AN ANALYSIS OF TWO UPLAND ORGANIC PROFILES FROM THE LATER MESOLITHIC

A palynological investigation supported by radiocarbon dating of sites on Dartmoor and Bodmin Moor, England

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ABSTRACT

Two peat profiles have been examined from upland sites in England at Blacklane Brook, Dartmoor and Dozmary Pool, Bodmin Moor. The techniques employed include pollen analysis, estimation of relative amounts of charcoal present and radiocarbon dating. Both sites have been subject to previous less detailed palaeoecological investigations which gave indications of fluctuations in the extent of open vegetation during prehistory.

The aim of the study is to test the hypothesis that upland vegetation changes were taking place during the Later Mesolithic period which could be attributed to the activities of man. The results from the radiocarbon dated profile at Blacklane Brook show that during this period irregular increases in the proportions of taxa indicative of open ground took place associated with decreases in tree and shrub species representation. Charcoal is present within the profile indicating that burning may have been the cause of the observed decreases in woody vegetation. The link between vegetational changes and the purposeful use of fire by man is conjectural. However, the possible reasons for such a practice are discussed.

Inversions in the sequence of radiocarbon dates at Dozmary Pool suggest profile disturbance and/or discontinuities. Assuming that the part of the profile covered by the Later Mesolithic is undisturbed it gives evidence of fluctuating areas of open vegetation, again accompanied by charcoal within the profile.

The limitations of the techniques employed are considered in the light of the implications these have for the interpretations drawn. The future of studies within the field of vegetation history is thought to require refinements in the degree of resolution of the technique of vegetation reconstruction accompanied by greater attention being devoted to the statistical and sampling problems of pollen analysis.

"The landscape is our heritage and our future.
We can read the past in it, and if we protect it,
it offers us a future."

Isabella Jedrzejczyk

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STATEMENT OF COPYRIGHT

CHAPTER 1

INTRODUCTION

1.1 The Scope and Purpose of the Investigation

Using the principal techniques of stratigraphic recording, pollen analysis and radiocarbon dating two upland organic profiles from the south west of England have been examined to obtain information regarding the nature of the vegetation cover during the Later Mesolithic period. The aim is to provide evidence either in support or refutation of the hypothesis that a detectable impact was taking place on these upland landscapes which could be attributed to man.

The Later Mesolithic cultural period has been dated to span approximately the years 8,750-5,000 bp (Switsur & Jacobi, 1979; Simmons & Tooley, 1981). During this time man is believed to have practised a hunting, gathering and fishing economy, and to have been present in relatively low numbers in England. Earlier workers (e g. Iversen, 1949) were of the opinion that at this stage humans had very little effect on the surrounding environment.

However, the idea has evolved that far from being an insignificant factor in environmental change man was, at least in certain of the more marginal habitats, influencing the vegetation cover in a way capable of detection by current techniques (see Rankine, Rankine and Dimbleby, 1960; Dimbleby, 1962; Roux & Leroi-Gourhan, 1964; Keef, Wymer & Dimbleby, 1965; Smith, 1970; Fowler, 1978; Simmons, 1979).

It has been proposed (see Mellars, 1975) that in the upland zone man was employing fire to stimulate the growth of young shoots and open up the vegetation to attract grazing animals and facilitate hunting. This would result in an increase in the extent of open types of vegetation. Over 180 phases of forest interference or recession from British pollen diagrams during the Mesolithic period have been recognised by Innes (1981). Recent pollen diagrams where indications of forest disturbance have been linked to the possible activities of Mesolithic people include Simmons & Innes (1981), Chambers (1983), Turner & Hodgson (1983) and Smith (1984). From a study of non-marine mollusca at a Mesolithic site in Dorset, Preece (1980) describes a partial opening of the vegetation cover which is tentatively ascribed to human disturbance.

The archaeological evidence of the period is largely restricted to scatters of flint tools characterised by narrow blade microliths, a few organic remains such as hazel nut hoards, and some examples of post holes, pits and hearths representing dwellings and other features. To form a picture of the Later Mesolithic period it is necessary to combine as many lines of evidence as possible. These include archaeological remains, inferences from the use of ethnographic parallels and various types of palaeoenvironmental information, such as micro- and macrofossil analysis, and the presence of charcoal deposits (Simmons & Innes, 1981) and the indicators of soil erosion (Simmons et al, 1975). The different categories of evidence can be set within the chronological framework provided by radiocarbon dating. In Chapter 2 a discussion of current information available within these areas is given.

It is only by combining knowledge from the fields of archaeology, botany, pedology and biogeography that reasonable inferences can be drawn about the nature of any impact by man on the landscape during the Later Mesolithic. Much of the evidence is of a circumstantial type, and care has been taken to draw attention to the limitations which this imposes.

1.2 The Choice of Sites and Methods Used

The two sites investigated are located at the upper reaches of Blacklane Brook, Dartmoor, Devon and at Dozmary Pool bog, Bodmin Moor, Cornwall. They are both upland sites with substantial peat deposits containing well-preserved pollen and plant macrofossil remains. Standard techniques of stratigraphic analysis and palynology (see Chapter 3 and Appendices 1 and 2) have been used to obtain palaeoenvironmental information.

At each of the two locations a peat profile has been examined in detail and stratigraphic information recorded, including measurements of any charcoal present, pollen analysis and the identification of wood remains. Pollen diagrams have been produced and zoned for each site to allow an interpretation of the environmental history to be made. Radiocarbon dating of the peat has been employed to enable the data to be placed in its chronological context.

Both sites were chosen as previous analyses had indicated the likelihood of possible early impact by man on the vegetation (Simmons, 1964 for Blacklane Brook; Conolly, Godwin & Megaw, 1950 and Brown, 1977 for Dozmary Pool). In the case of the Dartmoor site no firm dating evidence was then available. At Dozmary Pool the period covered by the Later Mesolithic was not investigated in much detail by Brown and his radiocarbon dates were obtained from material predating this time. Therefore both sites were considered worthy of more comprehensive investigation.

Upland sites were selected as these areas provided the necessary conditions for peat accumulation and for the preservation of sub-fossil remains. Also archaeological evidence indicates the former presence there of Mesolithic peoples. It has been proposed that the marginal nature of the upland areas with cooler, wetter climates and poorer soils made them more likely to be altered by the activities of man (Dimbleby, 1978), and that the less vigorous vegetation cover there would have been an attraction.

Thus upland areas possess the advantages of frequently having well-preserved biostratigraphic deposits which enable a picture of past environmental conditions to be reconstructed, and which possess ecosystems which are more likely to change as a result of interference by man, plus the known presence of human societies during the Later Mesolithic.

It must be borne in mind that when dealing with this period of prehistory many uncertainties are involved, particularly regarding the process of reconstructing environmental changes from the fragmentary and selective evidence available. Many aspects of early human social organisation are impossible to reconstruct with certainty, and so all interpretations must be examined critically. When only slight changes are being looked at knowledge of the degree of reliability of the techniques employed is important to gauge the accuracy of the interpretations drawn. This aspect is discussed in Chapters 4, 5 and 6.

1.3 Note on Standard Terms and Nomenclature

Radiocarbon dates are quoted in years before present (bp), which is taken as the internationally agreed year of 1950. Where the initials bp, bc and ad in lower case are used this refers to uncalibrated radiocarbon years. Uncalibrated radiocarbon years have been quoted in this thesis since the precise influence of the de Vries effect on the accuracy of radiocarbon dating is not yet fully resolved.

Botanical nomenclature follows that of Clapham, Tutin & Warburg (1962). The keys of Moore & Webb (1978) were used for pollen and spore identification. The term pollen analysis is taken to include both pollen and spores. Where the term man is used it encompasses both men and women.

CHAPTER 2

THE NATURE AND EXTENT OF EXISTING KNOWLEDGE REGARDING THE LATER MESOLITHIC IN BRITAIN AND THE CONTEMPORANEOUS ENVIRONMENTAL CONDITIONS

2.1 Introduction

This chapter seeks to place the study in the context of existing knowledge regarding the Later Mesolithic period and the environmental conditions of the time. First there is a brief discussion of Flandrian chronology, and of the broad environmental changes which have taken place since the last ice age, concentrating on the period in question. Next the material archaeological evidence from the Mesolithic period is examined to establish the types of direct information available about Mesolithic man. This is followed by a brief discussion of how the archaeological and environmental evidence has been interpreted from the point of view of palaeoeconomies. The development of views about the relationships between Mesolithic man and the environment are outlined, and attention is drawn to some of the assumptions behind palaeoeconomic models.

2.2 The Flandrian Environment of Britain

The major changes in the vegetation and climate of Britain since the last ice age have been established. Accounts of the changes in vegetation on a broad scale can be found in Godwin (1975) and Pennington (1974), although new ideas have emerged regarding some of the finer detail as described in Section 2.4.

Research workers have divided the Flandrian into a number of zones which are summarised in Figure 1. The investigations of Blytt (1876) and Sernander (1908) into the distinct vegetational layers

Fig. 1 Summary of the approximate relationships between Flandrian zonation schemes for England and Wales.

Chronozones	Blytt & Sernander climatic periods	Godwin zones	Vegetation	Archaeology
Flandrian III Late Temperate	Sub-Atlantic (decreasing warmth)	VIII	Alnus-Betula-Quercus-Fagus.	Historical
	Sub-Boreal (warm, dry continental)	VIIb	Quercus-Alnus.	Iron Age
				Neolithic 5010∓80bp
Flandrian II Early Temperate	Atlantic (climatic optimum, warm, wet, oceanic)	VIIa	Quercus-Ulmus-Alnus.	Later Mesolithic
				7107∓120bp
Flandrian I Pre-Temperate	Boreal (becoming warmer and drier)	VI	Pinus-Corylus-Ulmus.	
		V	Betula-Pinus-Corylus.	Earlier Mesolithic 9798∓200bp
	Pre-Boreal	IV	Betula-Pinus-Juniperus.	Earlier Mesolithic

Chronozones: Sparks & West(1972).

Climatic Periods: Blytt(1876) and Sernander(1908).

Godwin Pollen Zones: Godwin(1940).

Dates: Hibbert, Switsur & West(1971).

revealed by plant macroremains in peat deposits led to the proposal of a succession of what were thought to be climatically controlled periods for the post-glacial in north west Europe. Later, on the basis of changes in the representation of tree species in pollen diagrams Godwin (1940) described a series of pollen assemblage zones for England and Wales.

The boundaries of the pollen zones have subsequently been radiocarbon dated, but an inconsistency in dates from different sites has been revealed by Smith & Pilcher (1973), with the exception of the elm decline at the end of zone VIIa, the Atlantic period. Thus the contemporaneity of pollen zones in diagrams from different locations cannot be assumed without the confirmation of independent dating. As with most types of continuous data the imposition of sharply defined boundaries is artificial and the method of their derivation should be clearly understood.

In Figure 1 the relevant zone boundaries are dated according to those found at Red Moss, Lancashire (Hibbert, Switsur & West, 1971), which has been designated as the type site for the Flandrian stage in England (Hibbert & Switsur, 1976).

West (1970) tackled the problem of relating the zonation of pollen diagrams to the process of correct biostratigraphical subdivision and proposed the chronostratigraphical framework of an initial tripartite division into Flandrian I, II and III. The chronozone sequence relates approximately to that of Godwin's pollen assemblage zones as shown in Figure 1.

From these various schemes of subdivision of the Flandrian it can be seen that the Later Mesolithic period falls partly in late

Flandrian I and principally in the Flandrian II chronozone, which is equivalent to the late Boreal and the Atlantic periods, or to pollen zones late VI and VIIa. The Atlantic period has been termed the 'climatic optimum' and winter temperatures are believed to have averaged 2°C above those of today. Temperatures began to fall off again from about 5,300 bp (Frenzel, 1966).

Detailed accounts of the changing Flandrian environment with a particular emphasis on the role of man can be found in Simmons & Tooley (1981) and Evans (1975). Here it is appropriate only to draw attention to the most significant events and characteristics of the period under scrutiny.

The pattern of relative sea level changes around England after the retreat of the ice is important. During the Mesolithic, a period of approximately 5,000 years (c.10,000-5,000 bp) in general relative sea level rose considerably, probably at an irregular rate punctuated by interludes of recession (Tooley, 1978).

At the outset of the Mesolithic Britain was still connected by land to the continent. However, it is believed that by about 7,800 bp (Kolp, 1976) this link was finally broken. A number of important consequences were produced, including a presumed increase in the oceanicity of the British climate, a reduction in land area and the creation of a physical barrier to the easy dispersal of plant and animal species including man.

From the evidence of the analysis of pollen and plant macroremains, the Boreal period was a time of forest expansion and migration under conditions of increasing warmth, with a significant expansion of Corylus/Myrica particularly in the west. Species requiring open habitats were suppressed and often excluded so that by the end of the Boreal an almost continuous forest cover dominated by Betula, Corylus/Myrica and Pinus is postulated.

The opening of the Atlantic period is marked by a substantial increase in alder pollen, thought to reflect warmer and wetter conditions which caused a rise in the level of groundwater. Additionally, Smith (1984) has reviewed pollen evidence from a number of sites where he interprets the rise in alder between 8,000-5,000 bp as resulting from a widespread disturbance of the forest cover which locally reduced competition.

Tilia, the most thermophilous of the British trees reached its maximum extension during the Atlantic. Most of England was covered by deciduous woodland dominated by Quercus, Tilia and Ulmus, with abundant Corylus/Myrica and Alnus, and some Fraxinus and Betula. However, regional and local variations inevitably occurred dependent on intricate and varying relationships between biological and environmental factors.

In the uplands the nature and extent of woodland cover is often not clear, and it is one of the issues focused on at the two sites investigated. There are many uncertainties involved in unravelling the links between the original vegetation, the sub-fossil evidence available today and the reconstruction of the characteristics of that vegetation.

Pennington (1974:56) quotes examples of pollen diagrams indicating continuous forest cover up to at least 2,500 feet (758m) on well-drained sites, with bog communities developing on more level wet areas. Only above about 3,000 feet (910m) was open montane grassland thought to have existed. However, there is an increasing body of evidence indicating some forest reduction in the uplands which has been attributed to man as discussed in Section 2.4. The end of the Atlantic period is marked by the decline in frequency of Ulmus pollen at around 5,000 bp and this coincides roughly with the close of the Later Mesolithic period.

2.3 The Archaeological Context of the Later Mesolithic Culture

General introductions to the Mesolithic archaeology of England have been given by Mellars (1974), Morrison (1980), Phillips (1980) and Megaw & Simpson (1979). Here, the aim is only to outline the nature of the available archaeological evidence in order to clarify the foundations of the models of palaeoeconomies which have been proposed.

Archaeologists have divided the Mesolithic on the basis of stone tool typology and radiocarbon dating into an Earlier and Later phase (Jacobi, 1973). The Earlier Mesolithic is thought to have begun in Britain after about 8,500 bc (10,450 bp), with the transition to the Later Mesolithic during the seventh millenium bc. This transition between the two is not sharply defined. In England the oldest known Later Mesolithic site is at Filpoke Beacon, County Durham, which is radiocarbon dated to 6,810 bc (8,760 bp). The succeeding Neolithic period began around 3,000 bc (4,950 bp).

Small stone tools, termed microliths, are characteristic of the Mesolithic. Those typical of the Earlier Mesolithic are of the broad blade, non-geometric type, whereas those of the Later Mesolithic are mainly narrow blade, geometric forms. Assemblages have been subdivided according to the predominance of different types, and in some cases inferences have been made on this basis as to the functions carried out at particular sites (eg. Mellars, 1976).

As has been pointed out by Clarke (1976) there is no certainty in the ascription of specific uses to particular microlith types. It is thought by some workers (eg Mellars, 1976) that the microliths acted as barbs on missiles such as arrows. In some cases in situ alignments of microliths have been discovered indicating that they formed parts of composite tools. It is not impossible that these may have been used for the harvesting of plant foods. Studies of Mesolithic human teeth from the Breton sites of Teviac and Hoedic ascribe their wear patterns to a plant rather than an animal diet (Pequart et al, 1937). Microwear analysis of stone tools may help to shed some light on their functions and provide firmer evidence for the interpretation of palaeoeconomies.

Artefactual evidence from the British Mesolithic comes from numerous unstratified surface finds and from a relatively small number of detailed site excavations. Wymer & Bonsall (1977) provide a gazetteer of Mesolithic find spots, which reveals the wide distribution of material remains. In the counties of Devon and Cornwall alone they record over two hundred and fifty find sites of Mesolithic stone tools. However, it must be borne in mind that this type of evidence is extremely selective. Only artefacts made of resistant substances are generally preserved, and these are subject to destruction or displacement by disturbance, apart from the chance elements involved in actual discovery.

