perceive but as more becomes known about early man in the Americas insight may yet be gained into the former role of man.

5.2 Conclusions

The main purpose of this paper has been to try to develop thought about the overall impact of man on British vegetation history. For this purpose I have particularly chosen to focus attention on the earlier Holocene which, apart from studies notably by Simmons and A.G. Smith, is a period about which we have far less detailed palaeoecological information. The criticism that parts of the text appear to constitute an exercise in theoretical palaeoecology may easily be made yet I would merely say that, as with any hypothesis, let it be tested whenever appropriate opportunities arise. Our ideas about vegetation changes have until now been conditioned by the strictures of a climatic hypothesis and only when the evidence for man's activities appeared overwhelming after the Neolithic was his influence built in to the model. I have therefore tried to identify the need for a more consistent approach to the impact of man, rather than picking and choosing which bits of the Holocene records are susceptible to explanation in terms of 'natural succession' and which are essentially due to man's influence.

Although a great deal more evidence needs to be assembled to support a comprehensive thesis concerning the effects of man's activities I hope it will be seen that existing interpretations of human impact from pollen diagrams are bound to give only a partial view. Effectively, one cannot argue convincingly for 'natural processes' in the early Holocene merely because of a lack of evidence for clearance phases. It is anticipated that these ideas will allow the reinterpretation of a number of existing early Holocene pollen records as well as offering a more realistic and flexible framework within which regional variations in vegetation history can be interpreted. Some of the remarks made herein may also encourage others to be more watchful about archaeological evidence relating to early Holocene changes and further, to aim palaeoecological studies more directly at early archaeological sites in order to reduce the number of peat cores which can only be described as 'shots in the dark'.

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