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Faculty of Science

Department of Geography

A PALYNOLOGICAL STUDY OF THE IMPACT OF MAN ON THE LANDSCAPE OF CENTRAL SOUTHERN ENGLAND, WITH SPECIAL REFERENCE TO THE CHALKLANDS

by

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ABSTRACT

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Doctor of Philosophy

A PALYNOLOGICAL STUDY OF THE IMPACT OF MAN ON THE LANDSCAPE OF CENTRAL SOUTHERN ENGLAND, WITH SPECIAL REFERENCE TO THE CHALKLANDS

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The investigation was formulated to clarify and supplement the limited palaeoenvironmental evidence available from the chalklands of central southern England. Pollen analysis was the principal technique utilised. Only two deposits within the chalk outcrop contained sufficient fossil pollen for analysis: a riverine peat north of Winchester and a mire in clays overlying chalk at Snelsmore in Berkshire. Consequently, five sites peripheral to the chalk were also examined: Amberley in Sussex, Rimsmoor, Okers and Kingswood in Dorset and Woodhay in Berkshire.

The sequence from Winchester provides evidence for the Boreal and Atlantic woodland of the chalk and exhibits an early *Ulmus* decline clearance. Open conditions appear to have prevailed in at least this area of the Hampshire Downs since the Early Neolithic. The Snelsmore data show that from the end of the *Ulmus* decline clearance, woodland was a more common feature of the local landscape.

The peripheral sites in general exhibit phases of woodland clearance and regeneration similar to sites elsewhere in Britain. At several of these peripheral sites there is a good correlation between the chronology of episodes in the pollen diagrams and archaeological events on the chalklands, although the representation of pollen from vegetation on the chalk outcrop may have been low. The rapidly accumulating peat at Rimsmoor shows clearance episodes in considerable detail and at Kingswood a phase of Mesolithic disturbance may be recorded.

It is proposed that certain areas of the chalk, such as that around Winchester, have been characterised by an essentially open landscape since the Early Neolithic. In other areas, however, as perhaps typified by the Snelsmore analysis, woodland was more common. Edaphic and socio-economic reasons are advanced for these differences.

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CHAPTER 1

INTRODUCTION

1.1. BACKGROUND

The chalk outcrop of southern England has been the focus of considerable archaeological and botanical interest for a number of decades. Investigations of its environmental history have, however, been extraordinarily limited. Perceptions of past conditions were, until recently, constrained by an over-rigid application of present-day analogues. The term 'downland' is synonymous with the largely open, treeless habitat of the chalk landscape of today; from this developed the hypothesis that ever since the Devensian stadial the chalk has supported a vegetation of grassland or scrub. It was a view largely prevalent within the archaeological literature. Piggott (1954), for example, envisaged Neolithic cultures colonising a landscape that was already open grassland and Grinsell (1964) and Renfrew (1973) have both published artefact distribution maps for prehistoric periods depicting the chalk as 'open downland', sandy soils as 'heathland' or 'light vegetation and woodland' and clays as 'dense woodland'.

Ecological research (section 2.2.) has demonstrated the naivety of this hypothesis by showing that the openness of the chalk, like that of the heathlands, is a result of human activity in woodland clearance and in the suppression of regeneration. As early as 1922 Tansley was describing the course of the succession from grassland to scrub in an enclosed site in the South Downs. In the late-1950s and 1960s the myxomatosis epidemic (A.S. Thomas 1960a, 1963) and the decline in sheep farming illustrated the importance of grazing in preventing scrub invasion and woodland development. Palynological investigations of sites in southern England and elsewhere in Britain indicate that forest was widespread in mid-postglacial times. Direct evidence for a forested chalk landscape is derived from a single and somewhat equivocal (section 2.1.1.1.) pollen-analysed site at Lewes (Thorley 1981) and from a number of chalk soils which have yielded sequences of subfossil Mollusca (e.g. J.G. Evans 1972; Kerney et al. 1964).

Consequently, it is now generally accepted that the chalklands once supported a more or less continuous forest cover. Nevertheless, the composition is largely unknown, and, likewise, the chronology and nature of its clearance. A high density of artefacts from the Neolithic period onwards have led to speculation that the forest was clear-felled in the early Neolithic to remain permanently open (eg. J.G. Evans 1975). This would be in contrast to much of the rest of Britain which experienced a succession of clearance and regeneration episodes (Godwin 1975a). Barrows located on skylines and astronomical structures such as Stonehenge all imply an extensively open landscape at the time of their construction. The palaeoenvironmental data may lend some support to this theory and yet as most are from sequences of snail shells preserved beneath monuments (eg. J.G. Evans 1967, 1972) it is debatable precisely how representative they are of general chalkland conditions. A more random sampling base is possibly provided by dry valley infills, but these are themselves usually a result of human activity and can also be very difficult to date (eg. Waton 1982a).

When compared with the surrounding geologies, the chalk outcrop tends to exhibit a high density of archaeological remains. This implies that the chalk was especially favoured for settlement. Franklin (1953) assumed that the woodland was lighter and thus its potential ease of clearance attracted Neolithic man, whilst J.G. Evans (1975) notes that the culture shows a predeliction for lighter, well-drained soils. Butzer (1971) even suggests that these first agriculturalists may have excavated pits to assess soil suitability prior to settlement. However, the greater density of artefacts could simply be a result of differential preservation. Arable cultivation may have been concentrated off the chalk after the fifth century A.D. and consequently remains in the latter areas will have experienced an extra 1500 years of degradation and destruction through ploughing.

This research project was devised because of the extremely equivocal nature of this evidence relating to the palaeoecology of the chalklands. Problems were encountered in the selection of sites for investigation (section 3.1.) and consequently only two, Winchester and Snelsmore, may show directly the vegetational history of the downs. The remaining five sites from the periphery of the chalk frequently show events that can be correlated with archaeological data from the respective adjacent areas of downland. Consequently, whilst discussion centres upon the environmental history of the chalk and, in particular, the impact of man, the analysis includes a consideration of more general conditions in southern England.

1.2. OBJECTIVE

This study involved, for the first time, a comprehensive examination of the riverine and other peats of the chalklands of central southern England. It was undertaken to assess their suitability for pollen analysis and as a result seven sites were investigated in detail. The objective of the research has been the clarification of two major issues:

a) The development, form and composition of the original forest vegetation of the chalk outcrop
b) The chronology of its removal and subsequent land use, the incidence of regeneration and the degree of spatial variation.

1.3. AREA OF INVESTIGATION

The area designated for study encompassed the downlands of Hampshire, Dorset, Wiltshire (herein the 'central area') and Berkshire and the North and South Downs (Fig 1.1.). The chalk of The Chilterns and northwards was excluded because of the prevalence of, most significantly, glacial till. The Lincolnshire and Yorkshire Wolds were not examined.

1.4. RADIOCARBON DATES

Throughout this thesis radiocarbon determinations are expressed according to the internationally accepted 'Libby half-life' of 5568 years (Renfrew 1974). As discussion is most concerned with the activities of human cultures dates are expressed in terms of years Before Christ or Anno Domini and follow the convention of lower case letters, bc and ad respectively, to indicate uncalibrated dates. Calibration in general is not used because of the uncertainty surrounding the various different calibration curves available (Renfrew 1974) and to simplify comparison with other work. During discussion of the pollen diagrams, dates shown without laboratory numbers and standard deviations are derived from time:depth curves.

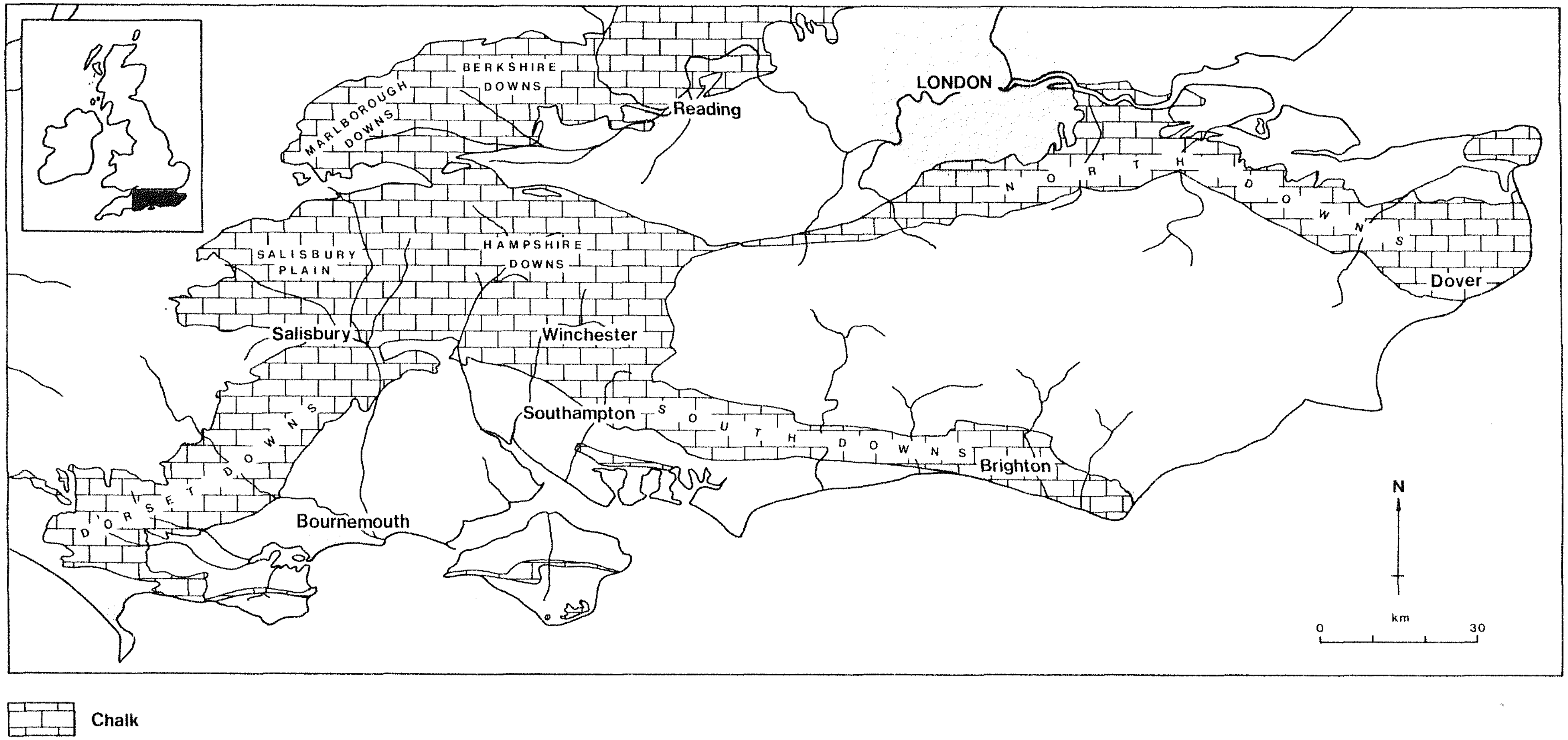


Figure 1.1. The chalklands of southern England: general location map

1.5. CHRONOLOGY AND ARCHAEOLOGICAL PERIODS

For convenience events are related to periods of time with approximate archaeological correlations. It is increasingly recognised that classification of time into Neolithic, Bronze or Iron Ages,

> "obscures the essential continuity of prehistoric farming settlement by making artificial divisions" (ApSimon 1976,41).

However, as ApSimon describes, they do provide convenient divisions of time to simplify discussion: he advocates subdivisions of the Neolithic and Bronze Ages based on chronology and general phases of activity rather than on frequently diachronous cultural characteristics.

The Mesolithic period is assumed to last until the beginning of Neolithic activity in the early fourth millennium bc (Table 1.1.). The Neolithic is subdivided according to ApSimon (1976), a rather more succinct method than those of, for example, I.F. Smith (1974), Whittle (1980) and Magaw and Simpson (1979), but includes their more important characteristics. ApSimon's (1976) scheme is also followed for the Bronze Age: it is similar to that of Burgess (1974).

Subdivision of the Iron Age is controversial with few workers willing to commit themselves to rigid early, middle or late classifications. The system adopted here was suggested by T.C. Champion (pers.comm.) and is based on the pottery types as outlined by Cunliffe (1978) and social and economic conditions. The Early Iron Age lasts from c. 800bc to c. 300bc and is characterised in Wessex by pottery of the Early All Cannings Cross group (Cunliffe 1978; A:2 p.351) and All Cannings Cross-Meon Hill group (A6, p.355). The Middle Iron Age is from c. 300bc to c. 50bc with The Maiden Castle-Marnhull style (A:19, p.368) common and the Late Iron Age, from 50bc to the first century ad, Durotrigian type pottery (A:33, p.382).

1.6. NOMENCLATURE

The nomenclature of vascular plants follows Clapham et al (1968); bryophytes, A.J.E. Smith (1978); liverworts, Watson (1968); and Mollusca, Waldèn (1976).

Table 1.1. Chronology of prehistoric periods followed in this thesis.

Sources ApSimon 1976
T.C. Champion (pers.comm.)
Cunliffe 1978

Period	Subdivisions	Dates
Roman		
		ad43
	Late	
		50bc
Iron Age	Middle	
		300bc
	Early	
		800-500bc
	Late	
		900bc
Bronze Age	Middle	
		1250bc
	Early (Beaker: pre-?2000 to c.1600bc)	
		2000-1700bc
	Final	
		2000bc
	Late	
		2500bc
Neolithic	Middle	
		3000bc
	Early	
		3500bc
	Earliest	
		4000-3500bc
Mesolithic		

CHAPTER 2

PREVIOUS RESEARCH

Published research relevant to chalkland environmental history may be divided into palaeoecological and ecological sources. Direct archaeological data, such as site density, are not examined as the relationship of sites to environment is highly equivocal; for example, a high density of remains may imply either an extensively open landscape, or a forested one with a constantly changing mosaic of clearings or a low level of subsequent agriculture (section 3.7.) The chapter concludes with a discussion of pollen dispersal, a factor of significance in the selection of sites for this project.

2.1. PALAEOECOLOGICAL RESEARCH

This section is divided into pollen-analysed sites, subdivided into 'natural' peat deposits and archaeological site data; and subfossil molluscs, from both dry valley infills and archaeological contexts. A third section briefly discusses macrofossil plant remains recorded during archaeological excavations. The location of each site discussed is shown in figure 2.1.: the text number refers to the number in the diagram.

2.1.1. POLLEN ANALYSED SITES

2.1.1.1. NATURAL PEAT DEPOSITS

The term 'natural' is here defined as a peat deposit that has accumulated, or a subfossil snail sequence that has been preserved, without the influence of man, or only indirectly as a result of human activity.

Very few deposits with pollen likely to have been derived from vegetation on the chalk outcrop have been analysed. Seven main sites are known and only two of these are from within the chalk outcrop itself: Lewes and Leckford. The remaining five are from the peripheral geologies surrounding the chalk (Wingham, Frogholt, Amberley, Litton Cheney and New Shide Bridge) and at all seven, the pollen present includes pollen from plants on other strata. Furthermore, at only Amberley is the extent of the deposit known, so it is only here that pollen source area

Figure 2.1. Location of sites discussed in Chapter 2

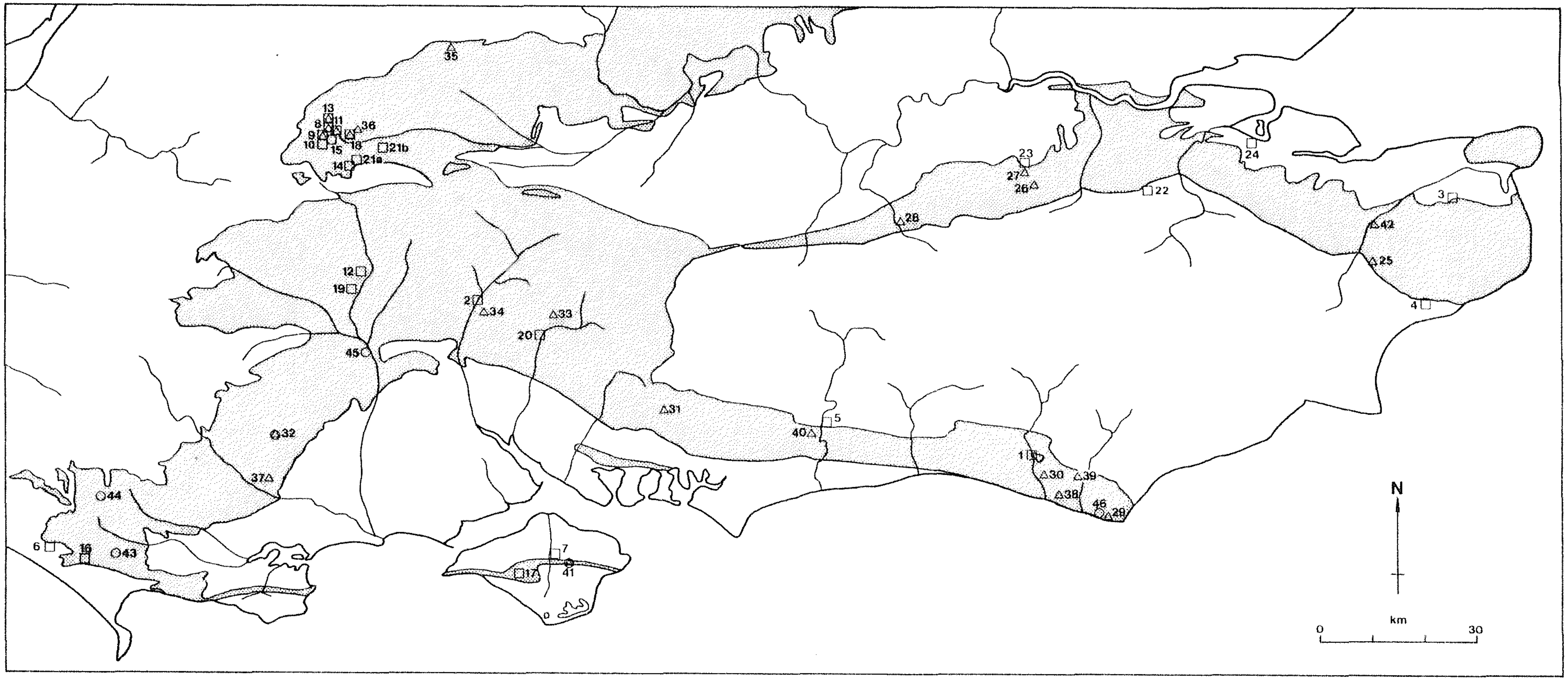
Figure 2.1. Location of sites discussed in Chapter 2. Key to map opposite

1. Lewes
2. Leckford
3. Wingham
4. Frogholt
5. Amberley Wild Brooks
6. Litton Cheney
7. New Shide Bridge
8. Horslip
9. South Street
10. Beckhampton Road
11. Avebury
12. Durrington Walls
13. Windmill Hill
14. Knap Hill
15. Silbury Hill
16. Black Down
17. Newbarn Down
18. Overton Down
19. Wilsford Shaft
20. Winchester

21a. Wansdyke, Red Shaw

21b. Wansdyke, New Buildings

22. Addington
23. Keston
24. Lower Halstow
25. Devil's Kneadingtrough
26. Cudham
27. Keston
28. Juniper Hall
29. Kiln Combe
30. Itford Bottom
31. Chalton
32. Thickthorn Down
33. Bridget's and Burntwood Farms
34. Stockbridge Down
35. Rams Hill
36. Fyfield Down
37. Badbury Earthwork
38. Bishopstone
39. Alfriston
40. Bury Hill
41. Arreton Down
42. Julliberries' Grave
43. Maiden Castle
44. Shearplace Hill
45. Little Woodbury
46. Belle Tout



□ Pollen
△ Mollusca
○ Macroscopic plant remains

Figure 2.1. Location of sites discussed in Chapter 2. Key opposite.

(section 2.4.3.) can be calculated. These two factors greatly hinder an investigation of chalkland vegetational history, yet some valuable data are obtainable.

Lewes, Sussex (1). South of Lewes and within the South Downs is a 2 to 3km diameter alluvial basin, The Vale of the Brooks, a part of the Ouse valley. A detailed geomorphological examination of the sedimentary fill by D.K.C. Jones (1971) revealed a threefold division with a middle layer characterised by lenses of peat, from which Thorley (1971a, 1971b, 1981) analysed two cores, Lewes I and Lewes II respectively. They were taken from a transect from the NW corner of the Upper Rise to the N edge of the basin. It was about 500m. in total length and Lewes I, the deeper section (1200-750cm.) about 200m. from the basin edge and Lewes II (750-350cm.) about 80m. from the Upper Rise (all measurements from diagrams in Jones 1971).

Pollen analyses conducted of both cores revealed sequences difficult to date by the conventional Godwin pollen zonation (Godwin 1940; Thorley 1981). Radiocarbon assays of three samples gave the following results: Lewes I, about the centre of the sequence 4340±180bc (BIRM-168); Lewes II, near the base 3724±167bc (BIRM-167) and at the top of the sequence 1240±125bc (Lab. number not available).

The Lewes I diagram shows that the area was wooded well before 4340±180bc and Thorley notes two phases of disturbance, one prior to 4340bc and one after that date. The latter is characterised by the selective decline of Tilia and Ulmus and slightly raised levels of non-arboreal pollen. She attributes the disturbance to the Mesolithic.

In the longer Lewes II diagram, Thorley recognises six periods; A - low Tilia and Ulmus with increased herbs and Pteridium, presumably related to Mesolithic activities in "...the pursuit of game" (p.100); B - a phase of regeneration (the date of 3724±167bc is from this level); C - forest with decreasing Pinus and Fraxinus; D - forest with reduced Ulmus and Tilia; E - minor clearance of Neolithic or Early Bronze Age date; and F - significant woodland clearance with a decline in arboreal pollen and major increases in grasses, herbs and Pteridium. This is radiocarbon dated to the Middle Bronze Age.

Thorley (1981) suggests that woodland disturbance was slight and that there was no significant clearance of the eastern end of the South Downs until the Middle Bronze Age. She points out that this accords well with the archaeological evidence, there being few pre-Bronze Age remains in the area (but see section 2.1.2.2.) though she accepts the probability of the destruction of earlier artifacts. However, she contends that prior to the Middle Bronze Age there was the selective removal of elm and lime which she argues were,

> "a distinct community on the moist base-rich valley side soils either on the superficial deposits or on the marly soils of the Lower Chalk, potentially attracting game, pastoralists and agriculturalists" (p.102).

Unfortunately, by her estimation, the important early Neolithic horizon which elsewhere in Britain includes the elm decline is absent because of negligible pollen between Periods C and D.

Thorley's work at Lewes is invaluable but some of her arguments are questionable. Of central importance is the question of precisely what is represented in her diagrams. She states that,

> "As Tauber (1965) has indicated, the pollen in a basin of this large size must have been derived from several kilometres around the site and therefore certainly from the Chalk Downs, half a kilometre away" (p.102).

Tauber (1965) however refers to a sampling point in the centre of an open basin, not to one, in this instance, on its edge. Additionally, Tauber's model relates to a large open pollen receiving surface, such as a lake (section 2.4.3.). In the Vale of the Brooks the extent of the pollen preserving surface is not known, but appears to have been discontinuous: the gross stratigraphy is described as interbedded peats and peaty-clays (Jones 1971). Presumably, between wetter peat forming areas, possibly meander cut-offs, there were drier areas that could have supported some of the vegetation which Thorley attributes to the chalk. It seems highly likely that the basin was formerly a mosaic of alder carr and open marsh with drier areas of woodland. Consequently, it may have been erroneous to state that the pollen was being derived from the chalk. The diagrams may simply indicate clearance of the basin floor, perhaps occurring long after major downland clearance; the pollen evidence alone is inadequate to justify her argument.

As already mentioned, correlation of the periods at Lewes with

Godwin's zones was difficult, but Thorley does not adequately consider why this should have been the situation. It appears that Periods A and B of Lewes I are of late-Boreal or Boreal-Atlantic Transition date from the levels of Pinus pollen. The early peak of Alnus may represent initial colonisation of the flood plain before its more general establishment, or alternatively, the diagram is post-Transition in date and the Pinus pollen represents the survival of the species perhaps either locally on base-deficient deposits or in the Weald to the north. This may lend further weight to the argument that the diagrams portray predominantly local conditions. In addition, the chronology may also be suspect. Thorley only briefly mentions the possibility that the radiocarbon samples may have been contaminated and then views it as unlikely: they were collected using a Hiller corer, not the best instrument for obtaining clean sediment.

Thorley places particular emphasis upon the selective declines discernible in the diagrams of Tilia and Ulmus, suggesting the preferential exploitation of a distinct community. Whilst this may be plausible, it should be noted that the Quercus and Coryloid pollen frequencies fluctuate, often quite markedly, at the same time, and to an extent often greater than that which would be caused by the percentage interrelationship of the curves. Thorley states that these were a separate community from the more demanding Tilia and Ulmus, but as they are disturbed contemporaneously it is not possible to imply that they were either separate or as part of the same community. This is particularly relevant as Ulmus and Tilia tend to be the two most markedly affected species in British postglacial pollen diagrams probably as part of more general clearances (see sections 9.3. and 10.3.). The issue is further complicated as Ulmus pollen is susceptible to degradation whilst Tilia is more resistant (Havinga 1964, 1967, 1971): Thorley notes problems of preservation so some of the fluctuations could be a result of this factor. Furthermore, the nature of the soils on the superficial deposits is open to debate. I have observed at the present day very localised, strongly calcifuge vegetation on valley gravels in the Test valley at Leckford. Thorley's own geological map shows valley gravels as one of the most extensive deposits in the vale. The Lewes diagrams appear largely devoid of such species, with the possible exception of Pinus, but it seems plausible that soils developed on such strata, as with the exposure of Upper Greensand to the south-east, were not as base-rich as her theory requires. The possible importance of extensive unmapped superficial deposits in the Vale, however, cannot be underestimated. The evidence therefore is inadequate to support her hypothesis of a distinct elm-lime community; that such a community may have existed nevertheless cannot be denied.

As such, the Lewes data are of limited value until more work is undertaken in the Vale: further cores would permit the application of three-dimensional pollen diagram principles (Turner 1975) and thereby a more reliable indication of the location of activity in the area. More detail may also be gained by pollen counts at intervals closer than the 10 and 20 cm adopted by Thorley.

Leckford, Hampshire (2). In the Test valley of Hampshire there are extensive areas of riverine peat and these are especially well developed in the Leckford section. Seagrief (1955) examining the area found the peats rarely deeper than 170cm and composed chiefly of *Phragmites* and rootlet remains. Analysis of a core over 210cm in depth revealed the upper 140cm to have very sparse pollen. He presents a table of actual numbers of grains counted in those samples which contained any pollen at all (p.84), between 75 and 135cm: Seagrief found difficulty in interpreting the results but implies that the Boreal-Atlantic Transition may be present in the base of the deposit and that *Centaurea cyanus* at 100cm and various other herbs may indicate the early existence of open habitats.

The significance of this site lies in its location within the centre of the Hampshire Downs and it is thus disappointing that the pollen evidence is so equivocal. From the high level of *Pinus* and absence of *Alnus* in the lower two samples (130 and 135cm) Seagrief's inference that these represent the Boreal period is acceptable. It is noteworthy that non-arboreal pollen is consistently higher above 100cm: between 105 and 130cm the stratigraphy is a "greyish-green sandy mud with shells" (p.83) whilst above and below there is *Phragmites* peat. This is not taken into account in Seagrief's interpretation and it is most probable that there is a major discontinuity in, or truncation of, the deposit at this level. The sequence is clearly incomplete, though it implies that extensively open conditions could have prevailed over the period represented by the last 100cm of peat accumulation. The degree of openness may, however, have been exaggerated by the resistence of certain herb grains to degradation. The basal levels are of value in suggesting that in the (assumed) Boreal period the chalk was covered by a forest dominated by pine and hazel, typical of the period elsewhere in Britain. The implications of this, particularly with reference to soils, will be discussed later (section 9.4.2.2.).

Wingham (3) and Frogholt (4), East Kent. Godwin (1962) has investigated two sites in East Kent, Wingham, near Canterbury, and Frogholt near Folkestone. Both peat deposits were buried under inorganic sediments and discovered during excavations for sewer and water services respectively.

At Frogholt, about 1km from the chalk escarpment, 135cm of peat of fluviatile origin was discovered under 300cm of overburden. Pollen, macrofossil and radiocarbon analyses showed that the deposit had accumulated over a period of 500 years from about 1030bc to 540bc. The pollen diagram shows diverse and fluctuating herbs and, towards the top, a very marked intensification of land use with all herbaceous species and Pteridium increasing. Tree pollen also fluctuates at the top showing woodland clearance and the stratigraphy changes to sand: this Godwin correlates with the increased cultivation of the first Iron Age settlement.

At Wingham, 2km from the edge of the exposed chalk, about 200cm of organic sediment was found beneath 30cm of material. Two radiocarbon dates showed that the deposit accumulated between about 1700bc and 200ad. Arboreal pollen is here consistently below 25% total pollen, with, as at Frogholt, an abundant herb flora. There is also a marked intensification of land use occurring at about the same chronological level as Frogholt, the Early Iron Age.

Both sites show Pinus at 10% to 30% tree pollen, unusually high for mid-postglacial diagrams and it increases markedly during the Early Iron Age intensification: Godwin interprets this as improved dispersal of its pollen from stands on the sands of the central Weald. At Wingham Tilia declines at approximately 1200bc and Fagus rises at 200ad.

In his conclusion, Godwin states that the sites indicate that parts at least of the chalk was largely disforested by as early as 1700bc. The greatest abundance of agricultural indicators occur from the Middle Bronze to Early Iron Ages with the highest cereal frequence recorded only in the first third of the period. The archaeological evidence as quoted by Godwin does not conflict with these results: there are prolific remains of Bronze and Iron Age cultures on the Downs.

Wingham is the more interesting of the two sites and, as it is complemented by Frogholt, certain inferences can be made about chalkland palaeoecology (Godwin 1962). However, it is necessary to qualify this by stating that both deposits are peripheral to the chalk outcrop. Pollen from non-chalk areas is inevitably represented in both diagrams, and as suggested by Godwin, an example may be the high Pinus. Wingham nevertheless is located in an area of Head Brickearth (Smart et al., 1966), in this area a calcareous sand and so probably similar in soil forming character to chalk. Unfortunately, evidence is not available regarding the extent of the peat deposits nor the positions therein of the sampling points: consequently deductions cannot be made directly about the proportion of the pollen derived from the chalk. Despite this problem, the correlations between the two sites is remarkable for the period they both represent. Regrettably, an arboreal pollen/non-arboreal pollen diagram is not shown for Frogholt which would have enabled a more direct comparison with Wingham. At Frogholt, as Turner (1970) mentions, there are higher and greater fluctuations in herbs suggesting a considerable variation in the quantity of land farmed temporally and spatially. The main conclusion that can be drawn from this work is that the events recorded at both sites happened over an area which includes both sites. Godwin's main conclusion that this area of the chalk was largely disforested by the Early Bronze Age is acceptable, but it cannot be denied that other areas may have been involved.

Amberley Wild Brooks, Sussex (5). North of the Arun Gap in the South Downs is a considerable tract of low-lying alluvium, Amberley Wild Brooks, and its centre was discovered by A.R. Clapham and H. Godwin to be a derelict raised bog (Godwin 1943). Godwin subsequently analysed samples from a core through the peat and underlying clays, a depth of nearly 400cm. As Amberley was at the time considered as part of a larger work on sea level changes, the analysis was used primarily as a dating tool so the published diagram shows only tree pollen and Corylus (Godwin, 1943). It portrays the later Subboreal and Subatlantic periods with a change from frequent to rare Tilia and Pinus at 250-275cm, the clay-peat transition. A dramatic rise in Betula pollen is recorded which the stratigraphy, Godwin states, does not indicate as being caused by birches growing on the bog surface. The depression of all curves at the level of the birch maximum appears to be a result of the interrelationship of these percentage curves. At about 70cm Fagus shows a pronounced rise as Betula is declining: Godwin notes this late expansion of a species now common on the scarp of the South Downs.

Godwin's proposed chronology was confirmed by a radiocarbon date of 670±110bc (Q-690) for the 250cm level (Godwin and Willis 1964).

The site was re-worked by Thorley (1971a) who encountered two main problems: she failed to find the same depth of deposit as Godwin and discovered that pollen preservation was generally poor. From the fifteen samples she was able to count it is possible to discern some similarities with Godwin's diagram, but in general the results were disappointing. Thorley did not attempt to zone the diagram because of these problems. She found that arboreal pollen was high at the base of the diagram, but soon after Gramineae and weeds increased whilst Tilia fell. Thorley suggests that this was a selective clearance of lime as oak pollen was not reduced and elm retained its former low level. She correlates this with the Late Bronze Age or Early Iron Age, for which evidence of occupation exists locally. The increased Betula values that follow are interpreted as colonisation of abandoned farmland.

Again this site is peripheral to the chalk, by about 1500m, but in this instance its areal extent is known, about 1km^2, as shown on the Geological Survey Map (One Inch Sheet 317). It is likely that the pollen representation at Amberley is more regional in nature with 17-80% (sections 2.4.3. and 4.3.2.) of the pollen derived from in excess of several hundred metres from the site. However, the chalk outcrop comprises only a minority of this area so inevitably downland vegetational change will have been masked by pollen derived from plants on non-chalk geologies. The regional nature of the pollen representation is shown by the broad similarities of the two cores. Thorley's (pers.comm.) was derived from its western edge whilst Godwin's was almost certainly from the eastern half. (Godwin (pers.comm.) was unsure about the location of his core but my own work strongly suggests that this was the position (section 4.3.2.).)

Perhaps the two most significant features of the pollen diagrams are the declines of Tilia and rise of Fagus. Presumably the former was associated with more general clearance in the western Weald whilst the latter may indeed reflect a genuine expansion of the beech on the chalk. Thorley's contention of minimal removal of oak at the time of the Tilia decline is questionable as Quercus pollen is, in fact, reduced contemporaneously.

It was because of the unfulfilled potential of the site that a second re-working has been undertaken as a part of this research. This has entailed a detailed analysis of a core from a position believed to correspond very closely to that of Godwin's original analysis. Further discussion of the site is therefore postponed.

Litton Cheney, Dorset (6). Two buried peat deposits on the hillside near Litton Cheney in Dorset were analysed by Sidaway (1963). They had probably developed as a result of landslipping and were discovered when two drainage ditches were dug 120m south of the edge of the chalk outcrop. Section 1 revealed 60cm of peat under 120cm of overburden and Section 2, 15cm of peat under 50cm of overburden. The pollen indicated differing ages for the two sequences.

In Section 1 the six samples countable suggested that the peat had accumulated from the Boreal to the Subboreal period. The rather restricted pollen diagram shows in the Boreal levels high Corylus (30 to 40% of Total Pollen) and Tilia (15%) with Quercus (10%) and low Betula (5%), Pinus (1 to 2%) and Alnus (5%). The Atlantic is characterised by high Alnus (40 to 50%) with Quercus (7 to 10%) and Corylus (20%), the Subboreal by declining Alnus, Corylus and Quercus with increasing Gramineae, herbs and Pteridium. This latter is interpreted as Subboreal clearance. Ulmus is low, maintaining a constant frequency of about 2%, and Tilia declines markedly between the Boreal and Atlantic levels: Sidaway (1963) assumed this to be equivalent to the Ulmus decline.

The second section shows fairly uniform spectra with minimal arboreal pollen, except for Castanea at 5 to 10%. Herbs and grasses are high and cereal pollen is present suggesting a cleared landscape subject to arable and pastoral agriculture. Sidaway dates this as post-Roman largely because of the Castanea pollen and the archaeological evidence that a spring near the deposit formed a watering place for an Early Iron Age/Romano-British settlement. Clearance of the area would therefore be expected by that date.

Neither sequence was radiocarbon assayed and whilst the date of Section 2 is reasonable, that of Section 1 is more suspect. In re-interpreting the data two factors are relevant: first, the work was undertaken when Sidaway was an undergraduate so that identifications and discussion would have been limited by his lack of experience - he was, however, supervised by G.W. Dimbleby; and, second, differential preservation may have distorted the spectra. Regarding the latter, it is noteworthy that certain corrosion susceptible species (Havinga, 1971) are low, such as Betula, Quercus and Ulmus with Fraxinus absent, whilst the resistant Corylus and Dryopteris are more abundant. Furthermore, my own examination of samples from the site in 1979 revealed that excessive degradation precluded any re-working of the deposits; presumably (further) deterioration has occurred over the intervening years. Indeed the high Tilia could be a reflection of its resistance to destruction and recognisability after degradation. Additionally, it is unlikely that such a time span would be represented in less than 60cm of peat, even allowing for compaction.

As a result of these factors it is more probable that Section 1 represents a period between the Ulmus decline and early Subatlantic period; the low Ulmus and Quercus and high Corylus support this contention. The decline of Tilia traditionally (Godwin 1940) would be taken as the start of the Sub-Atlantic, but as this is now known to be highly diachronous (Turner, 1962; section 10.3.), it can only be assumed that the sequence represents the later prehistoric period. The upper levels may show the beginning of the clearance present in Section 2, and in the lower, the peaks of Betula, Corylus and Alnus immediately post-elm decline regeneration.

In this area it seems there was more or less complete regeneration following primary clearance, although direct evidence for the latter is absent. To what extent this relates to the chalk cannot be discerned in the absence of information concerning the extent of the deposits.

New Shide Bridge, Isle of Wight (7). During extensive modifications to the course of the River Medina at New Shide Bridge, a buried peat was found stratified within alluvial sediments (Shackley 1976). The peat bed was approximately 20cm in depth and was in about the centre of 460cm of deposits overlying coombe rock; the edge of the chalk was about 100m to the south. Two wood samples were assayed (2260±80bc BIRM-360(a); 2230±60bc BIRM-360(b)) and the bed assigned to the Late Neolithic. Analyses of pollen, plant macrofossils, insects and mammalian bones produced entirely complementary results.

Pollen was sparse in four samples from the peat subjected to analysis. In the one sample with sufficient pollen for statistically significant percentages, Gramineae (14% Total Pollen), *Artemisia* (1%), *Rumex* (1%) and *Plantago* (2%) with *Quercus* (3%) and *Corylus* (2%) were indicative of very open woodland. Cereal pollen was not recorded. Alnus pollen attained 60%, denoting its presence around the site of peat accumulation. The plant macrofossils, apart from *Alnus*, were different from the pollen spectra suggesting a different catchment. These included *Fraxinus*, *Acer*, *Crataegus*, *Ulmus* and *Cornus*, the first three of which,

"might be expected to grow on higher ground" (Shackley 1976, 387)

As Shackley states it was not possible to determine the extent of the peat bed so deductions regarding the size of the pollen catchment are not possible. It is also unfortunate that the analyses represent a single point in time instead of a temporal sequence. However, the clear indication from all the evidence that the area was essentially cleared and being utilised as pasture is invaluable. This may have included the chalk where the macrofossil wood remains possibly indicate some activity at this time.

Miscellaneous Various other peat deposits have been analysed but are of limited relevance in the present context.

In the Lower Thames estuary, Devoy (1977) investigated several sequences to the north of the chalk as part of a study of sea-level changes: the diagrams were used primarily for dating and consequently are skeletal. They also show a preponderance of pollen from locally-growing species such as Alnus and so are of little value in the elucidation of chalkland vegetational history. No further reference will therefore be made to these sites.

Haskins (1978) studied a number of deposits in the Poole Basin and of these two are worthy of mention. East Stoke Fen is regarded by her as possibly showing some influence from chalkland vegetation but the sequence is more typical of the Poole Basin river valleys, to judge from the new data presented within this thesis , the location of the fen in excess of 2km from the chalk outcrop and her own work. The second site, Godlingston Heath, is 1km from the Purbeck chalk ridge and from comparison with another site in this thesis, Kingswood, has more in common with Haskins' heathland sites.

In the Isle of Wight, Scaife (Scaife 1980; Tomalin and Scaife 1980) has investigated for pollen a number of valley mires as well as soils buried under barrows. The valley mires are generally in excess of 2km from the chalk and thus probably bear little relation to chalkland vegetational history. Some of his results from the buried soils will however be mentioned in the next section.

2.1.1.2. POLLEN INVESTIGATIONS OF ARCHAEOLOGICAL MATERIAL

The following discussion concerns the most relevant sites to chalkland palaeoecology that have been investigated because of their association with archaeological monuments. They cannot be, therefore, a random sample and it is unknown how typical they are of general chalkland conditions. Most are also soils which inevitably restrict interpretation because of the likelihood of differential preservation and the very local origin of the preserved pollen.

As all the sequences relate to short periods of time, the treatment is essentially chronological with chalk sites considered first and peripheral sites later.

Wiltshire-Neolithic sites examined by Dimbleby and Evans (1974). In Wiltshire a series of soils buried beneath Neolithic monuments have been examined for both pollen and Mollusca (Dimbleby and Evans, 1974). The pollen data illustrate the problems of preservation in calcareous soils and a major conclusion from the study was that pollen in such soils represents the latest, most ephemeral phase, whereas the snails tend to represent a very much longer time series. At seven sites sufficient pollen permitted comparison with the snail data.

At five of them the snails indicated the expected sequence of change from woodland to open conditions prior to burial. At the earliest, the Horslip long barrow (8) (3240±150bc BM-180), the lowest pollen sample indicated grassland, while the two above, open woodland, especially of *Corylus*, suggesting recolonisation of formerly agricultural land by woodland prior to barrow construction. At another mound, the South Street long barrow (9) (2810±130bc BM-356) the pollen again suggested open woodland, dominated by *Betula* and *Corylus* with clearings shown by Gramineae, Liguliflorae and *Pteridium*, followed by more open conditions with less *Corylus* and *Betula* and some cereal pollen. Ploughmarks in the chalk at the base of the soil attest to the presence of arable agriculture at the site (Fowler and Evans, 1967). From the low *Quercus* pollen the woodland was secondary and possibly more scrub-like. At the Beckhampton Road long barrow (10) the sequence was similar with open conditions characterised by some cereal pollen but with *Corylus* suggesting scrub or a woodland margin in the vicinity. At Avebury (11), a Late Neolithic henge monument, the pollen reflects possibly an earlier treeless phase replaced by a more wooded one, though still essentially open. Another henge, Durrington Walls (12) of Middle Neolithic date, exhibited a similar snail sequence but with differing pollen. Dimbleby suggests that although the pollen of woody species dominated the spectra, pollen from the most recent grassland phase may not have persisted.

At two sites the Mollusca indicated only woodland conditions. It is readily explained at Windmill Hill causewayed enclosure (13) by truncation of the soil profile. The physical nature of the soil supports the contention with the pollen which represents open conditions with a limited amount of hazel scrub: the upper soil bearing open-country snails was removed. The existence of open conditions in the vicinity at the time of construction is also attested by the Mollusca at Horslip, 500m to the south. Knap Hill causewayed enclosure (14) was problematical, although the sampling for Mollusca may have omitted horizons bearing open-country fauna. The analysis (Connah 1965) from the old land surface showed open scrub whilst in the ditch infill there was a change from thicker scrub to lighter and more open scrub. The pollen showed an environment of hazel woodland which had become denser prior to bank construction.

Despite the variation between sites some general comments may be made. First it is apparent from the abundance of non-arboreal pollen and _Corylus_ that clearance of woodland had occurred at all sites. Second, at several sites there was some regeneration and at three (Avebury, Horslip and Knap Hill) there was abandonment of the areas before monument construction. Knap Hill is a special case: possibly the abundant Clay-with-flints in the area rendered it less suitable for agriculture and consequently it was not extensively cleared. Third, the significance of _Corylus_ in the landscape is pronounced, perhaps exaggerated by the resistence of its pollen to degradation. A recent re-examination of the long barrow sequences (Horslip, Beckhampton Road and South Street) has led to the hypothesis that they were constructed within an environment of clearings in scrub woodland with perhaps increasing open grassland (Ashbee _et al_. 1979). Overall, the environmental picture is one of a varying mosaic of grassland, scrub and woodland.

Silbury Hill, Wiltshire (15). Silbury Hill is a round barrow some 30m in height located 1.4km south of Avebury and probably of a Late Neolithic date. The most significant palaeoecological feature is the central turf stack where the anaerobic conditions following mound construction were sufficient for the preservation of vegetation. It was also possible to pollen analyse the old ground surface, a patch of Clay-with-flints (Dimbleby in D. Williams 1975).

Two sequences were examined and both indicated that there was a well established grassland community in the area with low tree pollen. Cereal pollen was absent and with few arable weeds, cultivation seemed unlikely. Williams suggests that hazel scrub existed possibly as belts on the edge of woodland; the latter appears to have been mixed oak, slowly declining as marked by a reduction in Ulmus and Tilia pollen over time. Neither ash nor beech pollen was recorded.

The pollen evidence is entirely complemented by that of the bryophytes (D. Williams 1976) and grasses in the turf stack, as well as the seed and wood remains.

> "The picture that emerges is one of open, fairly long established grassland probably representing an extensive clearing, and being maintained by grazing pressure" (p.75)

Woodland, he states, was restricted to the lowlands with none in the immediate vicinity whilst scrub, especially hazel,

> "was very common due to continual changes occurring in the distribution of grassland and wood in the region" (p.81)

It is unfortunate that longer time sequences are not represented in these buried soils; nevertheless there are similarities, although the grassland nature of this Clay-with-flints site contrasts with that of Knap Hill at an earlier period. Their differing topographic locations and functions may be significant.

Black Down, Dorset (16). Eight kilometres west-south-west of Dorchester the chalk is capped by about 1.5km^2 of sandy gravel assigned to the Bagshot Series. An Early Bronze Age barrow located in the centre of the outcrop was excavated and the soil beneath analysed for pollen by Dimbleby (in Thompson and Ashbee, 1957). The soil was podzolised and pollen preservation generally better than in the chalk soils.

Dimbleby described this sequence of vegetation change from the pollen spectra. An initial early period of forest, mainly Quercus and Corylus with some Tilia, Ulmus, Betula and occasional Pinus was succeeded by one of more open country dominated by Pteridium, grasses and weeds of cultivation. Abandonment of cultivation is suggested by a gradual increase of Corylus, Alnus and the Ericaceae. Re-clearance of the scrub is then plausible with the collection of ivy for fodder a possibility (Bradley 1978b). The barrow was then constructed and thereafter Corylus and Alnus declined, Pteridium temporarily peaked whilst grasses and herbs increased. The environment was one of grassy heath with a gradual proliferation of true heath species over time.

The relatively low representation of oak and elm and the higher levels of hazel in the initial forest phase are strongly indicative of a secondary forest; the presence of a long barrow 1km north-west and various other features in the area attest to the presence of Neolithic cultures and, therefore, clearance of primary woodland. Round barrows are also common both on and off the Bagshot Series suggesting that at least in the location of barrows, preference may not have been given to either geology; presumably soils were different, but whether sufficient to influence occupation is conjectural. The pollen evidence implies that the composition of the pre-barrow forest was similar to the secondary woodland in the Avebury district. After barrow construction the vegetation appears to have been strongly determined by the easily podzolised substrate so cannot be compared with the adjacent chalk soils. It seems more typical of moorland and heathland areas with permanent clearance only after Bronze Age disforestation. Parallels may be drawn between this analysis and that at Litton Cheney (Sidaway 1963) 7km to the west, but the equivocal chronology of the latter hinders reliable correlation. It is not possible to state that as the pre-Early Bronze Age vegetation was an oak and hazel dominated secondary forest at both sites, the chalk in the vicinity was similarly forested, nor that because of implied differing soils the chalk was open. This is especially important because of the probably limited pollen catchments of the two sites.

Newbarn Down, Isle of Wight (17). The Early Bronze Age barrow on Newbarn Down is in a similar geological situation to the Black Down tumulus. It is located on the crest of the largest area of chalk in the Isle of Wight at a point where a Clay-with-flint capping is 400m in width.

Analysis of the buried soil by R.G. Scaife,

> "showed an essentially pastoral environment mixed with some agriculture, for the tree pollen was low at 10.6% [of Total pollen], whilst the grass [and herb] pollen totalled 89.4%. Thus the barrow was probably constructed on land that had once been arable, but which had either become fallow or had reverted to grassland" (Tomalin 1979, 276)

This result implies a more intensive land use than at Black Down and may be compatible with the open woodland and pasture conditions described for New Shide Bridge 6km north-east (Shackley, 1976; section 2.1.1.1.).

Further chronological or pollen analytical data are not supplied for the period before or after barrow construction.

Overton Down, Wiltshire (18). Three analyses have been conducted of Bronze Age material from Overton Down. In the report on the Overton Down Experimental Earthwork (Jewell 1963), Dimbleby describes (p.67) his analysis of two samples from beneath a small round barrow on the Down. The third is accredited to unpublished work by Birmingham in a paper on plant remains in Wiltshire (Grose and Sandell 1964) (Table 2.1).

Table 2.1. Overton Down: pollen analysis of Bronze Age samples
Sources 1. Dimbleby a) upper buried soil % Total Pollen
b) lower buried soil % Total Pollen
2. Birmingham

s = scarce, f = frequent, a = abundant

Source	Pinus	Quercus	Corylus	Gramineae	Cereal	Liguliflorae	Plantago	Pteridium
1. a)	0.5	0.9	2.4	19.9	0.5	10.9	43.1	7.1
b)		2.0	2.5	12.7	0.5	13.2	46.1	6.9
2.	s	s	s	—— Not Shown ——			a	s

The data are similar, other than the values for Pteridium.

Dimbleby interprets his results as possibly indicating abandoned arable cultivation and notes the representation of woody species and bracken. He suggests that hazel, though not growing on the site, which was completely open, was in the vicinity. Bracken presumably was flourishing on nearby Clay-with-flints: the soil under the barrow showed some influence from this material.

This environmental evidence is thus similar to the Neolithic material in the area with essentially an open landscape and some woody species such as oak and hazel.

The Wilsford Shaft, Wiltshire (19). The excavation of a suspected pond barrow at Normanton Gorse, 10km north of Salisbury, revealed a shaft 30m deep (Ashbee, 1963). This is now believed to be a Bronze Age well and wood from its bottom was dated to 1380±90bc (NPL-74).

The pollen analyses are unpublished, except in outline form in Grose and Sandell (1964) and can only be dated to the post-Middle Bronze Age period as the rate of infilling is unknown. The pollen is listed in Table 2.2.

Table 2.2. Pollen analysis of material from the Wilford Shaft.
s = scarce, f = frequent, a = abundant.
Source: Grose and Sandell 1964.

Helianthemum nummularium	s	Ulmus sp.	s
Poterium sanguisorba	f	Urtica sp.	s
Hedera helix	?	Alnus glutinosa	s (+ wood)
Umbelliferae	f	Corylus avellana	f
Centaurea nigra	s	Quercus sp.	f
Artemisia	s	Fagus sylvatica	s
Plantago sp.	a	Pteridium aquilinum	a
Chenopodiaceae	f	Polypodium vulgare	a
Rumex	s		

In the lists of Grose and Sandel (1964) neither Gramineae nor cereal pollen are tabulated.

The similarity of the environment portrayed by this material and that from the other sites in Wiltshire is marked: again there are abundant herbs with hazel and oak, suggesting an essentially open landscape but one perhaps with some scrub or woodland. The degree of openness may however be inflated by pollen from species growing in the mouth of the well, such as, for example, members of the Chenopodiaceae and Polypodium. A serious omission from the data is that neither the percentages are shown nor the criteria for defining 'scarce', 'frequent' or 'abundant'. Nevertheless, work on the beetles also recovered from the shaft (Osborne, 1978) substantiates the pollen evidence with,

"a large fauna virtually all indicative of open treeless situations" (p.34)

Winchester (20). There is a paucity of pollen analysed material referring to the period after the Bronze Age, but evidence is available from two sites, Winchester and Wansdyke. Samples from Winchester relating to the Iron Age and Roman periods were analysed by E. Isenberg (unpublished) and the results summarised by Murphy (1977). Most are from buried peats and cess-pits in Winchester. A pre-Roman sample (BS 380) from Brook Street showed a spectra of 25% (of Total Pollen) tree pollen, 32% herbs, 14% Gramineae and 29% cereal. The figure for tree pollen includes 8% *Corylus* suggestive of disturbed scrub rather than mature woodland (Murphy 1977) and the weeds of agriculture, Cruciferae, Compositae, Chenopodiaceae and *Plantago lanceolata* were abundant. It appears

> "that the area was extensively deforested before the early Roman town developed and that farming was well established."
> (.p.132)

A Second Century ad sample showed very similar results but with lower tree pollen which Isenberg considered represented a well-balanced agriculture of arable and pasture. The major implication was that the Winchester area of the Hampshire chalklands was subjected to intensive arable exploitation from at least the Early Iron Age to the Late Roman period. This is fully supported by the plant macrofossil evidence which is analysed in detail by Murphy (1977).

Wansdyke, Wiltshire (21). The Wansdyke is an earthwork dating to between c. ad450 and ad600 and the excavation of two sections south and south-east of Avebury produced two contrasting sequences (H.S. Green 1971). At Red Shaw (21a) where 'Celtic' fields underlie the feature the pollen indicates that after the cessation of arable farming there was pasture until the construction of the dyke. The pollen was dominated by Gramineae, *Plantago lanceolata* and Liguliflorae with some *Pteridium* and plants of rough pasture including *Succisa*, Ranunculaceae and *Centaurea nigra*. There was no record of cereal pollen and weeds of arable ground were almost absent (Dimbleby in Green 1971). The environment indicated was one of open pastureland with neither woodland nor arable near enough to influence the pollen rain. The soil was of thin iron-pan type, formerly base-rich which had subsequently undergone acidification. The surface geology of the immediate area is chalk.

In contrast, the other section, at New Buildings (21b) was constructed through wooded country. The pollen indicated open land with woodland nearby; there was some evidence of arable farming with cereal and Rumex pollen, but this was probably for only a short time. The area was then abandoned, permitting the spread of birch and perhaps hazel and bracken immediately before earthwork construction. This section was located in the centre of an area of chalk overlain by $40km^2$ of Clay-with-flints.

The contrast between the two sections is pronounced, implying a causal relationship with substrate. A long period of arable cultivation is suggested by the fields at Red Shaw, whilst at New Buildings it may be speculated that the heavier or base-deficient soils (see section 9.4.2.2.) discouraged cultivation after a brief experimental period. It is conceivable that the section of the dyke at Red Shaw is earlier than at New Buildings (Green 1971), but, other things being equal, the environment at Red Shaw might then be expected to be forested, whereas open conditions prevailed at New Buildings: indeed the reverse of the observed. It is probably significant that the Clay-with-flints shows a marked paucity of monuments and even today much is under woodland (Savernake Forest).

The North Downs - pollen analyses of peripheral soils Pollen analyses of soils located on geologies on the chalk periphery are limited in number, but three in the North Downs are worthy of consideration in the present context: Addington, Keston and Lower Halstow.

Peat sealing a Mesolithic layer at Addington (22), 10km west of Maidstone, was recorded by Burchell and Erdtman (1950). The chalk is 1km to the north and the pollen indicated a more or less closed forest of Alnus, Betula and Corylus with Quercus, Tilia and Ulmus. The absence of pollen of Pinus, Fagus and Carpinus led them to hypothesise that the basal portion of the peat formed in the Neolithic. Dimbleby (1963) re-worked the material and concluded likewise that the low values of Ulmus, the absence of Fagus and relatively low Corylus indicated that the peat formed in the early part of Zone VIIb. The forest here was therefore secondary and indicated woodland regeneration during or after the Neolithic, at least below, the chalk downs.

The analysis at Keston (23) involved three different sections, of which one had suffered from faunal mixing and was of little value (Dimbleby 1962). The area concerned is an embayment of Eocene beds in the north edge of the Downs, about a kilometre across. The two sections were 300-400m from the chalk. A podzol buried under the rampart of an Iron Age camp showed the vegetation at the time of construction to be closed oak forest with Corylus, Betula and Ilex and very low herbs.

For comparison with this spectra, a second sequence was analysed from the adjacent Keston Common, now Calluna heath with Betula and Pinus. This revealed a buried level, assumed to have been covered before the construction of the camp as Tilia was higher. Altogether, the diagram shows, as above, Quercus dominating, with a slight opening in the canopy, followed by regeneration prior to burial and subsequently a slow reduction in forest.

In summary, the sequence that emerges is one of secondary forest undergoing slight and occasional disturbance prior to the Iron Age and thence slow disforestation. The absence of Ulmus and low Tilia in the camp profile is indicative of the secondary forest, developed after ?Neolithic clearance.

The final site, Lower Halstow (24), is 8km east of Gillingham, Kent, and is located in the midst of an area dominated by London Clay, Thanet Beds and Head Brickearth with the chalk exposed 4km to the south. Material from an Early Iron Age to Roman site was analysed by Erdtman (cited in Thorley 1971a). Thorley states,

> "Below the Iron Age surface pollen of Alnus, Betula, Ulmus, Tilia, Quercus and Salix were represented. Fagus accompanied a similar spectrum above this surface" (p.110).

These spectra have the distinctive character of secondary closed woodland and attest to the late presence of woodland in this area. This is in notable contrast with the Wingham site 40km to the east, where an extensively cleared landscape is evident from at least the Early Bronze Age (Godwin 1962; section 2.1.1.1.), despite at least the partial similarity of the superficial geologies of the two locations. Lower Halstow is more comparable with Keston and the chalk hillwash analyses of Kerney and Carreck (1954) (section 2.1.2.1.), perhaps denoting a relatively late date for extensive clearance in the central area of the North Downs.

2.1.1.3. POLLEN EVIDENCE: CONCLUSIONS

The analyses discussed above illustrate the complexity of the pollen data relevant to chalkland vegetational history. Examination of the few known polliniferous peats suggest that the east end of the North Downs were extensively cleared by the Early Bronze Age, yet the South Downs demonstrate major clearance possibly occurring later. Outside the south-east the Litton Cheney investigation is inconclusive but suggests late clearance whilst at New Shide Bridge in the Isle of Wight there may have been at least one period of open woodland on the chalk in the Late Neolithic.

Soil pollen data are more widespread but are dominantly from archaeological contexts that may not be typical of the downs as a whole. Those in Wiltshire exhibit largely open conditions with some scrub and open woodland from the Neolithic period onwards. It should be noted however at this stage that pollen analysis alone cannot indicate scrub reliably; Mollusca, in contrast, may do so (section 2.1.2.). There are nevertheless local variations with a tendency towards more wooded conditions where non-calcareous deposits overlie the chalk. Locations such as Knap Hill, New Buildings and Black Down show major clearance later than the Neolithic and in the central North Downs the few analyses of peripheral soils suggest woodland during and after the Neolithic. The value of the latter is restricted by their location off the chalk, but the contrast between Lower Halstow and Wingham is notable. The central North Downs are also overlain by extensive Clay-with-flints inferring that perhaps the chalk soils were particularly favoured by early settlers, although such deposits are fairly common to the east. Various reasons may account for this discrepancy: the soils themselves, the density of the vegetation they supported, or subsequent differential preservation of archaeological artefacts. However, there are exceptions: Silbury Hill, for example, is sited on Clay-with-flints but the environmental sequence is identical to adjacent areas now on chalk substrates. The intense occupation of this area may have been such as to require exploitation of areas of heavy soil, or, alternatively, Silbury Hill may have been located in that position purely because it was less suitable for farming.

Evidence for later periods is scarce but there seems to have been extensive arable farming on the downs from the Iron Age in at least East Kent and in central Hampshire. This is compatible with documentary evidence.

In this discussion the importance of non-calcareous deposits overlying the chalk is readily apparent, although data are lacking on how much more extensive they may have been in the past. A number of the buried soils now in areas of rendzina soils have a substantial clay component, suggesting significant soil changes over the last 5,000 years.

2.1.2. STUDIES OF SUBFOSSIL MOLLUSCA

Analyses of subfossil Mollusca have been the major source of chalkland environmental evidence. The calcareous soils readily preserve the carbonate shells of snails and slugs, in contrast to pollen exines. Regrettably, the utility of snail faunas is limited as it is not possible to imply from mollusc assemblages floral composition. Only gross estimations are possible such as open grassland, shaded woodland or intermediate habitats, but nevertheless these data are of value. Such interpretations do require the careful extraction and identification of all species in a given soil sample and some early work relied purely on hand-picked specimens from archaeological sites. Such samples tend to be composed of only the larger examples whose environmental requirements may not be representative of the fossil assemblage as a whole. However, in late-1930s A.S. Kennard, the pioneer in the field, began to appreciate this fact and subjected all samples to a systematic treatment. Even then his main concern frequently appeared to have been the interpolation of climatic conditions, a dubious objective given the importance of microhabitat to snail faunas.

As with the review of pollen sites, this section is divided into two: dry valley infills and archaeological sites. The restriction of the latter is that in being associated with sites specifically chosen by man, the local habitat may not have been typical of the general environment. Dry valley infills overcome this immediate problem, but the question arises of how representative are the faunas of the valley bottoms and immediately adjacent slopes of the whole landscape. This is made more complicated as such infills have often been the result of human clearance and agricultural activities. It is only possible to speculate that the dry valley faunas may be slightly more reliable indicators of environments than those from archaeological sites.

2.1.2.1. DRY VALLEY INFILLS

Relatively few studies of dry valley infills have been undertaken within the area under investigation and these are confined to the North and South Downs.

The North Downs. The Devil's Kneadingtrough, Kent (25). Detailed investigations were undertaken of The Devil's Kneadingtrough, a valley in the escarpment of the North Downs at Brook, near Ashford in Kent (Kerney et al. 1964). The importance of the site lies both in the detailed environmental sequence that was portrayed in the infill of the valley, and its location in the same area as Wingham and Frogholt (Godwin, 1962; section 2.1.1.1.). Two sequences from different parts of the valley are discussed below.

In the upper part of the coombe a section of the infill was visible in the abandoned rifle butts. Postglacial sediments 150cm in depth overlay Lateglacial coombe rock. The snails demonstrated an initial phase of early partial clearance from 150 to 130cm followed by regeneration of woodland and then a main clearance at 80cm. Thereafter, the landscape became progressively more open. Dating was problematical, but since the original report was compiled, charcoal from 81-101cm has given a date of 2590±105bc (BM-254: Barker et al. 1971). This indicates a date of Middle to Late Neolithic for the main clearance and earlier for the initial episode. The charcoal identifications themselves are noteworthy: fragments were common below 80cm, and the lowest samples, at the level of the early clearance, were of Taxus and Betula, followed by Fraxinus and more Betula (Kerney et al. 1964, Fig 14). Betula in particular is a pioneer species and would be expected during the regeneration phases shown by the Mollusca.

In contrast to the sequence from the upper valley, that from the mouth 300m to the south showed rather more intense exploitation (Borehole V). The lowest deposit again was coombe rock and this was overlain by a shallow soil (260-240cm depth) with snails characteristic of Atlantic woodland. Deposits relating to this period were absent from the butts sequence. At 240cm there is a marked clearance with damp grassland and scrub. Above, the hillwash present shows continuously open conditions with periods of drier and damper grassland and scrub. Betula and Taxus were again plentiful in the charcoal present in the lower half of the wash. Iron Age sherds were recorded at 220cm and 185cm.

Kerney, Brown and Chandler (1964) correlate the single major clearance at the mouth with the early partial clearance at the head of the valley. They suggest a Neolithic date which is supported by the radiocarbon assay. The second, and major clearance, at the head of the valley is assumed to be Iron Age from both the sherds and the presence of 'Celtic' fields on the surrounding downland; from Mollusca and sherds they suggest that hillwashing had largely ceased by 400ad. They conclude that in the Neolithic the lower part of the coombe was largely cleared of woodland for pasture whilst the upper part was not so seriously affected.

These results are consistent with Wingham and Frogholt - the latter is 13km to the east - in showing, firstly, clearance at least as early as the Early Bronze Age and, secondly, in implying that an intensification of land use occurred in the iron age. Furthermore, as Turner (1970) points out, the variations between the pollen sites indicate variation in farming activity (see section 2.1.1.1.) and this is borne out by the local differences between the two ends of the coombe.

The Neolithic hillwash and charcoals are also significant. The 70cm of deposit at and below the radiocarbon-dated level at the head of the valley is unusual as such deposits are more characteristic of the relatively intense farming methods of Iron Age and later periods. Clearly there must have been soil disturbance which Evans (1971) compared with that visible under the South Street long barrow (section 2.1.1.2.). Evidently, whilst the head of the valley was abandoned to scrubby woodland the surrounding slopes and hill tops were cultivated. The charcoal records are not unexpected for pioneer species on the chalk and the finds of Taxus are interesting; the pollen of this species is poorly preserved and rarely identified and thus it is an important early record of the species on the chalk. It should be noted that yew has been important in history for bows, axe shafts, spears and also in a religious context (Godwin 1975a), so its presence, as with any charcoal, does not necessarily mean its local growth.

It appears therefore that this area of downland was wooded in the mid-postglacial and that clearance occurred from the Early to Middle Neolithic and was widespread by the Iron Age.

Cudham (26) and Keston (27), Kent. Four outline analyses of Mollusca were undertaken of 'rainwashes' at Cudham and Keston, near Downe in Kent (Kerney and Carreck 1954). At Berry's Hill, Cudham on the side of a dry valley 1.2m of chalky wash overlay probable coombe rock. It yielded 31 species of snails, all characteristic of woodland; its date was unknown, but was certainly pre-Roman and could have been as early as the Atlantic.

At the other three sites the fauna are indicative of open country and are dated to the Roman or Medieval periods by certain species. At Newbarn Lane, 800m south-east of Berry's Hill the few woodland fauna present are restricted to the base of the sequence and Kerney and Carreck (1954) note the likelihood of the activity of man in woodland clearance and perhaps cultivation as part, at least, of the cause of the hillwashing. Blackbush Shaw, 400m west of Newbarn Lane produced an almost identical assemblage. At the fourth site, Blackness Lane, near Keston,

> "a few species suggest the presence of some woodland at the time of formation of the ... deposit" (p.344)

The wash was 400m from the edge of the chalk and about 1000m from Dimbleby's (1962) soil pollen analyses at Keston (section 2.1.1.2.). The latter indicated clearance from the Iron Age onwards for the chalk periphery: the woodland fauna present in small quantity at both Newbarn Lane and Blackness Lane may imply a similar date for major clearance of the chalk. The present abundance of Clay-with-flints may not have favoured early settlement.

Kerney and Carreck's data are interesting, but their value is limited by both the absence of methodological description and the presentation of the results. There is no information on the location of samples in the washes and the lists give only the totals of each species found in each deposit. From the discussion more than one sample was analysed from each hillwash but re-assessment of the data is difficult. It is only possible to state that the interpretation of the Berry's Hill sequence is generally acceptable, whilst at the other two Cudham sites too much emphasis may have been placed on the open country species; the presence as well of the shade-loving Discus rotundatus, and the Zonitidae may indicate the persistence of woodland during the proposed Roman and Medieval periods. This would be compatible with the Keston soil pollen analyses.

Juniper Hall, Surrey (28). To the west, but within the North Downs, a dry valley infill at Juniper Hall, near Dorking was subjected to both physical and mollusc analysis (Barrett and Chatfield, 1978). Two trenches revealed 175cm and 200cm of infill characterised by chalk breccia overlain by yellow brown clays and sand. Dating was largely by inference from features in the surrounding downs as datable artefacts were not recovered.

In summary the sequence was as follows. The lower chalk breccia with few snails was assigned to the late glacial. There was no positive evidence for a climax forest stage - deposits of this age either did not accumulate or were destroyed, perhaps by increasing levels of erosion following the initial stages of primary clearance. The more finely textured deposits above were probably pre-Roman and the existence of Iron Age fields in the vicinity suggest an Iron Age date; the snails were consistent with this hypothesis. The richer deposits above were post-Roman and showed, in its later phase, an increase in shade-loving species and greater land surface stability.

The likely significance of Iron Age cultivation is again evident, but data of primary clearance were lacking. This sequence is broadly similar to two hillwash deposits investigated by me in Hertfordshire (Waton 1982a). Clay-with-flints are abundant in the Juniper Hall area.

The South Downs: Kiln Combe, Itford Bottom and Chalton. In the South Downs major studies have been undertaken of three dry valley infills (Bell 1978, 1981a, 1981b) and they are of interest for the comparison they afford with the Lewes pollen site (Thorley 1981; section 2.1.1.1.).

At Kiln Combe (29), near Eastbourne, 300cm of postglacial sediments were recorded overlying lateglacial chalk meltwater deposits and redeposited

Clay-with-flints. Snails from a fossil tree root hole were typical of shaded woodland showing that at least this part of the downs was originally tree covered. On the surface of the Clay-with-flints a soil had developed, datable by numerous remains to the Beaker period and this was characterised by Mollusca of more open conditions. This was buried beneath hillwash, presumably the result of cultivation in the Beaker period or soon after, and a second buried soil above was of Iron Age origin. Further chalky hillwash overlay this soil, perhaps associated with a nearby 'Celtic' field system, and above was a flint bed of Roman origin, itself buried by Medieval ploughwash. Subsequent to the Beaker soil the Mollusca indicate progressively more open conditions until, by the Medieval period, the fauna were limited to that of open dry habitats.

Itford Bottom (30) is located on the east side of the Ouse valley 4km south-south-east of the Lewes pollen site. Two metres of sediment were present overlying lateglacial chalky wash and in its surface a series of depressions were shown by the snails to be tree root holes of probable mid-postglacial origin. A thin and truncated buried soil above, as at Kiln Combe, was of Beaker and Early Bronze Age date (1770±120bc, BM-1545) and the Mollusca indicated that this was a secondary clearance of isolated trees and shrubs in a fairly open landscape (Bell 1981b). Cultivation was shown by the overlying accumulation of hillwash, probably associated with the complex of second millenium sites on the neighbouring Itford Hill (Burstow and Holleyman 1957). Various lines of evidence, including a nearby field system, indicated that cultivation continued into the Iron Age, but little further accumulation appears to have occurred since then; alternatively the sequence may have been truncated.

The Chalton excavation (31) produced similar results.

The sequences imply an increase in activity in the Early Bronze Age and thereafter permanent and intensifying clearance. In two aspects the results are at variance with the Lewes pollen data: firstly, at Lewes clearance occurs from the Middle Bronze Age; and secondly, at Itford Bottom, clearance was of an already fairly open landscape, not the woodland suggested by the pollen data. It is conceivable that local clearance occurred in the Early Bronze Age, becoming only more general in the Middle Bronze Age, but the widespread distribution of barrows implies an extensive exploitation of this area of the downs during the earlier period. The mollusc data overall tend to support the contention that the Lewes pollen site represents chiefly an extension of activity to the valley floor rather than the time of general downland clearance.

The South Downs sites clearly show that soil erosion has occurred both generally within the valleys but also at the sampling sites: although fossil tree-root holes were recorded, there was no evidence for an associated soil, nor for primary clearance (see also Barrett and Chatfield 1978; Waton 1982a). Agriculture after primary clearance itself may have caused soil erosion, a proposal compatible with the 70cm of Neolithic hillwash at the Devil's Kneadingtrough. Discontinuous and truncated dry valley infills appear to be widespread.

Other areas. Investigations of valley infills are very limited and virtually non-existent outside the North and South Downs. Several sequences in The Chilterns scarp have been examined, but as this is outside the area under discussion, these will not be examined in detail. In general the sequence appears to be the same with evidence for woodland, then clearance and open conditions, e.g. Pink Hill (J.G. Evans 1972) and Pitstone (J.G. Evans 1966). Some sites show truncation, however, with post-primary clearance sequences resting unconformably on lateglacial deposits (e.g. Pegsdon, Sparks and Lewes 1957; Royston area, Waton 1982a). These suggest that the history of at least the scarp is not greatly different from the areas already discussed.

2.1.2.2. MOLLUSC ANALYSES ASSOCIATED WITH ARCHAEOLOGICAL SITES

Numerous soils associated with archaeological monuments have been examined, particularly by J.G. Evans (1967, 1972) in Wiltshire. The following discussion concerns some typical sites and some of the more problematical in the central chalklands and then several from outside the area are described. The treatment is essentially chronological.

Avebury, Wiltshire (11). The sequence through the buried soil under the henge bank is probably the most complete to have been recovered from a chalk soil (Dimbleby and Evans 1974). The snails represent successively tundra, open Boreal forest, dense Atlantic forest, slight disturbance, then major Neolithic clearance. Arable cultivation took place and this was followed by grassland, of long duration and maintained by grazing animals; the sequence ends with the construction of the henge at c.2000bc. It is typical of the soils buried in the Neolithic in the Avebury area, although pollen from the same soils (section 2.1.1.2) implies some variation in the period immediately prior to burial (Dimbleby and Evans 1974).

<u>Horslip, Wiltshire</u> (8). As mentioned above (section 2.1.1.2), this Early Neolithic long barrow (3240±150bc, BM-180) had a buried soil reflecting only open country conditions. A number of sites examined have exhibited this apparent anomaly. Evans (1972, 362-363) states that despite this it can be assumed that forest clearance has occurred: this is readily acceptable, at least in the Avebury district, as there is ample evidence for woodland. Presumably, as in some of the valley infills, either soil erosion, turf removal, or pedological conditions not conducive to snail preservation have caused the absence of woodland fauna. The snails from a Thickthorn Down (32) long barrow (Dorset) may also fall into this category, although the analysis was restricted (Drew and Piggott 1936).

<u>Windmill Hill causewayed enclosure, Wiltshire</u> (13). Another anomalous sequence was from the earthwork on Windmill Hill, 800m from Horslip where only woodland fauna were recorded. Soil truncation, perhaps deturfing, occurred, removing the horizons with open country Mollusca (section 2.1.1.2.; Dimbleby and Evans 1974).

<u>South Street long barrow, Wiltshire</u> (9). The sequence from the soil under the South Street mound was more typical of the Avebury fauna except that evidence for arable cultivation was pronounced with ploughmarks scoring the chalk substrate (Fowler and Evans 1967). Additional information is available from the site for the post-barrow environments from the analysis of the barrow ditch (Evans 1972). The sequence in any ditch is distorted by its locally damp and shaded nature, tending to favour snails not necessarily representative of the surrounding countryside. However, it is clear that later in the Neolithic some shading over of the habitat occurred, although some open ground remained: the site had not been totally

abandoned, though neither cultivation nor grazing were taking place. A brief period of cultivation is recorded for the Beaker period which is followed by dry grassland and subsequently ploughwashing in the Roman and Medieval periods.

Bridget's and Burntwood Farms, Hampshire (33). As part of the rescue excavations along the proposed course of the M3, investigations at Bridget and Burntwood Farms, 4km north-east of Winchester provided a series of samples (Fasham 1980). These indicated that in the Late Neolithic there was a period of small-scale woodland clearance, followed by regeneration. Woodland was prevalent for much of the Bronze Age, but there was extensive clearance and cultivation from the Late Bronze Age with a further intensification of activity in the Roman period.

Fasham (1980) stresses that,

> "a variegated landscape should probably be envisaged, in which case the woodland on Bridget's Farm may be localised" (p.83).

At this site major clearance only seems to have occurred from the Late Bronze Age, in contrast to the Neolithic in Wiltshire. A cause of the variegation Fasham notes may however have been the existence locally of patches of Clay-with-flints: outside the immediate area, permanent clearance may have been much earlier.

Stockbridge Down, Hampshire (34). A round barrow excavated on Stockbridge Down 13km west of Fasham's (1980) sites, illustrates perhaps this concept of a variegated landscape. A number of samples of two different ages were examined by Kennard (in Stone and Hill 1940). The earlier, of Beaker age, was characterised by species indicative of damp woodland scrub whilst the later, of about the Middle Bronze Age, was similar to the present vegetation, open grassland. The former is suggestive of secondary regrowth and the latter suggests that in contrast with Fasham's site intensification of activity, at least locally, was at an earlier date. It is conceivable, given the recent re-appraisal of the Bronze Age (e.g. Current Archaeology Number 67), that both samples are referable to the Early Bronze Age.

Rams Hill, Berkshire (35). The Bronze Age and Early Iron Age sites on Rams Hill were first investigated by Piggot and Piggott in 1940 but more recently excavations were conducted by Bradley and Ellison (1975). Samples analysed for Mollusca from several different contexts suggested that major woodland clearance had occurred in the Neolithic and that the Early Bronze Age environment was one of intermediate scrub or long grassland. Woodland then regenerated, to be followed by clearance and the re-establishment of a similar habitat to the Early Bronze Age by the eleventh century bc. Again woodland regeneration was recorded, but only briefly, and was by the early first millennium replaced by short-turfed grassland until 50bc. Arable cultivation occurred from 50bc to 100ad.

The degree of temporal variation is pronounced and the generally less intensive exploitation may be related to the greater abundance of Clay-with-flints in this area of downlands, as with Fasham's sites.

Overton (18) and Fyfield (36) Downs, Wiltshire. Samples from two lynchets 1300m apart were examined by Evans (1972). The development of both was initiated in the Iron Age and this is reflected in the snails which were of open country type: grassland and arable. In the pre-lynchet soil at Fyfield a woodland fauna was found, but the date of this material was not ascertained.

Badbury Earthwork, Dorset (37). Further data of Iron Age environments are available from the defensive site of the Badbury Earthwork, which also has evidence for Beaker and Deverel-Rimbury occupation (J.G. Evans 1972). The soil under the bank revealed an open-country, possibly arable, fauna. The ditch sequence was more complex - the lower half of the secondary fill denoted very shaded conditions: Evans states that despite the level in the ditch,

> "the apparently rapid spread and colonization by shade-loving species and their virtual dominance suggest that substantial refuges were close at hand" (p.339).

There was then an episode of clearance with grassland and arable, thence further cultivation before the grassland of the present. Chronological details are not given but the period of shade is perhaps significant.

The South Downs: Bishopstone, Alfriston and Bury Hill. Fragmentary evidence is available from three locations in the South Downs.

On a hilltop at Bishopstone (38) in Sussex Bell (1977) found evidence for settlement from the Neolithic to the Romano-British period. Samples from various contexts were analysed and from these Bell was able to suggest that clearance occurred in the Early Neolithic, although some woodland remained and this was reduced in the Late Neolithic. There was evidence for short-turfed grassland in the Neolithic. Bronze Age material was lacking but the Iron Age samples showed severe arable conditions which over time became more stable with increased grassland. By the Anglo-Saxon period short-turfed grassland was prevalent.

Snails recovered from samples from the excavation of an oval burial mound at Alfriston (39) in Sussex were analysed by Thomas (in Drewett 1975). These indicated that the environment at some time before the mound was constructed was of open grassland with a few shrubs. Those from the ditch,

> "suggested an early open habitat with rubbly soils, not long after the mound was built, succeeded by dense vegetation (perhaps dense shrubs)" (p.150).

The chronology of the phases was unclear but an antler from the ditch gave a date of 2360$\pm$110bc (HAR-940).

At Bury Hill, Sussex (40), the recent excavation of a non-causewayed Neolithic enclosure (c.2700bc) provided further samples (Bedwin 1980). Thomas found that here, as at the Offham (Drewett 1977b) and Barkhale (Drewett 1979) enclosures, also in Sussex, the feature had been built in a shaded wooded environment, perhaps a forest clearing (K.D. Thomas 1982).

The evidence from these sites underlines the importance of local variation. Clearance of the block of downland between the Cuckmere and Ouse, as represented by the analyses from Itford Bottom, Bishopstone and Alfriston, occurred in the Neolithic. In contrast, the area represented by the three enclosures clearly experienced major clearance at a later date. Bury Hill, in particular, is notable, located as it is 3km from Amberley Wild Brooks. Pollen at the latter shows a largely forested environment until the Middle or Late Bronze Age, although it must be emphasised that the record at the site includes pollen from plants growing on other than chalk soils (section 2.1.1.1.). Such later clearance suggests that Clay-with-flints may be present, but in fact, despite extensive woodland at the present day, there are few such deposits shown on the Geological Survey map (Figs 4.13, 4.14).

Miscellaneous: Arreton Down and Julliberries Grave. Two other sites relevant to the discussion are located in the Isle of Wight and the North Downs respectively.

On Arreton Down (41) samples from the soil buried beneath an Early Bronze Age barrow on chalk indicated dry open downland and those from the ditch were similar (Alexander et al. 1960). This complements the Newbarn Down barrow pollen analysis (Tomalin 1979; section 2.1.1.2.) and perhaps that at New Shide Bridge, 3km to the west (Shackley 1978; section 2.1.1.1.). The former is 10km from Arreton Down and on Clay-with-flints implying a land use independent of soil type, although as Dimbleby and Evans (1974) emphasise, the pollen may reflect the most recent, ephemeral stage.

Julliberries Grave (42) is a long barrow in the North Downs which was excavated in the 1930s (Jessup 1937, 1939). Kennard analysed snails from various locations and all showed a similar environment of damp grassland with a little scrub growth or thick herbage. This interpretation is still acceptable from the species list presented. The site is of interest because of the nearness of Wingham (16km) and the Devil's Kneadingbrough (8km) and also the abundant superficial deposits in the vicinity.

2.1.2.3. MOLLUSC EVIDENCE: CONCLUSIONS

The mollusc data as a whole appear complementary to that of the pollen. However, in the North and South Downs differences are apparent: in the South Downs this may in part be because of the nature of the pollen catchment at Lewes, although some real variation is discernible between snail sites; in the North Downs major clearance seems to have been late in the central area.

As with the pollen evidence there is some indication that the occurrence of heavy soils may be important in delaying the date of extensive clearance.

Nevertheless, there are exceptions with early clearance probable between the Ouse and Cuckmere and the east end of the North Downs, both areas with patches of Clay-with-flints, and the similarity of two Early Bronze Age environments in the Isle of Wight despite differing geologies. Conversely, a section of the South Downs west of the Arun, even in the absence of Clay-with-flints, witnessed relatively late clearance.

In summary, the chalk of the central area of downland may have remained largely free of woodland from the early Neolithic. Scrub and trees were nevertheless present: the typical prehistoric chalk landscape from this evidence could have been a constantly changing mosaic with areas of grassland, and arable interspersed with woody vegetation. The relative abundance of each presumably was determined by the requirements of human cultures.

2.1.3. PLANT MACROFOSSIL REMAINS

Finds of macroscopic plant remains are very briefly discussed: it is impossible to reliably interpret environment from remains present in the archaeological contexts from which most are derived. Furthermore, until recently charcoals, exclusively, were examined and these can give a biased impression of vegetation for only woody species, grain and some seeds may be preserved in this manner. Only in such instances as the Devil's Kneadingtrough (Kerney _et al._ 1964; section 2.1.2.1.) where charcoals occur in conjunction with other environmental indicators, can any reasonable deductions be made about the environment. The problem, as succinctly stated by Godwin (1975a), is that of the selection of, in particular, wood by man,

> "oak for piles, hazel and willow for wattle, yew for spear shafts, and it is not unlikely that even for firewood some selection operated" (pp.8-9).

Quercus is particularly common on archaeological sites, frequently to the exclusion of all others, and perhaps indicating its importance in construction.

Maiden Castle, Dorset (43). Salisbury and Jane (1940) studied the charcoals found in Neolithic, Early and Late Iron Age layers at Maiden

Castle in Dorset. From the abundance of specimens, their nature and the diversity of species they argued that they represented a random sample of species growing on the chalk in the area. They concluded that in the Neolithic the chalk was covered in a more or less closed woodland of oak-hazel type which by the Late Iron Age was essentially similar, but more open. At least for the Neolithic period this is consistent with the pollen data from Black Down 6km to the west (Thompson and Ashbee 1957; section 2.1.1.2.), except that Maiden Castle is in an area largely free from non-calcareous deposits. An interesting record is that of Taxus charcoal at 8% of the total of Neolithic material, but minimal in the Iron Age; this complements the finds from the Devil's Kneadingtrough (Kerney et al. 1964; section 2.1.2.1.).

Godwin and Tansley (1941) seriously criticised Salisbury and Jane, emphasising the selective exploitation problem and also attacking their arguments concerning edaphic and climatic conditions. They also cited a body of data, largely archaeological, which, with their criticisms, implied that the downs were cleared in the Neolithic, grassland was probably dominant in the Bronze Age with arable in the Iron Age.

The main conclusion that can be drawn from the study is that the species recorded were presumably available in the vicinity. The area of "the vicinity" is unknown: whether they were derived from on the chalk or from other geologies cannot be ascertained. The edge of the chalk is 2½km to the south and 6km to the east; if the site was the major meeting point apparent from the archaeological data, then its catchment, in terms of people, may have been considerable and have included communities settled on the surrounding non-chalk geologies.

Arreton Down, Isle of Wight (41). The charcoals recovered from beneath the Early Bronze Age barrow on Arreton Down similarly illustrate the problems of selection (Alexander et al. 1960; section 2.1.2.2.). It was stated earlier that the Mollusca, in indicating dry open downland, were compatible with the pollen analyses at Newbarn Down (Tomalin 1979; section 2.1.1.2.) and perhaps New Shide Bridge (Shackley 1978; section 2.1.1.1.). The charcoals were dominated by Quercus and Corylus, with Fraxinus, Salix, Populus and Alnus with the bones of sheep or goats, pig, cattle, red deer and possibly wild pig. This clearly represents a mixed environment: the site of the barrow was dry and open whilst the range of animal bones and charcoals imply the exploitation by the barrow builders of both open and wooded habitats, the nature of the latter in part at least reflected by the charcoals. This mixed environment may be similar to that at New Shide Bridge in the Late Neolithic; it cannot be shown whether the wooded areas were located on or off the chalk.

Thickthorn Down long barrow, Dorset (32). A similar picture is presented by the Thickthorn Down barrow in Dorset (Drew and Piggot 1936) with *Quercus*, *Pinus*, *Corylus* and *Crataegus* charcoal present in contexts indicated by the Mollusca to be initially dry grassland, but subsequently with damp scrub or possibly woodland.

Shearplace Hill, Dorset (44). There is a complex of Middle Bronze Age earthworks associated with fields and droveways on Shearplace Hill (Rahtz 1962). The fields indicate the existence of open areas yet the charcoals are dominated by *Fraxinus* and *Quercus* with *Populus*, *Rhamnus cathartica* and *Prunus* spp.

Little Woodbury, Wiltshire (45). The Iron Age hillfort of Little Woodbury is located to the south of Salisbury. Carbonised grain indicative of arable agriculture was recovered with charcoals dominated by *Quercus*, with *Corylus*, *Betula*, *Salix* and *Fraxinus* (Brailsford, 1949). Again, the fields indicate at least the local presence of open land: the charcoals could be from wood imported from elsewhere.

Belle Tout, Sussex (46). The data from the Beaker settlement at Belle Tout, west of Beachy Head in the South Downs (Bradley 1970) is invaluable in the prolific and largely non-carbonised macroscopic remains indicative of cultivation and open land. If anything, there is a bias away from woody species; Mollusca were sparse so it is impossible to derive any idea of the general character of the environment. The remains included emmer, barley, flax, *Polygonum aviculare*, *P. convolvulus*, *P. persicaria*, *Galium aparine*, *G. verum*, *Parietaria judaica*, *Anisantha sterilis*, *Rumex*, *Festuca* and *Sinapis arvensis*.

The site is within 2km of Kiln Combe (Bell 1978, 1981a, 1981b; section 2.1.2.1.) which showed major Beaker/Early Bronze Age occupation. The evidence from Belle Tout is therefore not at variance with the other sites already discussed within this block of downland east of the Ouse. The Alfriston oval barrow interestingly has charcoals dominated by Crataegus with Pyrus, Rosa, Hedera, Corylus, Betula and Corylus (Drewett 1975).

Silbury Hill, Wiltshire (15). Another source of non-carbonised remains was Silbury Hill where the anaerobic conditions of burial led to the outstanding preservation of organic material in the turf stack (Williams 1975, 1976). The bryophytes in particular were specially valuable as they are sensitive indicators of microclimate and soil surface conditions. The results are discussed in section 2.1.1.2. and will not be repeated here.