Thus the distribution of Mesolithic find sites has to be interpreted with extreme caution because of the biases in the nature of the evidence available. Many artefacts have no details of stratigraphic context or chronology. An added complication regarding the Earlier Mesolithic is that sites have been lost through inundation by the sea.

Apart from stone tools other objects recovered of Later Mesolithic date include antler and bone points, fragments of red ochre, charcoal deposits, caches of hazel nuts, coastal shell midden deposits and occasionally other organic materials including bone fragments from food animals. At the classic Earlier Mesolithic site of Star Carr, Yorkshire many organic materials were preserved by waterlogging including a wooden lakeside platform, wooden paddle and rolls of birch bark (Clark 1954, 1972). Undoubtedly Mesolithic peoples would have made much use of wood, hides and vegetable fibres which are rarely preserved.

Excavations at Later Mesolithic sites have revealed traces of hearths, depressions and postholes, for example at Abinger, Surrey (Leakey, 1951) where they have been interpreted as representing pit dwellings. Where sites have been systematically excavated, analyses can be made of the density and distribution of artefacts and an indication of site size obtained. Mellars (1976) divided settlement types on the basis of size, noting that the largest are generally confined to the lowlands. This division has been utilised in the construction of models of palaeoeconomies of the period (see Section 2.4).

From this brief summary of the known types of Later Mesolithic remains it can be seen that interpretations are of necessity based upon incomplete data owing to the problems of preservation, discovery and dating of evidence. However, provided that these limitations are borne in mind it is possible, when the archaeological and environmental evidence is viewed conjointly to construct hypotheses about the mode of life during the Later Mesolithic.

2.4 Later Mesolithic Vegetation Changes and Palaeoeconomies

The last two sections dealt with the broad environmental conditions during the Later Mesolithic and the nature of the artefacts from this period. In this section subtler changes in the Atlantic vegetation are looked at together with proposed explanations in relation to palaeoeconomies.

Detailed pollen analyses from many sites in Britain have revealed fluctuations in genera indicative of periods of opening up of the forest vegetation prior to the Neolithic. Discussions of these phenomena together with possible explanations may be found in Smith (1970); Evans, Limbrey & Cleere, (1975) and Simmons & Tooley (1981). These clearances, apparently often small scale and temporary, have in many cases been attributed to Mesolithic man. Prior to the 1960's it was thought that pre-agricultural man interfered very little with the vegetation (eg Darby, 1956:189).

Evidence from peat and soil pollen analyses (eg Dimbleby, 1962) coupled with the presence of charcoal deposits has resulted in the conclusion being drawn that fire had led to deforestation. It has been hypothesised that Mesolithic man in the uplands made deliberate use of fire in order to produce vegetation attractive to herbivores and thus to aid the hunting process, and also possibly to increase the nut harvest by encouraging hazel. Although charcoal deposits in many upland areas indicate widespread fires having occurred it is not possible to prove that they were started deliberately,or for that matter unintentionally, by man.

The main supporting data for the creation of open areas in the uplands comes from the identification of temporary clearance phases in pollen diagrams plus in some cases the continuous presence of taxa indicative of permanent forest recession. Peaks in the frequency of Corylus/Myrica pollen may have been the result of burning, and inwash stripes of mineral matter could have been a consequence of surface erosion (Simmons, 1979).

In the uplands the environment, with its marginal nature, has been more susceptible to the influences of man's activities than in the lowlands. There is some controversy as to the extent of human influence in the processes of upland soil deterioration, peat formation and deforestation (Moore, 1972, 1975; Ball, 1975). Maguire (1983) found a complex situation regarding the onset of peat initiation, with dates from along the base of a transect at Broad Amicombe Hole, northern Dartmoor, varying considerably. Apart from the postulated clearance activities of man a complex of other factors is involved, not least the numerous changing climatic variables coupled with the passage of time. Undoubtedly the relative importance of specific factors will vary depending on the situation concerned, but in a marginal environment the added influence of man, possibly employing such a powerful tool as fire, is more likely to have a significant, and in some cases lasting, effect.

Since the early seventies archaeologists have concentrated far more on the study of process in prehistory rather than on simply chronological or artefactual analyses. Renfrew (1974) saw the importance of dividing the cultural system into a number of subsystems, namely subsistence, technology, social organisation, cognitive basis, trade and communication, and population characteristics.

For some of these aspects it is not possible to obtain significant information, for example details of the beliefs held, but in other areas useful questions can be asked and hypotheses developed on the basis of the evidence available. There is a growing body of research work devoted to the questions of palaeoeconomics. The models proposed for the Mesolithic as explanations for the apparent practice of burning of upland vegetation will be discussed next.

It must be emphasised that the links between the increases in plant genera characteristic of open ground, deposits of charcoal and the artefactual evidence for the presence of Later Mesolithic man are of necessity circumstantial. However, hypotheses relating to the mode of subsistence at this time together with the insights suggested by ethnographic parallels provide likely explanations of these contemporaneous phenomena.

It is assumed that prior to the Neolithic the general mode of subsistence was by hunting, gathering and fishing. The usually small occupation site size coupled with little evidence of substantial structures has resulted in the view that the hunter-gatherers were semi-nomadic and moved on a seasonal basis in search of resources. Annual cycles of exploitation have been proposed (eg Simmons, 1975a) although these inevitably must be a simplification of the situation. Evidence quoted as indicating seasonal occupation, such as the presence of hazel nuts, is open to various interpretations so that it is difficult to obtain an accurate reconstruction of the time and duration of site occupation.

The territorial analysis approach of Higgs & Jarman (1975) distinguishes a site territory (within two hours walking distance) and an annual territory exploited over a year. The site catchment consists of the whole area from which a group obtains food and raw materials. They produced a simplified model defining the various resource areas available in the transition from uplands to coast.

This approach of course begs the question of the size, permanence and splitting of groups and does not embrace the possibility of cycles being far from regular and of the occurrence of overall shifts in the territory.

Bearing in mind the problems of defining catchments and territories it is useful to look at the studies which have been made of the resources available to Later Mesolithic peoples (eg Jacobi, 1979). From a knowledge of potential resources it is possible to construct models of palaeoeconomics. However, there are a number of important stumbling blocks which have not yet been resolved, particularly regarding the role and importance of plant foods in the diet, the population size and the nature of the relationships between man and the resources utilised.

Developments in the application of isotope chemistry to prehistoric bones offer scope for providing information about diet and patterns of seasonal movement (Isaac, 1985). Isotope analysis of bone collagen from six Danish Mesolithic skeletons indicated a predominant reliance on seafood (Tauber, 1981). Sealy & van der Merwe (1985) in a study of prehistoric human remains from the southwestern Cape, South Africa, concluded that the carbon isotope ratios of coastal skeletons reflected a predominantly marine diet whilst those from inland skeletons an almost entirely terrestrial diet. This evidence tends to refute the previously held model of a pattern of winter coastal and summer inland mountain occupation and may have implications for similar hypotheses applied to the British Mesolithic. However, the technique is dependent upon an adequate sample of bones from suitable periods and locations being available for analysis as well as upon environmental similarities.

It is not clear how close the relationship was between man and the animals hunted during the Mesolithic, for instance as to when steps towards domestication began. High frequencies of ivy pollen (Hedera) at several Mesolithic sites have led Simmons & Dimbleby (1974) to suggest that it might have been collected as a fodder plant for deer.

Studies of faunal remains at Mesolithic sites have revealed information about the species hunted (eg Jarman, 1972). Again caution must be invoked in interpretation owing to the distorted nature of the evidence, particularly the biases against the recovery of smaller bones. In upland acid areas where chances of preservation are poor such remains are extremely scarce. However, it seems probable that red deer (Cervus elaphus), boar (Sus scrofa), wild cattle (Bos primigenius) and roe deer (Capreolus capreolus) were important food animals. Estimations of the ungulate food resources provided by different habitats have been provided by Mellars (1975). He concludes that by removing the tree cover of an area it is able to support an ungulate biomass increased by a factor of ten times. Thus there would have been considerable advantage in creating and maintaining areas of open vegetation.

Ethnographic studies of recent hunter-gatherer groups reveal the widespread employment of fire to keep vegetation open and to produce a flush of new growth attractive to herbivores. Numerous examples have been quoted in the literature, for instance by Yellen & Harpending (1972). Whilst care must be taken in attempting to draw parallels between recent groups and Mesolithic peoples occupying a rather different environment the ethnographic evidence does indicate that fire is a frequent tool employed by man in hunter-gatherer economies.

The principal model regarding the palaeoeconomy of Mesolithic man in parts of Britain including an upland area may be summarised as involving periods of summer hunting on the uplands and of winter coastal strandlooping, with possibly an intermediate site being occupied during the transition periods (Simmons, 1975b). The sizes of camps are thought to have varied at different seasons, with the largest gatherings taking place in winter at coastal sites.

The significance of the various components of this broad model may well have changed as the Mesolithic approached its later phases in view of the possible increasing human population density and decreasing resources of large animals. If a stage is reached where more detail is available about dated Mesolithic sites it may be justifiable to propose different models of palaeoeconomy for different phases of the period. Recent work has suggested that the Mesolithic period cannot be characterised by a single social type and that present day models prevent an appreciation of the diversity of the hunter-gatherer world (Price & Brown, 1985).

Morrison (1980:136) states that in contrast to the Earlier Mesolithic, the Later Mesolithic displays a larger number of sites exploiting a greater variety of environments. In view of the flooding of the North Sea area and the subsequent loss of Earlier Mesolithic sites this statement must be qualified. However, a partial explanation of this apparent change may be that the low-lying land bridge area was a focus of exploitation in the Earlier Mesolithic, as suggested by the concentrations of Earlier Mesolithic barbed bone and antler points in east and southeast England and also by the recovery of artefacts from the present day sea bed. It is interesting that in the Later Mesolithic barbed bone and antler points appear to be restricted to coastal sites.

The land bridge may have acted as a routeway for animal migrations, and possibly seasonal movements of large herbivores took place over it between what is now mainland Britain and the Continent. Thus it may have been a focus of hunting activity in the Earlier Mesolithic, particularly as the land area became narrower with rising sea level and a funelling effect resulted.

With the eventual severance of the land connection animal and human populations would have been largely confined to Britain. In broad terms it is possible that human groups over an extended period gradually developed means of utilising the higher lands more intensively and occupied areas which had not been relied on to such an extent previously. Affinities in stone tool typology suggesting contact between Britain and the Continent seem to have ended by the last quarter of the seventh millenium bc (Jacobi, 1976).

The smaller scale nature of the extant Later Mesolithic tool kits might reflect the exploitation by necessity of greater numbers of small animals and birds, as opposed to the larger ungulates. This view is supported by the evidence of Meiklejohn (1978) that for a survey of seven Mesolithic sites in the United Kingdom and France there was an increase in the number of animal species present by up to a third between the Earlier and Later Mesolithic and that there was also a higher number of smaller mammals.

Following on from the isolation of Britain, over a long period of time the pressures of human populations on herbivores might have begun to result in a fall in animal numbers. This, combined with the spread of closed forest and consequent reduction in browse, may have made necessary the postulated burning of upland areas to encourage and concentrate game. It is difficult to estimate human population numbers during the Mesolithic. Meiklejohn (1978) suggests that population growth rate was very low in the Palaeolithic (in the range of 0.004-0.01% per annum) and that it proceeded slowly until a marked expansion in the late Atlantic. He cites Brinch Petersen (1973) for Denmark, and Newell (1973) as providing supporting evidence for this population increase.

Cohen (1977) puts forward a hypothesis linking the development and adoption of agriculture to increasing population pressure on resources. An agricultural economy brings the benefit of higher food output per unit area, but tends to involve a greater workload, leading Cohen to argue that it is only adopted as a result of a pressure on society such as increasing population.

It is possible that towards the end of the Mesolithic the growing population reached a point where the food resources being exploited could not keep pace with it, and perhaps the resources became diminished despite manipulations of the vegetation by burning. In such a situation the adoption of means to increase food output would clearly be advantageous. Obviously the interrelationships between biological and economic systems would have been highly complex, and the factors involved with population growth are notoriously intricate. However, the rather sparse evidence regarding the Later Mesolithic/Neolithic transition does not seem to contradict the broad outline of Cohen's views.

2.5 Summary

Brief accounts given in this chapter of Mesolithic environmental conditions and archaeology reveal that the available evidence is incomplete and frequently of a kind open to a number of different interpretations. It is only by taking all of the sources of information together that a picture of likely circumstances and events can be hypothesised. In situations where the supporting evidence is so tentative it is crucial that its reliability and resolution are scrutinised.

Many pollen diagrams from upland England reveal fluctuations in the proportions of tree and heliophyte genera prior to the Neolithic, but these reductions in tree cover cannot be precisely located or defined in extent using present techniques. Vertical vegetation structure and the mixture of species in particular areas are a matter of conjecture, as a great deal of subjectivity is involved in the interpretation of pollen diagrams. Thus pollen analysis, in the present state of the art, has to be recognised as a rather imprecise technique when it is applied to detailed questions of localised vegetation changes.

Where vegetation changes have been detected accompanied by indications of burning and soil erosion it seems likely that they are related events. However, the role of man in this process is a matter of speculation. From the arguments outlined in Section 2.4 it is possible that Mesolithic man had good reason to employ fire to influence vegetation type and structure. Although archaeological evidence can reveal the presence of man it cannot reveal whether or not fire was used intentionally. Thus although a correlation frequently exists between the opening up of vegetation and evidence of fire, the causal link of man, in the chain of events is speculative. Grazing pressure from herbivores alone could have resulted in the maintenance and even creation of open vegetation.

CHAPTER 3

TECHNIQUES OF INVESTIGATION

3.1 Introduction

In this chapter the methods of analysis carried out on the peat samples obtained from the sites at Blacklane Brook, Dartmoor and Dozmary Pool, Bodmin Moor are described. At the Dozmary Pool site slightly different techniques of sample collection, pollen analysis, charcoal estimation and radiocarbon dating were employed.

3.2 Sample Collection and Stratigraphic Recording

In 1980 monolith tins were used to sample the profile of a cleaned peat face of 219 cm depth at Blacklane Brook (Grid Reference SX 627686). After the pollen analysis of the samples had been carried out the site was revisited to obtain further peat samples for radiocarbon dating. The samples for dating were located in the profile by measurement from the sharp inorganic to peat interface at the base, and subsequently by pollen analysis to correlate with the pollen diagram.

At Dozmary Pool (Grid Reference SX 192744) a Russian peat sampler was used in 1981 to obtain a 281 cm profile. This hand operated corer produces samples with minimal deformation or compression of the sediment (West, 1972:102). Owing to Brookhaven counters becoming available for radiocarbon dating at Harwell the cores used for pollen analysis also provided enough material for dating.

Field notes were made in each case of the stratigraphic features of the peat. A more detailed examination was carried out upon return to the laboratory to facilitate comparison with profiles from the sites obtained by previous workers.

3.3 Pollen Analysis and Macroremain Identification

The pollen from the Blacklane Brook peat samples was extracted by standard methods (Faegri & Iversen, 1975), stained with aqueous safranine and mounted in glycerol jelly. Hydrofluoric acid treatment was unnecessary owing to the scarcity of mineral matter in the profile. A minimum sum of five hundred dry land pollen grains was counted at each level, and a relative pollen diagram constructed from the results. At both sites the samples used for pollen analysis were 0.5 cm thick, and the pollen counted by evenly spaced traverses over the slide. Identification was carried out using the keys of Moore & Webb (1978), backed up by a reference collection of modern material.

In the case of Dozmary Pool the pollen was extracted and mounted in silicone oil (Whitehead, 1961; Andersen, 1960). Appendix 1 gives the details of the method. The oil allows grains to be rolled and examined from every angle which aids identification. Stockmarr tablets containing *Lycopodium* spores as an exotic marker were used so that a pollen concentration diagram could be produced in addition to a relative diagram based solely on percentages (Stockmarr, 1971).

Any seeds which were discovered in the peat samples were identified by Dr. P.A. GreatRex. Wood identifications were made on the basis of the keys of Schweingruber (1978), and were confirmed by Mrs. A. Caseldine.

3.4 Charcoal Estimation

Charcoal was found to be present in both profiles and so means of estimating the relative amount at each level were utilised. For the Blacklane Brook site the amount of charcoal present on each pollen preparation slide relative to other levels was assessed on the basis of the area occupied per field of view on a scale increasing from one to four. This method is similar to that used by Tallis (1975). It gives a broad indication of fluctuations in the amount of charcoal present reflecting the occurrence of burning.

A more reproducible and standardised method of charcoal estimation was used for the Dozmary Pool samples, based on the techniques of Innes (1981), who estimates that the error limits of his procedure are of the order of ±3%. In this case the sievings from the standard volume (0.5 cubic centimetres) peat samples were examined for charcoal, as well as the pollen preparation slides.

The sievings were placed in a petri dish with a constant volume of water and the area occupied by charcoal measured using graph paper below the dish and a low power microscope (x 10). Charcoal was identified by its black, shiny appearance together with its tendency to shatter when probed with a mounted needle. On the microscope slides the area occupied by completely black fragments was measured using an eyepiece graticule in relation to a standard number (50) of Lycopodium spores. The precise details of this method are given in Appendix 2. Swain (1973) used polystyrene microspheres as an exotic marker so that the influx rate of charcoal to lake sediments could be calculated.

At present there are no completely satisfactory techniques available for measuring the absolute quantity of charcoal in peat samples. A chemical method originally devised for soil samples is available which firstly determines the total carbon present in the sample using the loss on ignition method (Avery & Bascomb, 1974), and then the organic carbon content using the chromic acid reduction technique (Allison, 1935) as developed by Schollenberger. The amount of inert carbon present, which is assumed to be charcoal, is found by subtracting the organic carbon content from the total carbon content. These methods require quantities of peat greater than would be available from Russian corer samples.

The chromic acid reduction procedure is not a totally reliable means of measuring the organic carbon content. The more resistant organic compounds are not attacked, so that only oxidisable carbon is estimated rather than total organic carbon. To obtain a figure for total organic carbon a conversion factor is used which varies from material to material, and so introduces a source of error. Only about 90% of organic matter is recovered by this technique.

Black et al (1965) report that with this method various forms of elemental carbon including charcoal are in fact partially attacked and not excluded altogether. Thus this means of measuring charcoal quantity contains several uncertainties and inaccuracies and necessitates the use of arbitrary conversion factors. Winkler (1985) has developed a nitric acid digestion and ignition technique which measures the weight of charcoal relative to the dry weight of the sample, and which is said to give results comparable to those obtained by the counting of microscopic charcoal.

For the purposes of this investigation the mechanical technique of relative charcoal quantity estimation described in Appendix 2 provides a satisfactory result within the confines of the amount of material and time available.

3.5 Radiocarbon Dating

To provide a chronological framework to the profiles peat samples were submitted to Dr. R.L. Otlet at the Low Level Measurements Laboratory, Harwell for radiocarbon dating. Three samples of a minimum of 200 g fresh weight and of 2 cm thickness from the Blacklane Brook profile were dated. Care was taken to avoid contamination by recent organic matter. Loss on ignition tests showed that the samples contained between 94 and 98% organic matter by weight.

Five peat samples of at least 1.5 g fresh weight and of 1 cm thickness were submitted from the Dozmary Pool core for dating using the newly available Brookhaven counters, which can produce results from very small quantities of carbon. All treatments were carried out at Harwell, apart from the extraction with forceps of visible rootlet remains. The results are expressed in terms of radiocarbon years before present with predicted measurement error given as plus or minus one standard deviation.

CHAPTER 4

A RADIOCARBON DATED RELATIVE POLLEN DIAGRAM FROM BLACKLANE BROOK, DARTMOOR

4.1 Introduction

The first palynological investigation at the Blacklane Brook site (Simmons, 1962 & 1964) revealed evidence of forest recession prior to the elm decline, as indicated by a sudden peak in Gramineae and *Pteridium*, falling levels of *Corylus* and *Quercus* pollen plus a resurgence of heliophyte taxa. The present study aims to provide a more detailed analysis of the profile coupled with the use of radiocarbon dating, so that vegetation changes can be related to an absolute time scale (Simmons, Rand & Crabtree, 1983).

4.2 Site Description and Context

The Blacklane Brook profile (Grid Reference SX 627686, altitude 457 m O.D.) was derived from a cleaned peat face on the west bank of the stream in the vicinity of Simmons' original 122 cm deep section which he sampled in 1960. The location of the site is given in Fig. 2, and Plate 1 shows the exposed peat face. The new section is of greater depth (219 cm), but parallels the original stratigraphy. On the nearby gently sloping plateau area to the west probing revealed blanket peat of over four metres depth.

The site is located beside a tributary of the River Erme in the southern part of the granitic mass forming Dartmoor. The highest point on the moor is 621 m O.D. and there are considerable areas over 490 m O.D. The present day vegetation of the area around the site consists of blanket bog dominated by *Calluna vulgaris*, *Erica tetralix*, *Eriophorum angustifolium*, *Molinia caerulea*,

Fig. 2 Location of the Blacklane Brook sample site, Dartmoor.

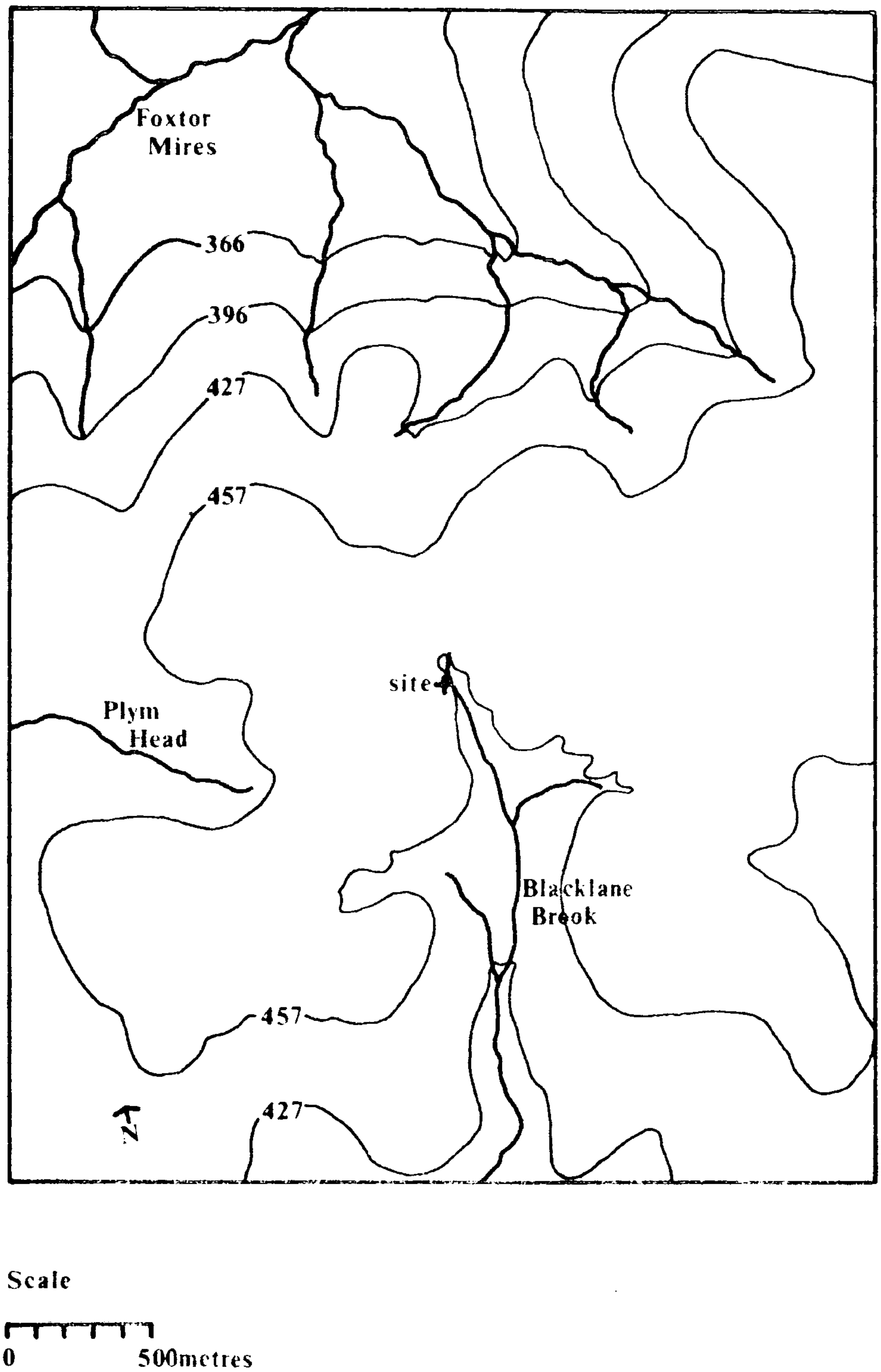


Plate 1 The exposed peat face at Blacklane Brook, Dartmoor.

Plate 2 View looking south east across Foxtor Mires, Dartmoor.

Trichophorum caespitosum and Sphagnum spp. At lower levels Calluna-Molinia moorland is present, and also some acid grassland sometimes invaded by Pteridium. Valley bogs occur, for instance Foxtor Mires (Plate 2) within 3 km of the site where Juncus, Sphagnum and Molinia predominate.

The relatively high altitude of Dartmoor together with its western situation leads to an oceanic type of climate characterised by high rainfall (2,030 mm per annum on the southern upland bog area), high humidity, moderate temperatures and frequent hill fog. The moorland provides rough grazing for sheep, cattle and ponies and the practice of swaling (burning) is frequently carried out for the purposes of grazing management.

4.3 Stratigraphy

The stratigraphy of the Blacklane Brook peat profile collected in 1980 is as follows:

Depth (cm)	Description
0 - 20	Very fibrous peat with contemporary Molinia and Calluna roots.
20 - 110	Reddish brown fibrous Eriophorum peat; large quantities of epidermal fragements gradually decreasing in frequency downwards. Humification of the matrix becoming greater towards the base.
110 - 174	Dark brown well-humified amorphous peat, with wood fragments at 142 and 169 cm.
174 - 182	Wood layer of Salix and Betula. Tree rings suggesting slow growth. Size of wood recovered suggests scrub rather than woodland.

Plate 3 The peat profile at Blacklane Brook, Dartmoor.

Plate 4 View of the interior of Wistman's Wood, Dartmoor.

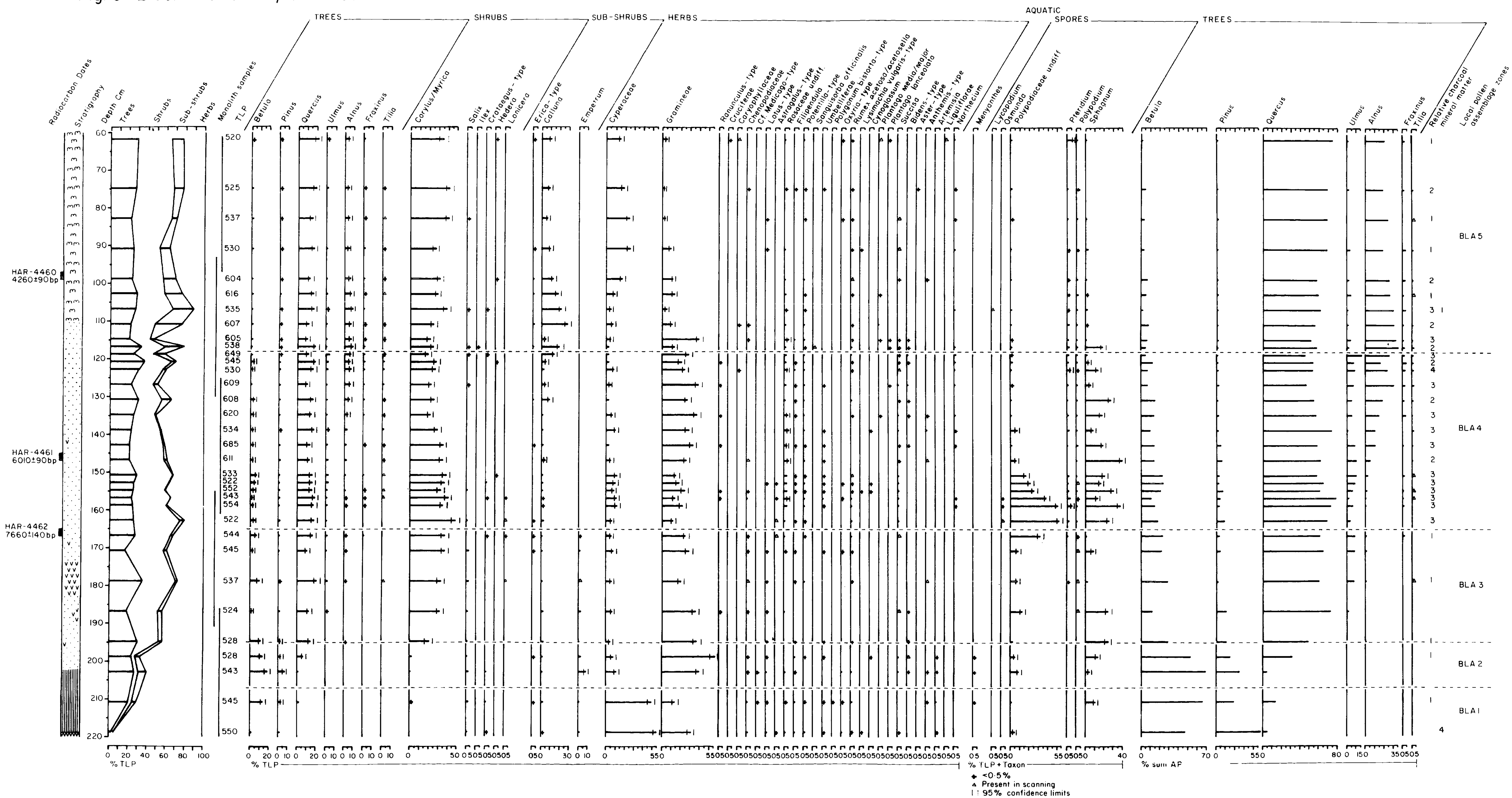
182 - 202	Dark brown amorphous peat with scattered wood fragments.
202 - 219	Dark brown laminated _Carex_ peat, becoming lighter towards the base where there is a higher silt content. Occasional small twig fragments. Seeds of _Menyanthes_, _Carex rostrata_ and _Carex_ sp. were identified from 211 cm by Dr. P.A. GreatRex.
219 cm +	Sharp transition to greyish brown silty clay with granite gravel.

The pollen preparation slides revealed the presence of microscopic charcoal throughout the profile in varying quantities. Mineral matter was detected towards the base of the peat and at 107 cm. Wood remains and the sharp transition to the mineral horizons at the base of the profile are shown in Plate 3. A brief investigation of the peat faces adjacent to Blacklane Brook revealed the presence of wood fragments reaching 5 cm branch diameter up to 30 m upstream and 300 m downstream from the site.

4.4 Diagram Construction

The pollen counts obtained have been used to produce a relative pollen diagram showing the percentage representation of each taxon identified as bar histograms. A minimum of five hundred land pollen (LP) grains was counted at each level. Pollen and spores of types not included amongst the land pollen sum have been expressed as a percentage of the land pollen total plus the taxon concerned. To aid comparison with the original 1964 diagram tree pollen has also been expressed as a percentage of arboreal pollen (AP).

Fig. 3 Blacklane Brook, Dartmoor



The pollen diagram (Fig.3) also displays the peat stratigraphy, relative quantities of microscopic charcoal and mineral matter, the results of radiocarbon dating and the positions of the monolith tin samples.

The fact that the number of pollen grains counted at each level is only a small proportion of those present in the peat sample means that it is important to give an indication of the reliability of the results. Thus 95% confidence limits are plotted on the diagram calculated according to the methods of Mosimann (1965). These help to distinguish real changes in the pollen spectrum between levels from random fluctuations.

The major drawback of constructing a pollen diagram on a relative percentage basis is that an increase in the frequency of a particular pollen type will automatically result in the depression of the frequencies of other types. This lack of independence of the components of the pollen spectrum at any particular level must be taken into account at the interpretative stage.

4.5 Pollen Diagram Zonation

To aid the process of interpretation the pollen diagram has been subdivided by inspection into pollen assemblage zones (PAZ) on the basis of changes in the pollen proportions. These are described below with figures given as percentage total land pollen (TLP).

Zone BLA 1 207 - 219 cm : Cyperaceae - Gramineae PAZ. Low Quercus (less than 3%); Betula 1-14%; Cyperaceae 49-55%; Gramineae 15-30%; small peaks of Filipendula, Potentilla-type and

Compositae; herbaceous pollen 70%+. Base of zone defined as base of peat.