Winchester. A similarly detailed indication of the environment is available for the central Hampshire chalklands in the Iron Age and Roman periods (Murphy 1977). Seeds, pollen and other plant remains showed that the area was extensively farmed (section 2.1.1.2.).

2.1.3.1. MACROSCOPIC BOTANICAL EVIDENCE: CONCLUSIONS

The value of charcoal remains in archaeological deposits is severely limited and indeed may only be of value to the palaeoenvironmentalist if additional botanical and mollusc remains are present. Unfortunately, in the majority of excavation reports available, charcoals are the only organic remains reported; the flotation and similar techniques that permit the retrieval of seeds and other remains of non-woody species are a recent innovation. The investigations of Silbury Hill, Belle Tout and Winchester are examples of excavations where such techniques have been used with great success.

Little can be deduced overall from the evidence; the hypothesis of a 'mosaic' environment based on the pollen and mollusc data cannot be rejected.

2.1.4. PALAEOECOLOGICAL EVIDENCE: CONCLUSIONS

A number of tentative conclusions can be drawn despite the limited data. There is incontrovertible evidence for closed woodland in the mid-postglacial; its composition cannot be ascertained. Neolithic clearance was widespread and seems to have led to the creation of a landscape largely free of woodland cover in the central chalklands and parts of the North and South Downs. Grassland and arable habitats appear to have been interspersed with fluctuating amounts of scrub and perhaps isolated woodland. In other parts of the North and South Downs Neolithic disturbance was transitory with much forest regeneration. Major clearance in these areas took place during or after the Bronze Age. In the central chalklands the Bronze Age seems to have exhibited essentially identical conditions to the Neolithic. The Iron Age influence was considerable with arable agriculture perhaps widespread throughout the downs, a situation that continued into the Roman period. After this time, from the documentary evidence, agricultural pressures are assumed to have been reduced with a larger amount of grassland than before.

The reasons for this degree of spatial variation are not clear, but there seems to be a loose relationship between the occurrence of superficial deposits, notably Clay-with-flints, and sites showing later permanent clearance. Whether this is a causal relationship, and if so the nature of its influence, is unknown.

2.2. ECOLOGICAL RESEARCH

As shown in the previous sections there is no evidence to support the early contention that the downlands have always been free from forest cover. The results of recent ecological studies are complementary and in the first section below the characteristics and controls of the succession of vegetation on the chalk are briefly examined. A second section investigates the calcicole-calcifuge habit to ascertain whether the calcareous nature of the substrate is significant in determining the form and composition of the vegetation.

2.2.1. CHALKLAND VEGETATION SUCCESSION

This discussion concentrates on vegetation changes from grassland and excludes any consideration of the colonisation of bare chalk soils, which is irrelevant in the present context.

With the removal or relaxation of grazing pressure chalk grassland is rapidly colonised by scrub, ultimately to be replaced by woodland, a sequence common to most of Britain. Grazing is repeatedly emphasised in the literature as the prime cause of the maintenance of the grassland plagioclimax (e.g. Hope-Simpson 1940; Salisbury 1952; Smith, C.J. 1980; Tansley 1949; Tansley and Adamson 1926) and grazing by rabbits is often seen as most significant. The influence of this animal became obvious after the myxomatosis epidemic of the late 1950s and early 1960s led to its virtual extinction in some areas. A.S. Thomas (1960a) studied the various changes, noting how there was an increase in turf height, and a considerable increase in the abundance of flowers in some places, although there was possibly a reduction of botanical interest with a tendency for some plants to decline in abundance. Woody taxa also increased, especially bramble and gorse. In a subsequent paper Thomas (1963) described the continuing changes in favour of woody species in areas still free from rabbits, but stated that they did not only have a destructive influence; their pellets and urine enrich the soil in certain places. This favours nitrogen-demanding species such as *Urtica dioica* and *Sambucus nigra*. Watt (1957) observed a similar effect on the Breckland variant of chalk grassland (Mesobrometum) where in grazed areas the absence of a physiological dominant resulted in an intimate mix of species. Ungrazed localities exhibited a mosaic which was the result of dominance and overall showed a more varied microhabitat and structure and presented over a longer period of time a richer, though less concentrated display of form and colour. Observations of the same plots continued until about 1975 and reinforced the earlier findings (Watt 1981a, 1981b). The small-scale changes induced by the removal of rabbits and pasturing was especially well demonstrated by two 25cm x 25cm quadrats in the same location on the Hampshire-Sussex border (Tansley 1949, Figs.101 and 102). In the first quadrat experiencing moderately heavy rabbit pressure, 441 shoots of 21 species were recorded, in the second, six years after exclosure, only 20 shoots of 10 species.

Exclosures have been utilised successfully on a number of occasions to promote vegetation succession. A good example was that on the Ditcham Park Estate on the western end of the South Downs (Tansley 1922). It was constructed in 1908-1909 and located to include a woodland edge as well as grassland. By 1920 *Rubus* had increased considerably whilst *Crataegus*, *Fagus*, *Fraxinus* and *Quercus robur* had also become more abundant; the closed woody vegetation on the edge of the wood had advanced by 1.2 to 4.3m, mostly by the vegetative growth of *Rubus*. At the same time the density of scattered colonisation by woody plants had doubled and the two new arrivals to the exclosure were *Taxus baccata* and *Fagus sylvatica*. Tansley (1922) suggested that the future would involve three stages: loose scrub with *Crataegus* and *Rosa micrantha* dominant; ashwood; quickly succeeded by beechwood in about 50 years. No further work was published on the exclosure. It seemed that *Fagus* was a slower migrant than *Quercus* but that the latter was discouraged by the thin (20cm) soils, whilst over the eleven years the most important woody colonisers were *Crataegus* and *Fraxinus*, followed by the two roses.

The nature of the chalk scrub has been investigated in most detail for The Chiltern escarpment (Tansley 1949, 372). Two communities are characteristic: the juniper and hawthorn seres, named from their respective dominants; the main seral distinction is that beech directly colonises the former whilst the latter may have an intermediate ashwood stage before beech enters. Shrub species present include *Cornus sanguinea*, *Ligustrum vulgare*, *Prunus spinosa*, *Rhamnus cathartica*, *Viburnum lantana*, *Rosa* spp., *Euonymus*, *Sambucus nigra* and on deeper soils *Acer campestre* and *Corylus avellana*. Other trees occurring with the scrub are *Sorbus aria*, *Taxus baccata*, *Quercus robur*, *Carpinus betulus* and occasionally *Pinus sylvestris*.

Chalk woodlands are characterised by beech, ash or yew. Beech is particularly prevalent and it seems that only in the southeast does it compete with oak. The shallow chalk rendzinas are not conducive to the establishment and growth of oak and as a result beech is dominant; on loams and deep soils while both flourish, beech is at an advantage as it grows at least equally tall and casts a deeper shadow (Tansley, 1949, 361). As mentioned previously (section 2.1.1.1.) beech's dominance is of recent origin: reasons for this will be advanced later (section 10.6.2.). In the South Downs ashwoods are common and although Fraxinus does not especially favour dry rendzinas, herbs on such substrates, notably Mercurialis, are fewer and permit more ready regeneration (Wardle 1961).

The yew often forms pure stands, as at Kingley Vale in Sussex, because its dense foliage shades out all other trees and shrubs (Tansley 1949, 374). It readily colonises chalk scrub, particularly juniper and hawthorn, apparently requiring them as a'nurse'; establishment in grassland is possibly hindered by grazing. However, as regeneration of yew under its own canopy is minimal, such woods may decline as older specimens die, to be replaced by scrub communities prior to a re-establishment of the species (Watt 1926).

The nature of the substrate or soil has been referred to above and its character seems significant in determining vegetation. The juniper and hawthorn seres of The Chilterns already mentioned develop as a result, at least in part, of differing edaphic situations: the former on firmer, shallower, more calcareous soils with lower humus content and on more exposed and steeper slopes, whilst the latter is on gentler, more sheltered slopes with deeper, less calcareous soils with a higher humus content (Tansley 1949, 372-3). At Ditcham Park several woodland types were recognised, some of which occurred specifically on certain soils, e.g. oak-hazel woods on the deeper leached soils of dip slopes, and 'calcicolous coppice' on thin chalk soils (Adamson 1922). Beechwoods were present on both rendzinas and Clay-with-flints. Such relationships of woodland and soils may, however, be significantly influenced by management practices but there seems to be some undeniable evidence that certain soils are more suitable for certain types of woodland. At the micro-scale further differences are apparent where the soil has been disturbed. Twenty-five years after one season's cultivation, marked vegetation differences could still be discerned between an abandoned arable field and the surrounding area near Princes Risborough (Lloyd and Pigott 1967). In the old field a rich herb vegetation with many young plants of Cornus sanguinea and other shrubs flourished with, as a characteristic feature, very few grasses. The site was formerly grassland and is surrounded by grassland, beechwood, scrub and arable; experimental and other eivdence suggested an inadequate water supply to the soil was responsible and once the grasses were removed, they could not become re-established. Cornus sanguinea seems particularly suited for the colonisation of bare soil because of seed characteristics and vegetative reproduction whilst in grassland Crataegus seems a more common pioneer scrub (Tansley 1922; Lloyd and Pigott 1967).

In summary, the influence of soil type on chalk successions is pronounced, but is modified by other factors including exposure and aspect. Grazing is crucial in maintaining open conditions: on its removal, woodland development is rapid and typically results in woods dominated by beech, ash or yew. None of these three taxa is optimally suited to chalkland conditions, but they are favoured largely because other species, such as oak, are more seriously disadvantaged by the soils. The prevalence of at least beechwoods is a recent phenomenon and will be discussed later (section 10.6.2.).

2.2.2. THE CALCICOLE-CALCIFUGE HABITS

A specific part of the above discussion that requires separate treatment is the calcicole-calcifuge habit. Plants that seem to prefer, or are actually confined to, soils with a high lime content are known as calcicoles; other species, referred to as calcifuge, are found on soils free from lime. This implies a simple chemical preference but the situation is more complex: characteristically calcicoles are intolerant of soil pH less than 5, have some resistance to drought, some degree of susceptibility to competition from tall grasses and most have an intolerance of waterlogging (Grubb et al. 1969, 207). They are also less susceptible to chlorosis, a condition where chlorophyll production is inhibited because of the failure to take up, or make use of, certain minor elements in the presence of, in this instance, excess free lime (Wood and Nimmo 1962). Chlorosis is widespread in plants growing on calcareous soils, affecting amongst others, such characteristic chalkland species as Corylus, Crataegus, Fagus, Fraxinus, Ligustrum, Poterium sanguisorba, Sambucus nigra and Clematis vitalba (Grime and Hutchinson, 1967).

The causes, as stated above, are complex. Steele (1955) from experimental evidence suggested that both pH and calcium supply were factors affecting the success of calcicoles: magnesium supply seemed irrelevant over a wide range, insofar as it affected the soil pH. In two separate experiments involving a total of only three calcicole species aluminium in the ionic form was limiting (Clymo 1962; Rorison 1960b); its greater concentration in more acid soils may be the reason for the preference for the base-rich soils. Alternatively, Grime and Hutchinson (1967) suggested that phosphorus deficiency limited production on calcareous soils and may intervene before a high potential for lime-chlorosis is reached. A more complete view was provided by the experimental study of Jefferies and Willis (1964) who experimented with four different species. They postulated that calcicole plants are much more selective than calcifuge plants in the different ions that are absorbed and in calcicoles this may involve a relatively low net uptake of calcium. In calcifuge plants the selectivity may not be so efficient with the result that under high calcium regimes they absorb a greater quantity of calcium into the tissues at the expense of other ions. They quote (p.705) another experimenter who found decreased levels of potassium and magnesium in the leaves of three species grown in solutions with elevated calcium levels. Other experimental work indicates that the form of the available nitrogen may also be important. Gigon and Rorison (1972) found that calcicoles make better growth on nitrate-nitrogen and calcifuges on ammonium-nitrogen. Nitrification of ammonium to nitrate-nitrogen normally proceeds more rapidly in neutral and calcareous soils than in acid soils.

Competition is also important: Simon <u>et al</u> (1973, 616) state that many species will grow successfully in the 'wrong' soil providing they have it to themselves and Salisbury (1920, 207) mentions <u>Pinus sylvestris</u> in the Champagne which occurs as a calcicole through pressure from other calcifuge species. Unfortunately, Salisbury does not give any further details: pine in this country only becomes seriously chlorotic on chalk after a height of 4.6m to 5.5m. has been attained (Wood and Nimmo 1962). More recently Fenner (1975) found that in the absence of competition several strict calcicoles will grow satisfactorily on chalk heath soils.

Water is another factor: Grime and Hutchinson (1967) found that the incidence of lime chlorosis in wetter areas is less frequent, allowing <u>Calluna</u> and <u>Empetrum</u>, for example, to grow on limestone soils in Teesdale. Salisbury (1920) lists a number of plants with a marked calcicolous tendency which grow on dry chalk soils and also in very damp, or even aquatic habitats: <u>Fraxinus</u>, <u>Rhamnus cathartica</u>, <u>Acer campestre</u>, <u>Cornus sanguinea</u>, <u>Ligustrum vulgare</u>, <u>Sambucus nigra</u>, <u>Solanum dulcamara</u> and <u>Rubus</u>

caesius. Grime (1963) notes how certain species regarded as calcifuge in Britain are of widespread but local occurrence on shallow soils over calcareous substrata, but states that they have not been observed on calcareous soils that are subject to severe drought. Beech is often seen as a chalk species: in fact it is only intolerant of waterlogged soils and is widespread on well-drained clays, sands and gravels. However, the dryness of chalk soils has probably been overstressed (Smith, C.J. 1980), a fact first noted by Anderson in 1927. Indeed Fenner (1975) lays particular emphasis on the exceptional ability of chalk and chalk-derived soils to supply water effectively to plants. He quotes a considerable body of data which suggest that certain species may be confined to chalk soils because of sensitivity to drought.

Physical factors may also be important. The greater aeration and 'warmth' of chalk soils is repeatedly mentioned in the literature. To this Hope-Simpson (1938) adds texture: Pteridium tolerates calcareous soils despite being reduced in vigour, but its extreme rarity on chalk may be because of the hindrance its rhizomes encounter in the parent rock. He also invokes a 'seed parent effect' in operation at a site where calcareous soils were surrounded by acid Greensand derived soils: the vegetation on the latter was continually shedding seed over the alkaline area. A final point is considered by C.J. Smith (1980):

> "Others, encompassing the much rarer plants mainly of the southern and eastern Chalk, are restricted to this formation simply by its fortuitous geographical position" (p.209).

Chalk heath habitats have often been studied in relation to calcicoly. These are

> "plant communities growing over chalk and containing an intimate mixture of the usual chalk grassland species with heather (Calluna vulgaris) or bell heather (Erica cinerea)" (Grubb et al. 1969, 175).

They are usually developed on thin superficial deposits, most often Clay-with-flints, which is derived from the basal levels of the Reading Beds (Limbrey 1975). It has been suggested that calcifuges are rooted in the upper acid soil, the calcicoles deeper, into the base-rich horizons. Grubb et al. (1969) show that such differential rooting does not occur and that the mix seems to be the result of the ability of all the plants to form healthy root systems in soils at pH 5 to 6. They suggest that competition and physical factors such as poor aeration and too low a temperature are most important in excluding strict calcicoles from most soils at pH 5 to 6 in Britain. However, they do recognise a group of extreme calcicoles, mostly orchids, as they do not grow on the warm dry soils of chalk heath.

Heath plants have also been observed growing on soils on the scarps of 'Celtic' fields, on banks and on mounds. A.S. Thomas (1960b) interprets these as indicative of former cultivation by hand and that the shallow acid soils on which they are growing may be derived from plant remains deposited during land clearance for crops, or from weeding the crops. Further work has not been undertaken on these particular features so it is not possible to assess the validity of the hypothesis, except to state that leaching of the deeper soils may be a more reasonable explanation.

It is evident from this body of research that calcicoly has a complex cause, although competition and water relations might be most important. As only a few plants appear to be strictly limited to, or excluded from, calcareous soils it seems that the gross effect on the vegetation composition may be relatively minor. However, with the palaeoecological data, there is some ecological evidence to suggest that the existence and depth of superficial deposits will exert an influence on plant distributions.

2.3. PALAEOECOLOGICAL AND ECOLOGICAL RESEARCH: CONCLUSIONS

The evidence from the ecological and palaeoecological literature is essentially complementary: forest must have been widespread across the chalk in the mid-postglacial and it is only through the activities of man that the present landscape is dominantly open. Grazing undoubtedly has been important in maintaining the openness of the downs. Regeneration, however, has occurred in some parts of the North and South Downs. Elsewhere, notably in the central chalklands, it has been much less and possibly limited to scrub, although this is difficult to determine at least from the pollen evidence. The reason for this spatial variation may be related to soil conditions and the occurrence of superficial deposits. Other factors however may be in operation and the problem is investigated in section 9.4.2.2.

2.4. POLLEN DISPERSAL

In any research involving pollen analysis the origin of the pollen is of prime relevance to the interpretation of the data. Pollen percentages cannot be converted directly to vegetation percentages because of the operation of two associated variables, pollen dispersion and pollen production. Consequently, a taxon that is abundant in the vegetation but which produces small amounts of heavy and poorly dispersed pollen (e.g. Fagus) may only be represented by a very low percentage in the pollen diagram. Conversely, a taxon such as Pinus with a high production and efficient dispersal may have a high pollen percentage despite being scarce in the vegetation.

The two variables are generally associated because of the different methods used by plants for pollination. Insect pollinated or entomophilous species rely on insects attracted by a prominent flower and nectar for the transfer of pollen from one plant to another. The pollen grains tend to be large and sticky so as to adhere readily to the insect and, additionally, will be produced in lower numbers as transfer to another flower will be more probable. Alternatively, taxa utilising wind pollination (anemophilous) will tend to produce light dry grains in vast numbers: they are liberated into the air where only a small proportion are carried to the stigmas. By its very nature, pollen analysis tends most efficiently to record wind pollinated species.

Additional complications beyond the basic division of anemophilous and entomophilous, not to mention cleistogamous (self-fertilising), are imposed by habitat. A single isolated tree, for example, will tend to produce more pollen than one of the same species inadense woodland stand; wind speeds will also be greater and dispersal enhanced. Corylus as an abundant understorey shrub in a closed forest may flower minimally, but with an opening of the forest canopy, flowering will be increased and there will be a marked increase in pollen representation even though the areal extent of hazel may not have changed. Furthermore, plants at the extremes of their range may show low ecological performance, including minimal flowering (Moore and Webb 1978, 113). Overall however, the pollen production of a forested area will be approximately equal to that of an open area (Faegri and Iversen 1975), but the representation of an individual pollen type in a pollen diagram will tend to obey the Sutton equation (Janssen 1973). This states that the dispersal of small particles (pollen) in the atmosphere is dependent on the height and the strength (production) of the source and in pollen diagrams is modified by the distance to the sampling point. Consequently, trees, usually wind pollinated and of height, will tend to be better represented than grassland herbs, low growing and entomophilous. Heim (cited in Faegri and Iversen 1975, 69) has demonstrated that in even small clearings (about 200m) tree pollen percentages may be reduced from 70% to 20% whilst a small birch copse in heathland raises it from 30% to almost 90%.

Much of the early work in pollen analysis assumed that pollen was liberated into the air where it was mixed, to fall as an even 'pollen rain' over the landscape. Through an awareness of the forementioned variables, it is now recognised, as stated by Faegri and Iversen (1975), that the evenness of the pollen rain should not be over-rated. The variation of the pollen rain and its implications for pollen analyses is briefly discussed below. In this thesis knowledge of the probable origin of the pollen at each site is crucial because of the concern with chalkland environments. Dispersal therefore is most important in this context and the following will concentrate on this aspect insofar as this is possible given its association with production.

2.4.1. DISPERSAL DISTANCE

Numerous studies have been undertaken to investigate the relationship between the pollen present in, for example, moss polsters and the surrounding vegetation. In general they illustrate the steep distance decay curve of most pollen types, asymtopic in form, and steeper in woodland than in open areas. Andersen (1967) in Draved Forest, Denmark, found dispersal distances of less than 20m to 30m in an area with a tree height of 20m and concluded that vertical fall equalled horizontal drift in importance. Calculations showed that the expected distance should be 300-2000m: this discrepancy is probably accounted for by the major part of deposition occurring in rain drops or in large aggregates (Andersen, 1974). Investigating isolation in Quercus petraea with results also applicable to Q. robur, Semerikov and Glotov (1971) found a maximum dispersal of about

80m in closed forest. For Tilia cordata, Pigott and Huntley (1980) recorded a value of 60m to 100m. Similarly, Tilley (1978) in the New Forest discovered a maximum distance of about 75m in woodland. Tauber (1977) found that the pollen in the trunk space (section 2.4.3.) was from within 200m. A much reduced dispersion is implied by the findings of Colwell (1951), as far as can be discerned from investigations employing differing methodologies. Working with radioactive labelled pollen of Pinus coutteri in California he found the bulk was deposited within 10m. These data relate to tree species: as mentioned above, dispersal of herb types is generally much less. For two species of Carex in woodland Handel (1976) noted that very few chemically-tagged grains were carried beyond 1m. Despite this very restricted dispersal there is interspecific variation: Rumex and Plantago in particular may be transferred some distance (e.g. Caseldine 1981; Tinsley and Smith 1974).

In open areas dispersal is more efficient, evidently because of greater air movement. Turner (1964a) working with sample transects in Ayrshire distinguished a β component in the pollen rain which was defined as that derived from local sources. Her transects extended from pine plantations into open bog and showed that the β component does not travel further than 300-500m from the edge of the woods, a range influenced by prevailing winds. In Yorkshire, Tinsley and Smith (1974) found a very rapid decline in arboreal pollen within 100m of the woodland edge to less than 15% in general with regional prevailing winds having little effect. Cundill (1979) also discovered a very rapid decline, but did find that dispersal was strongly influenced by topography and prevailing winds. As Faegri and Iversen (1975, 69) state, from the woodland edge tree pollen declines rapidly over 100 to 300m to 3% to 30% of its former value. Nevertheless, pollen can be carried for many kilometres ('long distance transport') and records of, for example, arboreal pollen well beyond a treeline are not uncommon (eg. Ritchie and Lichti-Federovitch 1967; Terasmae 1967).

Any interpretation of fossil pollen spectra must therefore include a consideration of these factors. Quantification has been attempted, a procedure consisting of two main divisions: correction factors and dispersion models. They are not independent, but for convenience they are discussed separately.

2.4.2. CORRECTION FACTORS

The concept of correction factors was devised to make pollen percentages more quantitatively representative of vegetation percentages. Davis (1963) first advocated their use on any major scale and proposed the term R-value, the ratio between the pollen percentage of a species and its percentage in the vegetation. It takes into account interspecific variations in dispersion and production to permit a 'correction' of the pollen percentages. Using the technique she proposed that the widely recognised Pine Pollen Zone in North America was, in fact, a time when larch, balsam, fir, maple and poplar were the dominant species, not pine. Subsequently, others, including Andersen (1967, 1970, 1973), devised their own sets of correction values for specific areas.

The value of correction factors has been repeatedly questioned. Davis's original work was, for example, criticised on three accounts (I.C. Prentice, pers.comm.): they were poor estimates statistically - that for larch was based on only six grains; long distance transport could have a major effect; and too small an area was assessed for vegetation percentages. The most serious problem was described by Oldfield (1970a):

> "unless we know how far away from the collection point the plants forming a pollen source were growing, we cannot strictly speaking apply correction factors to translate the frequency of a particular pollen type at the collection point into abundance of the taxon producing it in the local vegetation" (pp.167-168).

To this Moore and Webb (1978, 114) add that the local environment of the individual affects the value for the species. As Oldfield indicates, the result is that individual correction factors are most appropriately used only in those areas for which they were devised. Investigations have tended to support these criticisms. For example, Comanor (1967) in New Jersey found that they lacked any inherent consistency and did not clearly enhance interpretation and Janssen (1967) in Minnesota discovered considerable variation, although for a few pollen groups they could be used. Indeed, Davis (1967, 1969) after the use of absolute pollen frequencies and other methods subsequently revised her earlier conclusions. A result of these findings was a more flexible approach to their application. After initial criticism (Faegri, 1966) Faegri (in Faegri and Iversen 1975) lists six sets of factors derived from various authors, yet proposes that on a rough and ready scale only two should be used, one for over-producers and one for under-producers. A more extreme view is perhaps taken by Janssen (1970) who recommends solely the construction of auxiliary diagrams which eliminate grossly overrepresented grains.

There has recently been a renewed interest in correction factors (Bradshaw, 1981a, 1981b; Parsons and Prentice, 1981; Parsons et al. 1980). Bradshaw (1981a), for example, utilises two methods of correcting fossil pollen spectra for data from south-east England. The first is for absolute data and involves regression analysis, a modification of Andersen's (1970) model; the second is for percentage data, R_{rel}-values. In the first, the slope of the regression line for each species is proportional to the pollen representation of that species and the intercept shows the 'background' level, a figure representing the pollen of that species derived from long distance transport. Amongst other factors, this overcomes the problem caused by long distance transport in the original R-values of Davis. R_{rel}-values are calculated by dividing the crude R-values for each taxon present by the R-value for, in this instance, Quercus, the reference species. In contrast to R-values, R_{rel}-values are theoretically constant for any combination of a group of taxa and are independent of the mixture of taxa from which they are calculated. These methods permitted the conversion of fossil pollen data in a small pond into quantitative vegetation data at the spatial scale of the woodland stand.

Work with correction factors is currently gaining considerable support with particularly large-scale investigations in North America to determine appropriate values for differing conditions across the entire continent (I.C. Prentice, pers.comm.). Ultimately, it may be possible to directly convert fossil pollen percentages into past vegetation communities.

2.4.3. MODELS OF POLLEN DISPERSION

Associated with what the fossil pollen represents is the actual origin of the pollen. The first major attempt to determine this was the model devised by Tauber (1965) which accounts for the various routes by which pollen reaches a mire or lake. He assumes that the site is surrounded by forest and that the pollen rain consists of four major parts.

First, the trunk space component (Ct)-pollen derived from the canopy above or the herbs and shrubs beneath and carried within the trunk space; air movement is relatively slow so deposition occurs after a short distance. Secondly, the canopy component (Cc)-pollen from the canopy or below, transported in, or just above, the canopy itself. Thirdly, the rain component (Cr)-pollen raised by thermals or turbulence to high altitudes and deposited by rain, generally derived from a large area. Finally, the water component (Cw)-pollen brought in by streams flowing into the basin. To this scheme Moore and Webb (1978) add a local component derived from aquatics on the surface of a lake or peat-forming species on a mire surface. Tauber (1965) maintains that a major part of the transport takes place in the trunk space and implies that whilst the pollen input to very small basins is dominated by this component, larger basins have proportionally less Ct and more Cc, to a certain size when Cr dominates. Consequently, small basins will only represent the very local vegetation, and, in contrast, large basins, only the regional vegetation.

Tauber's model has been the subject of considerable debate with much of it centring on the importance of the trunk space component. Faegri and Iversen (1975) state that, first, there is no trunk space in the case of non-arboreal pollen, although they seem to neglect the fact that the model was devised for a forested area; and secondly, his conclusions are unacceptable for forests: pollen abundance is lower than would be expected and there is a close correlation between the pollen spectra deposited on the forest floor and that in the canopy overhead (Andersen 1967). Indeed, Currier and Kapp (1974) conclude that in their study of a small lake (100m diameter) in a forested area the above canopy component contributed most of the pollen deposited in the lake, although this size of lake could fall into Tauber's middle category which experiences maximum input from Cc. Borowik (1963, 1966) found that the greatest catches of tree pollen were made in clearings in and around the forested area, not in the forest, and that almost no non-arboreal pollen came into the forest from the surrounding grassland. Faegri and Iversen (1975), in consequence, place less emphasis on Ct yet they are willing to accept the major threefold division as perhaps useful. Nevertheless, Tauber's (1977) recent 5 year trials tend to support his original hypothesis: 60% of airborne pollen grains over a lake 200m x 100m in size had been transported through the trunk space, 35% above canopy and only 5% was from rainout. Comparison with vegetation around the lake showed that Ct was derived from within 200m of the edge of the lake and Cc from a maximum of 1000m.

The water component is also significant (Jacobson and Bradshaw 1981) as a single stream may effectively, for example, by the very nature of its watershed, grossly increase the effective pollen catchment of a water body out of all proportion to its size. At Oakdale in Yorkshire, Calluna and Pteridium levels were greatly inflated in the first winter flood (Peck 1973) and in Tauber's study the input from a stream totalled 50% of the total pollen deposited on the lake bottom (Tauber 1977). This is relevant in this thesis as one core selected for study (Amberley) includes water-deposited clays in its basal levels.

Given the equivocal nature of the Tauber model of transfer, particularly regarding quantification, a more useful concept to adopt is probably that of local, extralocal and regional deposition first propounded by Janssen (1966, 1973). Jacobson and Bradshaw (1981) present revised definitions of these terms: local pollen originates from within 20m of the edge of the basin; extralocal from plants between 20m and several hundred metres of the basin; and regional from plants at greater distances. With increasing basin size, this model, like Tauber's, predicts increased representation of regional pollen. They present a diagram showing the relationship between the size of a basin without an inflowing stream and the relative proportions of pollen originating from different distances around the site and received at its centre. It was developed for sites within forest and is largely an intuitive model, but based on experimental data. Such a model can be of little more than a general guide, especially since allowance is not made for heterogenous areas and changing wind directions, nor, for a small site, pollen source area effectively increasing with woodland clearance around the site. However, despite these constraints, it is valuable as an indication of the probable area from which pollen is likely to be derived for any given size of site. Thus the model is used in this thesis as a tool to aid the interpretation of the spectra at each site.

2.4.4. POLLEN DISPERSAL: CONCLUSIONS

Even after a considerable amount of research quantifying pollen dispersal and deposition the subject remains equivocal. Nevertheless, it is clear that the size of a basin will be important in determining the likely origin of the pollen. Whilst at a small site the pollen will have been derived from a restricted zone, that deposited at the centre of a large site will be representative of a more extensive area. Some more precise numerical description is possible from recent work as typified by the model of Jacobson and Bradshaw (1981) and this is of considerable value in interpretation. To this may be supplemented observations of transects through open and forested areas which may, for example, indicate woodland if arboreal pollen exceeds 50% of the total pollen (Tinsley and Smith 1974; Jonassen and Heim, cited in Simmons and Tooley 1981) and the use of three-dimensional pollen diagrams to illustrate the extent of open areas (Turner 1975).

CHAPTER 3

METHODS

As shown in Chapter 2, most of the environmental evidence directly relevant to chalkland ecological history has been derived from the analysis of subfossil Mollusca. However, as already stated (section 2.1.2.) vegetation composition cannot be deduced from such work and consequently pollen analysis has been utilised as the central technique throughout this research.

3.1. SITE SELECTION

3.1.1. CRITERIA AND LOCATION

Several criteria were considered in selecting sites for pollen analysis. These were as follows: peats, to minimise the influence of waterborne pollen; locations such that the preserved pollen might be derived from vegetation on the chalk outcrop; larger deposits, to maximise the record of pollen from regional vegetation; and deposits representing as long a time period as possible (section 2.4.; Jacobson and Bradshaw 1981). In the event, only one site, Winchester, adequately fulfilled all of these criteria.

A number of sources were consulted to locate potential sites. Large-scale Ordnance Survey maps (1:63, 360; 1:50,000; 1:25,000; 1:10,560; and 1:10,000) provided most information, especially the older editions: these showed wet areas and marshes now drained and hence excluded from more recent editions. Drift geological maps were of limited value; occasionally they did depict peat deposits, but the accuracy of the mapping appeared to be poor from fieldwork. Soil maps were a more reliable source, but surveys in the area under consideration are minimal and there was no published data: access however was granted by D.W. Cope (pers.comm.) of the Soil Survey to their recent investigation of the Vale of Pewsey. Field evidence was also used, particularly the presence of fen vegetation and poplar plantations; the latter has been one of the more economical uses of drained peat beds.

An additional method adopted was correspondence with archaeologists active in the region, district councils, water authorities and gas and electricity boards. Public service excavations had revealed the buried peats at Wingham and Frogholt (Godwin 1962; section 2.1.1.1.). Despite general interest suitable deposits were not found. Publicity at local conferences similarly failed to produce any viable peats.

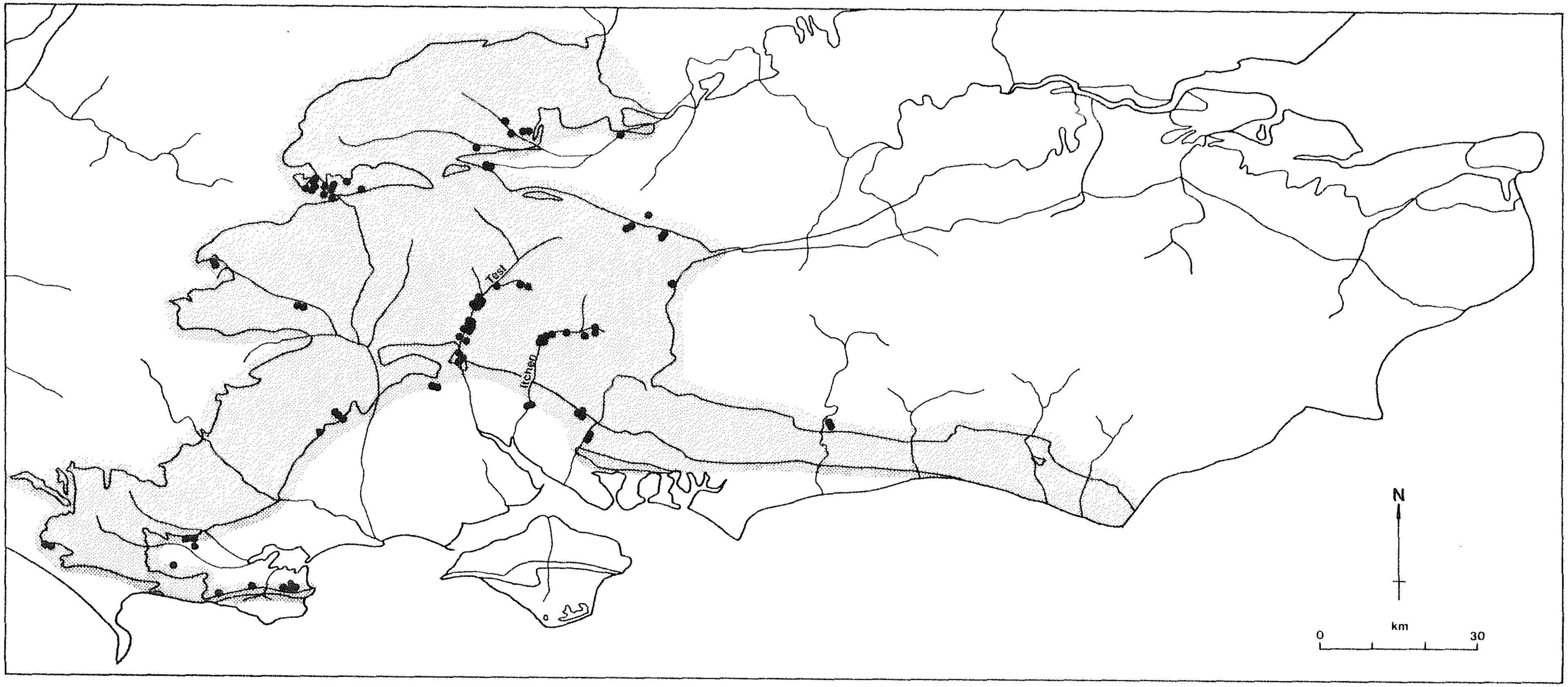
Place-name evidence suggested several potential sites but in all cases, if peat had been present, it had subsequently been lost, either through cutting or wastage after drainage. St. Edith's Marsh in Wiltshire is a good example: numerous calcifuge plants, especially Rhododendron, are prevalent at about ST 983638, just below the chalk scarp and perhaps on a remnant of once more extensive peats.

Ultimately, the majority of sites examined and selected were located by map and field observations. Exploratory cores were extracted from deposits over 50cm in depth and in more extensive areas of peat several cores were taken. These were subjected to preliminary analysis at 10-20cm intervals to assess pollen content. The area investigated and the location of the exploratory cores are shown in Figure 3.1.

3.1.2. RIVERINE PEATS

It was emphasised in Chapter 2 that the majority of published pollen analyses of peats in the area of the chalk outcrop were subject to considerable influence from vegetation on non-chalk substrates. To overcome such distortion, the fieldwork involved a detailed examination of peats located in river floodplains located within the chalk outcrop. The objective was to obtain a series of long pollen analysed cores that could be directly relevant to chalkland palaeobotany. Peat deposits were plentiful but problems of poor pollen preservation were encountered.

A thorough and intensive investigation was undertaken of the extensive peats of the Test and Itchen valleys. In the Test peats are especially common below Chilbolton and form large beds 100cm to 200cm in depth between Leckford and Houghton despite considerable evidence of cutting. This varies from rectangular, steep-sided pools near Longstock and Mottisfont used now as decoys and the 'Peat Spade' pub at Longstock, to obvious stratigraphic discontinuities. 'Swan Island' (SU 362366) near Longstock is shown as a peat cutting on the tithe map of 1839 and the stratigraphy there consists of 50cm of peat under 130cm of sloppy light-brown clayey



Area investigated

Core

Figure 3.1. Area investigated for polliniferous deposits and location of preliminary cores

infill. Thirty-seven cores were taken from peats in the Test of which 18 were from the Leckford Estate, an area of about 2km^2 of Phragmites fen and carr vegetation. Samples from all showed minimal pollen preservation and although some horizons were just countable, no single core had a sufficient number of polliniferous levels to warrant investigation. Seagrief (1955; section 2.1.1.1.) encountered similar problems. The cores from Leckford were located at random: fisheries, waterways and impenetrable thickets prevented the application of regular grid sampling procedures. Coring was concentrated in this small area because monoliths separated by 5m on an archaeological site in Warminster were found to have significantly differing pollen contents. No such variation was discovered at Leckford.

In the Itchen valley, peats were less extensive. A total of 13 cores showed results very similar to those from the Test, with minimal pollen preservation. However, one core from the deep peat (430cm) of Winnall Moors, north of Winchester, was found to have just sufficient pollen for analysis and consequently was selected for detailed examination.

In view of these largely negative results cores from a number of other chalkland valleys were analysed to determine the extent of the problem. These were taken from the Loddon at Basing (2 cores), the Lambourn at Boxford and Woodspeen (2), the Crane at Cranborne (1), the Kennet at Kintbury (1), a tributary of the Wey at Neatham (1) and the Wylye at Steeple Langford (2). All showed very similar results with poor preservation of pollen; in total 240 samples were prepared from 64 cores. From this first systematic investigation it may be concluded that in general conditions in chalkland river valleys have not been conducive to pollen preservation. Some exceptions exist, as in the case of Winchester and Lewes (Thorley 1981; section 2.1.1.1.) but they are clearly unusual. Isolated levels occasionally were polliniferous and the basal levels of some of the deeper peats, notably in the Test, consistently had some degraded grains of Pinus and Corylus. These are grains resistant to degradation (Havinga 1971) and so to be expected in such material, yet it may be speculated that at least some of the chalkland peats began to accumulate in the Boreal period. The results of Seagrief's (1955) work at Leckford (section 2.1.1.1.) as well as that at Winchester (section 6.2.) lend support to this hypothesis.

The reasons for the low pollen content were unclear, particularly as macrofossil preservation was frequently good. The pollen preparation schedule was examined: losses of pollen during preparation of samples would, however, have had to have been considerable to have caused the observed effect. Furthermore, known polliniferous samples were frequently included with batches of samples from chalkland peats and these always showed good pollen spectra. An alternative explanation may have been that the special calcareous conditions of the peat resulted in the conventional pollen preparation schedule being inappropriate. For example, J. Renfrew (pers.comm.) and F.J. Green (1979) observed seeds of Medieval age replaced by calcium phosphate in archaeological deposits in Winchester; if pollen grains similarly had been truly fossilised, then they may have been destroyed during sample preparation. To investigate this possibility an experiment was conducted. Five sample preparations were undertaken, each of sixteen same depth samples, five from two polliniferous peripheral peats, three from one apparently non-polliniferous peripheral peat and seven from two apparently non-polliniferous riverine peats (Table 3.1.). The five preparations consisted of one complete schedule, one water only and three with the omission of one or more chemical stages (Table 3.2.). In the final samples there were no major differences in the pollen frequency of the same samples subjected to different preparations, at least as far as could be discerned given the variable amounts of non-pollen residue remaining. Statistical analysis was not possible because of the difficulty experienced in counting the material. It was therefore concluded that the preparation schedule was not responsible for the absence of pollen from the chalkland peats. It is noteworthy that others have also encountered the problem: Seagrief (1955) at Leckford, A.J. Thorley (pers.comm.) in the North Downs and various Southampton University undergraduates working on other Test and Itchen valley peats.

Environmental factors, therefore, are the probable cause of the poor pollen preservation. Experimental evidence suggests that under conditions of high pH, the oxygen content of water is greater, permitting the microbial attack of pollen exines (Faegri 1971; Havinga 1971; Sangster and Dale 1964). However, numerous analyses of peats from the Fenland (eg. Godwin 1978) and the calcareous meres of the Brecklands (Godwin 1968) indicate that in practice, high pH may not be deleterious to pollen although these sites imply that minimal water movement may be

Table 3.1. Samples analysed to investigate whether sample preparation was causing destruction of pollen

Sample No	Site	Depth (cm)	Comments
1	Kingswood	170	Known polliniferous peripheral peat
2		180	(control)
3	Woodhay	10	Known polliniferous peripheral peat
4		35	(contrul)
5		55	
6	Bishops Waltham	125	Apparently non-polliniferous
7		145	peripheral peat
8		165	
9	Leckford Estate	165	Apparently non-polliniferous
10		185	chalkland riverine peat
11		205	
12	Winnall Moors,	75	Apparently non-polliniferous
13	north end	175	chalkland riverine peat
14		250	
15		335	
16		420	

Table 3.2. Modified preparation schedules used for each of samples in Table 3.1.

Schedule	Description
1	Complete: HCl-KOH-sieve-HF-HCl-glacial acetic acid-acetylation-glacial acetic acid-staining-silicone fluid (Control)
2	Water only: sieve-staining-silicon fluid
3	Minus KOH: HCl-sieve-HF-HCl-glacial acetic acid-acetylation-glacial acetic acid-staining-silicone fluid
4	Minus HCl and HF: KOH-sieve-glacial acetic acid-acetylation-glacial acetic acid-staining-silicone fluid
5	Minus acetylation: HCl-KOH-sieve-HF-HCl-staining-silicone fluid

significant in reducing degradation (K.E. Barber, pers.comm.). Dimbleby (1978) states that waterlogging is a sufficient condition, although samples from the deep calcareous bottom muds of Alresford Pond yielded very little pollen, but perhaps this was because of rapid sediment accumulation.

Field observations may provide a solution; it was noted repeatedly during fieldwork that the surface of the Phragmites fens were dry in summer (1978-1981), but invariably under 10cm to 30cm of water during the winter. If waterlogging is important for pollen preservation, then water table fluctuations may be critical: pollen is released in spring and summer and that which falls on the dry fen surface will be readily degraded before the water table rises again in the autumn (Barber 1981b). This mechanism readily explains both the absence of pollen and the preservation of plant macrofossils, which die and collapse in the autumn and winter. As S. Limbrey (pers.comm.) has commented, the high pH would reinforce this effect: under acid conditions temporary summer drought would have little effect because the activity of micro-organisms would still be slow. The higher oxygen content of the inundating water in the autumn would hasten the destruction of any remaining pollen.

The significance of water levels is illustrated by the Winchester analysis. Only in this core, the deepest from Winnall Moors, was pollen preservation sufficient to permit detailed analysis. The depth of the peat and its apparent freedom from cutting implies its accumulation in a very wet area and, thus, one with minimal water table fluctuations. The pH, furthermore, is consistently between pH 7 and pH 8.

Water table fluctuations therefore may be an important explanation for the generally poor pollen preservation, although high pH must be contributory. It must however be acknowledged that chalk groundwater levels have been falling for several millennia, hastened recently by the exploitation of aquifers. The total fall may exceed 18.3m (Pelham 1964). Consequently, the summer dryness of the fen surfaces may be only a relatively recent phenomenon. Further research can obviously be undertaken into this problem.

In spite of the largely negative results of the investigation of riverine peats and its consequences to the research it has been of value. For the first time a systematic study of chalkland peats has shown them to be generally unsuitable for pollen analysis; this had been suspected but until the present study few investigations had been conducted.

3.1.3. PEATS ON SUPERFICIAL DEPOSITS

During investigation of the Lambourn valley, conversation with a gardener resulted in the discovery of another site. He recalled cutting turf on Snelsmore Common, north of Newbury, up to about 1960. This is an area of heath and woodland on Plateau Gravel overlying clays on chalk. Of the two polliniferous mires present, that in the east was investigated because it was larger, was composed of more cohesive peat, and was more accessible; the west bog is in a valley with thick Betula scrub. The importance of the Snelsmore site lies in the numerous superficial deposits in the vicinity, providing a possible comparison with other areas free from such strata and thus potentially helping to resolve the nature of the influence of heavier soils on the intensity of exploitation (section 2.3.).

Similar geological formations were examined, but the bogs at Snelsmore appeared unique.

3.1.4. PERIPHERAL PEATS

As the work on chalkland peats produced only two sites suitable for investigation, the methodology was re-orientated to include a study of peats peripheral to the edge of the chalk outcrop by up to about a kilometre. These were to be complemented by analyses of Mollusca from adjacent chalk dry valley infills. However, because of the necessity of finding complete sequences, the difficulty of dating, and the limited environmental data available (section 2.1.2.) this latter was abandoned in favour of a greater emphasis on the pollen data. It was appreciated that extrapolating from the chalk periphery to the chalk itself was problematical, but was the next best option given the problems of the riverine peats.

Forty-eight cores were examined from the following locations: The Weald (2 cores), Vale of Pewsey (12), South Hampshire Tertiaries (9), Poole Basin (15), Newbury area (2), West Dorset (2), West Wiltshire (2), Basingstoke area (2) and Reading area (2).

The results varied. Unpublished soil maps of the Vale of Pewsey (D.W. Cope, pers.comm.) showed extensive areas of peat on Greensand, as were those in the Reading area: all were devoid of pollen. This was disappointing as R. Scaife (pers.comm. and 1980) in the Isle of Wight had found all of his most polliniferous sites on Greensand. The explanation may be related to differences in the Greensand and/or the chalk surrounding, causing greater groundwater fluctuations and higher pH than in the Isle of Wight.

In The Weald the most common zone of peat formation lies 2 to 4km from the chalk in the sands of the Folkestone Beds and Lower Greensand, but this was considered to be too far from the chalk to merit attention. The two cores were from the derelict raised bog at Amberley (section 2.1.1.1.) and were polliniferous. As already described, the deposit was selected for detailed re-examination.

Peats on the Tertiary strata north-east and north-west of Southampton also revealed only poor pollen preservation, frequently had been cut and were too far from the chalk to be suitable for analysis. The two cores from west Dorset were from Sidaway's (1963; section 2.1.1.1.) site at Litton Cheney; as described, little pollen was recorded preventing any re-working of the material. The two Wiltshire cores were from buried peats exposed in an archaeological excavation at Emwell Street, Warminster (R. Smith, pers.comm.). They were of Roman and later origin and exhibited poorly preserved pollen that was probably derived chiefly from taxa growing on the peat surface. The two cores from the Basingstoke area were from a buried peat bed near Cowdery's Down, north-east of the town. These also showed poor preservation and may similarly be of Medieval or later date: these results, as with those from Warminster, are of little relevance to this thesis and, likewise, will be published elsewhere (Waton 1983, in preparation). Near West Woodhay 8km west-south-west of Newbury, a polliniferous valley mire was found in Prosser's Hanging, a strip of woodland 1km north of the escarpment of the Hampshire Downs. It was selected for analysis despite its shallow depth of only 100cm.

The Poole Basin, as found by Haskins (1978), is rich in peats and 15 cores were taken from 9 different sites and three were selected. Kingswood, a valley mire extending northwards from a springline 500m from the Purbeck chalk ridge; of the peats in the area this was the closest to the chalk. It is 250cm in depth and is near three of the sites analysed by Haskins: these latter produced similar results and it was hoped that differences between them and Kingswood could be attributed to chalkland influences. The other two sites were Rimsmoor and Okers. Both are peat-filled dolines, 600m south of the chalk outcrop and 150m apart, located south-west of Bere Regis. Rimsmoor was 1800cm deep and the smaller Okers was analysed to help assess the spatial extent of the vegetational changes recorded at Rimsmoor.

3.1.5. SUMMARY OF SELECTED SITES

In total, only seven sites were sufficiently polliniferous for analysis and all were investigated:

Within the chalk outcrop:

Winchester, Hampshire - calcareous valley fen peat

Snelsmore, Berkshire - acid valley mire on superficial deposits

Peripheral to the chalk outcrop:

Amberley Wild Brooks, Sussex - derelict raised bog and underlying clays

Rimsmoor, Dorset - peat-filled doline

Okers, Dorset - peat-filled doline

Kingswood, Dorset - acid valley mire

Woodhay, Berkshire - acid valley mire

They provide a reasonable geographic coverage of the chalklands of central southern England (Fig 3.2.) and have shown significant trends and correlations with existing archaeological and palaeoenvironmental data (Chapters 6 to 11). Each site is described in detail in Chapter 4.

3.2. POLLEN ANALYSIS

3.2.1. FIELDWORK

At each site selected for investigation a preliminary survey was undertaken to permit the mapping of the extent of the deposit. This entailed the use of an Abney level with measurements taken to the nearest half degree. A grid of long and cross sections was surveyed with the horizontal distance between each reading determined chiefly by breaks of slope. In most instances, profiles were surveyed up the line of maximum slope and at intervals governed by local topography. The results of such methods were considered to be sufficiently accurate considering the research objectives.

The cores analysed for pollen were at each site taken from the deepest point as indicated by stratigraphic investigations carried out in conjunction with the surveying. An exception was Kingswood where, at the deepest point (280cm), the lower 70cm was an homogenous and very wet black mud. Disturbance was considered to be a possibility and the core was thus from a position 20m to the north where the peat was 250cm in depth. At all sites other than Rimsmoor cores were obtained with a modified Russian

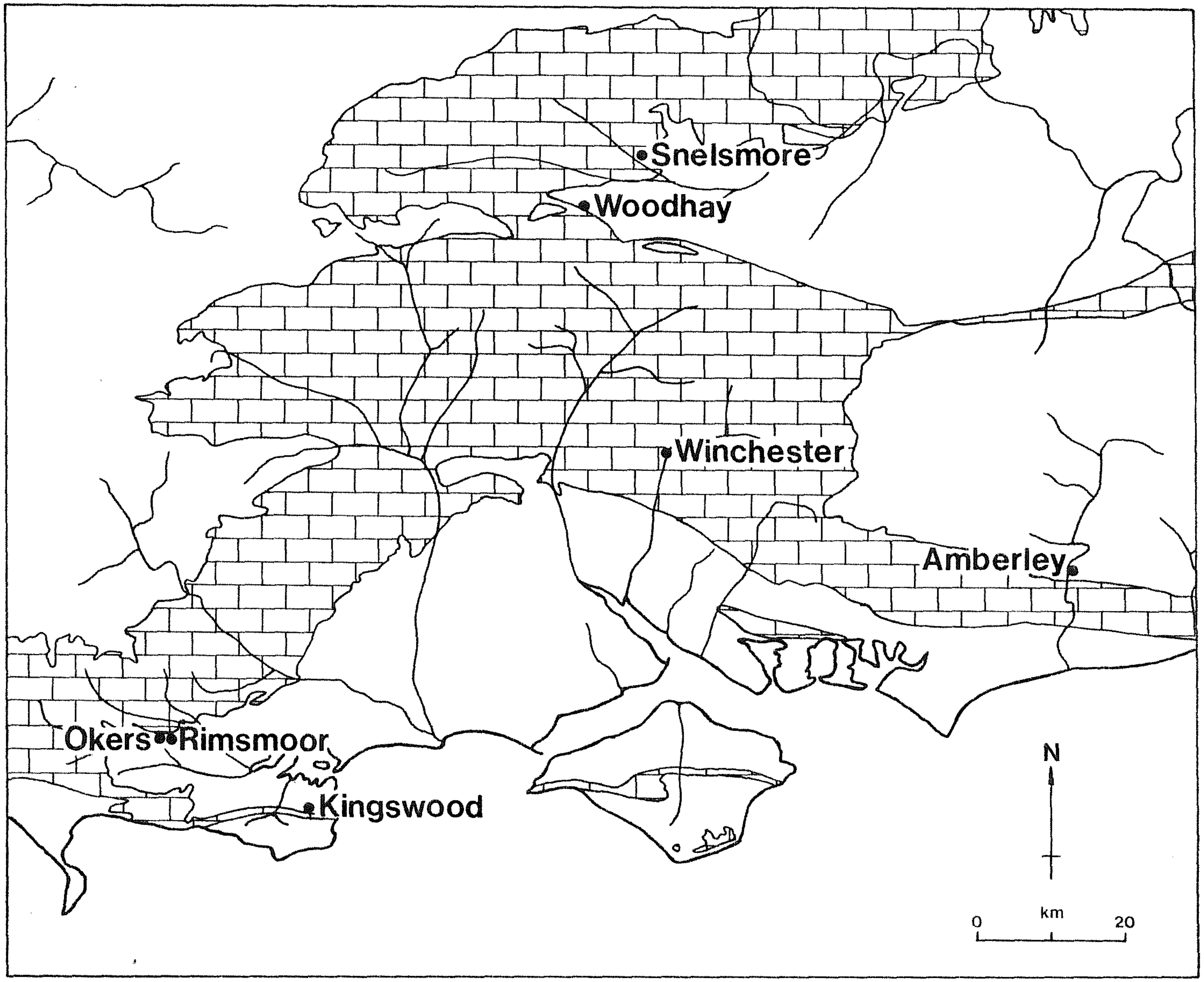


Figure 3.2. Sites selected for investigation

sampler (Barber 1976) having a chamber 50cm by 4cm. Core segments were taken from alternate holes about 20cm apart with 5cm overlaps. The semi-circular cores were slid into longitudinally-cut plastic drainpipe sections, wrapped in kitchen foil and polythene and stored frozen.

At Rimsmoor the Russian sampler could only be used to a depth of 1070cm. The screw action of the Hiller corer permitted deeper sampling. From 1070 to 1215 cm a large chambered instrument (50cm x 4cm) was used but from 1220 to 1800cm only the smaller 35 x 2cm Hiller would penetrate the peat. The version with removable inner liners (K.W. Thomas 1964) was unavailable so samples, at 5cm intervals, were taken from the chambers in the field and stored in sealed vials, frozen, until required. Great care was exercised throughout to prevent contamination. Longer core segments could not be taken from Rimsmoor. This would have entailed the use of a large piston corer or similar instrument, but the bog surface was too wet, and the peat too fibrous, for their operation.

3.2.2. PREPARATION OF SAMPLES

At five of the sites the sampling interval was in units of 4cm as this allowed easy subdivision for closer counts (Moore and Webb 1978). Units of 5cm were used at Rimsmoor because of the greater depth of the deposit and to simplify the sampling of the Hiller cores; Okers similarly was sampled in multiples of 5cm. It was discovered during the later stages of the work that more readily cleaned samples of more consistent size (0.5 to 1.0cm^3) could be obtained by sampling from frozen cores using specially-sharpened spatulas. This also minimised the frequency with which disturbance to the cores may have been caused by repeated freezing and thawing; low temperature (4°C) storage facilities were not available (Birks 1973).

Relative pollen counts were utilised throughout. Pollen influx was not calculated for the following reasons: tablets of exotic pollen, the most convenient method of determining pollen concentration, were unobtainable; the numerous radiocarbon assays required; and the frequently equivocal results derived from peats because of variations in accumulation rate (eg. Donner et al 1978). Furthermore, the objective of the research was to assess the overall nature of the chalkland palaeoenvironment: whilst pollen influx could have provided invaluable additional data, it was felt that the less time-consuming relative counts would be adequate to fulfill this objective. Computer techniques were not utilised as time for experimentation was severely limited as a consequence of the negative results obtained from the riverine peat work (section 3.1.2.).

The preparation of samples followed the schedule described by Barber (1976) with some modifications. The first stage involving 10% HCl to remove carbonates was unnecessary except for samples from Winchester. KOH at 8% was added to the samples which were left in a boiling water bath for 15 minutes before one sieving at 180 μ. When pollen concentration was low boiling was continued for 30 minutes, distilled water being added to prevent the KOH concentration rising above 8%. and the samples were then sieved three times. HF treatment when necessary involved leaving samples in a boiling water bath for 30 minutes, and for highly siliceous material, this was repeated three to four times using fresh HF on each occasion. This was inadequate for the clays at Amberley: the use of fine nylon screens was considered (Cwyner et al. 1979), but the cheaper and easier sodium pyrophosphate method (Bates et al. 1978) was used instead. This doubled or tripled the concentration of pollen in the final residue, in relation to HF treatment on its own. During acetylation samples were subjected to a maximum of 5 minutes in the boiling water bath. All samples were mounted in silicone fluid to avoid the deterioration that occurs with glycerol and to permit the rolling of grains for identification. Toluene was used prior to the addition of silicone, but in later preparations it was substituted by tertiary-butyl alcohol (Berglund 1979), a much less hazardous chemical. A sixteen-place centrifuge was used throughout and samples were subjected to 5 minutes at 3500 rpm on all occasions, except when using sodium pyrophosphate. None of the modifications to the schedule had any discernible deleterious effect on the pollen spectra.

Microscope slides were prepared so that there was a maximum of about five grains in each field of view (x 400) in rich samples to simplify counting. The coverslips were 18 x 18mm in size and traverses were made at 1mm intervals and avoided the edges (Brooke and Thomas 1968). Counts were conducted using a Nikon binocular microscope at a magnification of x400. Critical identifications were at x1000 with optional phase contrast.

3.2.3. THE POLLEN SUM

The pollen sum is the statistical basis for the expression of individual pollen frequencies. Until recently a sum based on 150 arboreal pollen (A.P.) was most often used, but this has largely been abandoned because, even in a deforested landscape, tree pollen will, by definition, amount to 100%. The nature of the sum is determined by the objective of the study (Wright and Patten 1963): the 150 AP sum originates from the period when forest history was the main purpose of pollen analysis. Current research is generally concerned with the development of the whole landscape and consequently non-arboreal pollen is usually included in the sum. Essentially, there are two variants: total pollen (excluding obligate aquatic taxa and spores), as recommended by the International Geological Correlation Programme (IGCP) (Berglund 1979); and 'dry land' pollen. The former is best suited to lake sediments and the latter, because of the exclusion of species likely to have been growing on the site of accumulation, is ideal for profiles from peat bogs. It is for this reason that a dry land pollen (DLP) sum was used in this project.

The minimum number of grains included in the sum determines the statistical significance of the percentages calculated from it, and the number of types occurring in low abundance that will be recorded. The higher the sum, the fewer the fluctuations caused by sample size and the more representative the sample is of the population of preserved pollen. Barber (1976) notes that pollen percentages do not change significantly after a sum of 200 grains has been counted and Dimbleby (1957) found that all taxa with a final value in excess of 1% were identified within the first 250 grains. Minimum counts of 500 are recommended by Berglund (1979) and a number of researchers use this number (Devoy 1977; Handa and Moore 1976). Continental analysts often record in excess of 1,000 grains (eg. Digerfeldt 1977). After consideration of these data, it was decided that for the objectives of the research, a minimum sum of 300 DLP would be sufficient; at all sites except Rimsmoor in excess of 350 grains were counted. The total count of pollen and spores was usually 500 to 2000. The DLP sum was to have been effectively doubled by scanning the same number of traverses of fresh material as had been required to attain the sum. Time limitations, however, precluded this refinement. In the pollen diagrams a plus sign (+) denotes grains recorded during preliminary scanning, but not subsequently encountered when counting. Inevitably, this tends to be biased towards larger grains, but the information is portrayed as records of, for example, cereal pollen grains, may be important.

It is arguable that as most of the sites are peripheral to the chalk, counts should have been considerably higher to record those grains derived from the chalk. This was not considered feasible because of the difficulty of determining the precise origin of the pollen grains and the extra time required for such a procedure. Attention was focussed upon obtaining detail from sites by close-interval sampling, where necessary, rather than by high counts.

The determination of 'dry land' species was based largely on the habitat descriptions of Clapham et al. (1968), supplemented by additional sources, such as Tansley (1949) and the Biological Flora of the British Isles (Journal of Ecology). Whilst most plants will grow in most places, the classifications are based on optimal requirements and the likely influence of local conditions. They are not presumed to be definitive, as is evident from some of the results (see later chapters). This problem in part was inevitable because of the use of a single scheme, to avoid confusion, at a number of different types of site.

Taxa not included within the pollen sum are grouped, largely on ecological grounds, and expressed as a total of DLP plus the total of that group (eg. DLP + Σ Mire Herbs). The non-DLP groups are as follows:

1. Alnus and Salix - two genera of wet habitats with similar growth habits that may have been present on and around the sites.
2. Ericaceae - species of especially mire surfaces, but also dry land.
3. Mire Herbs - species probably growing on the bog surface, including Cyperaceae, Hydrocotyle and others such as Succisa and Thalictrum with more variable substrate requirements.
4. Aquatics
5. Pteridophyta
6. Sphagnum

With this number of separate groups disturbance caused by individual pollen types (eg. Alnus: Janssen 1959), because of their percentage interrelationship, are minimised. The Pteridophyta could arguably have been included in the DLP sum: Pteridium in particular prefers a deep, well-drained rich loam (Braid 1959). The latter often behaves in a similar manner to pasture indicators (eg. Simmons 1969a) as at, for example, Rimsmoor. Tinsley and Smith (1974) however find that bracken is an erratic producer of spores and is thus unreliable, although this may have been a result of the annual fluctuations that would be averaged-out in fossil pollen samples. In the present research, Pteridium was excluded principally to simplify comparison with other work and also because of its propensity for colonising dried peat (Oldfield 1963).

3.2.4. POLLEN IDENTIFICATION

Pollen grains were identified by reference to the key of Faegri and Iversen (1975), photographs (Erdtman et al. 1961) and type slides from the Southampton collection as well as my own preparations. The key of Moore and Webb (1978) was used only for the differentiation of the Tubliliflorae and certain equivocal grains; further reference was discouraged by its format, a number of mistakes and its failure to separate certain important types such as the cereals from the rest of the Gramineae. The identifications of most types are as in Faegri and Iversen (1975). Additional comments are appropriate for the following:

Taxus. The pollen of yew was of special interest in the study but in no sample was there a grain that could confidently be assigned to Taxus. Regrettably, therefore, the research contributed little directly to our knowledge of the history of this species on the chalk.

Prunus type. This includes pollen of Crataegus type, Pyrus and Prunus.

Rumex. At Winchester this genus was differentiated into two types on the basis of size: R. acetosa type, less than 20 μ; and R. crispus type, greater than 25 μ. Further separation as shown by Birks (1973) was not attempted.

Cannabis type. Godwin (1967a) defines criteria for differentiating Cannabis and Humulus, though Andrew (1970) records that it is only possible if the grains are in good condition. However, Zant et al. (1979), like others, found that they,

> "were unable to make this distinction with confidence and therefore ... present the pollen as Cannabis/ Humulus" (p.229).

After studying modern reference material, I similarly decided that reliable separation was not feasible: they are shown, therefore, as Cannabis type.

Corylus and Myrica. Pollen analysts have frequently devoted considerable time to the separation of minor herbs but have not differentiated these genera. This is perhaps surprising for as early as 1934 Godwin described their distinguishing characteristics and I also found that it was relatively straightforward with practice. However, since this work was undertaken, the results of an experiment conducted by Edwards (1981) have been published: these suggest that they could not be consistently separated using ordinary light or phase-contrast microscopy. Nevertheless, my results are expressed in their original form because of the behaviour of the curve(s) in relation to the other pollen curves, and the occurrence of macrofossil remains. It is accepted that this may incorporate some misidentifications.

The criteria employed for separation were derived from reference material and published work. Myrica grains generally had heavier exines often with a slight rugulate sculpturing and the inner surface of the exine was usually absent in the vicinity of the circular pores (Erdtman et al 1961). Corylus, conversely, exhibited thinner exines with the inner surface present around the circular to longitudinally-elongated pores (Erdtman et al 1961). Faint arci were often present between the pores of Corylus (Erdtman 1954). However, as Godwin (1975a) states, some are always inseparable and these are shown as Corylus/ Myrica undiff. at the one site, Kingswood, where Myrica was common.

Tubuliflorae. Moore and Webb (1978) differentiate this subfamily into a number of different types. Centaurea scabiosa, C. cyanus, C. nigra type, Bidens type and Anthemis type are separated according to their criteria. Differentiation of Cirsium, Serratula type and Aster type was more difficult and these are all shown as Serratula type only.

Gramineae. Faegri and Iversen (1975) provide a key for distinguishing different groups of grasses. For each of the wild groups shown, modern samples were prepared of representative species, but observation failed to show any readily discernible unique features, except for Phragmites. When the criteria for the latter were applied to fossil material from Rimsmoor it was found that this pollen too could not be reliably and consistently separated; attempts at differentiation were thus abandoned. As Molinia is grouped by Faegri and Iversen with grasses of dry land, its separation was not attempted. Consequently, the Gramineae curve inevitably includes pollen from species growing on the bog surface. Where this may be significant is shown by the coincidence of high grass pollen and macrofossil remains and/or low dry land herb pollen.

Cereal. Characteristically cereal pollen is over 40 μ in size and has a large pore with a protruding annulus (Faegri and Iversen 1975). A number of grains in the approximate range of 38 to 42 μ with only small, poorly delineated pores, were observed and these may have been derived from certain wild grasses, including Agropyrum. Only those conforming to the previous specification, and invariably larger than 45 μ , were recorded as Cereal type.

Secale type. The identification of rye pollen was as described by Faegri and Iversen 1975); the prolate shape of the grains was most diagnostic.

3.2.5. POLLEN DIAGRAM ZONATION

It is customary to divide pollen diagrams into a series of sections or zones to facilitate description and interpretation. Godwin in 1940 devised a scheme of pollen zones for the lateglacial and postglacial of southern Britain, but an increased awareness of the importance of local influences ultimately led Cushing (1967a) to formulate the concept of 'assemblage zones'. In contrast to earlier systems, these are defined solely on the pollen represented regardless of climatic, ecological and temporal factors. Most recently, Walker (Walker and Pittlekow 1981; Walker and Wilson 1978) has advocated an alternative to zonation which entails the statistical analysis of the data for each taxon. This technique, however, is only appropriate for pollen influx data.

In this thesis a variant of the pollen assemblage zone concept is utilised. It has been adopted because the concept proper requires each zone to be a unit of approximately constant pollen frequencies (Birks 1973) which may consequently necessitate repeated subdivision. This, as Walker and Wilson (1978) observe for zones as a whole, can obscure the essential continuity of a sequence. Thus the diagrams were divided into local zones each distinctly different from those above and below and can include, within a single zone, clearance and regeneration phases. Given the central objective of investigating the nature of human activity, it was believed that this was the optional method of handling the data. Zone boundaries were positioned by 'eye-balling' as time was not available for computer analysis. Subsequently, however, Dr I.C. Prentice subjected the counts from Rimsmoor to analysis by CONSLINK, SPLITINF, SPLITSQ and principal components analysis (Birks in Berglund 1979); the results will be published at a later date.

Individual zones at each site are grouped into 'Periods' which are approximately comparable in time between sites, although the environments represented may differ. Therefore, they are not chronozones (Turner and West 1968; West 1970) or regional pollen assemblage zones (Berglund 1979). This scheme has been adopted because of the scarcity of radiocarbon-dated and correlated sites in southern England and to simplify discussion of the archaeological data. Local zones are depicted by a two or three letter prefix, denoting the site, followed by a hyphen and the number of the zone. (Core notations are similar but omit the hyphen.) Periods are prefixed by the single letter 'C', followed by a hyphen and number. The C refers to chalk: the Periods are not assumed to be either diagnostic of, or unique to, the chalk, but because of the central concern of the thesis and in the absence of original data here from other areas, such as the New Forest, C is preferred to, for example, CSE (central southern England).

3.2.6. POLLEN DIAGRAM FORMAT

The format of the pollen diagrams follows that of H.J.B. Birks as adopted by the IGCP (Berglund 1979). It has been modified because of the slightly different techniques used and with most of the important information located to the left. The taxa are presented in stratigraphic order within each category (see below), although *Corylus*, *Corylus/Myrica* and *Myrica* (where recorded) and *Salix* are together, as are *Calluna* and Ericaceae undiff. The curves are not 'blacked-in' but left open to readily show the sampling interval. All scales are the same and x10 exaggerations are not shown; the latter is questionable on statistical grounds when applied to low percentages and is also time-consuming to draw. A plus sign (+) indicates a species recorded whilst scanning but not encountered during counting traverses.

The sections of the diagrams, from left to right, are as follow :

1. Stratigraphy, with symbols after Troels-Smith (1955) and Berglund (1979) as shown in Table 3.3. (section 3.3.).
2. Core segments.
3. Depth in centimetres.
4. Charcoal abundance, where 0 = no charcoal, 1 = trace, 2 = occasional, 3 = frequent, 4 = abundant, as assessed from the residue remaining on the sieve after boiling in KOH.
5. Pollen abundance, where 0 = no pollen, 1 = four or more slides counted, 2 = two to three slides counted, 3 = up to one slide counted (excluding 4) and 4 = pollen at 95 to 100% of the residue on the slide. Although allowance is not made for differing preparation schedules and it need not show the actual abundance of pollen in the unprepared sample, some indication however may be apparent.
6. Pollen degradation, where 0 = no significantly degraded grains to 4 = abundant degraded fragments of grains. Counting indeterminable grains (eg. Caseldine 1980) was considered but, like the more quantified assessment of forms of degradation (Cushing 1967b), was discouraged by time limitations.
7. pH (Winchester only).
8. Radiocarbon dates and samples, where appropriate, expressed in years ad/bc.
9. A summary pollen diagram of dry land types divided into trees and shrubs; Corylus; Gramineae; herbs; and cultivars. Corylus is depicted separately because at several sites it is one of the species most markedly affected by man, and grasses and other herbs because of the potential effect of Phragmites and Molinia in inflating the Gramineae curve. Cultivars include Cereal type undiff, Secale type, Cannabis type and

Fagopyrum, but exclude other species such as Castanea, Juglans and members of the Cruciferae that may have been cultivated.

10. The main pollen diagram, Trees are shown first, then Corylus and Shrubs; hazel is considered fundamentally to be a tree (Faegri and Iversen 1975; Rackham 1980) yet has probably existed for much of the post-primary clearance period as a shrub. To compromise, hazel is shown first, immediately after the trees. Where recorded, Corylus/Myrica undiff is shown next with Myrica to simplify comparison of the curves given the possibly equivocal identification of these taxa (section 3.2.4.). Salix follows because of its tendency to be as much a tree as a shrub. Ilex is included within this category, though like Corylus, it may be a canopy-forming species (Scaife 1980). Gramineae and cultivars are shown together as they can be the most obvious indicators of human activity.

Dry land herbs follow: at an early stage in the research these were divided into 'grassland indicators', 'arable indicators' and 'others' to aid interpretation. This was soon abandoned because of difficulty in assigning many types to the groups (Behre 1981) and resulting absence of significant trends in the final diagram. Arable/pasture indices were investigated: those of Turner (1964b) and Roberts et al. (1973) were applied to some of the Rimsmoor data. Turner (1964b) states that in general, less than 15% characterised an arable region and greater than 50%, a pastoral region. The results did not greatly supplement what was obvious from the raw pollen spectra: even at the cultivar peak at 160cm, the indices were only 35 and 39% respectively, and at the Tilia decline clearance, 80 to 90%. As Behre (1981) and J. Turner (pers.comm.) state, what is relevant are those weeds normally associated with each land use in the area under investigation. Therefore, these indices were not used because of the following: soil deterioration is evident at sites such as Rimsmoor and consequently it is inappropriate to extrapolate present weeds to past land uses; the difficulty of distinguishing arable and pasture weeds; and the results of the preliminary calculations.

The remaining categories illustrated are mire herbs, aquatics, Pteridophyta and Sphagnum.

11. Approximate dates of zone boundaries interpolated from time:depth curves.
12. Local pollen zones and Periods.
13. Depth in centimetres.

3.2.7. SUMMARY POLLEN DIAGRAMS OF PERIODS

In the discussion of the five Periods, Chapters 6 to 12, the dry land pollen data for each Period at each site was averaged and is presented in summary form as pie diagrams (Figs 6.1, 7.1, 9.1, 10.1, 11.1) (Haskins 1978). These are utilised in preference to isopollen maps (eg. Birks et al. 1975) because of the relatively small number of sites under consideration.

To simplify comparison between Periods, the same divisions are used throughout:

1. Betula
2. Pinus
3. Corylus
4. Quercus + Ulmus + Tilia - taxa perhaps prevalent in undisturbed mixed oak forest.
5. Other trees: Fagus + Fraxinus + Carpinus + Juglans + Castanea + Euonymus + Aesculus + Acer + Abies + Picea - tree taxa more generally common in the later postglacial.
6. Gramineae
7. Herbs
8. Cultivars (see section 3.2.6.)
9. Others - DLP not included above

3.3. PLANT MACROFOSSIL ANALYSIS

The examination of macrofossil remains encompassed within the research was limited to that necessary for the derivation of basic stratigraphy and the major peat-forming taxa. Time limitations precluded the detailed examination of peat samples for seeds and other remains in each core pollen-analysed. The emphasis throughout was on pollen analysis.

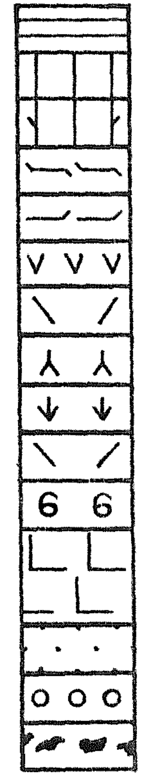
In both the laboratory and in the field, sediment composition was assessed according to a simplified version of the IGCP recommended modification (Berglund 1979) of the Troels-Smith (1955) system. Identifications were restricted to, in particular, the presence of the remains of the Gramineae, especially *Phragmites* and *Molinia*, the Ericaceae, *Myrica* and bryophytes, notably *Sphagnum*. As demonstrated by Rybníčková and Rybníček (1971) knowledge of the local presence of these taxa assist in the interpretation of pollen diagrams.

The method of sediment recording adopted for the field stratigraphic investigations differed marginally from that for the pollen-analysed cores. The purpose of the field studies was to discern the general nature and sequence of the deposits and the most suitable location for the pollen cores. This included the assessment of components, as well as *Substantia humosa* (Sh) as a part of the whole. In the laboratory each sample for pollen analysis was first assessed for Sh, and then the other components independently after the KOH and sieving stage: the residue left on the sieve, i.e. that larger than 180μ, was inspected under a low power zoom binocular microscope and the components expressed on the 0 to 4 scale (0 = absence, to 4 = maximum, or sole presence of). The inorganic residue passing through the sieve was also assessed independently. Consequently, for each pollen-analysed sample there is a component formula with, in brackets, Sh, clay or silt content expressed as a proportion of the original unsieved sample. This is followed by the components remaining after sieving expressed as a part of the total on the sieve and excluding that which had either passed through or had been broken down by KOH. In the site stratigraphic diagrams obtained by fieldwork only the one or two most prevalent components are illustrated with Sh. In the stratigraphic column in each pollen diagram, all components are shown with Sh omitted, as recommended by Berglund (1979). It is however included in the text tables (Chapter 4). This may hinder the direct comparison of the two sets of data, but it was decided that as the more refined information was available from the laboratory work, it should be portrayed.

Other components composing less than 25% of the total are shown in the text tables by a plus sign (+) and in order of abundance. In the diagrams the density of the symbols is proportional to their occurrence and *Limes*, or boundaries, are shown by a solid line if the boundary zone was less than 1cm, or simply by a change in symbol if greater than 1cm. Table 3.3. summarises the deposit components and symbols utilised in the study.

Table 3.3. Stratigraphic components. After Troels-Smith 1955, Berglund 1979

Term	Abbreviation	Description	Symbol
Substantia humosa	Sh	Completely disintegrated organic substances	
Turfa herbacea	Th	Remains of subsurface parts of plants	
Turfa herbacea (Phragmitis)	Th (Phrag)	Remains of subsurface parts of <u>Phragmites</u>	
Turfa bryophytica	Tb	Remains of mosses	
Turfa bryophytica (Sphagnii)	Tb (Sphag)	Remains of <u>Sphagnum</u>	
Detritus lignosa	Dl	Fragments of wood and bark, greater than 2mm	
Detritus herbosus	Dh	Fragments of herbaceous plants, greater than 2mm	
Detritus herbosus (Ericales)	Dh (Eric)	Fragments of Ericaceae, greater than 2mm	
Detritus herbosus (Molinae)	Dh (Moli)	Fragments of <u>Molinia</u>, greater than 2mm	
Detritus granosa	Dg	Fragments of ligneous and herbaceous plants, less than 2mm	
Testae molluscorum	Tm	Calcareous shells of Mollusca	
Argilla steatodes	As	Clay, less than 0.002mm	
Argilla granosa	Ag	Silt, 0.002 to 0.06mm	
Grana minora	Gmin	Sand, 0.06 to 2.0mm	
Grana majora	Gmaj	Gravel, 2.0 to 60 mm	
Charcoal	-	Charcoal	



Physical properties are shown only for the pollen-analysed cores, though they were noted in the field investigations. Humositas, the degree of humification is not shown in the diagrams because of the difficulty of varying symbol thickness; a figure on the 0 to 4 scale is however presented in the text tables based on the average humification of all components. Nigror, the degree of darkness, Stratificatio, the degree of stratification, Elasticitas, the degree of elasticity, and Siccitas, the degree of dryness, are likewise tabulated. Sediment colour was noted in the field for oxidation and hence darkening after exposure to air was usually a very rapid process.

As mentioned in section 3.2.6., charcoal was recorded on the five point scale during inspection of the sieve residue. It was also recorded in the field, but because of the methods employed, it would have been recorded only in horizons where it was especially prevalent.

3.4. ANALYSIS OF pH

The exceptional pollen preservation in the core from Winnall Moors (Winchester), prompted the investigation of pH to assess whether this had been a result of locally acid peat accumulation. A second Russian core was taken from a point 70cm to the west of the position of the pollen core, to avoid previously disturbed peat.

Coring was undertaken in the morning of 27 August 1981 and the analysis of pH completed that afternoon. The method described by Allen et al. (1976) was utilised. The core was cut into 10cm sections and each was thoroughly mixed with de-ionised water in the ratio of 2:1. Each sample was then allowed to settle for 20 minutes before the reading was taken with a Beckman Model 3500 digital pH meter.

3.5. RADIOCARBON DETERMINATIONS

Twelve radiocarbon determinations were made available by the Ancient Monuments Laboratory (Department of the Environment) and were undertaken at AERE Harwell.

Pollen samples were chiefly from Russian corer segments 50cm x 4cm in size (section 3.2.1.). These provided insufficient material for dating so subsequently additional cores were taken for this purpose. At Rimsmoor, the multiple shot technique was used: with this standard corer the equivalent of a 50cm core length was required to provide sufficient material for dating. To minimise error, 25cm was adopted as the sample thickness, necessitating the combining of only two core segments in most instances. In normal circumstances such a thickness would be unacceptable, but given the extreme depth of the deposit (1800cm), it was considered reasonable in view of the increased error likely from the bulking of further segments.

Material from the other four sites subjected to C-14 assay was collected with a larger Russian corer that became available after the Rimsmoor study was completed. This provided semi-circular cores 35cm x 9cm; a 10cm thickness of peat provided ample material for a reliable date. Multiple shots were thus unnecessary. Prior to dispatch to Harwell, all samples were precisely correlated by pollen analysis to the main core at each site.

The dates are expressed according to the 'Libby half-life' of 5568 years and includes the stable isotope correction: the deviation per mil of the ratio of the stable isotopes $^{13}C/^{12}C$ of the sample from that of an adopted standard (Otlet 1980). Throughout, the dates are expressed in uncalibrated years bc/ad (section 1.4.) (Table 3.4.). The error term of $\pm$ one standard deviation is shown in the text, whilst in the time: depth curves $\pm$ one and $\pm$ two standard deviations are illustrated (Smith 1975). This provides a more obvious visual indication of the likely date of the sample: there is a 95% probability that the true date is within $\pm$ two standard deviations.

3.6. DOCUMENTARY EVIDENCE

Both primary and secondary sources were examined. Primary, unpublished documents were consulted at the Dorset (DRO), Hampshire (HRO), Berkshire (BRO) and West Sussex Record Offices. These included maps, tithe awards and estate charters to investigate recent land use, dates of the planting of exotic tree species, and the incidence and location of peat cutting.

Table 3.4. Radiocarbon determinations from the selected sites

Site	Correlated depth, cm	Sample number	Laboratory number	Date bp	Date ad/bc	Tree-ring range(1)	Comments
Winchester	281-291	WT 1/1	HAR-4342	5630±90	3680bc	4600-4510BC	*Ulmus* decline
Snelsmore	206-216	SM 1/1	HAR-4241	2570±90	620bc	850-800 BC	Basal peat, core SM 1
	135-145	SM 1/2	HAR-4236	1290±80	660ad	640-680 AD	Basal level of clayey horizon
Amberley	95-105	AWB 1/1	HAR-4234	1360±80	590ad	600-640 AD	*Fagus* rise
(2)	250	-	Q-690	2620±110	670bc	870-830 BC	*Tilia* and *Pinus* decline/peat-clay interface
Rimsmoor	1125-1150	RM 1/1	HAR-3919	5150±70	3200bc	4020-3950BC	Pre-*Ulmus* decline
	1060-1085	RM 1/2	HAR-3920	4690±70	2740bc	3590-3400BC	Late-*Ulmus* decline clearance
	790-815	RM 1/3	HAR-3921	3820±80	1870bc	2390-2200BC	*Tilia* decline
	410-435	RM 1/4	HAR-3922	2350±70	400bc	490-450 BC	Pre-extensive clearance
	355-380	RM 1/5	HAR-3923	2080±80	130bc	220-130 BC	During extensive clearance
	150-175	RM 1/6	HAR-3924	610±60	1340ad	1310-1360AD	Cultivation maximum
Kingswood	175-185	KW 1/1	HAR-4239	4560±60	2610bc	3400-3280BC	Post-*Ulmus* decline
	95-104	KW 1/2B	HAR-4367	2380±80	430bc	550-470 BC	Clearance

(1) McKerrell (1975)

(2) Godwin and Willis (1964)

3.7. ARCHAEOLOGICAL DISTRIBUTION MAPS

The information portrayed in distribution maps of archaeological remains can be misleading. Inevitably, they can only record finds which may bear little relationship to original concentrations of human activity. For example, much of the chalk may have experienced minimal tillage since the end of the Roman period whilst surrounding areas could have been subjected to an extra 1500 years of disturbance. Thus preservation of earlier remains would tend to be greater in the former area, implying perhaps erroneously, that pre-Anglo-Saxon activity was centred on the chalk outcrop. In addition, detailed field work, for example, at Hambledon Hill (R. Mercer and R. Smith, pers.comm.) and in Sussex (Cunliffe 1973) and east Hampshire (Shennan 1981) has produced evidence for local concentrations of settlement that is probably a product of the absence of such work elsewhere. Even the significance of the finds are debatable: burial mounds often appear to have been constructed in abandoned or marginal zones (eg. Dimbleby and Evans 1974; Fleming 1971); polished stone axes may be located well away from main centres of Neolithic settlement (Bradley 1972); and the possibly ambiguous evidence of Mesolithic remains has recently been discussed in detail by Mellars and Reinhardt (1978) (Chapter 8).

Nevertheless, archaeological distribution maps are valuable for they do show where former communities were active. Therefore, a number are presented in this thesis, although as a result of the constraints mentioned above, they cannot show if colonisation of an area did not take place. For all periods, except the Mesolithic, only a selection of types of finds are shown, for the plotting of all known remains would be prohibitive at the adopted map scale. The maps were drawn following the advice of Grinsell (1972).

CHAPTER 4

SITES

4.1. WINCHESTER

Core location: WT 1 SU 48602991

Plates 1 and 2

The core was from Winnall Moors, an extensive area of rich calcareous fen to the north of the City of Winchester (Figs 4.1 and 4.2.). The surrounding area is chalk subjected to arable cultivation with some grassland on steeper slopes. Immediately to the west and south the suburban area of Winchester covers much of the valley floor and adjacent chalk.

4.1.1. STRATIGRAPHY AND PRESENT VEGETATION

Winnall Moors is situated at about 35m OD, extending from Winchester northwards for 2 to 3km. Peat is widespread although its precise distribution and depth over all this area could not be determined because of inaccessible private land and reclamation. North-east of the A33/A34 alluvial silts and clays are prevalent with a carr vegetation dominated by *Salix* with some *Alnus*. To the south peats are more numerous, but often interbedded with clays, silts and calcareous marls. *Phragmites* fen is common. Peat-bearing sediments extend beneath the old city of Winchester as shown by archaeological excavations (Murphy 1977), subsidence problems in the Cathedral and the borehole data briefly summarised by Aldsworth (1973).

The limited stratigraphic investigation possible suggested that peaty deposits also extend across the entire width of the flood plain north of Winchester. The east edge is now pasture while much of the western side has been reclaimed for use as a recreation ground. To the south of the A33 at SU493314 200cm of peat overlies white chalky clays and supports *Phragmites*. From here southwards to about SU490305 is private land, but from there to the city peat is continuous, though often with inorganic inwashes. At 490305 the peat depth is 260cm and 300m to the south-east, 290cm.

Peat attains its greatest depth in the rectangular area immediately to the north of Durngate, as defined by the main course of the Itchen to the east and the channel flowing into Swift's Lake. It was therefore examined in greater stratigraphic detail by a grid of eleven cores (Figs 4.3, 4.4). With one exception, these all displayed a similar sequence of peat types with inorganic inwashes occurring at varying depths and in varying thicknesses. Core 4, 5m from the present river, differed with a buff-coloured marly chalk deposit between 80 and 260cm, overlying gravel. This was presumably a result of major river activity; the variable nature of inwashes in the other cores similarly relates to periods of flooding and river migration.

The stratigraphy in the rectangular area and to the north, south of SU 490305, can be summarised as follows. From 0 to 15cm a wet rootlet peat overlies about 50cm of chalky clay with some roots, a result of the former use of the area as watermeadows (section 11.3.). Below is peat of low humification (humo 2) and mid-brown in colour, becoming darker with depth to attain a dark blackish brown (humo 3 to 4). Phragmites remains are common throughout with mosses especially frequent in the mid-brown material of the upper third of the peat. The bryophytes included a record of cf. Drepanocladus revolvens at 120cm. The total depth of the peat varies from 170 to 340cm with inorganic inwashes more common at deeper levels. White or light grey chalky clay or silt underlies the peat with a boundary zone of only 0 to 2cm. This is 20 to 40cm in depth and rests on gravel.

The rectangular area is characterised by a particularly rich calcareous fen vegetation. Winnall Moors is owned by Winchester City Council and is now under the management of the Hampshire and Isle of Wight Naturalists' Trust. Species recorded by the Trust include Equisetum palustre, Caltha palustris, Galium palustre, Vicia cracca, Rumex acetosa, R. hydrolapathum, Epilobium hirsutum, Lysimachia vulgaris, Filipendula ulmaria, Potentilla anserina, Plantago lanceolata, Mentha aquatica, Succisa pratensis, Angelica sylvestris, Cirsium palustre, Senecio aquaticus, Iris pseudacorus, Juncus effusus, Carex riparia, C. acutiformis, Glyceria maxima, Phalaris arundinacea, Phragmites australis, Salix spp., Alnus glutinosa, Populus spp., Viburnum opulus and Crataegus monogyna (R. Page, pers.comm.).