Zone BLA 2 195-207 cm : Gramineae-Betula PAZ. Quercus increasing to 7%; Betula peaks at 12-18%; Pinus peaks at 7%; Corylus/Myrica less than 3%; Empetrum peak 9%; Cyperaceae declining from 11 to 7%; Gramineae peaking at 57%. A range of herbs is present in low numbers. Sphagnum increasing from 5% to 25%. Base of zone defined as where Gramineae replaces Cyperaceae as the dominant herb pollen.

Zone BLA 3 165-195 cm : Quercus-Corylus/Myrica - Gramineae PAZ. Betula declines to below 10%; Quercus 11-20%; Ulmus and Alnus appear for the first time in low numbers; Corylus/Myrica 21-37%; Cyperaceae 8% and below; Gramineae 25-36%. Occasional presence of other herbs. Total herbaceous pollen declining from 43 to 26%. Base defined where Corylus/Myrica reaches 20%.

Zone BLA 4 118-165 cm : Quercus-Ulmus-Alnus-Gramineae PAZ. Quercus 11-18%; Ulmus reaches peak of 4%; Alnus increases to 7%; Fraxinus and Tilia consistently present in low numbers; Corylus/Myrica declines from a maximum of 49% to 19%; Gramineae variable from 12 to 39%; highest levels of Pteridium and fern spores; peaks of Rosaceae pollen and a wide variety of herbaceous taxa present; Sphagnum at high levels. Total tree plus shrub pollen dominant but declining irregularly from peak of 65% down to 47%.

Zone BLA 5 60-118 cm : Quercus-Alnus-Corylus/Myrica-Calluna PAZ.

Low Betula (less than 2%); Quercus 10-20%; Alnus 6-9%; Corylus/Myrica 22-41%; Calluna reaches maximum of 29%; Cyperaceae rises again to 25%; Gramineae tails off to 3%; Sphagnum low. Tree plus shrub pollen ranges from 42-66%. Base defined by small, but marked drop in Ulmus.

4.6 Radiocarbon Dating Results

Three peat samples were submitted to Harwell for dating. The low numbers of samples only provides a general indication of the chronology of the profile. Table 1 gives the results for the Dartmoor samples.

Table 1 Radiocarbon analyses from Blacklane Brook, Dartmoor

	Depth(cm)	Sample material	Lab. no.	Date C14 years bp	bc
A	97-99	Blanket peat	HAR-4460	4260 ± 90	2310 ± 90
B	145-147	Blanket peat	HAR-4461	6010 ± 90	4060 ± 90
C	165-167	Blanket peat	HAR-4462	7660 ± 140	5710 ± 140

If it is assumed that the radiocarbon date represents the centre of the peat sample (ie 98 cm for sample A) the 48 cm between sample A and B covers approximately 1750 ± 180 radiocarbon years, the 20 cm between B and C 1650 ± 230 radiocarbon years, and the 68 cm between A and C 3400 ± 230 radiocarbon years. Thus between A and B 1 cm of peat represents on average 33-40 radiocarbon years, between B and C on average 71-94 radiocarbon years, and overall between A and C on average 47-53 radiocarbon years. These figures must be used with caution as they are only an approximation and the radiocarbon dates are too widely spaced to indicate detailed variations in accumulation rates. Also it is possible that sudden discontinuities may exist within the stratigraphy owing to erosion or inwashing. Bearing these limitations in mind the pollen samples of 0.5 cm depth cover on average somewhere in the region of 17-20 radiocarbon years between A and B, 36-47 between B and C, and overall 24-27 radiocarbon years between A and C. This data gives an indication of the degree of temporal resolution of the pollen diagram which is particularly important when looking in detail at vegetation changes.

Taking into account the caveats mentioned in the previous paragraph, if the Later Mesolithic is defined as covering 8,500 to 5,000 radiocarbon years bp, then in the Blacklane Brook profile it would start at 175-178 cm and end at about 116-121 cm. These depths in the profile have been estimated using the three radiocarbon dates and the accumulation rates which they indicate. Reassuringly the small elm decline present on the diagram occurs between 117-119 cm.

The present resolution of radiocarbon dating is not very precise, and the International Study Group (1982) showed that considerable variability occurs in results between laboratories indicating that caution must be employed when comparing dates. They recommended that quoted errors should in reality be multiplied by a factor of between two and three and that caution should be exercised in attempting to resolve differences in radiocarbon dates of less than two hundred years.

4.7 Some problems of pollen diagram interpretation

There are many factors involved in the largely subjective process of reconstructing original vegetation types from pollen analytical evidence. A summary of the major variables and uncertainties relevant to each stage is given in Fig.4. Attempts are being made to tackle some of these problems in a rigorous way. For instance Prentice (1985) proposes a simple theoretical model quantifying the concept of pollen source area related to production and dispersal biases in pollen representation. Dissimilarity coefficients have been used to provide a quantitative aid to the identification of modern analogues for fossil pollen samples (Overpeck, Webb & Prentice, 1985). However, these methods are still in their preliminary stages and are in need of further refinement. Edwards (1979) discusses the difficulties of using palynological data in the context of prehistory.

In the present study which seeks to throw light on upland vegetation changes during the Later Mesolithic period, there are several technical limitations of particular concern. Where small scale changes, both spatially and temporally, are being examined the degree of resolution of the data is critical. Problem areas include the reliability of data derived from a single peat profile, definition of the location and area covered by postulated vegetation types and the identification and form of species represented by *Corylus*/*Myrica* pollen.

To date, pollen analysis generally tends to rely upon a single profile from the site concerned and from which one sample is counted at each level selected.

Fig. 4 Summary of the major variables and uncertainties involved in the process of pollen analysis

ORIGINAL VEGETATION	-Differential pollen production between species and over time.
↓	
POLLEN RAIN	-Differential pollen dispersal. -Differential pollen deposition. -Differential effects on deposition of local variations in topography and climatic factors.
↓	
DEPOSIT CONTAINING POLLEN	-Differential pollen preservation. -Disturbance of profile by erosion,burning etc. -Unknown extent of pollen source areas. -Uncertain relationship between proportions of local and long distance pollen.
↓	
PEAT SAMPLE	-Uncertain representativeness of the sample for the body of sediment at that level. -Uncertain degree of homogeneity of the peat vertically and horizontally.
↓	
POLLEN EXTRACTION & COUNTING	-Selection of extraction techniques. -Selection of size of pollen count at each level. -Varying taxonomic precision of identification. -Variations between analysts.
↓	
POLLEN DIAGRAM	-Choice of pollen sum for relative diagrams. -Provision of statistical confidence limits.
↓	
RECONSTRUCTION OF THE ORIGINAL VEGETATION	-Uncertain relationship between pollen representation and vegetation types. -Problem of definition of size and location of postulated vegetation types. -Present day analogues may not exist for past vegetation types. -Uncertainty as to stature of species eg. *Corylus*. -Identification uncertainties eg. *Corylus*/*Myrica*. -Some taxa under or not represented eg. *Populus*. -Difficulties of time scale resolution.

How representative each sample is of the population at that level is a debatable point, and this is greatly influenced by the homogeneity of the population. It is likely that the pollen representation at any one time-synchronous level in peat would vary spatially, especially where samples might be biased by the inclusion of ripe stamens from an in situ plant. Thus it is important that information is obtained regarding the magnitude of both horizontal and vertical variations in the pollen content of peat deposits so that a correct sampling procedure can be adopted and the reliability of the results assessed. In fact, to reach a given accuracy, sampling rate must be more intense with increasing population heterogeneity. It is when minor changes in vegetation types are of particular interest that the degree of precision and replication of the results is crucial.

Woodhead and Hodgson (1935) give the results of counting ten pollen slides from the same sample, ten different preparations from the same sample and ten samples from the same level but up to 60 feet (18 m) apart horizontally. The pollen sum counted was 150 and only part of the data set is published. However, although the pollen proportions obtained in each case were broadly similar it was found that for some taxa the representation differed by up to 10% in all three instances. This early data set is not as comprehensive as would be desired, but it does indicate that the pollen population in peat sediments is quite variable in a horizontal plane. Turner (1975) uses the variations in pollen representation at a level between pollen profiles separated horizontally as evidence in the study of prehistoric land use.

Confidence limits are plotted on the pollen diagram which merely take account of the fact that the pollen counted in a single sediment sample is only a fraction of the population of that sample, and which do not include the effects of the horizontal and vertical variability in pollen representation discussed in the two previous paragraphs. Basic assumptions are made of a competent worker counting well preserved pollen (Maher, 1972). In the case of 95% confidence limits they show that 95% of the calculated limits will contain the true proportion of the taxon in the sample. It is only where the confidence limits do not overlap that significant changes between the levels probably exist. The size of the pollen sum counted is important in reducing the spread of the confidence limits.

On the basis of the analysis of a single profile it is not possible to define accurately the location or size of areas of postulated plant communities (Janssen, 1970). For example it is possible that a small clearing close to the site could produce similar pollen data to that resulting from more extensive clearings at a greater distance. A host of complicating factors are involved. The importance of the local pollen component may vary depending on the surrounding vegetation structure. Analysis of macroremains can provide useful information regarding the local peat forming community. It is difficult to define pollen catchment area, and dispersal rates and distances in open habitats are likely to be far greater than in closed woodland. Thus, at the Blacklane Brook site it is quite likely that the pollen catchment area would have varied over time as the vegetation structure and distribution changed.

Studies of present day surface pollen samples relating pollen assemblages to extant vegetation can help considerably in the process of pollen diagram interpretation (eg Caseldine, 1981; Bradshaw, 1981). A surface sample was examined from Blacklane Brook. The green parts of a living Sphagnum moss polster of 4 cm^2 were collected, and it is thought that the pollen represents approximately the input of the last five years (Pitken, 1975). However, the pollen spectrum from a surface sample has not undergone the same processes as those which form peat, and in the past quite different plant communities may have existed, making it difficult to extrapolate backwards.

Bonny (1980) has shown that annual catches of tree pollen and of non-tree pollen over five years varied by factors of up to 6.8x and 3.2x respectively. She considers this variation to be due to annual differences in pollen production, which are partly determined climatically, rather than to variations in the efficiency of pollen dispersal. Thus past climatic changes would have greatly affected pollen production.

Stevenson (1985) concluded from a study of modern pollen spectra in Spain that, especially in areas with a complex mosaic of vegetation types, non-local pollen inputs are important in blurring the differences between the pollen rains of otherwise distinct plant communities. This fact mitigates against the accurate interpretation of past plant communities in detail.

Tree distribution is hard to define from present pollen analytical evidence. Surface studies give proportions of arboreal pollen as a percentage of total land pollen ranging from about 62-84% for samples taken from within woodlands (Caseldine & Maguire, 1981). However, recent work has highlighted how macroscopic evidence can contradict the inferences made from pollen results (Wilkins, 1984).

Wilkins collected macroscopic wood remains from peat at forty sites on the Island of Lewis, Outer Hebrides, Scotland and had ten samples radiocarbon dated. Birks & Madsen (1979) on the basis of the pollen analysis of a core from near Little Loch Roag had concluded that there was no evidence for trees ever having been present on the island. The extensive wood remains of *Pinus*, *Betula* and *Salix* contradict this inference. In Birks and Madsen's pollen diagram the maximum percentage of total land pollen for *Pinus* was 5%, *Betula* 12% and *Salix* 2%. This work emphasises the anomalies which can occur between the representation of pollen taxa in samples and the presence of these taxa in the vegetation of that time. It is not impossible that at the times when trees have been able to colonise peat poor conditions for pollen preservation have also occurred.

Corylus pollen can only be easily distinguished from that of *Myrica* by using the electron microscope. Consequently the combined group *Corylus*/*Myrica* is given on the pollen diagram. Whether the pollen represents hazel and/or bog myrtle is crucial to the interpretation of the site's vegetation history. Plant macrofossil evidence from Dartmoor includes sub-fossil wood from *Corylus* (Simmons, 1962; Beckett, 1981), and Simmons (1964) reports that up to that date no macro-remains of *Myrica* had been found. Therefore the assumption has been made that the pollen is predominantly from *Corylus*. If this is indeed the case the structure of the vegetation containing *Corylus* is of importance. It is possible that *Corylus* formed pure stands in places and may have attained its small tree stature of up to six metres (Clapham, Tutin & Warburg, 1962), or existed as scrub or as an understorey in woodland.

4.8 Interpretation of the Blacklane Brook pollen diagram

The overall sequence of vegetation change found in the present study parallels that of Simmons' 1964 diagram which was constructed on the basis of arboreal pollen percentages. It is only within zone BLA 1 that tree plus shrub pollen is below the figure of 22% TLP obtained for the present day surface sample. This indicates that apart from the earliest zones of the pollen diagram the tree and shrub cover was considerably greater than is the case with today's open landscape.

In zone BLA 1 (Flandrian I) herbaceous pollen is dominant with Cyperaceae being the most frequent taxon. A variety of other herbaceous taxa are present in low numbers, notably Chenopodiaceae, Rosaceae, *Filipendula*, *Potentilla*-type, *Rumex* and *Artemisia*. Tree and shrub representation is low but increasing at the top of the zone. *Betula* is the dominant tree with some *Pinus* and *Salix*. It is possible that at this stage some or all of the birch pollen represents the dwarf birch *Betula nana*. The pollen assemblages suggest an open vegetation dominated by sedges together with various herbs and grass. Towards the end of the zone some birch and willow was present, probably either as scrub or in a prostrate form. A sedge and *Sphagnum* mire became established on the site, and the presence of *Menyanthes* indicates open pool habitats. Both *Quercus* and *Corylus/Myrica* pollen are present early in the profile as is characteristic of other diagrams from the south west (Beckett, 1981; Brown, 1977).

Tree plus shrub pollen reaches 40% of TLP in zone BLA 2 (Flandrian I) reflecting a decrease in the extent of open vegetation. Gramineae takes over from Cyperaceae as the dominant pollen type, and a variety of other herbaceous taxa are present at low frequencies. Betula and Pinus reach their highest frequencies and Quercus steadily increases. Empetrum heath is at its maximum development. It is likely that at low altitudes oak and hazel woodland was spreading.

During zone BLA 3 (Flandrian II) deciduous forest becomes established within the region of the site dominated by Quercus with Corylus/Myrica. Tree plus shrub pollen reaches 70% TLP and herbaceous taxa are lower in number and frequency. This is the zone which coincides with the main deposits of wood macroremains of Salix and Betula indicating on site scrub. Salix is characteristically under-represented in the pollen record owing to its low pollen production and insect pollination. It would appear that this woody vegetation became swamped by blanket peat development. The preservation of wood remains depends on the rapid envelopment of the material within the peat, so that an absence of tree remains may only reflect a lack of such suitable conditions. Also the tree remains tend to be biased towards those species capable of colonising and growing on blanket peat (Tallis & Switsur, 1983).

As the pollen rain would have been derived from a wide area it is not possible to locate vegetation types with certainty. However, the evidence does indicate the presence of oak woodland, possibly at lower altitudes and ascending further within sheltered valleys. The high proportions of shrub pollen point to considerable area of scrub vegetation, possibly being dominant at the higher altitudes. A landscape with oak woodland at the lower altitudes grading into hazel and willow with birch scrub with increasing height is envisaged. Open areas appear to have been of restricted extent including some areas of Empetrum heath and mire vegetation.

At the opening of zone BLA 4 (Flandrian II) tree plus shrub pollen reaches its highest level of 75% TLP, and then declines with fluctuations to 45% TLP in the closing stages. There is a marked increase in the number and frequency of herbaceous taxa, particularly Rosaceae, *Potentilla*-type, *Succisa* and Umbelliferae. A notable feature at the commencement of the zone is a large peak in Polypodiaceae followed by a peak in *Pteridium*. In a surface pollen transect study (Caseldine, 1981) the Filicales curve (equivalent to Polypodiaceae) showed very high percentages corresponding with the occurrence of *Dryopteris austriaca* in the woodland understorey. Although different species may have been involved at Blacklane it is interesting that the peak occurs at the time of the highest recorded tree and shrub pollen totals.

The *Pteridium* spores and herbaceous species represent an increase in open habitats. *Alnus*, *Ulmus*, *Fraxinus* and *Tilia* are present at low frequencies and presumably reflect pollen derived from mixed deciduous forest probably at lower altitudes. Some scrub vegetation seems to have been present in the site vicinity as suggested by the occasional wood remains still present in the profile. *Narthecium* pollen appears and this together with high *Sphagnum* levels suggests increasing acidification and the spread of mire communities.