4.1.2. CORING AND ANALYSIS

The core for laboratory analysis was taken from a point 60m north-east of Swift's Lake (Fig 4.3) and 6m north-west of the fence demarcating the edge of a raised south-west to north-east trending strip of ground bearing vegetation of drier substrates, including Rubus, Trifolium and Plantago. It was located on the crest of a ridge of the former watermeadow system to avoid any disturbance that may characterise the furrows to either side. The organic deposits were 430cm in depth with minimal inorganic inwashes in the peat; it was expected that such horizons could represent truncation of the profile and so cause disturbance to the pollen spectra (this was shown to be the case for Alnus between 333 and 343cm). Cores to the south-west (1) and north-east (2) showed deeper sediments (450 and 510cm respectively) but were not selected because of the greater depth of inwashes. The stratigraphy of the pollen core is shown in Table 4.1. A sample of moss was analysed for the modern pollen rain.

As the pollen was known to be sparse in the deposit all samples were subjected to the rigorous preparation schedule as outlined in section 3.2.2. Samples were counted at 8cm intervals throughout the core; the low pollen content and considerable time required for counting precluded closer sampling except for one additional level at the elm decline (PD1). The deepest polliniferous sample was 429cm.

As analysis was undertaken late in the research period only one radiocarbon date was available: the low pollen content had discouraged earlier investigation. Material was taken from a point 30cm east of WT1 and correlated pollen-analytically to the level of the elm decline. This gave a date of 3680±90bc (HAR-4342) and is shown in the time:depth curve diagram (Fig 4.5).

Subsequently, an additional core was taken from a point 70cm west of WT1 for pH measurement. The basal peat/clay interface in this core was recorded at 445cm, 15cm deeper than in WT1. All other major stratigraphic features were proportionately lower. It seems probable that these differences are solely due to local variations in microtopography. The results of the pH analysis are shown on the pollen diagram but to make the cores more readily comparable, the pH core has been computationally shortened to align the major stratigraphic features of the two sequences.

The precise extent of the peat deposit is unknown but probably exceeds

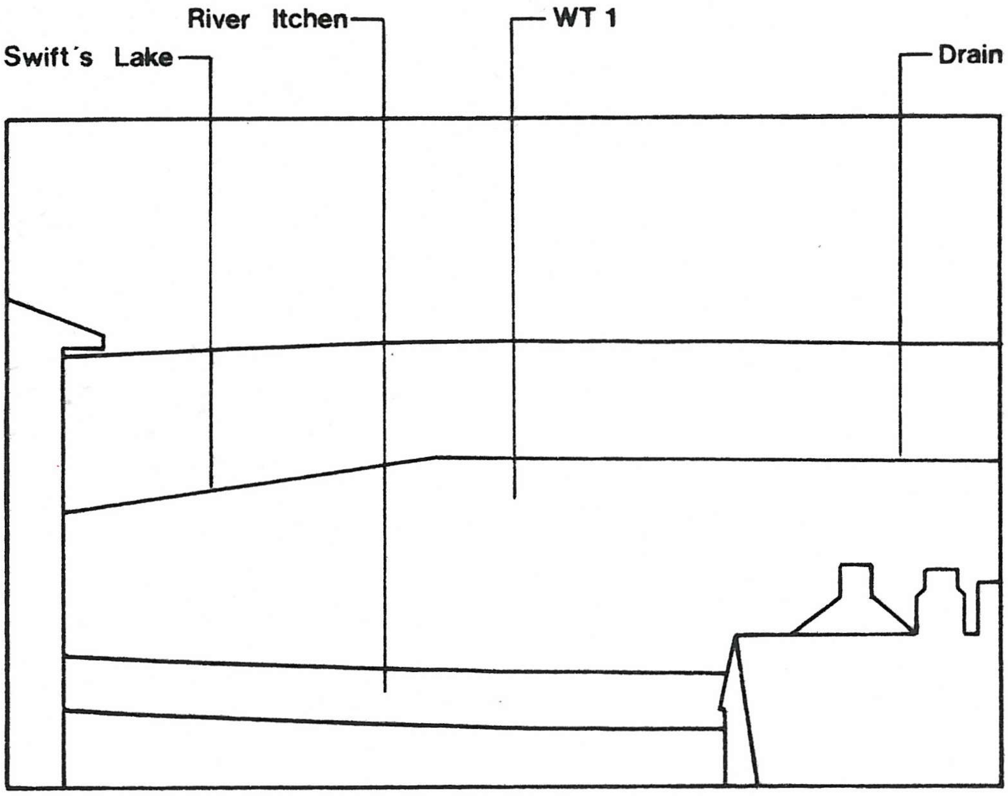


Plate 1. Winchester: the southern end of Winnall Moors

From SU 48802974 looking NW
10 February 1981

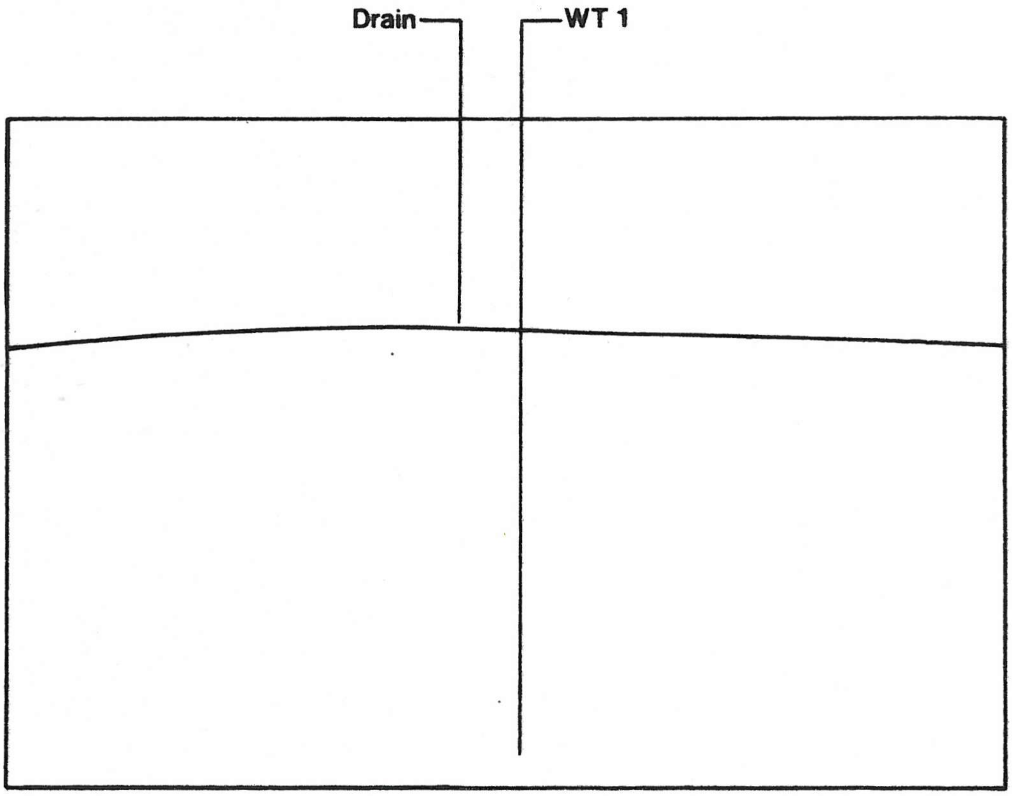


Plate 2. Winchester: fen vegetation at site of core WT 1

From SU 48602991 looking NW
27 August 1981

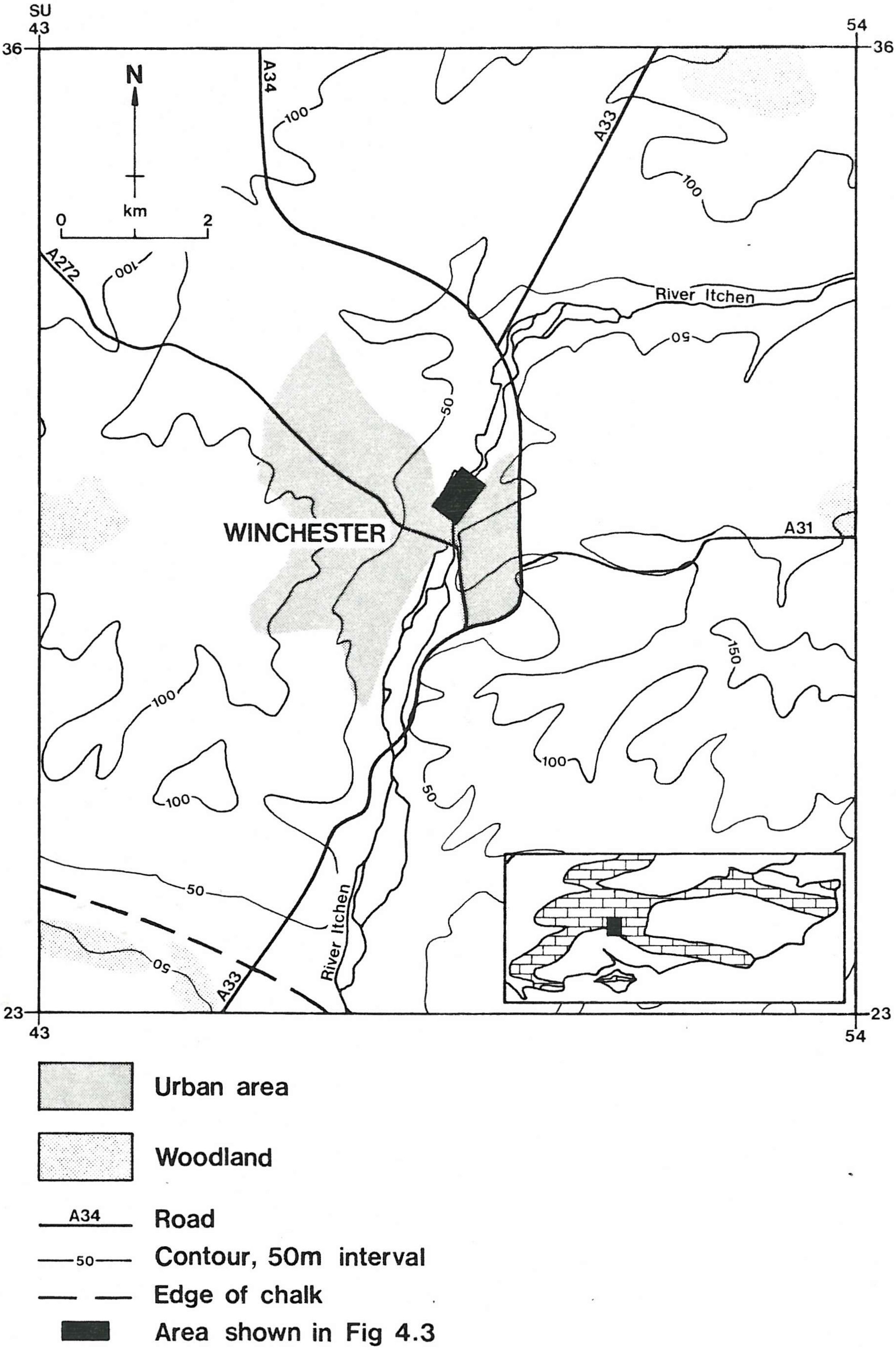


Figure 4.1. Winchester: general location map

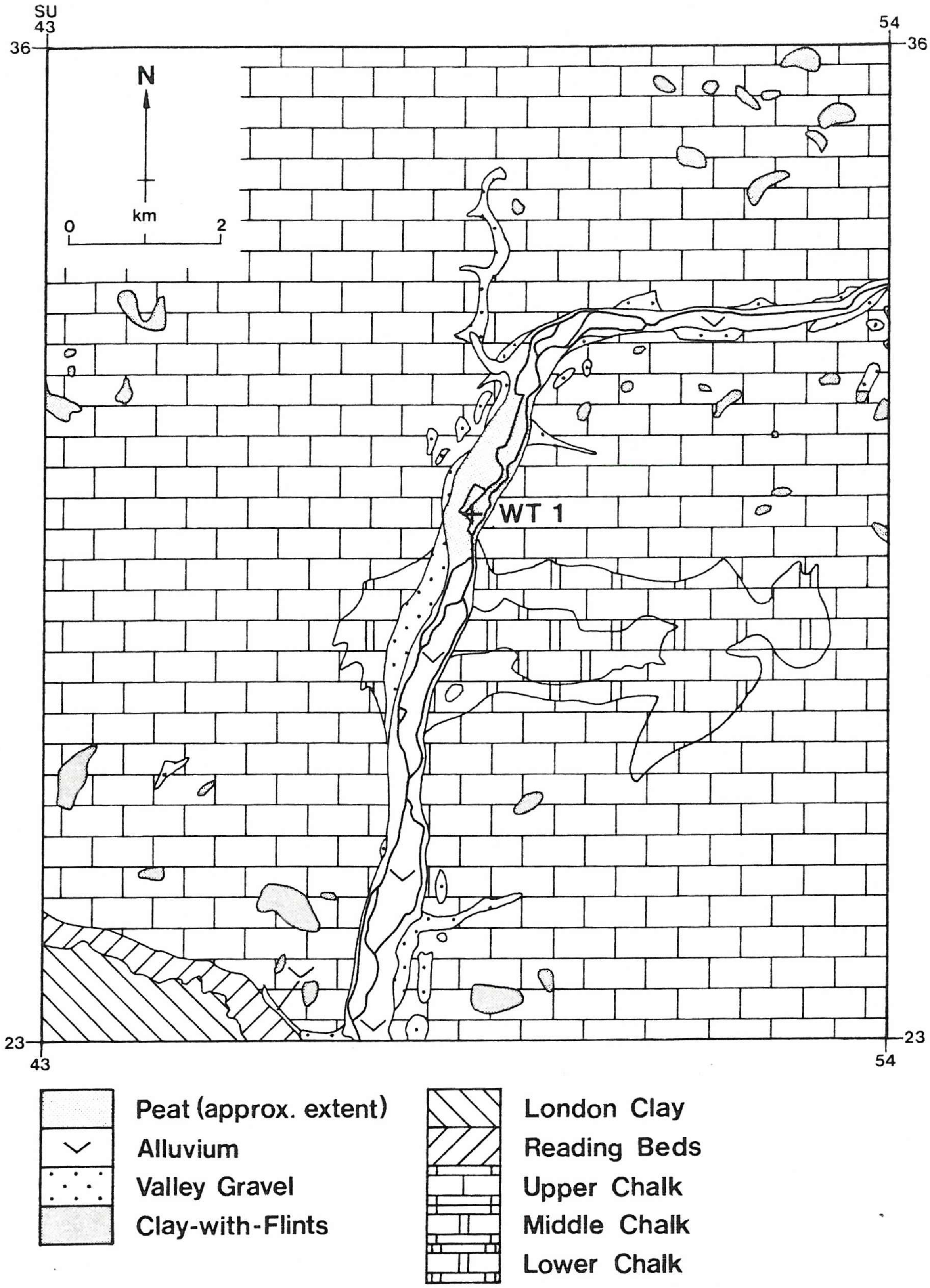
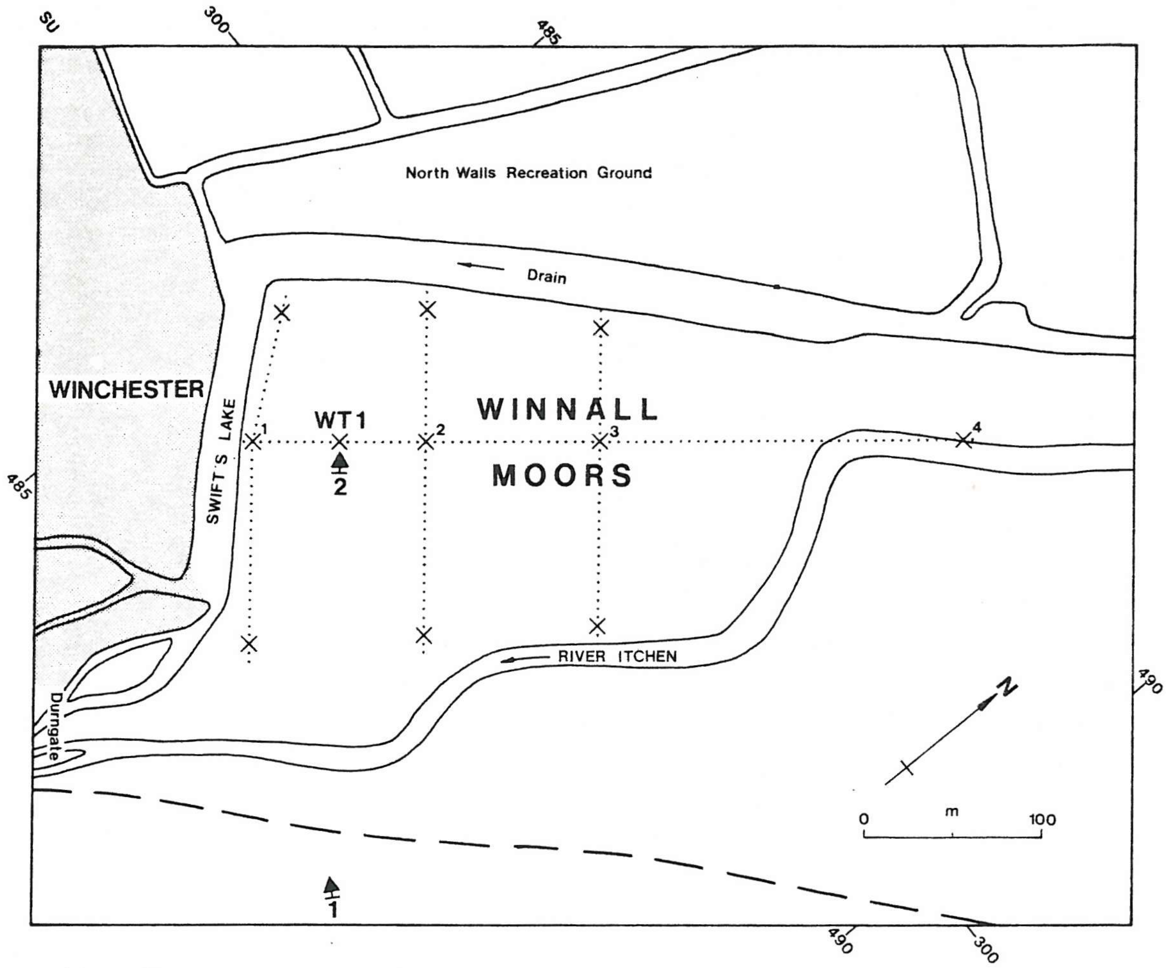


Figure 4.2. Winchester: geology



× Core
·········· Section line
— — Edge of floodplain
◄1 Location of Plate

Figure 4.3. Winchester: plan of site

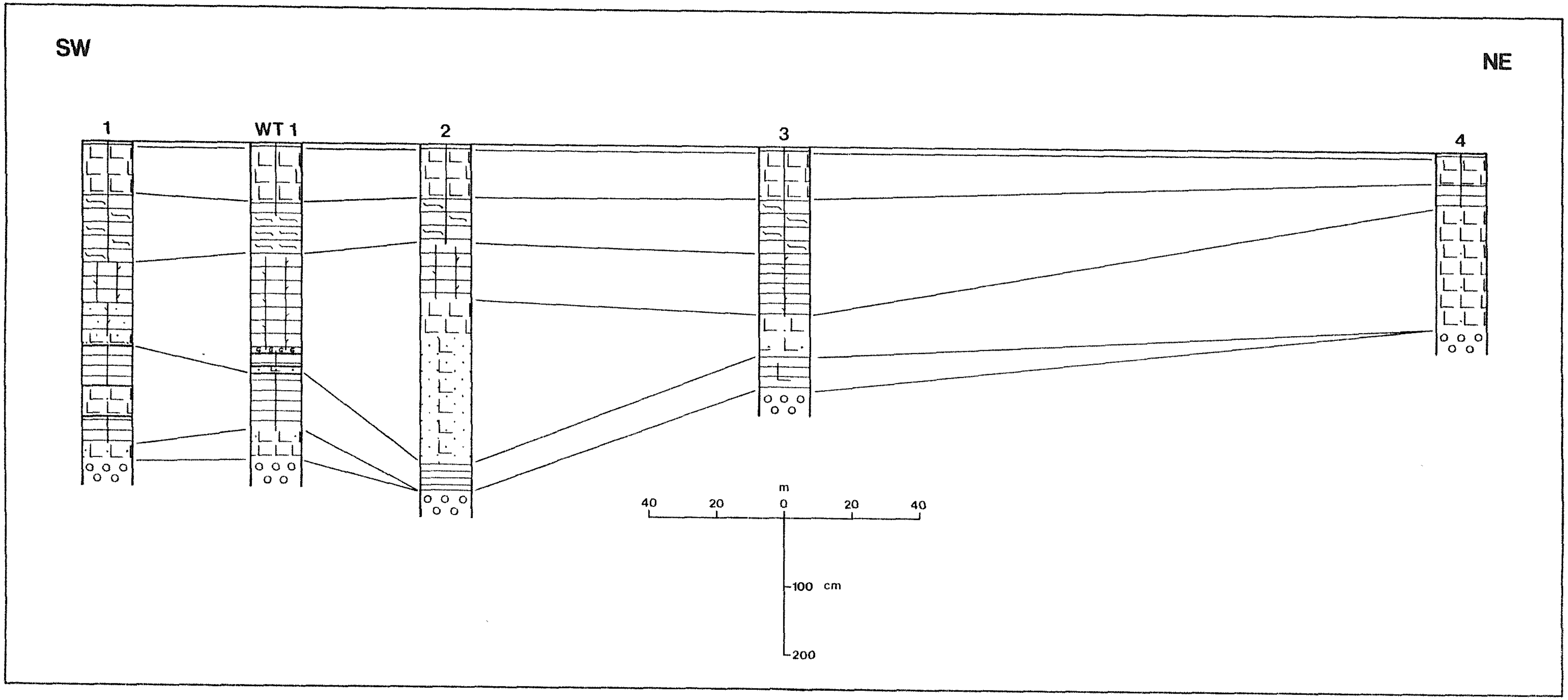


Figure 4.4a. Winchester: stratigraphy, long section
See Table 3.3. for symbols

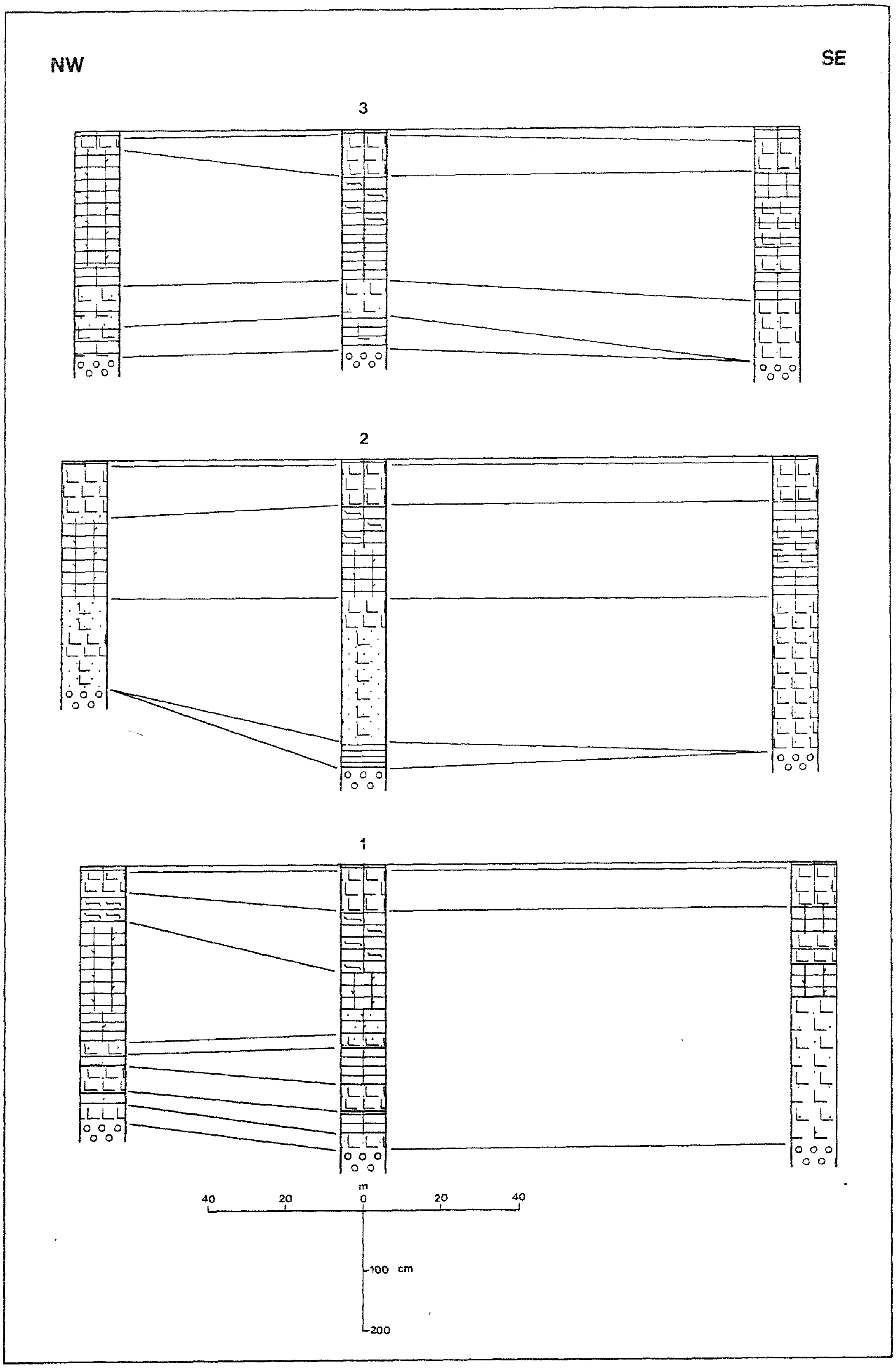


Figure 4.4b. Winchester: stratigraphy, cross sections
See Table 3.3. for symbols

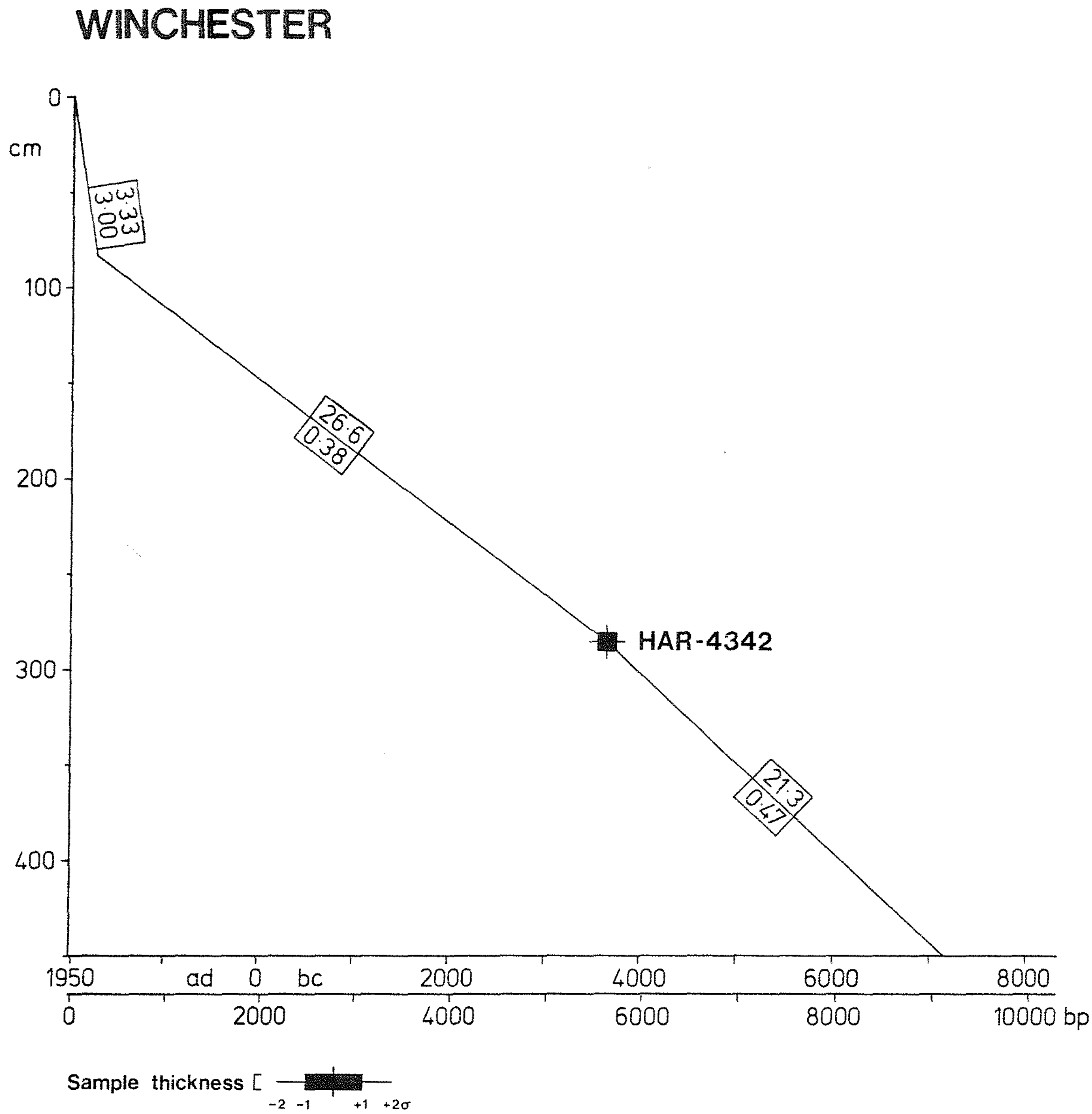


Figure 4.5. Winchester: time:depth curve. Accumulation rates shown in boxes; upper figures yrs cm^{-1}, lower figures mm yr^{-1}

Table 4.1. Stratigraphy of Winchester pollen core, WT 1

Depth(cm)	Nig	Strf	Elas	Sicc	Humo	Components	Description
0-10	3	0	2	1	2	(Sh3) Th 3, Dg 1	Dark brown wet rootlet peat
10-76	1	0	1	3	2	(Sh1, A3) Th 3, Gmin+	Light brown clay with roots
76-87	2	0	2	2	2	(Sh1, A1) Th 4	Dark brown clayey peat
87-88	0	0	0	2	2	(Sh1) Gmin 3, Gmaj 1	Chalk band
88-112	2	0	2	2	2	(Sh1, A1) Th 3, Dg 1	Mid brown clayey peat
112-118	2	0	3	2	2	(Sh1) Th 2, Dg 2, Tb+	Mid brown rootlet peat
118-122	2	0	3	2	2	(Sh2) Th 2, Tb2	Mid brown rootlet and moss peat
122-152	2	0	3	2	2	(Sh2) Th 2, Tb 1, Dh 1, Dg+	Mid brown rootlet and moss peat
152-170	3	0	2	2	2	(Sh2) Th(Phrag) 2, Dg 2, Dh+, Tb+	Dark brown <u>Phragmites</u> peat
170-294	3	0	2	2	2	(Sh2) Th(Phrag) 3, Dg 1, Dh+, Tb+	Dark brown <u>Phragmites</u> peat
294-312	2	0	2	2	3	(Sh2) Th 3, Gmin/Tm 1, Dg+, lim inf1	Dark brown peat with sand and snail shells
312-333	3	0	1	2	3	(Sh3) Th 3, Dg 1, Dh+ lim inf 2	Very dark brown rootlet peat
333-343	1	0	1	2	3	(Sh 1, As+, Ag+) Gmin 3, Th 1, Dg+	Chalk sand
343-410	4	0	1	1	3	(Sh3) Th 2, Dg 2, Dh+	Black peat
410-430	3	0	1	1	3	(Sh3) Th 2, Dg 2, Dh+, lim inf 2	Dark grey peat
430-440	1	1	0	1	-	(As 2, Ag 1) Gmin 4	Grey-white sandy clay
440-445	1	1	0	1	-	(As+, Ag+) G min 4	Grey-white clayey sand
445-464	1	1	0	1	-	(As 3, Ag 1)	Grey-white clay
464+	1	1	0	1	-	Gmaj 4	Gravel

700m south-west to north-east and 200m south-east to north-west. Applying the minimum value to the Jacobson and Bradshaw (1981; section 2.4.3.) model indicates that about 18% of the pollen recorded will have been from within 20m of the edge of the deposit, 57% from 20m to several hundred metres and 25% from in excess of several hundred metres. If an approximate mean value of 500m is adopted, then the figures change to 10%, 10% and 80% respectively. This suggests that perhaps 80 to 90% of the recorded dry land pollen may have been derived from vegetation on the surrounding downlands. Consequently the pollen spectra may provide a fair representation of the vegetational history of the chalklands of this area of central Hampshire.

4.2. SNELSMORE

Core locations: SM 1 SU 46317045
SM 2 SU 46297047

Plates 3 and 4

Snelsmore Common is situated north of Newbury and is an area of heathland developed on deposits overlying the chalk (Figs 4.6 and 4.7.). Cores were analysed from the main valley mire and associated terrace bog. Surrounding the Common, arable is prevalent on the downs with pasture in the river valleys. Woodland is most widespread on the Eocene clays and on some of the Clay-with-flints.

4.2.1. GEOMORPHOLOGY, STRATIGRAPHY AND PRESENT VEGETATION

Snelsmore Common is a fairly level plateau at about 135m OD and is managed as a country park by Newbury District Council. The Upper Chalk is overlain successively by Reading Beds, London Clay and Plateau Gravels with some Bagshot sands to the north. The central area is confined chiefly to the Gravel deposit, much of which is characterised by birch scrub and open areas of *Calluna* heath. Around its periphery where clays and sands exert a stronger influence on soil type, mixed oakwood is dominant.

Two valleys draining southwards from the southern margin of the heath contain valley bogs developed in London Clay below the junction with Plateau Gravels (Fig 4.8.). The west bog is limited in extent, largely inaccessible because of dense birch growth and with very wet unconsolidated peat. In contrast, the east bog is in a large open valley with deep cohesive peat in a clearly defined area. Consequently, only material from the latter was analysed.

The valley is about 500m in length above its confluence with a minor right bank tributary and about 200m in width at its widest point. Terraces are developed in the lower reaches with peat present on the western side. The lower 150m of the valley was surveyed with one long section and seven cross sections (Fig 4.9. and 4.10.). The main bog is developed in this area and has a maximum width of 13m and length of 55m with a stream outflow located at 120m OD and 100m north of the confluence. Up-valley from the main bog the ground remains peaty; a secondary basin 20m north contains peat of a shallower depth which declines to a thin (30cm) peaty soil for most of the upper reaches. The east valley side is dry with a minor terrace about 150cm above the level of the centre of the bog. Conversely, the west valley side is wetter with a patchy peat deposit at about 250cm above the level of the bog. The difference in level between the two terraces is probably caused by interbedded peats, clays and sands on the west side overlying gravel, a surface exposure on the east side. A stream channel is developed from about 20m north of the outlet of the bog and from this point the bog surface slopes at 5^{o} into the incised gorge that characterises the valley below the bog.

Systematic coring of the peat on the west terrace was hindered by its extremely uneven distribution and locally dense scrub vegetation. Nevertheless, where the depth was greater than 50cm, the upper half was mid- to dark brown rootlet peat overlying dark brown-black (humo 3, Sh 3) sloppy rootlet peat. This graded into blue clay with an abrupt transition to hard sand.

The stratigraphy of the valley floor bogs differed (Fig 4.11.): the upper part of the secondary bog was a fairly homogenous mid-brown rootlet peat with some Sphagnum (humo 2, Sh 2), grading into clay overlying gravel. Peat attained a maximum depth of about 130cm, with clay or clayey peat up to about 30cm. The lower part of the secondary bog and the main bog were similar with mid-brown root and Sphagnum peat (maximum depth 90cm) overlying peaty clay (about 50cm). This was separated by a sharp junction from mid brown peat (65cm) above clay or gravel. Within the lower peat unit a bed of gravelly peat 2cm thick was recorded in some cores.

The vegetation of the valley was diverse when recorded on 20 August 1981. The upper reaches and upper valley sides were mainly Betula pendula with some Fraxinus excelsior, Quercus spp, Pinus spp, Rubus spp and Ulex europaeus. Calluna vulgaris heath is present on the plateau to the west and woodland of Quercus spp and Fagus sylvatica in and below the gorge. The immediate environs of the bog are open with the dry east side mainly Pteridium aquilinum and grasses with occasional Erica cinerea, Betula spp and Calluna. The wet west side differed considerably with Sphagnum spp, Molinia caerulea, Narthecium ossifragum, Dactylorhiza maculata subsp. ericetorum, Drosera rotundifolia, Calluna, Erica tetralix, Polytrichum commune, Juncus acutifolius, Pteridium, Ulex europaeus, U. minor and saplings of Salix, Betula, Pinus and Quercus. The main bog included Molinia, Eriophorum angustifolium, Narthecium, Sphagnum, Polytrichum, Drosera rotundifolia, Cirsium dissectum, Calluna, Erica tetralix with Potamogeton spp. in a wet inflow from the west terrace and Lonicera periclymenum and Potentilla erecta at the edges. The secondary bog in the basin up valley was similar floristically but with more Cyperaceae, Juncus acutifolius and J. subutiflorus and some Menyanthes trifoliata. Species of Sphagnum recorded included S. capillifolium and S. magellanicum.

4.2.2. CORING AND ANALYSIS

Two cores were taken for pollen analysis, one from the main bog (SM 1) and one from the west terrace (SM 2) (Fig 4.9). In the main bog the deepest deposit was 3.3m north of point 2, or 28.3m from the bog outlet. A moss polster of Sphagnum was sampled separately from the same location for the assessment of modern pollen rain. On the terrace the deepest peat was 31m NW of SM 1. The stratigraphies of the two cores are shown in Tables 4.2. and 4.3.

Pollen was abundant in the deposit and all samples were subjected to the standard preparation schedule. The deepest polliniferous levels were 220cm in SM 1 and 103cm in SM 2. Sampling was at 4cm intervals with certain critical levels at 2cm intervals (PD 2).

In the core SM 1 two levels were selected for C-14 assay, the base

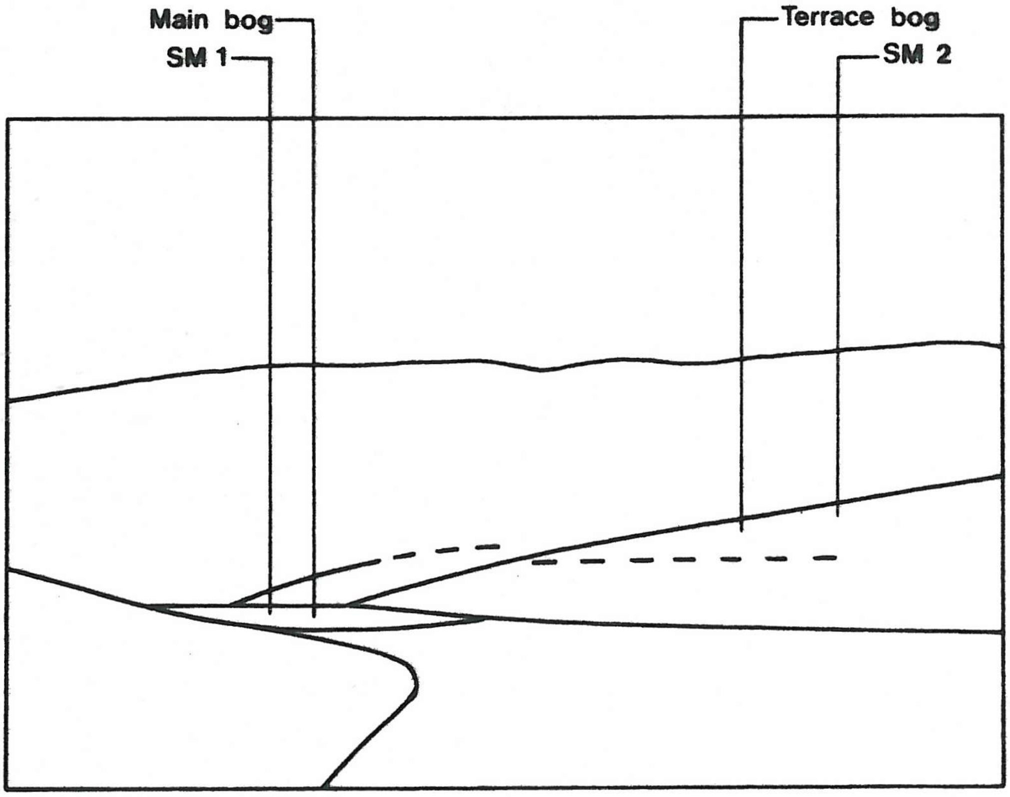


Plate 3. Snelsmore: general view of site

From SU 46337053 looking S
22 May 1980

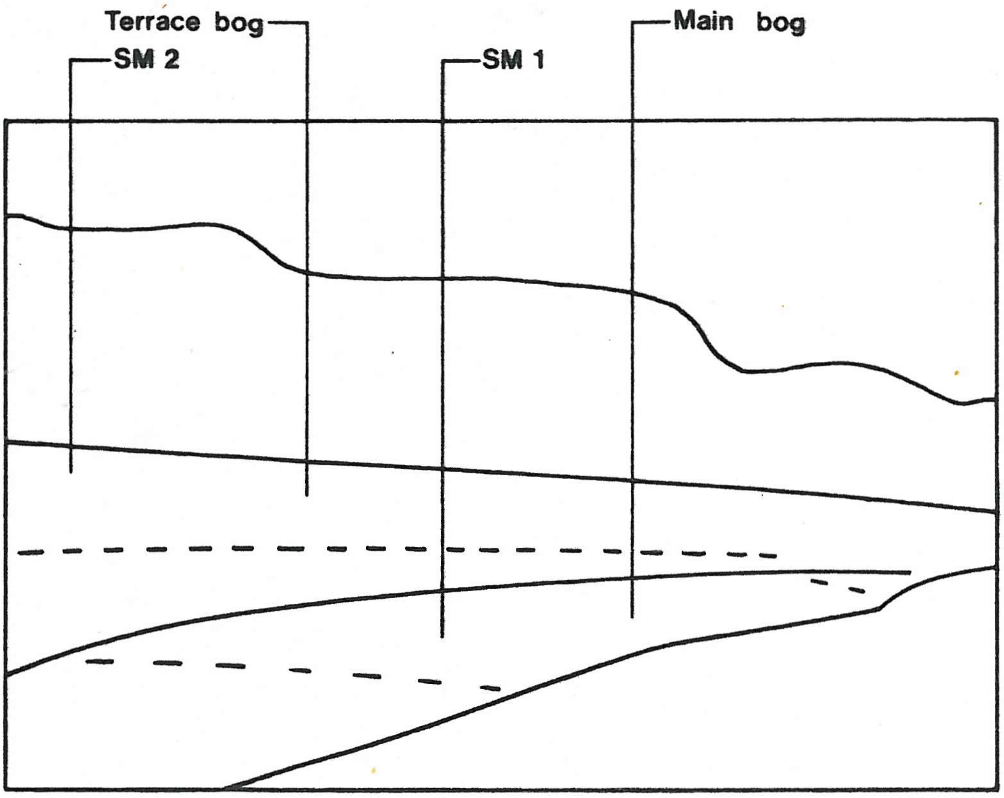


Plate 4. Snelsmore: main and terrace bogs

From SU 46327044 looking NW
22 May 1980

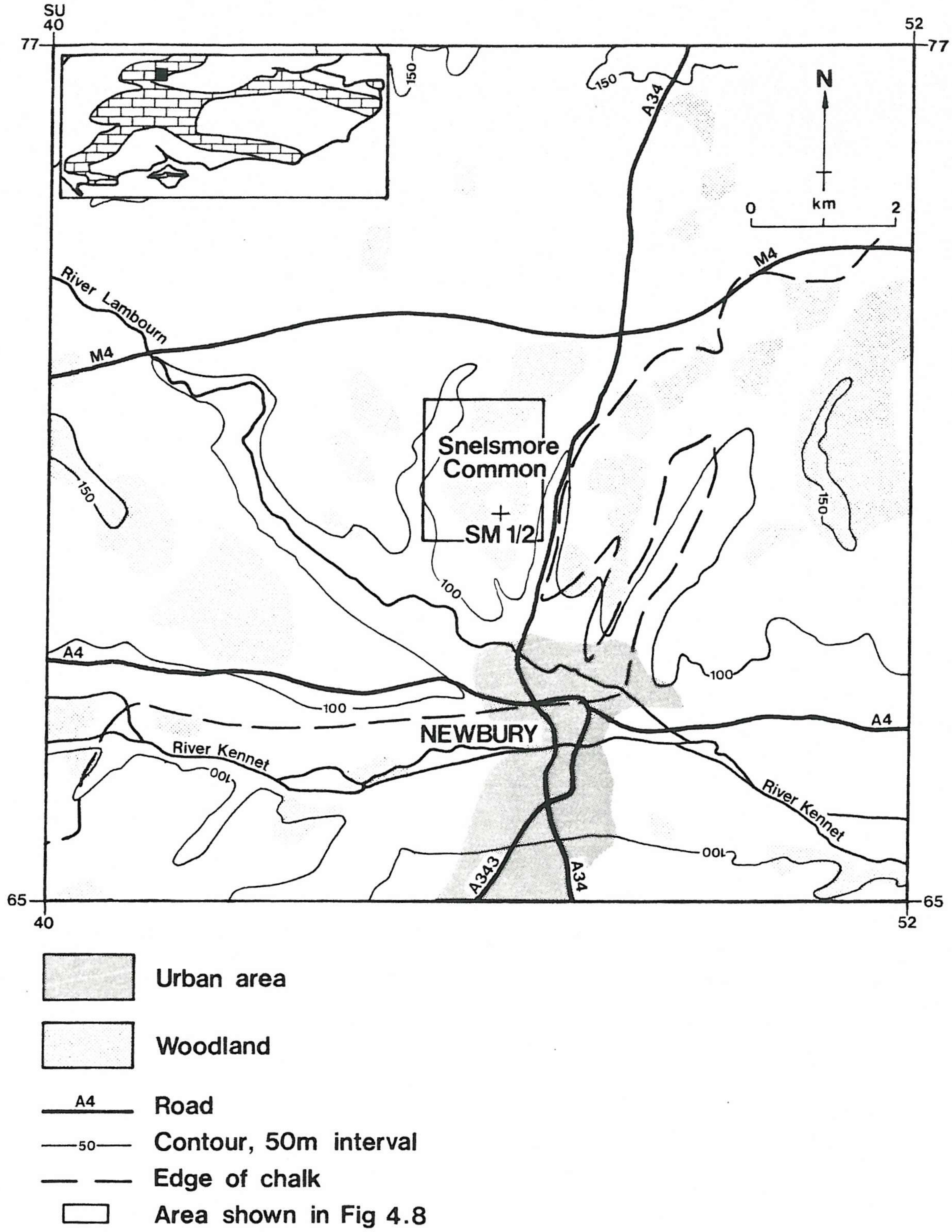


Figure 4.6. Snelsmore: general location map

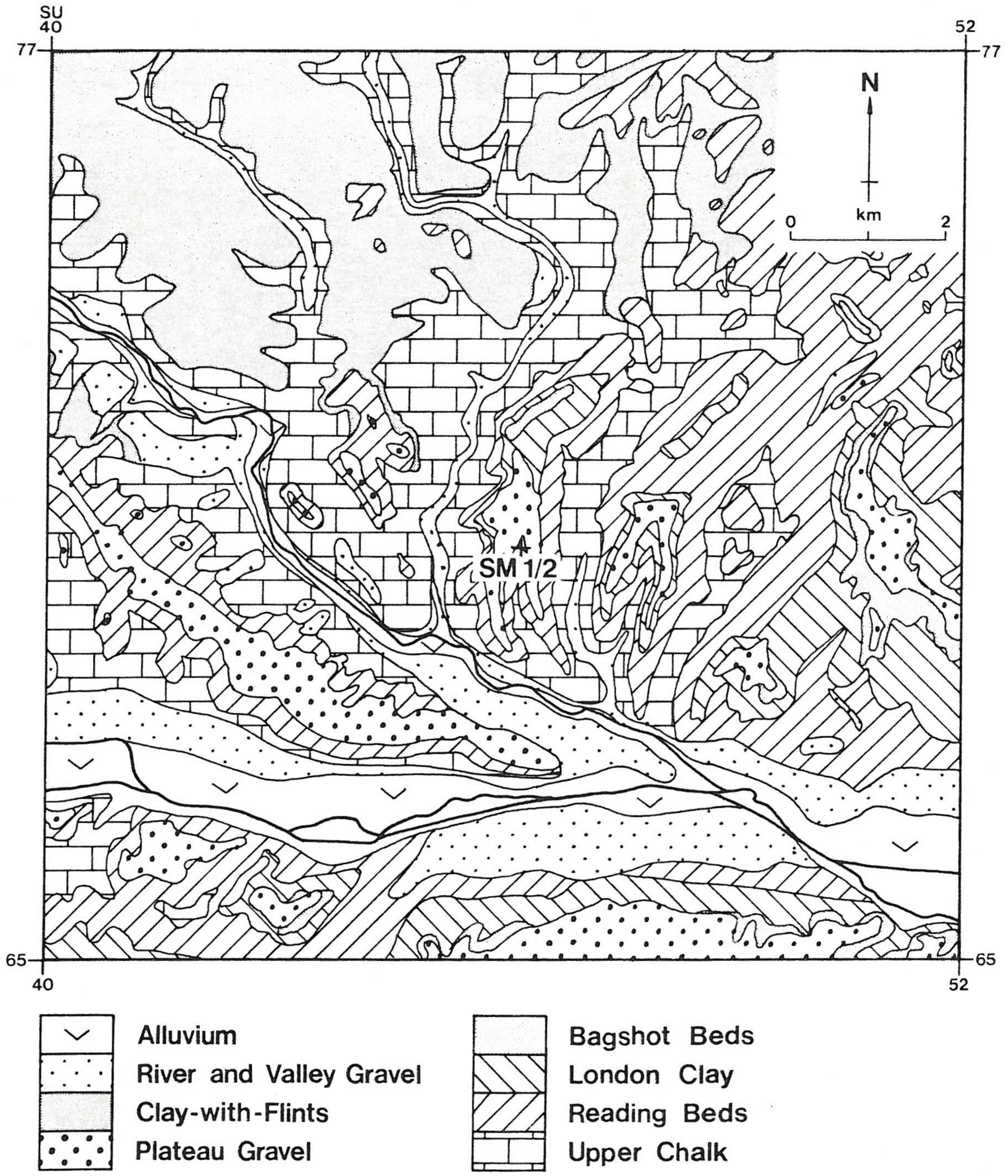


Figure 4.7. Snelsmore: geology

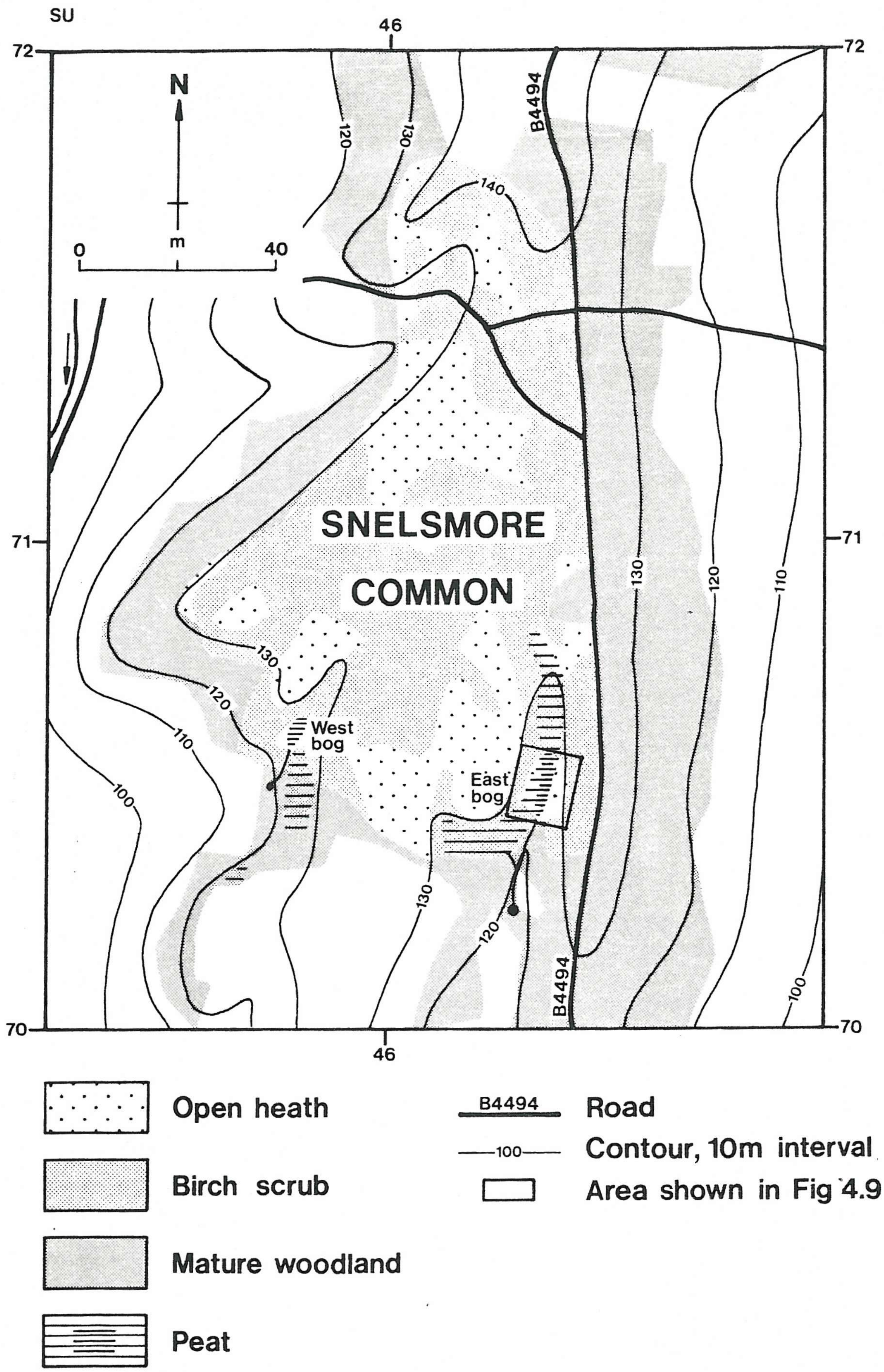
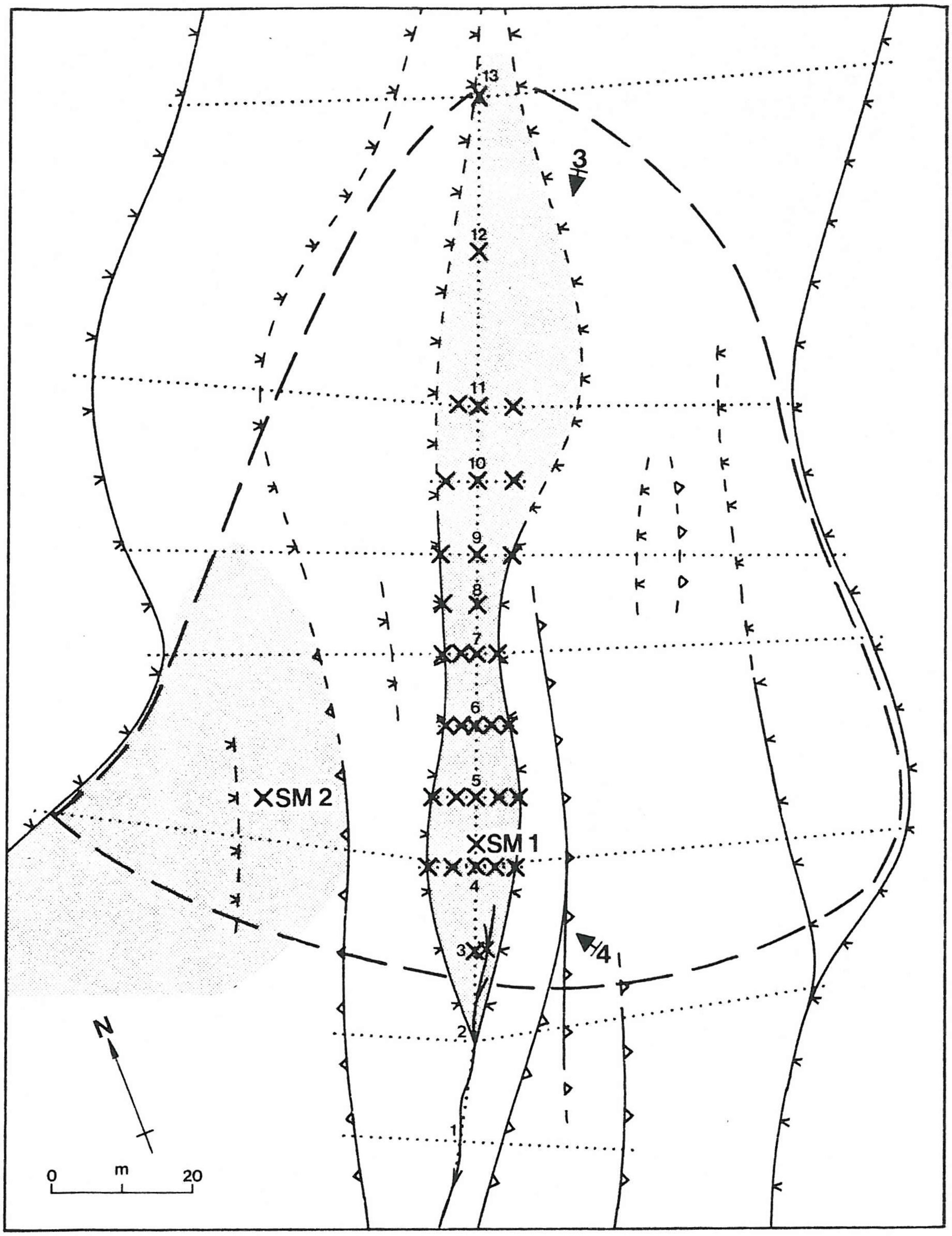


Figure 4.8. Snelsmore: The Common
Source: Newbury District Council



Main area of peat
X Core
.... Survey line
— — Limit of open area
◄3 Location of Plate

Concave break of slope
Concave change of slope
Convex break of slope
Convex change of slope

Figure 4.9. Snelsmore: plan of site

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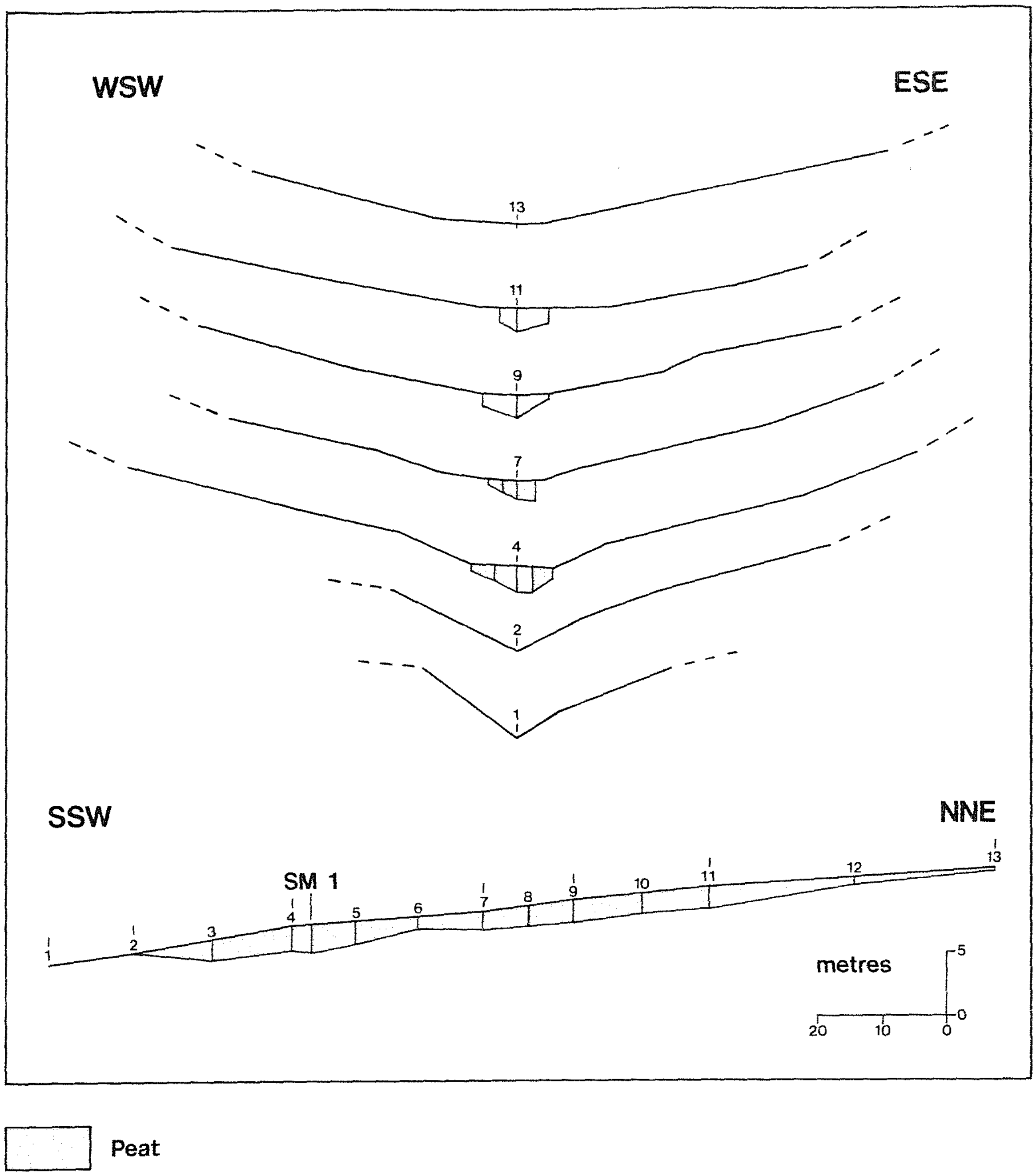


Figure 4.10. Snelsmore: long and cross sections

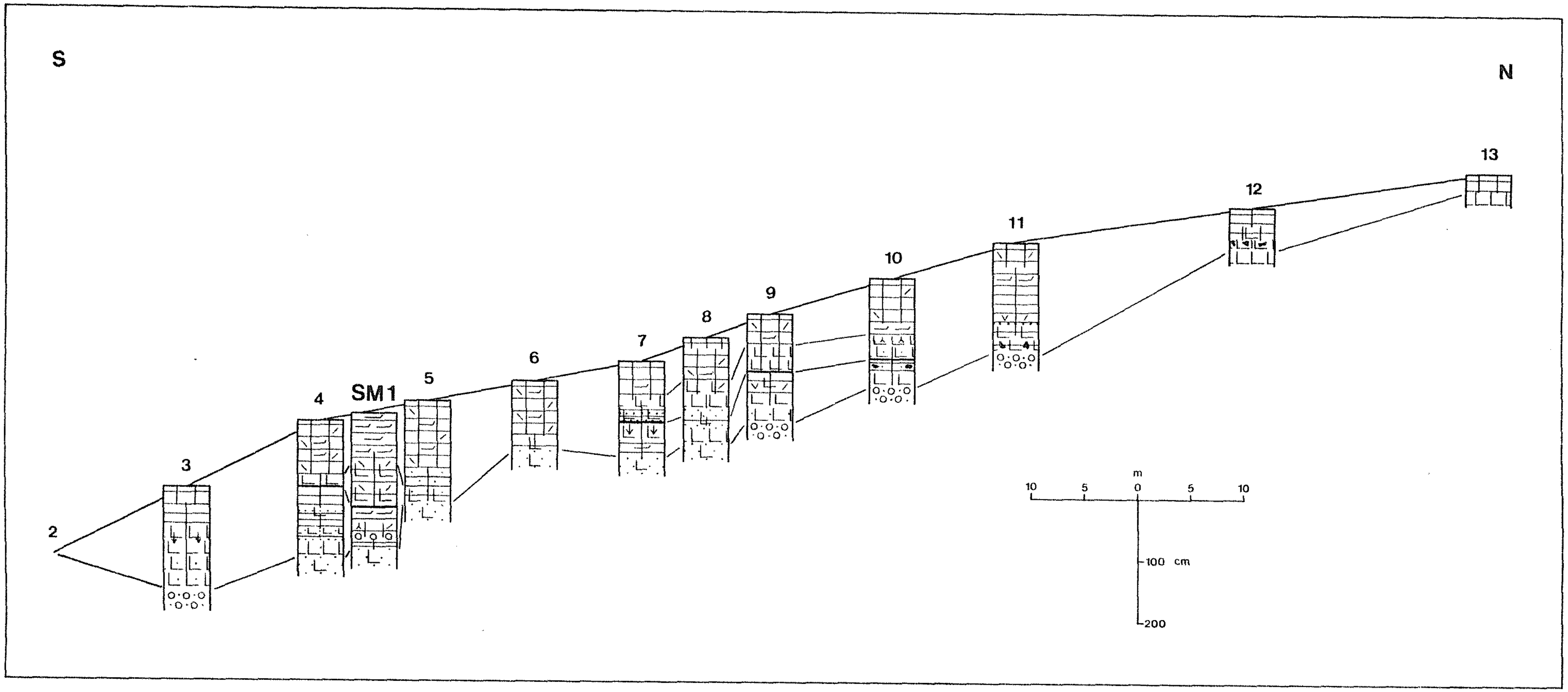


Figure 4.11a. Snelsmore: stratigraphy, long section
See Table 3.3. for symbols

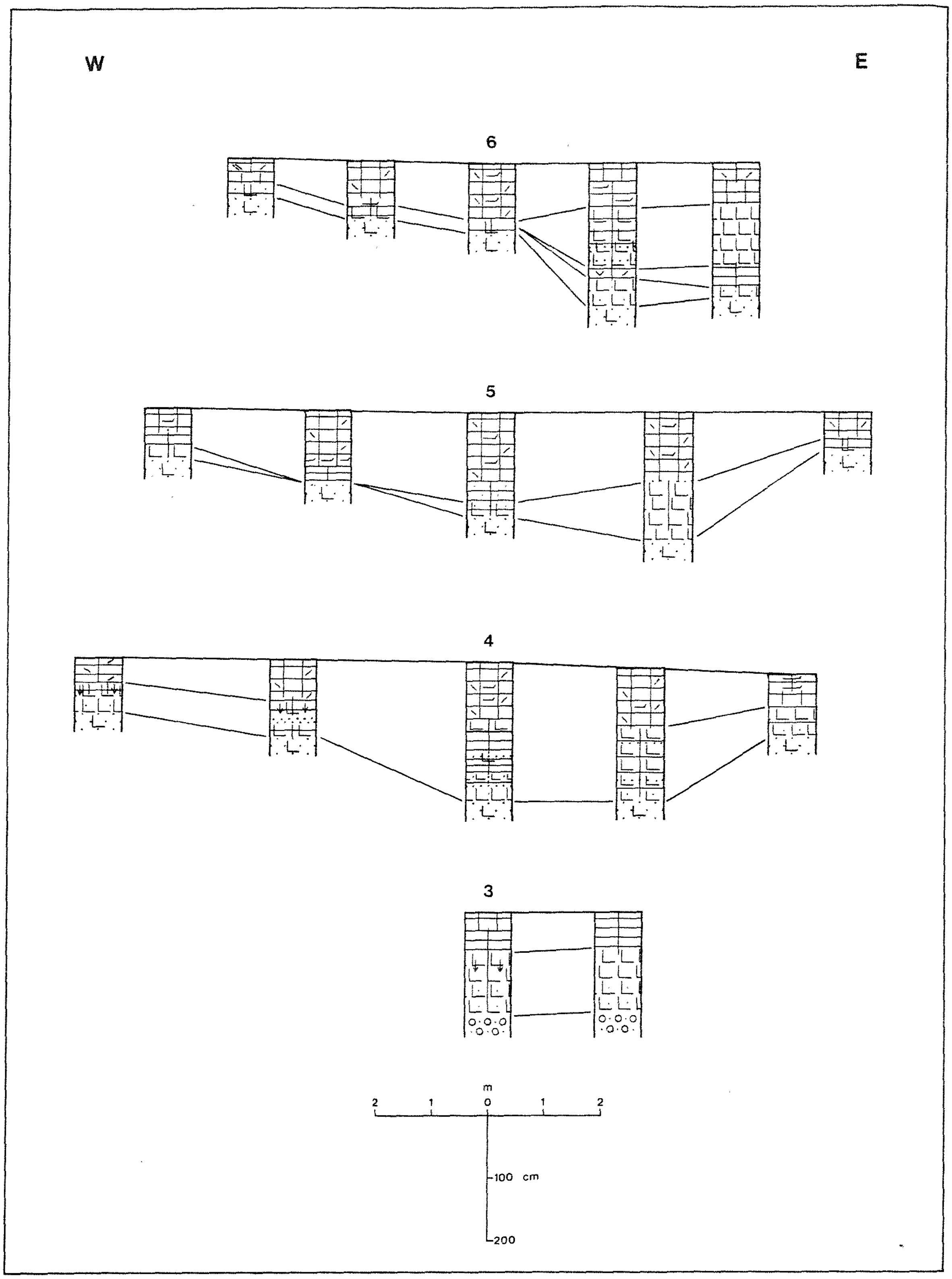


Figure 4.11b. Snelsmore: stratigraphy, cross sections 3, 4, 5 and 6. See Table 3.3. for symbols

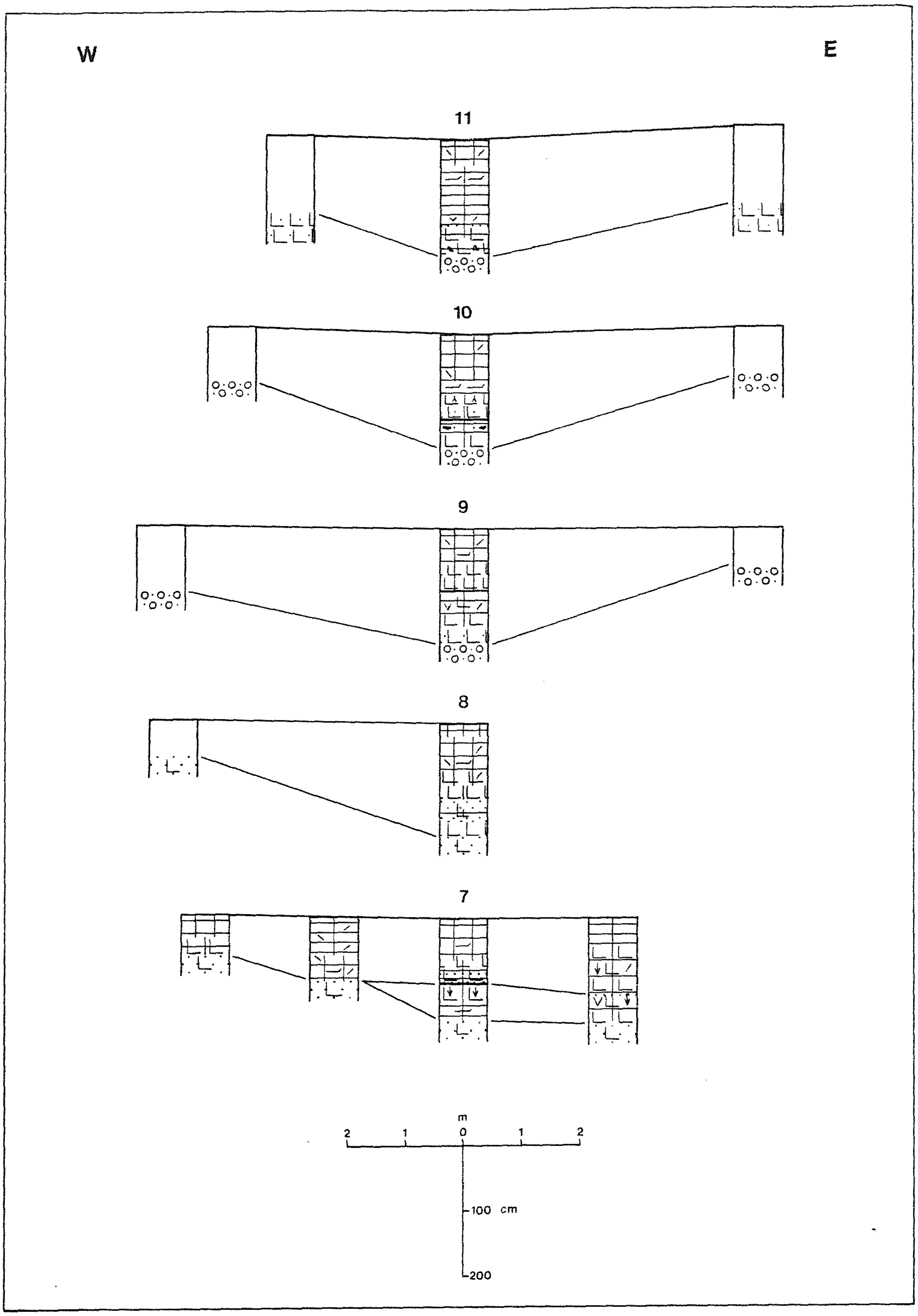


Figure 4.11c. Snelsmore: stratigraphy, cross sections 7, 8, 9, 10 and 11. Open cores were only assessed for depth of basal inorganic horizon.
See Table 3.3. for symbols

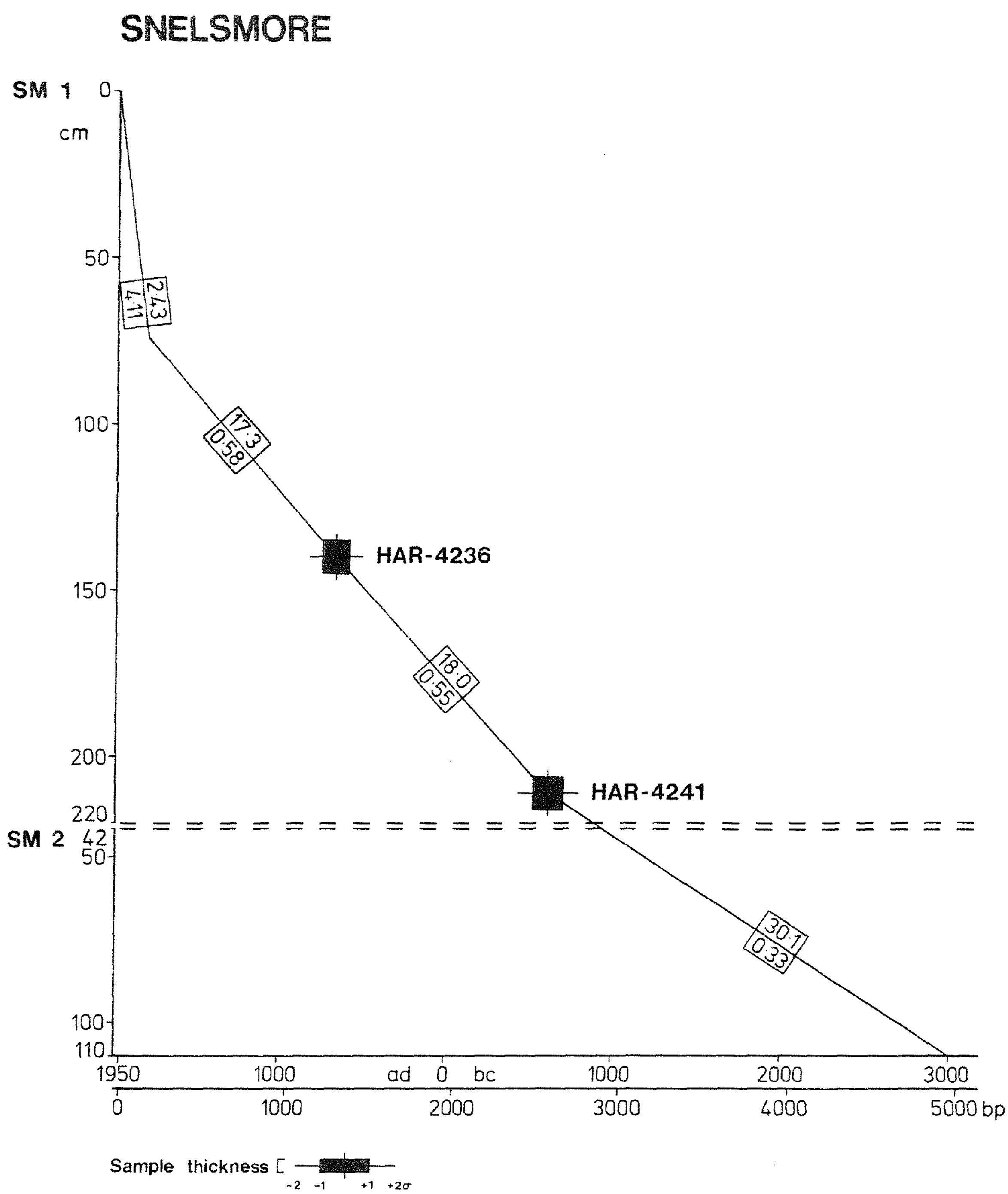


Figure 4.12. Snelsmore: time:depth curve. Accumulation rates shown in boxes: upper figures yrs cm^{-1}, lower figures mm yr^{-1}

Table 4.2. Stratigraphy of Snelsmore pollen core, SM 1

Depth(cm)	Nig	Strf	Elas	Sicc	Humo	Components	Description
0-28	2	0	2	1	2	(Sh1) Tb(Sphag) 4, Dg+, Gmin+, Dh(Eric)+	Fresh *Sphagnum* peat with Ericaceae
28-34	2	0	2	1	2	(Sh2) Tb(Shag)3, Th 1, Dg+, Dh+, Gmin+	Mid-brown *Sphagnum* peat with roots
34-50	2	0	2	1	2	(Sh3) Th 3, Tb(Shag)/Dg 1, Dh+, Gmin+	Mid-brown rootlet peat
50-64	2	0	2	2	2	(Sh2) Tb(Sphag)3, Th 1, Dg+, Dh+, Gmin+	Grey brown *Sphagnum* peat
64-80	2	0	2	2	2	(Sh2) Th2, Tb(Sphag)1, Dg 1, Gmin+	Grey brown rootlet peat with *Sphagnum*
80-88	2	0	2	2	2	(Sh2) Tb(Sphag)3, Th 1, Dg+, Gmin+	Grey brown *Sphagnum* peat
88-96	2	0	2	2	2	(Sh2, As 1) Th 2, Tb(Sphag)2, Dg+, Gmin+	Grey brown clayey peat
96-154	2	0	1	2	2	(As 2, Sh1) Th 3, Dg 1, Gmin+, lim inf 1	Grey brown peaty clay
154-176	2	0	2	2	2	(Sh2) Tb(Sphag)3, Th 1, Dg+, Dh(Eric)+, Gmin+	Mid-brown *Sphagnum* peat
176-188	2	0	2	2	2	(Sh2, As+) Th 3, Dg 1, Dh(Eric)+	Mid-brown rootlet peat
188-200	2	0	2	2	2	(Sh2, As+) Th 2, Dg 1, Gmin1	Sandy mid-brown rootlet peat
200-201	2	0	2	2	2	(Sh1) Gmaj3, Th 1	Gravel bed
201-212	2	0	2	2	2	(Sh2, As+) Dg 2, Th 1, Gmin 1, Dh(Eric)+	Sandy mid-brown peat
212-216	2	0	2	2	2	(Sh2, As+) Gmin3, Th 1, Dh+, Dg+	Sandy peat
216+	2	0	0	2	2	(Sh+ As+) Gmin4, Th+, Dg+	Sand

Table 4.3. Stratigraphy of Snelsmore pollen core, SM 2

Depth(cm)	Nig	Strf	Elas	Sicc	Humo	Components	Description
0-50	2	0	1	1	2	(Sh3, As+) Th 3, Dg 1	Mid brown rootlet peat
50-64	3	0	0	1	3	(Sh2, As 1) Th 3, Dg 1, Dh+	Dark brown clayey rootlet peat
64-100	3	0	0	0	3	(Sh2, As 2) Th 2, Dg 2, Dh+	Dark brown clayey peat
100-104	1	0	0	2	3	(As 3, Sh1) Th 3, Dg 1	Grey peaty clay
104+	0	0	0	2	-	(As 4)	Light blue clay

of the sequence and the lower part of the clay horizon. The latter was to show whether the sharp junction at 154cm was a result of peat cutting and was located between 135 and 145cm to avoid possible contamination from below. The samples were from a point 30cm from the location of SM 1 and gave dates respectively of 620±90bc (HAR-4241) and 660±80ad (HAR-4236) (Table 3.4.; Fig 4.12.). A third sample from the base of SM 2 was abandoned after consultation with Harwell because of rootlet contamination.

The small size of the main bog means that the majority of the pollen will have been of very local origin. Applying a minimum basin size of 10m diameter to the Jacobson and Bradshaw (1981) model (section 2.4.3.) suggests that 77% of the pollen will have come from within 20m of the edge of the deposit, 13% from 20m to several hundred metres and 10% from in excess of that distance. The elongated nature of the deposit is unlikely to have greatly increased these figures; for a circular basin 40m in diameter, the respective proportions are 70%, 20% and 10%. The extent of the original deposit from which core SM 2 was derived is unknown. However, it is probable that approximately the same proportions apply; thus the preserved pollen in both cores was chiefly from vegetation on the non-calcareous strata of the Common, with perhaps less than 10% from the surrounding chalk.

4.3. AMBERLEY

Core location: AWB 1 TQ 03711449

Plates 5 and 6

The site is the derelict raised bog discovered by Godwin and Clapham (Godwin 1943). It is located in Amberley Wild Brooks, an extensive basin of riverine and estuarine alluvium at about 2m OD (Figs 4.13 and 4.14). The core was from the south-east part of the deposit, about 1500m north of the South Downs scarp. Permanent pasture is widespread in the Brooks whilst arable cultivation is prevalent at the scarp foot and on the downs east of the Arun Gap. Wood and grassland are more common to the west of the Gap and on the strata surrounding the basin.

4.3.1. STRATIGRAPHY AND PRESENT VEGETATION

The peat deposit is shown on the Geological Survey map (One Inch Sheet 317) to be elongated east to west and covering an area of about $1km^2$ in the northern part of the basin. Field survey however showed that the west end extended about 250m further than marked (Fig 4.15).

The deposit surface varied only very slightly in level (in the order of 1 to 2m) and consequently detailed surveying was considered unnecessary given the objectives of the study. Parts that were noticeably 'raised' above the general level of the basin were noted and are shown in Figure 4.16.

Stratigraphy was investigated by a grid of 28 cores located on a long section and series of cross sections (Fig 4.15). Peat depth, the corresponding isolines and the depth of the basal sand where the underlying clay could be penetrated are illustrated in Figure 4.16. Maximum peat depths of about 200cm were recorded in three locations, the south-east, the west and south central areas. Between these peat depth was 100cm or less with only 25cm between the south-east and south central sections, although to the north a belt exceeded 100cm. These deeper areas correspond with the raised areas; the present feature clearly does not consist of a single central dome but three subsidiary domes.

Peat stratigraphy was fairly uniform wherever it was 100cm or more in depth and very similar to that described by Godwin (1943) and Thorley (1971a) (Fig 4.17). Phragmites remains were common in the peat with levels rich in Sphagnum. Above, and only present in peat over 150cm in depth, were horizons of Sphagnum and Molinia. Excessive degradation in very shallow peats (20-30cm) prevented recognition of remains other than roots.

The sub-peat stratigraphy varied. In the west the peat directly overlay the basal sands but elsewhere there was usually in excess of 100cm of grey clay. This was rich in Phragmites in its upper levels. To the north-east the clay was extremely stiff and coring time-consuming, so only one core was extended beyond about 350cm: this showed sand at 800cm, about -6m OD.

As described above, most of the peat deposit is under permanent pasture although several areas with evidence of cutting are overgrown with sedges or carr (Fig 4.15). Two of these are managed as Nature Reserves by the Sussex Trust for Nature Conservation. Species recorded by the Trust in the Brooks include: Utricularia spp, Hydrocharis morsus-ranae, Sagittaria sagittifolia, Potentilla palustris, Dactylorhiza praetermissa, Leersia oryzoides, Filipendula ulmaria, Glyceria maxima, Carex paniculata, Thelypteris palustris, Salix spp and Alnus glutinosa (Chelmick 1976).

4.3.2. CORING AND ANALYSIS

The south-east dome had the deepest peat, about 240cm, and in contrast to the west dome, it overlay 150cm of clay. This favoured its selection for coring as did the experiences of Godwin and Thorley. Godwin (1943) analysed a core of very similar stratigraphy to that of the south-east dome which was polliniferous. The precise location of Godwin's core is unclear from the paper and he was unable to find any further details when approached (Godwin, pers.comm.). However, the correspondence between the stratigraphy and pollen spectra of his core and that from the south-east dome analysed in this thesis imply that his was from the same area. Thorley's (1971a) core from the west dome showed very poor pollen preservation and had developed directly on the basal sands.

The main core for analysis, AWB 1, was from a point about 165m north of a collapsed barn at the highest point in a field bounded by drainage ditches (Fig 4.15). The stratigraphy is shown in Table 4.4.

In an adjoining field an additional core (AWB 2, Fig 4.15) was taken from a position 100m east of AWB 1. At this point (TQ 03811450) the peat was only 210cm in depth but the clay extended to 480cm. As the peat was known to be richer in pollen from preliminary analyses, preference was given to the place where it attained its greatest depth, i.e. AWB 1. In an attempt to push back the pollen record the clays from 300cm downwards at AWB 2 were cored. However, nine pollen counts through this material showed it to represent the same period, as inferred from the pollen spectra, to that recorded in the basal clays of AWB 1.