In zone BLA 5 (Flandrian III) tree plus shrub pollen increases again up to 68% TLP. The variety and frequency of herbaceous taxa is reduced and Gramineae reaches its lowest levels. There is a corresponding rise in *Calluna* levels, and *Corylus*/*Myrica* proportions rise again. *Sphagnum* spores become infrequent and Cyperaceae rises. This indicates a picture of expanding tree and scrub vegetation and a decrease in open grassy areas, with heather and sedge associations becoming locally important. There is little evidence indicating clearance activities by Neolithic peoples although some weed types such as Chenopodiaceae, Plantago and Rumex are sporadically present, reflecting some human intervention.

4.9 Possible mechanisms behind the vegetation changes during the Later Mesolithic

In the Blacklane Brook pollen diagram the Later Mesolithic is represented by the upper part of zone BLA 3 together with zone BLA 4. After the initial peak in tree and shrub vegetation there is an irregular decline together with corresponding increases in herbaceous taxa reflecting the expansion of grassy habitats. This trend corresponds with the highest recorded levels of relative charcoal quantity. Even at the time of maximum tree cover some areas of open mire would have been present and it appears that these extended during zone BLA 4.

The supplementary lines of evidence of charcoal levels and wood macroremains give additional data to help with the process of explaining these apparent vegetation changes. Not being able to define the areal distribution of proposed vegetation types is a limiting factor in the interpretation. However, clues are provided by plant macroremains and inferences from present day vegetation.

It is thought that from the point of view of climatic conditions trees would not have been prevented from covering Dartmoor (Simmons, 1962). The present climatic limits of tree growth in Britain are thought to vary from about 600 m in south Wales and the eastern Scottish Highlands to 300 m or less on the exposed moorlands of the north west Scottish Highlands and islands (Ratcliffe,1977). Wood remains of Quercus, Betula, Alnus, Corylus and Salix have been found up to 415 m on Dartmoor, and Betula, Salix and Sorbus at 457 m at Blacklane Brook (Simmons, 1962).

Small oak copses are present today at Wistman's Wood (440 m) Plate 4, Black Tor Copse (440 m) and Piles Copse (315 m). Proctor, Spooner & Spooner (1980) describe increases in the area and height of Wistman's Wood this century, which they suggest might be due to a combination of changing climate, grazing and developmental factors. Thus it would seem that during the climatic optimum oak woodland would have been capable of growing up to at least 440 m, where local wet mire conditions did not preclude this. Maguire & Caseldine (1985) provide a discussion of the evidence available for the former distribution of forest on northern Dartmoor.

There are several possible explanations which could account for the decrease in tree plus shrub pollen in zone BLA 4. The stratigraphy and pollen spectra suggest that mire communities were spreading in zone BLA 4. This could have been triggered off by a complex of factors including increased rainfall resulting from climatic changes due to sea level rises, and/or the hydrological results of interference by grazing animals/man on the vegetation cover, and/or successional and soil developmental changes. The presence of consistently high relative charcoal levels throughout zone BLA 4 suggests that fires were a common occurrence, which might not be expected naturally during a period of increasing oceanicity of climate.

Evidence of burning has to be treated with some caution as there are several likely problems involved in its interpretation. One, arguable, possibility is that sub-surface burning could result in the formation of charcoal within a profile at a later date than that of the deposit (Boyd, 1982). Also when an intense surface fire occurs it may burn down into the peat to some extent. Maltby (1980) has shown that severe fire on Calluna moorland on the North York Moors resulted in considerable complete peat ignition and subsequent erosion. This has implications for the continuity of a pollen profile where charcoal is detected. Thus charcoal present in a profile may reflect in situ burning and/or soot particles blown or washed in from elsewhere.

Where charcoal is found the cause of the fire is uncertain. For example remains of conifers which were burned before fossilisation have been found near Bridgend, South Wales dating from the early Mesozoic providing evidence of a forest fire some 195 million years ago (Bassett & Edwards, 1973). An early example of fire associated with a hominid occupation site dated to be over 1.4 million years old comes from Kenya (Gowlett et al, 1981).

Under the wet climatic conditions of Dartmoor it is likely that man initiated the fires, but whether this was intentional or accidental is a matter of speculation. In the period after the elm decline the relative charcoal levels drop back, tree plus shrub pollen rises again and grassland is reduced. This suggests that burning had previously helped to maintain areas of open grassy vegetation at the expense of shrub and tree communities.

Archaeological evidence for the presence of Mesolithic peoples in the Dartmoor area is given by Jacobi (1979) and Beckett (1981). The latter reports that recent investigations on Dartmoor and the adjacent coastal plain "have emphasised the extensive character of Mesolithic settlement in the region."

Beckett's pollen diagram for Blacka Brook just over 7 km to the south west of Blacklane Brook and 187 m lower in altitude, shows tree plus shrub proportions during the Later Mesolithic declining from around 80% to 55% TLP. Though these proportions are a little higher this parallels the situation found at Blacklane Brook. The precise interpretation of these proportions in terms of surrounding tree cover is equivocal, but it must be borne in mind that surface pollen studies (Caseldine, 1981) have shown that the representation of tree pollen falls off rapidly away from the woodland edge. Thus mire sites if themselves covered by open vegetation would not produce high arboreal pollen percentages even if woodland existed relatively close by. Edwards (1982) discusses the problems of detecting the presence of woodland edges using pollen diagrams, and suggests that unless the sampling site is within 30 m of the woodland edge very little impact is likely to be detected.

Although there are many uncertainties involved in the interpretation of the available evidence it does indicate that during the Later Mesolithic people were present on and around Dartmoor, fires were a common occurrence at the higher altitudes and in the region of the Blacklane Brook site tree and scrub vegetation irregularly decreased with grassy and mire areas increasing. It would seem that the evidence taken together suggests that the fires resulted from man's activities and that burning was a cause of increased areas of open vegetation. However, contributory factors to this increase are likely to have included the greater climatic oceanicity of the time resulting in the extension of mires, and possibly pressures from large grazing animals acting to keep some vegetation open. Any clearance of vegetation by burning would have been likely to reinforce peat development owing to its effects on the hydrological cycle. It is likely that a complex interplay existed between climatic factors, burning, grazing pressure, peat extension and vegetation development.

CHAPTER 5

RADIOCARBON DATED RELATIVE AND POLLEN CONCENTRATION DIAGRAMS FROM DOZMARY POOL, BODMIN MOOR

5.1 Introduction

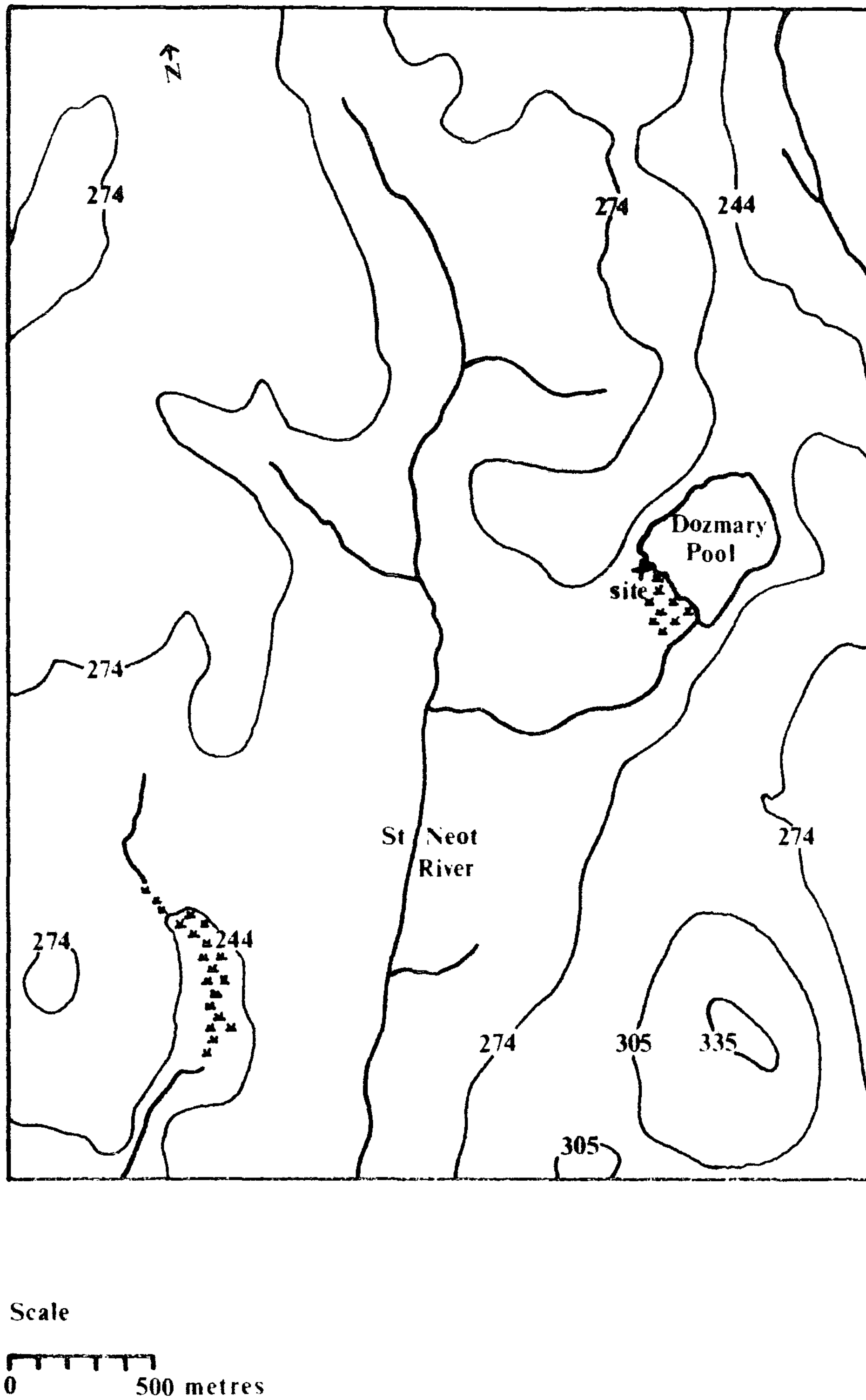
Conolly, Godwin & Megaw (1950) published an outline pollen diagram for peat deposits from Dozmary Pool. The analysis was carried out in 1936 by Megaw and plotted on the basis of percentage arboreal pollen. It was noted that layers of ash and charcoal in the peat corresponded with temporary disturbances in the run of tree pollen curves, but there was insufficient detail to allow further interpretation.

A more comprehensive investigation of a profile from the raised bog next to the Pool was carried out by Brown (1977). However, the study concentrated on the early Flandrian, with close pollen sampling (at 2 cm intervals) only continuing to around the position of his latest radiocarbon date of 6,451 ± 65 bp. Carbonised material, bands of charcoal fragments and pieces of burnt peat were identified from much of the profile.

Dozmary Pool is a major find site for Mesolithic flint microliths (Wainwright, 1960). These have been collected from an unstratified context, but on the basis of flint typology Jacobi (1979) considers them to be comparable to assemblages from Thatcham sites I, III and VII which date from the first half of the eighth millenium bc.

In the present study detailed analysis on a relative and pollen concentration basis has been carried out supported by radiocarbon dating in order to look more closely at the vegetation history of the Later Mesolithic period. Relative quantities of charcoal found at different levels within the peat were also measured.

Fig. 5 Location of the Dozmary Pool sample site, Bodmin Moor.



5.2 Site Description and Context

The pollen cores were obtained using a Russian borer from the raised bog at the south west end of Dozmary Pool (Grid Reference SX 192744, altitude 265 m O.D.). The location and site details are shown in Fig. 5. Bodmin Moor is a granitic upland reaching a height of 419 m, with large areas over 305 m. The oceanic climate is characterised by westerly winds and a high annual rainfall of 1,140 mm plus. Altitude and rainfall are lower than on Dartmoor, and blanket bog occurs relatively rarely.

Heather moorland is now restricted to several main locations in the south east of the moor, and today grasslands are the most widespread community on Bodmin Moor. Apart from enclosed pasture a mosaic of communities dominated by Molinia caerulea and Agrostis-Festuca associations exist. Other species present in the grasslands include Calluna, Ulex, Pteridium, Juncus spp., Galium saxatile and Potentilla erecta. Bog growth has occurred in some valley locations and is characterised by Sphagnum spp., Molinia, Rhynchospora alba, Eriophorum spp. and Trichophorum cespitosum. Willow scrub is present along some valley bottoms and bushes of stunted hawthorn and holly grow on clitter slopes. Oakwoods are today confined to steep sided valleys on the margins of the moor.

The raised bog at Dozmary Pool (Plates 5, 6, 7) supports a plant community which includes Eriophorum vaginatum, Sphagnum spp., Molinia caerulea, Trichophorum cespitosum, Narthecium ossifragum, Rhynchospora alba, Calluna vulgaris, Erica tetralix, Potentilla erecta, Galium sp., Polygala serpyllifolia, Juncus effusus, Carex spp. and a few Salix shrubs.

Plate 5 View looking south east over Dozmary Pool bog, Bodmin Moor.

Plate 6 View of Dozmary Pool bog showing sample site(arrowed).

Plate 7 View of Dozmary Pool bog showing marginal willow shrubs.

5.3 Stratigraphy

The following stratigraphy was observed from the Russian sampler cores collected in 1981.

Depth (cm)	Description
0 - 80	Unhumified coarse, fibrous light reddish-brown *Sphagnum/Eriophorum vaginatum* peat.
80 - 90	Darker slightly humified fibrous *Sphagnum/Eriophorum vaginatum* peat.
90 - 112	Unhumified coarse, fibrous light reddish-brown *Sphagnum/Eriophorum vaginatum* peat.
112 - 252	Dark brown/black well humified *Sphagnum/Eriophorum vaginatum/Calluna* peat. Frequent horizontal dark bands with distinct ones at 124-128 cm, 151-156 cm, 169-171 cm. Quartz grains up to 2 mm diameter at 204 cm. *Calluna* stems, leaves and flowers common. Frequent carbonised material throughout, including fragments measuring 14 x 8 mm at 200 cm and 20 x 10 mm at 213 cm. Carbonised *Calluna* stems at 203, 211, 213, 229 and 237 cm, carbonised leaves at 211 and 229 cm, and a carbonised flower at 165 cm.
252 - 265	Highly humified monocotyledonous peat containing carbonised material. Piece of charcoal 4 x 3 mm at 253 cm. *Juncus* seeds present towards the base.

265 - 281 Detritus mud containing occasional Sphagnum leaves, frequent Juncus seeds and Isoetes megaspores. Dr. P.A. GreatRex identified seeds of Elatine hexandra, Juncus effusus type and Juncus articulatus type from 265 cm. 281 cm + Grey kaolin clay.

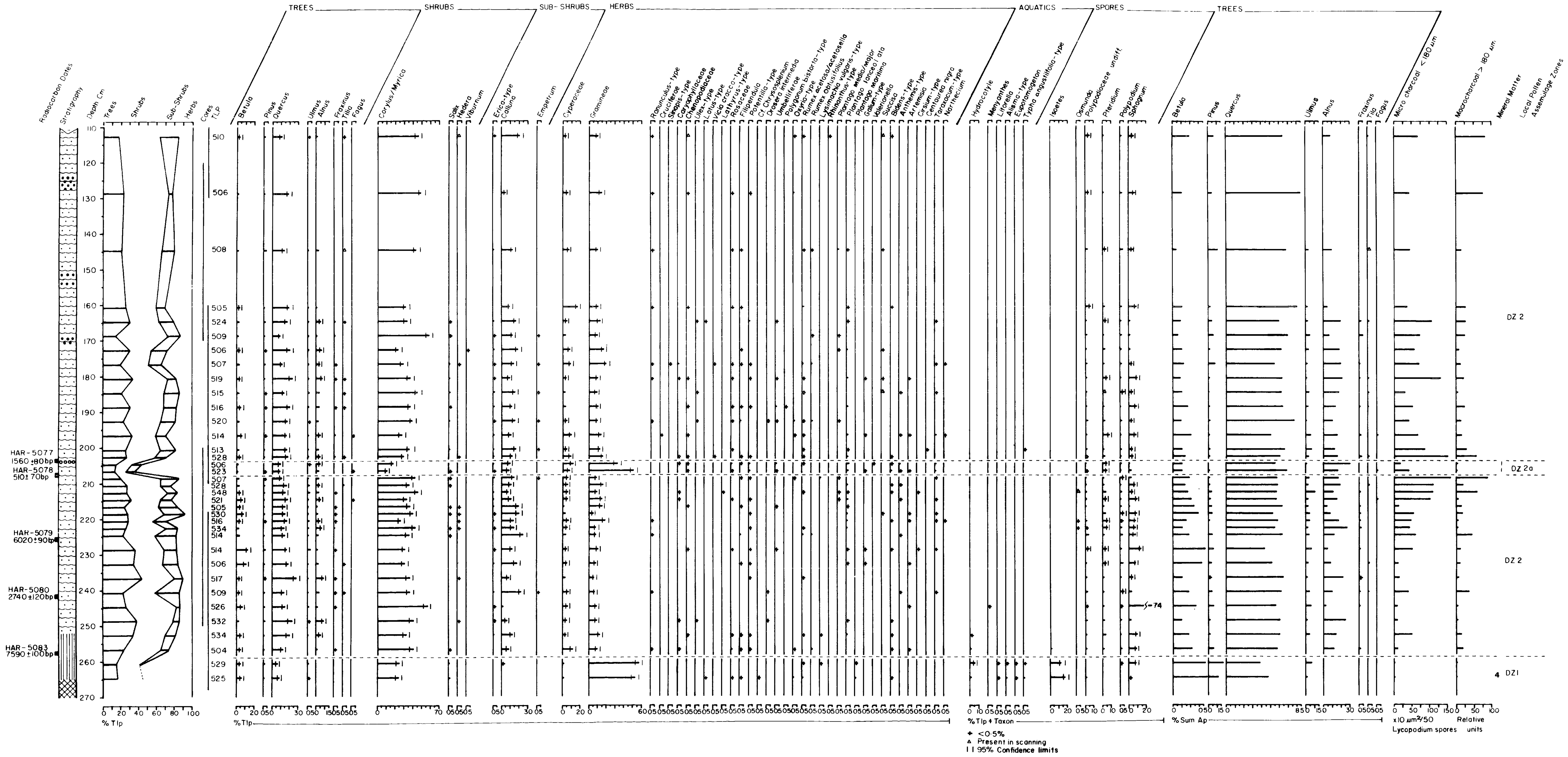
This profile is 46 cm longer than that described by Brown (1977), but it consists of essentially similar stratigraphic units. However, in this case no Salix wood fragments were recovered, which may have been a consequence of the smaller diameter of the borer used. Brown discovered large pieces of burnt peat at a depth of 145-150 cm, and in this study pieces of charcoal and carbonised material were frequently encountered. Inwashed mineral matter was noted by Brown at 80-85 cm within the unhumified Sphagnum/Eriophorum peat whereas in this study quartz grains were identified at a depth of 204 cm within the well humified peat.

5.4 Pollen Diagram Construction and Zonation

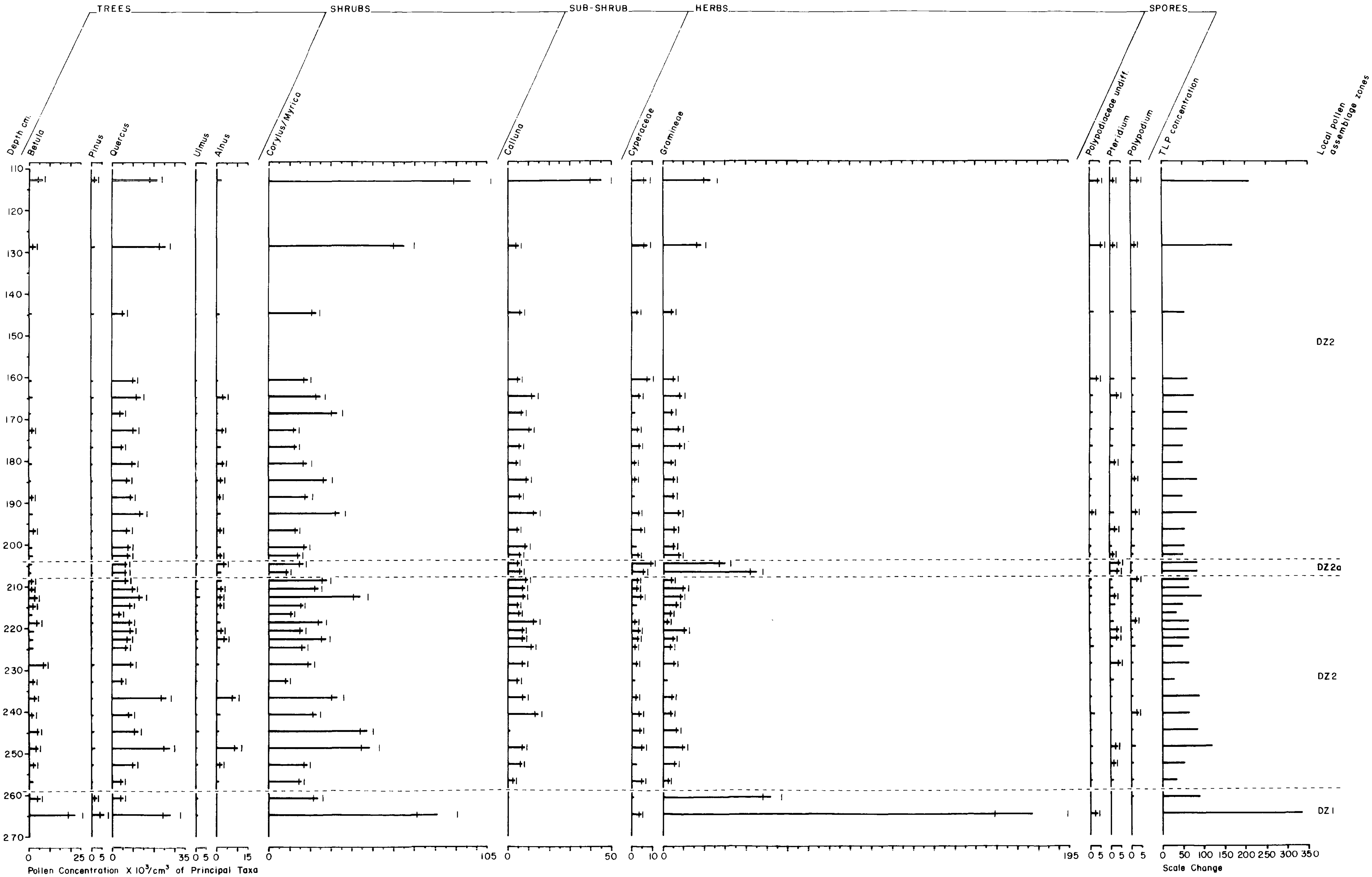
The pollen count results have been plotted in the form of relative (% TLP) and pollen concentration diagrams (Figs. 6 and 7). At least five hundred land pollen grains were counted at each level. The diagrams also show 95% confidence intervals, the stratigraphy, radiocarbon dates and the relative amounts of charcoal and mineral matter present in each sample.

Owing to the nature of the pollen results obtained and the evidence from the radiocarbon dates for possible profile disruption the pollen diagram can only be zoned in a rudimentary way. The lower part of the diagram (259-265 cm) shows an assemblage with a marked aquatic component. Above this, frequent minor fluctuations

DOZMARY POOL, BODMIN MOOR. FIG. 6



DOZMARY POOL, BODMIN MOOR POLLEN CONCENTRATION FIG. 7



occur in the run of the pollen curves, and one phase showing sudden change (204-208 cm) is present, but otherwise distinct zones cannot usefully be delimited.

Zone DZ1 259-265 cm : Phragmites-type-Corylus/Myrica PAZ. Corylus/ Myrica in the region of 20-25% TLP. No Fraxinus, Tilia or Alnus present. Quercus around 10% and Pinus 5% TLP. Phragmites-type pollen up to 55% TLP. Distinct aquatic/marginal component of Isoetes, Eupotamogeton, Hydrocotyle, Alisma-type and Litorella virtually absent by top of the zone. Trees plus shrubs just over 40%.

Zone DZ2 113-259 cm : Corylus/Myrica-Pteridium PAZ. Corylus/Myrica ranges from 30-55%. Quercus in region of 15-20%, reaching a peak of 30% TLP. Opening of the zone is marked by the occurrence of Alnus, Fraxinus, Calluna, Pteridium and Polypodiaceae. Tree plus shrub pollen shows oscillations between 55-80% TLP. Wide selection of heliophyte herbaceous taxa present in low numbers including Chenopodiaceae, Potentilla-type, Umbelliferae, Rumex, Plantago lanceolata, P. media/major, Bidens-type, Anthemis-type and Artemisia.

One subzone is recognised:

Subzone DZ 2a 204-208 cm : Gramineae subzone. Gramineae reaches 64% TLP with an associated increase in heliophyte herbs. Corylus/Myrica reduced to 10-15% TLP. Tree plus shrub pollen rapidly declines to about 25% TLP.

5.5 Radiocarbon Dating Results

Five peat samples were submitted to Harwell for radiometric dating using Brookhaven counters. Owing to the small quantity of peat necessary for this method (around 1.5 g wet weight) the material was obtained directly from the pollen core itself. The results for the Dozmary Pool site are given in Table 2 below.

Table 2 Radiocarbon analyses from Dozmary Pool, Bodmin Moor

Depth(cm)	Sample Material	Lab.no.	Date C14 years bp	bc/ad
203 - 204	Peat	HAR-5077	1560 ± 80	390 ± 80 ad
207 - 208	Peat	HAR-5078	510 ± 70	1440 ± 70 ad
225 - 226	Peat	HAR-5079	6020 ± 90	4070 ± 90 bc
241 - 242	Peat	HAR-5080	2740 ± 120	790 ± 120bc
257 - 258	Peat	HAR-5083	7590 ± 100	5640 ± 100bc

The dates show a very irregular depth-to-time sequence. The four upper dates are from the raised bog peat and the deepest date from within the monocotyledonous peat. This latter date (7,590 ± 100 bp) for a sample 5-6cm down into the monocotyledonous peat is in general accordance with Brown's (1977) result of 6,793 ± 70 bp for the bottom centimetre of the overlying raised bog peat plus the top three centimetres of the monocotyledonous peat. His most recent date comes from the lowest five centimetres of the raised bog peat plus one centimetre of the underlying monocotyledonous peat giving a result of 6,451 ±65 bp.

It would appear that the time-to-depth inversions of the four upper dates from the raised bog peat obtained in this study indicate that contamination of the samples and/or profile disruption has taken place. Whilst contamination or sampling error cannot entirely be ruled out it is more likely that profile disturbance has occurred. Evidence for this comes from the frequent presence of charcoal indicative of burning and from mineral matter within the profile suggestive of erosion and inwash from the surrounding slopes. Where erosion has taken place profile discontinuities can occur and older material can be washed in (Vuorela, 1980). Peat digging may also have been practised and some disturbance will have resulted from the various palaeoecological investigations which have taken place at the site.

These results reveal the importance of obtaining a number of radiocarbon dates for a profile, for in this case they reveal the strong likelihood of discontinuities and inversions. Thus the pollen sequences cannot be taken on their face value as showing progressive vegetation changes through time. In the following section the pollen diagram results are discussed, but the problems of chronology preclude the drawing of detailed inferences about vegetation changes during the time period covered by the raised bog peat stratigraphic unit.

5.6 Discussion of the Dozmary Pool Pollen Diagram

In the lowest zone DZ1, 259-265 cm, Gramineae pollen is dominant. Using the keys of Faegri & Iversen (1975) it was found that at 265 cm 99% of the Gramineae pollen was of *Phragmites*-type and at 261 cm 97%. In contrast only 8% of Gramineae pollen is of *Phragmites*-type at 205 cm. These high percentages indicate that during zone DZ1 *Phragmites* was probably growing in situ and formed a major component of the monocotyledonous peat of this zone. It is likely that the high local *Phragmites*-type pollen percentages would depress the representation of other pollen types from the surrounding area.

Tree plus shrub pollen composes in the region of 40% TLP with *Corylus*/*Myrica*, *Quercus*, *Betula* and *Pinus* being the most frequent species present. A number of aquatic taxa occur and *Calluna*, *Pteridium* and *Alnus* are absent. The overall picture presented is one of local stands of *Phragmites* and other waterside plants, together with a combination of tree, scrub and open vegetation in the surrounding area. *Quercus* is the major tree species represented, but *Betula* and *Pinus* are relatively more important than later.

Corylus/Myrica is the principal shrub present. No macro-remains of *Myrica* have been found in this or earlier studies at the site. If *Myrica* was present it would be expected to have grown on the bog itself. Thus the assumption has been made that the pollen is all or predominantly *Corylus*. This could be checked only by the use of electron microscopy (Edwards, 1981).

The stratigraphical and chronological problems of zone DZ 2 have already been referred to. The sharp fluctuations in pollen curves present in subzone DZ 2a (204-208 cm) are indicative of the possibility of stratigraphic irregularities, which have been confirmed by the radiocarbon dating results. Just below the subzone tree plus shrub pollen is of the order of 65% TLP, whereas within it it drops rapidly to under 30%. The *Corylus/Myrica* curve falls greatly and there are corresponding increases in Gramineae and open ground herbs such as *Potentilla*-type, *Bidens*-type, Chenopodiaceae and *Plantago lanceolata*.

The radiocarbon dates bracketing the subzone show inversion with 207-208 cm having a date of 510 ± 70 bp and 203 - 204 cm of 1,560 ± 80 bp. Mineral matter was found within the peat suggesting that vegetation disruption was sufficient to allow surface erosion and inwash. Although superficially the subzone represents a marked discrete clearance episode the radiometric evidence confirms that stratigraphic disturbance and discontinuity has taken place.

A second instance of date inversion occurs between the samples at 241-242 cm (2,740 ± 120 bp) and at 225-226 cm (6,020 ± 90 bp). Thus it is only possible to discuss very generally the vegetation of zone DZ 2, the lower parts of which would cover the Later Mesolithic period. Tree pollen reaches a maximum of 44% TLP at 237 cm. The tree plus shrub pollen maximum of 82% TLP occurs at 245 cm, and values are generally in the region of 60-70% TLP through the zone. Only at 207 cm does tree plus shrub pollen fall below 30% TLP. Shrub pollen is virtually all of Corylus/Myrica type.

From an examination of modern pollen rain data Maguire and Caseldine (1985) suggest that open ecosystems have tree pollen values not exceeding 45% TLP, whilst the minimum tree pollen value for forest communities is 20% TLP. The Dozmary Pool figures indicate the presence of a considerable but fluctuating degree of tree/scrub cover, but also that an open ground component was consistently present confirming the view of Brown (1977). During subzone DZ 2a the open ground expanded mainly at the expense of Corylus/Myrica. For comparison a surface pollen sample was prepared using living Sphagnum from the bog (Bradshaw, 1981). The present day open landscape is reflected by values of 10% tree pollen, 6% shrub pollen, 2% sub-shrub pollen and 82% TLP herbaceous pollen.

An important question to ask is why did tree pollen percentages not reach higher values at this site, particularly during the period of the climatic optimum? Brown (1977) considers that exposure was the major factor in limiting the progress of succession towards closed canopy communities. However, evidence exists for past tree growth in exposed sites such as the Isle of Lewis, Outer Hebrides (Wilkins, 1984). Birnie (1984) provides pollen and macrofossil evidence for a phase of tree and shrub growth throughout Shetland within the period 8,000-4,500 bp.

The development of woody vegetation in itself modifies and ameliorates the microclimate. It may be that factors such as grazing pressure and/or burning were responsible for the suppression of tree cover in the area. Analysis of soil from under a Bronze Age barrow at Colliford (c. 242m O.D.) 3.4 km south west of Dozmary Pool (Maltby & Caseldine, 1982) provides evidence for the existence of a brown soil type prior to the Bronze Age, which later developed an iron pan and an acid peaty surface. The brown soil type may have originated under a woody plant community, though this might have been of an open, scattered nature.

Overall pollen concentration values ranged from between 50,000 to 200,000 grains per cubic centimetre within the monocotyledonous and raised bog peat. The problematical radiocarbon dates do not allow the construction of a pollen influx diagram. The pollen concentration figures tend to mirror the results given by the relative percentage data, but often accentuate the peaks and troughs obtained particularly for the Corylus/Myrica and Quercus curves. Pollen concentration data differs from relative percentage information in that it provides a means of assessing the representation of a taxon at a particular level independently of the fluctuations of other taxa at that level. This is a particular asset where small scale changes are being examined.