In several cores a peaty-clay was stratified between the clay and basal sand. The bed was thickest at TQ 03131506 (Fig 4.15), occuring between 170 and 200cm, and a single 50cm core segment of the bed was sampled for laboratory analysis (core AWB 3). Two samples indicated an age comparable with that of the

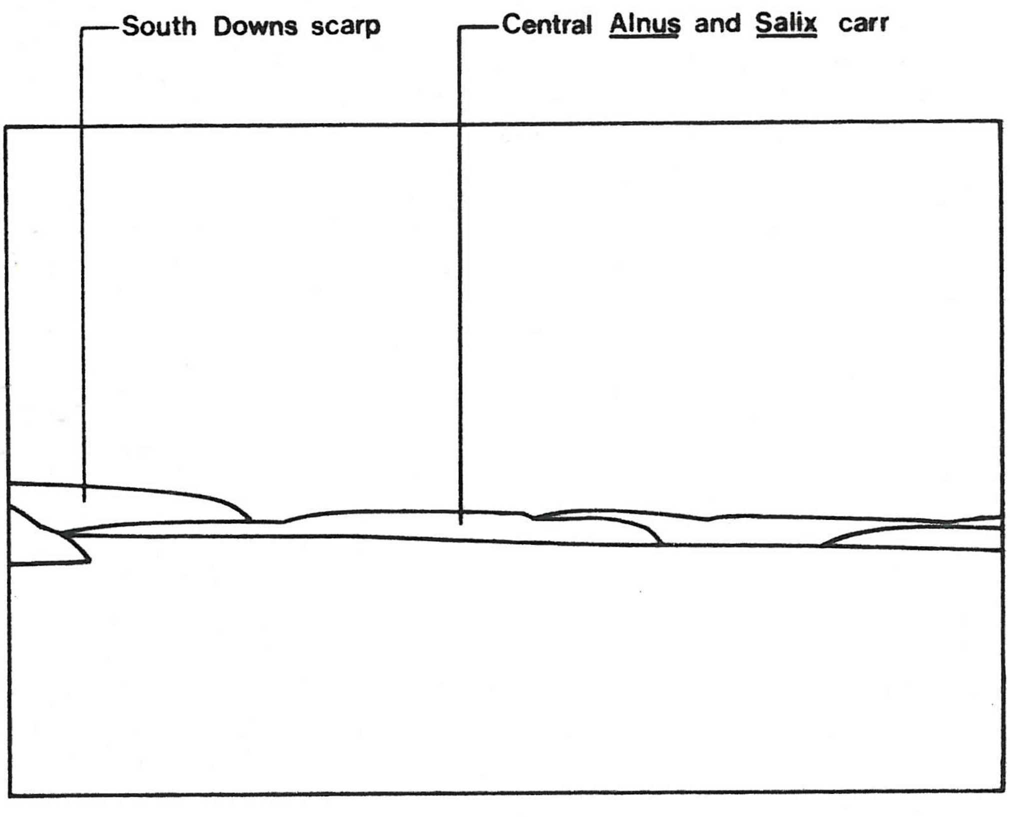


Plate 5. Amberley: general view towards centre of derelict raised bog

From TQ 037146 looking WNW
18 August 1980

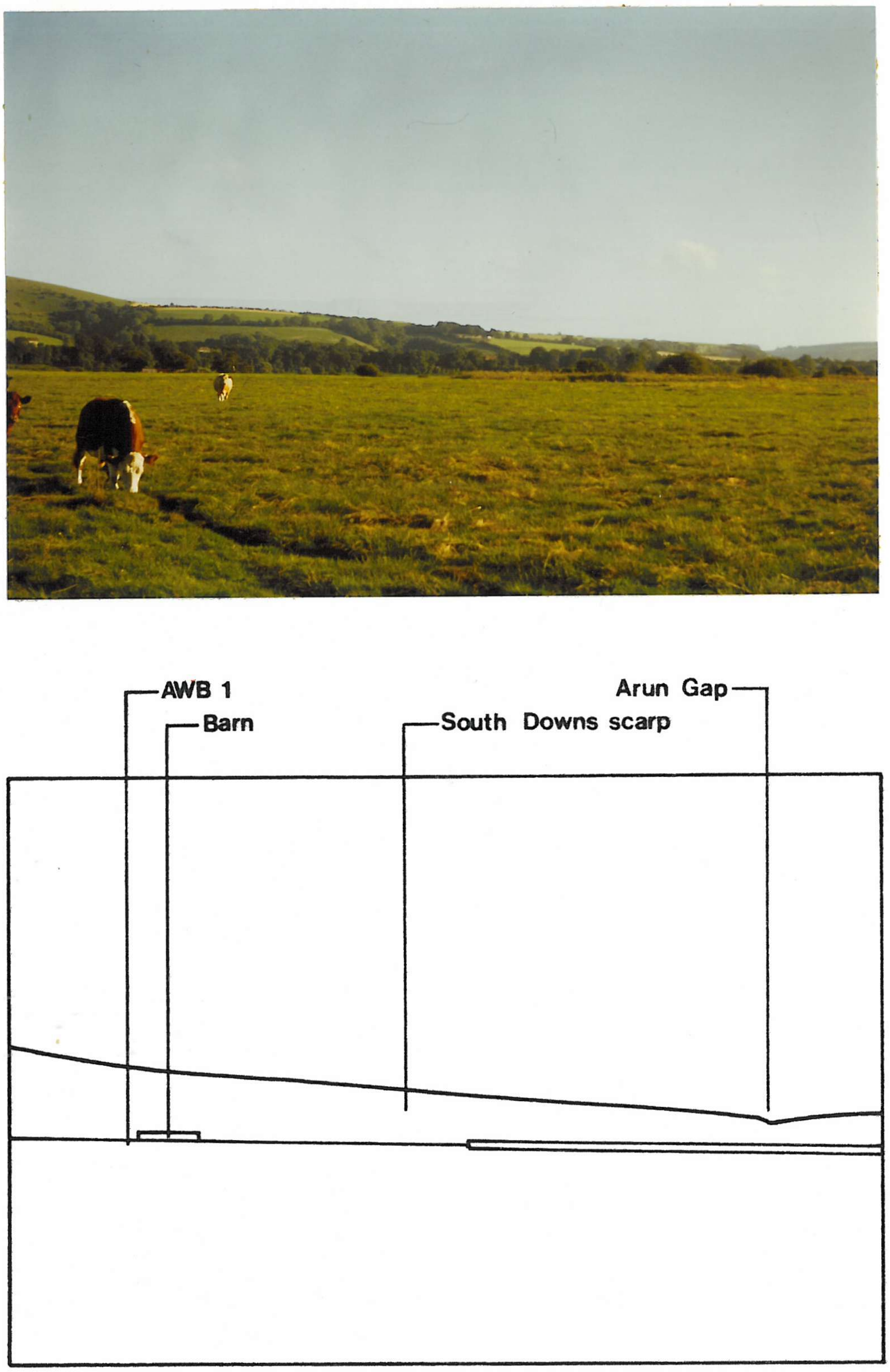
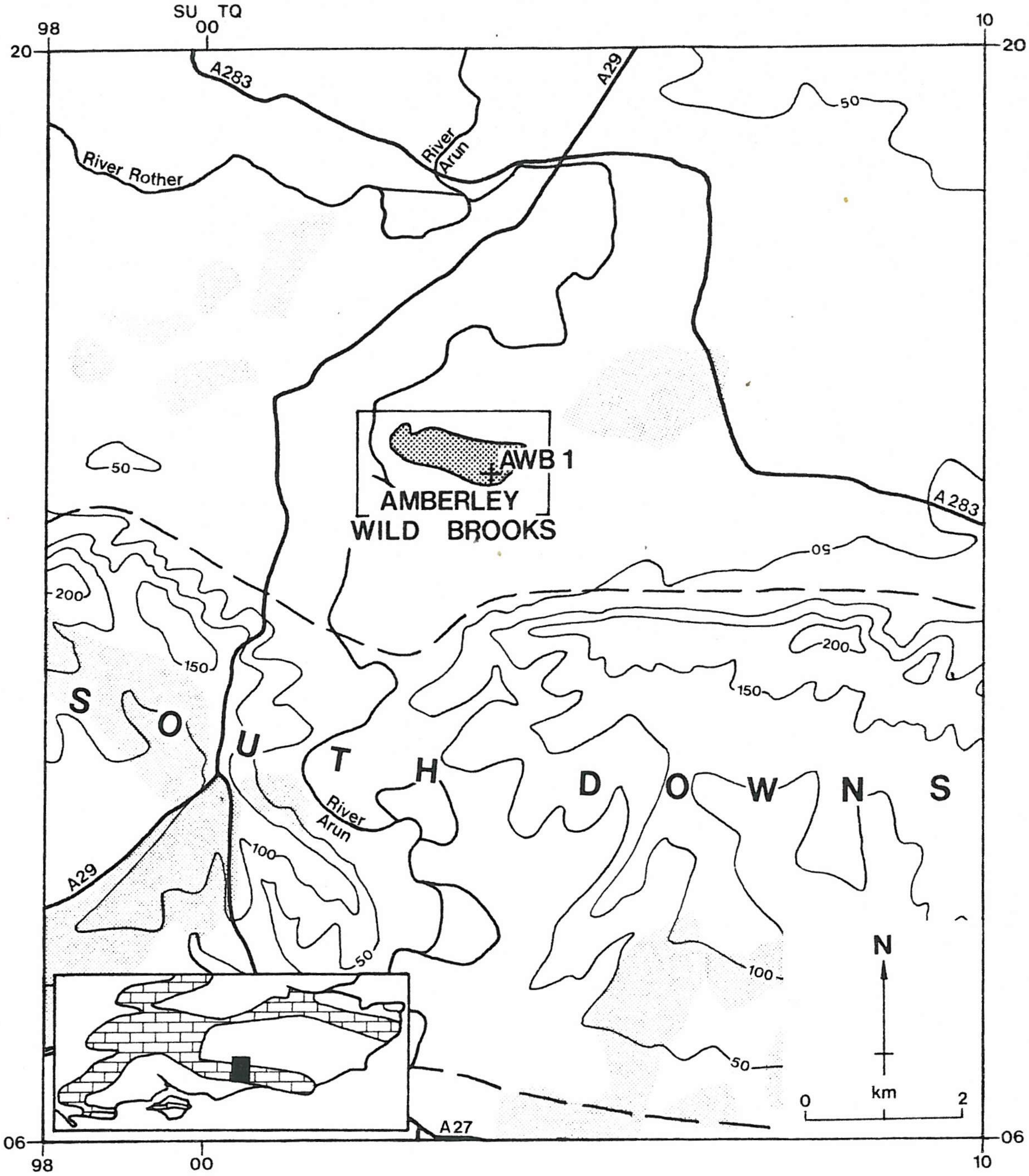


Plate 6. Amberley: view towards site of core AWB 1 with chalk scarp beyond

From TQ 037147 looking S
18 August 1980



Woodland

Peat

A27 Road

50 Contour, 50m interval

Edge of chalk

Area shown in Figs 4.15 & 4.16

Figure 4.13. Amberley: general location map

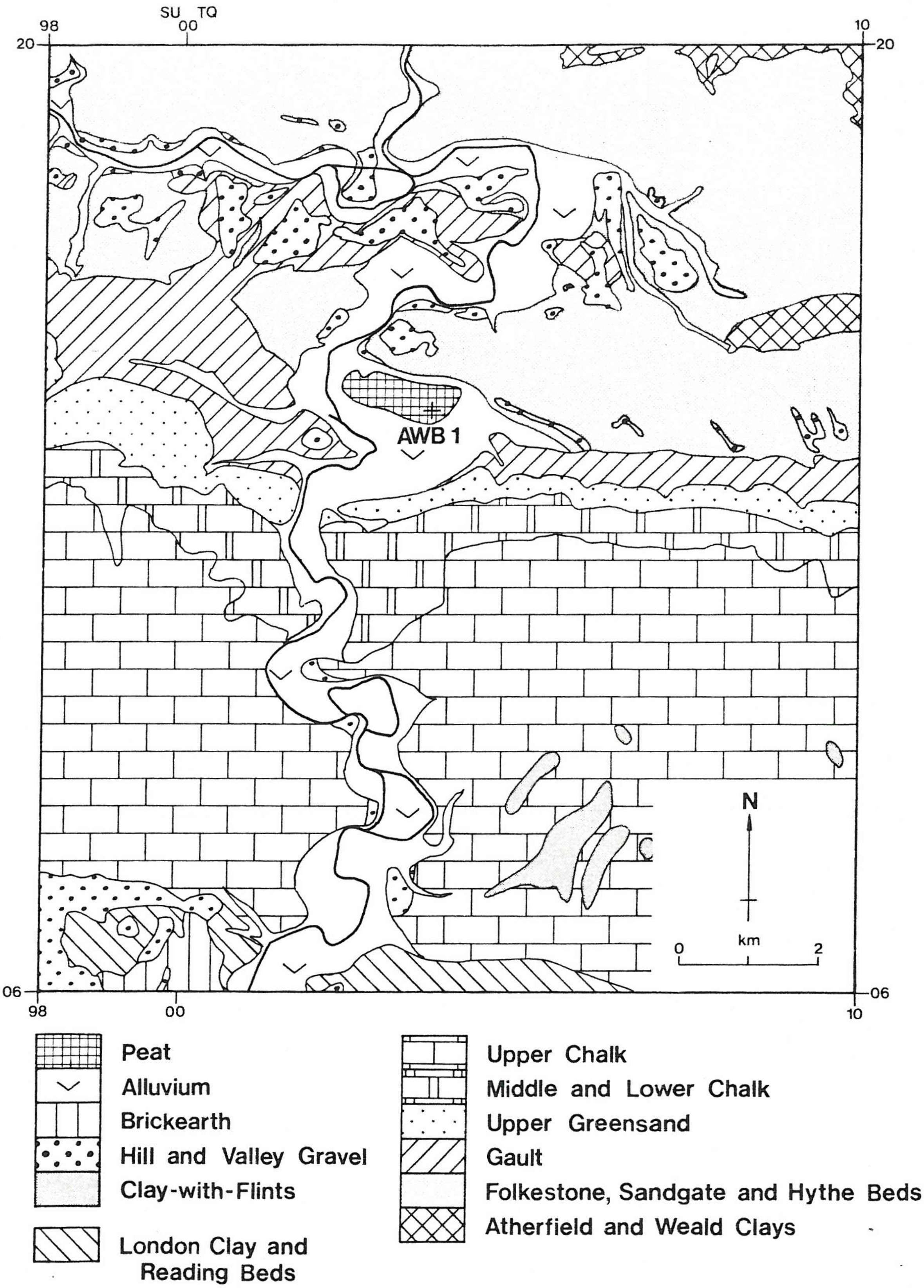


Figure 4.14. Amberley: geology

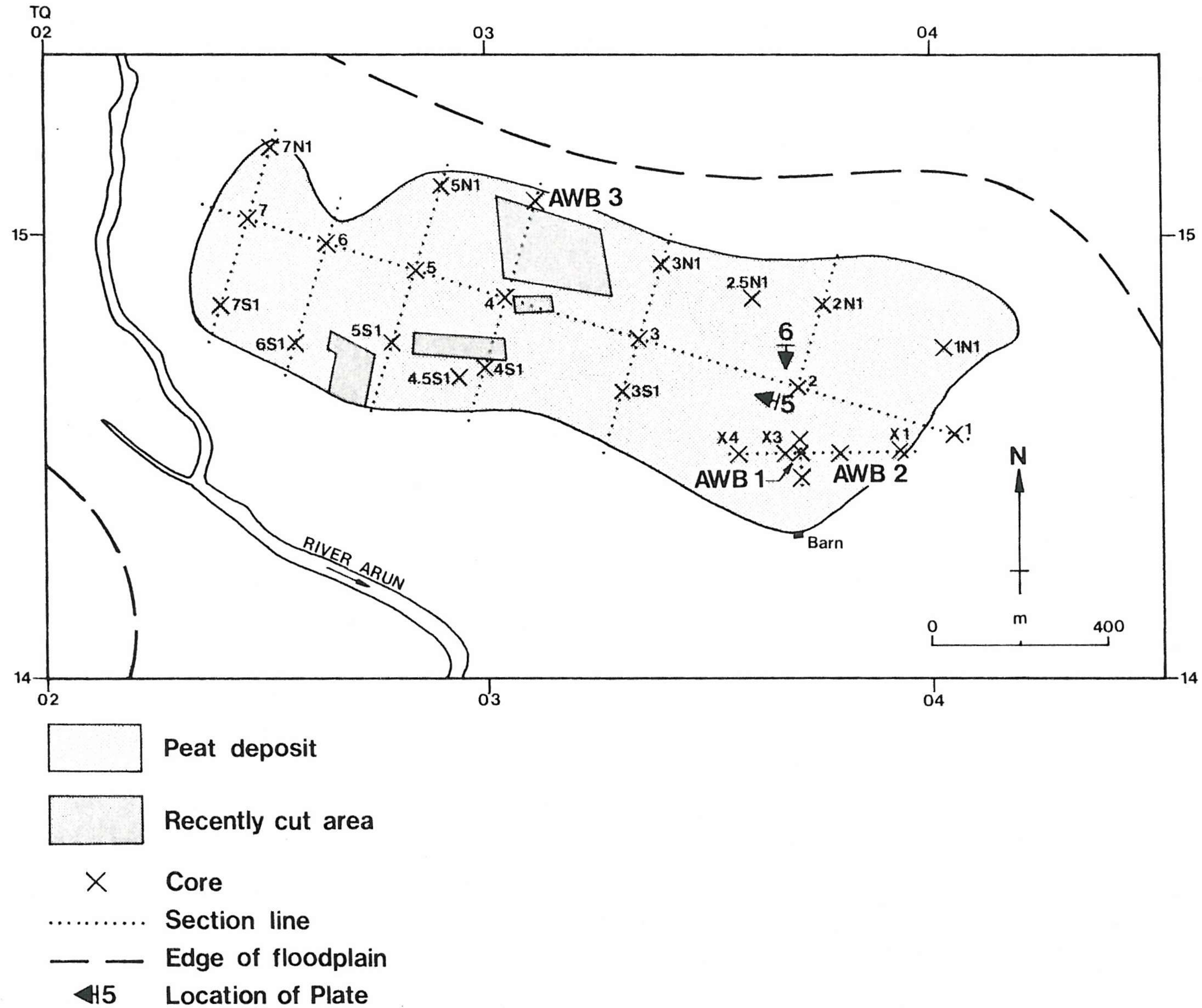
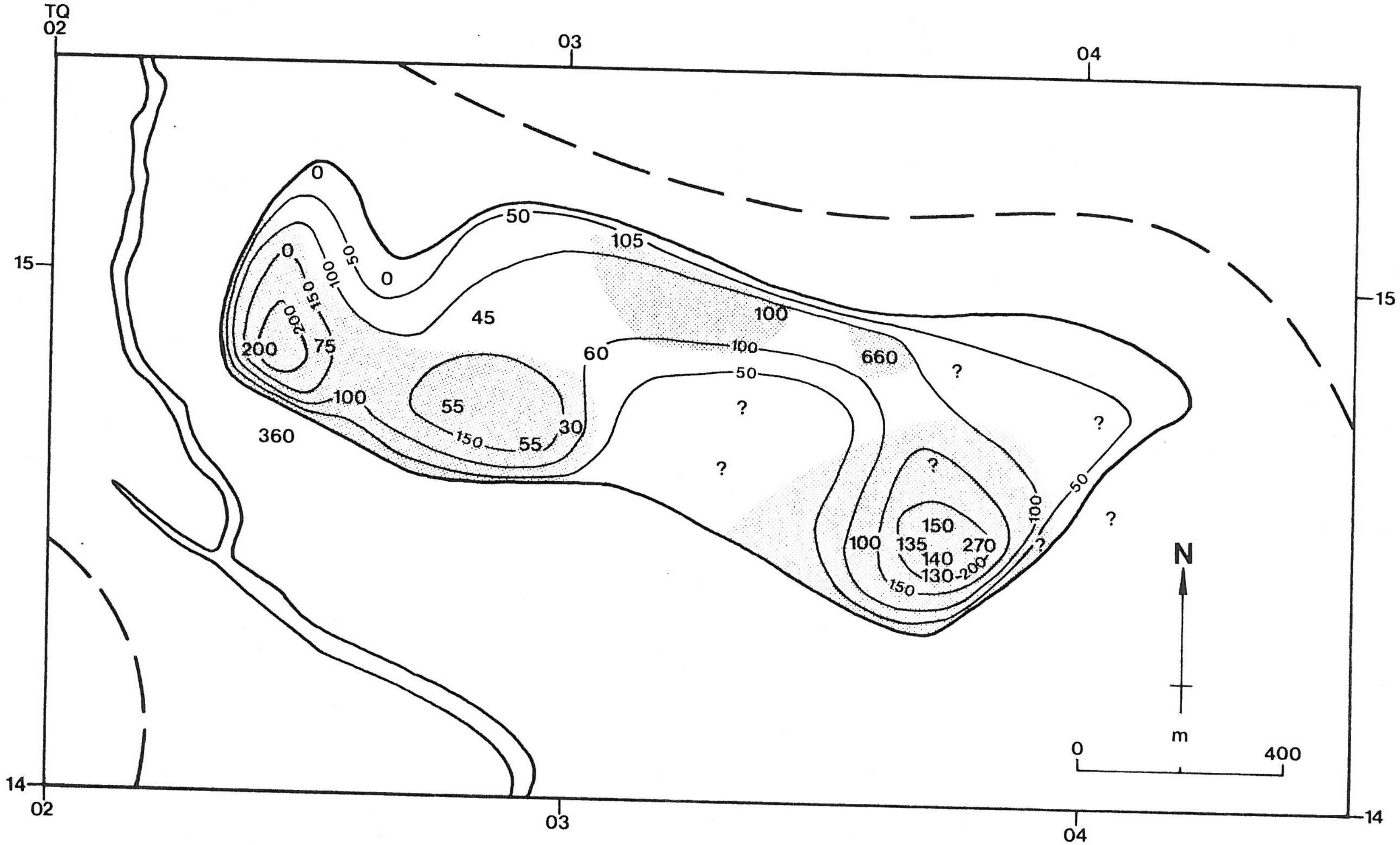


Figure 4.15. Amberley: plan of site



—50— Isoline of peat depth, 50cm intervals

50 Clay depth, cm

'Raised' area

Figure 4.16. Amberley: peat and clay depths

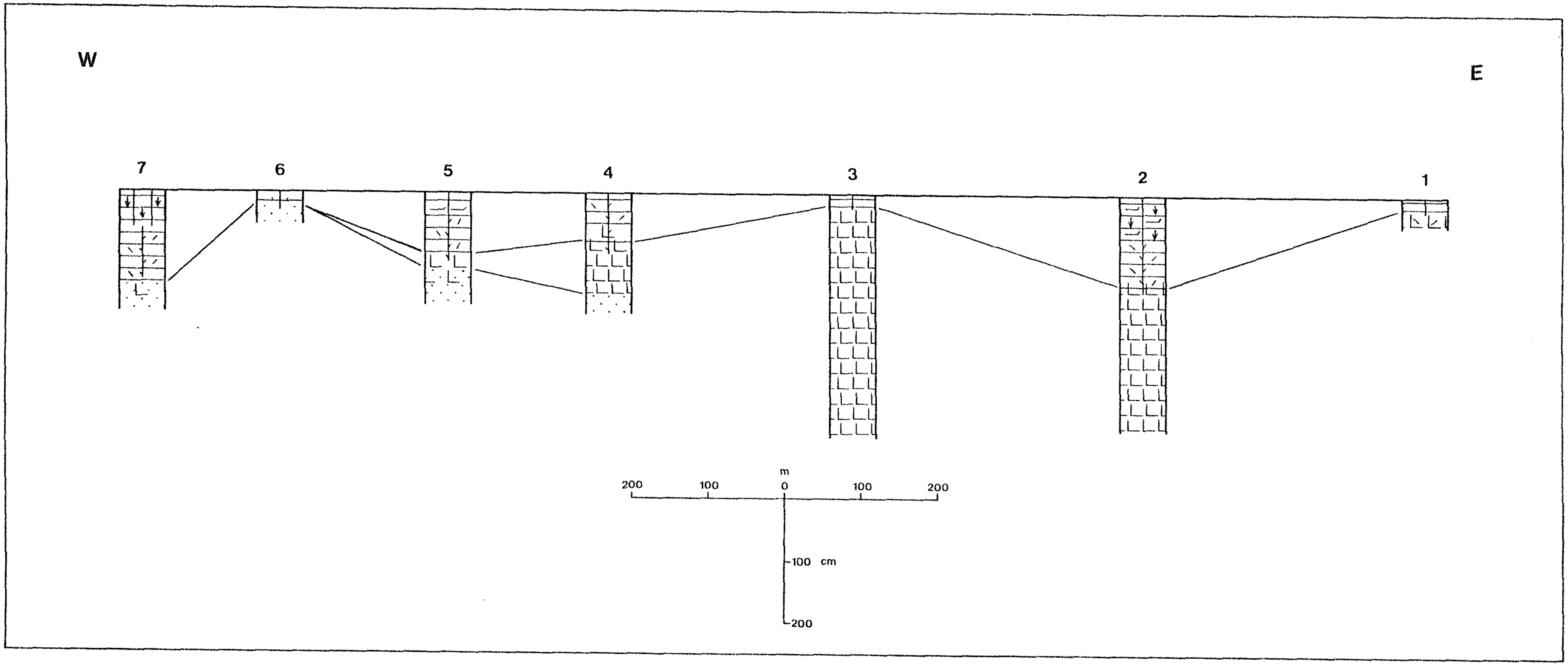


Figure 4.17a. Amberley: stratigraphy, long section
See Table 3.3. for symbols

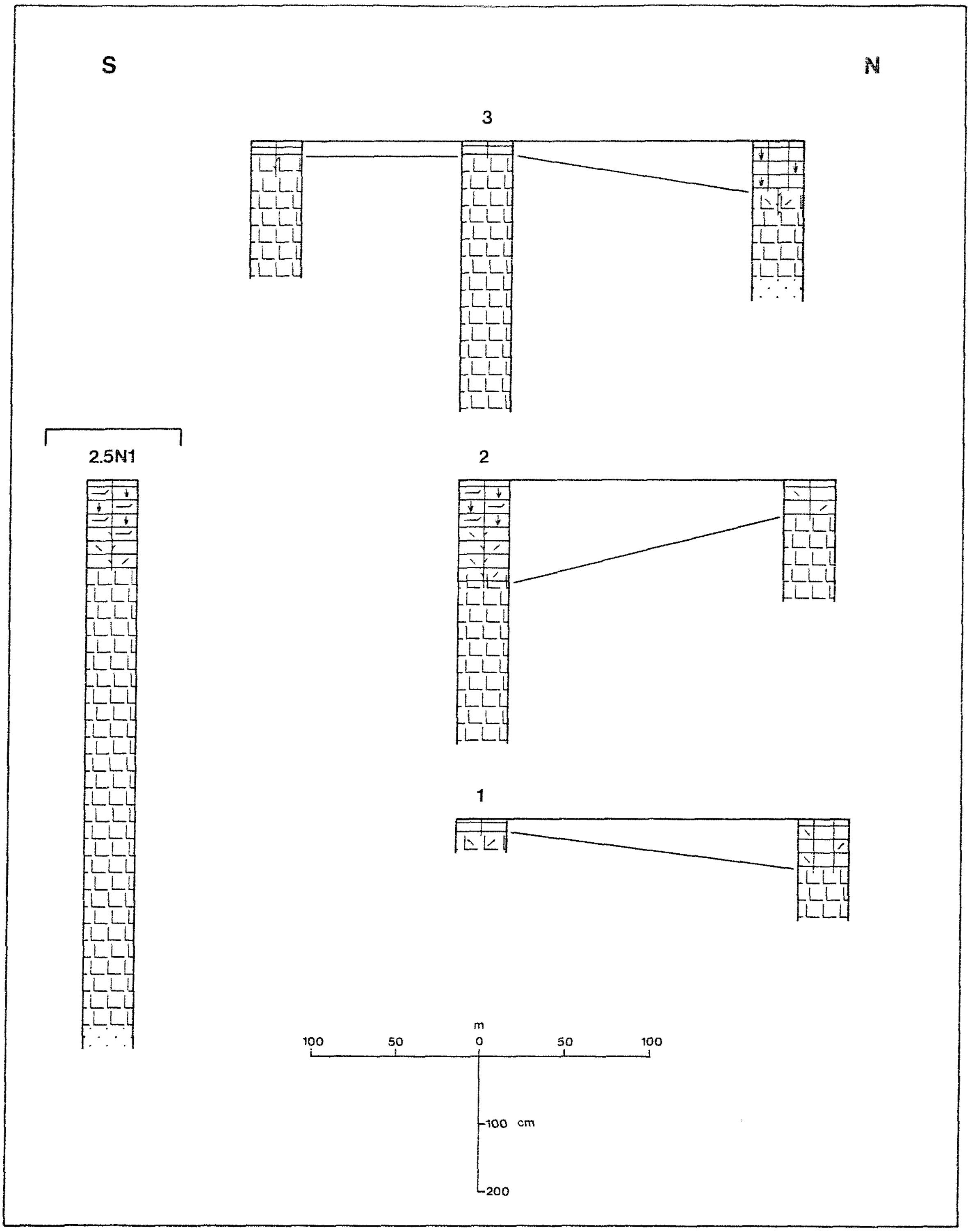


Figure 4.17b. Amberley: stratigraphy, cross sections 1, 2 and 3.
See Table 3.3. for symbols

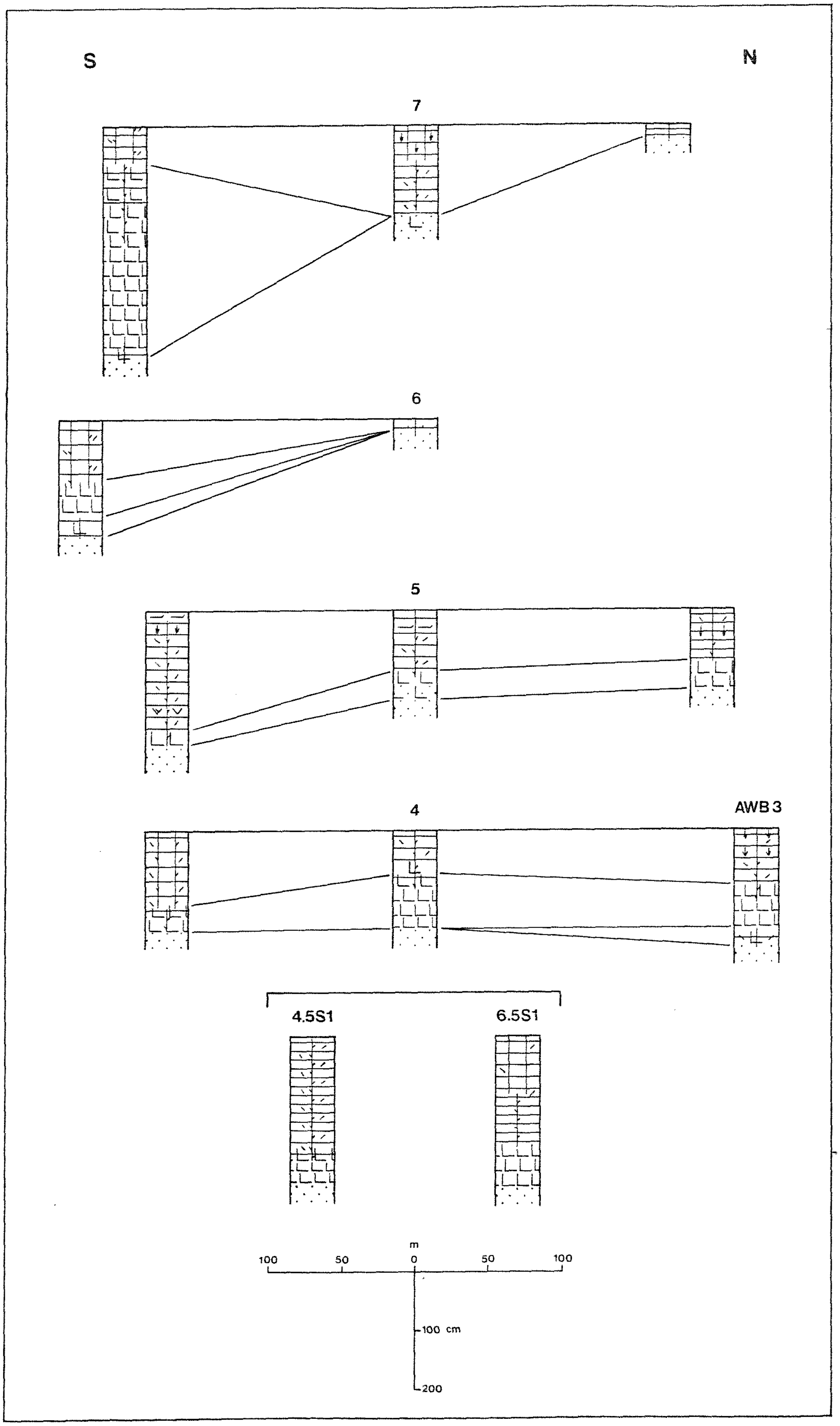


Figure 4.17c. Amberley: stratigraphy, cross sections 4, 5, 6 and 7.
See Table 3.3. for symbols

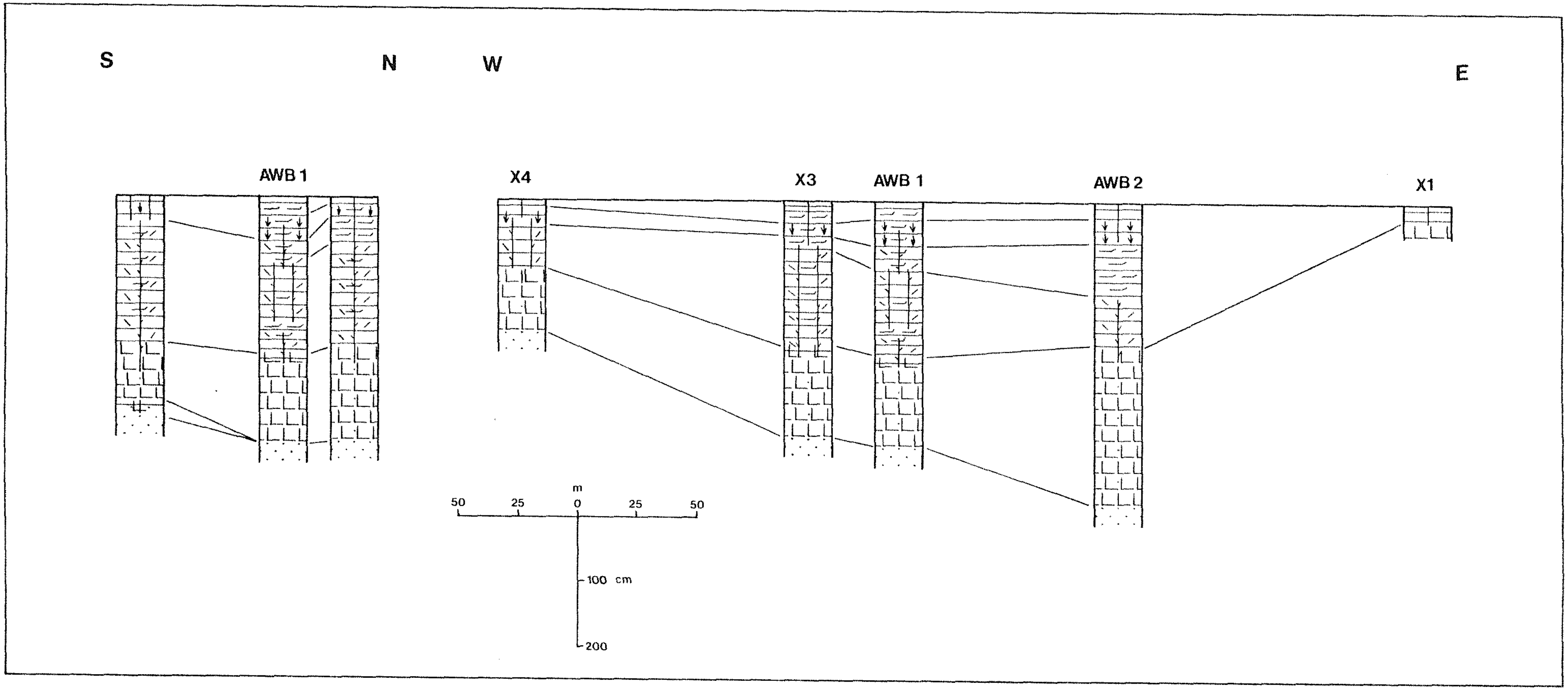


Figure 4.17d. Amberley: stratigraphy of south-east 'dome'.
See Table 3.3. for symbols

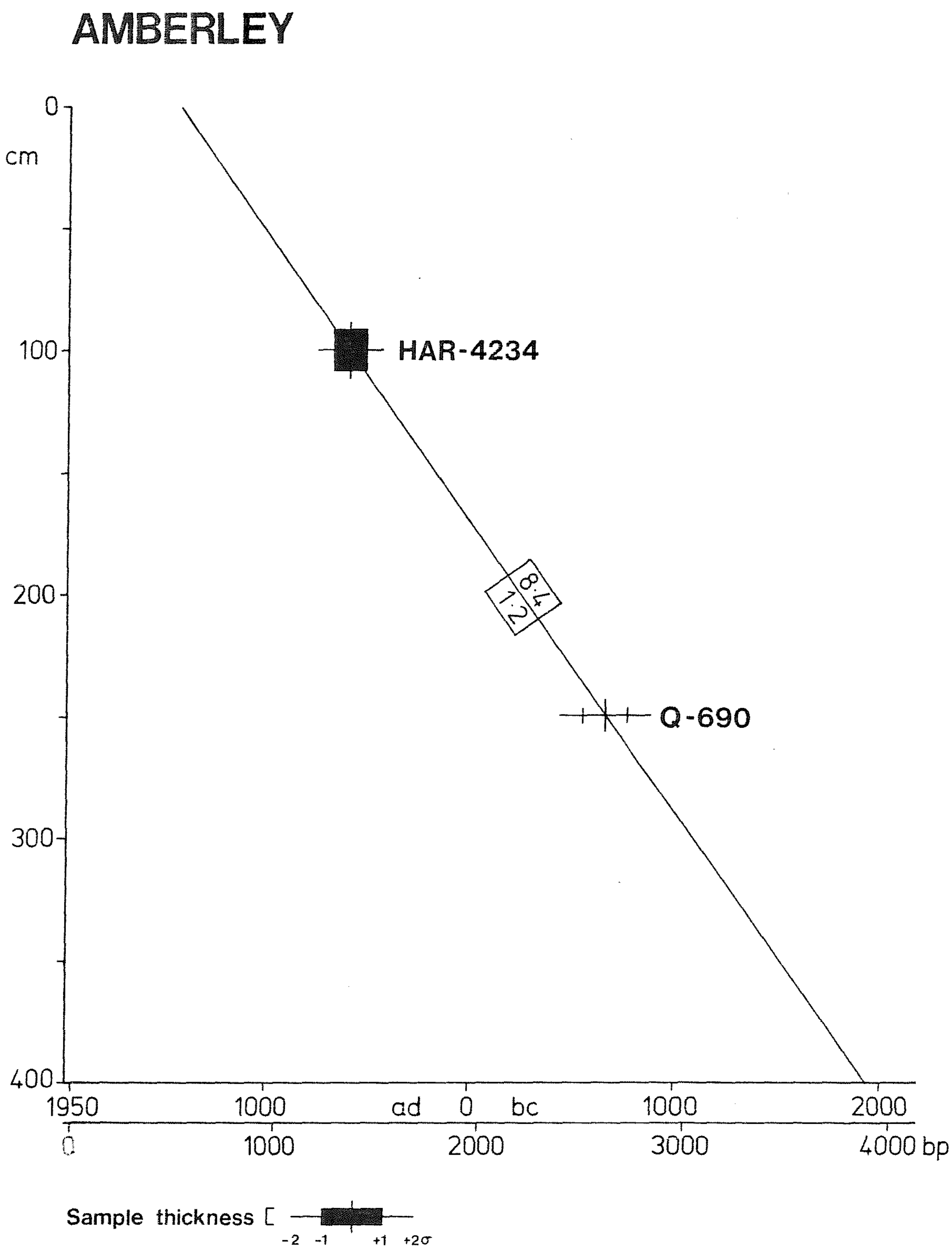


Figure 4.18. Amberley: time:depth curve. Accumulation rate shown in box: upper figure yrs cm^{-1}, lower figure mm yr^{-1}

Table 4.4. Stratigraphy of Amberley pollen core, AWB 1

Depth(cm)	Nig	Strf	Elas	Sicc	Humo	Components	Description
0-10	3	0	2	2	2	(Sh2) Th3, Dg/Tb(Sphag)1	Dark brown rootlet peat
10-45	3	0	2	2	2	(Sh2) Tb(Sphag)3, Dh(Moli)1, Th+, Dg+	Dark brown *Sphagnum* peat
45-75	2	0	2	2	2	(Sh2) Dh(Moli)2, Tb(Sphag)1, Th 1, Dg+	Mid-brown *Molinia* peat
75-110	2	0	2	2	2	(Sh2) Tb(Sphag)2, Th(Phrag)1, Dg 1, Dh+	Mid-brown *Sphagnum* peat with *Phragmites*
110-150	2	0	2	2	2	(Sh2) Th(Phrag)2, Dg 2, Tb(Sphag)+, Dh+	Mid-brown *Phragmites* peat
150-160	2	0	2	2	2	(Sh2) Th(Phrag)3, Dg 1, Dh+	Mid-brown *Phragmites* peat
160-165	2	0	2	2	2	(Sh2, As+) Th(Phrag)3, Tb(Sphag)1, Dg+ Dh+	Mid-brown *Phragmites* peat with *Sphagnum*
165-175	2	0	2	2	2	(Sh2, As+) Th(Phrag)3, Dg 1, Dh+	Mid-brown *Phragmites* peat
175-200	2	0	2	2	3	(Sh2, As+) Th(Phrag)2, Dg 2, Tb(Sphag)+, Dh+	Mid-brown *Phragmites* peat
200-220	3	0	2	2	3	(Sh3, As+) Tb(Sphag)3, Th(Phrag)1, Dh+	Dark brown *Sphagnum* peat with *Phragmites*
220-230	3	0	2	2	3	(Sh3, As+) Th(Phrag)2, Tb(Sphag)2, Dh+, Dg+	Dark brown *Phragmites* and *Sphagnum* peat
230-240	3	0	1	2	3	(Sh2, As 1) Th(Phrag)3, Dg 1, Dh+	Clayey dark brown *Phragmites* peat
240-250	3	0	1	2	3	(Sh2, As 1) Th(Phrag)3, Dg 1	Clayey *Phragmites* peat
250-260	2	0	1	2	3	(Sh1, As 2, Ag+) Th(Phrag)3, Dh 1	Peat-clay
260-380	1	2	0	2	2	(As 3, Ag 1, Sh+) Th 3, Th(Phrag)1, Dg+	Grey banded clay, some *Phragmites*
380-385	1	1	0	2	-	(As2,Ag1) Gmin4	Grey sandy clay
385+	2	1	0	2	-	(As 1, As 1) Gmin4	Orange-grey clay

basal clays of AWB 1 so further investigation was not undertaken.

Pollen concentration was known to be low in both the peats and clays so samples were subjected to the rigorous schedule described in section 3.2.2. The generally low level of pollen degradation suggests that this was because of rapid deposit accumulation and its resistance to chemical breakdown rather than poor pollen preservation. Samples were analysed at 8cm intervals and the deepest polliniferous sample was 376cm (PD 3).

One radiocarbon date was already available from the site: 670±110bc (Q-690, Godwin and Willis 1964) for the peat clay interface at 250cm. H. Godwin (pers.comm.) was unable to find any information on the depth range of the sample; it is shown here as a single bar of arbitrary width in the pollen diagram and time : depth curve (Fig 4.18). Core AWB 1 is assumed to have been from the same location as Godwin's original core and so it is included in the pollen diagram. Additional material was taken from the level of the Fagus rise (95-105cm correlated depth) from a point 50cm from AWB 1. This gave a date of 590±80ad (HAR-4234).

The pollen core AWB 1 was from about 150m from the edge of the peat deposit. In a basin 150m in diameter the Jacobson and Bradshaw (1981) model predicts (section 2.4.3.) that 23% of the pollen will have been derived from within 20m of the edge of the basin, 60% from 20m to several hundred metres and 17% from in excess of that distance. In reality the Wild Brooks for much of its history was probably one large open sedimentary basin with an effective diameter in excess of 1500m: the predicted values change to about 10%, 3% and 87%. This implies that the pollen preserved in the core was from an extensive area around the Wild Brooks, although chalk geologies probably represent less than one half of this area. Consequently interpretation of chalkland vegetational history is hindered by a substantial input of pollen from plants on other geologies.

4.4. RIMSMOOR

Core location: RM 1, RM 2, RM UD, RM TD SY 81429218

Plates 7 and 8

Rimsmoor is a doline filled to a depth of nearly eighteen metres with polliniferous sediment. It is located 4km south-west of Bere Regis in Bryants Puddle Heath on the southern edge of the Dorset Downs (Figs 4.19

and 4.20). The current land use in the area is strongly determined by geology: the chalk downs are primarily arable and the Tertiary basin, mostly heathland and coniferous plantation.

4.4.1. GEOMORPHOLOGY, STRATIGRAPHY AND PRESENT VEGETATION

The bog at Rimsmoor has developed in an enclosed depression or doline, caused by the slow solution of the chalk underlying the Tertiary strata. Dolines are particularly common on the heathlands between Dorchester and Bere Regis and in some areas they attain densities of a hundred or more per square kilometre. Private observation and the detailed morphometric work of Sperling et al. (1977) indicate that the mean diameter is 10 to 20m and depth 2 to 4m. Larger examples do occur and Culpeppers Dish 300m north of Rimsmoor is exceptional with a diameter of about 85m and depth of 20m (Fig 4.19.). The general form is usually conical although some on hillslopes, as in the case of Rimsmoor (and Okers) are elongated downslope; Rimsmoor indeed may be a double feature, the development of the smaller, southern component hindered by the larger feature of the main basin.

Rimsmoor was surveyed and cored in detail to determine its form and the stratigraphy of the enclosed bog (Fig 4.21.). A single long profile was surveyed with nine cross profiles and a total of 40 cores examined (Fig 4.22). Essentially it is a hollow with a maximum width of 60m and length of 90m. The northern part is a single large depression with, to the south, a shallow extension. The maximum depth is about 26m, but only 4m in the southern part. The bog fills this to a depth of about 18m in the north, but only 1m and less in the south. Water inflow is discernible by seepage from the north slope of the depression and outflow is through a narrow cut 60-130cm deep in the lower east side. The height of the edge of the basin is greatest on the north-west side, at about 8m above the surface of the bog. To the south the basin rim merges with the hillslope as the feature shallows. These data are presented in an isometric drawing (Fig 4.23).

Rimsmoor is unusual in that most dolines in the area are free from accumulations of organic remains and thus are free-draining. The adjacent Okers (section 4.5) is similar in also containing peat. Significant surface drainage into those without peat is unusual, yet a notable exception is the complex of dolines 300m west of Rimsmoor. A stream flows southwards into the largest of the group, which has a level wet floor 4 to 5m in diameter and sides gently inclined at 10 to 20^{o} upslope, but almost vertical ($70-80^{o}$) downslope. The latter is 5 to 6m in height and chalk is exposed in the lower 2m (shown as 'Doline sink' in Figure 4.19.).

The deposits are almost exclusively peat and this was found to overlie a white leached sand in all cores with the exception of 6E 1 from which was retrieved a mottle clay (?Reading Beds) (Fig 4.24). At the deepest point some grey clays are present interbedded with peat below 1550cm and between about 100 and 150cm a wet clayey horizon extends across most of the northern part of the bog. Very wet fresh Sphagnum dominated peat occurs above this level and below is peat of a highly humified nature (humo 4) in the southern area but of a mid-brown colour and again rich in Sphagnum with roots in the main basin. The colour darkens with depth and increasing amounts of Phragmites remains are preserved. In the north-west quadrant of the main basin a tongue of very stiff sandy clay occurs immediately below the extensive clayey horizon. This was clearly a result of landslipping: a scar is readily discernible on the north-west side of the basin.

The prevalence of peat in the deposit strongly implies that the depression has subsided slowly and that peat accumulation has been maintained at a similar rate. The concave form of the stratigraphy supports this hypothesis: correlated levels are deeper in the centre of the bog than at the margins (Figs 4.23, 4.24). If subsidence was highly intermittent or the basin was the result of a single collapse of strata, lake deposits, notably clay, would be common. Conditions favourable to clay sedimentation apparently only existed at an early stage in the formation of the depression and during a brief phase more recently. This observation complements Reid's (1899, 19-20) explanation of the development of dolines in this area, one not rejected by Sperling et al. (1977). He lists three reasons why solution of the underlying chalk is rapid and irregular: its surface is well above the level of saturation so water sinks freely into it; the climate is moist favouring the development of acid, peaty vegetation; and the Reading Beds in the area vary from coarse freely-permeable gravelly-sand to impervious plastic clay each with only a limited lateral extent. Consequently, drainage is concentrated into certain areas which undergo solution, intensified by the influence of acid soils on water pH.

Once established in a peat-filled basin like Rimsmoor the constant supply of acid water will enhance the process. The problem, however, lies in its initiation: the most ready explanation is that the Reading Beds at Rimsmoor are vertically differentiated with sands underlying a lens of clay. Drainage may have been concentrated by surrounding clay lenses into the basal sand causing localised solution. Once subsidence had started, the clay provided an almost impervious surface in which water could accumulate and only very slowly percolate through to the chalk below, increasing the subsurface concentration of drainage. This theory is hypothetical as borehole data do not exist for the Reading Beds around Rimsmoor: it is, nevertheless, consistent with Reid's explanation.

Rimsmoor is surrounded by pine forest, planted in the 1950s on Calluna and Ulex heathlands, remnants of which survive in fire breaks and the area around Oakers Bog (Fig 4.19). Isolated groups of oaks remain within the plantation, particularly in dolines, as for example, in and near Culpeppers Dish and in the sink holes already described. The sides of the depression are dominated by grasses, Calluna vulgaris, Erica tetralix and Ulex europaeus with Pteridium aquilinum abundant on the steep north-west slope. A single specimen of Prunus spinosa is present at the top of that slope and Lonicera periclymenum occurs sporadically. Wetter communities prevail in the area of seepage on the north slope (see below). The bog surface is a very wet Sphagnum dominated mat, resembling a schwingmoore in the centre where it is encroaching upon a pool ('Rimsmoor Pond'). Its depth corresponds to that of the wet subsurface clay horizon.

Doctors Colin and Honor Prentice kindly undertook a detailed vegetation survey of the bog surface on 31 July 1981. The approximate positions of the twenty 2m relevés they examined are shown in Figure 4.25. Thirty-five different species were recorded and the results were analysed using standard phytosociological methods. An interactive table-rearranging programme was utilised to produce Table 4.5. It shows, most notably, Molinea caerulea, Erica tetralix and Drosera rotundifolia, widespread wet heath and bog species ('constants' in this table); Sphagnum tenellum, a typical wet heath species; S. capillifolium, S. papillosum, S. pulchrum and Narthecium ossifragum, characteristic valley bog species; and Rhynchospora alba and Eriophorum angustifolium, which are characteristic of inundated situations. In summary, relevés 5 and 16 are species-poor *Molinia*-dominated communities; 19 and 20 are species-poor *Juncus acutiflorus*-dominated communities; 1 to 18 represent a typical valley bog community; and 7 and 8, an inundated 'lawn' variant of a typical valley bog community (8 is an almost typical *Rhynchospora alba* hollow with *Drosera intermedia*). I am indebted to the Prentices for the survey, analysis and interpretation.

4.4.2. CORING AND ANALYSIS

The main core for pollen analysis, RM 1, was taken from slightly west of the centre of the main north section of the bog (Fig 4.21). Preliminary coring and visual projection of the basin sides had indicated that this was likely to be the deepest point. It was situated 23m from the north edge of the bog surface on the line of the long section, 19m from the west edge and 20m from the east edge. Subsequent coring for C-14 samples however suggested that a point 1 to 2m to the north-west may have been deeper, but this was impossible to ascertain with certainty because coring depths in excess of 1600cm involved several days' work. Furthermore, such exploratory probing would have disturbed the deposit and hindered future work.

From 0 to 150cm, the base of the clay horizon, the deposit was too wet to sample with the Russian corer. A second core, RM 2, was therefore taken from a point 17m to the north on the long section and 6m from the edge of the bog where the clay and overlying fresh peat were more consolidated. Pollen counts through RM 2, including the upper 50cm of underlying peat, showed a close correspondence with the upper 50cm of RM 1. Consequently, the pollen diagram is a composite of RM 1 from 150cm downwards and RM 2 from the surface to the base of the clay inwash, in this latter core located at 170cm.

It was suspected during the early stages of the work at Rimsmoor that the bog had been cut over: the clay horizon and overlying material possibly representing renewed accumulation after the cessation of cutting (Waton 1980). To investigate this possibility two further cores were examined. Core RM 3 was from a raised area of peat in the north-east of the basin, RM 4 from peat buried under the landslip tongue beyond the present limit of the bog (Fig 4.2.1.). Pollen counts from these cores were compared with RM 1 and RM 2; whilst RM 3 was very similar to RM 2, RM 4 was more difficult to correlate but was certainly earlier than the 150cm level in RM 1, a not unexpected conclusion given that the landslip pre-dates the clay horizon. RM 3 and RM 4 did not contribute any significant new data so further reference will not be made to these cores.

Two additional 50cm core segments were taken for close interval counts of the Ulmus and Tilia decline clearances (RM UD and RM TD). Both were taken from points at a distance from RM 1 to avoid disturbed peat and the large water-filled pool created over the seven day period it took to sample the whole depth of the deposit. They were obtained during coring for radiocarbon samples. The Tilia decline core was derived from a point 4m south-south-east of RM 1 and was easily located because of the associated clay inwash. Of eleven 50cmcores from various depths between 1000 and 1130cm only one, the last, actually straddled the Ulmus decline: there is no obvious change in the stratigraphy at this level so only through pollen analysis could the horizon be located. This core was from a point 2m south of RM 1.

The stratigraphy of the cores is shown in Tables 4.6, 4.7, 4.8 and 4.9.

Preparation of samples for analysis was by the standard techniques as pollen was abundant in most levels. HF treatment was unnecessary except for in the levels below 1550cm, at about 800cm and from 0-170cm. The basic sampling interval was to have been 10cm throughout the core. However, because of artificial pollen fluctuations caused by the veering Hiller below about 1200cm (section 5.4.1.), a 20cm interval was adopted from about 1260cm. Nevertheless, the earlier counts at 1350, 1450, 1550, 1650 and 1750cm are shown (PD 4a). Certain levels were counted at 5cm intervals whilst the Ulmus and Tilia decline clearances were counted at intervals of 1 or 2cm in the supplementary cores RM UD and RM TD (PD 4b). The deepest polliniferous sample was 1780cm.

Six bulked samples were C-14 dated with the following results: 1125-1150cm 3200±70bc (HAR-3919); 1060-1085cm 2740±70bc (HAR-3920); 790-815cm 1870±80bc (HAR-3921); 410-435cm 400±70bc (HAR-3922); 355-380cm 130±80bc (HAR-3923); and 150-175cm 1340±60ad (HAR-3924) (Table 3.4).

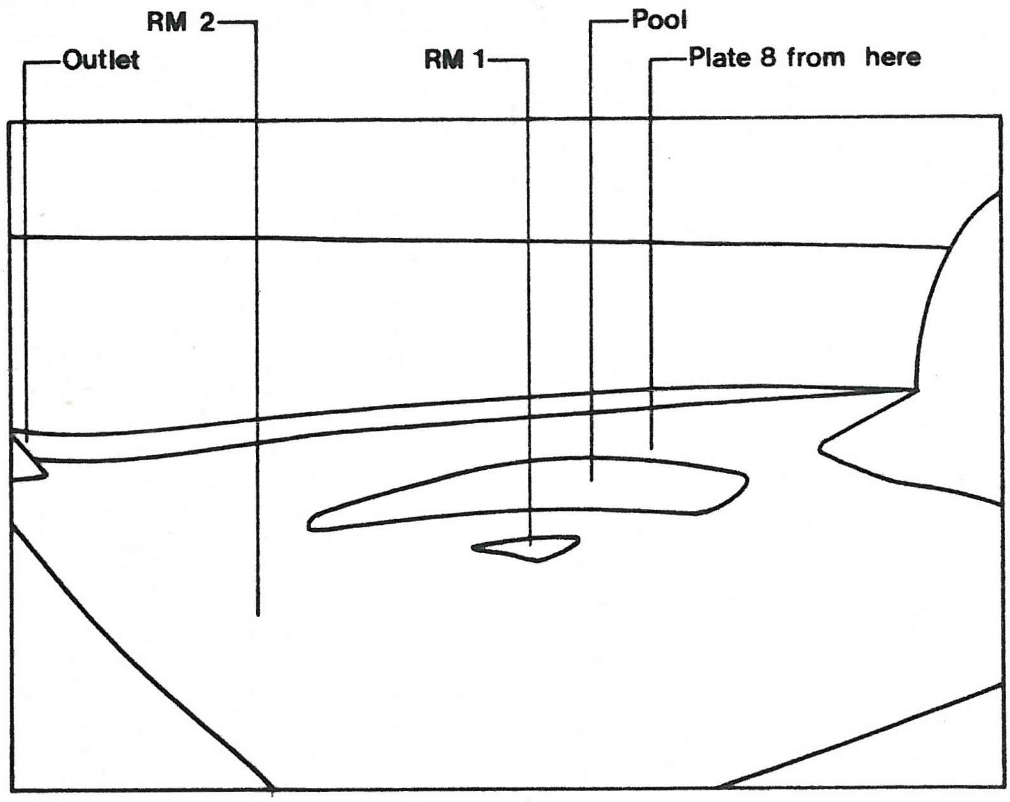


Plate 7. Rimsmoor: general view

From SY 81429222 looking SSE
21 April 1980

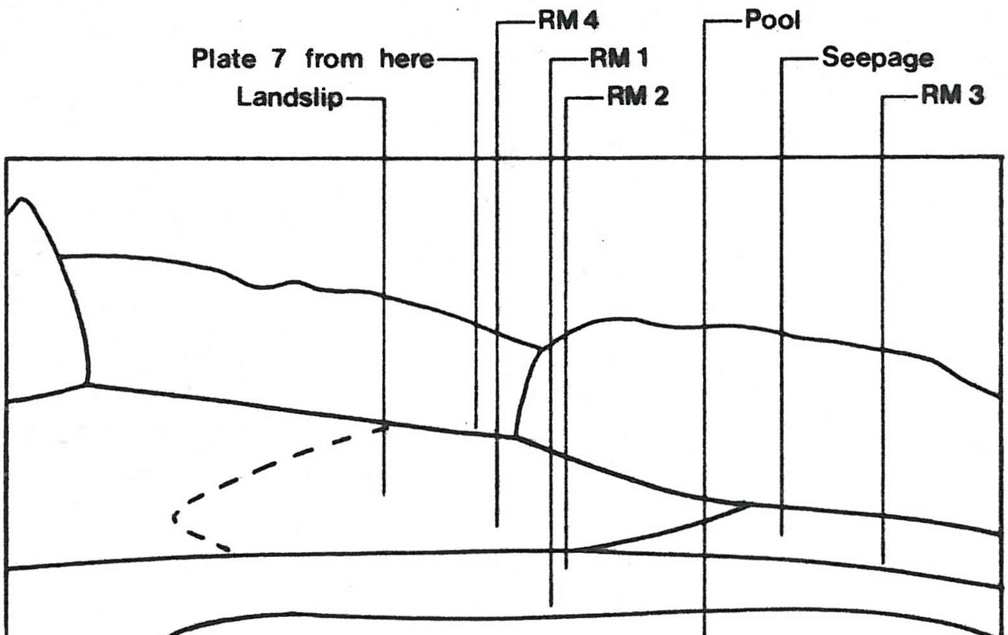
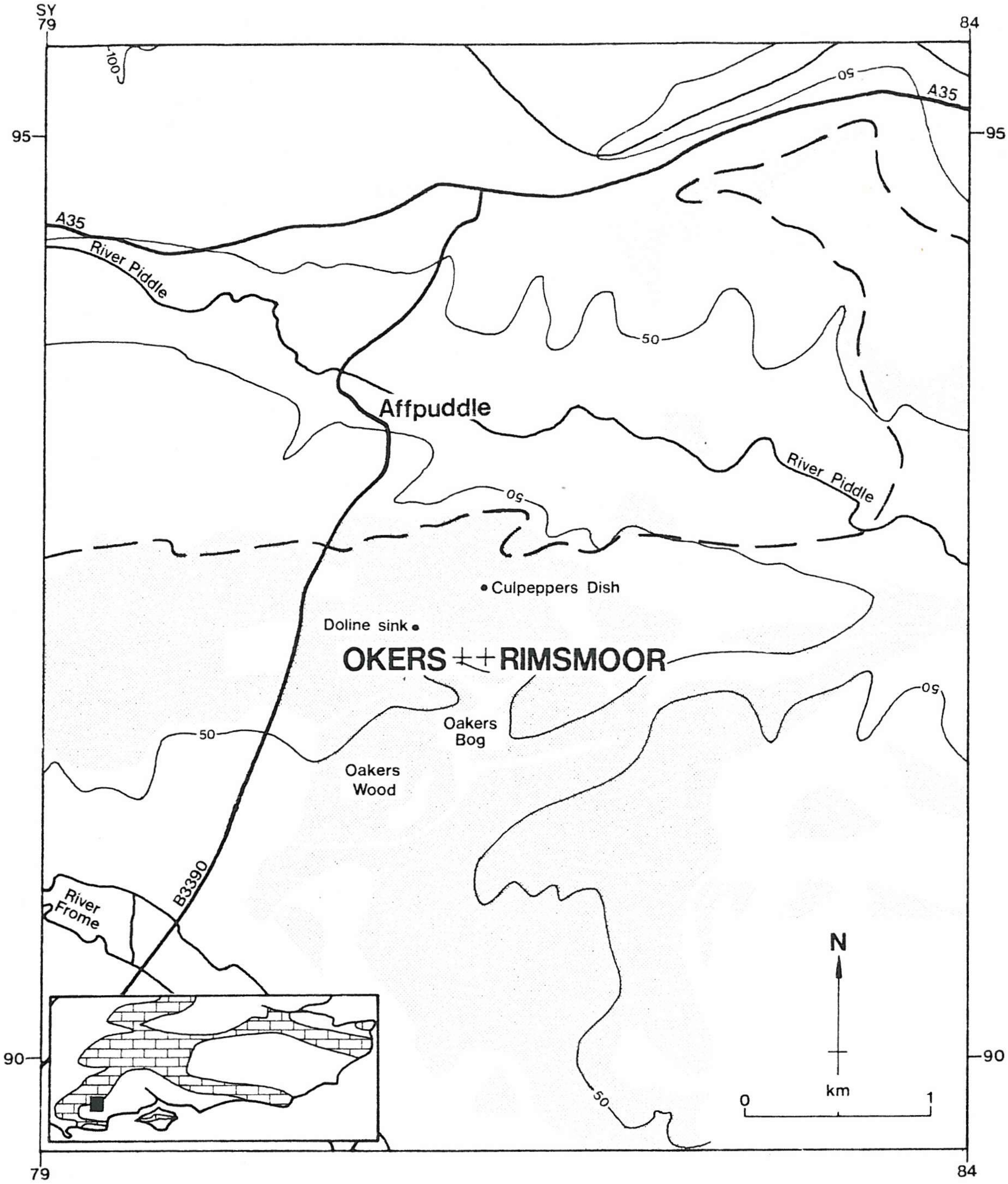


Plate 8. Rimsmoor: view of main part of bog

From SY 81429216 looking NNW
31 July 1979



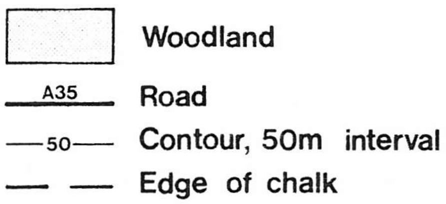


Figure 4.19. Rimsmoor and Okers: general location map

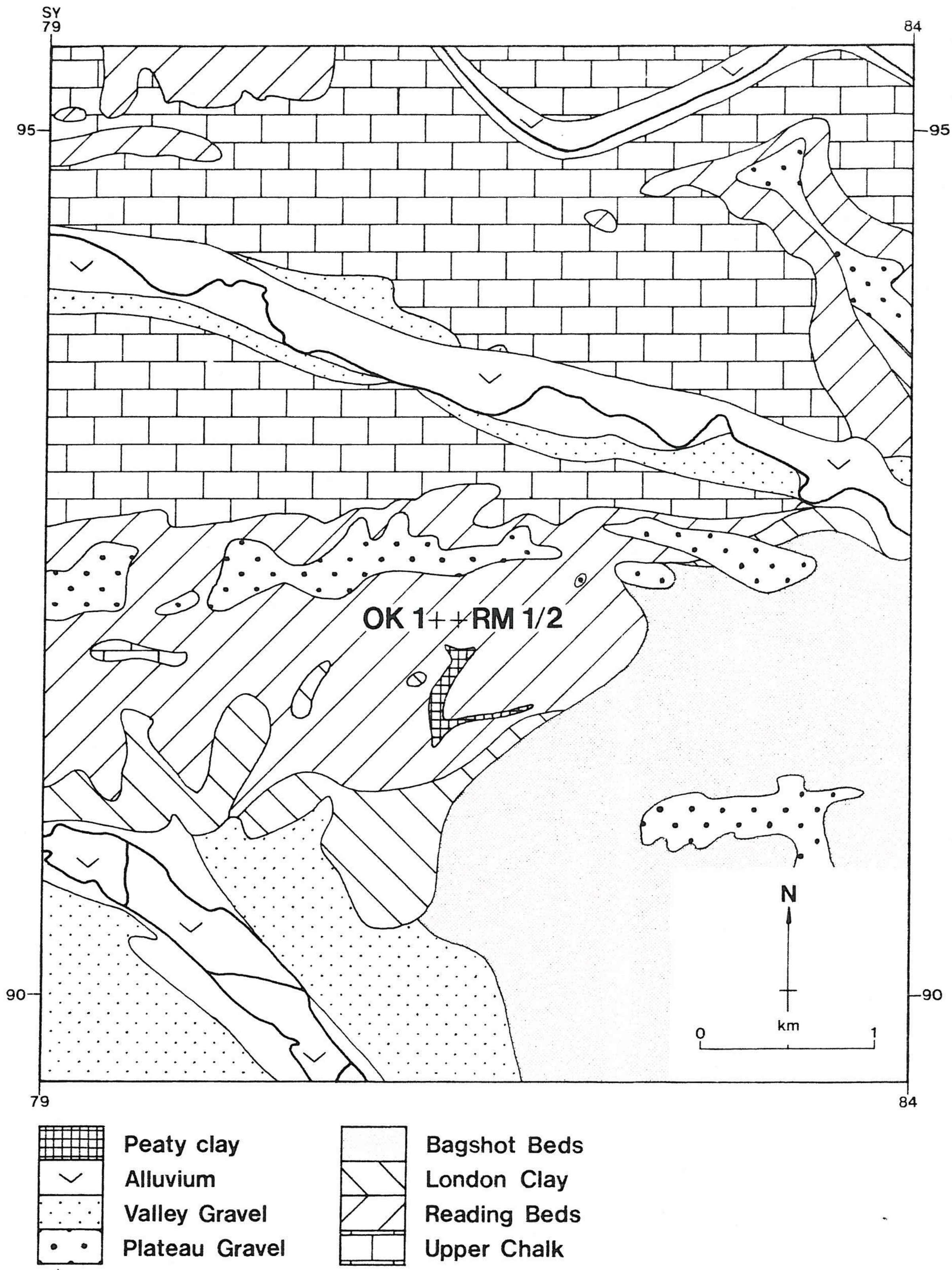
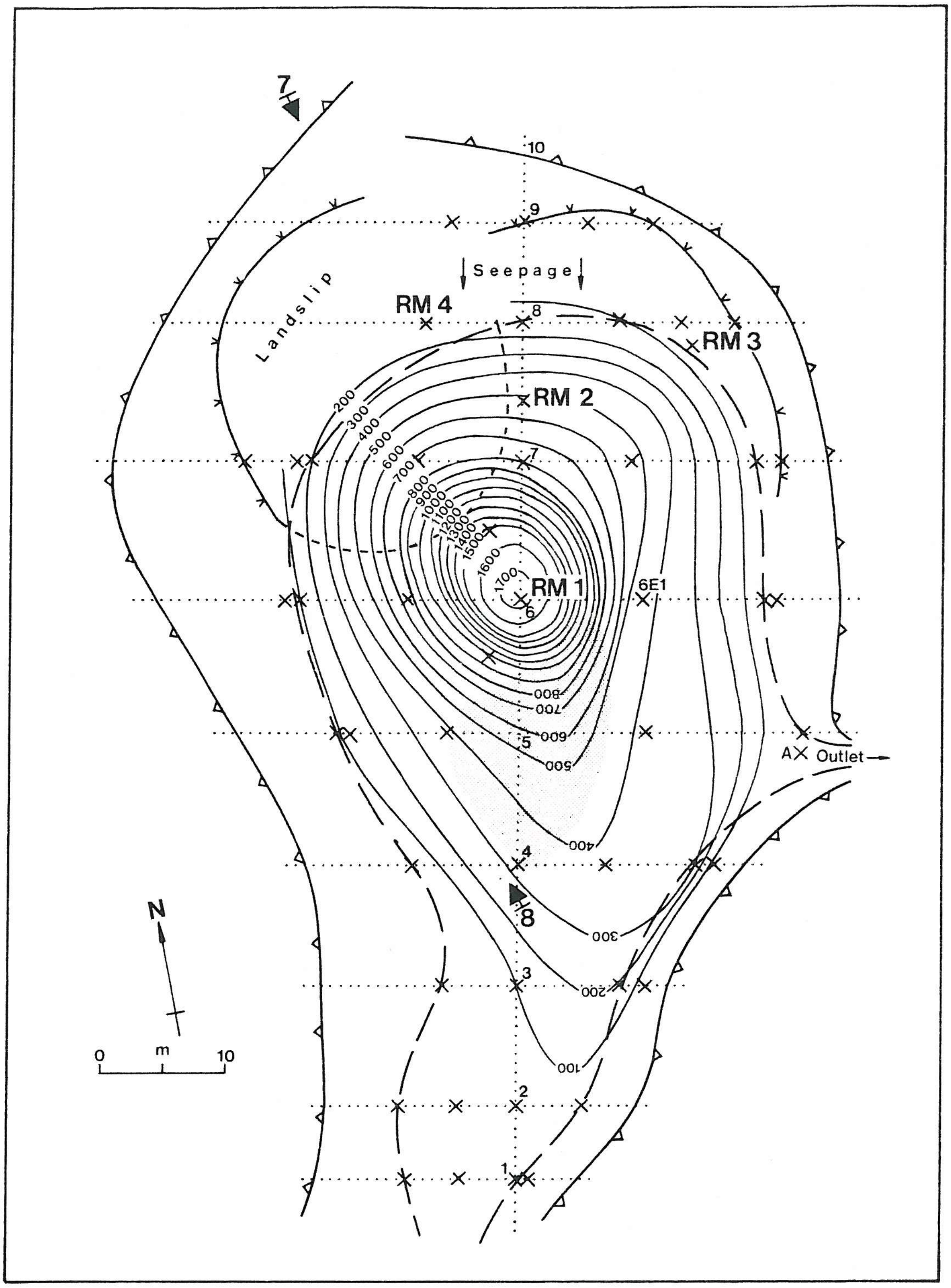


Figure 4.20. Rimsmoor and Okers: geology



×	Core
··········	Survey line
— —	Edge of bog
—100—	Isoline of peat depth, 100cm interval
- - - - -	Approx limit of landslip tongue
(shaded box)	Open water
	Concave break of slope
	Convex break of slope
7	Location of Plate

Figure 4.21. Rimsmoor: plan of site

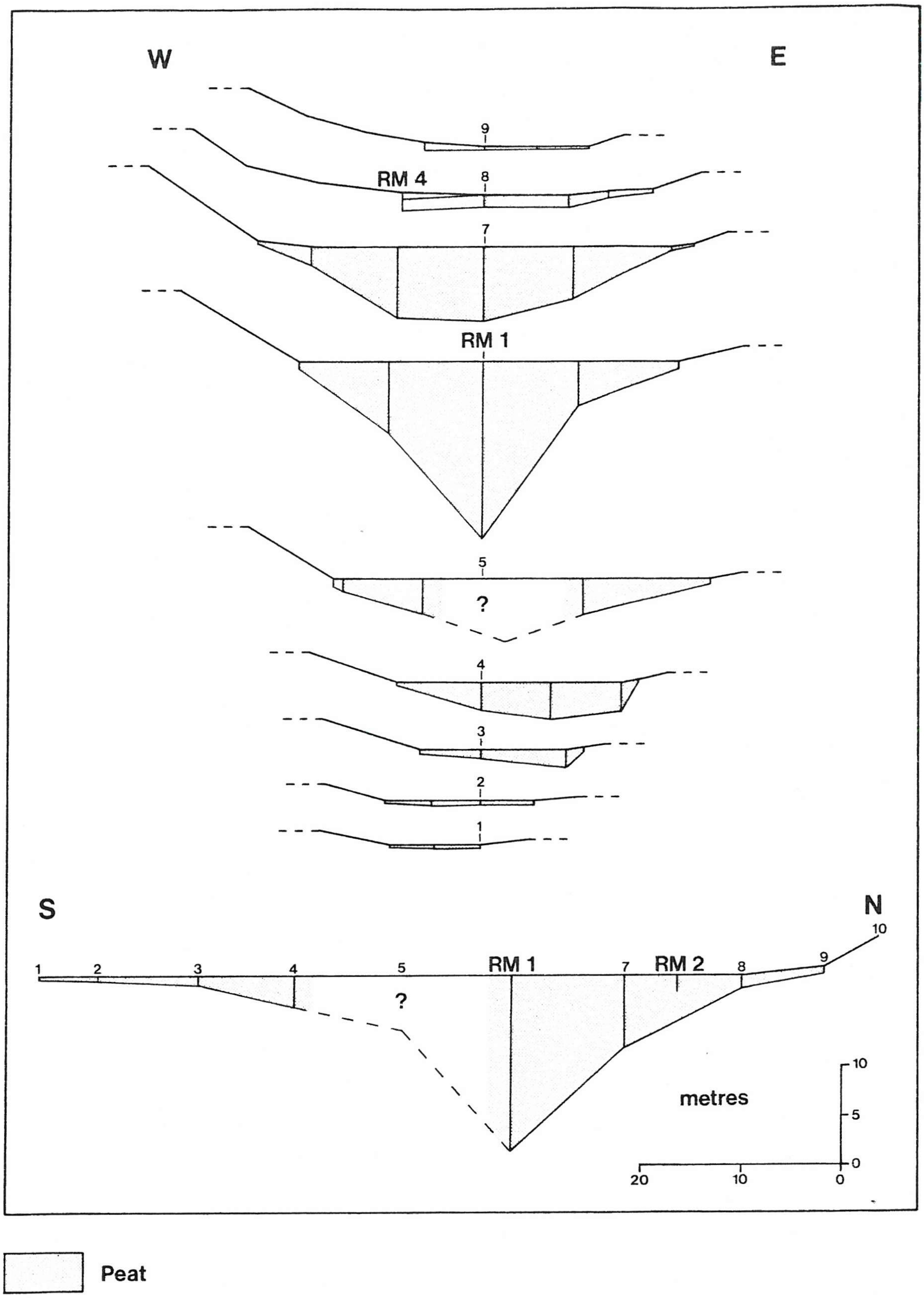


Figure 4.22. Rimsmoor: long and cross sections (no vertical exaggeration)

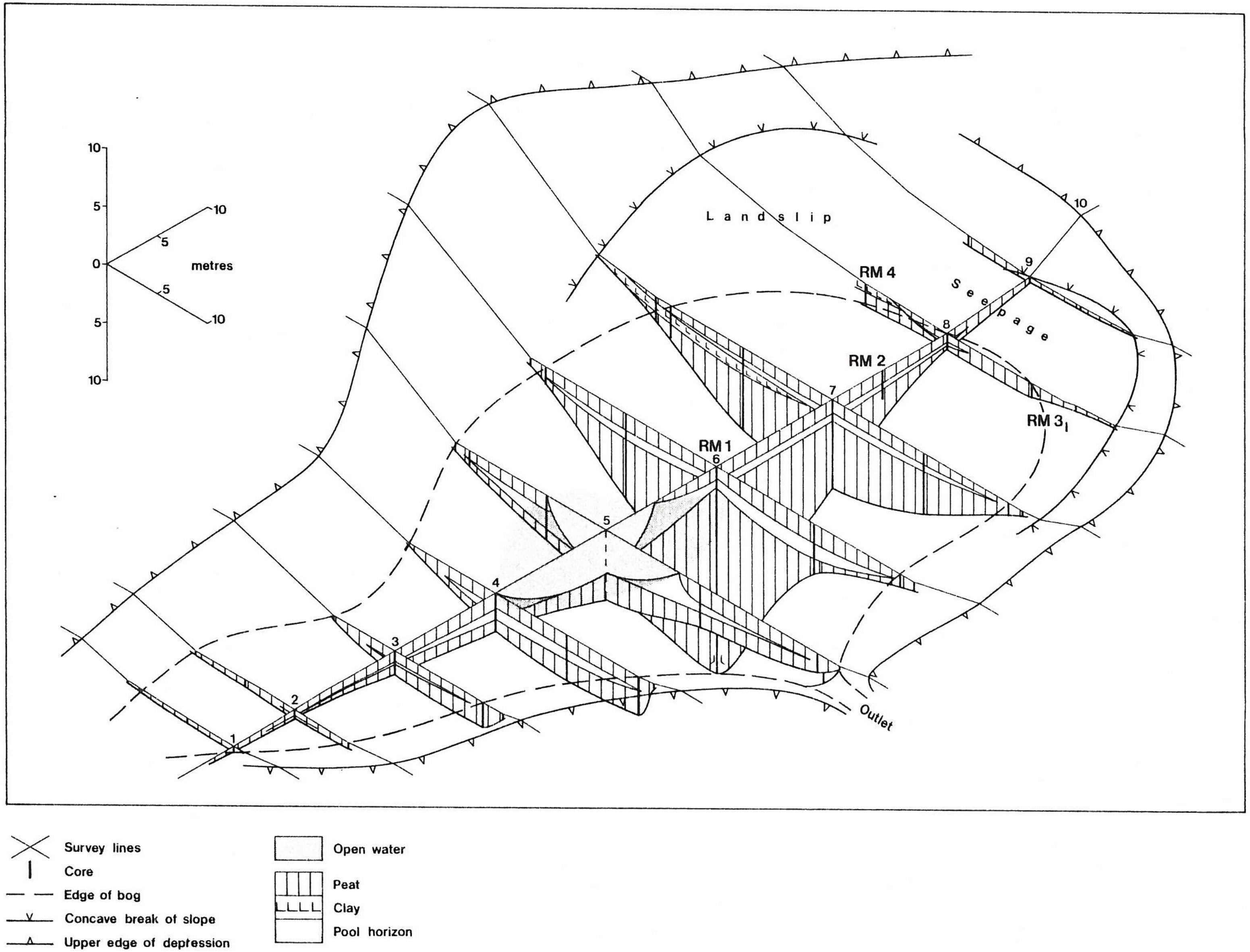


Figure 4.23. Rimsmoor: isometric view from south-east

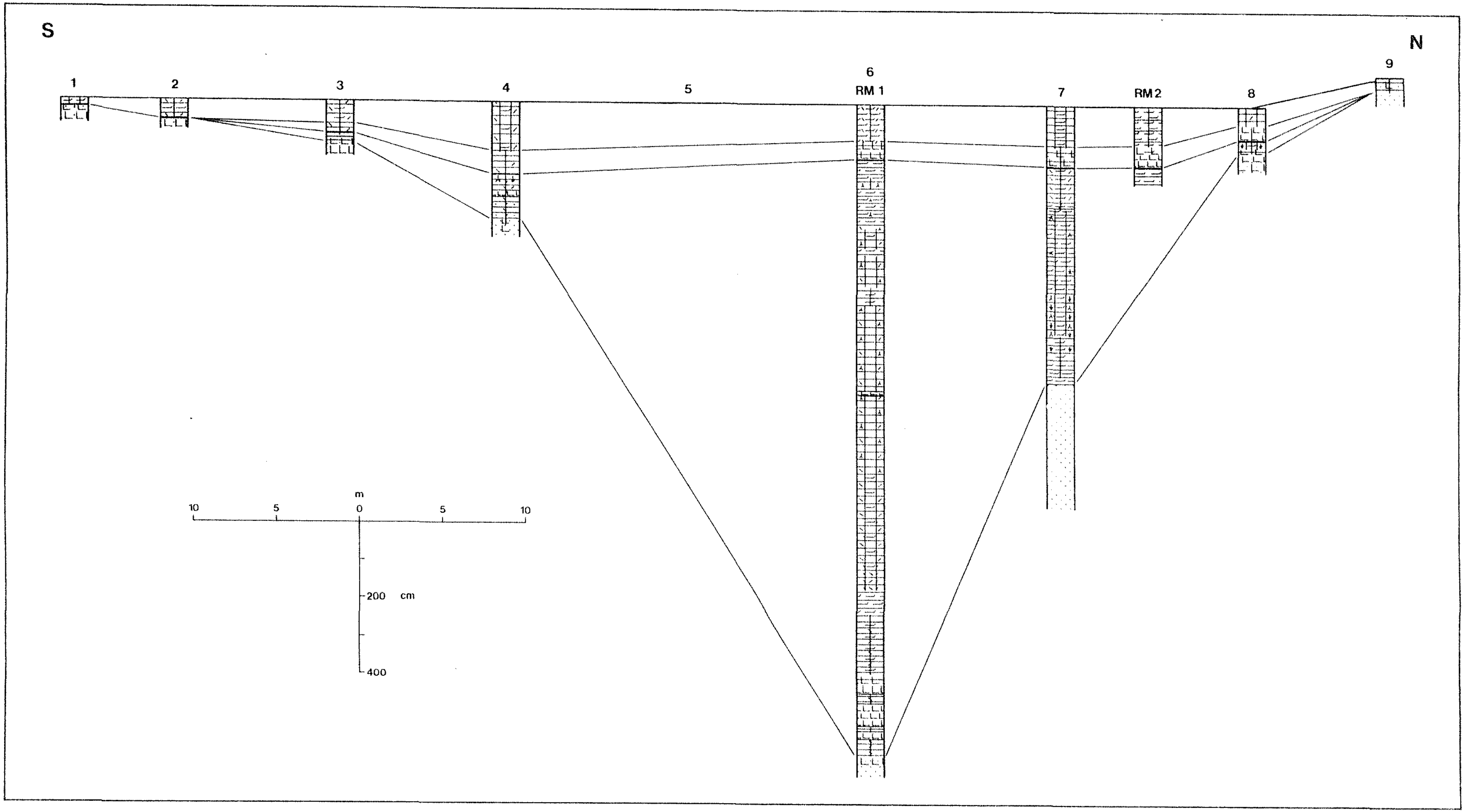


Figure 4.24a. Rimsmoor: stratigraphy, long section.
See Table 3.3. for symbols

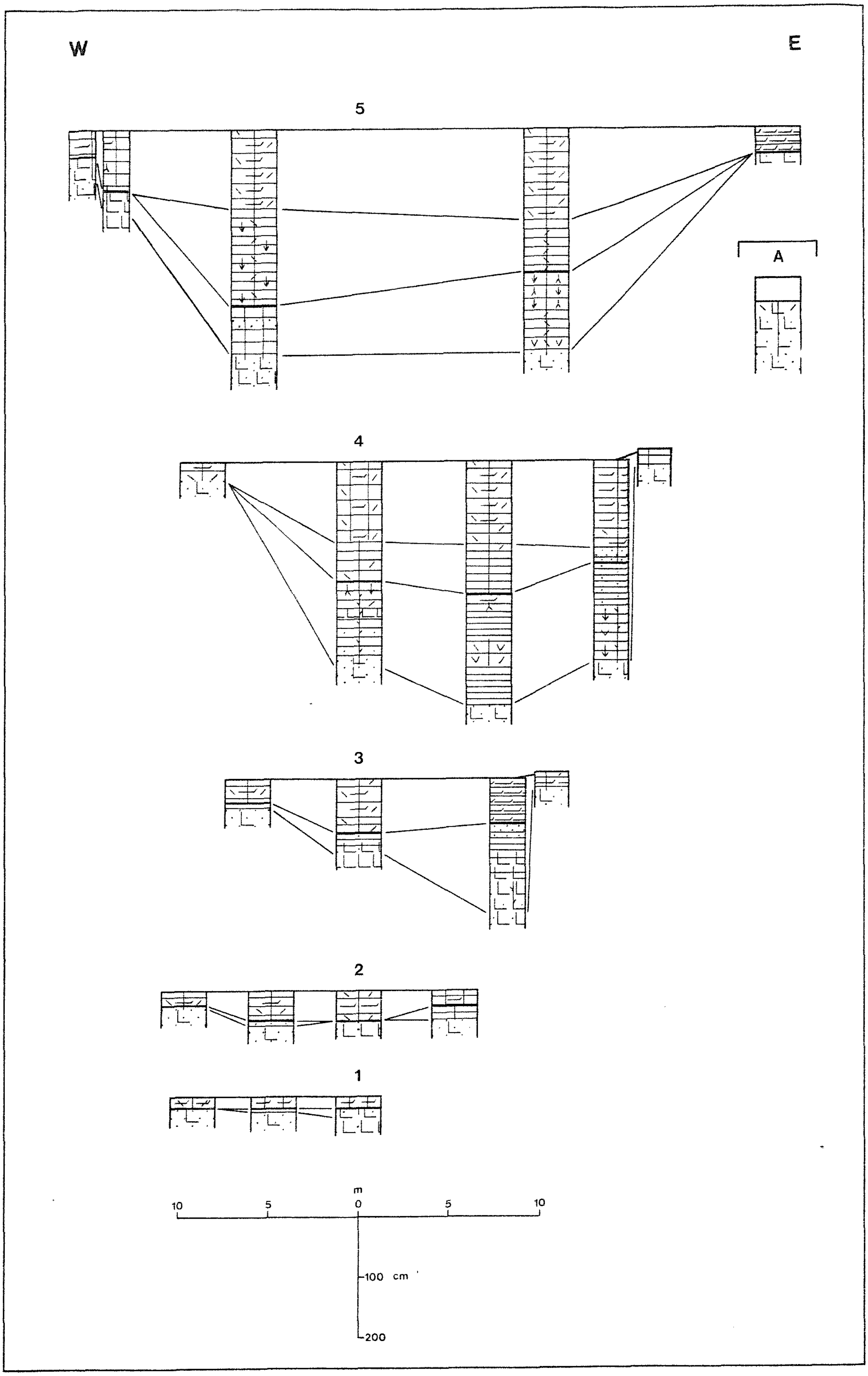


Figure 4.24b. Rimsmoor: stratigraphy, cross sections 1, 2, 3, 4 and 5. See Table 3.3. for symbols

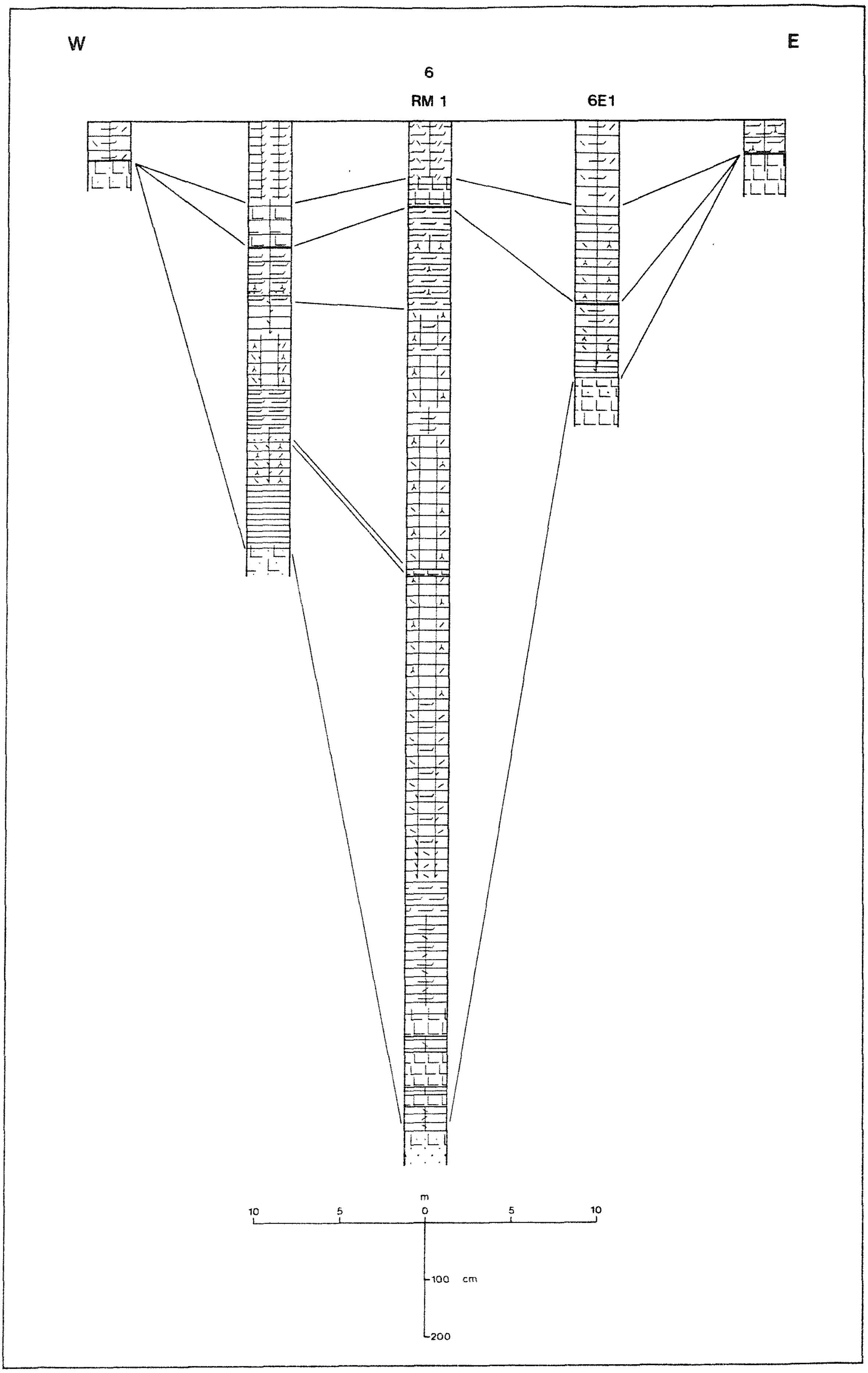


Figure 4.24c. Rimsmoor: stratigraphy, cross section 6.
See Table 3.3. for symbols

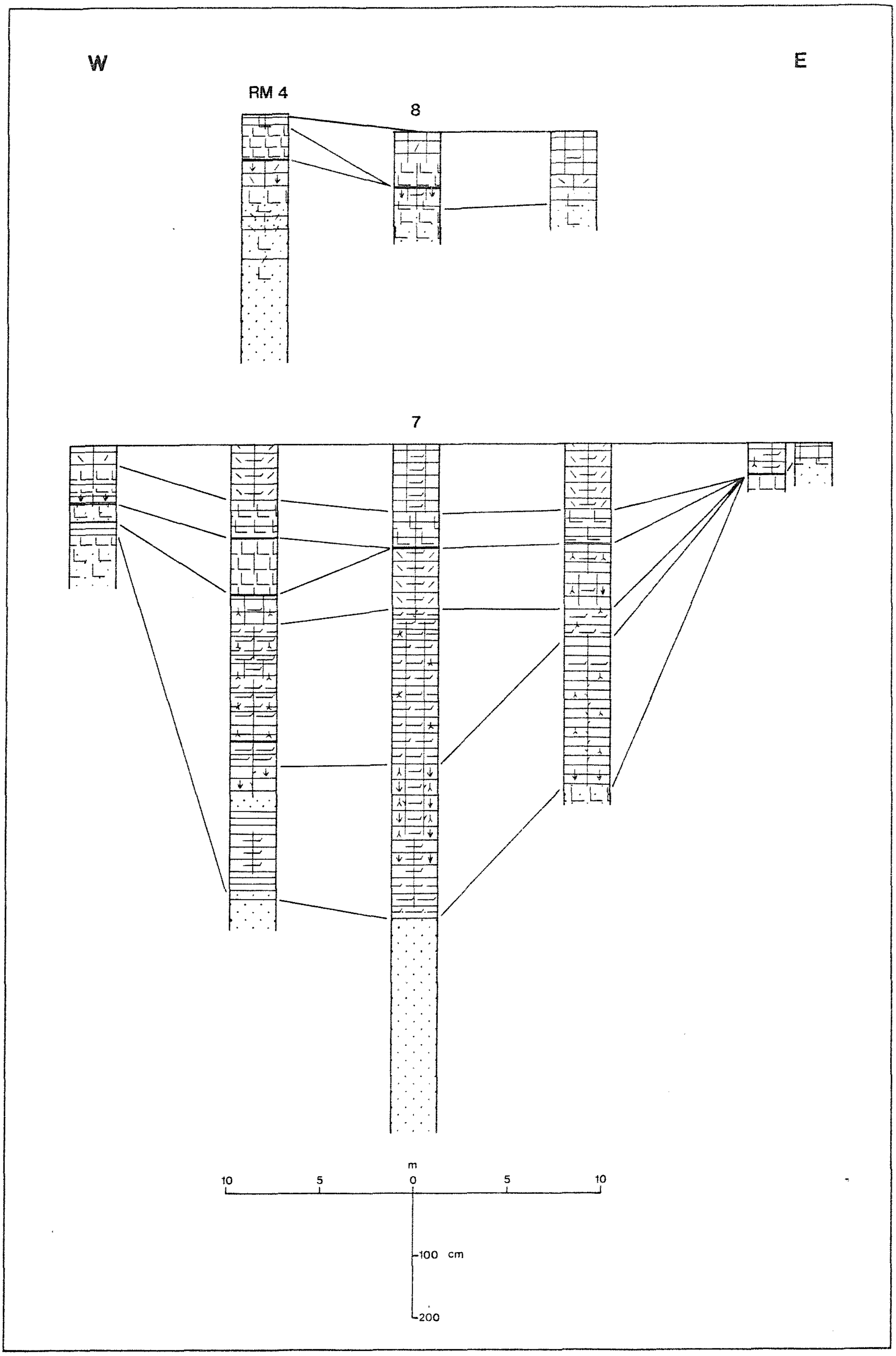


Figure 4.24d. Rimsmoor: stratigraphy, cross sections 7 and 8. See Table 3.3. for symbols

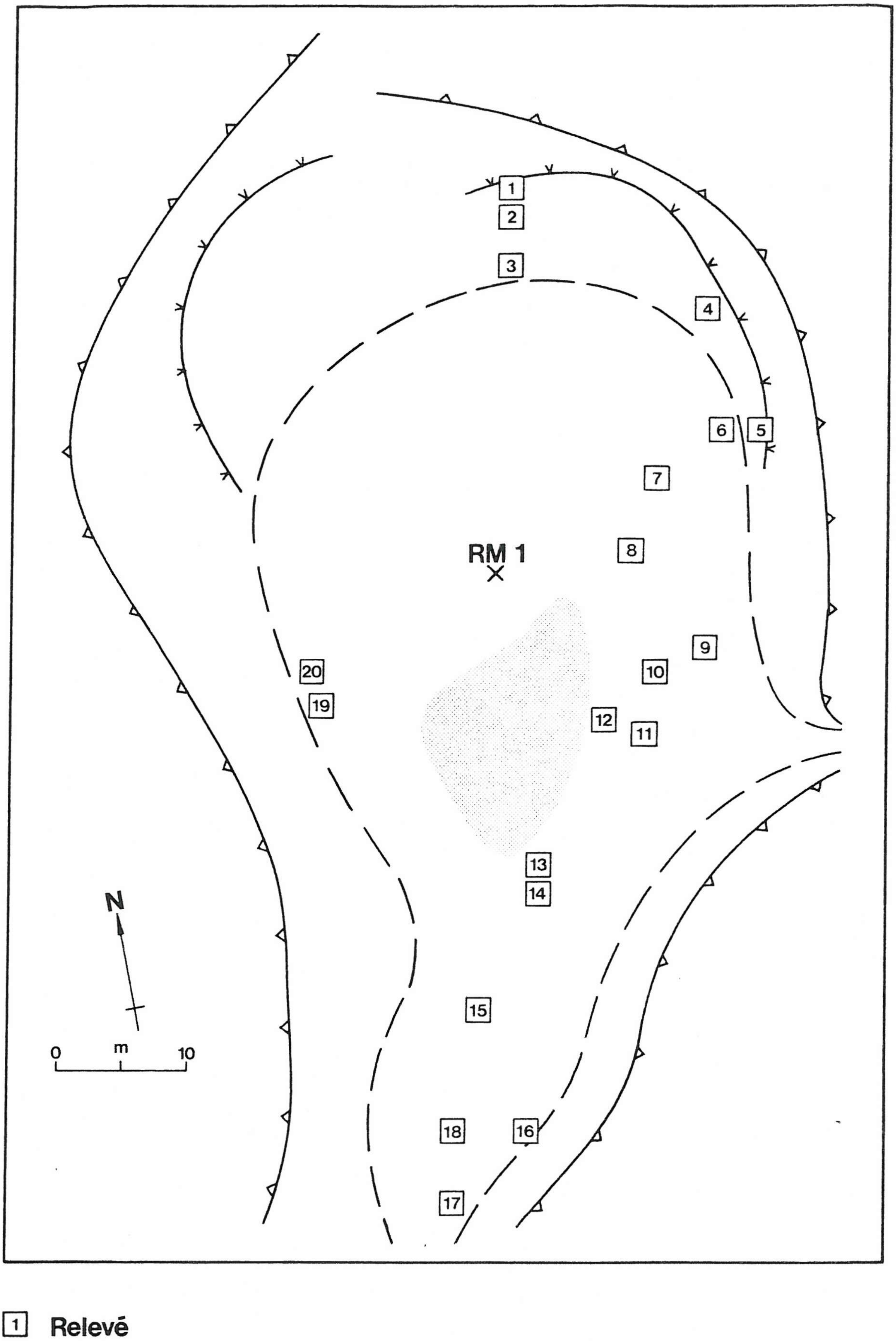


Figure 4.25. Rimsmoor: positions of relevés surveyed on 31 July 1981

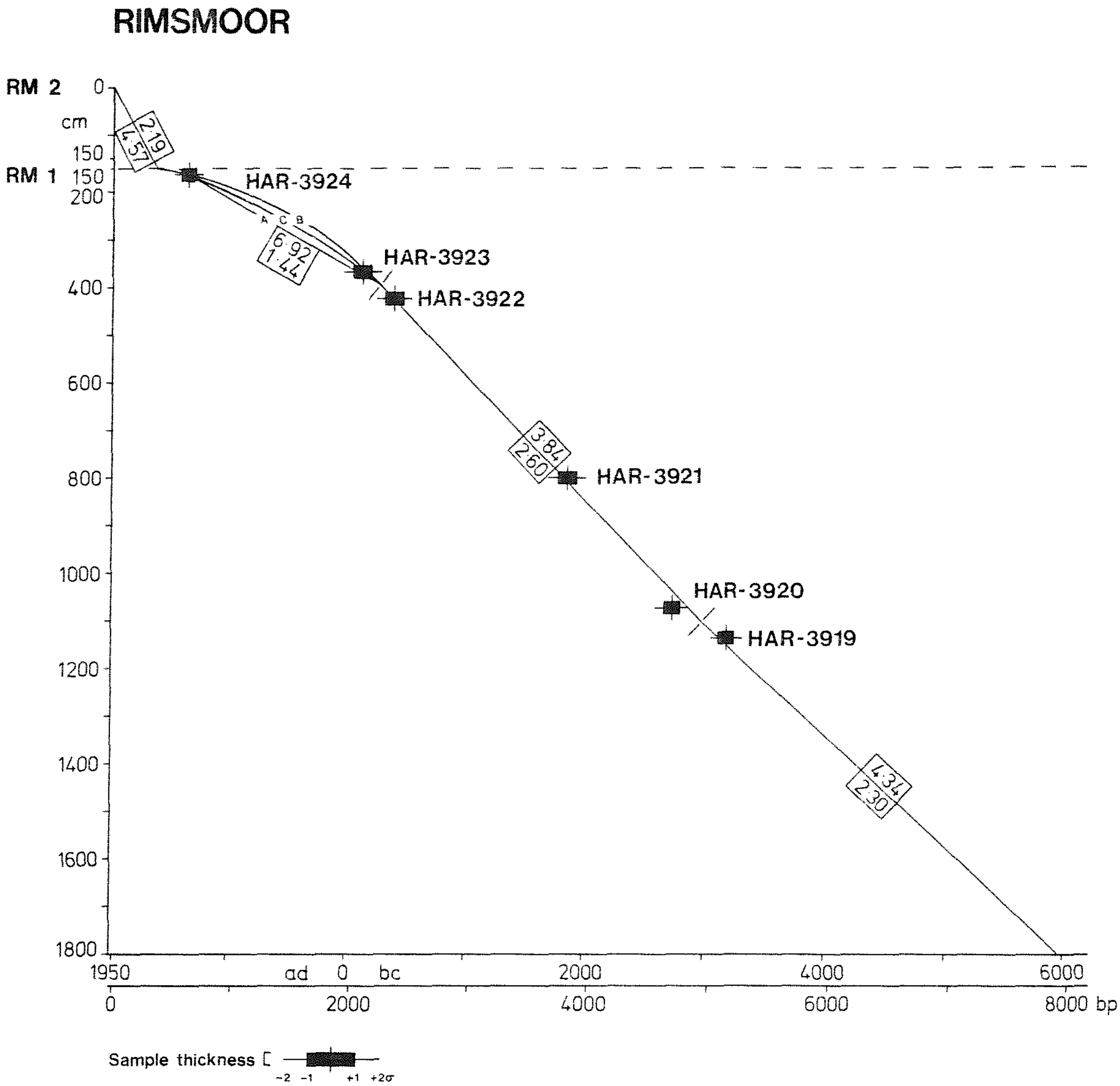


Figure 4.26. Rimsmoor: time:depth curve. Accumulation rates shown in boxes: upper figures yrs cm^{-1}, lower figures mm yr^{-1}

Table 4.5 Rimsmoor: vegetation survey of bog surface (31 July 1981). Domin Scale where 10 = maximum abundance. (See Fig 4.25 for positions of relevés).

Species	Relevés																			
	5	16	19	20	1	2	3	4	6	13	15	17	18	7	9	10	11	12	14	8
Molinia caerulea	9	9	9	8	4	6	4	8	6	3	3	6	3	3	4	3	4	4	..	3
Erica tetralix	4	4	3	3	4	4	3	5	3	6	7	8	7	3	3	2	3	..	1	..
Drosera rotundifolia	..	..	2	1	2	3	3	1	3	2	3	..	3	3	3	3	4	3	3	2
Sphagnum tenellum	2	..	4	3	3	5	..	3	..	5	6	4	3	..	..	..	..	..	..	..
Ulex minor	1	3	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Juncus acutiflorus	1	..	6	8	..	..	..	..	3	..	..	2	1	1	..	..	..	..	..	..
Aulacomnium palustre	..	..	3	3	..	..	..	..	..	5	..	..	..	..	..	2	..	..	..	..
Pteridium aquilinum	..	..	1	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Calluna vulgaris	1	1	..	..	3	2	3	4	..	4	5	..	4	..	..	..	..	..	..	..
Mylia anomala	..	..	..	..	..	..	3	..	..	1	5	1	2	..	..	3	..	..	3	..
Sphagnum capillifolium	..	..	1	..	5	4	8	4	4	6	6	..	8	3	3	7	..	..	3	3
Sphagnum papillosum	..	..	4	..	3	..	2	2	6	..	6	..	4	..	2	3	3	..	4	3
Sphagnum pulchrum	..	..	..	4	2	7	6	5	8	2	..	..	..	10	9	7	10	7	9	6
Narthecium ossifragum	..	..	..	..	3	3	3	2	3	..	2	..	3	3	3	3	3	2	..	3
Rhynchospora alba	..	..	..	..	..	..	..	..	3	4	..	..	..	3	3	3	3	3	3	3
Eriophorum angustifolium	..	..	..	..	..	..	..	..	..	3	3	..	..	3	3	3	1	4	3	3
Cladonia portentosa	..	..	..	..	..	3	..	..	..	..	3	3	2	..	..	..	..	..	..	..
Agrostis setacea	..	..	..	..	3	2	2	..	..	..	..	..	..	..	..	..	..	..	..	..
Sphagnum cuspidatum	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	..	..	..	6
Cephalozia spp	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	..	..	3	..
Menyanthes trifoliata	..	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	3	3	..	..
Drosera intermedia	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	7
Juncus squarrosus	..	..	..	..	..	..	2	1	..	..	..	..	..	..	..	..	..	..	..	..
Calypogeia fissa	2	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Hypnum jutlandicum	..	4	..	..	..	..	..	..	..	..	..	4	..	..	..	..	..	..	..	..
Ulex europaeus	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Potamogeton polygonifolius	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	..	..
Sphagnum auriculatum	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	..	..
Lepidozia setacea	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	3	..
Hypogymnia physodes	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..
Erica cinerea	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Scirpus cespitosus	..	..	..	..	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..
Sphagnum compactum	..	..	..	..	..	..	..	..	..	..	..	3	..	..	..	..	..	..	..	..
Odontoschisma sphagni	..	..	..	..	..	..	..	..	..	..	..	..	3	..	..	..	..	..	..	..
Lonicera periclymenum	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Table 4.6. Stratigraphy of Rimsmoor pollen core, RM 1

Depth(cm)	Nig	Strf	Elas	Sicc	Humo	Components	Description
150-200	2	0	3	1	1	(Sh2, As+) Tb(Sphag)3, Th 1, Dg+	Mid-brown *Sphagnum* peat
200-225	2	0	2	1	2	(Sh2) Th2, Dg 2, Dh(Eric)+	Mid-brown rootlet peat
225-340	2	0	2	1	2	(Sh2) Tb(Sphag)3, Th 1, Dg+, Dh(Eric)+	Mid-brown *Sphagnum* peat
340-395	2	0	2	1	2	(Sh2) Th 2, Dg 1, Dh(Eric)1, Tb(Sphag)+	Mid-brown rootlet peat
395-410	2	0	2	1	2	(Sh2) Tb(Sphag)4, Dg+, Th+	Mid-brown *Sphagnum* peat
410-500	2	0	2	1	2	(Sh2) Th 3, Dg 1, Dh(Eric)+, Tb+	Mid-brown rootlet peat
500-550	2	0	2	2	2	(Sh2) Th 2, Tb(Sphag)2, Dg+	Mid-brown rootlet and *Sphagnum* peat
550-782	2	0	2	2	2	(Sh2) Th 3, Dh(Eric)+, lim inf 1	Mid-brown rootlet peat
782-795	1	0	0	2	2	(As 4, Sh+) Th 4, lim inf 4	Light grey clay
795-1000	2	0	2	2	2	(Sh2) Th 3, Dg 1, Dh(Eric)+, Tb(Sphag)+	Mid-brown rootlet peat
1000-1150	2	0	2	2	2	(Sh2), Th 2, Dg 1, Tb(Sphag)1, Dh+	Mid-brown rootlet peat
1150-1275	2	0	2	2	2	(Sh2) Th(Phrag)2, Dg 1, Tb(Sphag)1, Dh+	Mid-brown *Phragmites* peat with *Sphagnum*
1275-1325	2	0	2	2	2	(Sh2) Th(Phrag)3, Dg 1, Dh+	Mid-brown *Phragmites* peat
1325-1400	2	0	2	2	2	(Sh2) Tb(Sphag)3, Th 1, Dg+	Mid-brown *Sphagnum* peat
1400-1550	3	0	1	2	3	(Sh3) Th(Phrag)2, Tb(Sphag)1, Dg 1, Dh+	Dark brown *Phragmites* and *Sphagnum* peat
1550-1575	2	0	1	2	3	(As 3, Sh+) Th 3, Dg 1	Grey peaty clay
1575-1600	2	0	0	2	3	(As 4, Sh+) Th(Phrag)4, Dh+, Dg+,	Grey clay with *Phragmites*
1600-1630	3	0	1	2	3	(Sh3, As+) Th 3, Dg 1, Dh+	Dark brown peat
1630-1690	2	0	0	2	3	(As 4, Sh+) Th(Phrag)4, Dg+	Grey clay with *Phragmites*
1690-1705	3	0	1	2	3	(Sh3, As+) Th 3, Dg 1	Dark brown rootlet peat
1705-1720	2	1	0	2	3	(As 4, Sh+) Th 3, Dg 1	Dark brown clay
1720-1770	1	0	1	2	3	(Sh3) Th 3, Dg 1	Dark brown rootlet peat
1770-1787	2	1	1	2	3	(As 4, Sh+) Th 3, Dg 1	Dark brown clay
1787+	1	0	0	1	-	Gmin4	Grey sand

Table 4.7. Stratigraphy of Rimsmoor pollen core, RM 2

Depth(cm)	Nig	Strf	Elas	Sicc	Humo	Components	Description
0-100	2	0	3	1	1	(Sh1, As+) Tb(Sphag)4, Dg+, Th+	Fresh *Sphagnum* peat
100-120	2	0	2	1	1	(As 2, Sh1) Tb(Sphag)4, Th+	Clayey *Sphagnum* peat
120-170	1	0	0	1	1	(As 4, Ag+, Sh+) Th 4, lim inf 2	Light-grey clay

Table 4.8. Stratigraphy of Rimsmoor *Ulmus* Decline core, RM UD

Depth(cm)	Nig	Strf	Elas	Sicc	Humo	Components	Description
1040-1042	2	0	2	2	2	(Sh2) Th 2, Dg 1, Dh(Eric)1, Gmin+	Mid-brown rootlet peat
1042-1055	2	0	2	2	2	(Sh2) Th(Phrag)2, Tb(Sphag)1, Dg 1, Dh(Eric)+, Gmin+	Mid-brown *Phragmites* peat with *Sphagnum*
1055-1078	2	0	2	2	2	(Sh2) Th(Phrag)2, Tb(Sphag)1, Dg 1, Dh(Eric)+	Mid-brown *Phragmites* peat with *Sphagnum*
1078-1087	2	0	2	2	2	(Sh2) Th(Phrag)3, Dg 1, Dh+	Mid-brown *Phragmites* peat
1087-1090	2	0	2	2	2	(Sh2) Th(Phrag)2, Dh 2, Dg+	Mid-brown *Phragmites* peat

Table 4.9. Stratigraphy of Rimsmoor _Tilia_ Decline core, RM TD

Depth(cm)	Nig	Strf	Elas	Sicc	Humo	Components	Description
800-807	2	0	2	2	2	(Sh2), Th 2, Tb(Sphag)2, Dh(Eric)+, Dg+	Mid-brown rootlet and _Sphagnum_ peat
807-816	2	0	2	2	2	(Sh2), Th 4, Dg+, Dh(Eric)+	Mid-brown rootlet peat
816-825	2	0	2	2	2	(Sh2) Th 3, Dg 1, Dh(Eric)+	Mid-brown rootlet peat
825-827.5	2	0	2	2	2	(Sh2) Th 2, Dg 1, Dh 1	Mid-brown rootlet peat
827.5-828.5	2	0	1	2	2	(As 2, Sh 1) Th 3, Dg 1	Clayey peat
828.5-831.5	1	0	0	2	-	(As 4, Sh+), lim inf 2	Grey clay
831.5-835	2	0	2	2	2	(Sh2) Th 2,Tb(Sphag)1, Dg 1, Dh+	Mid-brown rootlet peat with _Sphagnum_
835-845	2	0	2	2	2	(Sh2) Th 2, Tb(Sphag)2, Dg+, Dh(Eric)+	Mid-brown rootlet and _Sphagnum_ peat
845-850	2	0	2	2	2	(Sh2) Th 3, Dg/Tb(Sphag)1, Dh+	Mid-brown rootlet peat

These are shown in the time:depth curve, Figure 4.26. Dates HAR-3919 to 3923 are almost perfectly aligned with a mean accumulation rate of 3.84 yrs cm^{-1}. This is four to five times the modal value for bog peat recorded by Walker (1970) (16.7 to 19.6 yrs cm^{-1}, or 0.5 to 0.5mm yr^{-1}). A comparable rate of about 3.8 yrs cm^{-1} is recorded for about a metre of peat at Tregaron by Turner (1964b, 1981). Rimsmoor however is possibly unique for this rate is maintained for a depth in excess of 7m, c.2600 C-14 years. If only 1cm interval samples were counted then events lasting as little as 10 to 12 years may be discerned: the site therefore provides a unique opportunity for the detailed resolution of short-term events, within the constraints imposed by annual variations in pollen production.

The pollen source area at Rimsmoor will have increased over time as the basin slowly enlarged. To a certain, but more limited extent, this will have occurred at the other sites as peat accumulated and extended spatially. The felling of surrounding woodland will also have had the same effect at all sites except the larger Winchester and Amberley. The subsurface form implies that the diameter of the bog at the time of the Ulmus decline was about 10m (Fig 4.21). The Jacobson and Bradshaw (1981) model predicts that at this time 77% of the pollen will have come from within 20m of the edge of the bog, 13% from 20m to several hundred metres and 10% from beyond. At present, the diameter is about 40m; the respective values are 70%, 20% and 10%. Thus very little of the recorded pollen will have been derived from vegetation on the chalk 600 to 800m to the north. Nevertheless, the density of archaeological remains on the chalk imply that peripheral areas may also have been utilised. For this reason as well as the exceptional depth of the deposit, analysis was considered worthwhile.

4.5. OKERS

Core location: OK 1 SY 81279221

Plates 9 and 10

Okers is a second peat-filled doline, located 150m west of Rimsmoor (section 4.4.), in Bryants Puddle Heath, near Bere Regis, Dorset (Figs 4.19 and 4.20).

4.5.1. GEOMORPHOLOGY, STRATIGRAPHY AND PRESENT VEGETATION

Okers is very similar to Rimsmoor, only smaller. It is not shown on any Ordnance Survey map, including the latest metric edition (1972) of the 1:2500 plan, despite being an obvious feature on aerial photographs. The site is mentioned in the same passage as Rimsmoor in Thomas Hardy's, "The Return of the Native" (1878, 349) (section 11.5). The spelling adopted here is the same as Hardy's and in the tithe map of 1839: Okers, as opposed to Oakers of the Wood 500m to the south. The name is probably a corruption of Wolgar, rather than referring to oak trees (Brocklebank 1968; Mills 1977; section 10.6.1.).

It is a compound feature, again like Rimsmoor, with a secondary depression, which at Okers is at the north end; similarly the north-west side is higher and steeper, the others are more subdued (Fig 4.27). The maximum width of the depression is about 35m, length about 50m and height of the crest of the basin about 4.5m above the level of the Pool (Fig 4.28). The floor of the subsidiary doline in the north part is 50cm below the water level in the main section, yet it is dry. Another doline about 8m in diameter and 3m deep is located approximately 20m south-west of Okers. It too is dry despite its bottom being some 3m lower than the water level of Okers, although local _Juncus_ spp indicate moister soils. These features support the theory of the extreme localisation of the geological factors that may cause waterlogging (section 4.4.1.).

The main part of Okers is flat-bottomed, 20m wide (east to west) and 30m long (north to south) with the eastern half characterised by less than 50cm of peat on firm sand (Fig 4.29). From the centre the basal sand dips steeply (48^{o}) westwards and the peat attains a depth of 375cm 3m from a point where only 40cm was recorded. Further investigation of the subsurface profile was prevented by the pool: this has generally straight and vertical sides and is undoubtedly the result of peat cutting. A floating mat of vegetation and water depths in excess of 170cm made further work impossible: the construction of a platform was discouraged by the time this would have required. However, projection downwards of the basal sand surface and the slope of the west side of the basin on cross section 3 indicates a maximum depth of infill of at least 500cm below the water surface.

The accessible peat varied in colour from mid-brown at the surface to very dark brown at the base and remains of wood and Phragmites became more common with increasing depth. Sphagnum layers occurred at various levels and a clay horizon 1 to 4cm in thickness was recorded in three cores between 70 and 100cm below the surface.

The local vegetation was recorded on 31 July 1981 with Drs Colin and Honor Prentice. The basin sides were dominated by grasses and Pteridium with some Ulex europaeus. On the north side were Lonicera periclymenum and Digitalis purpurea and a single specimen of Ilex aquifolium. Species in the wet area around the pool included Juncus effuscus, J. conglomerata, J. acutifolius, J. berbosus, Eleogitans fluitans, Sphagnum recurvum, Molinia caerula, Agrostis canina subspp. canina, Calluna vulgaris, Erica tetralix and Potentilla erecta. The floating vegetation mat on the pool was composed principally of Sphagnum cuspidatum. The surrounding area was heathland until planted with pines in the 1950s.

4.5.2. CORING AND ANALYSIS

The core for pollen analysis (OK 1) was from the deepest peat that was accessible, located on the east edge of the pool. This point was 11m from the north edge of the doline and 10m from the east edge. The vertical side of the pool was 70cm to the west and 20cm of water covered this peat. A surface sample was taken of Sphagnum from the floating mat. The stratigraphy of OK 1 is shown in Table 4.10.

Samples were taken at 10cm intervals and prepared using the standard schedule. The pollen diagram (PD 5) was not radiocarbon-dated: its chronology was derived by comparison with Rimsmoor (section 5.5) and a tentative time:depth curve was constructed (Fig 4.30). The deepest accessible polliniferous sample was 395cm.

As with Rimsmoor, the surface area of the peat will have increased over time as the doline developed, and as a result, the pollen source area will also have become greater. The peat surface prior to cutting was about 12m in diameter. Application of this value to the Jacobson and Bradshaw (1981) model suggests that about 76% of the pollen will have been derived from within 20m of the edge of the bog, 14% from 20m to several hundred metres from the edge of the bog and about 10% from in excess of that distance. These figures probably represent minimum values as the

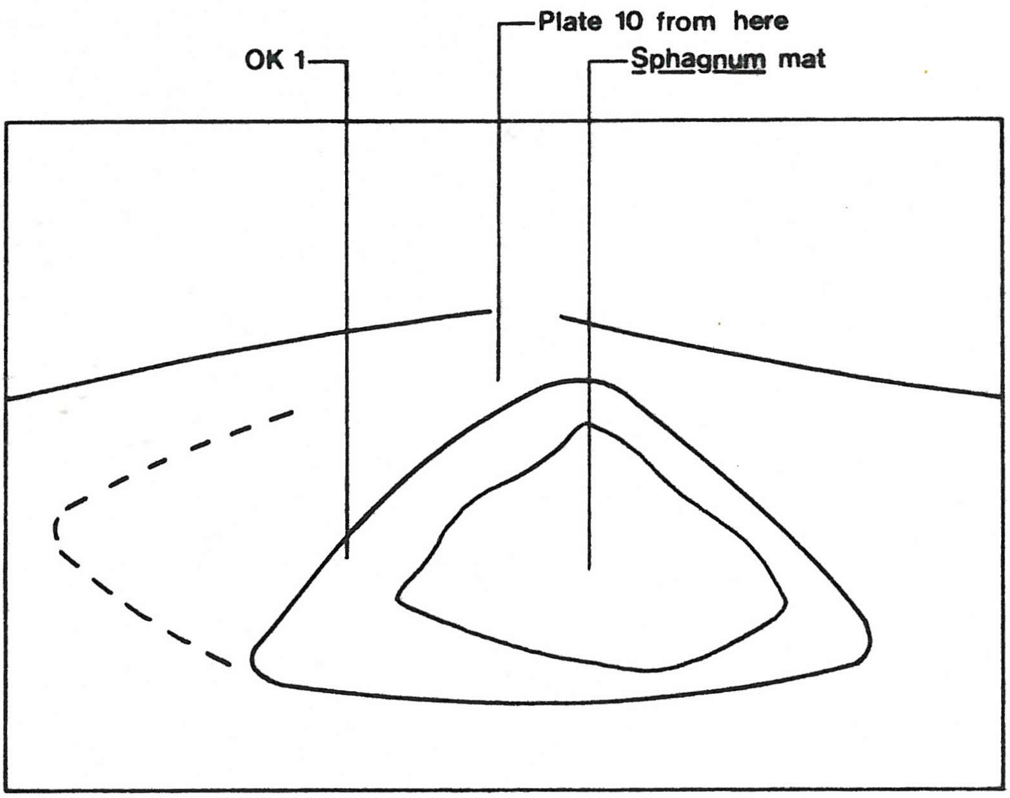


Plate 9. Okers: general view from north

From SY 81279223 looking S
11 April 1980

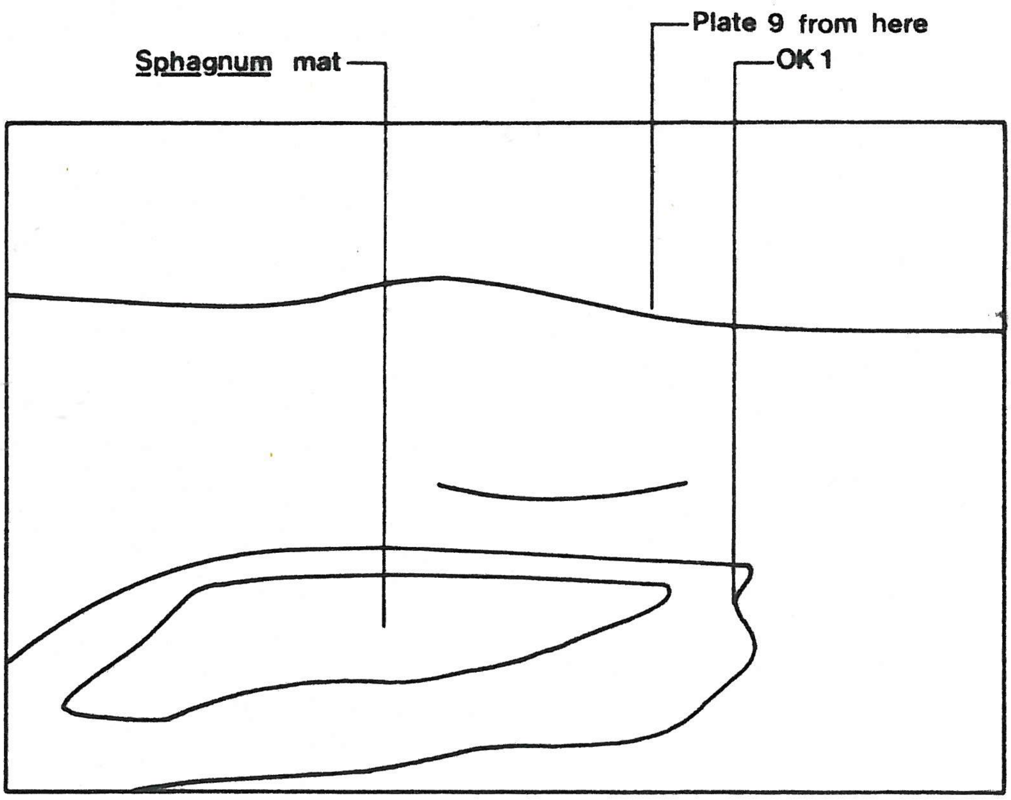


Plate 10. Okers: view from south

From SY 81279219 looking N
11 April 1980

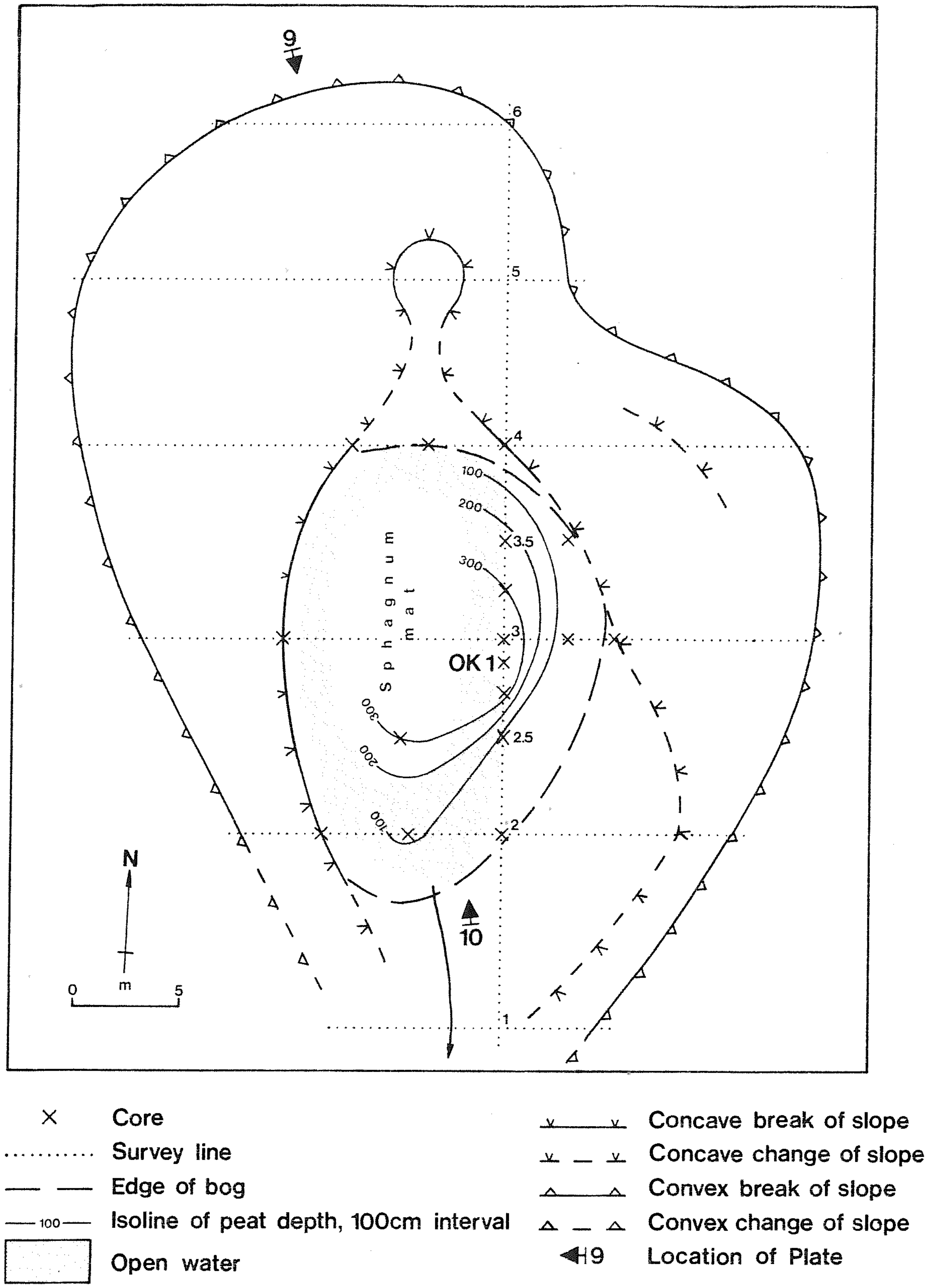


Figure 4.27. Okers: plan of site

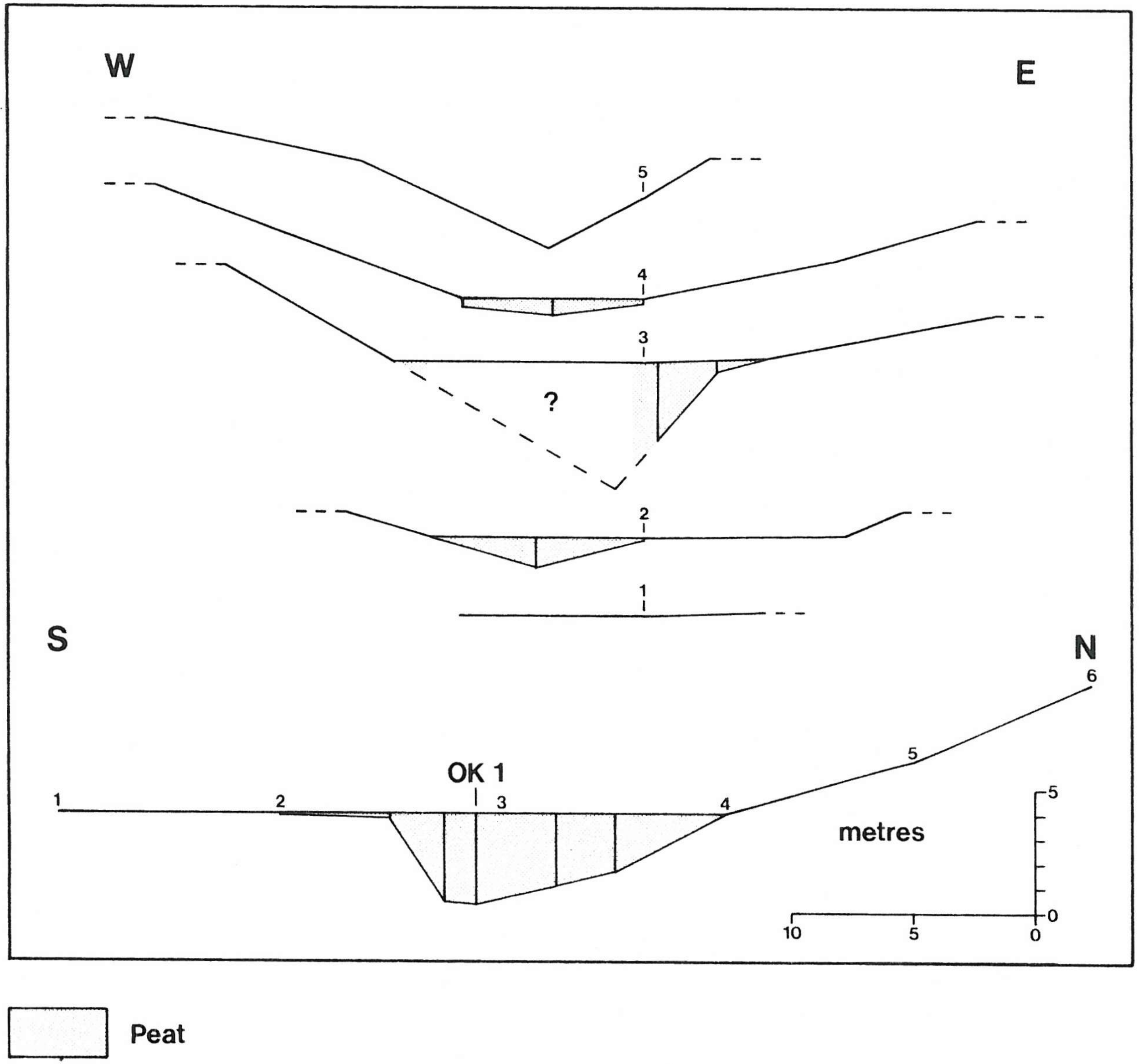


Figure 4.28. Okers: long and cross sections (no vertical exaggeration)

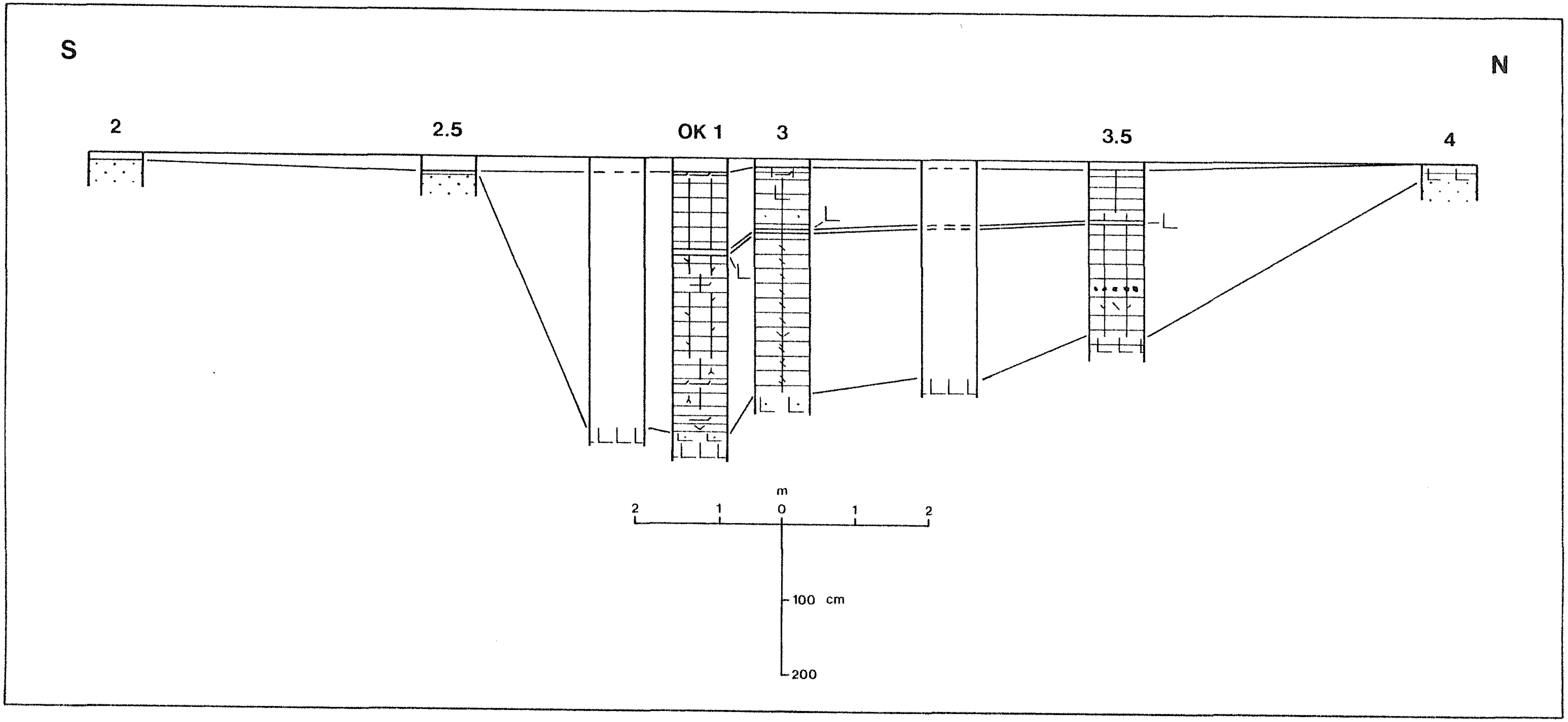


Figure 4.29a. Okers: stratigraphy, long section. Open cores were assessed only for depth of basal inorganic horizon. See Table 3.3. for symbols

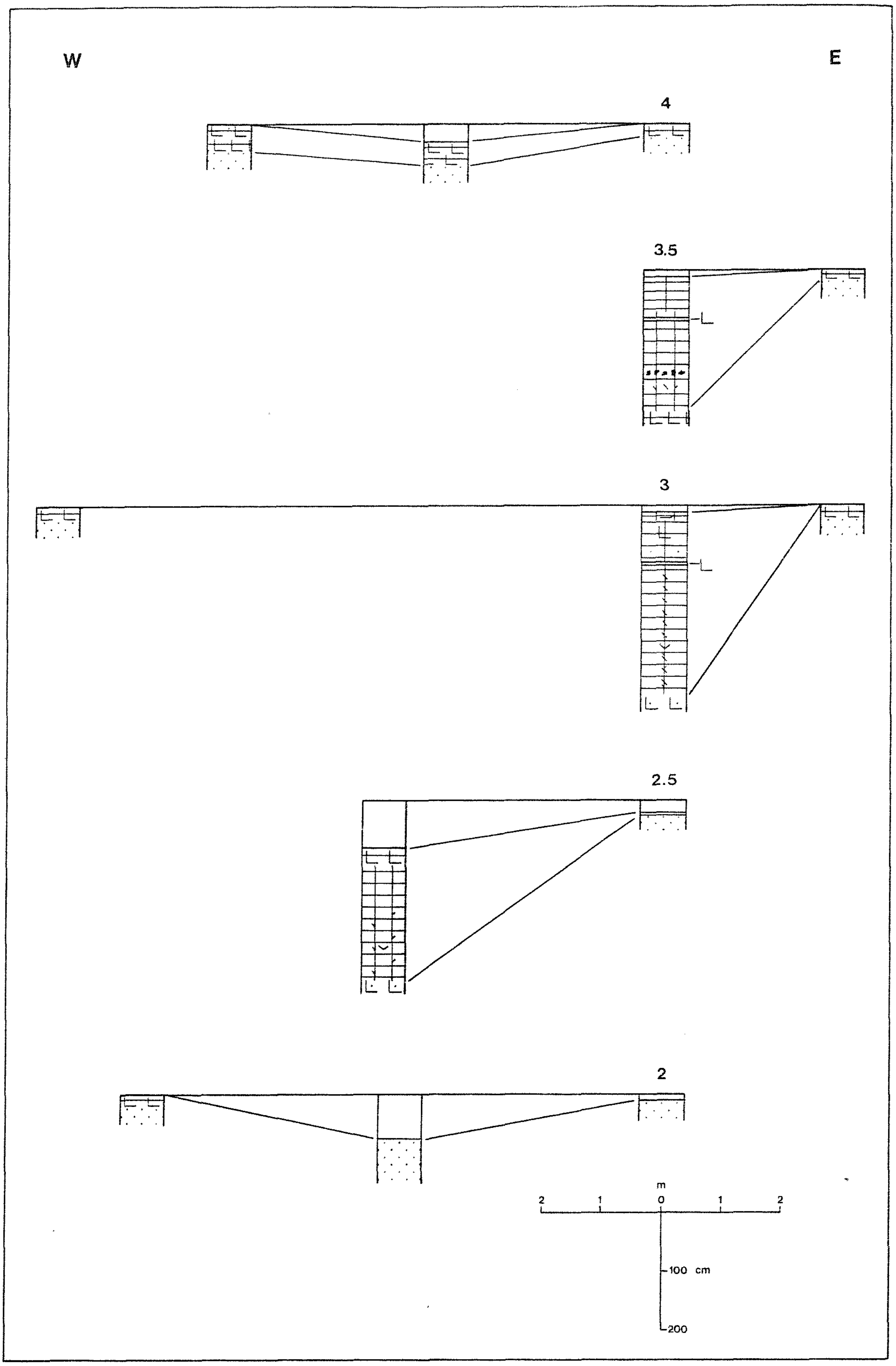


Figure 4.29b. Okers: stratigraphy, cross sections.
See Table 3.3. for symbols

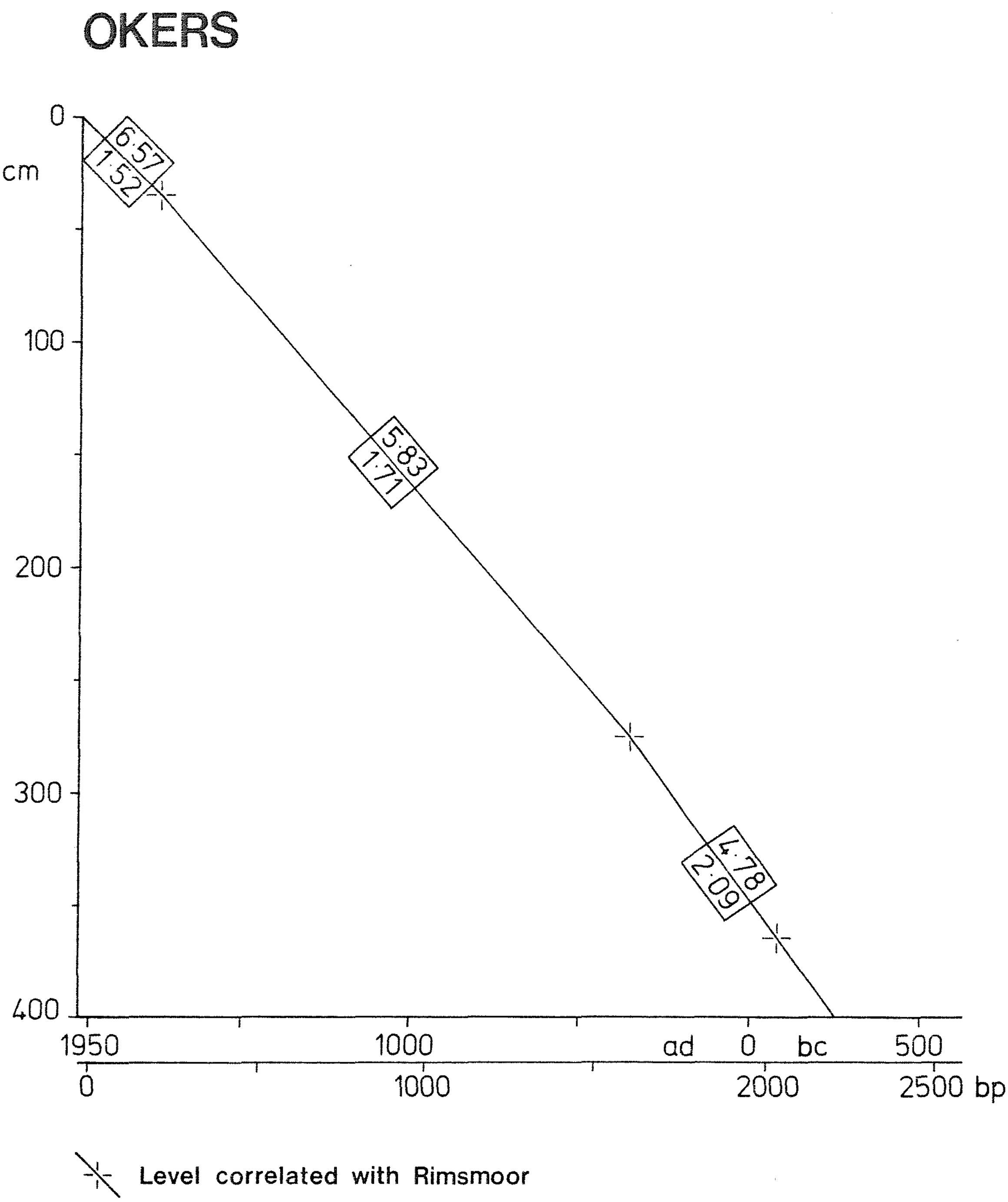


Figure 4.30. Okers: time:depth curve. Accumulation rates shown in boxes: upper figures yrs cm^{-1}, lower figures mm yr^{-1}

Table 4.10. Stratigraphy of Okers pollen core, OK 1

Depth(cm)	Nig	Strf	Elas	Sicc	Humo	Components	Description
0-3	2	0	3	2	1	(Sh+) Tb(Sphag)4	*Sphagnum*
3-19	-	-	-	0	-	-	Water
19-24	2	0	2	1	1	(Sh2, As+) Tb(Sphag)4, Th+	Mid-brown *Sphagnum* peat
24-127	3	0	2	1	2	(Sh2, As+) Th 4, Dg+, lim inf 2	Mid-brown rootlet peat
127-132	1	0	0	2	2	(As 4, Sh+) lim inf 2	Light grey clay
132-162	2	0	2	2	2	(Sh2) Th(Phrag)3, Dg 1	Mid-brown *Phragmites* peat
162-185	2	0	2	2	2	(Sh2) Th(Phrag)3, Tb(Sphag)1, Dg+	Mid-brown *Phragmites* peat with *Sphagnum*
185-230	2	0	2	2	2	(Sh2) Th(Phrag)3, Dg 1, Dh+	Mid-brown *Phragmites* peat
230-231	2	0	2	2	2	(Sh2) Tb(Sphag)4, Th+	Mid-brown *Sphagnum* peat
231-275	2	0	2	2	2	(Sh2) Th(Phrag)3, Dg 1, Dh+	Mid-brown *Phragmites* peat
275-307	3	0	2	2	2	(Sh2) Th 2, Dg 1, Dh 1	Dark brown rootlet and detritus peat
307-312	3	0	2	2	2	(Sh2) Tb(Sphag)4, Dg+, Dh(Eric)+	Dark brown *Sphagnum* peat
312-345	3	0	2	2	2	(Sh2) Th 2, Dg 1, Dh(Eric)1	Dark brown rootlet and detritus peat
345-362	3	0	1	2	3	(Sh3) Tb(Sphag)2, Th 1, Dg/DL 1	Dark brown woody *Sphagnum* peat
362-370	3	0	1	2	3	(Sh3) Dg/DL 3, Th 1	Dark brown detritus peat
370-375	1	1	0	2	3	(Sh+) Gmin4, Th+	Grey sand
375-385	1	1	0	2	3	(As 2, Ag 1, Sh+), Gmin1, Th+	Grey sandy clay
385+	1	1	0	1	-	(As 4, Ag+)	Grey clay

pollen diagram relates to a period of generally open conditions, yet, like Rimsmoor, actual representation of chalkland vegetation will have been low. Nevertheless, its location near Rimsmoor enables some indication of the extent of the vegetation changes recorded at both sites.

4.6. KINGSWOOD

Core location: KW 1 SZ 00578222

Plates 11 and 12

The bog on Kingswood Heath is located on the southern margin of the Poole Basin to the east of Corfe Castle and north of the Purbeck chalk ridge (Figs 4.31 and 4.32). Land use is strongly influenced by soils and slopes. *Calluna* heathland and coniferous plantations dominate the Bagshots with some improved grassland, including a golf course, along the foot of the ridge. Arable farming is practised on the London Clay step abutting the chalk and on the chalk of Ballard Down. Permanent grassland prevails on the steeper slopes of the ridge with a strip of woodland, King's Wood, on its north-facing slope. The Wood is dominated by *Fraxinus* with *Corylus*, *Quercus*, *Crataegus monogyna*, *Sorbus aria* and *Hedera helix*. *Castanea sativa*, *Pinus* spp and *Picea* spp are planted on the lower slopes.

4.6.1. GEOMORPHOLOGY, STRATIGRAPHY AND PRESENT VEGETATION

The mire is situated 1km west of the Godlingston Heath bogs investigated by Haskins (1978) and in similar geology: Bagshot Beds. The Geological Survey map (sheet 343) shows one area of peat on the Heath at 005827 but omits an area to the south at 006822. This has developed below a distinct springline at about 75m OD at the foot of the slope leading up to the London Clay step. It does not coincide with any change in geology so may be solely the result of relief. Above is dry grassland and below is wet heath; *Ulex europaeus* and *Rubus* spp prevail along the springline. With its location nearer the chalk, only this southern deposit was examined.

The bog forms an area of wet heath 100m east to west and 300m north to south between improved grassland to the west and dry heath to the east. The southern half is essentially a level area with a shallow valley incised

1 to 2m into and along the east central margin, later curving westwards to form a step feature across the bog. The level area above the step and below the springline is characterised by longitudinal ridges of drier peat and vegetation doubtlessly caused by peat cutting. These features are also visible in grid square 004824. To the north, below the step, conditions are drier with generally less than 50m of peat.

Only the south-east area was surveyed and investigated stratigraphically, because of deeper peat and less obvious disturbance. A long section from the south-east corner of the bog at 0060282100 (shown on the 1:2500 plan) was followed northwards along the shallow valley to the west of a boundary fence and thence westwards with the valley (Fig 4.33, 4.34). Five cross sections were followed up to 40m from the long section.

The peat in the area west of the valley and south of the step was less than 100cm in depth and individual cores frequently showed a sharp change at 30-80cm (Fig 4.35). Above this probable cutting junction mid-brown rootlet and Molinia peat prevailed and below, darker peat (humo 3-4) on clay and sand. On the long section a maximum depth of 160cm of peat was recorded above the step, with the cutting junction at 85cm. Peat depth fell to 20-40cm at the step but increased below it to 100 to 190cm without any obvious stratigraphic discontinuity. The form of the peat below about 50cm was dark (humo 3-4) with root and Molinia remains; above 50cm mid-brown, less humified, with roots, ericaceous remains and Sphagnum.

The following species were recorded growing on the bog on 29 June 1981: Ranunculus repens, Polygala vulgaris, Montia fontana, Potentilla erecta, Drosera rotundifolia, Epilobium sp, Hydrocotyle vulgaris, Myrica gale, Calluna vulgaris, Erica tetralix, Pedicularis sylvatica, Pinguicula lusitanica, Succisa pratensis, Cirsium palustre, C. dissectum, Potamogeton cf polygonifolius, Narthecium ossifragum, Juncus effusus, J. conglomeratus, J. bulbosus, Planathera bifolia, Eriophorum angustifolium, Schoenus nigricans, Carex panicea, C. echinata, Molinia caerulea and Agrostis setacea. The bryophytes included Campylium stellatum var stellatum, Polytrichum commune, Hypnum jutlandicum, Sphagnum papillosum, S. subnitens, S. capillifolium and Lepidozia setalla. A line of Salix cinerea subsp. atrocinerea extends diagonally across the southern part of the bog from the south-east corner and Ulex europaeus is present on the drier step. Myrica is most abundant along the line of the valley and below the step exploiting locally nutrient-rich water. Large tussocks of Juncus and Carex are present along the east side of the valley and below the step.

4.6.2. CORING AND ANALYSIS

The pollen core, KW 1, was from a location 13m east of point 4, which was 2m east of the boundary fence. The edge of the bog was 7m to the east. The peat was 250cm deep and overlay sand (Table 4.11). A sample of Sphagnum was taken from a polster 20m to the west.

The pollen was generally abundant and samples were subjected to the standard preparation (section 3.2.2.). The interval was 4cm, with some critical levels at 2cm; the lowest polliniferous sample was 232cm (PD 6). Two levels were selected for C-14 assay, 100cm and 212cm. In five separate cores the level of suspected Mesolithic interference (section 8.2.3.1.) could not be re-located despite sampling at intervals as close as 3cm. In KW 1 the event occurs over about 6cm depth of peat; this anomaly may be accounted for by local fluctuations in accumulation rate. Consequently, material from just above the Ulmus decline clearance was dated. It was correlated to a depth of 175 to 185cm in KW 1 and gave the result of 2610±60bc (HAR-4239).

The second sample was located at a correlated depth of 95 to 104cm to date a phase of clearance and cultivation, and to determine whether the core had been disturbed by cutting, for the stratigraphy is markedly more clayey above 123cm. The result was 430±80bc (HAR-4367; Table 3.4; Fig 4.36).

The likely pollen catchment area is equivocal because of the discontinuous nature of the deposit and the location of the core. With the edge of the bog 7m to the east, the minimum effective diameter is 14m as the Jacobson and Bradshaw (1981) model assumes a sampling point situated in the centre of a basin (section 2.4.3.). This figure suggests that 76% of the pollen will have come from within 20m of the edge of the bog, 14% from 20m to several hundred metres and 10% from beyond. The total width of the deposit at this point is about 30m, giving values respectively of 73%, 17% and 10%. These proportions suggest that again relatively little

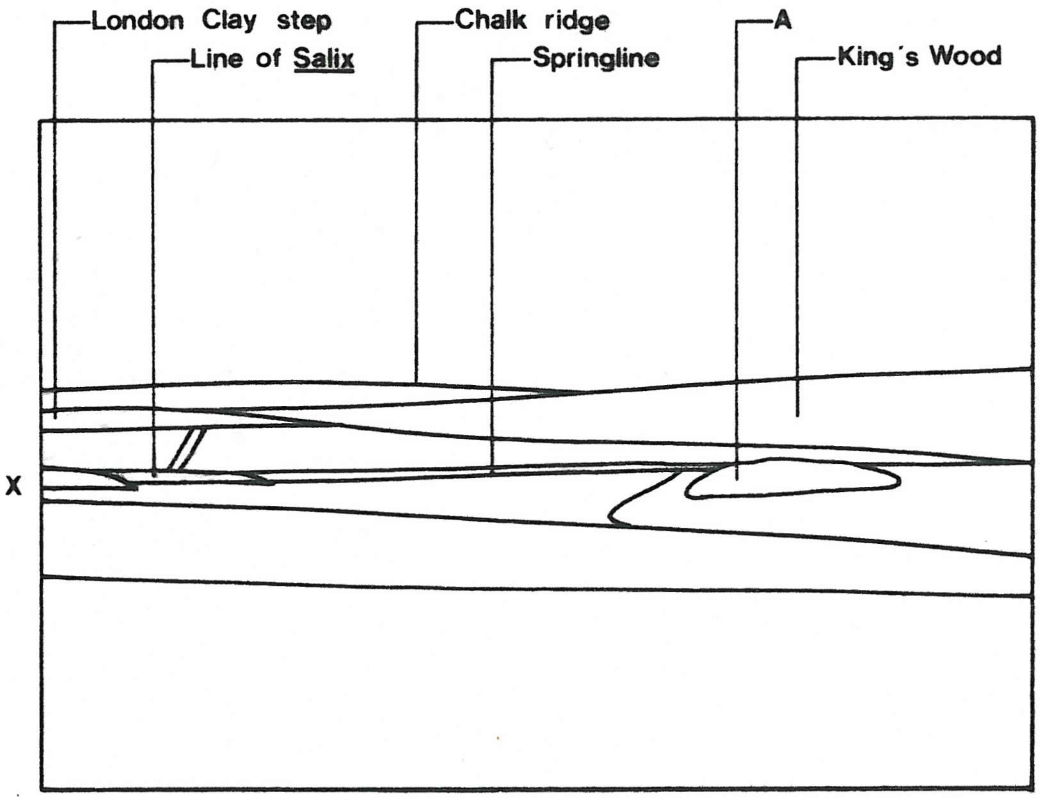


Plate 11. Kingswood: general view across bog towards chalk ridge. Core KW 1 from location just out of view at 'X'. Note *Ulex* scrub ('A') - also visible in Plate 12

From SZ 00458250 looking S
9 July 1980

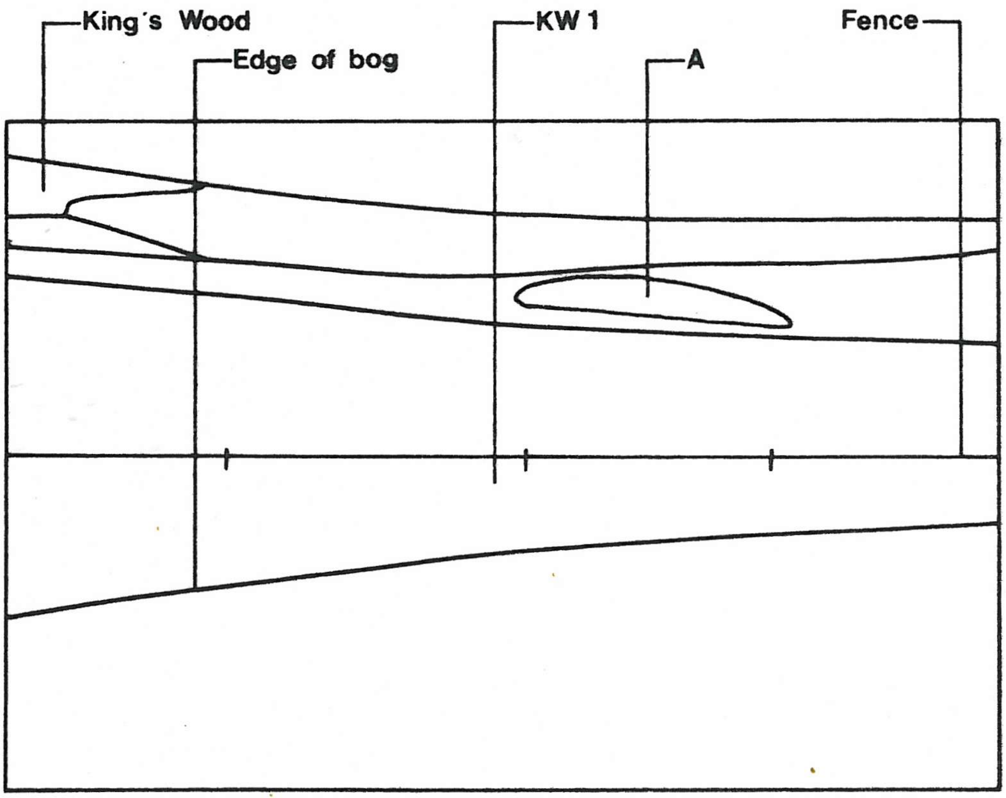


Plate 12. Kingswood: site of core KW 1. Note Ulex scrub ('A') - also visible in Plate 11

From SZ 00608222 looking W
29 June 1981

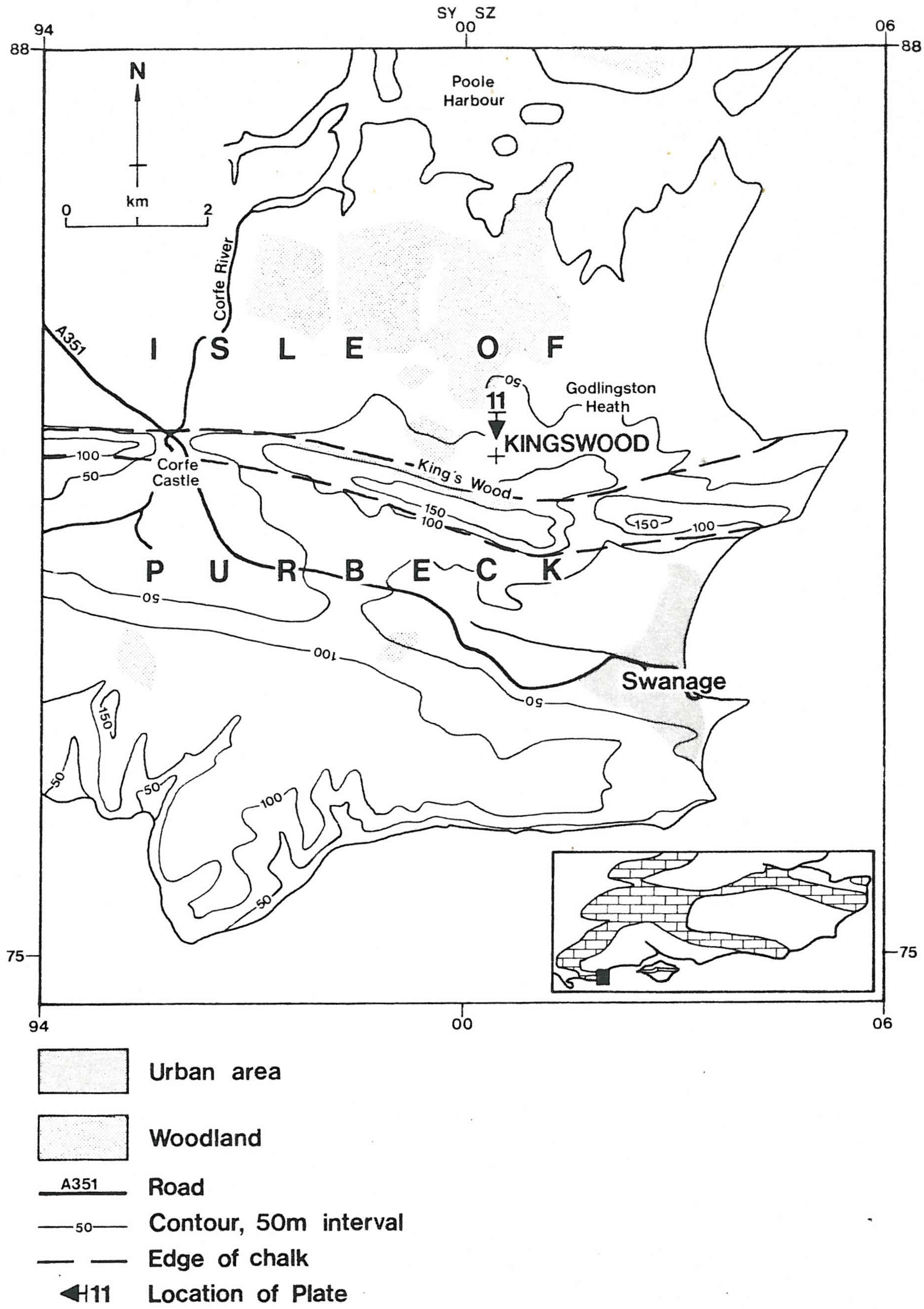


Figure 4.31. Kingswood: general location map

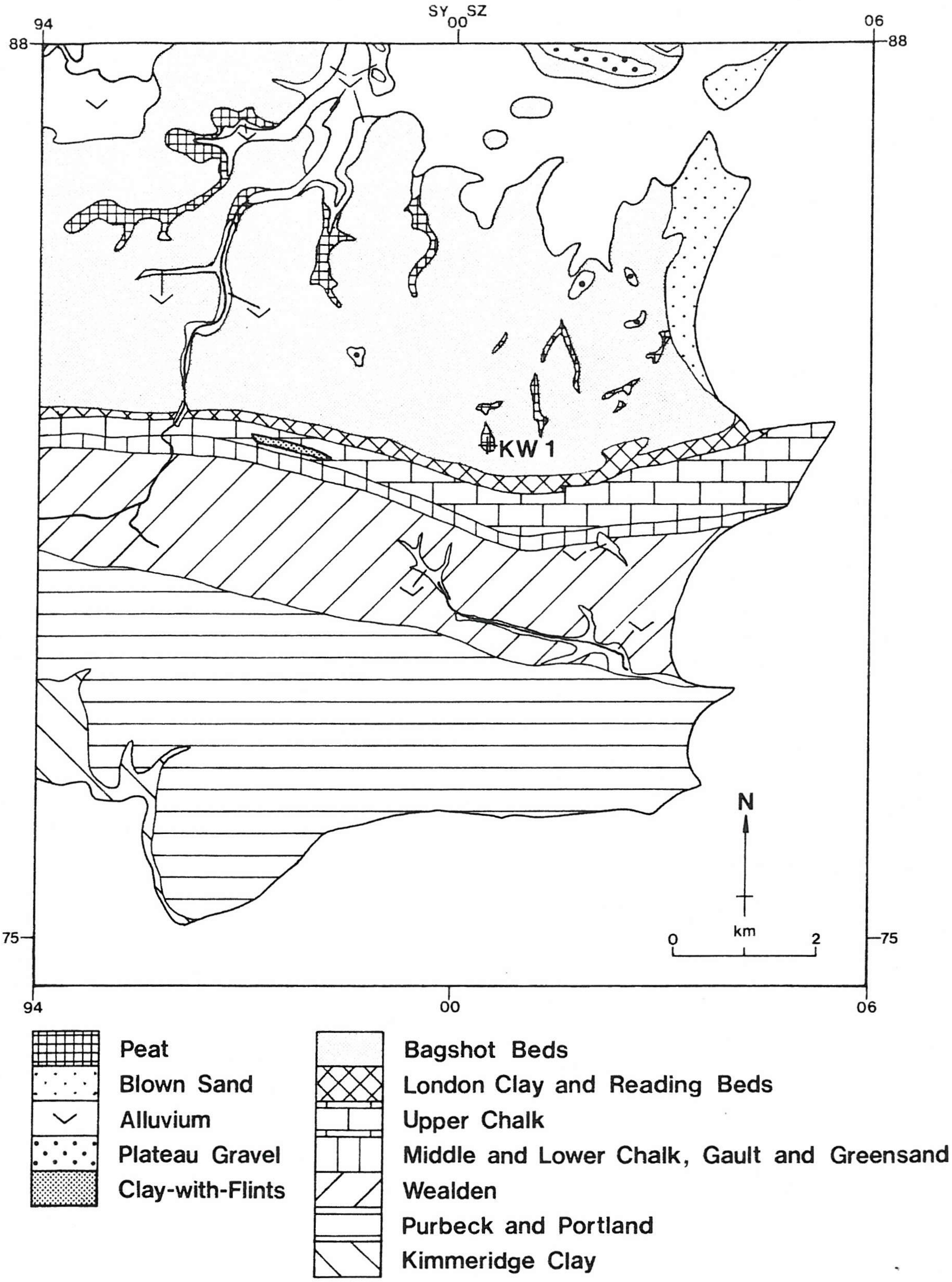


Figure 4.32. Kingswood: geology

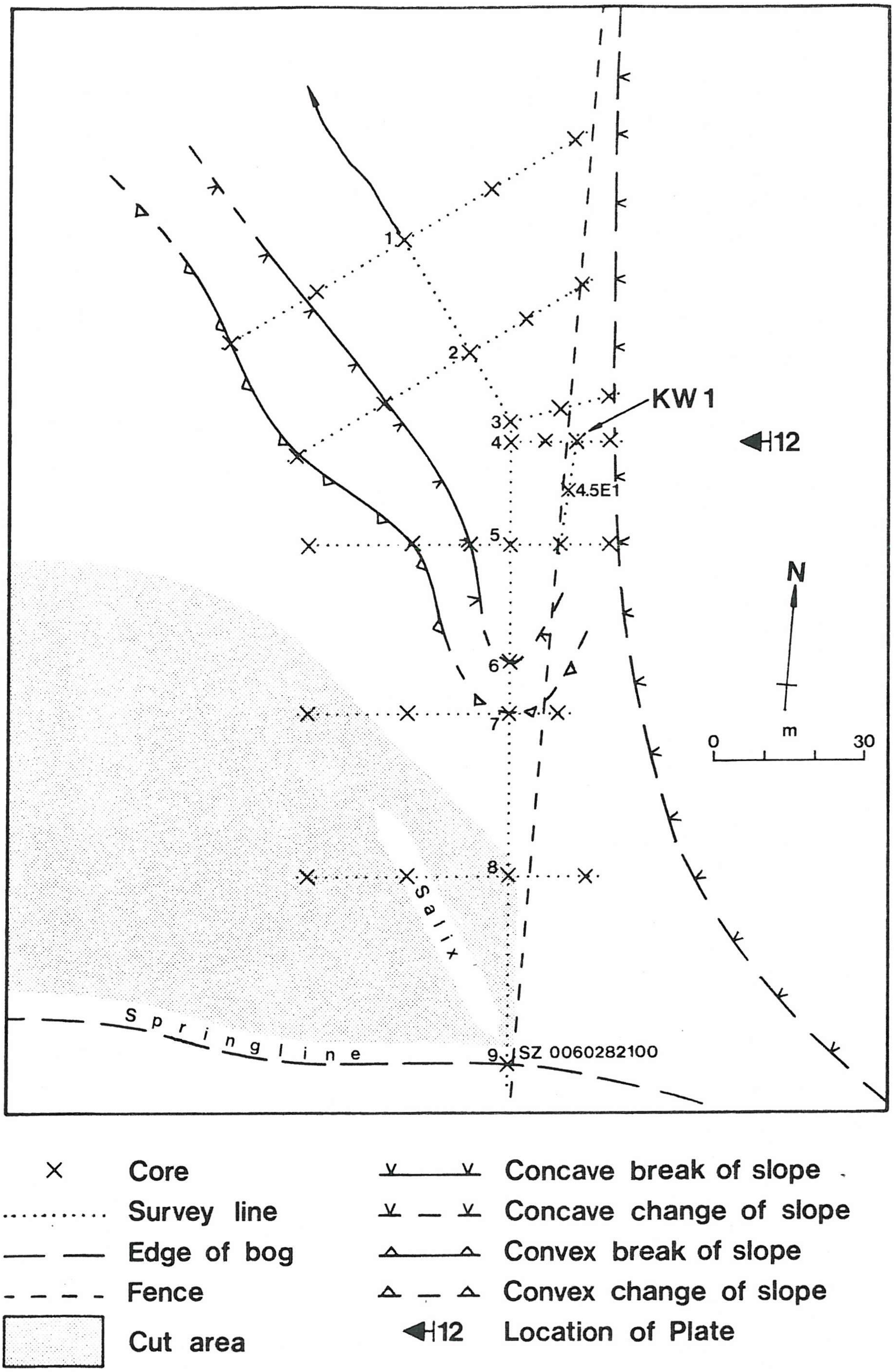


Figure 4.33. Kingswood: plan of surveyed area

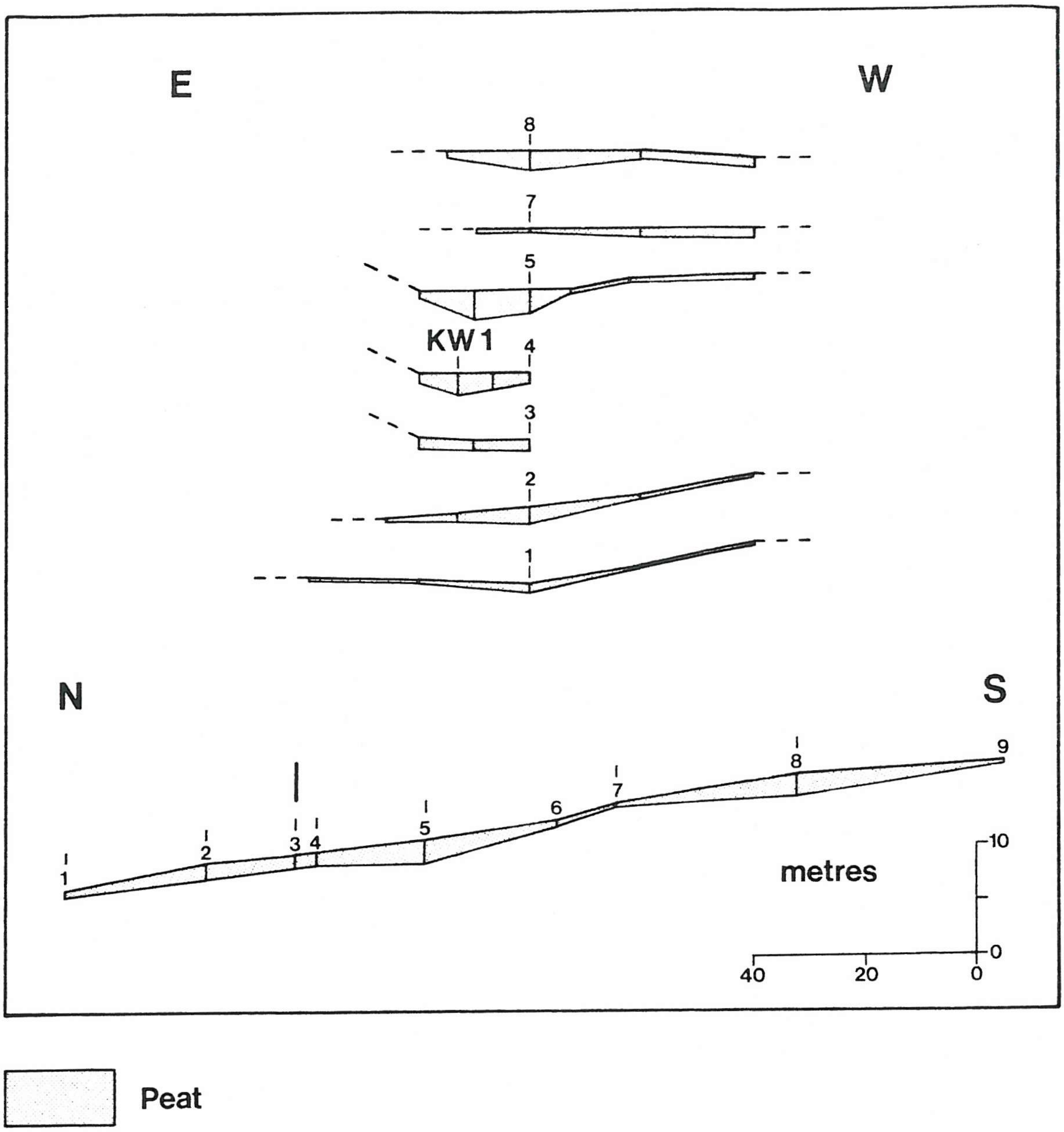


Figure 4.34.   Kingswood: long and cross sections

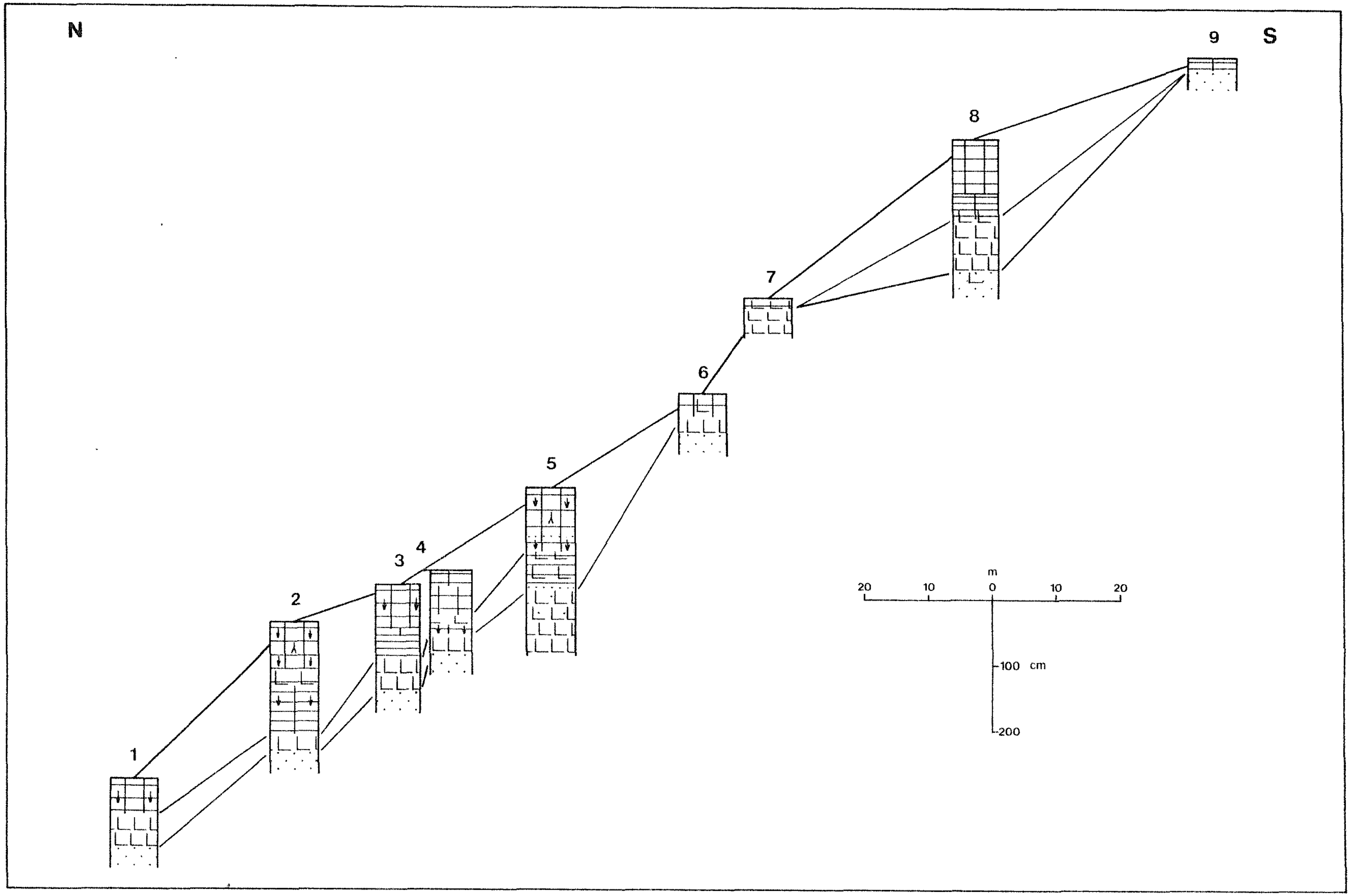


Figure 4.35a. Kingswood: stratigraphy, long section. See Table 3.3. for symbols

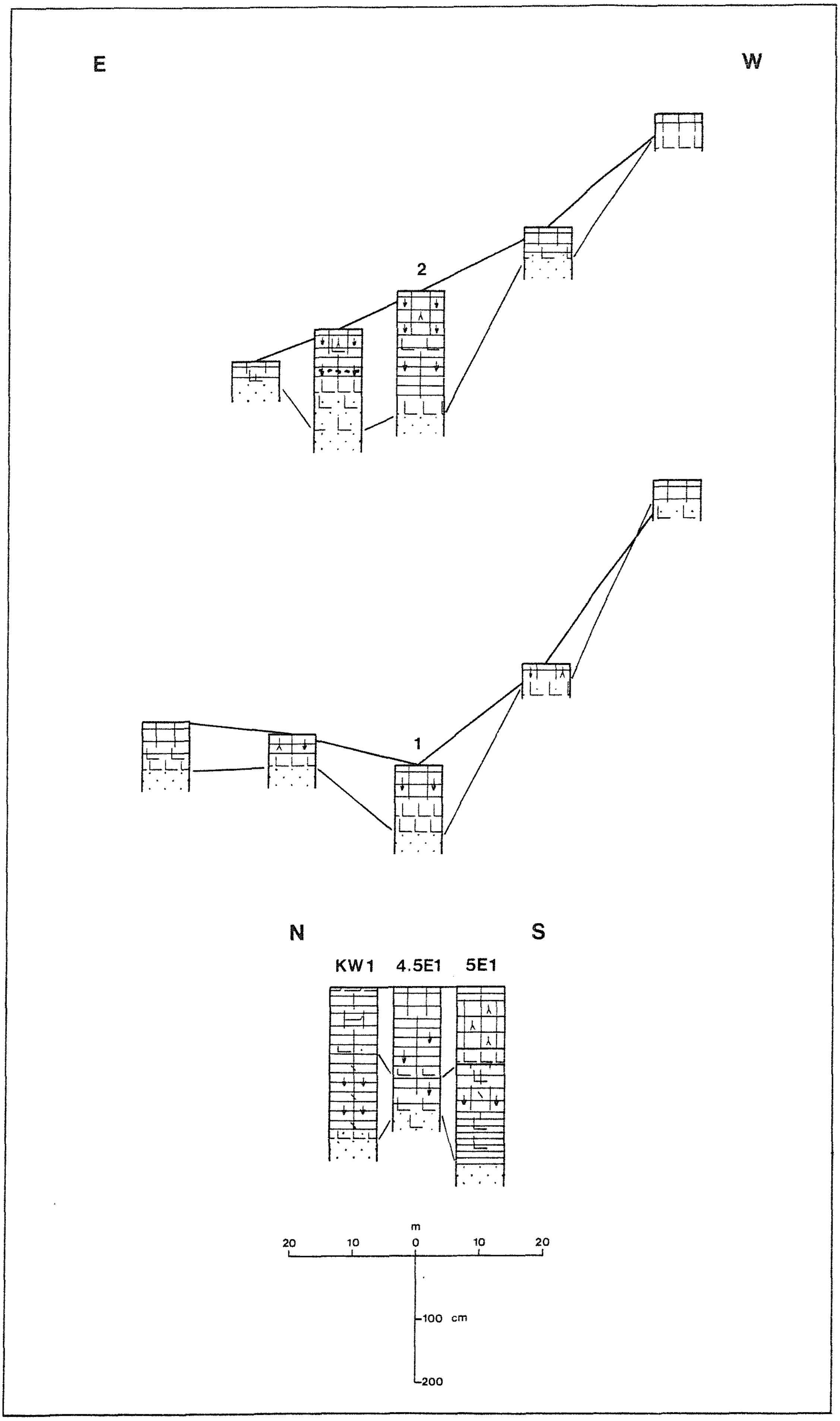


Figure 4.35b. Kingswood: stratigraphy, cross sections 1 and 2.
See Table 3.3. for symbols

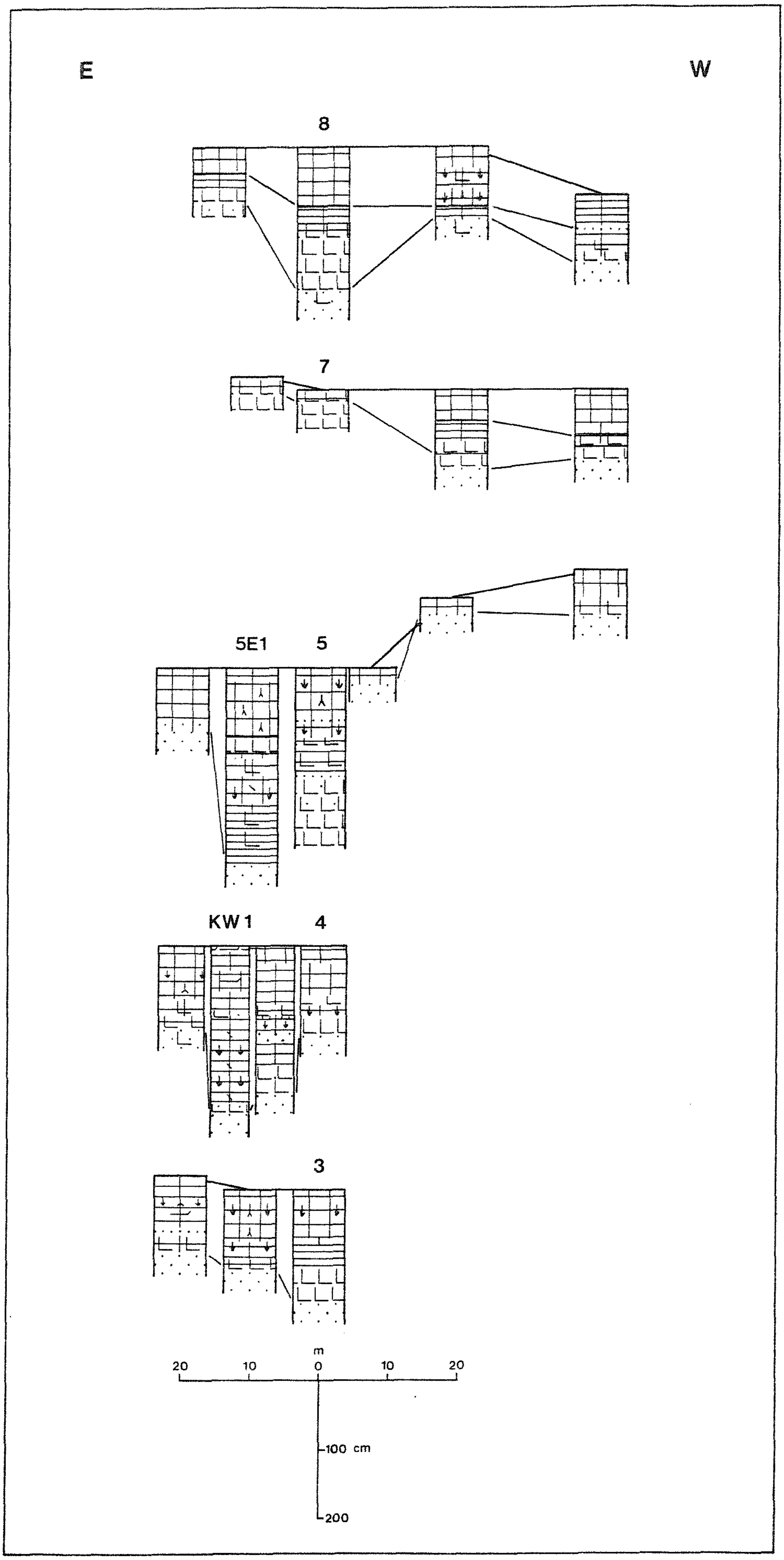


Figure 4.35c. Kingswood: stratigraphy, cross sections 3, 4, 5, 7 and 8. See Table 3.3. for symbols

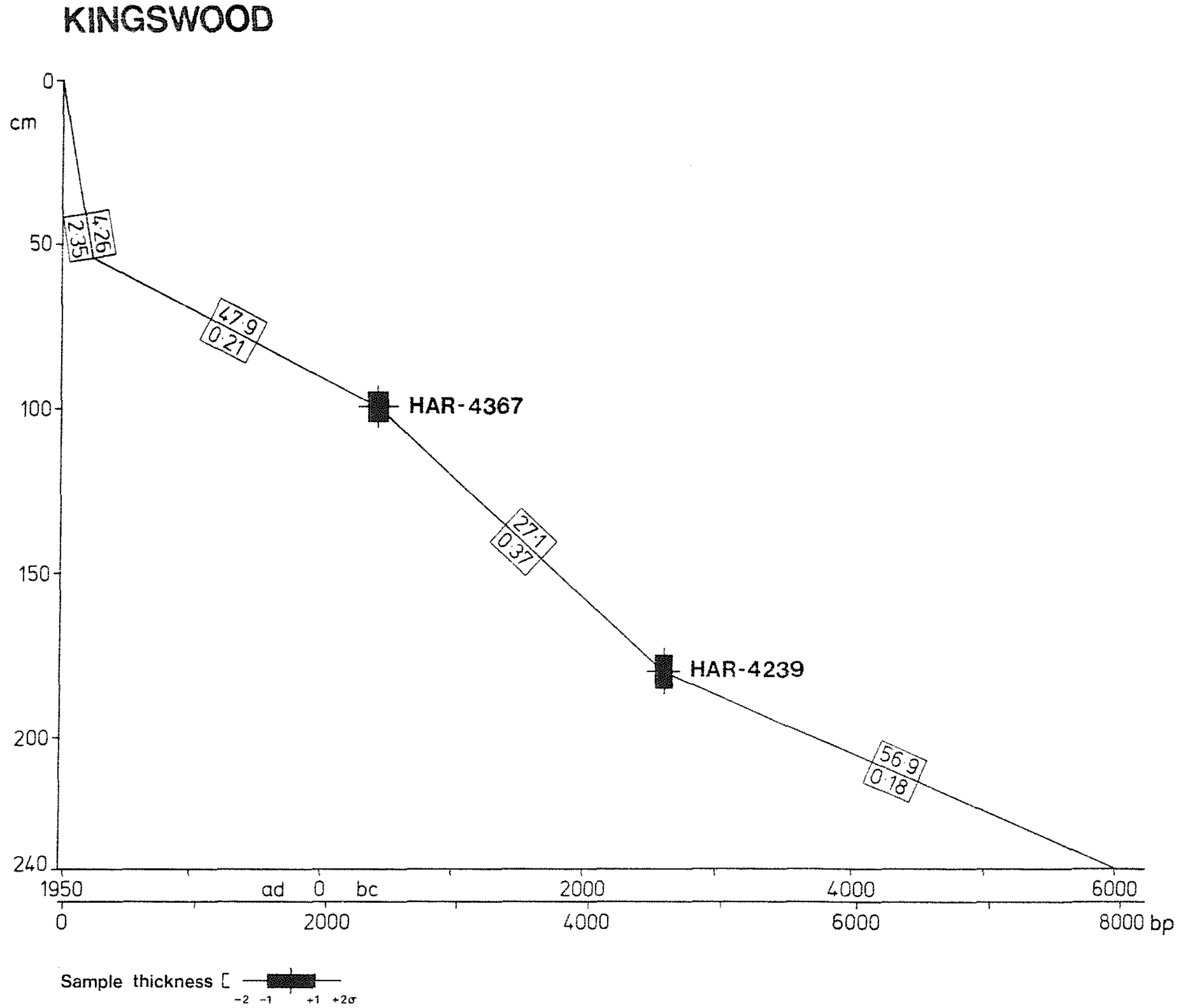


Figure 4.36. Kingswood: time:depth curve. Accumulation rates shown in boxes: upper figures yrs cm^{-1}, lower figures mm yr^{-1}

Table 4.11. Stratigraphy of Kingswood pollen core, KW 1

Depth(cm)	Nig	Strf	Elas	Sicc	Humo	Components	Description
0-6	2	0	3	2	1	(Sh1) Tb(Sphag)4, Dh+, Dg+	Dark grey-brown *Sphagnum* peat
6-24	3	0	1	1	3	(Sh3, As+) Th 3, Dg 1, As+	Dark grey-brown rootlet peat
24-36	2	0	2	1	3	(Sh2), Th 2, Tb(Sphag)2, Dg+, Dh+	Light brown rootlet and *Sphagnum* peat
36-66	2	0	2	2	3	(Sh2, As+) Th 3, Dg 1, Dh+	Light brown rootlet peat
66-88	2	0	2	1	3	(Sh3, As+) Th 3, Dh 1, Dg 1	Light brown rootlet peat
88-95	2	0	2	2	2	(Sh3, As+) Th 3, Gmin/Dh 1	Sandy mid-brown rootlet peat
95-105	2	0	2	2	2	(Sh3, As 1) Th 3, Dg 1, Dh+	Clayey mid-brown rootlet peat
105-120	2	0	1	2	3	(Sh3, As 1) Th 2, Dg 1, Dh 1	Clayey mid-brown rootlet and detritus peat
120-123	2	0	1	2	3	(Sh3, As 1) Th 3, Gmin1, Dg +	Clayey mid-brown sandy rootlet peat
123-226	3	0	1	2	3	(Sh 3) Dh(Moli)2, Th 2, Dg+, lim inf 2	Dark brown-black *Molinia* peat
226-232	2	0	0	2	-	(As 1, Ag 1) Gmin4, lim inf 3	Grey-brown sandy clay
232-236	2	0	0	2	-	(As 1) Gmin4, lim inf 3	Orange sand
236-242	0	1	0	2	-	(As 4, Ag+) lim inf 2	White clay
242+	1	0	0	2	-	(As+, Ag+) Gmin4	Grey sand

pollen will have come from vegetation on the chalk 500m to the south. Various differences in the pollen diagram from those of Haskins (1978) may, however, be attributable to such an influence (see later chapters).