Caseldine (1983) discusses the problems of relating site and environment in pollen analytical research in south west England. He draws attention to the dominance of bog communities in the pollen spectra from Bodmin Moor and the difficulty which this presents for the interpretation of surrounding vegetation types. The apparent lack of stratigraphic continuity at Dozmary Pool is an additional problem highlighted by the present study. A review of environmental change in Cornwall during the Flandrian is given by Caseldine (1980).

Brown (1977) in considering the Atlantic period on Bodmin Moor envisages that only scattered woodland was present with a predominance of Betula, Alnus and Salix on the valley floors and of Quercus, Ulmus and Corylus on the more sheltered hillsides. He sees the high Corylus/Myrica figures as reflecting areas of hazel scrub located mainly on the hillsides. In view of the aforementioned difficulties the results presented here do not provide adequate information to challenge these interpretations. However, several lines of evidence are suggestive of factors other than exposure alone being involved with the maintenance of areas of open vegetation on Bodmin Moor during Mesolithic times.

CHAPTER 6

DISCUSSION AND SUGGESTIONS FOR FUTURE WORK

6.1 Summary Discussion

The aim of this study has been to examine the hypothesis that during the Later Mesolithic period detectable vegetation changes took place in the uplands which could be attributed to human activity. Evidence was gathered from two study sites at Blacklane Brook, Dartmoor, Devon and Dozmary Pool, Bodmin Moor, Cornwall. Some of the limitations of the data obtained have already been discussed in section 4.7 and will be examined in section 6.2 in the light of the implications they have for the testing of the hypothesis.

The pollen and radiocarbon dating results for Blacklane Brook provide evidence for the presence of changing amounts of open vegetation within the pollen catchment area during the course of the Later Mesolithic period, together with evidence of burning in the form of charcoal within the profile. Thus it can be said that the hypothesis is supported that vegetation changes took place during the Later Mesolithic involving the suppression and reduction of woodland cover. These changes appear to have taken place on an irregular basis, but the techniques employed are not adequate to determine their precise temporal or spatial nature.

The changes in the vegetation which have been detected are circumstantially associated with evidence of burning. Although, in view of the discussions in Chapter 2 regarding the relationships between Mesolithic people, burning and the landscape, it seems likely that humans were the principal agents involved with initiating fires in the uplands the link can only be conjectural at this stage. Other feasible explanations of the variations in the amount of open vegetation cannot be entirely ruled out including the possibility of any one or a combination of the following : natural fires not involving man, fires accidentally started by man, variations in the intensity of grazing pressure, successional changes in the vegetation, soil developmental changes and climatic changes such as increasing precipitation resulting in the extension of mire habitats.

Owing to the indication of probable profile disturbance at Dozmary Pool it is not possible to make reliable interpretations of the nature of the vegetation within the pollen catchment area during the Later Mesolithic. If it is assumed that the relevant part of the profile is not disturbed and that it provides a continuous sequential record of the vegetation present it would appear that again open areas of fluctuating extent were consistently present and that abundant charcoal was found within the peat.

6.2 The Impact of the Limitations of the Techniques Employed and Suggestions for Future Work

A number of problems exist regarding the interpretation of the results of the present study. Not least of these is the question of the representativeness of a single profile, particularly when the aim is to detect and study small scale changes. Edwards (1983a) has reviewed the limited amount of work dealing with the quantitative aspects of this issue, reaching the overall conclusion that at the level of the presence/absence of the major pollen taxa the data from adjacent profiles are adequately reproducible.

However, where detail is sought it is clear that further work should be carried out on the amount of variability between closely spaced samples, both horizontally and vertically, so that it becomes clear what degree of quantitative change in pollen data can be considered to reflect vegetation differences as opposed to fluctuations due to random and sampling errors. The use of confidence intervals on pollen diagrams is essential to allow for the fact that only a small proportion of pollen is counted from any one pollen sample.

It is important to ascertain which species the Corylus/Myrica pollen found in high proportions at each site actually represents. The use of electron microscopy would be able to distinguish between the two and so provide critical information about the composition of the vegetation which at present rests upon the supposition that the pollen is at least largely Corylus.

As employed here the techniques of pollen analysis do not provide detailed information as to the size or distribution of respective areas of open and wooded vegetation. It is possible to go some way towards answering these questions by using a number of closely spaced profiles, a method which has been termed three-dimensional pollen analysis. Innes (1981) uses this approach for a study of Mesolithic vegetation changes on the North Yorkshire Moors. Edwards (1983a) draws attention to some of the possibilities for alternative interpretations of the results of this technique. Without a more rigorous statistical approach again there is the difficulty of distinguishing what degree of change in the pollen data represents a parallel vegetational change.

In order to increase the degree of resolution of pollen analysis on the time scale Edwards (1983a) reports that at Durham University J. Innes is examining pollen samples of 0.1 mm thickness. Garbett (1981) has produced a diagram from a core sampled at 0.2 cm intervals using a microtome. Provided that caution is observed regarding stratigraphic conditions this refinement of the technique could make more detailed information available regarding the duration of changes. It provides scope for answering some of the statistical problems of the degree of heterogeneity of pollen distribution, particularly if adjacent cores are also examined.

The study of plant macroremains can complement pollen analysis and provide additional information for a palaeoecological study. It gives a means of detailing the on site vegetation, and where wood remains are present it can provide hard evidence for the nature and extent of tree cover, which is an important issue in studies of prehistoric vegetation. GreatRex (1983) used surface samples from mire communities to show that plant macroscopic remains tend to come from plants within a metre of the sampling point except in the case of parts adapted for wind or water dispersal.

The subject of palaeoecology can best be advanced by the study of clearly defined problems capable of hypothesis construction and testing (Edwards, 1983b). There is considerable scope for the refinement of existing techniques particularly regarding the degree of spatial and temporal resolution obtained for environmental changes. These techniques tend to be time and labour intensive so that in order to answer major questions, such as whether or not a tree line existed or about the nature and extent of various vegetation types through time, it would be wise to concentrate resources on detailed localised studies employing a variety of complementary lines of evidence.

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Appendix 1 Pollen Preparation Using Stockmarr Tablets and Silicone Oil

1) Solution of carbonates and disaggregation

   a) Add 5 Stockmarr *Lycopodium* tablets to 0.5 cm^3 peat. Sample volume obtained by displacement of liquid in a measuring cylinder.

   b) Add cold 10% HCℓ soln. until effervescence stops. Stir.

   c) Centrifuge. Decant.

2) Evacuation of alkali soluble organic compounds

   a) Add KOH soln. to almost fill the tube. Stir.

   b) Heat in boiling water for 30 mins. Stir occasionally.

   c) Decant through sieve (mesh 180 micrometres). Wash residue.

   d) Centrifuge. Decant and wash with distilled water until supernatent liquid is unstained.

3) Acetylation-evacuation of unaltered lignin and cellulose (in fume cupboard).

   a) Add glacial acetic acid. Stir, centrifuge and decant.

   b) Add acetylation mixture (1:9 conc. sulphuric acid to acetic anhydride). Stir well.

   c) Heat in boiling water for 1 min. Stir occasionally. Top up with glacial acetic acid.

   d) Centrifuge and decant.

   e) Add glacial acetic acid. Stir, centrifuge and decant.

   f) Add distilled water, stir, centrifuge and decant.

   g) Add distilled water, stir, centrifuge and decant.

4) Dehydration and staining (in fume cupboard)

   a) Add tertiary butyl alcohol. Centrifuge and decant.

   b) Add 1 cm^3 of tertiary butyl alcohol plus 2 drops of safranin soln. and transfer to small vials. Centrifuge and decant.

   c) Add silicone fluid-same colume as the sample. Stir. Plug vial with cotton wool.

Appendix 2 Method of Estimation of the Relative Quantity of Charcoal in Peat Samples

1) Charcoal with dimensions over 180 micrometres

a) Take the material retained on a 180 micrometre mesh sieve from a 0.5 cm^3 peat sample and put it with 10 cm^3 of water in a petri dish positioned over a sheet of graph paper.

b) Count the number of 1 mm^2 squares occupied by charcoal out of a sample of 10 cm^2 using the x10 magnification of a binocular microscope.

c) The results are on an area basis so that only the relative quantity of charcoal over 180 micrometres is indicated. The method allows the comparison of samples from different levels.

2) Charcoal present on pollen preparation slides with dimensions under 180 micrometres

a) Using an eyepiece graticule record the total area of completely black fragments encountered with a set number of exotic marker grains (50 *Lycopodium* spores for the Dozmary Pool samples) on a pollen preparation slide at x 50 magnification.

b) The relative area units obtained are on the basis of square micrometres of charcoal per 50 *Lycopodium* spores.

c) It must be noted that the units for the charcoal above and below 180 micrometres are not the same, so that relative amounts of each in one sample cannot be directly compared.

Appendix 3 Pollen count data from Blacklane Brook, Dartmoor.

Numerical key to pollen taxa identified at Blacklane Brook.

Number	Taxon
1	Betula
2	Pinus
3	Quercus
4	Ulmus
5	Alnus
6	Fraxinus
7	Tilia
8	Corylus/Myrica
9	Salix
10	Ilex
11	Crataegus-type
12	Hedera
13	Lonicera
14	Erica-type
15	Calluna
16	Empetrum
17	Cyperaceae
18	Gramineae
19	Ranunculus-type
20	Cruciferae
21	Caryophyllaceae
22	Chenopodiaceae
23	Cf. Medicago-type
24	Lotus-type
25	Astragalus-type
26	Rosaceae undiff.
27	Filipendula
28	Potentilla-type
29	Sanguisorba officinalis
30	Umbelliferae
31	Polygonum bistorta-type
32	Oxyria-type
33	Rumex acetosa/acetosella
34	Lysimachia vulgaris-type
35	Cynoglossum
36	Plantago media/major
37	Plantago lanceolata
38	Succisa
39	Bidens-type
40	Aster-type
41	Anthemis-type
42	Artemisia
43	Liguliflorae
44	Narthecium
45	Menyanthes
46	Lycopodium
47	Osmunda
48	Polypodiaceae undiff.
49	Pteridium
50	Polypodium
51	Sphagnum

Appendix 3 contd. Pollen count data from Blacklane Brook, Dartmoor.

Depth cm.	Pollen counts for each taxon 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
62	1	2	114	1	30	5	0	178	0	0	0	1	0	2	60
75	6	2	97	4	26	1	2	216	0	0	0	0	0	0	47
83	4	1	81	0	30	2	*	222	1	0	0	0	0	0	37
91	4	1	93	5	25	5	1	140	0	0	0	0	0	2	54
99	11	2	81	4	37	5	2	191	0	0	0	2	0	6	81
103	10	3	102	8	48	2	*	180	0	0	0	0	0	7	114
107	3	1	92	2	46	5	0	204	1	0	1	0	0	0	121
111	11	2	74	3	41	1	1	149	0	0	0	0	0	12	173
115	8	2	66	6	42	1	2	125	0	0	0	0	0	0	34
117	9	1	107	6	46	7	5	130	1	1	0	0	0	5	108
119	9	2	76	29	44	5	2	120	1	0	1	0	0	0	188
121	22	4	109	15	33	9	5	152	0	0	0	1	0	0	31
123	10	3	90	14	40	4	4	141	0	0	0	0	0	0	12
127	9	4	65	10	44	4	4	135	1	0	0	0	0	0	34
131	27	3	102	11	36	5	1	150	0	0	0	0	0	3	60
135	25	5	91	9	25	6	1	131	0	0	0	0	0	0	10
139	12	2	94	1	14	0	3	157	0	0	0	0	0	0	8
143	21	8	[illegible]	14	[illegible]	1	1	237	0	0	0	0	0	1	14
147	19	9	33	14	8	0	1	214	0	0	0	0	0	0	26
151	[illegible]	5	[illegible]	17	4	3	*	205	0	0	0	1	0	0	4
153	31	4	85	12	0	0	0	194	0	0	4	0	0	0	10
155	29	10	85	10	3	1	*	182	4	0	0	0	0	0	7
157	15	5	103	4	1	1	0	219	0	0	1	0	1	0	1
159	21	4	98	9	1	2	0	199	0	0	0	0	0	0	1
163	24	12	93	6	0	0	0	253	3	0	0	0	*	1	17
167	35	5	91	12	1	4	0	206	0	0	1	0	1	2	9
171	19	4	59	6	1	0	0	203	19	0	0	0	0	1	5
179	55	2	115	15	1	0	*	176	17	0	0	0	*	0	7
187	12	11	70	2	0	0	0	169	8	0	0	0	0	0	13
195	62	18	80	0	1	0	0	110	9	0	0	0	0	0	13
199	67	20	40	0	0	0	0	11	5	0	0	0	0	1	11
203	102	37	7	0	0	0	0	7	15	0	7	0	0	0	10
211	74	22	16	0	0	0	0	1	20	0	4	0	0	1	21
219	5	6	0	0	0	0	0	0	4	0	1	0	0	0	2

Appendix 3 contd. Pollen count data from Blacklane Brook, Dartmoor.

Depth	Pollen counts for each taxon														
cm.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
62	0	79	27	0	1	*	0	0	0	0	7	0	3	0	0
75	0	98	17	0	0	0	1	0	0	0	1	1	1	0	1
83	0	134	19	0	0	0	0	0	1	0	0	0	2	0	0
91	0	135	52	0	0	0	0	0	1	0	4	0	0	0	0
99	0	102	71	0	0	0	0	0	0	0	4	0	3	0	0
103	0	51	77	0	0	0	0	0	0	0	9	0	2	0	0
107	0	25	29	0	0	0	0	0	0	0	2	0	1	0	0
111	0	46	69	0	0	1	1	0	0	0	10	0	7	0	0
115	0	35	239	0	0	0	1	0	0	0	26	3	10	0	0
117	0	16	72	0	0	0	0	0	0	0	8	0	2	*	0
119	0	24	188	0	0	0	0	0	0	0	13	0	5	0	0
121	0	21	110	1	0	0	0	0	0	0	13	2	4	0	0
123	0	46	127	0	0	1	0	0	0	0	21	3	5	0	0
127	0	26	238	1	0	0	0	0	0	0	11	1	3	0	1
131	0	23	169	0	0	0	0	0	0	0	6	1	3	0	0
135	0	45	232	1	0	0	0	0	0	0	24	1	3	0	0
139	0	55	150	0	0	0	0	0	0	0	25	0	3	0	1
143	0	25	226	1	0	0	0	0	0	0	24	1	2	0	1
147	0	35	160	0	0	0	*	0	0	0	32	0	8	0	1
151	0	64	82	0	0	0	0	0	0	0	14	2	2	0	1
153	0	52	95	0	0	0	0	0	1	1	17	2	7	0	1
155	0	48	134	1	0	0	1	0	0	0	21	1	2	0	2
157	0	61	76	1	0	0	3	0	0	1	24	0	9	0	4
159	0	68	121	0	0	0	0	0	0	0	12	0	6	0	1
163	0	32	63	0	0	0	0	0	0	*	4	1	2	0	0
167	1	32	135	0	0	0	1	0	0	*	3	0	1	0	0
171	13	46	159	0	0	0	1	0	1	0	1	2	0	0	1
179	*	31	110	0	0	0	*	0	1	0	0	2	3	0	0
187	11	32	190	1	0	0	1	0	1	0	3	0	0	0	0
195	3	27	199	0	0	0	0	0	1	0	0	1	0	0	2
199	16	41	296	0	0	0	1	0	1	0	0	3	1	0	2
203	46	62	220	0	0	0	2	1	4	0	4	1	0	0	0
211	8	267	78	0	0	0	3	1	1	0	2	3	2	0	1
21[illegible]	8	305	167	0	0	0	4	0	3	1	9	10	3	0	1

Appendix 3 contd. Pollen count data from Blacklane Brook, Dartmoor.