4.7. WOODHAY

Core location: WH 1 SU 38546390

Plates 13 and 14

The core was from Prosser's Hanging, a strip of woodland near West Woodhay and 8km west of Newbury (Figs 4.37 and 4.38). Mixed farming and woodland prevail on the surrounding Tertiaries. On the chalk arable is common with grassland and some woodland on the steeper slopes and some Clay-with-flints deposits.

4.7.1. PRESENT VEGETATION

Prosser's Hanging is a strip of deciduous woodland 100m in width and flanking a tributary of the River Enborne (Fig 4.39). Much of the wooded area south-west from 384638 has gley soils but peat is only present on the south-east side of the stream between about 38526387 and 38636405. Indeed, the tithe map of 1840 (Gelling 1974) and an earlier map of 1831 (section 11.4.) names this section 'Peat Bottom'; 'Prosser's Hanging' is evidently of very recent origin.

The peat deposit is densely wooded with Alnus glutinosa, Betula pendula, Fraxinus excelsior and Quercus spp. On the drier margins Quercus is dominant with some Fagus sylvatica and in lighter places Sambucus nigra. A recently felled area to the south is thickly colonised by Rubus spp and Pteridium aquilinum. The ground flora of the wetter area when surveyed on 21 August 1981 was limited primarily to grasses, Sphagnum palustre, Eurynchium praelongum, Juncus effusus, Dryopteris dilatata, Rubus spp and Lonicera periclymenum. To the east, the drier Plateau Gravel hillslope is planted with pines, to the north and south, pasture with arable cultivation west of the stream.

Systematic surveying and stratigraphic investigation of the peat deposit was prevented by the dense vegetation. Furthermore, there were considerable local variations in peat depth and composition which would have hindered correlations. This may have been a result of attempts at drainage or peat cutting as approximately linear and drier areas of peat alternated with wet hollows of homogenous, largely inorganic sediments (section 11.4.).

4.7.2. CORING AND ANALYSIS

The core for analysis (WH 1) was from the deepest peat that could be located. This was about 100cm in depth (Table 4.12) and at a point 15m south-east of the stream and 20m north-east from the edge of the overgrown felled area (Fig 4.39).

Samples at 4cm intervals were subjected to the standard preparation schedule (section 3.2.2.; PD 7). Radiocarbon dating was not undertaken but hypothetical time:depth curves are illustrated in Figure 4.40 (sections 5.7, 10.9.).

The total extent of the deposit is about 30m by 100m. However, the pollen analysis indicates that the area around the core has been predominantly woodland at least since accumulation was initiated. In effect, this core is therefore from a basin 0m in diameter: the Jacobson and Bradshaw (1981) model predicts that about 79% of the pollen will have been derived from within 20m, 11% from 20m to several hundred metres and 10% from beyond (section 2.4.3.). Very little of the pollen will have been derived from vegetation on the chalk outcrop a kilometre to the south. Overall, the results were disappointing but some information of value was obtained from the analysis.

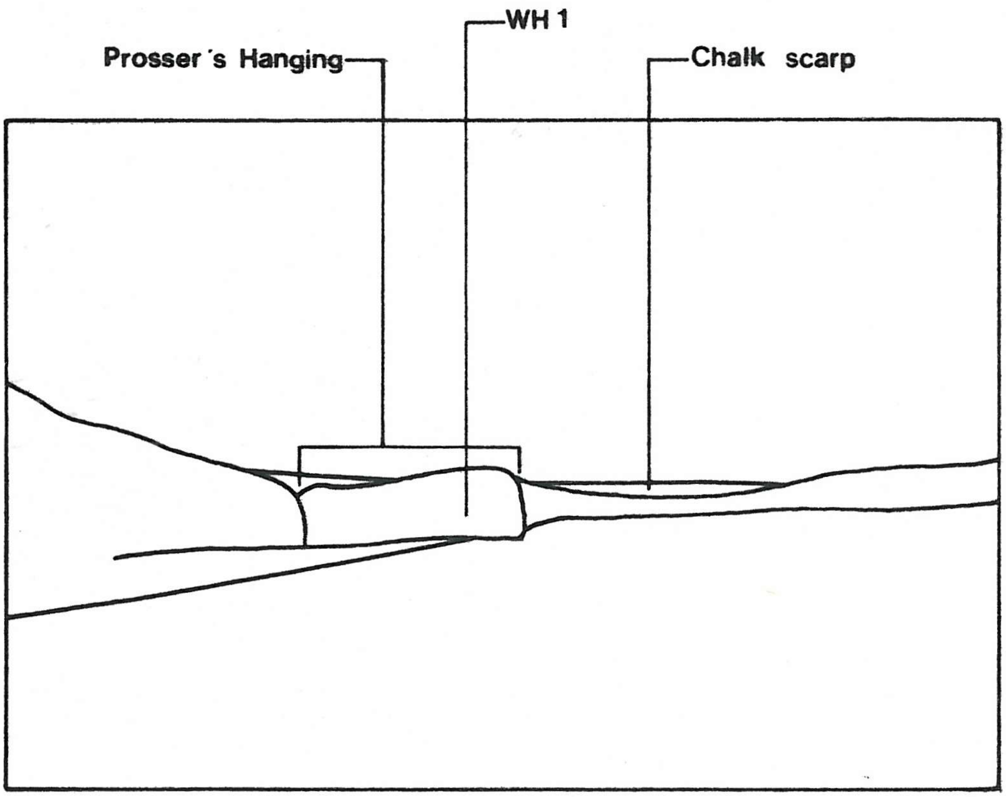


Plate 13. Woodhay: general view towards Prosser's Hanging.

From SU 38916438 looking SW
21 August 1981

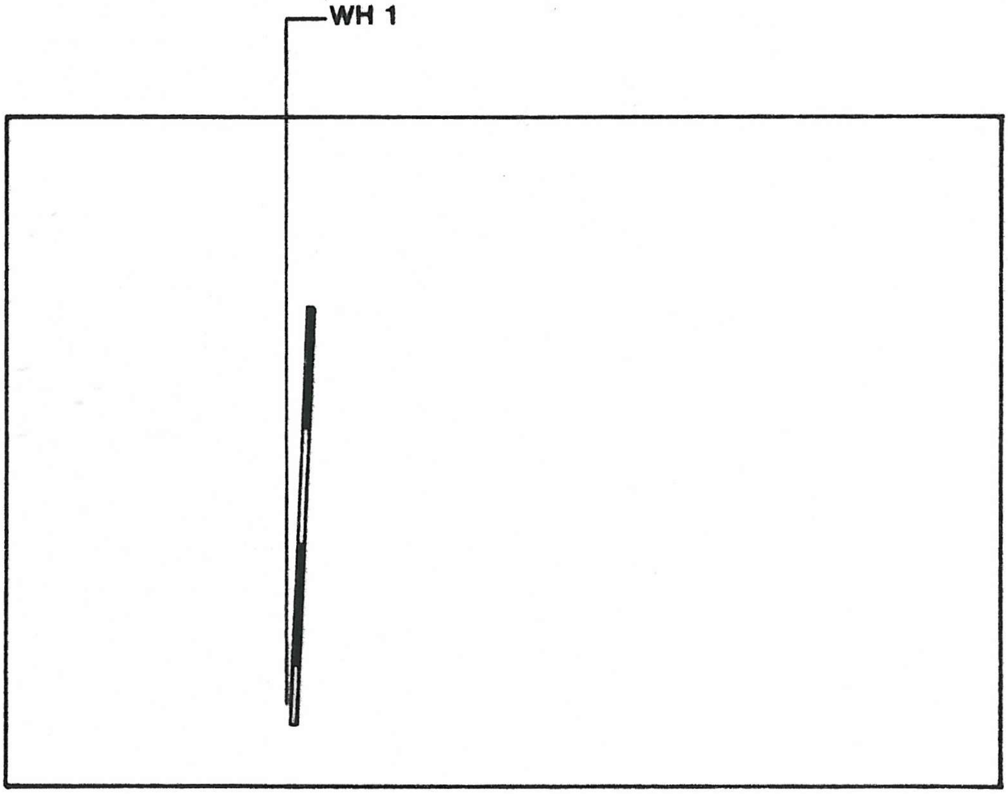


Plate 14. Woodhay: site of core WH 1. Survey pole in 50cm divisions

From SU 38546390 looking NE
22 January 1981

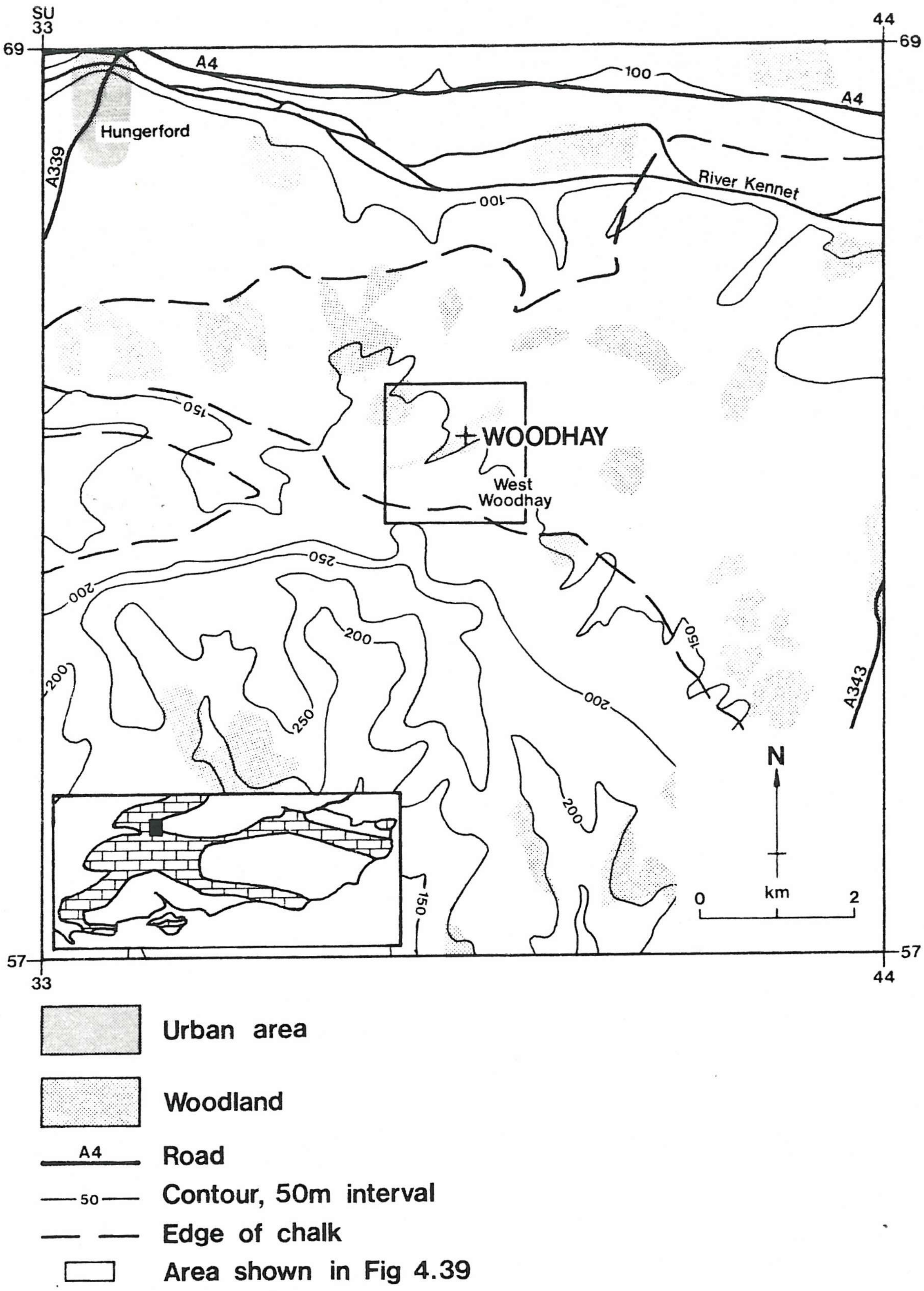


Figure 4.37. Woodhay: general location map

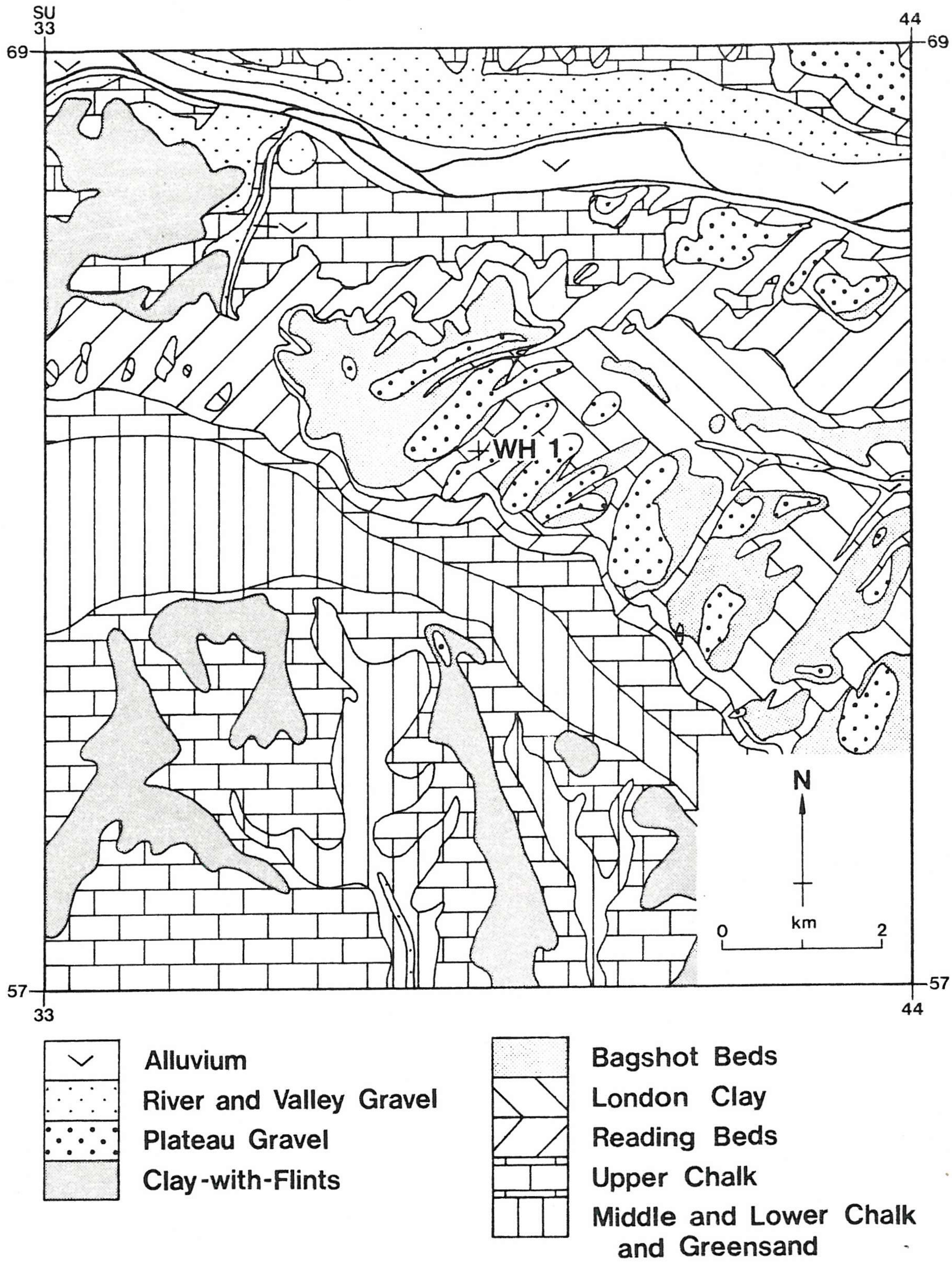


Figure 4.38. Woodhay: geology

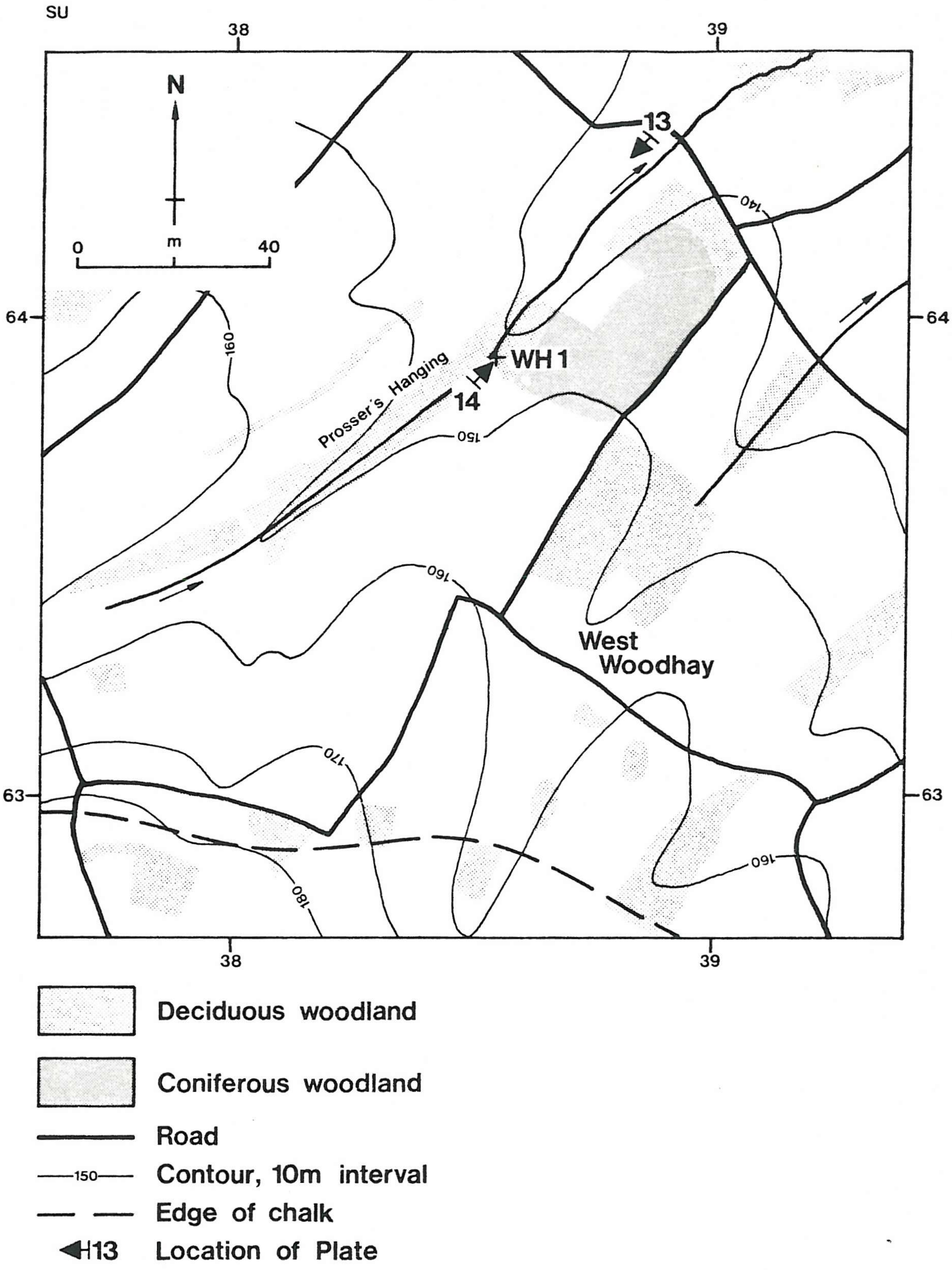


Figure 4.39. Woodhay: plan of site and locality

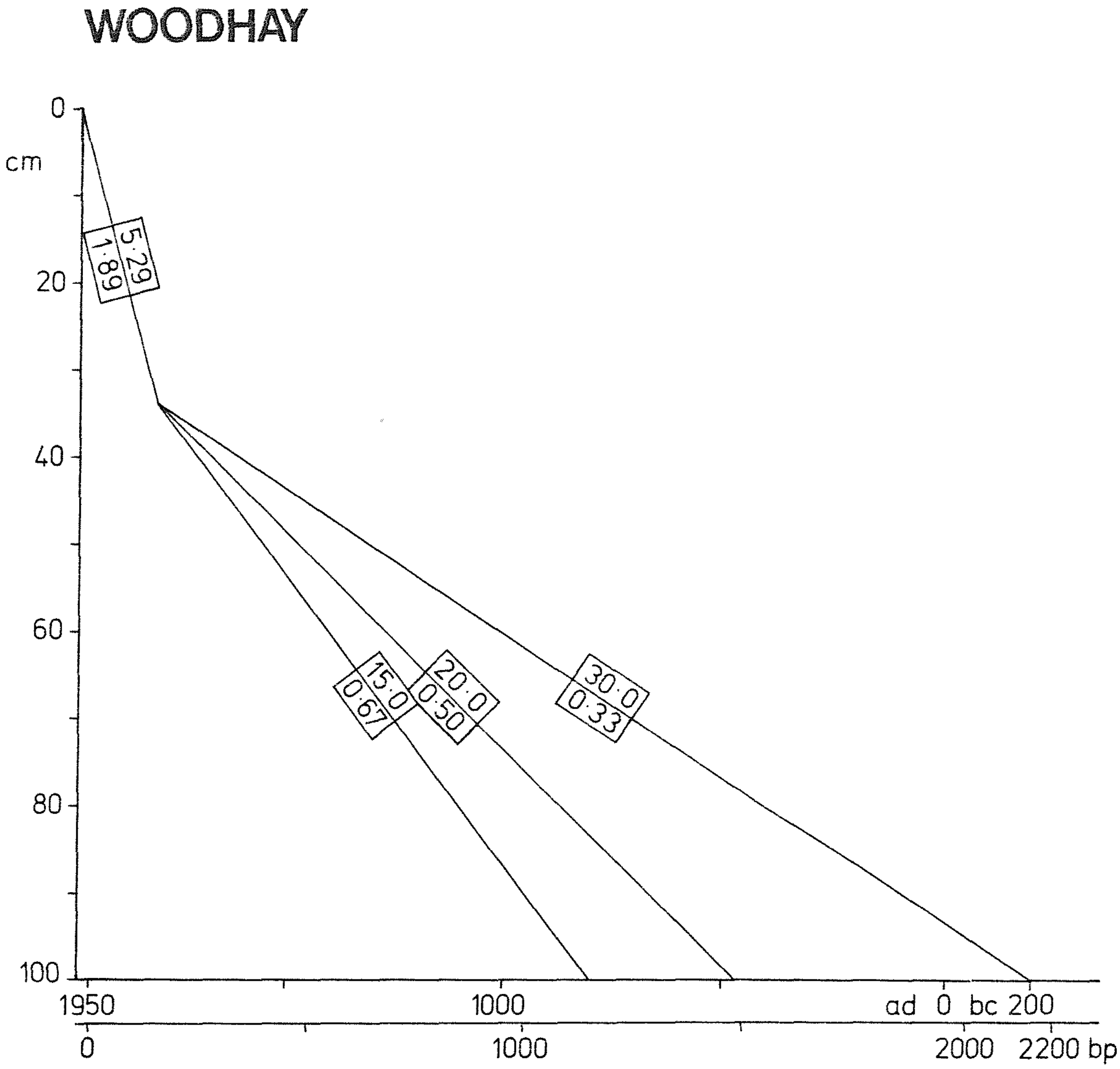


Figure 4.40. Woodhay: time:depth curves (hypothetical). Accumulation rates shown in boxes: upper figures yrs cm^{-1}, lower figures mm yr^{-1}

Table 4.12. Stratigraphy of Woodhay pollen core, WH 1

Depth(cm)	Nig	Strf	Elas	Sicc	Humo	Components	Description
0-7	1	0	3	2	1	(Sh+) Tb(Sphag)4	Fresh *Sphagnum* peat
7-17	3	0	2	2	3	(Sh2) Th 2, Tb(Sphag)1, Dg 1, Gmin+	Dark brown rootlet peat with *Sphagnum*
17-30	3	0	2	2	3	(Sh2, As+, Ag+) Gmin2, Th 1, Dg 1	Sandy dark brown peat
30-60	2	0	2	2	2	(Sh2, As+, Ag+) Th 2, Dg 2, Gmin+	Mid-brown rootlet and detritus peat
60-75	2	0	2	2	2	(Sh2, As+) Dg 2, Dh 1, Th 1	Mid-brown rootlet and detritus peat
75-77	2	0	2	2	2	(Sh2, As+) Tb(Sphag)3, Th 1, Dg+, Gmin+, Dl+	Mid-brown *Sphagnum* peat
77-80	2	0	2	2	2	(Sh2) Dg 2, Dh 1, Th 1, Tb(Sphag)+, Gmin+, Dl+	Mid-brown detritus peat
80-88	2	0	2	2	2	(Sh3) Th 2, Dg 1, Dh 1, Tb(Sphag)+, Gmin+, As+	Mid-brown rootlet and detritus peat
88-97	2	0	1	2	2	(Sh3, AS+) Th 2, Dg 1, Dh 1, Gmin+	Mid-brown rootlet and detritus peat
97-98	2	0	2	2	2	(Sh3, As+) Th 1, Dg/Gmin3	Sandy mid-brown detritus peat
98-105	No sample						
105	2	0	0	2	-	Gmin3, Gmaj1	Hard gravelly sand

CHAPTER 5

POLLEN DIAGRAM ZONATION

The characteristics of each zone are briefly described in this chapter. Interpretations are presented in the discussion, Chapters 6 to 11. The depths relate to the pollen diagrams and the dates are derived directly from the time:depth curves. Allowance is not made for changes in stratigraphy, including interstratified clay horizons, because of the difficulty of quantifying their effect on accumulation rate. The accuracy of the time:depth curves and possible alternatives are considered in the discussion chapters. The Period with which each is correlated is shown.

5.1. WINCHESTER

Zone WT-1 (C-1)
429-404cm c.6720-6190bc

The zone is characterised by *Betula* at 1 to 2% DLP, *Pinus* at 10 to 12%, *Ulmus* at 2 to 5%, *Quercus* increasing from 10 to 20% and *Corylus* falling from 31 to 27%. Tree, shrub and *Corylus* pollen total about 60% and Gramineae is at 30 to 40%. Herb levels are about 10% and dominated by *Ranunculus* type increasing from 1 to 5% and *Bidens* type declining from 5 to 1.5%. Other herb pollen recorded includes Umbelliferae, *Stachys* type, *Serratula* type, *Rumex acetosa* type, Cruciferae undiff, *Spergularia* type, Chenopodiaceae, Rosaceae undiff, Rubiaceae, *Plantago lanceolata* and Liguliflorae. Pteridophyta are low with Filicales at 7 to 15% and *Pteridium* at less than 2%; charcoal is frequent to abundant and pH is at 7.0 to 7.3.

Zone WT-2 (C-1)
404-348cm 6190-5000bc

At the beginning of the zone *Betula* falls to less than 0.5%, *Pinus* rises to over 20%, *Ulmus* remains constant at 3 to 4% and *Quercus* declines to 7 to 10%. *Corylus* is initially depressed to 15%, but rises to 30%. Tree, shrub and *Corylus* pollen varies from 45 to 60% and Gramineae at first peaks to 50%, then declines; herbs are low at 2 to 6%. *Ranunculus* type pollen falls from 6% at the end of WT-1 to 0% at the beginning of WT-2, to occur at low frequencies later in the zone. *Bidens* type is most common at 2 to 4%. Other herbs include Umbelliferae, Rosaceae undiff and Rubiaceae. Charcoal is less common than in WT-1 and pH varies between 7.2 and 7.4. Pollen abundance is low and degradation high, in part explaining the peak of Filicales, a spore resistent to deterioration.

Zone WT-3 (C-2)
348-286cm c.5000-3680bc
C-14 291-281cm 3680±90bc (HAR-4342)

WT-3 is markedly different from WT-1 and WT-2 with *Pinus* at less than 2%, *Alnus* up to 40% with *Tilia* rising to 7% and *Fraxinus* fluctuating between 1 and 2%. *Ulmus* and *Quercus* are also increased at 5% and 10 to 20% respectively; *Corylus* is marginally reduced. The tree, shrub and *Corylus* pollen total is similar at up to 60%. Herbs, however, rise from 2% to 15% by the end of the zone with many new types recorded for the first time including *Sinapis* type, *Plantago media/major*, *Anthemis* type and *Centaurea nigra* type. Charcoal is most abundant in the centre of the phase, coinciding with a peak of pH at 7.5. Pollen abundance is low and degradation is high which, with the fluctuating and high Filicales, imply poor conditions of preservation.

Zone WT-4 (C-3)
286-244cm 3680bc-2560bc
C-14 291-281cm 3680±90bc (HAR-4342)

The opening of WT-4 is marked by a major reduction in tree and *Corylus* frequencies. *Ulmus* drops from 4% to 0.5%, *Quercus* from 15 to 7%, *Tilia* from 5 to 0.5%, *Alnus* from 40 to 15%, *Fraxinus* from 2 to 0% and *Corylus* from 30 to 5%. The *Hedera* curve ceases having been at up to 1.5% in the previous zone and Filicales drop from 80 to 5%. At the same level Gramineae rises from 27 to 50% and most herbs also increase, especially Cruciferae undiff. (0 to 3%), *Spergularia* type (0 to 1%), Rubiaceae (2 to 7%), *Plantago lanceolata* (2 to 5%) and Liguliflorae (3 to 8%). In total herbs rise from 15% to 40% whilst tree, shrub and *Corylus* pollen fall from 55 to 12% and cereal pollen appears for the first time at up to 1%. These changes are generally maintained throughout the zone. Charcoal is initially abundant but abruptly falls, and pH is depressed to 7.0 before recovering to 7.2. Pollen degradation is less and pollen abundance is greater.

Zone WT-5 (C-3)

244-204cm c.2575-1500bc

Wt-5 differs from WT-4 because of the absence of cereal pollen and higher levels of Gramineae. The tree, shrub and hazel pollen total initially falls at the opening of the phase from 20% to 10%, subsequently rises to 30% before declining again at the WT-5/WT-6 boundary. Quercus with Corylus account for most of the fluctuations. Herbs decline from 35% to 20%, largely because of Cruciferae undiff falling from 17% to 0%, with Rubiaceae, Plantago lanceolata and Liguliflorae also reduced. Gramineae rises from 50% to 75%. Charcoal fluctuates from absent to common and pH is maintained at about 7.2 but falls to 7.0 at the end of the phase. Pollen is common and degradation variable.

Zone WT-6 (C-3)

204-172cm 1500-650bc

The zone opens with transitory falls in Betula pollen from 5 to 2%, Quercus 15 to 7% and Corylus 7 to 2% and a rise of Gramineae from 50 to 75%. Throughout the rest of the WT-6 Quercus rises to 17% by the end of the zone and Corylus to 10% whilst Gramineae attains a minimum of 32%. Overall, the tree, shrub and hazel total rises from 10% to 30% and herbs from 12% to 67%; most of the latter is a result of the increase of Liguliflorae pollen from 2% to 14%. Cereal pollen rises abruptly from 0% in the centre of the zone to a peak of 4% before the end of the zone; Secale type pollen is also recorded in low frequencies. Charcoal is only recorded at the beginning of WT-6 and pH peaks at 7.2. Pollen degradation is higher and abundance lower than in WT-5.

Zone WT-7 (C-4)

172-108cm 650bc-ad1060

Tree pollen is at a level consistently higher, in general, in WT-7 than at any time since WT-3. Quercus in particular is relatively high at 12 to 25%, but the frequencies of Betula and Alnus are also raised. The tree, shrub and Corylus total varies between 20 and 35% whilst Gramineae falls for much of the zone from an early maximum at 52% to 30%. Herbs however are greater rising from 20% to 43%, largely because of increases in Stachys type, Rumex acetosa type, Spergularia type, Plantago media/major, Sinapis type, Anthemis type, Centaurea cyanus and C. scabiosa. Cultivars are also higher after an initial depression: cereal undiff, Secale type and Cannabis type are recorded. Charcoal is only present at one level and pH rises progressively to a peak of 7.5. Both pollen abundance and pollen degradation are lower.

Zone WT-8 (C-4)
108-84cm ad1060-1700

Tree, shrub and Corylus pollen fall markedly from 32% to 12% in total, accounted for largely by Quercus, but also Betula and Fraxinus. Gramineae increases from 40% to 60% whilst herbs show a smaller rise from 23% to 28%. Plantago lanceolata shows a significant rise from 2% to 5% with similar increases in Stachys type, Rubiaceae and Liguliflorae. Cultivars are at 1% or less with cereals generally falling. Charcoal is absent and pH falls to 7.2. Pollen degradation and abundance remain low.

Zone WT-9 (C-5)
84-0cm ad1700-present

The trees, shrubs and Corylus total remains fairly constant at about 20% during WT-9, but Pinus rises progressively and Ulmus, Tilia, Alnus and Corylus all show transitory peaks. Gramineae and the herb total are also constant at about 55% and 25% respectively. The herbs are dominated by Bidens type, Plantago lanceolata, Liguliflorae and Sinapis type. Charcoal is present towards the end of the zone and pH climbs to a maximum of 8.2. Pollen is generally more abundant and degraded than in WT-8.

5.2. SNELSMORE

Zone SM-1 (C-3)
103-94cm (SM 2) 2800-2520bc

Zone SM-1 exhibits Betula at a maximum of 45%, declining to 15%. Contemporaneously, the following increase: Ulmus from 1 to 5%, Quercus from 15 to 25%, Tilia from less than 0.5% to 7%, Alnus from 2 to about 10% and Fraxinus from 0 to 2%. Corylus fluctuates between 30 and 40%, Gramineae declines from 9 to 4% and Pteridium from 5 to 2%. Total herbs do not exceed 3% and trees, shrubs and Corylus amount to over 90% of DLP.

Charcoal varies between rare and frequent, pollen is abundant and degradation is common.

Zone SM-2 (C-3)
94-62cm (SM 2) 2520-1550bc

Zones SM-2 and SM-3 are remarkable with trees, shrubs and *Corylus* composing between 92 and 98% DLP. SM-2 shows changing frequencies, SM-3 more stable conditions. In SM-2 *Betula* is initially at 10 to 15%, but rapidly falls at about 78cm to 2% and at the same level *Alnus* rises abruptly from 20 to 70% and subsequently is constant at 35 to 45%. *Ulmus* at first attains 7% but then steadily falls to less than 1%. *Tilia* is at a maximum of 10% but declines in the latter half of the zone. *Fraxinus* rises steadily, peaks at 5%, then decreases to less than 2% at the SM-2/SM-3 boundary. Throughout the zone *Quercus* rises steadily from 25% to 55% and *Corylus* falls from 40% to 28%. Gramineae is at 2 to 3% and in total, herbs, mostly *Melampyrum*, are at 1 to 3%. Charcoal is rather less than in SM-1, pollen remains very abundant and degradation is reduced.

Zone SM-3 (C-3)
62cm-cores SM 1/SM 2 junction 1550-920bc

Quercus is at about 60%, *Alnus* at 35%, *Corylus* at 25% with *Betula* at 3%, *Tilia* at 4% and Gramineae at 2 to 3%. *Ilex* is most abundant in SM-3 at about 4%. Herbs are at 2 to 3% and are dominated by Rosaceae undiff at 1.5% with *Plantago lanceolata* briefly present at 0.5% at the beginning of the zone. A single cereal pollen grain is present in the final count, 42cm. Charcoal is frequent throughout most of SM-3, pollen is abundant and degradation negligible.

Zone SM-4 (C-3)
Cores SM 1/SM 2 junction-199cm 920-410bc
C-14: 216-206cm 620±90bc (HAR-4241)

Marked changes occur at the SM-3/SM-4 boundary: *Quercus* falls from 50 to 25%, *Alnus* from 35 to 12%, *Corylus* from 35 to 17% and *Tilia* from 5 to 2%. Gramineae increases from 5 to 25%, *Betula* from 5 to 20% and herbs from 2 to 10%. The tree, shrub and *Corylus* total falls from 92 to 70%, subsequently recovering to 80%. Of the herbs, Plantago lanceolata is significant with an increase from 0.5 to 4% and several appear for the first time: Ononis type, Stachys type, Spergularia type, Poterium sanguisorba, and Anthemis type. Pteridium increases from about 1% to 10%. Two cereal pollen grains are present. Charcoal declines in abundance, pollen is frequent and degradation slight.

Zone SM-5 (C-4)
199-157cm 410bc-ad360

Tree, shrub and Corylus pollen in total declines from 80 to 60%, Gramineae increases from 20 to 30% and herbs rise from 6% to 20%. Further reductions occur in the frequencies of Quercus, from 28 to 15%, Corylus, from 25 to 17%, Tilia after a 5% peak at one level falls to less than 2% and Ulmus is recorded only sporadically. Alnus is reduced from 30% to 10% and Betula after an initial rise from 20 to 35% declines progressively through SM-5 to 10%. Of the herbs, Plantago lanceolata is notable, rising from 2 to a peak of 8% and Rumex, Rosaceae undiff, Rubiaceae, Liguliflorae, Ononis type and Anthemis type show continuous curves. Four cereal pollen grains are recorded. Charcoal is low or absent for most of the zone, pollen changes from abundant to frequent and degradation is minimal after the beginning of the zone.

Zone SM-6 (C-4)
157-93cm ad360-1470
C-14: 145-135cm 660±80ad (HAR-4236)

Tree, shrub and Corylus total 60 to 80%, about 20% greater than in SM-5: Betula is most abundant at 20 to 40%, having increased initially from 10 to 40%, Quercus is essentially unchanged at 20 to 30%, Alnus is raised to 15 to 30% and Corylus slightly reduced at 15 to 20%. Tilia is higher at 2-4% and Ulmus and Ilex more frequent at up to 1% with Fagus as a continuous curve for the first time. Gramineae is reduced to 15 to 20% with herbs at 7 to 15%: Plantago lanceolata is at less than 5% with other herbs lower, apart from Rosaceae undiff and Potentilla type which are both unchanged. Pteridium is also reduced. Cultivars are more common with first records for both Secale and Cannabis types. Charcoal throughout SM-6 is generally occasional to frequent, pollen abundant and the number of degraded grains changes from absent to rare.

Zone SM-7 (C-4)

93-74cm ad1470-1800

At the beginning of SM-7 *Betula* drops rapidly from 30 to 12%, then peaks at 20% before falling again to 12%, fluctuations followed by *Corylus* and *Calluna*. All other woody species decline: *Quercus* from 20% to 5%, *Tilia* from 3% to 0 and *Alnus* from 25% to 2%. Shrubs are few with *Hedera* and *Ilex* largely absent after having continuous curves in SM-6. Indicators of more open conditions tend to increase, though subsequently fall: Gramineae from about 20% to 50%, *Calluna* from 5% to 15%, *Plantago lanceolata* from 1 to 6%, *Spergularia* type from 0 to 4% and *Pteridium* from 5 to 7%. Herbs in total rise from 10 to 20% and there are records for all cultivars with Cereal type undiff exhibiting a continuous curve. Charcoal is absent, pollen is reduced in abundance and degradation temporarily raised.

Zone SM-8 (C-5)

74-18cm ad1800-1930

The zone is distinguished by having the lowest tree, shrub and *Corylus* pollen total at 30 to 50% and highest Gramineae and herb frequencies. Most tree pollen types increase from the opening of the zone, peak and then decline: *Pinus* from 1% to 7%, then 4%, *Ulmus* 0.3%, 2%, 0.3%, *Quercus* 10%, 25%, 10% and *Fraxinus* 1%, 2%, 0% whilst *Fagus* maintains levels of 2 to 6%. *Tilia* which previously followed the *Ulmus* curve is only sporadically present and *Alnus* is consistently low at 1 to 3%. *Betula* differs in attaining a minimum in the zone, from 10% to 4%, then 23%. *Corylus* is fairly static at 2 to 5% and a number of tree species are represented by pollen in low abundance: *Carpinus*, *Juglans*, *Picea* and *Aesculus* with a marked peak of *Castanea* late in the zone. Gramineae is high, attaining a maximum of 60% but with, overall, a decline from 45% to 35%. Herbs are at 20%, dominated by *Plantago lanceolata*, *Rumex*, Rosaceae undiff, *Sinapis* type, *Ononis* type and *Spergularia* type. *Pteridium* is present at 5 to 10% and cereals at up to 1.5%. Charcoal is recorded in the latter part of the zone, pollen is frequent to abundant and degraded grains are generally absent.

Zone SM-9 (C-5)
18-0cm 1930ad to present

This represents the most recent period with *Betula* pollen continuing the rise initiated in SM-8 to attain 50%. *Pinus* exceeds 10% late in the zone and temporary peaks occur in the pollen of *Quercus* at 20%, *Alnus* at 20%, *Tilia* at 1%, *Corylus* at 15%, *Fraxinus* at 1% and *Ulmus* at 1%. *Fagus* is reduced to 2%, before rising to 6%. The tree, shrub and *Corylus* pollen total climbs overall from 50 to about 80%, Gramineae is reduced from 30 to 12% and herbs from 10 to 6%, dominated by *Rumex* and *Plantago lanceolata*. Charcoal is absent, pollen is abundant and degradation minimal.

5.3. AMBERLEY

Zone AWB-1 (C-3)
376-332cm 1720-1360bc

AWB-1 is dominated by *Quercus* rising from 35 to 50% and *Corylus* at about 20%. *Betula* is at 2 to 3%, *Pinus* at 2-3%, *Ulmus* at 1%, *Tilia* at 2-5%, *Alnus* at 10 to 12% and *Fraxinus* at 1 to 3%. Tree, shrub and *Corylus* pollen total 70-80%, Gramineae 10 to 20% and herbs 10 to 15%. The most common herbs are Chenopodiaceae at 2 to 5%, *Plantago lanceolata* at 2 to 5% and *Bidens* type at 1 to 5%. Filicales vary from 5 to 10% and *Pteridium* increases from 5 to 10%. Charcoal is absent, pollen is low in abundance and degraded grains rare to occasional.

Zone AWB-2 (C-3)
332-268cm 1360-820bc

AWB-2 is similar to AWB-1 except that *Quercus* falls from 50% to 35%, *Corylus* is lower at 20%, Gramineae increases from 15 to 20% and herbs are higher at 10 to 20%. In particular, Chenopodiaceae peaks at 10%, *Plantago lanceolata* at 9% and *Pteridium*, a major peak, at 50%. *Betula* is marginally increased to 4%, *Pinus* and *Tilia* have maxima at 7 and 4% respectively and *Alnus* is fairly constant at 10%. The tree, shrub and *Corylus* pollen total falls from 75 to 65% and a single grain of cereal pollen is recorded at the end of the zone. Charcoal is largely absent, pollen low in abundance and degraded grains are rare to frequent.

Zone AWB-3 (C-3)

268-220cm 820-420bc

C-14 250cm 670±110bc (Q-690)

At the opening of the zone the tree, shrub and Corylus pollen total falls from 60 to 40%: in particular Pinus falls from 4 to 0.5%, Quercus from 30 to 2%, Tilia from 2 to 0.3%, Alnus from 10 to 7% and Corylus from 15 to 6%. Gramineae rises dramatically from 20 to 50% and herbs peak at 25% with Umbelliferae most prominent at 15%. Towards the end of the zone woody species recover, especially Corylus, and Gramineae and herbs fall. Charcoal is recorded in most levels, pollen abundance is low and the number of degraded grains fall from occasional to insignificant.

Zone AWB-4 (C-4)

220-180cm 420-80bc

This zone shows another period of reduced woodland pollen with Quercus falling from 25 to 12% and Corylus from 25 to 7%. Gramineae increases from 15 to 55% and herbs from 15 to 20%. The herbs are dominated by Rumex peaking at 15% with Plantago lanceolata at 2% and Artemisia and Ranunculus type at less than 1%. The zone terminates with woody species increasing again: tree, shrub and Corylus pollen initially fall from 60% to 30% at the beginning of AWB-4, but subsequently recover to 50%. Charcoal varies in frequency, pollen is more abundant and there are few degraded grains.

Zone AWB-5 (C-4)

180-140cm 80bc-ad260

A third major decline of woodland pollen is recorded affecting chiefly Betula, from 30 to 2%, and Corylus, from 12 to 4%. Quercus is little affected. The tree, shrub and Corylus pollen total falls from 50% to 15%, Graminea rises from 37 to 70% and herbs from 10% to 25%. Plantago lanceolata and Rumex are prevalent at 5% and 8-15% respectively with Chenopodiaceae and Liguliflorae. At the end of the zone Betula and other woody species increase and Gramineae and herbs fall. Two cereal pollen grains are also recorded. Charcoal is only present at the end of the zone, pollen is moderately abundant and degraded grains are absent.

Zone AWB-6 (C-4)

140-100cm ad260-590±80
C-14 105-95cm 590±80ad (HAR-4234)

The beginning of the zone is marked by an abrupt increase in *Betula* pollen from 7 to 50% and a fall of Gramineae from 55% to 25%. *Quercus* briefly falls from 15 to 8% but soon recovers, *Alnus* rises from 2 to 10% and *Corylus* from 4 to 16%. *Fraxinus* peaks at 2.5% with *Corylus* and *Quercus* at 112cm. At that level the tree, shrub and *Corylus* pollen total exceeds 80%, Gramineae is 15% and herbs 2%. Various herbs are present sporadically with *Plantago lanceolata* and *Rumex* dominant at 0.3 to 2% and 0 to 10% respectively. Charcoal is recorded at the opening of the zone, pollen is moderately abundant and degraded grains rare to occasional.

Zone AWB-7 (C-4)

100-44cm ad590±80-1060
C-14 105-95 cm 590±80ad (HAR-4234)

AWB-7 opens with the rise of *Fagus* pollen from 1% to about 6% and fall of *Betula* from 45% to less than 10%. *Quercus* pollen increases from 10 to 25%, *Corylus* falls from 15 to 3% and *Fraxinus* peaks at 4%. The total of tree, shrub and *Corylus* pollen falls from 70 to 20%, Gramineae rises from 20 to 65% and herbs attain 30%. Cultivars form continuous curve for the first time, dominated by Cereal type undiff with *Secale* and *Cannabis* types. Herbs are dominated by *Rumex* with *Plantago lanceolata* and Chenopodiaceae, Liguliflorae and *Anthemis* type. Charcoal is absent, pollen occasional to frequent and degradation low.

Zone AWB-8 (C-4)

44-0cm ad1060-1430

The zone is characterised by *Fagus* at a maximum of 6%, with increases of *Quercus* from 12 to 22%, *Corylus* from 2 to 6%, and *Calluna* from 2 to 22%. *Betula* is less than 5%. Tree, shrub and *Corylus* pollen in total rise from 20% to 40%, Gramineae initially falls from 60% to 30%, then increases to 55% and herbs rise to 35%, then decline to 12%. The herbs are dominated by *Rumex* falling from 25% to 4%, *Plantago lanceolata* peaks at 3% with Chenopodiaceae, Umbelliferae, Liguliflorae, Caryophyllaceae, *Potentilla* type, Stachys type, Ranunculus type and Sinapis type. Cultivars are at a maximum of 4% with Cereal type undiff at 1%, Cannabis type peaking at 3% and Secale type sporadically recorded. Charcoal is generally absent, pollen frequent and degradation negligible.

5.4. RIMSMOOR

5.4.1. MAIN CORE, RM 1/RM 2

Disturbed
1780-1655cm

Zonation of RM 1 below 1655cm is inappropriate because of the obviously distorted pollen spectra. The fluctuations in the Pinus and Alnus curves, the elevated Ulmus, Quercus and Fraxinus frequencies and depressed level of Corylus are most notable. It includes characteristics of both zones RM-1 and RM-2.

These features are a result of stratigraphic factors and sampling problems rather than reflecting the actual sequence of vegetation change. The stratigraphy is undoubtedly concave (Figs. 4.23, 4.24) as a result of the continuous subsidence of the doline. Some movement of sediment may thus have occurred, yet coring problems were probably more significant in distorting the spectra. The depth of the deposit made it impossible to ensure that the Hiller sampler remained in a vertical plane during coring; sideways movement will have led to the sampling of older and younger layers in such stratigraphy. This is illustrated by the manner in which on several occasions the nature of the deposit changed abruptly with core segment; for example 1657-1692cm was clay, the next segment from 1690, peat grading into clay by 1715cm, the next, 1720-1755cm, peat again. Pollen changes coincided with these changes in stratigraphy. Furthermore, one core segment encountered impenetrable sand at 1632cm after that preceding had sampled peat to 1750cm; the following met clay and peaty clay at 1780cm, the final core reached the sand at 1750cm. The hard sand at 1632cm and 1750cm was probably the basal sand recorded at a shallower depth because of the corer veering sideways.

Zone RM-1 (C-1)

1655-1570cm 5300-5000bc

RM-1 is characterised by declining Betula from 10 to 6% and Pinus from 12 to 2% with increases in Ulmus, from 3 to 7%, Quercus from 10 to 22%, Corylus from 30 to 40% and Alnus from 1 to 4%. Trees, shrubs and Corylus overall rise from 70 to 75%, Gramineae falls from 35 to 25% and herbs are at less than 1%, dominated by Potentilla type. Charcoal is frequent to abundant, pollen is frequent and degradation low.

Zone RM-2 (C-2)

1570-1102.5cm 5000-2980bc

C-14 1150-1125cm 3200±70bc (HAR-3919)

The rise of Alnus pollen from 5% to between 15 and 25% and only sporadic occurrence of Pinus readily distinguish RM-2 from RM-1. Ulmus is at 7 to 10%, Quercus 25 to 35% and Corylus 20 to 35% with continuous curves for Tilia at 2 to 3% and Fraxinus at 2 to 10%. Tree, shrub and Corylus pollen total 70% initially, later fluctuating between 50 and 85% with Gramineae 20 to 30%, later 15 to 50%. Herbs are less than 4% with Potentilla type and Melampyrum most significant. Pteridium fluctuates between 1 and 10%. New herbs are recorded at the beginning and end of the zone with two cereal pollen grains at 1200 and 1170cm. Charcoal is generally abundant, but absent in the centre of the zone, pollen is frequent and degradation minimal after the RM-1/RM-2 boundary.

Zone RM-3 (C-3)

1102.5-815cm 2980-1890bc

C-14 1085-1060cm 2740±70bc (HAR-3920)

The RM-2/RM-3 boundary is marked in particular by Ulmus falling from 7 to 0%, Gramineae from a brief peak at 50% to 7%, Alnus also from a peak at 78% to 10%, Corylus rising from 20 to 50% and temporary restrictions occuring in Tilia, Quercus and Fraxinus. Plantago lanceolata briefly peaks at 2% with Pteridium at 8%, and two cereal pollen grains. The remainder of the zone is characterised by Corylus at 50 to 60%, Quercus at 25%, Ulmus at 2 to 4%, Tilia at 1 to 2%, Fraxinus at up to 4% and Betula fluctuating between 4 and 15%. Tree, shrub and Corylus pollen total 90 to 95% and Gramineae is at about 5%. Herbs are at 1 to 3%. Charcoal is sporadically recorded, pollen is frequent and degradation minimal.

Zone RM-4 (C-3)
815-602.5cm 1890-1070bc
C-14 815-790cm 1870$\pm$80bc (HAR-3921)

Zone RM-4 opens with changes similar to those at the beginning of RM-3 but instead of *Ulmus*, *Tilia* is most drastically and permanently reduced from 2 to 0.3% or less. *Quercus*, *Ulmus*, *Betula*, *Alnus* and *Corylus* are temporarily reduced whilst Gramineae peaks at 20% and herbs at 5% with cereal pollen recorded. The curves generally return to their former levels by about 750cm with *Quercus* fluctuating between 25 and 35%, *Alnus* 15 to 20%, *Corylus* at up to 65% and Gramineae varying from 5 to 25%. Herbs are at less than 10%, but there is a continuous curve for *Plantago lanceolata* at 2 to 4% and later for Chenopodiaceae at less than 1%; *Calluna* steadily increases. Throughout the zone tree, shrub and *Corylus* total between 80 and 90%. Charcoal is present throughout with greater quantities recorded at the beginning of the zone. Pollen is generally frequent and degradation is minimal, except in samples from a clay inwash at 782 to 795cm.

Zone RM-5 (C-3)
602.5-415cm 1070-350bc
C-14 435-410cm 400$\pm$70bc (HAR-3922)

RM-5 opens with a major decline in woodland species and a dramatic increase in Gramineae. *Quercus* falls from 26 to 12%, *Corylus* from 60 to 16% and *Alnus* from 22 to 10%. The tree, shrub and *Corylus* total falls from 90 to 30%, Gramineae climbs from 10% to 55% and herbs from 10 to 20% with *Plantago lanceolata*, *Artemisia* and *Rumex* most abundant. *Pteridium* reaches 65% and *Calluna* is depressed. From about 350cm there is a recovery of woodland pollen and *Calluna* and a reduction of Gramineae and herbs. By the end of the zone tree, shrub and *Corylus* pollen total 75%. Cereal pollen is recorded at the beginning and end of RM-5. Charcoal is present in small amounts, pollen abundance is lower and degradation negligible.

Zone RM-6 (C-4)
415-285cm 350bc-ad350
C-14 380-355cm 130$\pm$80bc (HAR-3923)

RM-6 is similar to RM-5 and opens with a decline in *Corylus* from 45 to 10%, *Quercus* from 20 to 10% and *Alnus* from 10 to 4%. The tree, shrub and Corylus pollen total falls from 75 to 20%, Gramineae rises from 25 to 65% and herbs from 5 to 20%. Plantago lanceolata is especially common at 5 to 10% with Rumex, Artemisia, Spergularia type and Liguliflorae also prevalent at between 1 and 4%. The latter half of the zone shows a recovery of tree, shrub and Corylus to 70% with Gramineae lower at 20% and herbs at 10%. Calluna exceeds 30% in the first half of the zone, falling subsequently to 5%. Cereal pollen is recorded in most samples. Charcoal is present in low quantities, pollen increases in abundance and degradation is negligible.

Zone RM-7 (C-4)
285-150cm ad350-1600
C-14 175-150cm 1340±60ad (HAR-3924)

In RM-7 there is overall a progressive decrease of tree and shrub pollen and increase of open country types, but with a temporary reversal of this trend in the centre of the zone. Quercus and Corylus are most reduced, from 25 to 10% and 35 to 5% respectively. The tree, shrub and Corylus pollen total falls from about 70 to 20% through the zone, Gramineae rises from 30 to 50% and herbs from 10 to 25%. Plantago lanceolata remains common with Anthemis type and Rumex. Calluna increases steadily from 5% to in excess of 20%. Cultivars are high at a minimum of 3%, peaking at 15% at about 160cm. Secale and Cannabis types are frequent in addition to Cereal type undiff. Charcoal is low, pollen frequent and degradation negligible.

Zone RM-8 (C-4)
170-105cm (RM 2) ad1600-1750

RM-8 is distinguished by the lowest total of tree, shrub and Corylus pollen at only 20%, comprising Quercus at 3 to 8%, and Corylus at 8 to 12% with Gramineae at 52 to 63% and herbs at 20 to 30%. Plantago lanceolata is at a maximum of 15% with high Liguliflorae (5%) and Potentilla type (5%). Calluna varies between 15 and 20%. Cultivar pollen is low, represented by Cereal type undiff at 0.5%. Charcoal is absent, pollen is lower in abundance and degraded grains are rare to occasional.

Zone _RM-9_ (C-5)
105-0cm (RM 2) ad1700 to present

The total for tree, shrub and _Corylus_ pollen increases from 20% to 60% throughout RM-9. _Pinus_ in particular rises from 1% to 40% and _Betula_ from 1% to 10%. Others increase, then decline: _Ulmus_ from 0 to 4%, then 0.5%, _Quercus_ 8%, 27%, 20%, _Fraxinus_, 1%, 2%, 1%, _Fagus_ 0.5%, 2%, 0% and _Corylus_ 3%, 8%, 3%. Gramineae falls from 60 to 30% with _Plantago lanceolata_ from 12 to 1% and herbs also falling. _Calluna_ and _Pteridium_ are similarly reduced. Cereal pollen is higher than in RM-8 at 1 to 2%. Charcoal is absent, pollen is frequent and degradation negligible.

5.4.2. _ULMUS_ DECLINE, RM UD

In both the subsidiary diagrams from Rimsmoor the chronologies are obtained by taking the level with the first major disturbance as year 0 and then applying the mean accumulation rate of 3.84yrs cm^{-1}. Radiocarbon dates bc are derived from comparison with RM 1, although at this scale the duration of events is of more direct interest. The possibility of variations in accumulation rate are discussed in sections 9.3.4 and 9.4.3.3.

Subzone _RMU-1_ (RM-2,C-2)
1090-1078.5cm -46 C-14yrs to 0yrs (0=c.2980bc)

In RMU-1 _Ulmus_ is at 7 to 9%, _Quercus_ 30 to 35%, _Tilia_ 2%, _Fraxinus_ 2 to 3%, _Betula_ 3 to 5% with _Alnus_ peaking at 40%, then falling. Tree, shrub and _Corylus_ pollen total about 80%, Gramineae 15-20% and herbs 1 to 2%, predominantly _Potentilla_ type. Charcoal is occasional to frequent, pollen is frequent and degradation negligible.

Subzone _RMU-2_ (RM-3, C-3)
1078.5-1043cm 0-136 C-14yrs

The subzone opens with _Ulmus_ dropping from 8% to 3% between two contiguous 1cm samples and thereafter declines to less than 1%. Over the following two samples _Alnus_ falls from 30% to 14% and also reduced are _Tilia_, _Quercus_ and _Fraxinus_. Conversely, _Corylus_ rises steadily from 33% to 60%, _Betula_ from 3 to 6% and herbs, notably _Plantago lanceolata_, from 1% to 3% in total. The Gramineae curve is complex, initially peaking, then falling. Two cereal pollen grains are recorded towards the end of the subzone. Charcoal is mostly rare or absent, pollen is frequent and degradation negligible.

Subzone RMU-3 (RM-3, C-3)
1043-1040cm 136-148 C-14yrs

The final subzone is tentative and represented by only two counts. *Betula* is increased from 5 to 12%, and *Alnus* from 12 to 15%; *Corylus* is reduced from 60 to 52%.

5.4.3. *TILIA* DECLINE, RM TD

Subzone RMT-1 (RM-3, C-3)
850-843cm -27-0 C-14yrs 0yrs=c.1890bc

Corylus pollen at 55 to 65% dominates the zone with *Quercus* at 20 to 30%, *Tilia* at 2%, *Ulmus* at 1 to 1.5% and *Fraxinus* at 1.5 to 2%. Tree, shrub and *Corylus* pollen total over 90%, Gramineae 3 to 6% and herbs 0 to 1%. *Calluna* is initially at 4%, increasing to 7% and *Pteridium* fluctuates between 1 and 12%. Charcoal is absent until the end of the subzone, pollen is frequent and degradation minimal.

Subzone RMT-2 (RM-4, C-3)
843-815cm 0-108 C-14yrs

The subzone is characterised by *Quercus* fluctuating between 15 and 30%, *Corylus* falling from 60 to 40%, *Betula* rising from 6 to 12%, and *Ulmus* slightly increased to 1 to 2%. *Tilia* remains at 1 to 2% until the centre of the subzone at 827cm when it falls abruptly to 0.3%. Tree, shrub and *Corylus* pollen falls from 90 to 75%, Gramineae rises from 6% to a maximum of 24% at the end of the subzone, herbs peak at nearly 5% and two cereal pollen grains are recorded at 833 and 836cm. *Plantago lanceolata* dominates the herbs at 0.3 to 3% with *Potentilla* type, *Melampyrum* and *Rumex* relatively common. *Calluna* sharply peaks between 831 and 825cm. A clay horizon is present between 831.5 and 827.5 and charcoal through most of the subzone is occasional to frequent. Pollen is frequent to abundant and degradation is only significant in the clay.

Subzone RMT-3 (RM-4, C-3)
815-805cm 108-146 C-14 yrs

In RMT-3 Betula stabilises at 14%, Quercus increases from 15 to 32%, Fraxinus rises from 2 to 5% and Corylus after an initial peak falls to 43%. Tree, shrub and Corylus pollen climbs rapidly from 75% to a constant 92%, Gramineae falls from 20% to 4% and herbs to 1 to 3%. Pteridium is generally less than in RMT-3 at 5%. Cereal pollen is absent. Charcoal is not recorded, pollen abundance is markedly reduced and degradation is negligible.

Subzone RMT-4 (RM-4, C-3)
805-800cm 146-165 C-14yrs

The final four counts of the core show Betula falling from 15 to 6%, Quercus fluctuating between 50 and 58%, Alnus falling from 20 to 11%, Fraxinus falling from 4 to 0.5% and Corylus at about 40%. Tree, shrub and Corylus pollen in total falls from 93 to 88%, Gramineae is raised from 3 to 5% and herbs from 2 to 6%. Plantago lanceolata in particular rises from 0.5 to 4% and Pteridium peaks at 18%. Three cereal grains are recorded. Charcoal is absent, pollen frequent and degradation minimal.

5.5. OKERS

The Okers pollen diagram was not radiocarbon assayed and the chronology is based on comparison with Rimsmoor, 150 m to the east. This was hindered by the smaller size of Okers and consequently the greater influence of local factors, but it seems to represent the same period as the upper 360cm at Rimsmoor. The time:depth curve (Fig 4.30) was constructed from the three points most obviously comparable in both diagrams: the end of the second major clearance at Rimsmoor when cereal cultivation was being resumed, c.80bc at 365cm (about 360cm at Rimsmoor); the period of temporary regeneration at the end of this phase, c.350ad at 275cm (285cm at Rimsmoor); and the Pinus rise, c.1750ad at 35cm. From this curve the interpolated date for the rise of cereal pollen at 165cm of 990ad corresponds well with probably the same level, 200cm, at Rimsmoor of c.995ad, Likewise the end of the cereal curve at 95cm has the not unexpected date of about 1400ad. Furthermore, the resulting curve has a fairly constant accumulation rate of between 4.78 and 6.57yrs cm^{-1}.

Zone OK-1 (RM-6, C-4)
395-365cm 220-80bc

OK-1 is characterised by Quercus pollen rising from 20 to 65% with the following falling: Betula 6 to 2%, Alnus 10 to 3% and Corylus 23 to 7%. Tree, shrub and Corylus pollen in total rises from 50 to 72%, Gramineae falls from 40 to 20% and herbs peak at 18%, then fall to 7%. Plantago lanceolata as the most abundant herb peaks at 8% and declines to 3%, Calluna falls from 9 to 4% and Pteridium falls from 18 to 7%. A single cereal pollen grain is present in the final sample of the zone. Charcoal is recorded at a low level, pollen is frequent to abundant and degradation is slight.

Zone OK-2 (RM-6, C-4)
365-275cm 80bc-ad350

The zone is marked by values of Quercus that fall rapidly from 65% to a minimum of 10% whilst other woody species rise to a peak in the centre of the zone: Betula from 3% to 5%, Alnus 5% to 8%, Fraxinus 1 to 5%, Fagus 0 to 0.5% and Corylus 20 to 40%, then 30%. Trees, shrubs and Corylus attain a minimum of 50%, Gramineae peaks at 43% and herbs reach a maximum of 13%. Plantago lanceolata is prevalent at 2 to 8% with Chenopodiaceae and Rumex continuously represented. Pteridium reaches a maximum of 17% and cereal pollen occurs briefly at less than 1%. The end of the zone shows a reversal of the earlier trends with tree, shrub and Corylus pollen exceeding 85%. Charcoal is absent after the start of the zone, pollen is generally frequent and degradation minimal.

Zone OK-3 (RM-7, C-4)
275-165cm ad350-990

The zone opens with falling values of Betula and Quercus, from 30 to 2% and 25 to 8% respectively and a brief peak of Corylus at 30%. Tree, shrub and Corylus pollen falls from 88% to about 20%, Gramineae rises from 10% to about 50% and herbs from 5% to 30%. Plantago lanceolata reaches a maximum of 14%. Other herbs consistently present include Ononis type, Liguliflorae, Poterium sanguisorba, Rumex, Spergularia type and Stachys type. Pteridium and Calluna are relatively low at 10% or less. Cereal pollen grains are recorded sporadically, as is charcoal. Pollen is frequent and degradation negligible.

Zone OK-4 (RM-7, C-4)
165-95cm ad350-1400

OK-4 shows *Betula* slowly increasing from 2 to 7%, *Alnus* from 2 to 8%, *Fraxinus* from 0.5 to 3% and *Corylus* from 4 to 20% with *Quercus* constant at 12%. Tree, shrub and *Corylus* pollen climbs from 20 to 40%, Gramineae initially falls from 70% to stabilise at 50% and herbs reach a maximum of 25%. Cereal pollen is recorded in two peaks of 3% and 2% respectively. Herbs are dominated by *Plantago lanceolata* at up to 10% and *Rumex* at 7% with lower frequencies of Cruciferae undiff, Umbelliferae, *Potentilla* type, Liguliflorae, *Poterium sanguisorba*, *Urtica* and *Artemisia*. Charcoal is recorded sporadically, pollen is frequent and degraded grains are insignificant in number.

Zone OK-5 (RM-8, C-4)
95-35cm ad1400-1750

Zone OK-5 exhibits *Betula* falling from 8% to 4%, *Fraxinus* from 3 to 1% and *Corylus* from 25 to 15% with *Quercus* fluctuating between 8 and 12%. Tree, shrub and *Corylus* pollen fall from about 45 to 30% and Gramineae from 65 to 40%; herbs increase from 8 to about 20%. *Plantago lanceolata* and *Rumex* are the most common herbs, *Pteridium* falls from 10 to 5% and *Calluna* increases to over 20%. Cereal pollen is present at 0.3%. Charcoal is recorded in low quantities in the first half of the zone, pollen is frequent and only one level exhibits any degradation.

Zone OK-6 (RM-9, C-5)
35-0cm ad1750 to present

In OK-6 increases are recorded in *Betula* from 2 to 12%, *Pinus* from 1 to 20%, *Ulmus* from 0.5 to 1%, *Quercus* from 6 to 12%, *Fraxinus* from 1 to 2%, *Fagus* from 0.5 to 1% and *Carpinus* from 0 to 0.5%. *Corylus* overall is reduced to 1%, *Calluna* to 1%, Gramineae from 80 to 43%, herbs from about 10 to 7% and *Pteridium* from 5 to 1%. Tree, shrub and *Corylus* pollen increases through the zone from 20 to 50%. Cereal pollen is sporadic in occurrence and *Secale* and *Cannabis* types are represented by single grains.

Charcoal is only recorded at the beginning of the zone, pollen is frequent and degradation minimal.

5.6. KINGSWOOD

Zone KW-1 (C-1)
232-222cm 5550-5000bc

In KW-1 Betula is declining from 20 to 5%, Pinus from 12 to 3%, Corylus from 33 to 25% whilst Ulmus increases from 3 to 4%, Quercus from 10 to 17% and Alnus from 8 to 20%. Tree, shrub and Corylus pollen falls from 80 to 55%, Gramineae rises from 18 to 45% and herbs fall from 4 to 2%. Melampyrum is the most prominent herb at 2%. In addition Myrica falls from 5 to 1%, Salix from 5 to 0.5%, Calluna from 4 to 2% and Pteridium from 6 to 3%. Charcoal and pollen are both abundant and degradation is negligible.

Zone KW-2 (C-2)
222-183.5cm 5000-2800bc

Major fluctuations occur in the first part of the zone but it is characterised as a whole by Pinus at less than 1%, Ulmus at 4 to 5%, Quercus at 15 to 25%, Alnus at 15 to 30% and Corylus at 20%. The tree, shrub and Corylus total is lower at about 50%, Gramineae is generally in excess of 40% and herbs are at 1 to 2% for most of the zone. Melampyrum and Potentilla type are common herbs. Both charcoal and pollen are frequent to abundant and the number of degraded grains is insignificant.

Zone KW-3 (C-3)
183.5-135cm 2800-1375bc
C-14 185-175cm 2610±60bc (HAR-4239)

Zone KW-3 opens with pronounced falls in Ulmus from 7 to 1%, Quercus from 28 to 20%, Alnus from 20 to 8% and increases in Betula from 2 to 4% and Corylus from 20 to 40%. At about the same level minor peaks are discernible in Melampyrum, Plantago lanceolata, Rosaceae undiff, Artemisia, Umbelliferae and Liguliflorae. Gramineae maintains the fall initiated in the latter half of KW-2. For the rest of the zone the new frequencies generally attained are Betula at 3 to 5%, Ulmus at 2 to 5%, Quercus at 20%, Alnus at 10 to 15%, Fraxinus at 2 to 3%, Corylus at 40%, Gramineae at 20% and with herbs only occasionally recorded. Between about 166 and 150cm Betula increases to a peak at 60% and other tree pollen are depressed. Brief maxima however occur in Hedera, Calluna, Potentilla type, Rumex, Melampyrum, Chenopodiaceae and Umbelliferae. Tree, shrub and Corylus pollen reaches a maximum of 70 to 80% in the latter part of the zone. Charcoal is frequent to abundant, pollen is abundant and degradation is negligible.

Zone KW-4 (C-3)
135-106cm 1375-600bc

At the beginning of the zone Quercus pollen is increased to 30%, Gramineae to 45% and Plantago lanceolata abruptly from 0.5 to 9% whilst Corylus falls from 50% to 30% and Tilia from 2% to 0%. Betula is then elevated to 8%, Quercus maintains 20% and Corylus falls to 20%. A minimum of tree, shrub and Corylus pollen is attained at 116cm with Gramineae and herbs at peaks of 50 and 15% respectively. Cereal pollen is present for the first time from this level. Other herbs include Potentilla type, Rumex and Liguliflorae. Charcoal becomes less frequent through the zone, pollen remains abundant and some minor degradation is recorded.

Zone KW-5 (C-4)
106-54cm 600bc-ad1750
C-14 104-95cm 430±80bc (HAR-4367)

KW-5 is marked by a generally falling tree, shrub and Corylus level, although Corylus increases in the latter half of the zone. Betula is reduced to about 8%, Ulmus to less than 1%, Quercus to about 10% and Alnus to about 5%. Fagus is relatively abundant at up to 4%. Gramineae reaches 50%, Calluna 20% and Myrica 20 to 25%. Plantago lanceolata is at a maximum of 10%. Other prominent herbs are Potentilla type, Rumex, Umbelliferae and Liguliflorae. Herbs generally attain up to 20%. Cultivars are at a maximum for the diagram with Cereal type undiff at 2% and Cannabis type at 2% in the first half of the zone with Secale type recorded later. Charcoal is only recorded in the first part of KW-5, pollen is generally frequent and degradation low.

Zone KW-6 (C-5)

54-34cm ad1750-1850

In this zone tree, shrub and Corylus pollen peak at 75%, Gramineae falls to 25% and herbs are at less than 10%. Betula, Quercus, Alnus and Corylus peak at 15%, 15%, 10% and 32% respectively. Pinus rises from 2% to 20%, Myrica is depressed to under 10%, and Calluna falls to 10% and Pteridium is at 5%. Plantago lanceolata is reduced to 2% and Liguliflorae to 1%. Cereal pollen is recorded only in two levels. A small quantity of charcoal is present, pollen is frequent and degraded grains become more common.

Zone KW-7 (C-5)

34-0cm ad1850 to present

Tree, shrub and Corylus pollen fluctuates between 25 and 50% in KW-7 with Gramineae at 50 to 60%, herbs at 8 to 15% and cultivar pollen at generally less than 1%. Pinus maintains 15 to 20% whilst Betula is reduced to under 10%, Ulmus to 2%, Quercus 6 to 14%, Alnus 2 to 4% and Corylus 3 to 8%. Calluna and Ericaceae pollen vary between 5 and 20% and also higher are Plantago lanceolata, at 2 to 6%, and Rumex 1 to 2% with Urtica, Sinapis type and various other herbs. Charcoal is recorded at the end of the zone, pollen is less abundant and degraded grains vary from rare to occasional.

5.7. WOODHAY

The Woodhay pollen diagram, like Okers, was not radiocarbon dated; this factor and the relatively homogenous pollen spectra hinder the derivation of a precise chronology. A very tentative scheme is proposed in section 10.9.

Zone WH-1 (C-4)

98-34cm ?350bc-ad1800

WH-1 is characterised by fairly constant totals for trees, shrubs and Corylus at about 75%, Gramineae at 20 to 25% and herbs at 5 to 8%. Quercus increases slowly from 25 to about 40%, Alnus varies between 60 and 70%, and Corylus falls from 35 to 25%. Betula rises to an early peak of

15%, then falls to 8%, Pinus falls from 0.5 to 0%, Tilia shows a slight decline from 2 to 0.3% and Fraxinus is at 2 to 3%. The herbs are dominated by Plantago lanceolata at 1 to 2% with continuous records for Potentilla type, Rubiaceae and Umbelliferae. Charcoal is recorded at low levels, pollen is frequent and degradation slight.

Zone WH-2 (C-5)
34-0cm ad1800 to present

The stability of WH-1 is lost in WH-2. Betula exhibits a fluctuating peak of 15 to 25%, Quercus falls to about 15% and Corylus to about 2%. Pinus, Fraxinus and Fagus become more common but only Fraxinus exceeds 4%. Overall, tree, shrub and Corylus pollen is reduced to 60% at 16cm, then recovers to 70% at 4cm, then falls again to 50% at 0cm. The fluctuations in Gramineae pollen are the reverse with a maximum of 48% at 0cm. Herbs peak at 8cm, dominated by Potentilla type and Plantago lanceolata with Urtica, Rubiaceae, Artemisia and Rumex. Cereal pollen, in low frequency, is recorded from the centre of the zone. Low quantities of charcoal occur in the first half of WH-2, pollen is frequent and degradation minimal after the opening of the zone.

CHAPTER 6

PERIOD C-1 BOREAL WOODLAND

Sites: Winchester WT-1, WT-2
Rimsmoor RM-1
Kingswood KW-1

C-1 is the earliest period represented in the pollen diagrams and is correlated with the Boreal of Blytt and Sernander, Godwin's Zones V and VI (Godwin 1940, 1975a) and Fl I (West 1970). It is present at three sites, but at Rimsmoor and Kingswood only the terminal phase is recorded.

6.1. CHRONOLOGY

The dates of the zone are difficult to determine accurately because radiocarbon determinations were not undertaken for the Period: the chronology of clearance episodes was considered to be of greater importance in the allocation of the available assays given the research objectives. Approximate dates, however, have been obtained by comparison with other work.

The termination of C-1 has been put at about 5,000bc, as determined by Haskins' single date of 5029±70bc (SRR-789) for the end of her Zone D at Morden B, a site in the Poole Basin (Haskins 1978, 66); A.R. Tilley's (pers.comm.) two radiocarbon dates of about 5000bc for the _Alnus_ rise at two New Forest sites; the 'Mitchell BAT' at about 5,000bc (Smith and Pilcher 1973); and Godwin's estimated date of 7000bp (Godwin 1975a). Radiocarbon assays in general are very sparse for this period in southern England so without dates from each site under discussion such estimates must remain tentative.

The Period is assumed to open between 9600bp (7650bc) (Haskins 1978) and 9000bp (7050bc) (Godwin 1975a; Smith and Pilcher 1973) although none of the three sites record this event.

Dates of episodes within C-1 are determined by projecting the time: depth curves backwards in a straight line from the _Ulmus_ decline through the upper boundary at 5000bc. A constant rate of accumulation is assumed: this may not be valid but in the absence of evidence to the contrary, it is adopted to give a general indication of chronology.

6.2. WOODLAND COMPOSITION AT WINCHESTER

This examination of C-1 concentrates upon the Winchester pollen diagram: it represents the longest period and probably records most closely chalkland vegetational history. At this site the base of the organic deposit (430cm) has a date of c.6700bc. Most of the Boreal is present, although the continuous curves for Ulmus and Quercus throughout imply that Zone V is not recorded. The pollen data from the three sites are summarised in Figure 6.1.

At Winchester the pollen indicates that the woodland on the surrounding chalk was probably dominated by Quercus, Ulmus, Pinus and Corylus.

In WT-1 low Betula and Alnus pollen imply the restricted existence of both taxa in the pollen source area whilst the negligible frequencies in WT-2 suggest a further reduction in their abundance. At Elstead, however, early and low frequency Alnus was assigned to possible contamination (Seagrief and Godwin 1960). This need not be the case, for at various sites there are similar records for Alnus: Southampton (Zone IV, Godwin and Godwin 1940); Wareham (Zones IV and V) and Nursling (Zones III and VIa; Seagrief 1959); several sites in the New Forest (e.g. Cranesmoor, Zone V, Seagrief 1960; A.R. Tilley pers.comm.); East Stoke Fen (Haskins 1978); and possibly at Lewes (Thorley 1981; section 2.1.1.1.). This supports Godwin's (1975a) contention that alder was present sporadically prior to the Atlantic period in favourable locations. These sites will be recorded because such places are often suitable for peat formation; for example, the deposits from the Ouse, Frome and Itchen valleys and Southampton Water.

Dry land herb frequencies attain up to 10% in WT-1, but fall to about 3% in WT-2. They include types which subsume wetland species such as Ranunculus and Bidens types, but also Plantago lanceolata indicating that there was perhaps some dry land in the vicinity during WT-1. This may have been on the flood plain, because in WT-2 Cyperaceae is elevated suggesting, perhaps with higher Gramineae, changed hydrological conditions

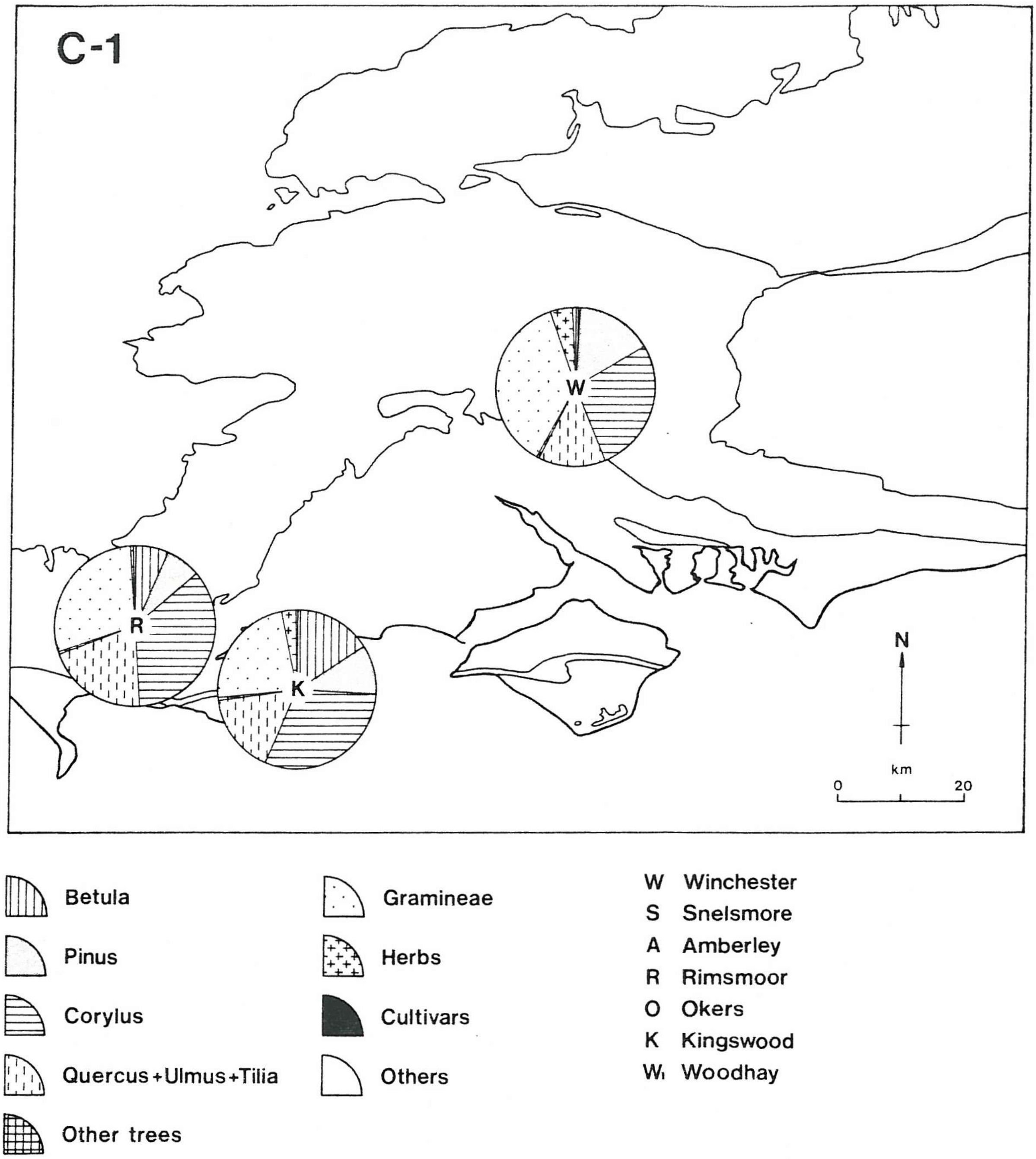


Figure 6.1. Period C-1: summary pollen diagrams

and resulting loss of drier habitats. Such a change may also have made conditions less favourable for Alnus and Betula growth.

In WT-2 Pinus shows an expansion chiefly at the expense of Quercus and Betula, although Ulmus is also slightly reduced. Herbs are low with only those types that include wetland taxa showing continuous curves. The interdependence of the percentages is inevitably masking the changes probably taking place in the woodland cover. The opening of the zone coincides with increased Gramineae pollen which in part must be responsible for the reduced Quercus and, temporarily, Corylus pollen. It must also be masking the increase of Pinus in the vegetation. The high Gramineae pollen at Winchester in both C-1 and C-2 is largely a result of Phragmites and other wetland grasses growing on the fen surface: their remains are abundant in the peat. Other fen plants included members of the Cyperaceae, Filipendula and some aquatics, such as Potamogeton, Typhaceae and Elatine.

6.2.1. QUERCUS AND ULMUS

The behaviour of the pollen curves preclude the application of Godwin's subdivisions of Zone VI, if it is accepted that most of the zone is recorded at Winchester. Quercus is consistently greater than Ulmus, although Zone VIa where Ulmus exceeds Quercus may be absent as the beginnings of both curves are not shown. In addition, Tilia is not recorded until the ensuing WT-3, correlated with Period C-2; Quercus with Ulmus and Tilia is diagnostic of Zone VIc. (The positioning of the WT-2/WT-3 boundary is discussed in section 7.2.).

Divergence from Godwin's subdivisions are common in analyses of sites in central southern England. At Wareham (Seagrief 1959) Quercus is established earlier but in the later Boreal Ulmus exceeds it, whilst at Nursling (Seagrief 1959) and Southampton (Godwin and Godwin 1940), like Winchester, Quercus pollen is generally more abundant than Ulmus. Nursling and the Southampton site are about 17km from Winchester. Only at Cranesmoor (Seagrief 1960) and Elstead (Seagrief and Godwin 1960) do the results conform to Godwin's scheme. Haskins (1978) in the Poole Basin found likewise that Quercus commonly exceeded Ulmus; she proposed that the expansion and establishment of oak before elm was partly a result of the expansion of the former from the south and east and the latter from the north-west. Brown (1977) has suggested that poorer soils may have discouraged Ulmus generally in south-west and central southern England; Haskins believes that many non-calcareous soils in southern England were already acidic by the Atlantic.

Neither of these hypotheses are readily acceptable because of the absence of conformity between the sites. The New Forest soils appear not to be substantially different from those of the Poole Basin, whilst the Nursling, Southampton and Winchester sites display similar vegetation sequences on differing geologies. The lack of any spatial trends between the different sequences may mitigate against Haskins' hypothesis. Presumably local site conditions, such as topography, slopes, aspect and drainage were more important. It is unfortunate that the Winchester site does not record whether Ulmus or Quercus arrived first in the area: this could have aided the resolution of this problem.

6.2.2. TILIA

Other pollen diagrams from southern England indicate that the absence of Tilia pollen at Winchester in the late-Boreal is unusual. Indeed, Quercus-Ulmus-Tilia spectra are characteristic of Godwin Zone VIc, further testifying to the inappropriateness of this subdivision to the Winchester data. Possible explanations are discussed in section 7.3.3.

6.2.3. CORYLUS

The most abundant pollen of the woody species is Corylus, but in the likely absence of Zone V levels, it is not possible to state whether the central chalklands, like the south-east (Godwin 1975a) and the Poole Basin (Haskins 1978), experienced major hazel expansion only in Zone VI. Elsewhere in Britain, its pollen characteristically reaches a peak in Zone V. Its later spread in the south may be a result of competition with the already established Pinus (Godwin 1975a).

In the formative years of pollen analysis, the hazel was viewed as an understorey shrub and thus excluded from the arboreal pollen sum. However, it is now seen as a woodland-forming tree (Faegri and Iversen 1975; Rackham 1980) and it will attain a height of up to about 12m (Clapham et al. 1968; A. Mitchell 1974). The habit adopted by Corylus has implications for pollen analysis: when present as an understorey shrub beneath a closed woodland canopy, it will tend not to flower, and so is not recorded in pollen diagrams; if Corylus pollen is recorded, it indicates hazel present as a marginal belt to woodland, in clearings, or in pure stands (Dimbleby 1978; Godwin 1975a). It is at a competitive disadvantage to the mixed oak forest trees and given the presence of Ulmus and Quercus at Winchester in the Boreal it would be expected that Corylus was restricted solely to the periphery of forest areas, with, perhaps, Pinus.

Two factors however suggest that this hypothesis may be rejected. First Corylus frequencies are about the same at Winchester, Rimsmoor and Kingswood, sites differing greatly in size. At the centre of the large site, Winchester, a fringing hazel belt will have had little major impact on the pollen spectra, whereas at the smaller Rimsmoor and Kingswood with the woodland edge at perhaps 2 to 5m from the pollen core, frequencies of 70 to 90% Corylus pollen might be expected. The similar frequencies suggest that Corylus was generally widespread within the forest canopy. However, at Winchester it is possible that the Corylus frequencies may have been elevated by hazel growing on drier areas of the flood plain and conditions conducive to pollen decay may have favoured the greater preservation of this resistant pollen type. The former is difficult to quantify (section 6.2.), but the absence of an inverse relationship between the frequencies of Corylus and the more susceptible Ulmus and Quercus (Havinga 1971) imply that the latter may be unimportant.

Secondly, Corylus may have been widespread because of its resistance to fire: abundant macrofossil charcoal suggests that woodland fires may have been common. (The role of Corylus as a possible 'fire climax' has been suggested by Rawitscher (1945); section 8.2.2.) This will have reduced the effectiveness of competition from oak and elm, although this mechanism would be unnecessary if these taxa had yet to become prevalent in the woodland. Thus, Corylus may indeed have been a significant component of the woodland canopy. Its occurrence as an understorey and on the woodland margin also, however, cannot be discounted.

Corylus tends to be abundant on basic and neutral soils (Clapham et al. 1968; Tansley 1949). The similar frequencies at Winchester and at the two sites at present in heathland, Rimsmoor and Kingswood may also suggest that the soils at the latter were not excessively acid at this time. Rackham (1980) (see also Clapham _et al._ 1968) however records that _Corylus_ will grow on acid soils of less than pH 4.0.

6.2.4. PINUS

The _Pinus_ curve at Winchester climbs to a peak of about 20% DLP, 60% arboreal pollen, towards the end of C-1 from a minimum of 10% DLP, 40% arboreal pollen in WT-1. It was noted above that the behaviour of this curve, as with others within the sum, is influenced by the pollen from local grasses, but there is clearly a real and significant peak. The evidence is equivocal at the two nearest published sites: the _Pinus_ at Southampton (Godwin and Godwin 1940) shows a slight fall in the later Boreal and at Nursling (Seagrief 1959) late-Boreal spectra are absent, although a maximum is apparent in Zones IV and V with a possible secondary peak in Zone VIb. The _Pinus_ at Cranesmoor (Seagrief 1960) is at a maximum in Zone V, at Wareham (Seagrief 1959) in Zone V and early Zone VI and generally in the Poole Basin in Zone V (Haskins 1978, Zone C). Two maxima are present at Elstead, one in Zones IV and V and a second in Zone VIb (Seagrief and Godwin 1960). Overall, in southern England as on the continent (Pennington 1974), _Betula_ and _Pinus_ are reduced with the rise of _Quercus_ and _Ulmus_. This is partly a statistical effect, but indicates chiefly a real reduction of birch and pine because of competition. In northern England and Scotland _Pinus_ generally reached a maximum in VIc (eg. Flixton, Clark 1971; Red Moss, Hibbert _et al_ 1971; Burnmoor Tarn, Pennington 1965). The late peak at Winchester may be a purely local phenomenon, or, alternatively, a secondary peak similar to the one at Elstead; confirmation is not possible because of the absence of earlier spectra, yet there is a decline from 20 to 10% between the first two samples in C-1 perhaps portraying the end of the main peak. Were this the case, then it is further evidence for an early expansion of pine in southern England as first noted by Erdtman (1928).

The mechanisms behind the behaviour of _Pinus_ were investigated by Oldfield (1965). In the south and east it spread over pioneer early postglacial birch woodland after a phase of falling water tables; in Lowland Lonsdale, in contrast, it expanded in an area of established deciduous forest during a period of recovering water tables after a phase of drying out. Pennington (1974) likewise favours an explanation involving soil conditions. Alternatively, Godwin (1975a) views that migration from the south, and the north and east, rather than the west, may have led to its virtual exclusion from the north-west in Zones V and VI. At Winchester, Corylus is increased with Pinus whilst Quercus is most seriously reduced; in contrast, the late maxima at East Stoke Fen and Luscombe (Haskins 1978) are at the expense of Corylus.

Edaphic factors do not readily explain the late peak at Winchester where in southern England generally Pinus is at home on most soils; nor migration for Godwin envisages a source in the south (Godwin 1975a). Furthermore, competition with the, presumably expanding, Ulmus and Quercus should have mitigated against a late peak of Pinus. Godwin (1975a) notes, however,

> "that there is substantial evidence for a phase of pronounced dryness" (p.462)

in Zone VIc. The evidence is largely stratigraphic and comes from sites such as Hockham Mere (Godwin and Tallantire 1951), Star Carr (Clark 1971) and, on the Isle of Wight, Gatcombe (Scaife 1980). It is also attested by chemical fluctuations in various deposits in the Lake District (Pennington 1970) and non-pollen microfossils have recently provided additional data from The Netherlands (van Geel et al. 1981). A drying of the fen surface of Winnall Moors could have permitted colonisation by Pinus. The absence of similar peaks of pine pollen at other sites may indicate, by contrast, failure to cross critical hydrological thresholds. Pollen degradation is higher and abundance lower in WT-2 than WT-1 which could itself be a result of a climatically induced drying of the fen. However, firstly, macrofossils of pine were not discovered during the stratigraphic investigations, although this need not mean that colonisation did not occur; and secondly Betula pollen is minimal, a taxon which would be expected to expand across previously wet areas with Pinus. It is conceivable that Betula was not present in sufficient quantity locally, unlike Pinus, yet the low percentages in WT-1 indicate its probable existence: its efficiently dispersed seeds will have led to rapid expansion across suitably open areas.

Furthermore, the degraded condition and low abundance of the pollen is also equivocal as this persists throughout the succeeding C-2, the Atlantic, which was a period of increased climatic wetness (section 7.2.). The adopted measures of abundance and degradation may have been too crude to detect relatively subtle changes, perhaps as confirmed by the higher Typhaceae in C-2. Nevertheless, as already mentioned (section 6.2.3.), there are no consistent fluctuations in grains susceptible and resistent to degradation across the WT-1/WT-2 boundary that can readily be interpreted in terms of a drying out of the mire surface. Indeed, as described in section 6.2. any change that may have occurred, at least at this boundary, may have been to wetter conditions on the flood plain.

Interestingly, the _Pinus_ peak coincides with reduced levels of charcoal. _Pinus_ is susceptible to burning (Godwin 1975a) and a lower incidence of forest fires may have permitted the temporary expansion of the species. However, _Corylus_, possibly dependent upon fires for its existence (section 6.2.3.), shows no corresponding reduction.

To summarise, there does not appear to be a readily acceptable explanation for the late C-1 peak of _Pinus_ at Winchester. Association with the postulated phase of climatic dryness cannot be convincingly demonstrated. Perhaps purely local factors were responsible. Especially important at Winchester may have been changes occurring on the flood plain as a result of river channel migration. This alone could have led to the fen in the vicinity of the pollen core becoming wetter, whilst another area, perhaps at the fen margin became drier and this, exemplified by or perhaps, because of temporary climatic dryness, may have experienced _Pinus_ colonisation at a time when more generally in the landscape _Pinus_ was in retreat. The elevated Filicales levels of WT-2 may relate to some expansion of woodland locally; explanations for this phenomenon based solely on pollen degradation cannot adequately be substantiated, because of the behaviour of the other pollen types. Further work is clearly required from other sites in central southern England.

6.2.5. WINCHESTER: CONCLUSION

The spectra from Winchester suggest that the surrounding chalk was mantled by woodland of _Ulmus_, _Quercus_, _Pinus_ and _Corylus_. The precise form of the community cannot be discerned directly from the pollen data.

It is probable that the relative importance of _Pinus_ and _Corylus_ is exaggerated by their more efficient pollen dispersal. _Ulmus_ and _Quercus_ will have had much of the Boreal to become generally established (c.2000 yrs) which implies that the resulting competition will have restricted _Pinus_ and _Corylus_ to peripheral zones. The similar pollen percentages of _Pinus_ and _Corylus_ at Winchester, Rimsmoor and Kingswood however imply that pine and hazel may have been generally present within the forest canopy. Regular forest fires may have favoured _Corylus_, yet would have counted against _Pinus_, unless some areas were persistently burnt and others were not. It is quite conceivable that there were distinct species specific communities in distinct edaphic or topographic zones, such as on the edges of the flood plain. Furthermore, oak and elm may not, in fact, have been totally established for reasons of, for example, sub-optimal climatic or edaphic conditions, lack of seed parents, or conceivably, the difficulty of invading at least dense stands of _Corylus_ because of shade (Rackham 1980). Finally, if oak and elm were prevalent, then the apparent even distribution of _Pinus_ and _Corylus_ may have arisen solely through the colonization of glades or temporary breaks in the forest cover, pollen analytically indistinguishable from the former. It is unlikely that a single hypothesis will adequately explain the phenomenon.

6.3. PERIOD C-1: CONCLUSION

The discussion has concentrated on the Winchester pollen diagram which portrays a vegetation sequence comparable with the published work from other sites in central southern and south-east England. The final phase of C-1 is also recorded at Rimsmoor and Kingswood. The major variation apparent at all sites is largely restricted to taxa likely to have been growing on or around each site, namely _Betula_, _Alnus_ and Gramineae. Variation with and between published sites largely arises from differing pollen sums. In the absence of any major discrepancies between sites, despite differing geologies, topographies and the sites themselves, it is apparent that the Boreal woodland may have been remarkably uniform in central southern England. The chalklands, at least in the vicinity of Winchester, were probably not readily distinguishable on gross floristic grounds from the non-calcareous areas (see discussion of soils, section 9.4.2.2.). Local variation existed, as, for example at Lewes (Thorley

1981), although the chronology of this site is imprecise. As a whole, the region was clearly distinct from the south-west where low values of Pinus are characteristic (Brown 1977; Simmons 1964), but otherwise it appears similar to the rest of southern Britain.

CHAPTER 7

PERIOD C-2 ATLANTIC WOODLAND

Sites: Winchester WT-3
Rimsmoor RM-2
Kingswood KW-2

Period C-2 is correlated broadly with the Atlantic period originally defined by Blytt and Sernander, Godwin's Zone VIIa (Godwin 1940, 1975a) and FLII of West (1970). It appears to be represented in its entirety at all three sites according at least to the criteria outlined below.

7.1. CHRONOLOGY

The C-1/C-2 boundary, the so-called Boreal-Atlantic Transition, for the reasons already discussed (section 6.1.) has been assigned a date of approximately 5000bc. The upper boundary, C-2/C-3, the end of the Atlantic period, has been located according to convention at the level of the *Ulmus* decline. This phenomenon is a pronounced feature in most pollen diagrams in Britain and occurs from approximately 3300 to 3000bc (Smith and Pilcher 1973). Four radiocarbon assays at the three sites in this work give dates for the *Ulmus* decline of 3680±90bc (HAR-4342) at Winchester, 2980bc at Rimsmoor and 2800bc at Kingswood. Whether these dates can be accepted as correct ages for the material assayed, and the nature and origin of the *Ulmus* decline itself, are discussed in section 9.3. They imply that the upper limit of C-2 is apparently diachronous at the sites by up to 880 years, making the total duration of the Period between 1320 and 2200 radiocarbon years.

7.2. THE C-1/C-2 BOUNDARY: THE BOREAL-ATLANTIC TRANSITION

The lower boundary was located primarily by reference to the *Pinus* curves: this was at the level where it attains approximately the frequency maintained throughout C-2. Consideration was also given to other curves, namely *Alnus* rising in frequency, and *Tilia* and *Fraxinus* which exhibit the beginnings of continuous curves at Rimsmoor and Kingswood.

The increase in *Alnus* is often given an equal weight to the falling

Pinus (Godwin 1940), but the *Alnus* pollen curve is more susceptible to variations caused by local growth of alder than *Pinus*, although both will colonize these areas. Indeed, as mentioned in section 6.2., alder was probably widespread during the Boreal period but limited to favourable locations such as river flood plains. The evidence of the pollen diagrams from the sites in this thesis lend weight to this hypothesis. At Kingswood *Alnus* is at 8% at the base of the sequence where *Pinus* is 12%; *Pinus* then falls to 1% and *Alnus* rises to 20%. Conversely, at Rimsmoor, *Alnus* is minimal until *Pinus* has fallen to less than 5%, at least as far as can be judged given the distortion caused by differing core segments. Winchester similarly shows low *Alnus* until *Pinus* is less than 7%, then there is a dramatic peak of 45% before a fall to 1% prior to a second increase in frequency. The first peak of *Alnus* at Winchester is confined to the two samples from a chalky inwash between 333 and 343cm. This suggests a change to water deposited pollen derived presumably from a point up-valley where alder was locally common, in contrast to the immediate area where it was infrequent. The other pollen curves are little affected by the inwash implying some overall homogeneity in the 'dry land' vegetation of the vicinity. Evidently alder may have been present in some quantity at a relatively early date at Kingswood, as at East Stoke Fen, 15km to the west (Haskins 1978) and Lewes (Thorley 1981), but not at Rimsmoor or Winchester. Thus, it was because of the probable local growth of *Alnus* and its effect on the pollen curve that greater emphasis was placed on the more pronounced and consistent behaviour of the *Pinus* curve in the locating of the C-1/C-2 boundary.

As stated above, other pollen frequencies were taken into consideration, notably *Tilia* and *Fraxinus* which assume continuous curves from this level at Winchester and Rimsmoor. At Kingswood both these taxa are recorded from C-1; this could relate to early local presence, as with *Alnus*, or, alternatively, a late decline in *Pinus*, as found by Haskins (1978) at Godlingston. The absence of most of the Boreal, C-1, at Kingswood precludes the confident resolution of this problem, although the elevated *Ulmus* and *Quercus* pollen from 220cm (which in part may be purely a statistical effect) likewise favoured the location of the boundary according to the *Pinus* curve. Similarly, at Winchester, the boundary could have been placed where *Fraxinus* is rising, two samples, or 16cm, higher, above the first peak of Alnus caused by the chalk inwash. Here too, the other pollen curves suggested that the spectra from the inwash had more in common with those above.

The changes that occur at the level of the Boreal-Atlantic Transition (C-1/C-2) characterised by a decline of Pinus and pronounced rise of Alnus are widespread phenomena; the event is not, however, totally synchronous (Hibbert et al 1971; Smith and Pilcher 1973). The cause was predominantly climatic change (Pennington 1974) with plant succession (e.g. A.G. Smith 1965) and possibly human activity (section 8.2.2.) contributory. In the original Blytt and Sernander scheme, based on stratigraphic investigations, the Boreal was envisaged as a period of drier continental climate, the Atlantic as having a moister oceanic regime; more recent work has not greatly altered these correlations. The Atlantic and probably the late-Boreal was the warmest period of the present interglacial, the climatic optimum or hypsithermal interval when mean temperatures were up to $2^{o}C$ higher than at the present day (Dansgaard 1969; Lamb 1977). Movement of the polar front northwards concurrently appears to have led to an increased incidence of depressions over Britain and thus increased rainfall (Lamb 1977; Magny 1982). The changes overall may have been stimulated, at least in part, by the separation of Britain from the continent and the establishment of marine circulation around the country (Simmons and Tooley 1981).

The major cause of the expansion of Alnus was probably waterlogging of soils that occurred as a result of increased climatic wetness, although as Magny (1982) indicates, drier conditions may also have had the same effect for alder would then have spread across substrates formerly too wet for its successful establishment. In contrast, the fall of Pinus was probably a consequence of increased competition from Quercus, Ulmus, Tilia and Alnus (Godwin 1975b). The abruptness of the alder rise may have been intensified by the postulated dry phase at the end of the Boreal period (section 6.2.4.). The Winchester evidence, as already discussed, is equivocal, whilst the data from Rimsmoor and Kingswood could indicate the opposite. Accumulation at both appears to have begun in the late-Boreal, suggesting a period of increased wetness. However, this date need only be a terminus post quem for accumulation may have begun earlier elsewhere at the sites, only later spreading to the points actually cored: this is plausible in view of the stratigraphy at both sites. A contributory, if not principal mechanism is that the dry period, if it occurred, is not recorded at either site, only the terminal phase when climate was already wetter but the vegetation had not yet adjusted to the change (A.G. Smith 1965; Watts 1973). The levels at both sites encompassing falling Pinus and rising Alnus, perhaps more correctly, should be considered as Boreal-Atlantic Transition spectra rather than one or the other as the drawing of a line implies. In instances of slow progressive change the 'broad' zone boundaries utilised, for example, by Oldfield in Powell et al. (1971) are commendable. Thus the base of the cores from Rimsmoor and Kingswood record a period of disequilibrium when the vegetation was out of phase with the climate, in much the same way as the fossil coleoptera work of Coope (1975) has demonstrated that the lateglacial thermal maximum occurred in pollen Zone I, and not Zone II as has been implied from the vegetation. If the base of the sequences are assumed to record the beginning of increased climatic wetness, then the general establishment of Alnus in the forests around Rimsmoor took about 450 and at Kingswood, a minimum of 700 radiocarbon years. These values are compatible with those postulated by Pearsall (1959) and Watts (1973). The climatic change itself could have occurred over that period, or, alternatively, it was swift and this was the period required at the two sites for the establishment of a new equilibrium; the work of Pearsall, Watts and the speed of climatic change (e.g. Dansgaard et al., 1969) favour the latter explanation.

The initiation of peat accumulation at Winchester and in parts of the Test valley (section 3.1.2.) in the earlier, drier Boreal, is probably a result of local hydrological factors. Likewise, the late rise of Alnus recorded at Winchester is presumably related to the absence of a suitable niche in that area, although from the evidence of the sand inwash, it was clearly present elsewhere on the floodplain.

Reference was made above to temporary instability or disequilibrium in the vegetation as a result of it being out of phase with a new climatic regime. Further evidence is possibly provided by the elevated herb levels at the Boreal-Atlantic Transition at Winchester and Kingswood, although at the latter this situation may have prevailed throughout the preceding Boreal. At Winchester peaks occur in Umbelliferae, Bidens type, Rosaceae undiff and Liguliflorae whilst at Kingswood a number of types are recorded, including Rumex, Melampyrum, Plantago lanceolata, Ranunculus type, Chenopodiaceae and Calluna. Temporary instability could be the cause of a greater frequency of openings in the forest canopy at this time, although as the period was of relatively long duration this effect need not have been especially pronounced. The situation is confused by uncertainty over where each taxon was present, but nevertheless instability in the surrounding woodland could still cause changes in the bog flora. For example, the declining frequencies of Myrica, Salix, Cyperaceae and Calluna at Kingswood may be significant. Salix and Myrica in particular may indicate a greater nutrient input to the bog as a result of a more open forest canopy, and their reduction in frequency, perhaps indicating a progressive loss of open ground.

Comparison with other work is hindered by the differing pollen sums and the method of portraying the data in pollen diagrams. In general at sites in southern England such herb peaks tend to be absent although they may be recorded at two of Haskins' (1978) sites in the Poole Basin (East Stoke Fen and The Moors). This could imply that conditions were such in certain localised areas to encourage instability of a sufficient magnitude to favour herb proliferation, at least on the surface of bogs. The possibility of human activity influencing this situation is discussed in section 8.2.3. Satisfactory resolution of the scale and nature of the changes at the Boreal-Atlantic Transition will only be possible in southern England when data become available from more sites.

7.3. WOODLAND COMPOSITION

Comparison of the pie diagrams for C-2 (Fig 7.1.) with those of C-1 (Fig 6.1.) show in particular the decline in Pinus to very low percentages. Corylus is also reduced at Rimsmoor and Kingswood and at all three the importance of Quercus, Ulmus and Tilia are significantly greater. As the diagrams are based on 'dry land' species only, the proliferation of Alnus is not shown.

At Winchester Ulmus and Quercus pollen are elevated with Tilia gaining in frequency throughout C-2. Fraxinus shows a more or less continuous curve and Corylus is initially inflated. Dominance of the surrounding woodland by Quercus and Ulmus is implied with Tilia later in the Period. Corylus is frequent. Alnus is only locally common in the latter half of the zone; the earlier peak, as discussed above (section

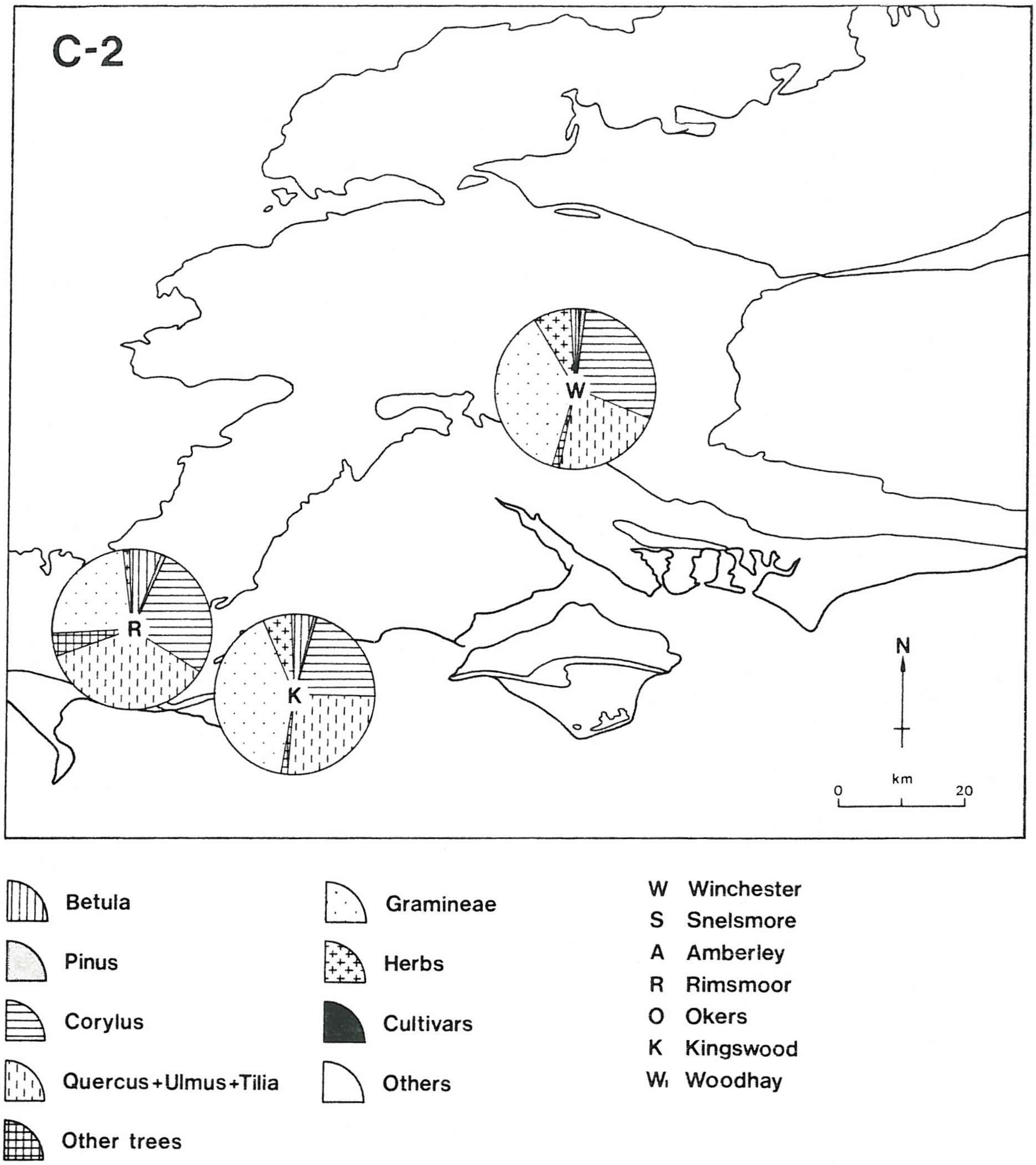


Figure 7.1. Period C-2: summary pollen diagrams

7.2.), is a result of waterborne pollen from a source upvalley. Pinus and Betula are infrequent, but later Betula is raised with a number of dry land herbs including Plantago lanceolata, Liguliflorae and Centaurea nigra type, suggestive of a progressive opening of the forest canopy.

Rimsmoor shows more constant pollen frequencies. Very low herb levels indicate an essentially closed forest canopy dominated by Ulmus, Tilia and Quercus. Both Corylus and Alnus are present in amounts implying some general occurrence in the forest canopy (sections 6.2.3. and 7.3.2.) or at least a relatively constant presence around the bog. Betula and Fraxinus were significant in the forest cover and Pinus was minimal.

Kingswood is similar to Rimsmoor in exhibiting less Corylus pollen and with significant levels of Betula. Fraxinus and Tilia are, however, very low. The woodland was dominated by Quercus and Ulmus with Corylus, Alnus and some Betula. A predominantly closed canopy is indicated by low herb levels, except in the early part of the zone from 216 to 208cm where peaks in a number of herbs suggest a temporary reduction in shade (section 8.2.3.1.).

At all three sites Gramineae levels are between 10 and 50% and are the result largely of the growth on the mire surfaces of notably, Phragmites or Molinia. The generally low herb totals imply minimal contribution of pollen from grasses on dry substrates.

7.3.1. PINUS

The decline of Pinus has already been attributed largely to competition with the broad-leaved forest trees (Godwin 1975b; section 7.2.). The phenomenon was widespread in southern England with most sites exhibiting the abrupt falls recorded in this thesis. However, at three sites, Wareham (Seagrief 1959; Haskins 1978), Godlingston (Haskins 1978) and Lewes (Thorley 1981), Pinus pollen declines only slowly through the designated Atlantic levels. Godwin (1962, 1975a) proposes that pine may have persisted in locally favourable sites such as the marginal woods around the Fenland, in the Brecklands, the Hampshire Basin and the central Weald. Thorley's data may indicate another area on certain superficial deposits in the Ouse valley (section 2.1.1.1.) and Haskins proposes survival in the Poole Basin on the sandier, gravelly soils and possibly on the surrounding calcareous geologies (Haskins 1978, 139). The existence of stands of Pinus may be attested by the low or sporadic records of pollen throughout the postglacial at most sites in southern England. Records of Pinus charcoal on archaeological sites may confirm its persistence, subject, of course, to the problems of this form of evidence (section 2.1.3.). These sites include Oakhanger, in an Atlantic context (Rankine et al 1960), and Stonehenge (Vatcher and Vatcher 1973) and Silbury Hill (Williams 1975) in Late Neolithic material. Another source of evidence is provided by the occurrence of the Red Squirrel (Sciurus vulgaris leucourus) in southern England which R.M. Tittensor (pers.comm.) believes similarly indicates survival of pine.

The Poole Basin sites (Rimsmoor and Kingswood) in this thesis do not convincingly support Haskins' proposal of persistence in the Poole Basin. However, this may be a result of the nature and location of the mires. In edaphic terms, Rimsmoor is situated in an area of clayey Reading Beds which apparently underwent podzolisation very much later than most soils in the Poole Basin (section 10.4.3.) and would therefore have been less suitable for Pinus at a time of competition with thermophilous trees. Kingswood however is located in Bagshot Beds, one of the geologies mentioned by Haskins as a candidate for pine survival, and furthermore it is only a kilometre west of the Godlingston sites. Nevertheless, this may be a good illustration of Haskins' argument regarding the limited dispersal of even Pinus. She quotes Turner's (1964a) findings that in an open area Pinus pollen can only be detected in a pollen spectrum within 300m of a pine plantation (section 2.4.1.); in a forested region the distance is likely to be even less. Consequently, the pine recorded in the Atlantic at Godlingston was perhaps a small community and probably located to the north or east of the site. The modern sample at Kingswood lends further support as this records Pinus pollen at only 20% despite the prevalence of the species locally and in particular an extensive pine plantation about 600m to the north. The situation is perhaps slightly confused by the problems of locating the C-1/C-2 boundary at Kingswood because of the elevated Alnus levels and the truncation of the Atlantic material at Godlingston 'A', yet the trends are sufficiently marked for this not to be the total explanation.

The survival of pine on the calcareous geologies, including the chalk, as discussed by Haskins (1978), is rather more equivocal. It regenerates well on the present day thin chalk soils, but only in the absence of broadleaved forest trees (Godwin 1975a; Wood and Nimmo 1962). It is proposed below (section 9.4.1.3.) that the thin soils of today are truncated remnants of formerly deeper formations: pine's status in the past on the chalk is thus unclear from modern analogies. The pollen data from Winchester are significant in showing that pine may have been widespread and co-existing with Quercus and Ulmus in the Boreal, albeit in marginal locations, in the chalklands as on other outcrops. By definition, it is reduced at the C-1/C-2 boundary in common with other areas although it maintains values of 1 to 2% unlike the 0 to 1% at Rimsmoor and Kingswood. If this difference was not a result of the survival of a resistent pollen in conditions of poor preservation then pine may have been slightly more abundant in the pollen catchment area of Winchester. Competition inevitably would have excluded it from the main woodland canopy: this probably represents an example of survival in isolated stands marginal to the flood plain as Godwin proposed for the Fens in Zone VIIb (Godwin 1975a). Essentially, the evidence mitigates against Haskins' (1978) hypothesis and suggests, at least in the Winchester area, only a very localised survival of Pinus in the chalklands after the Boreal period.

7.3.2. ALNUS

As discussed in section 7.2. Alnus experiences a considerable expansion at the beginning of C-2, the Atlantic period, in response largely to climatic change. Godwin (1975a) states that alder became part of the forest mosaic, colonising wet depressions and slopes in the prevalent mixed oak forest. However, this assessment is based on the results from pollen analysed sites which are invariably wetlands: the recorded Alnus pollen could be derived purely from trees around the bog with alder essentially absent elsewhere. McVean's (1956) experimental results lend support to this criticism: low light intensity is a frequent cause of regeneration failure in woods and thick herbaceous vegetation. Nevertheless, Dimbleby's (1962) analyses of podzols often in 'drier' areas tend to show Alnus as a component of the woodland in places away from bogs; indeed he emphasises that only with clearance and the resulting changes in microclimate has Alnus become confined to streamsides (Dimbleby 1976, 1978).

At Winchester it may, however, have been restricted solely to the surrounding flood plain. The first peak of Alnus pollen occurs in the two samples from the chalk inwash (333-343cm) which clearly represents an interruption to peat accumulation. The pollen curves imply that it was a brief event with little, if any, disturbance of the pre-existing peat with renewed peat accumulation occurring soon after its deposition. Only very minor changes are discernible in the spectra below, in and above the inwash, other than the elevated Alnus and Filicales levels. As was discussed in section 7.2., the contained pollen was probably waterborne from a location up-valley. If the pollen in the peat was chiefly airborne and derived from plants around the coring site, whilst that in the inwash was from up-valley, it may be speculated that the vegetation on the chalk at that time was similar in the area of the Itchen valley. The major difference would seem to be that alder was more prevalent on the flood plain up-valley; the elevated Filicales suggests the presence of ferns as part of the alder community, as well as attesting to its greater resistance to degradation. The time period represented by the inwash is unknown - it could reflect a single flooding episode - and for this reason allowance is not made for it in the time:depth curve.

The second peak similarly may be interpreted in terms of an expansion of the species on the flood plain. Rather uniquely Alnus is established towards the end of the Period, as opposed to the beginning as part of the general Atlantic woodland community. Indeed, Corylus at this one site is raised from the opening of C-2, perhaps suggesting rather fewer moister clearings if the introductory discussion to this section is appropriate. The rapid rise that begins in the latter part of the zone and its high frequency implies colonisation by Alnus of the flood plain and wetter margins of the woodland. It coincides with increased frequencies of Betula, Quercus and Corylus indicating some general woodland expansion which presumably included alder in the wetter areas, as may be borne out by the reduction of Gramineae and Cyperaceae.

The reason for the behaviour of Alnus at Winchester may be related to two factors. As already discussed, the greater climatic wetness seems to have made more soils in Britain suitable for colonisation by the tree. The implication from this is that the downland soils around Winchester were resistant to waterlogging, discouraging the establishment of Alnus. This is certainly plausible in view of the present rendzinas, but as will be discussed in section 9.4.1.3. there is a body of evidence to show that these are truncated remnants of formerly deeper soils; the late rise of alder nevertheless suggests that these too may also have been well-drained. The second factor to be considered is that the rise of Alnus coincides with an increased abundance of a number of herbs suggesting the existence of some open areas. This conflicts with the evidence for woodland expansion at the same time although the reductions of mire herbs, including Cyperaceae, as well as Gramineae, imply some contraction of marsh habitats and possible corresponding expansion of communities of dry substrates. The beginnings of these changes occur at about the same level as a bed of sand and mollusc shells. The possible role of man in these changes will be discussed in section 9.3.1.2.

The presence of Alnus in favourable locations in the Boreal was mentioned in section 6.2., taking East Stoke Fen (Haskins 1978) and possibly Lewes (Thorley 1981) as examples. Kingswood may have been another location as alder pollen is well represented before the Pinus decline. Haskins' (1978) pollen diagrams from Godlingston 1km to the east may not show this and indeed alder maintains low percentages (less than 10% Total Terrestrial Pollen) throughout the Atlantic after late, subdued rises if Haskins' zonation is accepted. Both sites are on Bagshots, but the differences probably arise from their locations. The two bogs are developed below springs and the pollen core from Kingswood is only 100m from the springline, whilst the nearest at the other, Godlingston 'A' is at a distance of 300 to 400m. Spring head locations with nutrient-rich water would have been suitable for early colonisation by Alnus in a period of relatively dry climate, or at least with the increased climatic wetness of the Boreal-Atlantic Transition, in much the same manner as the valley of the Frome as recorded at East Stoke. Such communities may have been limited to the spring heads with their higher nutrient status; down valley nutrient levels will have been reduced by mire plants. Additionally, the presence of Pinus at Godlingston attests to the existence of generally poorer soils in the vicinity of the pollen cores. A further factor is again the possibility of human interference (section 8.2.3.1.).

In the Atlantic period, C-2, the Alnus pollen maximum at 196cm at Kingswood attests to its continuing presence locally; likewise at Rimsmoor with its peaks at 1420cm and 1110cm. A fairly constant background level at both may also indicate its more general presence within the surrounding forest, although, admittedly, the same effect may have been produced solely by the persistence of bog-side communities. However, at least on the clayey soils around Rimsmoor some more general establishment of Alnus might be expected, if only temporarily in damper glades created through the death of individual trees.

To summarise, it is difficult to assess from these data alone whether Alnus was generally established within the woodland surrounding the two Poole Basin sites, although it is plausible at Rimsmoor. It undoubtedly grew around the two bogs. The pollen evidence from Winchester, in contrast, points fairly decisively to its growth only on the flood plain or its margins and not within the chalkland forest. Freely draining soils may have led to this situation.

7.3.3. TILIA

Tilia had probably achieved its full postglacial range in Britain by the late-Boreal, but it was most abundant in the Atlantic and Subboreal (Godwin 1975a). The higher mean temperatures may explain this consolidation (cf Pigott 1975). In C-2, the Atlantic, as recorded in the sites in this thesis, the frequency of Tilia pollen is indeed increased with mean values of 3.9% at Winchester, 1.6% at Rimsmoor and 0.4% at Kingswood. The figure from Winchester, the site assumed to most closely record chalkland conditions, is 2.4 times greater than Rimsmoor, supporting Godwin's (1975a) contention that after the Boreal, Tilia was most frequent in the major limestone areas.

As mentioned in section 6.2.2., Tilia pollen is absent from the presumed late-Boreal, late C-1, levels at Winchester. This is rather surprising for two reasons. First, Godwin (1975a) emphasises the significance of the south and east in Tilia's early establishment with records at Southampton, Elstead and Nursling, as well as East Stoke Fen (Haskins 1978) and in the New Forest (A.R. Tilley pers.comm.); and, secondly, it is a taxon which favours fertile and base-rich soils (eg. Clapham et al 1968; Mitchell 1974). However, the stated edaphic preference may have been overstressed. Godwin (1975a) only mentions the significance of calcareous areas in its later spread and Moore (1977) states that many sandy locations in the south-east which are now heathland were once covered by forests at least locally rich in lime. Moore quotes, for example, Girling and Greig (1977) who found that lime accounted for 30% of arboreal pollen (excluding Alnus) in the pre-Ulmus decline forest at Hampstead Heath. It should be noted that Baker et al. (1978) favour a Subboreal date for these spectra after working on a site in Epping Forest. Rackham (1980) also records that, at least in East Anglia, lime is predominantly a tree of acid soils and favours loess-rich substrates overlying clay.

This discrepancy may be accounted for by the differing requirements of the native species. Tilia platyphyllos is now, and was in prehistory, generally rarer than Tilia cordata (Godwin 1975a; Mittre 1971). It, indeed, does prefer base rich soils, whilst T. cordata and the hybrid, T. x vulgaris are more catholic in their tolerance of a wider range of soils (Clapham et al. 1968; Pigott 1969; Rackham 1980). In eastern England T. platyphyllos is currently virtually absent (Rackham 1980). The three species can be differentiated palynologically (Andrew 1971; Chambers and Godwin 1971; Mittre 1971) but this was not undertaken in the present research because of the difficulty of carrying it out optically and the consequentially time-consuming nature of the procedure. Therefore, it would appear that there is no viable reason why Tilia should have been excluded from chalkland soils in the late-Boreal and why, given the probable fertility of the soils, even greater frequencies are not recorded in the Atlantic at Winchester.

Godwin (1975a) suggests that generally in the Atlantic it was an important component of the woodland and possibly locally dominant, a view consistent with the findings of Birks et al. (1975). The latter was based on data from a number of sites including Elstead, Southampton and Lewes, although at the last differential preservation may have inflated the Tilia frequencies (section 2.1.1.1.). Tilia dominance has also been proposed for parts of the continent: in Denmark, for example, Iversen (1973) refers to the Atlantic as the 'Lime Period'. However, in 1960 he stated that in Britain,

> "*Tilia* has been of less importance, perhaps because *Ulmus glabra* and *Quercus petraea* are more competitive in oceanic regions" (Iversen 1960, 28).

It seems more probable that this illustrates a different aspect that may be relevant in the context of Winchester. Up until 1960 there had been few analyses of small basins: sites were predominently large and this would tend to under-record the abundance of the poorly dispersed *Tilia* pollen (Baker *et al* 1978; Greig 1982). The Hampstead Heath, Epping Forest and, most recently, the Oxborough Wood (Bradshaw 1981b) sites which all exhibit high *Tilia* levels are small basins, perhaps under 0.1ha in area. Greig (1982) maps *Tilia* pollen frequencies for a number of sites in Britain, including Winchester, Rimsmoor and Kingswood, during the Atlantic. The raw value at Winchester is one of the lowest in south-east and central southern England, yet when corrected according to Andersen (1970: x8) the discrepancy is reduced: 43% *Tilia* is recorded, compared with Elstead 39%, Southampton 77%, Rackham 50%, Lewes 75% and Iping Common 89%. Of these sites, Winchester is probably the largest which may account for its still relatively low figure.

It is notable, however, that *Tilia* rises steadily throughout C-2 at Winchester which may indicate that its postulated prevalence only arose late in the Period. This may have been the situation, yet it is difficult to envisage given the expansion of *Tilia* from the south and its preference for fertile soils. As stated above, it would be anticipated within the chalkland forest from the late-Boreal. It may tentatively be hypothesised that the rise of *Tilia* throughout C-2 in fact records its colonization of drier parts of the flood plain and perhaps the development of fen margin woods (Godwin 1975a; Rackham 1980). The parallel rise of *Alnus*, as discussed in section 7.3.2., implies the expansion of fen woods and such a habitat also may have been suitable for ferns, thus explaining the Filicales spore peak. The latter is not a result of differential preservation for the susceptible *Quercus* and *Betula* are also elevated. These latter suggest that there was a general expansion of woodland at this time (section 9.3.1.2.). Gramineae and Cyperaceae pollen are reduced perhaps additionally attesting to this replacement of open marsh habitats on the flood plain by fen woods of *Alnus* with *Tilia* in drier areas. Species identification of the *Tilia* pollen might provide confirmatory evidence if *T. cordata* composes most of the record, but only if T. platyphyllos was prevalent could the hypothesis be rejected (Godwin 1975a). Comparison with other chalk areas is hindered by the scarcity of data. At Lewes (Thorley 1981; section 2.1.1.1.) Tilia is fairly abundant, but perhaps as a result of differential preservation and, likewise, the possibility of the derivation of the pollen from fen margin woods. The Litton Cheney peats (Sidaway 1963; section 2.1.1.1.) may have a more restricted pollen source area and thus could indeed reflect lime domination of dry substrates, yet this may have been in the Subboreal.

On the chalk lime-dominated forests are thus expected on intuitive grounds, although the Winchester data cannot demonstrate this convincingly. Specific identification of the Tilia pollen as well as the analysis of other cores from the deposit (three-dimensional principles: Turner 1975) might help to clarify this contentious issue. The general situation in the sandy areas of central southern England differs from sites in the south-east with very low values of Tilia recorded at Cranesmoor (Seagrief 1960) and at most of Haskins' (1978) sites, and Kingswood, in the Poole Basin. Most of these are small basins and thus lime was clearly only a relatively unimportant component of the vegetation: Haskins suggests that the sandy soils of Poole Basin may have been podzolised at an early date (Haskins 1978), and the discrepancy between this area and, for example, Hampstead Heath (also on Bagshot beds) may relate to differing soil textures and a location further west with higher rainfall. The significance of the edaphic factor may be illustrated by Rimsmoor. It is situated within the clayey Reading Beds which would have been less susceptible to podzolisation (section 10.4.3.): the mean value of 1.6% is low but indicates the limited presence of lime around the site. The figure of 0.4% at Kingswood could indicate solely long distance transport, or, at most, that lime was rare within the pollen source area. Haskins (1978), from the variation between her sites in differing geomorphological locations, suggests that Alnus and Tilia grew preferentially on the richer soils of the major river valleys of the Poole Basin whilst Pinus survived on the poorer soils between. This localisation of lime and alder may explain the records of Alnus and Tilia pollen at Southampton (Godwin and Godwin 1940) and is perhaps also compatible with the Winchester data already discussed. At Kingswood, conditions may have been sufficient for Alnus, but inadequate for the more demanding Tilia.

7.3.4. OTHER WOODLAND COMPONENTS

In common with much of southern Britain the other woodland dominants were Quercus and Ulmus and similarly these were consolidated, attaining higher frequencies in C-2 than C-1. Corylus is lower in C-2 than C-1 at Rimsmoor and Kingswood, as elsewhere, but is about 4% higher on average at Winchester. Fraxinus is low at Winchester and Kingswood (mean for both sites 1.1% DLP), but at 3.8% at Rimsmoor. Fagus is recorded sporadically at Rimsmoor and Kingswood, but is absent at Winchester. Betula is infrequent at Winchester and fairly common (4 to 6%) at Rimsmoor and Kingswood.

Woodland composition overall at Rimsmoor and Kingswood may have been similar with Ulmus, Quercus and Corylus. The greater abundance of Tilia and Fraxinus at the former suggests a situation intermediate between Kingswood and Winchester. At Winchester Ulmus, Tilia, Corylus and possibly Fraxinus were more frequent in the pollen source area with less Quercus when compared with Rimsmoor and Kingswood. Comparison with published work is hindered by the usual inclusion of Alnus in the pollen sum, but tends not to show any major correlation with gross geology: the ratio of Ulmus to Quercus at Winchester is similar to that at Cranesmoor (Seagrief 1960) and several sites in the Poole Basin including Godlingston and Luscombe (Haskins 1978), but different from Southampton (Godwin and Godwin, 1940) and several other sites in the Poole Basin, for example Wareham (Seagrief 1959) and East Stoke Fen (Haskins 1978). This variation mitigates against any obvious correlation at Winchester with more fertile, well-drained soils, although the large pollen catchment area suggests that, in contrast to most of the other sites, its spectra will have been less influenced by local peculiarities in the vegetation.

At Rimsmoor local factors are clearly relevant. The Ulmus, Tilia and Fraxinus pollen is very unlikely to have been derived from vegetation on the chalk to the north (section 4.4.3.), but rather from the surrounding probably fertile clays of the Reading Beds. The presence of the light demanding Betula and Fraxinus may, like Alnus, relate to growth on the woodland edge around the site: the possibility of their more general occurrence in the woodland community is discussed in section 8.2.3.2.

The sporadic records of Fagus at Rimsmoor and Kingswood and especially its absence at Winchester is interesting in view of its common association with downland soils. However, it has been mentioned above (section 2.2.2.) that its prime requirement is for soils free from waterlogging. Records of it in the Atlantic are restricted but it shows a continuous curve at Wareham (Seagrief, 1959) although Haskins failed to repeat this finding, and it occurs intermittently at a number of other sites in the Poole Basin. This perhaps illustrates its preference for well-drained soils and its general presence at very low abundance within the Atlantic woodland. Nevertheless, it was proposed that freely drained soils on the chalk discouraged the general establishment of Alnus (section 7.3.2.). If this hypothesis is correct, then the absence of Fagus at Winchester may be a result of various characteristics associated with its pollen: its production is low and dispersal limited, so at a large site it will tend to be under-represented, like Tilia (section 7.3.3.); it is susceptible to degradation (eg. Havinga 1971) so any grains deposited at the sampling site may not have been recorded; and the fewer pollen samples counted, because of low pollen concentration, may have failed to detect levels where Fagus may have been preserved. Thus the absence of a pollen record at Winchester does not mean that Fagus was not present in the woodland.

In terms of woodland structure, Haskins (1978) speculates from the frequency of the Ericaceae, Pteridium and Plantago lanceolata that the woodland of the Poole Basin in the Atlantic was comparable with the 'heathy oakwoods' of today. The evidence from the Poole Basin sites in this thesis, Rimsmoor and Kingswood, does not necessarily conflict with this analogy as indicators of open ground are present at both. They include various types recorded in such woodland (Tansley 1949), for example, Potentilla, Rumex, Rubiaceae, Melampyrum, Calluna, Polygala, Pteridium and Dryopteris (included in Filicales). However, whilst Betula is often recorded, Ulmus, Tilia, Fraxinus and Corylus are less common. This rather implies that around at least Kingswood and Rimsmoor much of the herb pollen present was from taxa on the bog surfaces or around the drier margins with, beyond, a more closed forest canopy than is suggested by the analogy with heathy oakwoods. However, certain phenomena may attest to openings within this canopy (Chapter 9).

2.4. PERIOD C-2: CONCLUSION

The chalkland vegetation as recorded at Winchester is suggestive of predominantly forested conditions. Ulmus, Quercus, Corylus and Fraxinus may have been prevalent with, quite possibly, Tilia as a dominant. Alnus, with some Tilia, may have been confined to expanding fen woods. At the two Poole Basin sites forest is also recorded, probably dominated by Quercus and Ulmus with Tilia, Fraxinus and Corylus. Likewise Alnus may have been in wetter areas. Salix pollen is recorded at all three sites, derived chiefly from willows on and around each deposit. Hedera was evidently a common component of the woodlands with Ilex and members of the various species that contribute to Prunus type pollen.

Herb pollen is recorded at all three sites during C-2 and whilst this may in large part have been from plants growing on and around the deposits they may also indicate the existence of some clearings within the forest. This is discussed in the next chapter.

CHAPTER 8

MESOLITHIC ACTIVITY

8.1. INTRODUCTION

The paradigm that Mesolithic cultures were dominated by the environment and had little effect on the vegetation (e.g. Iversen 1949; Godwin 1956, 1975a) is based on a number of different lines of evidence. These include the following: the concept of a population with a primitive level of technology dependent solely on hunting and gathering for its subsistence; observations that the mid-postglacial levels in pollen diagrams showed generally forested conditions with trends that could be readily explained in terms of succession, climate and soils; and, in particular, the occupation site at Star Carr in Yorkshire where, even though some birch trees were felled, there were only barely detectable changes in the associated pollen diagrams. The concept is, however, attracting an increasing amount of criticism - there is growing evidence for generally subtle yet significant modification of vegetation, in the light of which there is a constant reinterpretation of earlier work. A recognition of the effectiveness of fire as a clearance mechanism (Dimbleby 1962; Simmons 1969b) as well as the tranchet axe for tree felling (A.G. Smith 1970) have provided ready means of disforestation. Active control of herbivores verging on domestication is feasible (Simmons and Dimbleby 1974; Jarmen 1976) whilst fire-controlled horticultural and arboricultural systems have been proposed (Clarke 1976). Even such characteristic features of the early and mid-postglacial as the Boreal <u>Corylus</u> maximum and the rise of <u>Alnus</u> at the Boreal-Atlantic Transition, may in whole or part be a result of the activities of Mesolithic groups (A.G. Smith 1970). This has led to a radical re-appraisal of the rôle of Mesolithic cultures as primitive hunter-gatherers.

As already stated, the influence on the vegetation may be too subtle to be identified with confidence in pollen diagrams, particularly when occupation debris has not been identified. Even where it has been, as at Star Carr, there may be little effect. Despite these problems of recognition and verification of Mesolithic activity, various features in the diagrams from Winchester, Rimsmoor and Kingswood are worthy of consideration in this context.

Kingswood The most obvious evidence at any of the sites is readily detectable in the first half of C-2, KW-2, at Kingswood. Between 216 and 208cm, c.4610-4270bc, there are pronounced peaks in Calluna, Melampyrum, Spergularia type and Umbelliferae and slight increases in Trifolium type, Plantago lanceolata, Rosaceae undiff, Campanulaceae, Bidens type, Centaurea nigra type, Serratula type, Vicia type, Ononis type, Stachys type and Ericaceae undiff. Contemporaneously Betula, Ulmus, Quercus, Alnus and Corylus are reduced. Charcoal is abundant, though slightly reduced at one level, 214cm. Gramineae, Sphagnum, Pteridium and Osmunda are decreased and Filicales spores are more frequent.

Rimsmoor The evidence at Rimsmoor is more equivocal without any comparably abrupt event. The elevated levels of Betula and Fraxinus may be relevant together with a number of herbs: Melampyrum, Umbelliferae, Urtica, Liguliflorae, Rumex, Artemisia, Plantago lanceolata, Centaurea nigra type, Campanulaceae and various others, as well as Pteridium and the Ericaceae. Charcoal is present in the first half of C-2, RM-2, and the latter part of the second half.

Winchester Most notable at Winchester are the beginnings of significant curves for Rubiaceae, Plantago lanceolata and Liguliflorae in the latter part of C-2, WT-3 with raised charcoal. As these changes culminate in the Ulmus decline, they will be discussed in the next chapter, section 9.3.1.2.

8.2. DISCUSSION

8.2.1. LOCAL HERBS

It is plausible that the presence and behaviour of certain pollen types is solely a result of changes in the mire vegetation occurring totally independently of human activity. Much of the discussion in this section concerns the relative frequencies of certain herbs: an attempt was made to exclude from the pollen sum all taxa likely to have been growing on the bog surface (primarily 'mire herbs'), but as already discussed certain types include wetland and catholic species (section 3.2.3.).

Many types classified in this thesis as dry land, such as Ranunculus type, Potentilla type and Bidens type include taxa tolerant of a wide range of soil wetness. The Gramineae record is also subject to this problem: before the Ulmus decline at all three sites its frequency is high, despite low herbs and is clearly a result of local Phragmites and Molinia growth. After the Ulmus decline it tends to behave in a similar manner to the herb curve.

An important example of a genus of wide tolerance and consistently present at Kingswood and Rimsmoor is Melampyrum. The species from which the pollen was derived was probably M. pratense described as "common in woods, heaths etc., on acid humus" by Clapham et al (1968, 330). Pilcher and Smith (1979) likewise find it consistently present in the Atlantic at Ballynagilly and note its likely presence there in "quite dense shade and on organic deposits" (p.354). Its pronounced peak at Kingswood from 216 to 208cm could indicate its temporary colonisation of the bog surface or its periphery in much the same way as the maximum of 66.7% at 470cm at Rimsmoor is almost certainly local over-representation. Such local growth is indicated because the peak occurs only in that one sample and not in any great frequency above or below; it also coincides with another single maximum of over 45% Hypericum, almost certainly present in a similar context (e.g. H. elodes). Other herbs with similarly continuous curves in C-2 at Rimsmoor and Kingswood are Potentilla type and Bidens type which as already mentioned include species of wet habitats: for example P. erecta, P. palustris and B. cernua, Pulicaria dysenterica respectively.

There are also taxa likely to be growing around the drier margin of the bog and on the woodland edge. Rimsmoor provides an extreme example of an available niche in such a location, albeit of an intermittent character. At the present day the sides of the depression in which the bog has accumulated are at slopes of up to 39^{o} and indeed on the north-west side there is clear evidence for landslipping (section 4.4.1.). Periodical slipping could also have taken place in the past, leading to loss of tree cover, if the slopes were wooded, and subsequent colonisation by plants of broken ground, including Artemisia and Spergularia rubra. Grasses and herbs such as Plantago lanceolata with the Ericaceae and Pteridium could then have become established, to be succeeded by Betula, Corylus, Fraxinus and eventually Quercus, Ulmus and Tilia. Landslipping is an intermittent process, as appears to be the subsidence of the dolines (Sperling *et al.* 1977 ; sections 4.4.1., 10.8.1.) and this could cause apparent clearance phenomena in the pollen diagram totally independent of human activity. All the pollen types mentioned are recorded in RM-2, although the 'clearances' are not, perhaps through the relatively low resolution of this section of the diagram and the masking effects of pollen from surrounding woodland. The theory as a whole is supported by the modern sample, an amalgam of three separate surface moss polsters totalling a sum of 1182 DLP. This shows various open country herbs even though coniferous plantation surrounds the site; the only 'open country' is on the basin sides, the track to the north-west and Oakers Bog to the south-east.

Such a ready mechanism does not exist at Kingswood. The major herb peak at that site coincides with a depression of the tree curves which must in large part be a result of that herb maximum. The herbs attaining relatively high frequencies include *Melampyrum*, Umbelliferae and *Bidens* type and may well be a result of a transitory change in bog flora: that such a change occurred is indicated by a reduction of Gramineae pollen and *Sphagnum* spores. The reason is most probably related to changes in the surrounding environment: at Ballynagilly *Sphagnum* and Gramineae likewise are reduced which Pilcher and Smith (1979) equate with a drying of the mire surface during a regeneration phase. Alternatively, it could represent simply the formation of a drier hummock on the mire surface and its subsequent degradation or swamping. This, however, is questionable in view of the evidence below, in addition to the fact that the original theory of cyclic peat bog regeneration (Osvald 1923) was initially questioned by Walker and Walker in 1961 and is now totally rejected by the work of Barber (1981a). The development and decline of a 'one-off' hump is plausible, except that *Plantago lanceolata* at least cannot survive in *Sphagnum* bog (Sagar and Harper 1964) indicating the existence of some open and drier soil within the pollen catchment area. Furthermore, of the other herbs increased in frequency at this level, *Trifolium* type, *Centaurea nigra* type, Campanulaceae, *Vicia* type and *Ononis* type all are composed mainly of taxa of dry habitats. Whether or not there is a real reduction in tree pollen and therefore possibly woodland cover is impossible to determine given the inter-relationship of the percentage curves; pollen influx determination was not undertaken for the reasons outlined in section 3.2.2.

At Rimsmoor there is no comparable event but there are two main periods of herb immigration. The earlier took place at the beginning of C-2 and coincides with macroscopic charcoal. The latter is at the end of the Period and includes records for cereal grains at 1200 and 1170cm, as well as renewed charcoal deposition. The latter is akin to that at Winchester, probably associated with the Ulmus decline: it too will be discussed in the next chapter (section 9.3.1.1.).

8.2.2. CHARCOAL, HABITAT MODIFICATION AND HERDING

Much of the data examined above can be explained in terms of primarily natural phenomena. The same can be said for the abundant macrofossil charcoal at all three sites, for as stated by Brown (1977), the presence of charcoal in peat only shows the occurrence of fire, not necessarily its deliberate use by man. Against this must be set the difficulty of burning damp mixed oak forest; Clark (1980) writes that,

> "While fire damage may well have occurred accidentally through its use in cooking and heating, wholesale burning under temperate conditions is more likely to have been intentional, whether as a tactic in hunting or conceivably as a means of improving grazing for animals like red deer" (p.42).

Clearly the problems arise of, first, distinguishing natural fires that may have occurred during exceptionally dry periods from those with a human origin, and secondly, separating charcoal derived from cooking fires at very small local encampments and that from larger scale burning activities. Furthermore, actual burning of mire or fen vegetation may have occurred during summer droughts, either naturally, or deliberately to improve grazing. Evidence for natural fires comes from a number of different countries: in Minnesota, for example, an average frequency of fire was found to be 60 to 70 years with a range of 20 to 100 years (Swain 1973); data from Australia shows how fire may be the proximate cause of major plant geographical changes (Walker 1982). Almost exclusively, however, these records are from areas with a greater proportion of conifers and in regions with a tendency for summer drought, and so inherently more susceptible to fire. In temperate deciduous forest with a well developed understorey fires are probably infrequent, although at only Kingswood is charcoal reduced across the C-1/C-2 boundary, a time of assumed increased climatic wetness (section 7.2.).

A growing body of data have been interpreted as the intentional use of fire by Mesolithic man as a clearance technique. Dimbleby (1962) was perhaps the first to advocate this possibility:

> "the use of fire by these people would have an effect out of all proportion to their numbers" (p.27).

At two sites in The Weald, Oakhanger (Rankine et al 1960) and Iping Common (Keef et al 1965), Mesolithic levels coincided with pollen evidence for a change from woodland to heathland, with, at Oakhanger, charcoal. These data at both are from the analysis of soils which, as A.G. Smith (1970) notes, are subject to greater problems of interpretation because of uncertainty over the origin of the spectra. Nevertheless, evidence has also been obtained from peat profiles: Simmons (1964, 1969a) has described features that may be interpreted as Mesolithic clearances on Dartmoor and in Yorkshire. Indeed, the possibility of such clearances leading to permanent vegetation change as a result of soil deterioration in areas of readily podzolised sands has been discussed by Simmons (1969b) and demonstrated by Dimbleby (1962).

The reason for deliberate fire clearance may be hunting: Mellars (1975, 1976) demonstrates the likelihood of a great increase in carrying capacity (possibly by a factor of ten) with disforestation to increase the number, weight, general health and reproduction rate of animals and to control the distribution of herds. Areas of locally rich browse would attract game and the reduced cover would simplify hunting. Chaplin (1975) suggests that certain features of the red, fallow and reindeer would have predisposed them to management by early man and P. Evans (1975) suggests that Bos in a wooded environment would be suffering from a phosphorus deficiency and so might be attracted to the open and fired areas of Mesolithic groups. Dog and pig husbandry may also have been undertaken (Clarke 1976). The intimacy of the relationship between human groups and their prey may have verged on domestication: Simmons and Dimbleby (1974) note the abundance of Hedera pollen at some Mesolithic sites and, much as Troels-Smith (1960) has hypothesised for the Neolithic, suggest the possibility of its deliberate collection to attract game. Furthermore, animal bones present at Mesolithic sites often show some bias by age or sex, rather than the randomness that would be expected through hunting; Jarmen (1976) considers the possibility of a distinct control of herds and slaughter and only a very slow change from wild to domestic animals. Indeed, Whittle (1980) suggests that there may have been a long sequence of change from the sixth millennium bc with sheep and goats only added in the final stage, the Neolithic. Actual herding has been hypothesised by Simmons (1969b, 1975a, 1975b) amongst others. Jacobi et al.'s (1976) argument for a regular cycle of burning is complementary.

Aside from the beneficial effect on hunting of burning, there are various other implications. The pronounced Corylus maximum of the Boreal period, a feature absent from other interglacials (Simmons and Tooley 1981), may be associated with Mesolithic activity (A.G. Smith 1970). Hazel nuts are common at Mesolithic settlements and at Broom Hill, Hampshire, their vertical spread over a metre of deposit suggest regular collection over at least a millennium (Jacobi 1981). Corylus is resistant to fire, sprouting vigorously from burnt rootstocks: its spread may have been accidentally or deliberately encouraged by the collection of its nuts and any regular burning would preferentially favour the species. It may be significant that at two Mesolithic sites, Flixton and Star Carr, the occupation level is at the start of the Corylus rise (A.G. Smith 1970). The Boreal hazel maximum may have been a fire climax (Rawitscher 1945; A.G. Smith 1970).

Other characteristics of the first half of the postglacial may also have been influenced by man. A.G. Smith (1970) also suggests that the rise of Alnus at the Boreal-Atlantic Transition may have been accelerated by the clearance of competing species in damper areas: one of the earliest alder rises begins at the Mesolithic level at Shippea Hill. The contemporary decline of Pinus and Corylus may also have been increased by human activity (A.G. Smith 1970). The occurrence of both Pinus, a fire susceptible species (Godwin 1975a), and Corylus in the Boreal may relate to their existence in distinct, separate communities (section 6.2.5.). Pinus may, however, have been encouraged in its initial spread through the deliberate burning of Preboreal Betula woods (R.T. Smith, pers.comm.).

Clarke (1976) emphasises the great importance of plants: he quotes the !Kung Bushmen who in calorific terms find gathering 2.4 times more productive than hunting. He stresses that the northward spread of various productive species including hazel, apple, pear, possibly beech and others may have been favoured by fire clearance and even planting. Clarke also describes various herbs, particularly those with tubers or rhizomes, that may have been important sources of nutrition and he re-assesses the typical microlith industry in terms of plant, rather than meat, processing. He proposes that there may have developed an economy which,

> "may have approached limited, fire-controlled asexual, horticulture and arboriculture based on vegetatively reproducing root staples, forest perennials, controlled nut and fruit trees, backed up by shell-fish, dog and pig husbandry" (p.480).

From excavation evidence, J.G.D. Clark (1980) notes that they were also very aware of the differing properties of wood: *Ulmus* and *Taxus* were used for bow staves, *Pinus* for arrows, *Corylus* for spear shafts and root wood for axe hafts.

Charcoal itself need not indicate clearance by fire: it can be a result of either domestic fires (see below) or the burning of axe-felled trees (Edwards 1979). The Mesolithic tranchet axe may have been used for tree-felling (A.G. Smith 1970) and J.G. Evans (1974) has postulated that this may have occurred, for example, on the Marlborough Downs to judge from the finds of these implements.

It should also be noted that clearings may be created independently of man through the death of individual trees and herbivore grazing (Tomalin and Scaife 1980).

8.2.3. THE SITES

The argument for some form of vegetation manipulation by Mesolithic cultures seems to be fairly conclusive, although proof of cause and effect is difficult. Some of the data from the sites in this thesis are assessed in the following section in the light of this evidence.

8.2.3.1. KINGSWOOD

At Kingswood whilst there may well have been a change in the vegetation on the mire surface between 216 and 208cm, its causes were possibly external to the bog. Furthermore, the most pronounced herb, Melampyrum is also a member of the field layer in woods (Clapham et al. 1968) and Iversen (1964; Simmons 1969b) has interpreted its presence in a pollen diagram as indicating the formation of a partial clearing in formerly virgin forest. Godwin (1975a) quotes evidence from Northern Ireland showing its association with clearance, and Norwegian data where it is shown to occur consistently at levels where fire has been used to clear ground. Charcoal is present throughout C-2 at Kingswood and is generally raised during this episode: it is conceivable that Melampyrum may also have been present in drier, open areas with other herbs such as Plantago lanceolata and the taxa represented by Trifolium type, as outlined in section 8.2.1.

The single record of Fagus at 208cm, at the end of this event, may be coincidental, although it commonly occurs in the upper parts of all the diagrams with indicators of clearance (section 10.6.2.). Furthermore, Clarke (1976) has implied that the nut-bearing beech's "suspicious preliminary advance into north-western Europe" (p.460) may have been associated with active introduction. Hedera exhibits a minor increase in frequency, which similarly could be coincidental, but may reflect some active gathering of the species (Simmons and Dimbleby 1974). Opening of the forest canopy could also have led to an increase in flowering with, in addition, dispersal enhanced in the more open conditions, as with the Filicales, although this may have been offset by fewer individual plants as a result of the clearance itself. As already mentioned, all tree pollen types are reduced but this could largely be a statistical effect from the elevated herb levels. It is nevertheless significant that Alnus is also reduced: this percentage is calculated outside the sum with Salix and so will not have been affected directly by the high herbs, implying a real reduction in arboreal pollen. However, a high count of local herbs within the sum will inevitably cause a reduction in the numbers of types counted outside the sum, but as Alnus levels do not return immediately to their former levels after the herb maximum this is unlikely to be the whole explanation. A second problem that cannot be totally discounted is that the changes which took place on the mire surface also affected the mire edge community of Alnus. The reduced Pteridium frequencies at this level are also problematical. In all the diagrams it tends to move with the total herb curve and this has been recorded by other workers (e.g. Oldfield 1963, 1969; Simmons 1969a). The work of Tinsley and Smith (1974) with modern samples suggests, however, that Pteridium is an unreliable indicator of open areas. This discrepancy may be a result of short-term variations being averaged out in the fossil pollen sample. The fall at Kingswood implies a reduction of open areas; it may equally indicate removal or trampling of bracken during the creation of camp sites, its exploitation for bedding (Dimbleby and Evans 1974) or uprooting for its nutritious rhizomes (Clarke 1976).

When all factors are taken into consideration it may be speculated that there was a real expansion of dry open ground at this time which temporarily led to changes in the bog flora. A variety of evidence implies that Mesolithic activity may have been responsible. As already mentioned, the bog is developed below a springline, an obvious settlement site both because of a ready supply of fresh water and the attraction of this to game. The significance of such sites is apparent from, for example, Dartmoor where the highest concentrations of Mesolithic implements were at spring heads (Grieg and Rankine 1956). The Mesolithic find sites as a whole show a marked concentration around water courses in central southern England (see, for example, Jacobi 1978, Fig 4), and there are several to north and south of the Purbeck chalk ridge (Fig 8.1.). The distribution maps of Mesolithic finds (Figs. 8.1. and 8.2.) portray all those recorded in Wymer (1977). No attempt has been made to distinguish individual types of find, or numbers, and, because of the bulk of available data, only remains from the Poole Basin and Winchester areas are shown.

At two of Haskins' (1978) sites there are events which she interprets as small-scale Mesolithic clearance; both are close to Kingswood. Core Godlingston 'A' was from a point 1500m north-east of KW 1 and 300-400m from the spring head. It shows slight fluctuations in the Boreal levels of certain pollen types followed by large influxes of iron and aluminium into the bog and an inwash of clay. The core from The Moors, 7km

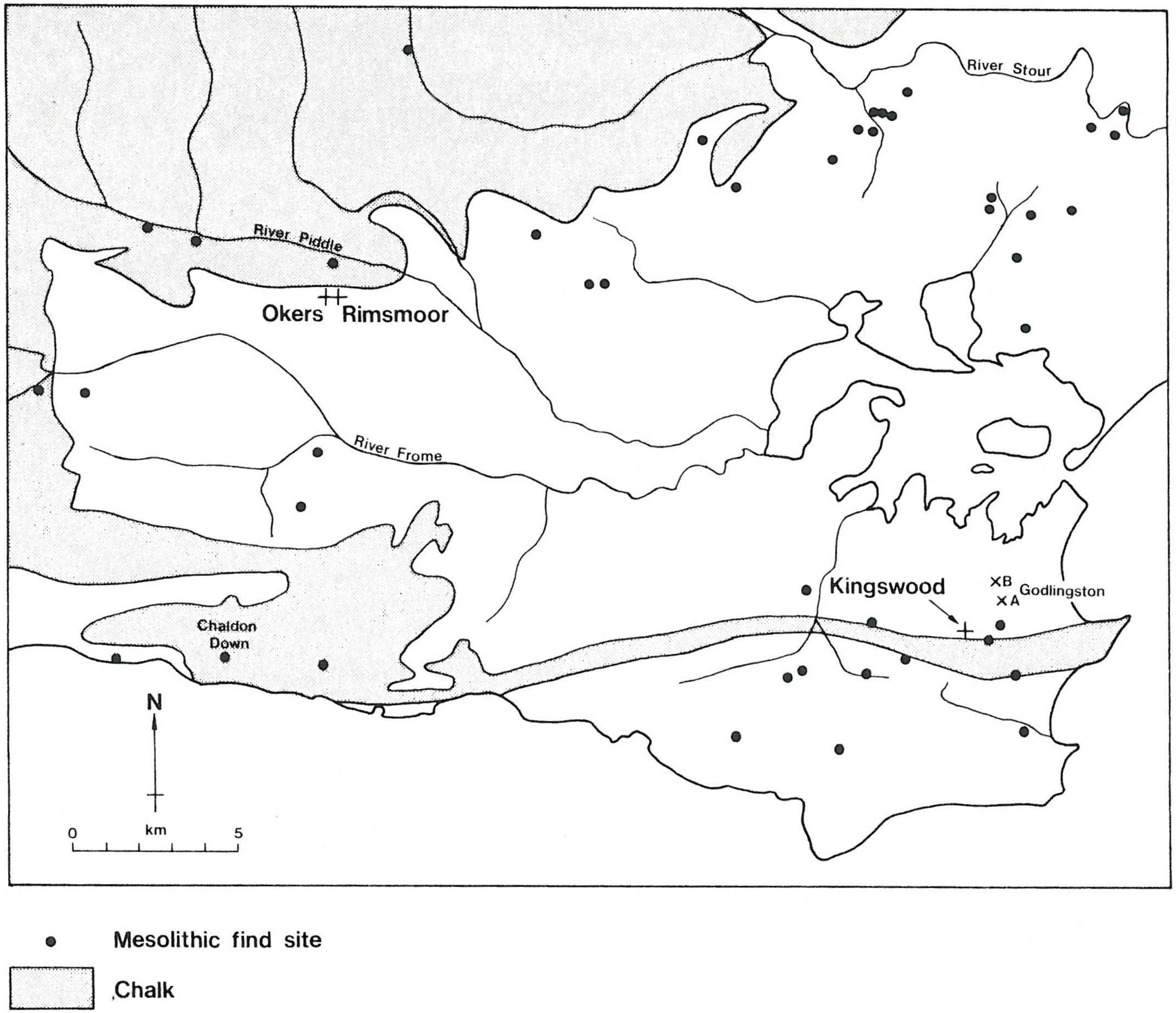


Figure 8.1. Mesolithic find sites in the Poole Basin.
Source: Wymer 1977

north-west of Kingswood exhibits a prolonged decline in Ulmus in the middle Atlantic with an associated peak in Pteridium. Whilst the significance of the latter pollen and spore fluctuations is arguable, the clay inwash and chemical changes at Godlingston 'A' do suggest some definite disturbance within the catchment area. Neither core shows an event similar in form and time to that at Kingswood: the 10cm interval adopted by Haskins may partly account for this discrepancy. It was also mentioned in section 4.6.2. that re-locating the episode for radiocarbon dating was impossible in the time available, perhaps implying a phase of more rapid peat accumulation at the point from which the core was taken. In addition, there is no similar record in core Godlingston 'B', 1200m from the spring head, to that in core 'A', arguing for both the extreme localisation of the events and the importance of spring head locations, although it is possible that accumulation at 'B' began after the event at 'A' had occurred. Finally, Haskins shows two Mesolithic sites in her distribution map (Haskins 1978 Fig 56) at the foot of the chalk ridge above Godlingston and Kingswood Heaths, although she fails to mention them in the text; the most recent gazetteer of Mesolithic sites (Wymer 1977) shows a single find site at SY 018822, 1000m south of core 'A' (Fig 8.1).

There was undoubtedly Mesolithic activity in the area of Kingswood which clearly had, at any one time, a limited spatial influence, if the diagrams do in fact record this activity. Presumably there was an exploitation of small selected areas, with water supply possibly the most important factor governing location and the bogs would consequently tend to record this activity; this contrasts with the larger scale activity proposed for some upland areas (Simmons 1969b). At Iping Common (Keef, et al. 1965) and Oakhanger (Rankine et al. 1960) such activity led to permanent deforestation, whilst at Addington (Dimbleby 1963), a late Mesolithic site with a more stable, developed forest community and soils with a higher pH (Dimbleby 1965) there was no detectable influence on the vegetation. The Poole Basin sites are intermediate in showing possible clearance phenomena, but with forest regeneration occurring afterwards perhaps because of a lower intensity of occupation, a more stable ecosystem or more resiliant soils. There may nevertheless have been slowly developing 'heathy oakwoods' in response to soils and man, subject to the equivocal nature of Haskins' hypothesis (section 7.3.4.).

To conclude, the Kingswood diagram may record a brief Mesolithic phase of clearance activity around a spring head for hunting or plant exploitation. It is recorded over 8cm of peat and is divisible into two phases, each of 170 C-14 years duration, of possible clearance, then regrowth. However, the duration of the event may have been different: these figures are based on average accumulation rates. Fire may have been used as a clearance mechanism, although the charcoal record could also indicate burning of the mire vegetation or solely camp fires. It is impossible to confirm the anthropogenic origin of the phenomenon in the absence of dated artefacts around this part of the bog. Intensive fieldwalking may be productive: Sims (1973), for example, was able to correlate a nearby flint scatter with early clearance recorded in the muds at Hockham Mere. Finally, it is conceivable that Mesolithic activity was responsible for the early rise of Alnus at this site (A.G. Smith 1970; section 7.3.2.).

8.2.3.2. RIMSMOOR

As mentioned above (section 8.1.), the evidence for Mesolithic disturbance at Rimsmoor is less precise. The site itself may well have been attractive as a resource for water, reeds and wildlife: attention may however have been drawn away from Rimsmoor by the valleys of the Piddle to the north and that now containing Oakers Bog to the south. This nevertheless need not have occurred because Rimsmoor could have provided then, as now, an abrupt contrast from the surrounding forest without the intervening alluvial or marsh zones of the valleys. It is also in a geological contact zone, the type of area apparently favoured by Mesolithic groups in the Weald (Mellars and Reinhardt 1978).

The herbs present can readily be explained in terms either of growth on the mire surface or around the mobile edges of the depression (section 8.2.1.). Correlations between herb levels, general pollen fluctuations and charcoal are difficult to discern, though some consistencies are apparent. The first phase of herb immigration may be related to temporary instability in the forest cover (section 7.2.), although it continues after the new forest community of the Atlantic (C-2) is established and coincides with fairly abundant charcoal. In the centre of RM-2 when charcoal is not recorded, Gramineae is also reduced and Betula shows greater fluctuations. Above, when charcoal is again recorded, there is a temporary peak in Melampyrum followed by renewed herb records and cereal pollen. Throughout, Pteridium markedly varies in frequency which may represent changing shade intensities, but quite possibly only around the sides of the basin. Interestingly, Oldfield and Strathan (1963) observe that at the present day bracken increases rapidly with clearance, especially if fire is involved, as it regenerates from resistant rhizomes (Dimbleby 1978). The greatest fluctuations in Pteridium during RM-2 are in the centre of the zone where charcoal is not recorded, but as Edwards (1979) states, it may also expand at the edge of axe-felled woodland.

The majority of the Gramineae pollen is probably from Phragmites; the reduced pollen level in the centre of the zone coincides with abundant macrofossil remains of Sphagnum. Betula and Fraxinus may be present around the woodland edge, explaining their high pollen values. Betula however, like Calluna which is also relatively high, are often increased by the activities of prehistoric man (Pennington 1974) and the latter is light-demanding (Simmons and Tooley 1981). Ash normally is higher after the Ulmus decline in pollen diagrams but at Rimsmoor it is lower, unlike Betula, which could imply its more general occurrence in the Atlantic. Fraxinus favours soils retentive of moisture (Wardle 1961) as those on the Reading Beds may have been, perhaps explaining its lower representation at Kingswood and Winchester. Nevertheless, ash would normally be overwhelmed by the members of the Quercetum mixtum. Rimsmoor at this time was probably less than 10m in diameter and its pollen therefore dominated by plants growing within 20m of the edge of the bog (section 4.4.2.) so this high frequency of a taxon with a low pollen production may represent a purely local phenomenon, perhaps encouraged nevertheless by continuous disturbance of the forest cover by fire and/or axe. Such activity should promote herb growth but the low herb record may be a result of many herbs being insect pollinated with a low production and dispersal and the fact that the pollen samples contain several years of peat accumulation (mean rate 4.34yrs cm^{-1}), evening-out short-term peaks (Swain 1973). To this may be added experimental observations that practically no herb pollen was transferred into a forest from an area of of grassland (Borowik, 1963; section 2.4.3.) restricted seed dispersal between isolated clearings; and the generally low regional pollen representation at such a small site. Indeed, with this size of site, herbs fringing the deposit are more likely to be recorded. The possible existence of significant clearings is readily explicable therefore despite the apparent anomaly of low herb pollen and high charcoal: herb pollen may be poorly dispersed, but in the heat of a fire, charcoal can be carried to a great height and over considerable distances (personal observation of stubble burning in Cambridgeshire).

Actual clearance, however, need not have occurred. A.M. ApSimon (pers.comm.) has suggested that the edges of Rimsmoor may have been seasonally occupied during the winter by Mesolithic groups. During this season cover and shade would have been less and clearance perhaps unnecessary, with no effect therefore on herb growth. I.G. Simmons (pers.comm.) has added that occupation could indeed have been at any time of the year, consisting solely of a small camp on the edge of the depression. In both instances, camp fires and even accidental or intentional burning of the Phragmites may have been the source of the charcoal. This may explain the occurrence of Urtica, a taxon with a predilection for Mesolithic settlement (Iversen 1949: Clark 1971), although Behre (1981) notes that it occurs naturally in river bank forests.