Depth cm.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
6[illegible]	0	1	1	0	0	*	1	0	0	0	0	0	*	6	0
75	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0
83	0	1	1	0	0	0	0	*	0	0	0	0	0	1	0
91	0	0	1	1	0	0	0	*	0	0	0	0	0	7	0
99	0	0	*	0	0	0	0	1	0	0	1	0	0	0	0
103	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0
107	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
111	0	0	1	0	0	5	0	0	0	0	0	0	0	0	0
115	0	0	2	0	0	1	1	1	1	0	0	0	0	0	0
117	0	0	4	0	0	0	1	1	2	0	0	0	0	6	0
119	0	0	5	0	0	0	0	1	5	0	0	0	0	19	0
121	0	0	1	0	0	0	0	1	2	0	0	0	0	10	0
123	0	0	1	0	0	0	0	*	0	0	0	0	0	7	0
127	0	0	0	0	0	0	1	5	5	0	0	0	0	5	0
131	0	0	5	0	0	0	0	2	2	0	0	0	0	0	0
135	0	0	1	0	0	1	0	5	1	0	1	0	0	6	0
139	0	0	0	0	1	0	0	3	0	0	3	0	0	2	0
143	0	0	0	0	0	0	0	3	1	0	0	0	0	1	0
147	0	0	0	0	0	0	0	1	0	0	*	0	0	0	0
151	0	0	*	0	0	0	0	8	0	0	0	0	0	0	0
1[illegible]3	0	1	1	0	1	0	0	3	0	0	0	0	0	0	0
1[illegible]5	0	0	2	1	1	0	0	6	0	0	0	0	0	0	0
1[illegible]7	0	1	4	0	0	0	0	8	0	0	0	0	0	1	0
1[illegible]9	0	0	3	0	0	0	0	7	0	0	0	0	0	1	0
1[illegible]	0	0	5	0	0	0	0	6	0	0	0	0	0	0	0
1[illegible]7	0	0	4	0	0	0	0	*	0	0	0	0	0	0	0
1[illegible]1	0	1	1	0	[illegible]	0	0	0	0	0	0	0	0	0	0
1[illegible]9	0	0	1	0	0	0	0	0	0	0	*	0	0	0	0
1[illegible]7	0	0	0	0	0	0	0	*	1	0	0	0	0	0	0
195	0	0	1	[illegible]	[illegible]	[illegible]	0	0	1	0	0	0	0	0	0
199	0	0	0	0	1	0	0	9	*	0	0	1	0	0	1
203	0	4	3	0	0	0	0	5	2	0	1	2	0	0	2
[illegible]11	1	2	10	0	0	0	0	0	0	0	2	3	0	0	2
[illegible]19	0	5	2	1	0	0	0	1	0	0	0	1	0	0	0

Column header: Pollen counts for each taxon

Appendix 3 contd. Pollen count data from Blacklane Brook, Dartmoor.

Depth	Pollen counts for each taxon					
cm.	46	47	48	49	50	51
62	0	0	6	44	5	7
75	0	0	3	11	1	0
83	0	0	2	3	4	3
91	0	0	3	1	2	20
99	0	0	3	1	6	4
103	0	0	0	2	15	2
107	*	0	5	1	6	18
111	0	0	4	24	4	1
115	0	0	1	10	5	7
117	0	0	11	22	11	134
119	0	0	1	19	3	13
121	0	0	13	11	8	26
123	0	0	12	31	2	87
127	0	0	2	8	9	41
131	0	0	3	7	6	236
135	0	0	7	10	6	134
139	[illegible]	0	42	18	5	50
143	[illegible]	[illegible]	11	5	10	142
147	0	0	6	0	5	412
151	[illegible]	0	109	10	3	146
153	0	0	149	13	*	107
155	0	0	192	15	4	293
157	0	1	355	23	2	87
159	0	1	579	38	7	[illegible]
163	0	*	567	10	4	190
167	0	0	201	6	1	7
171	0	0	54	0	*	49
179	0	0	47	2	*	16
187	0	0	78	0	*	176
195	0	0	18	0	0	170
199	0	0	33	0	0	84
203	0	0	58	0	0	25
211	0	0	4	0	0	66
219	0	0	2[illegible]	0	0	0

*present in scanning

Appendix 4 Pollen count data from Dozmary Pool, Bodmin Moor.

Numerical key to pollen taxa identified at Dozmary Pool.

Number	Taxon	Number	Taxon
1	Betula	36	Rumex obtusifolius
2	Pinus	37	Lysimachia vulgaris-type
3	Quercus	38	Rhinanthus-type
4	Ulmus	39	Plantago media/major
5	Alnus	40	Plantago lanceolata
6	Fraxinus	41	Plantago maritima
7	Tilia	42	Galium-type
8	Fagus	43	Valerionella
9	Corylus/Myrica	44	Succisa
10	Salix	45	Bidens-type
11	Hedera	46	Anthemis-type
12	Viburnum	47	Artemisia
13	Erica-type	48	Cirsium-type
14	Calluna	49	Centaurea nigra-type
15	Empetrum	50	Taraxacum-type
16	Cyperaceae	51	Narthecium
17	Gramineae	52	Hydrocotyle
18	Ranunculus-type	53	Menyanthes
19	Cruciferae	54	Litorella
20	Sinapis-type	55	Alisma-type
21	Caryophyllaceae	56	Eupotamogeton
22	Chenopodiaceae	57	Typha angustifolia-type
23	Ulex-type	58	Isoetes
24	Lotus-type	59	Osmunda
25	Vicia cracca-type	60	Polypodiaceae undiff.
26	Lathyrus-type	61	Pteridium
27	Rosaceae	62	Polypodium
28	Filipendula	63	Sphagnum
29	Potentilla-type		
30	Cf. Chrysosplenium		
31	Drosera intermedia		
32	Umbelliferae		
33	Polygonum bistorta-type		
34	Oxyria-type		
35	Rumex acetosa/acetosella		

Appendix 4 contd. Pollen count data from Dozmary Pool, Bodmin Moor.

Depth cm.	Pollen counts for each taxon 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
113	16	6	53	2	6	0	1	0	236	0	*	0	1	109	0
129	13	5	99	0	0	0	0	0	254	0	0	0	0	22	0
145	6	12	69	4	10	0	*	0	231	0	0	0	4	72	0
161	14	3	104	3	6	0	0	0	166	0	0	0	0	55	0
165	12	8	93	5	30	4	2	0	172	[illegible]	0	0	4	90	0
169	4	5	48	3	5	4	0	0	297	2	0	0	2	71	2
173	19	2	102	7	31	0	0	0	114	0	0	1	3	99	0
177	13	8	55	3	20	1	0	0	149	3	1	0	1	73	2
181	16	3	114	3	39	1	2	0	188	3	0	0	1	52	0
185	11	2	69	6	20	0	1	0	234	6	0	0	12	85	1
189	27	2	104	4	23	1	1	0	193	1	0	0	6	65	0
193	12	3	93	1	11	0	0	0	214	3	0	0	2	86	1
197	36	1	88	10	28	6	0	1	134	0	0	0	5	56	0
201	14	4	89	9	18	0	0	0	184	4	0	0	6	91	1
203	21	3	91	6	24	4	1	0	154	0	1	0	4	71	0
205	8	0	44	1	25	0	0	0	93	0	0	0	3	52	0
207	7	1	47	0	12	0	0	1	58	2	0	0	2	43	0
209	19	2	60	4	18	0	0	0	223	1	0	0	15	79	2
211	21	3	87	5	28	0	3	0	192	1	0	0	0	65	0
213	26	6	84	16	15	1	0	0	256	0	0	0	3	47	0
215	35	4	95	5	25	0	0	1	171	0	0	0	3	60	0
217	29	5	75	4	5	2	0	0	190	1	1	0	4	105	0
219	43	7	79	7	12	2	0	0	212	2	1	0	1	112	0
221	24	2	88	8	27	2	0	0	138	0	1	0	3	74	0
223	18	0	76	5	37	3	0	0	233	1	1	0	2	76	0
225	21	5	75	5	14	0	0	0	184	1	0	0	0	128	0
229	71	12	86	13	10	2	0	0	164	0	0	0	1	69	0
233	58	6	95	6	13	0	2	0	159	0	0	0	4	94	0
237	[illegible]	1	147	5	51	1	0	0	191	0	1	0	0	46	0
241	20	5	73	4	12	1	1	0	190	0	0	0	8	120	1
245	37	9	78	9	4	2	0	0	298	0	0	0	1	8	0
249	19	6	122	4	49	0	0	0	217	0	1	0	2	35	0
253	33	3	111	8	27	0	0	0	176	0	0	0	3	71	0
257	27	8	71	0	14	1	0	0	208	1	0	0	0	44	0
261	30	14	33	6	0	0	0	0	133	3	0	0	0	1	0
265	35	10	45	2	0	0	0	0	126	9	0	0	0	0	0

Appendix 4 contd. Pollen count data from Dozmary Pool, Bodmin Moor.

Depth	Pollen counts for each taxon														
cm.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
113	19	56	1	0	0	0	*	0	0	0	0	0	0	0	0
129	31	74	1	0	0	0	1	0	0	0	0	1	0	1	0
145	32	55	2	0	0	0	0	0	0	0	0	1	1	0	0
161	89	54	2	0	0	0	1	0	0	0	0	1	1	0	0
165	[illegible]	[illegible]	0	0	0	0	0	1	1	0	0	0	0	3	0
169	13	50	0	0	0	0	0	0	0	0	0	0	0	0	0
173	36	85	0	0	0	0	0	0	0	0	0	0	1	0	0
177	47	107	2	0	1	3	0	0	0	1	0	2	2	1	0
181	24	55	1	0	0	1	1	0	0	0	0	1	0	1	0
185	17	48	0	0	0	0	0	1	0	0	0	0	0	0	0
189	20	54	0	0	0	0	1	0	0	0	0	2	1	2	0
193	23	53	1	0	0	0	0	2	0	0	0	1	4	0	0
197	55	71	0	1	0	0	1	0	0	0	0	0	0	0	0
201	25	63	0	0	0	0	0	0	0	0	0	1	0	0	0
203	44	90	0	0	0	1	1	0	0	1	0	0	1	1	0
205	61	170	0	0	0	1	2	0	0	0	0	4	1	7	0
207	40	271	0	0	0	0	1	0	0	0	0	1	0	8	0
209	31	45	0	0	0	0	0	0	0	0	0	0	1	1	0
211	27	87	0	0	0	0	0	0	0	0	0	0	0	0	0
213	30	54	0	0	0	1	0	0	0	0	1	0	0	0	0
215	5	80	0	0	0	1	0	0	0	0	0	1	0	1	0
217	5	75	0	0	0	0	1	0	0	0	0	0	1	0	0
219	20	25	0	0	[illegible]	0	0		0	0	0	0	0	1	0
221	36	97	1	0	0	0	0	0	0	0	0	0	0	0	0
223	30	45	0	0	0	0	0	0	0	0	0	0	0	2	0
225	22	45	1	0	0	0	0	0	0	0	0	0	3	0	0
229	23	53	0	0	0	0	1	0	0	0	0	1	0	1	0
233	28	34	0	0	0	0	0	0	0	0	0	0	1	1	0
237	17	31	0	0	0	0	0	0	0	0	0	0	0	2	0
241	56	34	1	0	0	0	0	0	0	0	0	0	0	0	0
245	31	48	0	0	0	0	0	0	0	0	0	0	0	0	0
249	25	47	0	0	0	1	0	1	0	0	0	0	0	0	0
253	27	65	0	0	0	0	1	0	0	0	0	1	1	1	0
257	61	52	2	0	0	1	0	0	0	0	0	3	2	2	0
261	3	301	0	0	0	0	0	0	0	0	0	0	0	0	0
265	7	275	0	0	0	0	0	0	1	0	0	1	1	0	2

Appendix 4 contd. Pollen count data from Dozmary Pool, Bodmin Moor.

Depth cm.	Pollen counts for each taxon 31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
113	0	0	0	1	1	0	0	1	0	0	0	0	0	*	1
129	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
145	0	0	0	0	1	1	0	0	4	2	0	0	0	1	0
161	0	0	0	0	3	0	0	0	0	2	0	0	0	0	1
165	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0
169	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0
173	0	0	0	0	0	0	0	0	1	4	0	0	0	1	0
177	0	0	0	0	6	4	0	0	0	0	0	0	0	0	0
181	0	1	0	0	2	0	0	0	0	7	0	1	0	1	0
185	0	0	0	0	1	0	0	0	0	0	0	0	0	*	0
189	0	3	2	0	0	0	0	0	0	4	0	0	0	0	0
193	1	1	0	4	2	4	0	0	1	0	0	0	0	0	0
197	0	0	0	1	1	0	0	0	0	7	0	1	0	0	0
201	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0
203	0	0	0	0	1	0	0	0	0	7	0	0	0	0	1
205	0	6	0	0	1	0	0	0	0	15	0	0	1	0	1
207	0	1	0	0	0	0	0	0	0	13	0	2	0	0	6
209	0	0	0	1	0	0	3	0	1	0	0	0	0	0	0
211	0	0	0	0	0	0	0	0	0	6	0	0	0	0	2
213	0	0	0	0	1	0	0	0	2	2	0	0	0	0	2
215	0	0	0	0	0	0	0	0	2	4	0	0	0	0	0
217	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0
219	0	0	0	0	0	0	0	0	0	3	0	0	0	1	0
221	0	0	0	0	0	0	0	0	0	8	0	0	0	0	1
223	0	0	0	0	2	0	0	0	0	3	0	0	0	0	0
225	0	[illegible]	0	0	3	6	0	0	0	0	0	0	0	0	0
229	0	1	0	0	0	0	0	0	0	2	0	1	0	0	1
233	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0
237	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
241	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
245	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
249	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1
253	0	0	0	0	1	0	1	0	0	3	0	0	0	0	1
257	0	0	0	2	0	3	0	0	0	0	0	0	0	0	1
261	0	0	0	0	1	0	2	0	0	0	2	0	0	0	0
265	0	0	0	3	3	0	0	0	0	0	4	0	0	0	1

Appendix 4 contd. Pollen count data from Dozmary Pool, Bodmin Moor.

Depth cm.	Pollen counts for each taxon 46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
113	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
129	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26
145	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16
161	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38
165	0	0	0	0	1	0	0	0	0	0	0	0	0	0	8
169	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
173	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
177	0	0	0	0	1	1	0	0	0	0	0	0	0	0	14
181	0	1	0	0	0	0	0	0	0	0	0	0	0	0	6
185	1	0	0	0	1	0	0	0	0	0	0	0	0	0	8
189	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
193	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15
197	1	1	0	0	4	2	0	0	0	0	0	0	0	0	5
201	0	0	0	1	0	0	0	0	0	0	0	1	0	0	9
203	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
205	5	0	0	0	5	0	0	0	0	0	0	0	0	0	3
207	1	1	0	0	5	0	0	0	0	0	0	0	0	0	1
209	0	0	0	0	1	0	0	0	0	0	0	0	0	0	7
211	1	0	0	0	0	0	0	0	0	0	0	0	0	0	6
213	0	0	1	0	0	0	0	0	0	0	0	0	0	*	6
215	2	0	0	0	1	0	0	0	0	0	0	0	0	0	4
217	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
219	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
221	0	2	0	0	2	2	0	0	0	0	0	0	0	1	8
223	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
225	1	0	0	0	0	0	0	0	0	0	0	0	0	0	19
229	0	0	1	0	1	0	0	0	0	0	0	0	0	0	5
233	0	2	0	0	0	0	0	0	0	0	0	0	0	0	6
237	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
241	1	0	0	0	1	0	0	0	0	0	0	0	0	0	20
245	0	1	0	0	0	0	0	1	0	0	0	0	0	0	2
249	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
253	0	0	0	0	0	0	2	0	0	0	0	0	0	0	4
257	0	1	0	0	0	0	4	0	0	0	0	0	3	0	14
261	0	0	0	0	0	0	31	0	2	2	1	3	81	0	0
265	0	0	0	0	0	0	8	0	1	7	1	6	111	0	6

Appendix 4 contd. Pollen count data from Dozmary Pool, Bodmin Moor.

Depth cm.	Pollen counts for each taxon 61	62	63	No. Stockmarr tablets	No. exotics counted
113	6	10	31	5	274
129	5	11	37	5	439
145	21	22	29	5	1121
161	18	15	50	5	1013
165	25	5	8	3	464
169	5	19	11	5	1004
173	20	10	7	3	577
177	11	12	25	5	1232
181	33	7	58	3	701
185	*	22	27	5	914
189	8	6	49	3	686
193	18	17	24	5	697
197	36	8	48	3	688
201	10	14	28	5	1119
203	21	8	28	3	702
205	29	3	7	3	392
207	28	3	19	3	408
209	9	29	14	5	894
211	13	4	45	3	525
213	17	10	28	3	387
215	24	12	57	3	707
217	15	12	11	3	1107
219	14	23	53	3	541
221	38	2	40	3	566
223	37	8	41	3	581
225	12	16	37	5	1173
229	31	7	81	3	554
233	24	16	14	3	1134
237	5	4	27	3	383
241	5	27	21	5	908
245	4	2	1491	3	422
249	14	7	17	3	301
253	29	9	61	3	657
257	10	16	56	5	1528
261	0	1	50	3	386
265	0	0	2	5	176

Stockmarr tablets: 1 tablet has 11300∓400 Lycopodium spores
0.5 cubic centimetre peat samples * present in scanning