It is impossible to demonstrate unequivocally Mesolithic activity in the Rimsmoor pollen diagram. Nevertheless, some open ground may have been present around the site and the availability of fresh water and food sources, such as Phragmites and Pteridium rhizomes (Clarke 1976) may have encouraged exploitation. Regrettably, time was not available for fieldwalking around Rimsmoor as this may have demonstrated Mesolithic occupation. The nearest recorded find is at Briantspuddle, 1km to the north (Fig 8.1.).

8.2.3.3. WINCHESTER

It is difficult to distinguish with certainty any Mesolithic activity at Winchester. In part this may be a result of several factors. For example, the separation of Mesolithic and Earliest Neolithic (section 9.3.7.) is hindered by the uncertain chronology, a consequence of the chalk inwash (333-343cm) and the single radiocarbon date (HAR-4342), although the interpolated accumulation rate is similar throughout C-1, C-2 and C-3. Additionally, the flood plain may have supported a vegetation mosaic of drier areas as well as rich calcareous fen, both of which will have influenced the herb curves. However, charcoal is recorded yet this may indicate fires on the flood plain, or, alternatively, natural woodland fires arising from the proposed drier nature of the chalkland soils (see discussion of Alnus, section 7.3.2.).

On the whole, the significance of the chalk outcrop may have been limited in terms of Mesolithic activity. Recently, Jacobi (1978, 1981) and others have noted how finds tend to cluster on certain strata. Mellars and Reinhardt (1978) have investigated this in detail by examining the distribution of certain artefacts and occupation sites in relation to geology. They postulate that there was a low level of exploitation of the chalklands. Occupation sites in particular tend to be located in areas with sandy soils which are close to strata bearing other soils: the concentric outcrops of differing rock types fringing The Weald were particularly favoured, notable examples being Oakhanger, Iping Common and Addington. Even the one major site known on the chalk is located on its edge at Broom Hill in Hampshire (O'Malley 1978; Jacobi 1981; Fig 8.2). Mellars and Reinhardt hypothesise that the variation was a result of the edaphic influence on vegetation: on sandy soils the vegetation would tend to be drier with a less dense understorey in contrast to the vegetation of the Weald clays and fertile loams of the chalklands. The distribution of perforated 'pebble mace heads' and transversely-sharpened axes indicates that the chalk outcrop was utilised for subsistence and flint resources (Mellars and Reinhardt 1978, Figs 4 and 5; J.G. Evans, 1974; section 8.2.2.).

Correlations of soil type and vegetation have been common in the archaeological literature for a number of years (section 1.1.). There are, undoubtedly, a number of clear relationships discernible today (see, for example, Rackham 1980), yet applications to the past have frequently been without any viable ecological considerations. An example is the concept of grassland as the natural vegetation of the chalklands (see Chapter 2) and in the present context, Rowley-Conwy (1982) notes that lime-dominated forests were probably prevalent in the south-east.

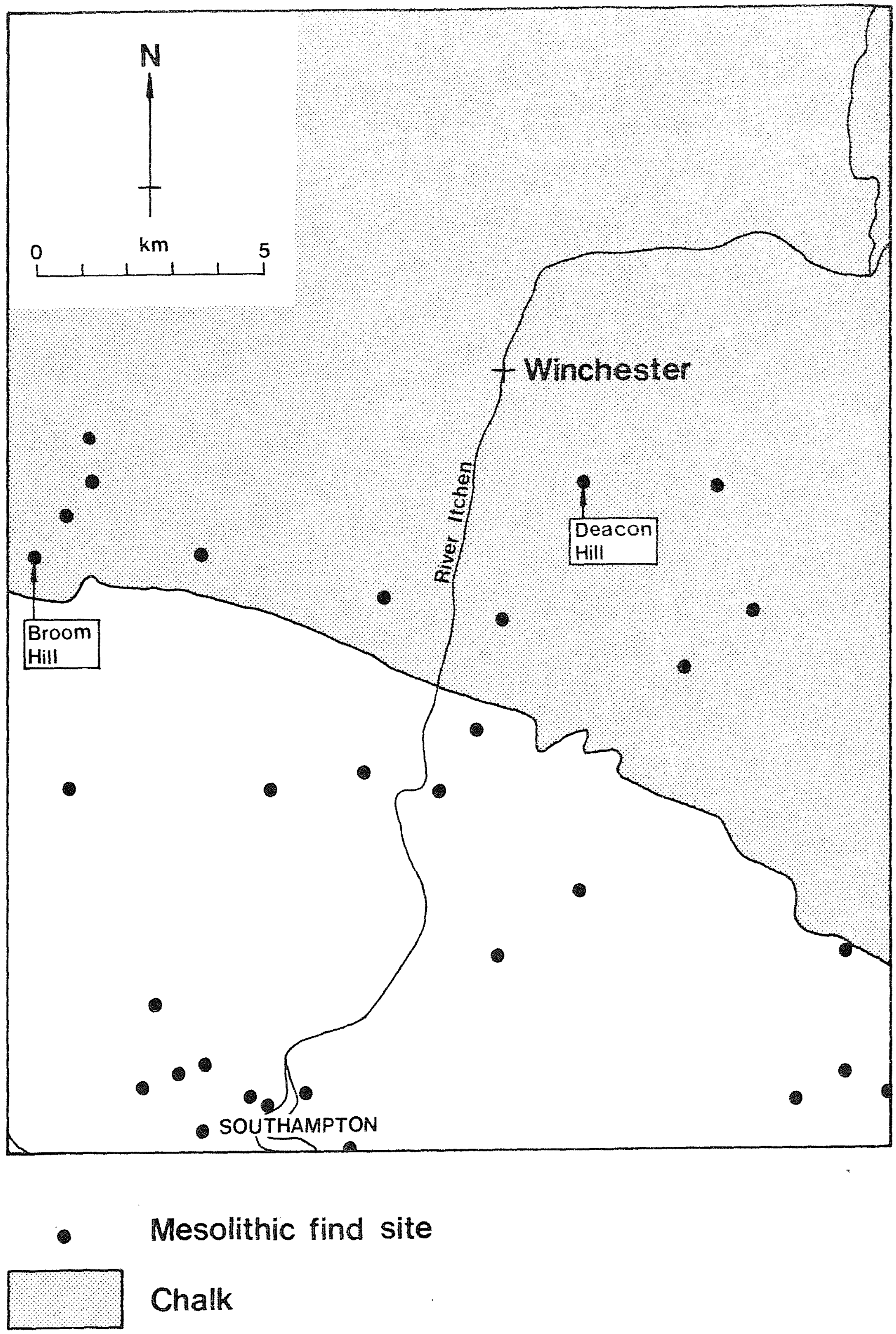


Figure 8.2. Mesolithic find sites in south central Hampshire.
Source: Wymer 1977

After discussing Mellars and Reinhardt's conclusions, he argues, however, that as lime casts more shade than oak, the understorey would be less dense, and so these forests would not be as unsuitable for hunting as they propose. Rackham's (1980) observations of modern limewoods tend to validate Rowley-Conwy's hypothesis.

As mentioned above, find sites tend to be relatively few on the chalk (see Figs 8.1 and 8.2), but this may in part be a result of subsequent destruction. Interestingly, the site on Chaldon Down (SY 785812, Fig 8.1) was discovered beneath two Bronze Age barrows (Wymer 1977) which had preserved the old land surface. There is also a pronounced clustering of sites in Southampton (Fig 8.2) clearly illustrating how a concentration of 'excavation' may lead to a possibly erroneous impression of the incidence of prehistoric activity. Clearly, the paucity of Mesolithic chalkland sites may relate solely to the destructive effects of the intensity of Neolithic agriculture. An indication of this may be given by, for example, the find site on Deacon Hill (SU 504275, Fig 8.2), a location which, because of altitude and topography, may have experienced less tillage. Shennan's (1981) fieldwalking in East Hampshire may also show that the sites exist on the chalk, but that detailed investigation is necessary before they can be located.

Mesolithic activity on the chalk around Winchester would, therefore, not be unexpected. Aside from the problems already mentioned, it may not be discerned with confidence because of the size of the pollen catchment. According to Mellars (1976) disturbance may have entailed, for example, clearance of 1ha strips with perhaps only six per square kilometre (about 6% clearance). At Winchester with a pollen source area of, conceivably, several square kilometres, such clearances may be masked by the pollen output from the unaffected forest; indeed, increased flowering of the forest edge trees may have elevated arboreal pollen (section 9.3.1.). Small-scale activity is best detected by small sites, if the clearance is nearby, as possibly illustrated at Kingswood. As noted earlier, finds tend to cluster in valleys and Mellars and Reinhardt (1978) suggest that this may reflect the importance of rivers for transport, as well as for water supply. Such finds are absent from the Itchen valley, which may accord with the pollen evidence, yet alluviation and peat development may have buried occupation material. If there was indeed disturbance within the valley, then this may have been obscured by the pollen from, as discussed, the unaffected areas. Similar factors may be in operation in the Somerset Levels where there was apparently no significant effect on the vegetation (Beckett and Hibbert 1978). However, at Hockham Mere with a possible pollen catchment of 36-300km^2 (Sims 1973) some minor disturbance is recorded. Perhaps this latter reflects a relative concentration of activity, perhaps compounded, as at Kingswood, by a more brittle environment (Dimbleby 1976). The chalkland landscape portrayed at Winchester may have been especially resilient to repeated clearance phases.

8.3. CONCLUSION

It seems probable that Mesolithic groups exerted some influence on the vegetation of Britain and it is plausible that there was activity near to the sites investigated in this research. Charcoal is widespread in the Boreal and Atlantic (C-1 and C-2) levels and whilst natural woodland fires may have been an unlikely origin, it is difficult to determine whether it represents deliberate clearance involving fire, the effects of camp fires, or intentional or accidental burning of bog or fen vegetation. Dry land herbs are recorded at the three sites but these might have been on or around the basins (Behre 1981) or simply from natural glades and trackways within the forest (Tomalin and Scaife 1980). Rimsmoor and Winchester both show various changes towards the end of C-2 which are probably associated with the ensuing Ulmus decline. Kingswood, however, exhibits a marked episode at the beginning of C-2 that could relate to a brief clearance event. All three sites may have been potentially attractive at this time both as sources of water and for the contrast in environments that they afford: some general exploitation and modification of the vegetation communities might therefore be expected. It must be emphasised, nevertheless, that although the influence of early human groups is likely, proof is impossible on the available evidence from the sites discussed in this thesis.

CHAPTER 9

PERIOD C-3 NEOLITHIC AND BRONZE AGE

Sites: Winchester WT-4, WT-5, WT-6
Snelsmore SM-1, SM-2, SM-3, SM-4
Amberley AWB-1, AWB-2, AWB-3
Rimsmoor RM-3, RM-4, RM-5
Kingswood KW-3, KW-4

Period C-3 correlates approximately with the Subboreal of Blytt and Sernander, Godwin's Zone VIIb and the first part of Fl III (West 1970). It is recorded at Winchester, Rimsmoor and Kingswood with the opening omitted from the sequences at Snelsmore and Amberley.

9.1. CHRONOLOGY

The beginning of C-3 is defined by the *Ulmus* decline, radiocarbon dated to 3680±90bc (HAR-4342) at Winchester, 2980bc at Rimsmoor and 2800bc at Kingswood. These latter two dates (interpolated from HAR-3919 and HAR-3920, and HAR-4239 respectively) are similar to that from Gatcombe in the Isle of Wight of 2900±45bc (SRR-1338) (Scaife 1980), but all three differ from the mean for other British dates of 3350 to 3150bc (Smith and Pilcher 1973). Reasons for this are advanced in section 9.3.5., although this variation may not be significant when the standard deviations are taken into account. The exceptionally early date for Winchester is discussed in section 9.3.1.2.

The upper boundary of C-3 is placed just below the level where the spectra indicate the more intensive, especially arable, land use of the Early Iron Age. The dates for this level are Winchester 650bc; Snelsmore 410bc; Amberley 420bc; Rimsmoor 350bc; and Kingswood 600bc. The total duration of C-3 is therefore between about 3030 and 2200 radiocarbon years.

9.2. THE GENERAL NATURE OF VEGETATION CHANGE

The summary pie diagrams for C-3 show marked but variable changes from C-2 at the three sites with spectra of both Periods (Fig 9.1.). At Winchester there is an expansion of herbs and a corresponding reduction

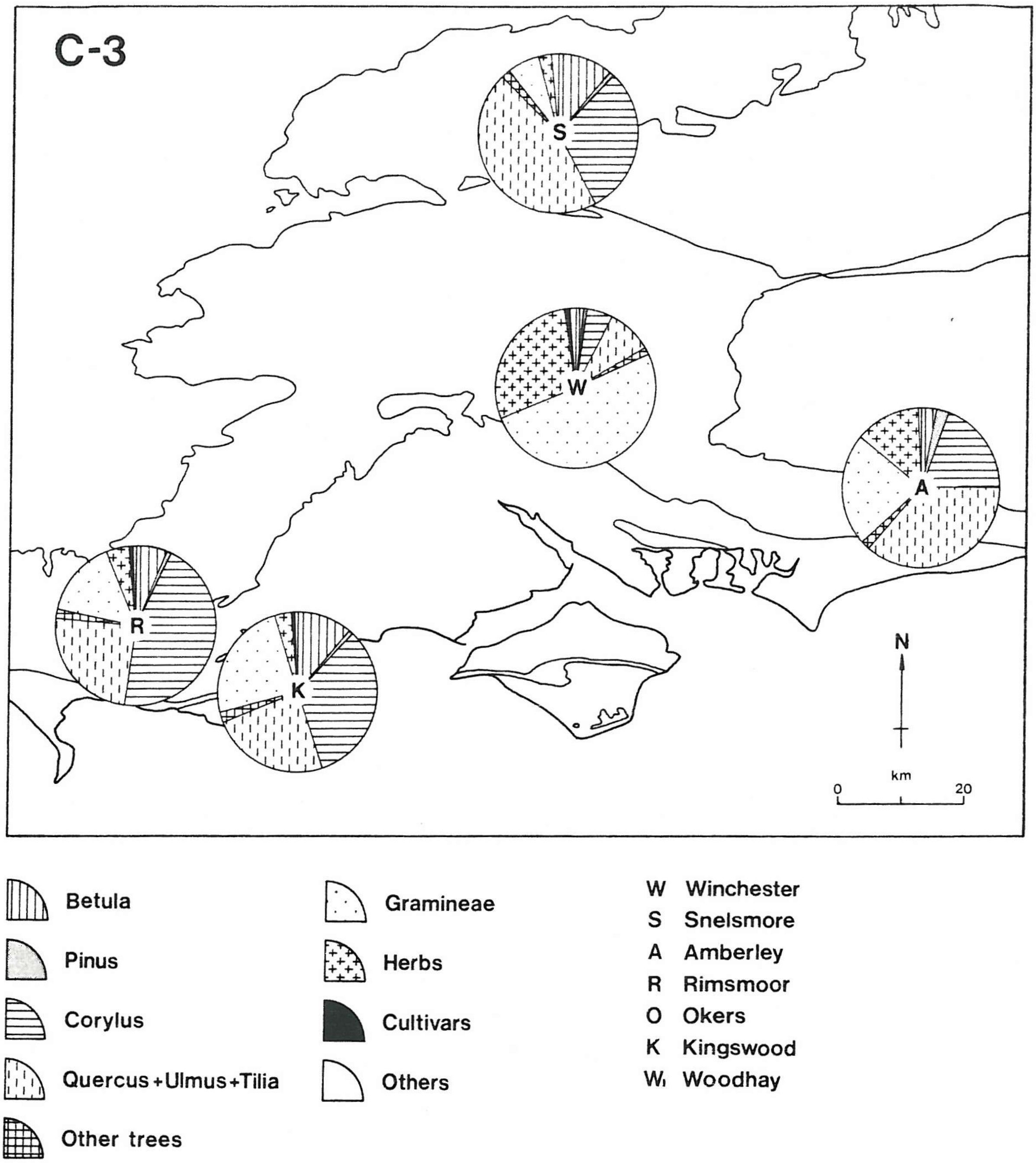


Figure 9.1. Period C-3: summary pollen diagrams

of tree and shrub species, including Corylus. Rimsmoor and Kingswood differ, with at both Corylus inflated at the expense of Quercus, Ulmus and Tilia pollen. The behaviour of herb and Gramineae pollen at the latter two sites are more complex because of various factors including the influence of pollen from plants on the mire surfaces. In particular, at Kingswood herbs overall are reduced as a result of the major peak of certain taxa in the early part of C-2, correlated with possible Mesolithic activity (section 8.2.3.1.).

The tree, shrub and Corylus pollen at Winchester amounts to less than 18%, well below the 50% Tinsley and Smith (1974) and Heim (cited in Simmons and Tooley 1981) regard as characteristic of a forested landscape: open conditions prevailed in the pollen source area. Data from Kingswood and Rimsmoor indicate, in contrast, more woodland. The other two sites vary: the Snelsmore spectra suggest a largely closed forest canopy whilst the Amberley sequence has a more open aspect. Cereal pollen is recorded at all five sites.

9.3. THE ULMUS DECLINE

9.3.1. PRE-ULMUS DECLINE INTERFERENCE

There is evidence from Rimsmoor and Winchester for disturbance of the vegetation immediately prior to the Ulmus decline. ApSimon (1976) has designated this period the Earliest Neolithic, which ends with the Ulmus decline and the appearance of certain monuments, notably long barrows and causewayed enclosures.

This highlights a major difficulty in palynology for it is usual to separate the Mesolithic and Neolithic at the Ulmus decline. A major problem with this scheme in southern England is that the majority of late Mesolithic dates lie in the fifth millennium bc, failing to meet the Ulmus decline whilst archaeological Neolithic dates extend back before this level (Bradley 1978a). Temporal overlapping of the two cultures will have occurred initially but not in the long term because the Neolithic way of life will have destroyed the subsistence base of the Mesolithic (A.M. ApSimon, pers.comm.). In the fourth millennium bc, J.G. Evans (1975) suggests that archaeologically and environmentally there may not have been a clear distinction between the two cultures. Illustrations of this may be the possible Neolithic flints found in a pre-Ulmus decline context at Storrs Moss (Powell *et al*. 1971) and the Mesolithic clearance and herding data discussed in section 8.2.2.

In the Earliest Neolithic phase groups newly arrived from the continent will have been slowly migrating across Britain. Only when some control had been gained over the environment and a situation of 'stable adjustment' had been achieved could large clearances have been created and monuments constructed (Bradley 1978a, 1979; Case 1969; Whittle 1978, 1980). The period may have lasted 500 years up to about 3,500bc and would have been characterised by 'garden plot cultivation' (A.M. ApSimon, pers.comm.). Coles (1976) notes that this will have had little or no impact on the pollen evidence and ApSimon (pers.comm.) in hypothesising that such a system may have entailed clearance of perhaps one hectare per square kilometre, less than 2% clearance, suggests that tree pollen may even have been increased because of the forest edge trees receiving more light. Minor as this clearance may have been, it is perhaps detectable in a number of pollen diagrams. For example, at Barfield Tarn (Pennington 1970), Hawes Water (Powell *et al*. 1971), Ballynagilly (Pilcher and Smith 1979) and Caselkeelty (Lynch 1981) minor herb fluctuations are recorded during the 300 to 400 years before the *Ulmus* decline. At all except Barfield Tarn there are archaeological remains that may be correlated with this period and at Ballynagilly and Caselkeelty cereal type pollen grains are recorded. Pre-*Ulmus* decline cereal pollen is also recorded in Haskin's (1978) Morden A diagram: here, however, they are present from the opening of her designated Atlantic period implying equivocal pollen identifications, incorrect zonation or interrupted sediment accumulation.

9.3.1.1. RIMSMOOR

A second period of herb 'immigration' in C-2 at Rimsmoor characterises the end of the Period and includes two cereal pollen grains at 1200cm (c.3400bc) and 1170cm (c.3720bc). The herbs are recorded from about 1210cm (3450bc) and are *Spergularia* type, Chenopodiaceae, Caryophyllaceae and *Ranunculus* type. This is about 400 radiocarbon years before the *Ulmus* decline at 1102.5cm. Contemporaneously, there are fluctuations in *Ulmus*, *Tilia*, *Betula*, *Quercus* and *Corylus* which may be related to disturbance. The cereal pollen record implies Neolithic, rather than

Mesolithic, activity, although the possibility of the latter occurring at the same time cannot be discounted. In contrast to Ballynagilly and Caselkeelty, archaeological evidence for Neolithic activity has not been found near (within a few hundred metres of) Rimsmoor, although this need not mean that it is not present. More fieldwalking could be valuable.

This interference and subsequent Ulmus decline are relatively late, perhaps implying that Neolithic activity was concentrated elsewhere at this time (section 9.3.5.). The cereal and herb pollen may be complementary, representing long distance transport from outside the area from which most of the pollen was derived (Ten Hove 1968). Alternatively, small groups may have been exploiting the area, perhaps even as pioneering communities from a centre of activity at a distance. Interestingly, charcoal rises steadily throughout this period, possibly indicating an increasing intensity of small clearings outside the pollen catchment area or, conceivably, a front of 'Ulmus decline clearance practice' migrating progressively nearer to Rimsmoor. It could also reflect a greater frequency of camp fires around the site (section 8.2.2.), and this itself may not be unrelated. Finally, it should be noted that the cereal grains at Rimsmoor may be a result of contamination from the wet surface layers of the bog, but this is seen as improbable because of their relationship to the herb pollen, the close juxtaposition of the Ulmus decline clearance, and the similar temporal relationship at Ballynagilly, Barfield Tarn, Hawes Water and Caselkeelty.

9.3.1.2. WINCHESTER

From about 312cm, 26cm below the Ulmus decline at Winchester, a number of herbs show either increased frequencies or the beginnings of continuous curves: Ranunculus type, Rubiaceae, Plantago lanceolata, Liguliflorae, Anthemis type, Rumex crispus type and Centaurea nigra type. Total dry land herbs rise from 6% at 312cm to 16% at 288cm, before climbing to 40% after the Ulmus decline.

A drying of the fen surface making it more suitable for the growth of these herbs is unlikely to be the reason for the phenomenon. It could have intensified pollen degradation for Filicales are prolific implying differential preservation yet it is improbable because the various susceptible and resistent types (Havinga 1971) do not show trends consistent with such a situation. In addition, aquatics are increased with Potamogeton recorded for the first time since WT-1, there is an inwash of chalk and shells at about 310cm and pH is falling (section 9.3.4.1.). Various herb pollen fluctuations may reflect changes in wetland species, such as the falling Gramineae and Cyperaceae above 312cm, and the brief peaks of Bidens type, Rosaceae undiff, Filipendula and Thalictrum at 328 to 320cm.

Overall, therefore, conditions in the fen may indeed have become wetter, suggesting that some of the recorded herbs were colonising newly cleared areas of dry land. This hypothesis is difficult to verify because of the heterogenous nature of the flood plain discussed in previous chapters. It could solely reflect the effect of channel migration leading to the drying out of one area of the flood plain, and perhaps inundation in the area of the pollen core. The close juxtaposition, however, with the Ulmus decline clearance may similarly reflect disforestation. Elevated Quercus, Betula, Fraxinus, Tilia and Alnus pollen conversely imply woodland expansion. The higher Alnus and Tilia was tentatively correlated in section 7.3.3. with the development of fen margin woods: the other species may also have been involved. Alternatively, and perhaps in accordance with the rising Plantago lanceolata frequency, a species of open pasture and not grazed forest (Iversen 1973), the woodland edge may have been pushed back, perhaps permitting the expansion of Alnus-rich fen woods (A.G. Smith 1970). Contemporaneously, there may have been a thinning of adjacent forest involving the removal of smaller and thus easier felled trees. The reduced shade will then have increased the flowering and hence pollen production of those remaining, whilst the higher wind velocities within and below the canopy may have contributed to the elevated arboreal pollen. In such a situation, the reduced Pteridium might reflect its removal to improve pasture, its utilisation for bedding, thatching (Reynolds 1981) or food (Clarke 1976).

Actual reclamation of the flood plain itself may even have occurred for pasture: Plantago lanceolata was prevalent during the recent phase of watermeadowing (section 11.3.).

The hypothesis as a whole must remain extremely speculative in the absence of further data from the site, especially the evidence that could be gained by the application of three-dimensional techniques (Turner 1975). Purely local changes in fen hydrology independent of man may well account for the changing pollen frequencies, and even if removal of woodland had occurred, this could reflect simply higher herbivore densities in the region. Nevertheless, as already mentioned, the association with the Ulmus decline suggests that human activity may have been at least contributory. This would be easier to demonstrate if cereal pollen had been recorded. However, it is notable that at Barfield Tarn (Pennington 1970) and Hawes Water (Powell et al. 1971) possible pioneer Neolithic activity is recorded about 700 years and 300 to 400 years respectively before the major fall of Ulmus. If 312cm at Winchester is taken as the beginning of this activity (c.4220bc) and the Ulmus decline is dated at 3680±90bc (HAR-4342) then the difference of 540 years is quite compatible with these sites. This places the beginning of the pioneering phase over 200 C-14 years earlier than the c.4000bc proffered by, for example, Whittle (1980).

The precision of the chronology is therefore brought into question. The inwash between 333 and 343cm was mentioned in section 7.3.2., but it is impossible to allow for its effect on the time:depth curve. The radiocarbon determination is perhaps more significant: it is 290 C-14 years older than the oldest published date of 3390±120bc (K-1097) from Barfield Tarn (Pennington 1970), one of three at the site between 3380 and 3390bc. Hard-water error (Shotton 1972) is an obvious cause for its significantly greater age given the alkaline peat and surrounding chalk. The sample was pretreated at Harwell to remove inorganic old carbon, but that absorbed by the plants at the time of peat formation will have been converted to organic carbon and consequently not eliminated. Although 'dead' carbon contamination would have to have totalled only about 8% if the true date of the sample was 3,000bc (West 1977), it is worthwhile comparing the date of 3680±90bc (HAR-4342) with the determination from the Lambourn long barrow (Fig 9.2.) of 3415±180bc (GX-1178); they overlap by five C-14 years at one standard deviation. Conceivably, they are both influenced by hard water error, particularly as the Lambourn date is the oldest for a long barrow. However, unlike the Winchester Ulmus decline date, it is not the only one for a long barrow on the chalk: the others give dates around 3,000bc and, interestingly, these include Wayland's Smithy

(2820±130bc, I-1468: I.F. Smith 1974), 5km north-west of the Lambourn barrow. This could attest to the Lambourn date being too old, but the Early Neolithic, the period characterised by barrow construction, has a duration of 500 years which is compatible with the two dates. Furthermore, three barrows near Avebury and within 3km of each other, show a similar variation in dates: Horslip, 3240±150bc (BM-180); South Street, 2810±130bc (BM-356); and Beckhampton Road 2517±90bc (BM-506b) (J.G. Evans 1972). The chronological association of these monuments after Ulmus decline clearances is well established as the social organisation necessary for barrow construction was only feasible after the pioneering phase. Mollusca from Wayland's Smithy indicate that it was constructed in grassland (J.G. Evans 1972), whilst the turf stack at Lambourn, which was also present in the former barrow, similarly indicates an open environment, at least locally (Atkinson 1965; Wymer 1966). The evidence from the three Avebury barrows is complementary (sections 2.1.1.2. and 2.1.2.2.).

In addition to the barrow assays, there is an intuitive argument in favour of an early date for the Ulmus decline in this area of the Hampshire chalklands. It is recognised that the Neolithic pioneers crossed from the continent (Megaw and Simpson 1979) and spread through Britain from the coasts and probably via river valleys. Most of the coastline of that period in southern England is now submerged and consequential aggradation in the river valleys has been considerable. Thus there will have been a drowning and burial of the occupation sites of the period. It is notable that some of the sites with very early dates for Neolithic activity are in north-west England and Northern Ireland, areas at some distance from mainland Europe. In part at least this apparent anomaly must have arisen because of the existence of plentiful deposits suitable for pollen analysis, in contrast to southern England, and isostatic recovery leading to a relative fall in sea level. The scarcity of early dates in southern England despite its apparent climatic and locational suitability for colonisation may be a factor of simply the drowning and burial of sites and the infrequent polliniferous deposits. It can be added that Neolithic settlers may have preferred low-lying lakeside or waterside situations, as in Europe (Powell et al 1971).

However, it cannot be discounted that the Winchester date may be in error without further assays from the sequence. Nevertheless, there appear to be good reasons for accepting it as approximately correct. Furthermore, radiocarbon dates are statistical estimations; if two standard deviations are taken into account, there is a 95% probability that the true age of the sample lies between 3860 and 3500bc, giving the range at 312cm of about 4110 to 4360bc. True dates near the upper ends of both these spectra would be more readily acceptable in view of other work. If 3000bc is the actual date of the event at Winchester from comparison with Rimsmoor and Kingswood, then the assumed pioneer activity begins at 3850bc (312cm), but it is speculated in section 9.3.5. that clearance may have been earlier on the chalk, the peripheral areas only being exploited later as a result of pressure on chalkland resources.

9.3.1.3. KINGSWOOD

There is no clear evidence for Earliest Neolithic activity at Kingswood, although just below the *Ulmus* decline the abundant charcoal and herbs, including *Melampyrum*, *Plantago lanceolata*, Roseceae undiff and *Artemisia*, may indicate some interference.

9.3.2. CAUSES OF THE *ULMUS* DECLINE

The fall of *Ulmus* percentages in the mid-postglacial is a widespread and broadly synchronous feature in pollen diagrams across North-West Europe. It was envisaged to have been the result of climatic change to more continental conditions (Iversen 1941) and was used to denote the boundary between the Atlantic and Subboreal periods. Godwin (1940) similarly adopted it to define his Zone VIIa/VIIb boundary.

A solely climatic origin has received increasing criticism: it has been one of the most controversial issues in postglacial palynology. As various detailed discussions have been published (e.g. Pennington 1974; Simmons and Tooley 1981; Ten Hove 1968) only a brief summary is presented below.

a) Climate. Climatic change to cooler, more continental conditions is implied by falls in other thermophilous species such as *Viscum*, *Hedera* and *Ilex* (Iversen 1944), oxygen isotope work (from about 2,500bc; Dansgaard *et al*. 1969), stratigraphic and non-pollen microfossil data from The Netherlands (Van Geel 1977; Van Geel et al. 1981) and, on mainland Europe, there is evidence for a phase of lower temperatures at the end of the Atlantic (the Piora Oscillation; Lamb 1977). Recent data for such a cause comes from, for example, south-west Ireland (Lynch 1981, but see section 9.3.5.) and, as a contributory influence, Hockham Mere (Sims 1973).

b) Disease. Aletsee (1959) and Watts (1961) for example suggest that a fatal elm disease may have caused the Ulmus decline. The recent epidemic of Dutch Elm Disease shows how effective a mechanism this could have been. It has most recently been investigated by Garbett (1981) and Girling and Grieg (1977).

c) Unfavourable ecological conditions. This includes a number of factors such as water table lowering, itself related to climatic change. This would more significantly affect Ulmus than Quercus (Tauber 1965) whilst exposing soils around rivers and lakes to colonisation by Alnus, Betula and Salix. The latter might filter the larger, heavier grains of Ulmus from the airflow to cause a reduction in the elm pollen deposited in the basin (Tauber 1965). Another factor is edaphic, with leaching rendering soils less suitable for the elm (Troels-Smith 1964).

d) Human activity. This could have taken many forms, from, for example, the deliberate lopping of elm branches, as well as those of Ilex and Viscum as fodder for stall-fed or tethered cattle (Troels-Smith 1960) to the deliberate felling of elm woods by agriculturalists, because of their presence on the better soils (Mitchell 1956).

There is evidence in favour of each explanation. Climatic change at about this time is well attested and probably involved a shift in air masses such that northern Europe became cooler and drier (Magny 1982). Disease is plausible, but difficult to prove without samples of elm wood available for examination. Water table lowering might be expected as a result of climatic change and increases of Betula and Alnus, in particular, often occur at the level of the Ulmus decline. Soil deterioration, operating on its own, would tend, however, to produce a more diachronous decline, and would also affect Tilia which can be unchanged across the horizon. Some knowledge of the Ulmus species involved might shed some light on the problem, although there is overlap in their climatic and edaphic requirements: the results of Stockmarr's (1970) work shows that confident species identification from pollen is impossible.

Human interference provides a ready mechanism and was invoked by Iversen in 1941 to explain changes interpreted as small-scale clearances (landnam) occurring up to 500 years (Iversen 1973) after the assumed climatically determined elm decline in Denmark. Comparing archaeological data and modern analogues, Troels-Smith (1960) suggested that the elm decline sensu stricto was a result of man. In Britain the occurrence of clearance indicators with the Ulmus decline lends further support to an anthropogenic origin. However, it may have been intensified by increased soil deterioration with climatic change and elm disease carried by the early agriculturalists tipping the balance against elms (A.G. Smith 1965). Multicausality is generally recognised to be significant: Rackham (1980) for example, favours agriculture and elm disease whilst Ten Hove (1968) invokes various factors including the lopping of branches, reducing pollen production and fertility, felling because of their growth on better soils, leaching, climate and, for small basins, Tauber's theory of selective filtering. The importance of man's influence is generally accepted, although the operation of other factors will have depended upon local conditions and the complex interrelationship of natural thresholds (Pennington 1975; A.G. Smith 1961).

As mentioned above, at most sites in Britain clearance ('landnam') occurs with the fall in Ulmus pollen, but at a number of sites in the Lake District (Garbett 1981; Oldfield 1963; Oldfield and Statham 1963; Powell et al 1971) and in the Isle of Wight (Scaife 1980) there is evidence for temporary regeneration between the two events. This is probably related to two different farming practices which on the continent have been associated to two different Early Neolithic cultures. At the sites examined in this thesis it has only been possible to separate a "Primary Elm Decline" sensu stricto (Oldfield 1963) at Rimsmoor, and then only tentatively, from the ensuing landnam.

9.3.3. NATURE AND DURATION OF THE ULMUS FALL

The precise chronology of the fall in Ulmus pollen percentages is obscured chiefly by the uncertainty surrounding the accumulation rates of the peats and also the differing pollen source areas. At Winchester the fall in Ulmus extends over about 8cm from 288cm to 280cm, approximately 330 C-14 years and at Kingswood, 4cm from 186cm to 182cm, but gaining in intensity between 184cm and 182cm, about 230 years and 115 years respectively. The event, however, at Kingswood falls on the junction between two core segments which may have distorted this estimate.

The Rimsmoor data are more complex with, in the main core, Ulmus at 9.4% at 1130cm, falling to 4.2% at 1115 and 1110cm, then rising to 5.9% at 1105cm, before falling to 0.5% at 1100cm. From 1130 to 1100cm is about 115 years, from 1105 to 1100cm, about 20 years, but a core segment junction occurs between the 1100 and 1105 samples, perhaps exaggerating the abruptness of the fall. Nevertheless, the one centimetre interval counts of core RM UD shows the major fall in elm pollen, from 8% to 3.5%, occurring between two samples, 1078 and 1079cm. Application of the average accumulation rate (3.8yrs cm^{-1}) indicates that it took place in less than four years. If a straight line is drawn between the 'bracketing' dates HAR-3919 and HAR-3920, then a figure of about seven years is appropriate. The discrepancy between the cores is probably explained by the segment junction in RM 1 and their differing locations in the bog. Various fluctuations discernible in the pollen spectra are less pronounced in RM UD which was from a point two metres south of RM 1 (section 4.4.3.), closer to the edge of the bog and possibly the area of maximum disturbance than the main core. Associated with this is the possibility of differing accumulation rates between the two locations, and the probability that local hydrological changes caused by the clearance will have affected peat growth. These are impossible to quantify on the available data, but a lower accumulation rate (7.08yrs cm^{-1} or 1.41mm yr^{-1}) during the clearance may be indicated by HAR-3919 and HAR-3920. Inevitably, the proposed chronology must remain speculative.

The pollen source area is probably important. The longer duration of the event at Winchester may relate to the progressive reduction of flowering elms throughout the large pollen catchment area. At Kingswood and Rimsmoor the initial declines from 186cm and 1130cm respectively may be a result of the general reduction of elm pollen in the regional pollen rain (as proposed for Cumbria by Pennington 1970) before the local elms were affected, from 184cm and 1078.5 (RM UD) respectively. Comparison with other work fails to provide conclusive evidence because of the paucity of close interval pollen diagrams and especially the minimal information usually presented about pollen source area. The results of close sampling at five sites is shown in Table 9.1., with the Rimsmoor data for comparison. The main conclusion which can be drawn is that the 3.8 to 7.0 years hypothesised for Rimsmoor may not be inappropriate. More high resolution work from other sites in Britain would clearly be of value.

It was described above that in the main core from Rimsmoor Ulmus pollen fluctuates in the four samples below the elm decline. Quercus, Betula and Fraxinus pollen vary in a similar manner but this may be due solely to a peak in Gramineae pollen at the same level. However, in core RM UD the Gramineae peak is largely absent, indicating its origin to be local growth at the site of RM 1. Nevertheless, various fluctuations are discernible in the four samples from about 1082cm (RM UD). Ulmus is reduced, then recovers, Alnus begins to fall, Betula is decreased with Calluna whilst Pteridium peaks. All are very minor changes, but may, nevertheless, be significant. Herb pollen, other than Potentilla is very low. This may reflect some interference with the forest cover before the elm decline proper but this seems not to have led to the creation of much open ground. Actual disforestation appears only to have occurred from the fall in Ulmus pollen at 1078.5cm. Interference may have began still earlier as suggested by the peak of Alnus and high charcoal. This may have been simply a small encampment as proposed for the Mesolithic, but of a sufficient magnitude to cause changes in the bog flora (the peak of Gramineae) and to the fringing vegetation. Removal of competing taxa around the bog could have permitted the temporary establishment of Alnus (cf. Smith 1970). This could have led to more general interference, as just described, and culminated in the elm decline clearance itself. The activity may have begun in excess of 40 radiocarbon years before the main fall of Ulmus pollen at 1078.5cm. The phase from 1082 to 1078.5cm may thus represent some selective exploitation of elm, perhaps as fodder (Troels-Smith 1960), with some limited clearance, most probably of Alnus, to improve access to the 'water hole' of Rimsmoor. The increased Corylus may be a result of increased flowering rather than a real areal expansion. Further counts, with a larger pollen sum might help to confirm that the fluctuations in

Table 9.1. The duration of the major fall in Ulmus pollen at six sites subjected to close-interval sampling

Site	Duration	Comments	Reference
Ellerside Moss, Cumbria	less than 2 yrs	Between two consecutive 0.2cm samples	Garbett 1981
Llyn Mire, Wales	less than 3 yrs	Between two consecutive 0.25cm samples	Moore 1980
Rimsmoor, Dorset	less than 3.8 to 7 yrs	Between two consecutive 1cm samples	This thesis
Gatcombe, Isle of Wight	about 15 yrs	Across three consecutive 0.2cm samples	Scaife 1980
Ballynagilly, Northern Ireland	less than 20 yrs	Between alternate counted 0.5mm samples	Pilcher & Smith 1979
Hawes Water, Lancashire	50 to 100 years	Across consecutive and alternate counted 1cm samples	Powell *et al.* 1971

Ulmus, in particular, are genuine and not purely stochastic.

At all three sites the level of the *Ulmus* decline is a general clearance of woodland. In the Winchester diagram it is especially pronounced with major reductions occurring in *Quercus*, *Tilia*, *Alnus*, *Fraxinus* and *Corylus* and with smaller falls in *Betula* and *Pinus*. The large decrease in Filicales and the cessation of the *Hedera* curve relate chiefly to loss of habitat, the former probably exaggerated by improved conditions of preservation. *Salix* pollen shows a slight increase, perhaps genuine and reflecting expansion on the flood plain after the removal of the postulated *Alnus* fen woods. *Rhamnus* is recorded for the first time; this typically limestone species may also have been present on the fen (see below; Godwin 1975a; Clapham *et al* 1968). Contemporaneously herbs rise, with the beginning of a continuous curve for cereal type. The Rimsmoor sequence differs with only *Ulmus* and *Alnus* significantly reduced whilst *Corylus* and *Betula* are elevated. Herbs rise briefly and cereal pollen is recorded. At Kingswood the changes are similar to Rimsmoor but herb frequencies are scarcely changed except that *Calluna* and *Pteridium* are raised. Cereal pollen is not recorded.

It is assumed that the major cause of these changes is clearance by man of woodland within the pollen catchment at each site. This is readily justifiable at Winchester where, from the pollen spectra, clearance was considerable with woodland failing to regain its former prevalence at any time above this level. Any alternative hypothesis invoking either climatic or edaphic change would require the crossing of a major threshold precluding woodland regeneration: from recent studies of chalkland communities (section 2.2.) it is obvious that the downland soils are totally suited to regeneration. Furthermore, these studies have shown that the maintenance of the open landscape is solely becuase of human activity and grazing animals. Final and conclusive evidence in favour of man being responsible for the clearance at the *Ulmus* decline and subsequent open conditions is the initiation of a continuous curve of cereal type pollen from this level: this is indicative of the likelihood of arable cultivation in the pollen source area.

At Rimsmoor the clearance is not nearly so marked with woodland regeneration of a distinctly different composition occurring contemporaneously; nevertheless, a limited amount of cereal type pollen is recorded again attesting to an anthropogenic cause. The Kingswood evidence is less conclusive with fewer herbs and no cereal pollen. However, the similarity to Rimsmoor of the date and nature of the changes are strongly indicative of the same factor, man, being responsible.

Human activity was undoubtedly the cause of the clearance at the level of the Ulmus decline. The reason why Ulmus was most affected may have been a result of its nutritious foliage. Troels-Smith (1960) proposed the lopping of branches for feeding to stalled or tethered cattle and this might have been conducted, in this area, to keep the animals from areas of arable and to prevent them from straying. Alternatively, or as a part of this practice, elms may have been ring-barked or pollarded to provide lush, easily accessible growth for cutting or browsing (Iversen 1960, 1973). This would readily explain the abruptness of the phenomenon at Rimsmoor (main decline at 1078.5cm, RM UD), unlike the more general lopping, or grazing of younger elms, unless this was abruptly and dramatically increased (section 9.3.5.). A requirement for fodder could likewise explain the falls recorded in Tilia at all sites and Fraxinus at Rimsmoor and Winchester as both are palatable and nutritious. It also provides a reason why at Rimsmoor and Kingswood Quercus was not so seriously affected: it would have provided pannage for pigs and would have been harder to cut (Ten Hove 1968). Oaks may therefore have been left, although their increased flowering with the thinning of the forest cover may have masked some felling. Other possible mechanisms include stripping of bark by cattle (A.G. Smith 1975) or its use as a food by the early settlers (Nordhagen, cited in Pilcher and Smith 1979). Selective felling of Ulmus and Tilia, because they were growing on better soils, is also conceivable at Winchester and Kingswood with their more geologically variable pollen source areas (section 9.3.4.).

Rackham (1980) invokes both man and disease in the fall of Ulmus pollen. He states that the fungus causing the present Dutch Elm Disease, Ceratocystis, is especially attracted to pollard and free-standing elms, rather than woodland elms. It could thus have contributed to an increased emphasis on grassland grazing and away from tree fodder as the elms died. According to Rackham, this explanation would also be more feasible in point of view of the logistics of pollarding in relation to the probable size of the British Neolithic population. Whilst Garbett's (1981) study involving *Hedera* as a possible indicator of dead elms was inconclusive, investigations of subfossil beetle fauna may eventually be confirmatory (cf. Girling and Grieg 1977). However, the at least partial recovery of *Ulmus* pollen at Rimsmoor, Kingswood and Snelsmore imply that if disease was affecting elms, it declined in severity as human activity was reduced; this is perhaps consistent with Rackham's observations.

Other explanations for the fall of *Ulmus* occurring independently of man cannot be substantiated from these data. At Winchester the curve for *Hedera* ceases at the elm decline and could indicate a change to a cooler climate (Iversen 1944), but it is best explained by loss of habitat as it is not repeated at the other two sites. Water table lowering (Tauber 1965) seems unlikely, for at Winchester, aquatics are elevated, although this could reflect conditions solely in the vicinity of the pollen core. Soil deterioration is suggested by the elevated Ericaceae from the elm decline at Kingswood and pH changes at Winchester (section 9.3.4.1.). It is unlikely, however, to have been sufficient to discourage *Ulmus* in these non-marginal lowland areas where even at Kingswood elm almost achieves its Atlantic level in KW-3: soil deterioration was probably a consequence of clearance.

The *Ulmus* pollen decline in this area was, therefore, associated with more general clearance. It may have been especially affected because of its suitability for fodder, although a subsequent epidemic of elm disease may have contributed to the reduction in elm pollen.

9.3.4. THE *ULMUS* DECLINE CLEARANCES

The intensity and duration of the land use phase that follows the clearance episode marked by the fall of *Ulmus* pollen varies considerably between the sites.

9.3.4.1. WINCHESTER

The evidence from Winchester is exceptional with tree, shrub and *Corylus* pollen at a total of only 20%, which is below the 25% to 50% Tinsley and Smith (1974) interpret as a site within 100m of a woodland edge, or one surrounded by dispersed trees. This implies a pollen catchment area largely free of woodland. Some Quercus and Corylus pollen is recorded, perhaps in part reflecting the value of oak and hazel for pannage and nuts respectively. Ulmus, Tilia and Fraxinus show the largest reductions presumably because of their palatability to grazing animals although being taxa of fertile soils this may indicate some preferential clearing for cultivation. Thorley (1981) describes the possibility of felling of elm and lime communities on the moist, base-rich valley sides of the Vale of the Brooks whilst on the upper levels of the downs there was a distinct oak-hazel flora. The evidence from Winchester may not be at variance with this model (cf Fasham 1980): however, precisely what is represented in the Lewes pollen diagrams is questionable (section 2.1.1.1.) and without further work, particularly involving three-dimensional pollen diagrams (Turner 1975) it is impossible to conclusively accept or reject the hypothesis at Winchester.

In the open areas grassland was prevalent from the abundance of pollen from herbs such as Plantago lanceolata, Liguliflorae, Ononis type, Centaurea nigra type and perhaps Ranunculus type. However, cereal cultivation may have been a significant feature of the landscape, but perhaps confined to the lower slopes of the valley sides both of which could equally well account for the continuous cereal pollen curve of up to one percent. It declines in importance later or possibly shifted to other areas. Certain herbs paralleling the movement of the cereal curve include Spergularia type and Anthemis type suggesting that some taxa in these groups were present in the arable fields, together with Polygonum aviculare. Cereal pollen is first recorded as the tree pollen is falling.

An additional analysis conducted only at Winchester was of pH and this shows some marked fluctuations across the Ulmus decline clearance. Precisely to what this refers is uncertain for relatively little work has been undertaken on peat pH in relation to palaeoecology; that pH appears to be 'fossilised' seems probable from the coincidence of certain changes in the pH and pollen curves. The most obvious explanation from this work relates to soil conditions, groundwater and surface runoff relationships. If it is assumed that in a forested chalkland environment infiltration will be more important than in an open area, then groundwater will tend to be a more significant input to a river system, such as the Itchen, during such times. Therefore, the steady rise in pH at Winchester from the later Boreal (WT-2) to a maximum in the Atlantic (WT-3, C-2) may relate to the slow establishment of a more or less closed forest canopy with a proportionally greater input of calcareous groundwater. From the level of increasing herbs at 312cm, falling pH suggests more surface runoff from circumneutral forest mull soils. At the most intense period of clearance, the Ulmus decline (286cm), pH is at a minimum of 7.0, implying a maximum in the ratio of surface runoff to groundwater input to the river system. Above this level, pH recovers to 7.2 perhaps indicating the establishment of a more continuous ground cover with reduced surface runoff. The non-synchroneity of the pH minimum and the cereal pollen maximum may relate to the fact that soil disturbance was greater during the main period of disforestation than subsequently, or in part, the fact that two cores were examined and only correlated by stratigraphy rather than pollen.

Whilst it is acknowledged that this hypothesis may not be the only explanation for the behaviour of pH, it seems most appropriate in view of the available evidence. Such a marked effect on the pH of the valley water tends to substantiate the case that the Ulmus decline clearance had a major impact on the landscape, although at risk of circular argument. It is unfortunate that restrictions on time precluded similar analysis at some or all of the other sites as this may have substantiated the hypothesis.

9.3.4.2. RIMSMOOR

The contrast between Winchester on the one hand and Rimsmoor and Kingswood on the other has already been mentioned: the latter conform with A.G. Smith's observation (in Simmons and Tooley 1981, 201) that at most British sites the Neolithic clearances involve variations of only a few percent in the pollen diagram. The main diagram from Rimsmoor indicates clearance activity with a minimum duration of 95 to 115 C-14 years and the close counted core (RM UD) suggest a maximum of 140 years (assuming an accumulation rate of 3.84yr cm^{-1}) to 250 years (at 7.0yrs cm^{-1}). The latter core illustrates the complexity of the event, though some disturbance of the curves was probably caused by grasses on the mire surface affecting the Gramineae totals. The main event begins at 1078.5cm with the fall of Ulmus pollen and this is followed over the next two centimetres by the decline of Alnus. Prior to 1078.5cm, in subzone RMU-1, herbs are limited to Potentilla type which may have been growing on or around the bog, sporadic Urtica and Artemisia and a continuous curve for Plantago lanceolata at 0.3%. Above 1078.5cm in RMU-2, herbs are more frequent in types represented and in the actual numbers of pollen grains counted: P. lanceolata in particular is increased, especially in the latter half of the subzone. Throughout RMU-2, assumed to record the main phase of clearance, Ulmus, Fraxinus and Tilia pollen are steadily reduced whilst Betula, Quercus, Alnus, Calluna and Pteridium generally fall, then rise to maxima, before falling again. Corylus fluctuates whilst experiencing a steady increase and Hedera is only sporadically recorded.

Within RMU-2 two main phases of land use may be discerned. The main Ulmus decline and ensuing Alnus fall is followed by a transitory peak of Betula suggestive of temporary colonisation by this taxon of newly cleared ground. The likely causes of the elm decline were discussed in section 9.3.2. and if its use as fodder was part of the reason then it may have been enhanced, with Tilia and Fraxinus, because the protein content of leaves is lower in open than in closed woodland (P. Evans 1975). Alnus is unpalatable (Iversen 1973) so its reduction as stated above, indicates its deliberate removal from around parts of the edge of the bog to simplify access to water.

During about the first third of RMU-2 the declining arboreal pollen probably reflects chiefly clearance for pasture, as suggested by the elevated herb levels. Cereal pollen was not recorded, although this does not negate the possibility of arable cultivation in the vicinity. In the second third of the zone increases in Quercus, Betula, Alnus, Calluna and to some extent Corylus with lower herbs suggest some expansion of wood and heathland over pasture. Finally, there seems to be an intensification of activity with clearance initially of hazel and later of other trees, with an increase of herbs, notably Plantago lanceolata and the recording of two cereal pollen grains. This suggests chiefly pastoral land use, but with some arable cultivation.

In the last, rather tentative subzone, RMU-3 there are some changes implying major woodland regeneration after a relaxation in land use intensity. However, in the absence of further counts from above 1040cm this must remain rather speculative, especially with regard to the raised P. lanceolata at 1040cm.

The duration of the main event, recorded in RMU-2, was between about 140 and 250 C-14 years, beginning at c.2980bc. Sphagnum spores are more numerous and Gramineae is reduced: at Ballynagilly (Pilcher and Smith 1979) this was interpreted as indicating a drying of the mire surface. This perhaps favours the adoption of the slower accumulation rate of 7.0yrs cm^{-1} and longer duration of 250 years. In summary, there were two main periods of clearance, separated by minor regeneration; the first may have been solely for pasture, the second included cultivation. Precise delineation of each is difficult, but they may have been of approximately equal duration, between 50 and 100 C-14 years. Iversen (1941) originally proposed that the main farming phase of the 'landnam' in Denmark lasted 50 to 100 years, but just before his death wrote that it probably had a minimum duration of at least 100 years (Simmons and Tooley 1981, 155-156); Sims (1973) calculated a figure of about 230 years for the clearance at Hockham Mere; and in Northern Ireland at three sites the events lasted 300 to 700 years with repeated clearances discernible at least at Ballynagilly (Pilcher et al. 1971; Pilcher and Smith 1979). These data may indeed attest to the appropriateness of the 250 year value at Rimsmoor.

The sequence of events in the classic model of Iversen (1941) was clearance - farming - regeneration but at least at British sites the evidence is more complex. Rimsmoor is not unique with its sequence of clearance - pasture - minor regeneration - pasture with arable - regeneration: at the three Irish sites, clearance and possibly arable farming - farming, possibly pastoral - regeneration (Pilcher et al. 1971); and at Llyn Mire, three main phases with arable more common in the first and third phases (Moore 1980). This illustrates the value of high resolution pollen analysis and the spatial variation in the Ulmus decline clearance phenomenon.

Iversen (1941) in his model was able to propose that even during the farming phase regeneration was underway, from the rising curves for Betula, Alnus and Corylus. At Rimsmoor the rise of Corylus and fluctuating *Betula* curves in particular suggest a similar situation and the the same is apparent at the Irish sites. The Rimsmoor evidence at least suggests variations in the ratio of the area being cleared to the area undergoing regeneration probably at a single location near to the bog, given the limited pollen source area. The time involved and the charcoal suggest some degree of sedentary land use rather than brief slash and burn. Charcoal is absent after the opening of the clearance phase (RMU-2) and various experiments have demonstrated how rapidly burnt areas lose their fertility (for example, the Draved experiment, Iversen 1956, 1973; Butser Hill, Reynolds 1977). Rowley-Conwy (1981) suggests that at the beginning of the Neolithic period the soils were at a peak of fertility and the addition of extra nutrients unnecessary. The incidence of cereal pollen at the end of the clearance phase, RMU-2, and in the absence of charcoal lends support to this contention. As an alternative, Rowley-Conwy invokes a long fallow system or permanent fields. This hypothesis is consistent with the evidence for clearances of several hundred years in length but is difficult to verify because in a pollen diagram a sequence of small clearances increasing in number, then declining over time will be indistinguishable from a single long term event. The small pollen catchment at Rimsmoor is in favour of Rowley-Conwy's hypothesis. Further support comes from Llyn Mire where during a second intensification of land use both woodland pollen and *Pteridium* spores are reduced: Moore (1980) suggests that bracken was being removed from formerly disturbed and abandoned ground, a form of rotation farming. Significantly at Rimsmoor at the start of the third phase Ericaceae and *Pteridium* also fall similarly suggesting a re-use of previously cleared areas and may thus attest to Rowley-Conwy's long fallow system. The incidence of charcoal argues against the use of fire as a mechanism for clearance: its initial abundance may relate to the burning of felled trees and undergrowth after drying (Iversen 1956), whilst later, in the presence of arable, the felled wood could have been valuable for fencing to prevent animals grazing the standing crop. The sporadic charcoal records after the start of RMU-2 may reflect domestic fires. The continuous record before, to initial clearance elsewhere, perhaps indicating that the Rimsmoor area was one of the last to be exploited in the region, an hypothesis not necessarily at variance with the lateness of the event.

To conclude, it appears from these factors that the actual extent of the open area at any one time in the vicinity was very limited and quite possibly was confined to the area surrounding Rimsmoor. The site itself may have been an important resource, as proposed for the Mesolithic (section 8.2.3.2.). The herbs at a maximum of only 3.9% tend to confirm this suggestion, although as Caseldine (1981) found, the herb totals recorded may be underrepresentative of the extent of the open area. How valid this may be cannot be ascertained because the small size of the site precludes the use of three-dimensional techniques as does the absence of any comparable site nearby.

9.3.4.3. KINGSWOOD

The third site, Kingswood, shows rather less significant changes in woodland composition at the level of the Ulmus decline. Ulmus, however, is reduced by over 5% whilst Corylus doubles in frequency, although the latter may relate simply to the proliferation of the taxon on the woodland edge. Herbs are minimal with only one recorded for the first time at this horizon, Liguliflorae; this contrasts with about eight at Rimsmoor and thirteen at Winchester. Other herbs present in low frequencies include Plantago lanceolata, Roseceae undiff, Artemisia and and Umbelliferae whilst Pteridium exhibits a transitory maximum. Cereal type pollen is not recorded.

The changes in tree pollen frequencies and the abundant charcoal indicate that clearance may have been widespread yet in this area the actual duration of farming was short. Precisely how short is difficult to determine because with the low accumulation rate of about 57yrs cm^{-1} and in spite of sampling at 2cm and 1cm intervals resolution of the event will have been low. It also occurs across the junction of two core segments. Comparison with Rimsmoor suggests nevertheless that the episode may have been even more restricted temporally and spatially. Interestingly, Alnus peaks just before the event, then falls, perhaps suggesting similar factors in operation at both sites. In considering Ulmus decline events with low non-arboreal pollen, Iversen proposes that this may indicate that only the smaller trees were removed and that cattle were grazed in the lighter forest, although the record of P. lanceolata suggests some open ground (Iversen 1973). A greater emphasis on forest grazing may explain the absence of cereal pollen, yet this need not mean that cultivation was not underway. However, in contrast to the other two sites, a possible indicator of cattle grazing, Trifolium repens (included in Trifolium type) (Iversen 1973) is not recorded, although again its absence need not indicate that the taxon was not present, nor that grazing was not taking place. Woodland itself was undoubtedly valuable in prehistory and in much of history for grazing, pannage, leaf litter, timber and hunting (Godwin 1975a) as indicated by, for example, isolated Neolithic axes (Bradley 1972) and antlers, ubiquitous at Neolithic sites (Simmons and Tooley 1981).

9.3.5. DISCUSSION: NEOLITHIC SOCIETY AND THE ULMUS DECLINE

What the Ulmus decline represents in terms of society in the early Neolithic is increasingly attracting attention (e.g. Bradley 1978a). As stated in section 9.3.1. the elm decline was visualised as the first indicator of Neolithic presence yet a study of radiocarbon dates appears to demonstrate the spread of activity from the Near East across Europe (Ammerman and Cavalli-Sfarza 1971): as Bradley (1978a) notes, this,

> "conflicts absolutely with the synchroneity of the elm decline" (p.7).

Ten Hove (1968) states it is unlikely that population suddenly increased at the elm decline, though it is conceivable that it crossed a threshold necessitating or stimulating the development of a new means of subsistence (Boserup 1965; Smith, P.E.L. 1972). As an alternative, the Malthusian view would suggest that this new economy could have permitted some population growth. The Boserup hypothesis is more in keeping with the archaeological evidence cited in section 9.3.1. for a slow build-up of population during the Earliest Neolithic which culminated in the Ulmus decline clearances. It is evident, as Bradley (1978a) states, that the elm decline may correspond

> "more closely with a period of intensified activity" (p.7).

For example, Bradley cites Sims (1973): at Hockham Mere Sims views the elm decline as a result of human activity, but evidence also for climatic change suggests that this and soil deterioration may have forced a "change from a nomadic existence to one where a stable community was built up" (Sims 1973, 235).

Thus the evidence suggests that the Ulmus decline clearance was a response to increased population and possibly changing environmental conditions. It could therefore occur at different times in different locations as governed by local factors, perhaps explaining the two different dates for the phenomenon recorded in this work. This naturally assumes that the radiocarbon ages are approximately true ages for the samples assayed: only further dates can confirm this contention.

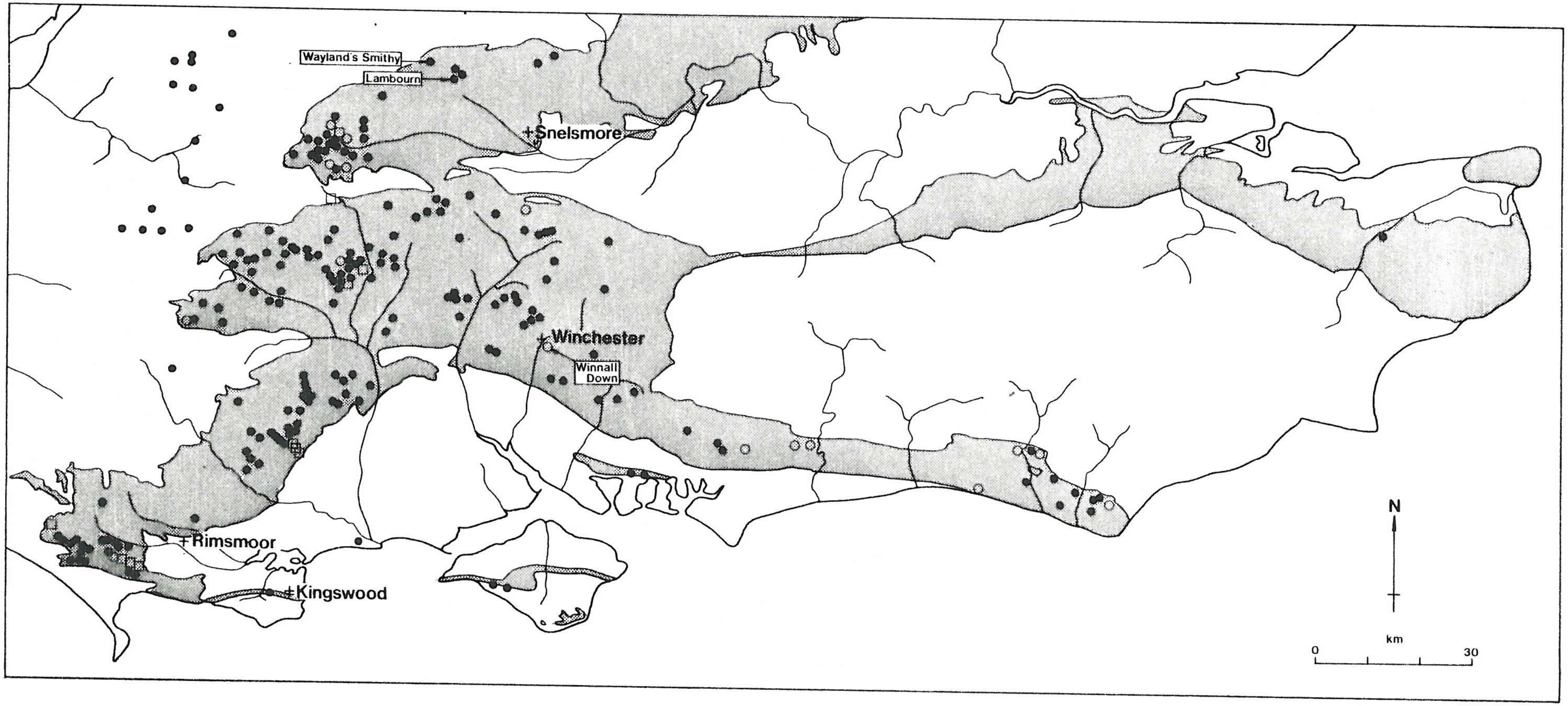
It was suggested in section 9.3.1.2. that the early date of the Earliest Neolithic and the Ulmus decline itself at Winchester was a result of its location in a major river valley in the south of the country, coupled perhaps with fertile, easily worked soils. If the high herb levels below the Ulmus decline do reflect clearances on dry land, rather than a proliferation of herbs on the flood plain, then this may indicate relatively intensive Earliest Neolithic land use, predisposing the Winchester area to an early crossing of the population threshold, as manifested by the recorded early Ulmus decline. Conversely, Rimsmoor and Kingswood show late dates for the event, particularly in relation to some Wiltshire monuments (e.g. Fussell's Lodge long barrow and Horslip long barrow; I.F. Smith 1974), which is perhaps consistent with the low level of Neolithic, pre-Ulmus decline activity indicated by the late C-2 pollen spectra at Rimsmoor. The causes may have been associated with soil conditions, especially in the Kingswood area, and locations at some distance from major rivers (Rimsmoor). Additionally, there is the pollen evidence from Winchester and mollusc and archaeological data from the Hampshire, Wiltshire and Dorset Downs (section 2.1.2.) as well as pollen evidence from the Poole Basin (Haskins 1978) and New Forest (Barber 1975, 1981b; A.R. Tilley pers.comm.). This body of data implies that there was considerable disforestation and utilisation of the chalk area whilst the Tertiaries were largely neglected. The more suitable soils (in relation to the level of technology) of the former may have led to a concentration of activity whilst the sandier, more fragile, soils of the Poole Basin and New Forest were avoided. This is perhaps borne out by the distribution of long barrows and causewayed-type enclosures. These principal monuments of the Early Neolithic, as well as the Late

Neolithic henges are mapped in Figure 9.2. Causewayed-type enclosures here include causewayed enclosures, interrupted ditch enclosures (Palmer 1976; Wilson 1975) and non-causewayed enclosures (Bedwin 1980). The clearances on the chalk may eventually have been insufficient for a growing population, or alternatively, soil deterioration and erosion (a Neolithic hillwash is recorded in the Devil's Kneadingtrough, Kent; Kerney et al. 1964; section 2.1.2.1.), necessitating a shift of population and area of exploitation into marginal areas, such as those in which Rimsmoor and Kingswood are located. Activity in these areas may then have slowly built up, culminating in the elm decline, or actually begun at that level; the pre-elm decline herbs and cereal pollen at Rimsmoor may in the latter case have been derived from extensive clearances on the chalk to the north. The archaeological evidence shows the construction of major monuments at around 3,000bc, including long barrows and causewayed enclosures (Fig 9.2), indicating social organisation, and possibly with the concomitant pressures on resources that might have stimulated wholesale population migrations. The late Ulmus decline at Morden B (2234±150bc, SRR-788) could reflect another later period of migration, although as Haskins (1978) acknowledges its lateness strongly implies a contaminated sample.

At Rimsmoor, the apparent initiation or increase of cultivation at the end of the clearance may indicate a continuing increase in the pressure on resources. At sites where the event is terminated after a century or so, there is thus an indication of a relaxation in pressure, and in this instance, presumably on the core area of the chalklands.

This concept of the Ulmus decline clearance being a result of population pressure provides an alternative explanation for Lynch's (1981) observations in south-west Ireland. As the event at Caselkeelty occurs at the end of a period of activity she favours a climatic or possibly an edaphic origin instead of an anthropogenic explanation. It is plausible that, as proposed above, the Ulmus decline clearance was an attempt by early Neolithic agriculturalists to alleviate pressure on resources, but for reasons such as, for example, the extreme maritime climate of the area, it failed. Consequently, the population either moved out of the region or went into a major recession from which it did not recover.

Perhaps slightly equivocal in this argument is the reason for groups



● Long barrow
○ Causewayed-type enclosure
□ Henge

Figure 9.2. Neolithic sites
Sources: Ashbee 1970; Fasham and Schadla-Hall 1981; Grinsell 1958; Palmer 1976; Richards 1978; I.F. Smith 1971; Wainwright and Longworth 1971; Wilson 1975

apparently, at least in southern England, to regress to an earlier mode of subsistence when obliged to move into marginal areas. This may be good evidence in favour of the fall in Ulmus pollen in particular to be a result of cattle stripping bark (Smith 1975) and browsing freely, rather than being tethered or stalled, with the rapidity of the fall at Rimsmoor explained by a sudden increase in the density of grazers. It could also testify to elm disease being transmitted directly or indirectly by man. Whatever the precise details, the general character of the clearances at Rimsmoor and Kingswood presumably reflect the most optimal land use at that time at a given population level, and may indicate that a major period of stress on the chalk occurred at around 3,000bc and lasted for only 150 to 250 years (the approximate duration of the episode at Rimsmoor).

Verification of this hypothesis must await the findings of other work in southern England and, in particular, the results of further radiocarbon assays.

9.4. POST ULMUS DECLINE: NEOLITHIC AND BRONZE AGE

The remainder of the Period, that is almost all of C-3, is considered systematically site by site, rather than via a two-fold Neolithic and Bronze Age division. This simplifies interpretation and conforms with an increasing body of opinion which suggest that the Neolithic-Bronze Age division is too precise; more natural socio-economic breaks appear to occur in the late Middle Neolithic and at the end of the Early Bronze Age (Bradley 1978a, 1979; Whittle 1978, 1980).

9.4.1. WINCHESTER: PERMANENT CLEARANCE

9.4.1.1. EARLY AND MIDDLE NEOLITHIC

Period C-3 is divisible into three parts at Winchester, zones WT-4, WT-5 and WT-6. WT-4 opens with the major clearance of the Ulmus decline and exhibits pastoral and arable farming. Towards the end of the zone cereal pollen is reduced whilst arboreal pollen is higher; it terminates at c.2560bc. Zone WT-5 begins with a decline in the pollen from woody species, which subsequently rise again, whilst herb values slowly fall and cereal pollen is not recorded. Finally, in WT-6 from c.1500bc-650bc arboreal pollen again falls at first, then rises, herbs are elevated and cereal pollen peaks at about 3% suggesting an abundance of arable cultivation in the pollen source area.

The equivocal nature of the chronology at Winchester was discussed in relation to the early date of the Ulmus decline (section 9.3.1.). A constant accumulation rate has been assumed for the period from the Ulmus decline (286cm) to the initiation of watermeadowing (84cm); in the absence of further assays this can neither be totally accepted nor rejected. Nevertheless, the interpolated dates, at least for C-3, show a degree of conformity with the archaeological record.

The pollen spectra of WT-4 are indicative of particularly open conditions. Considerable clearance of woodland occurred at the Ulmus decline and the low levels of the pioneers Betula and Fraxinus imply minimal regeneration at this time. The environment represented may be one where the woodland edge was pushed well back from the edge of the flood plain with the continuous exploitation of the cleared areas accounting for the high herb levels and low representation of the pioneer species. Continual utilisation of Tilia and Ulmus in the woodland may account for their low pollen representation. Alternatively, the dry land woody species pollen present, namely Quercus and Corylus, may represent isolated individuals or small copses in a totally open landscape. Which hypothesis is the more probable is difficult to ascertain from the pollen evidence alone but some mollusc data to be discussed later (Fasham 1980; section 9.4.1.4.) suggests at least the local survival of woodland.

In view of the foregoing discussion of the Ulmus decline, the new subsistence technology that the clearance presumably represents was apparently successful in this area of the chalk downs. Pastoral conditions with arable were established for over 1100 radiocarbon years and this is the period which coincides with the construction of long barrows and causewayed enclosures on the chalk (Fig 9.2.). These include a small enclosure with an interrupted ditch on Winnall Down and dating to between 2590 and 2930bc (Fasham 1978b). It was only when sufficient economic stability had been achieved that the social organisation and surplus required for the building of such earthworks was available (Bradley 1978a; Case 1969; Whittle 1980). Winchester provides an environmental manifestation of this phenomenon. Insofar as long barrow distributions show where human activity was concentrated, it is perhaps significant that the forty so far recorded are on the chalk and most are visible over comparatively large areas (Fasham and Schadla-Hall 1981). This is consistent with the open landscape suggested by the pollen evidence.

In the latter part of WT-4 there is some evidence for a reduction in activity with some expansion of, for example, Quercus, Betula, Ulmus, Corylus, Fagus and Prunus type and perhaps a reduction of both grassland and arable. The cause of this may be associated with events that culminated in the crossing of a threshold represented by the transition to WT-5.

9.4.1.2. MID-NEOLITHIC STANDSTILL AND SUBSEQUENT ADJUSTMENT

From the WT-4/WT-5 boundary (c.2560bc) the cereal pollen curve ceases, herbs are reduced and arboreal pollen briefly falls, then rises. The most marked feature of WT-5 is the absence of cereal pollen. There is increasing evidence from other areas for some reduction in the intensity of land use at this time: in the Somerset Levels, Beckett and Hibbert (1978) record a period of forest regeneration from 2350 to 2050bc and at a number of chalkland sites in Wiltshire there is some evidence for woodland regeneration from the middle of the third millennium (Evans 1972, 1975; Dimbleby and Evans 1974; see also Chapter 2) as well as on the Isle of Wight (Scaife 1980). J.G. Evans (1975) also notes how the archaeological record shows an increase in pig bones and 'chisel-ended' arrowheads, both associated more with woodland than with open conditions. Other changes in excavation finds similarly suggest a reduction in cultivation (Bradley 1978a) and the Late Neolithic Grooved Ware culture was traditionally viewed as practising a pastoral economy (M. Jones 1980). It should be mentioned that Edwards (1979) was rather less than convinced about the radiocarbon evidence for such a hiatus but at least the evidence from the sites in this thesis lends support to the hypothesis.

Reasons for a hiatus or 'standstill' at about 2500bc have been discussed by Bradley (1978a, 1979) and Whittle (1978, 1980). It seems most probable that the impetus of Early and Middle Neolithic activity could not be maintained, the economy and social organisation collapsed and consequently there were radical changes in subsistence, land use and ritual practices. Construction of, in particular, long barrows and causewayed enclosures ceased with a revival of such activity only towards the end of the Late Neolithic with henge building. Bradley (1978a) states it,

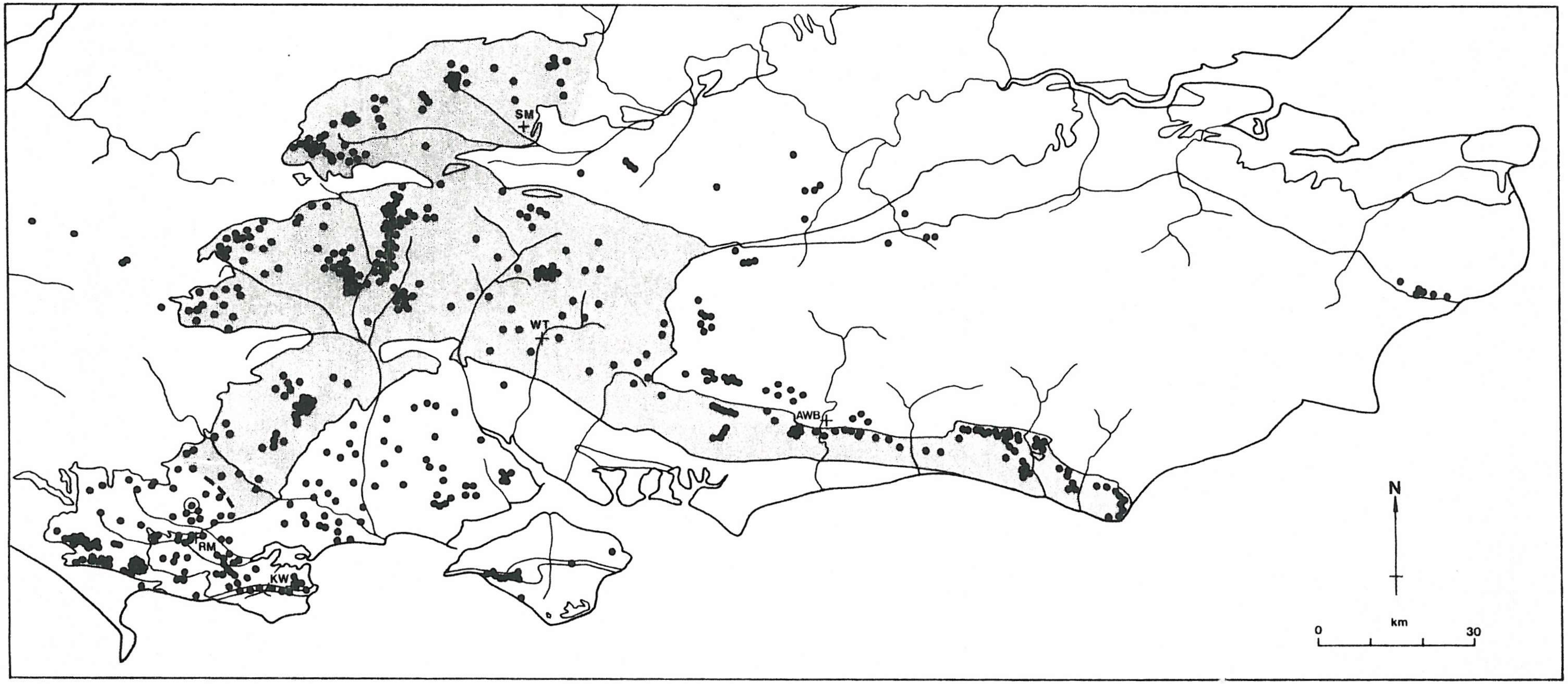
> "seems likely that the Neolithic expansion had temporarily outstripped the capacity of the system to support it" (p.106)

and there was a change from an intensive to a more extensive form of land use (Bradley 1978b).

At Winchester the WT-4/WT-5 boundary may represent a threshold: problems were developing in the preceding period, as perhaps shown by minor woodland regeneration, but only reached a critical stage at this time with a final reduction in cultivation. A swing towards more extensive uses may be indicated by some contraction of woodland and perhaps expansion of grassland, although the lower herb levels (especially Plantago lanceolata and Liguliflorae) may mitigate against the latter; local Phragmites growth could be inflating the Gramineae curve and obscuring the real changes occurring at this level. The absence of cereal pollen is unlikely to mean that cultivation was not practised. Recent work by M. Jones (1980) on the Grooved Ware culture has shown that they probably grew cereals and exploited woodland resources. Either the immediate area of the pollen catchment was little used for arable, or there was a return to the cultivation of small clearings in secondary woodland or scrub (A.M. ApSimon pers.comm.). In the latter alternative cereal pollen dispersal may have been limited by reduced wind speeds in the clearings and filtration of the pollen by the vegetation (Tauber 1965). In both cases the amount of cereal pollen in the pollen rain may have been too low to have been detected by the adopted pollen sum.

These conditions seem to have persisted to the end of the Early Bronze Age with some expansion of woody species, notably Quercus and Corylus. This is consistent with evidence from elsewhere as Whittle (1980), for example, proposes that his Later Neolithic terminates at the end of the conventional Early Bronze Age. Similarly, Bradley (1978b) notes how the late second millennium exhibits an increased exploitation of areas traditionally associated with the Bronze Age and that overall the trends which were started in the Neolithic were maintained in the subsequent period. The Hampshire chalklands differ to a certain extent from Dorset and Wiltshire in that, like the South Downs, henges are absent (Fig 9.2.). Fasham and Schadla-Hall (1981) suggest that this may indicate a less developed social and economic pattern than elsewhere in Wessex. Indeed, if long barrow densities reflect population densities, then the same may be true for the Early and Middle Neolithic in view of the greater numbers of mounds in parts of Dorset and Wiltshire.

Settlement evidence from the Winchester area is complementary: a recently excavated Beaker site produced evidence for mixed farming (A.M. ApSimon pers.comm.). Elsewhere the evidence for cultivation at this time is limited: several of J.G. Evans' snail analyses suggest soil disturbance, but this may have been associated solely with clearance for grassland (Ashbee et al. 1979; Fowler 1981). 'Celtic' fields however are widespread and attest to general cultivation (see below). Fasham and Schadla-Hall (1981) suggest that serious soil erosion on the more open and drier chalk downs may well have necessitated the widely observed expansion of the Early Bronze Age on to the present heathlands. This is portrayed especially well in Figure 9.3. by the distribution of Early Bronze Age round barrows, insofar as these reflect the location of activity. They show a proliferation in the New Forest and Poole Basin where the Neolithic influence may have been slight (cf Fig 9.2.). Transhumance could have been integral to the economy, as suggested by, most notably, Fleming (1971) in Dorset and Wiltshire and Drewett (1980) in the South Downs and, by implication, Bradley (1971) also in the South Downs and Bradley and Ellison (1975) in the Berkshire Downs. This may have involved an annual cycle of summer grazing on the high downs and winter grazing on, and manuring of, the stubble of arable fields in river valleys and possibly the present heathlands. Such hypotheses are not necessarily at variance with the Winchester pollen evidence, although cultivation clearly did not occur within the immediate area of flood plain because of its marshy nature.



●	Round barrow	WT	Winchester
◉	The Deverel Barrow	SM	Snelsmoore
----	Coomb's Ditch	AWB	Amberley
		RM	Rimsmoor
▒	Area with linear boundaries	KW	Kingswood

Figure 9.3. Bronze Age sites. The round barrow distribution is approximate, and, likewise, the area shown as hav.ing linear boundaries is generalised.
Sources: Bradley 1971; Bradley and Ellison 1975; Bowen 1978; Fasham and Schadla-Hall 1981; Grinsell 1958; Ordnance Survey maps

9.4.1.3. MIDDLE BRONZE AGE RECOVERY

The apparently less intensive land use of WT-5 terminates abruptly at an interpolated date of c.1500bc, the end of the Early Bronze Age, with clearance of Betula, Quercus and Corylus. The pollen of trees shrubs and Corylus then increases, with herb pollen, and from about 1070bc cereal pollen is again recorded to form a continuous curve at a maximum of 3%. Gramineae pollen is greatly reduced.

This probably indicates a general clearance of established oak wood and recently regenerated areas. The subsequent expansion of woodland is most readily interpreted in terms of, first, a change in farming towards arable and away from pasture within the pollen catchment area, and secondly, the difficulty of ploughing established grassland (Evans 1974). Tillage was probably conducted on areas which were formerly woodland whilst some of the grassland, perhaps on slopes, was abandoned to revert to scrub and woodland. Pteridium, the spores of which are greatest during the zone, may have formed a part of this succession. However, the overall validity of this scheme is problematical because of uncertainty over what was growing where within the pollen catchment and the influence of Phragmites in affecting the Gramineae and hence the other curves. It can only be a tentative model.

The creation of new habitats in and around arable fields may account for some of the elevated herbs, for example Plantago lanceolata, Liguliflorae and Rubiaceae, whilst others such as Bidens type, Cyperaceae and Cruciferae undiff may have been on the flood plain, favoured by the drier conditions indicated by the lower aquatics and pollen abundance and higher pollen degradation. The incidence of cereal pollen indicates that there was not simply a drying of the fen with general woodland regeneration on the downs. At this level pH fluctuates: after the Ulmus decline conditions of relative soil stability (see section 9.3.4.1.) are suggested by a constant value of about pH 7.2. The opening of WT-6 coincides with a fall to pH 7.0, presumably because of increased surface run-off after clearance and this is followed by a recovery to pH 7.2. This latter peak occurs at the beginning of the cereal pollen rise implying cultivation of more calcareous soils, or at a location down valley. The maximum of cereal pollen and minimum pH ensuing may relate to more general cultivation of formerly less calcareous woodland soils.

Zone WT-6 lasts from c.1500bc to c.650bc and suggests a major change in economy from WT-5. The frequency of cereal pollen at up to 3% implies, because of its tendency to be under-represented in pollen diagrams, that cultivation was an important feature in the pollen catchment. The record of Secale type pollen is notable and this is discussed in section 10.5.4. The Cannabis type pollen recorded at the beginning and end of the zone is probably derived from Humulus; Simmons (1964) also encountered this type in Bronze Age levels at Taw Head.

The change in economy appears to complement the archaeological evidence: the end of the Early Bronze Age is viewed as another major hiatus. Bradley (1979) sees it as a collapse even more dramatic than that during the Neolithic. By the Middle Bronze Age the construction of ceremonial monuments had ceased

> "and human effort seems to have been directed back almost entirely into intensive agriculture" (p.641)

There then ensued a major recovery with further colonisation, land organisation, the establishment of permanent settlements and, by 1000bc, there is considerable evidence for aggressive competition; the

> "ultimate basis of wealth now lay in the control of land" (Bradley 1979, 642)

This is reflected at Winchester from c.1500bc by increased grassland and, from c.1070bc, an expansion of arable.

A major feature of this period was the largescale surveying and division of the land, manifested by the construction of linear banks, often with ditches. They have been recorded in Dartmoor (Fleming 1979), Yorkshire (Manby 1979) and, in particular, on the chalk of Hampshire and Wiltshire (Bonney 1972; Bowen 1978), Berkshire (Bradley and Ellison 1975) and the South Downs (Bradley 1971). They were constructed from the Middle Bronze Age onwards and often over-ride pre-existing 'Celtic' fields. The general areas of the chalklands where they have been recorded is illustrated in Figure 9.3. Their function was probably to define territories in order to provide a better integration of arable and pasture. Territories as such have been proposed for Wessex in the Neolithic (the 'chiefdoms' of Renfrew 1973) and the Early Bronze Age (Fleming 1971) and these, conceivably, may have been the forerunners of the linear ditch system.

Increased clearance and agriculture was widespread in the Middle and Late Bronze Age as recorded, for example, in the Somerset Levels (Beckett and Hibbert 1978), Lake District (Pennington 1970) and Lower Severn-Avon valleys (Shotton 1978). On the chalk in Dorset the Middle Bronze Age hilltop settlement at Shearplace Hill (Rahtz 1962) suggests a shortage of land in the lower lying, less marginal areas (Taylor 1970). It was also a time of increased fortifications and weapons (Bradley 1978a).

Land division implies central organisation as this would be unlikely with a sparse rural population (Bradley 1972), whilst the other evidence indicates a clear increase of pressure on resources. An abrupt rise in population is, however, unlikely (eg. Fowler 1978); other factors were probably responsible with soil deterioration perhaps crucial. Bradley (1978a) proposes that the field systems which originated before this time were an attempt to overcome land wastage. Accumulations of colluvial deposits of this age have been recorded by Evans and Valentine (1974) and Kerney et al. (1964). In the later Bronze Age, Bradley suggests that colluviation may have been further damaging the soils and the division of land into distinct units which included a variety of terrain types was an activity to maintain food supply.

The present day shallow rendzinas of the chalk are probably truncated remnants of formerly deep brown forest soils. The process of soil deterioration and erosion consequent upon excessive cultivation has been discussed by J.G. Evans (1972), and Limbrey (1975) believes that human activity led to the development of sols lessivés in more clayey deposits and the loss of the eluvial horizons. Widespread deposits in dry valleys and the lynchets which define the 'Celtic' fields are direct evidence of soil movement. Valley deposits of Bronze Age and Iron Age date have been widely recorded from, for example, Wiltshire (Evans 1972), Buckinghamshire (Evans 1966), the North Downs (Kerney et al. 1964), the South Downs (Bell 1981a, 1981b) and possibly Hertfordshire (Sparks and Lewis 1957; Waton 1982a). As already mentioned, Fasham and Schadla-Hall (1981) suggest that soil deterioration may have been a factor in prompting the Early Bronze Age shift to the present heathlands whilst Taylor (1970) believes that the chalk may have been marginal land for much of prehistory (section 9.4.2.2.). The existence of deeper, less calcareous soils may explain the similarity to the rest of Britain of the pre-*Ulmus* decline forest at Winchester. Shallow rendzinas would have discouraged the Pinus component of the Boreal woodland because of its susceptibility to chlorosis (section 2.2.2.). As stated in section 7.3.2. the Atlantic soils however were probably more freely drained than elsewhere in Britain to judge from the presumed infrequency of Alnus off the flood plain.

Climate may have been an additional factor in this area. The deterioration that culminated in the middle of the first millennium bc was under way by the Middle Bronze Age (Barber 1982; section 10.2.). Fasham and Schadla-Hall (1981) state that the increase in wetness would be expected to have made the chalk more suitable for arable farming. The stratigraphic evidence from Winchester actually suggests a drying of the surface at this time, yet this could have been a result solely of locally changing channels.

The location of cultivation is difficult to ascertain from the pollen evidence alone. An as yet unpublished discovery of Deverel-Rimbury activity 300 to 400m west of the coring site and slightly earlier settlement to the north near Orams Arbour (A.M. ApSimon, pers.comm) imply cultivation of the valley sides. The former has an expected date of 1150-950bc which accords well with the rise of cereal pollen at 1070bc. The downland plateau was probably cultivated, although the evidence has been largely obliterated by ploughing over the last two centuries (K. Qualman and R. Winney, pers.comm.); linear ditches have been recorded (Bowen 1978) and there is a Deverel-Rimbury site on Winnall Down (Barrett and Bradley 1980; Fasham 1978b).

9.4.1.4. THE EXTENT OF OPEN CONDITIONS ON THE CHALK

The pollen data from Winchester imply that from the Early Neolithic onwards the pollen catchment area was extensively free from woodland. Those areas existing may have been confined either to the edge of the pollen catchment, on some hillslopes, as isolated copses or, indeed, as individual dispersed trees. The Jacobson and Bradshaw (1981) model may indicate that an area of 1 to 4km^2 or more of downland may be represented by the pollen catchment area.

Such a long period of open conditions is not exceptional within the chalk of Wessex. At Avebury, the henge was constructed in an area that had been primarily grassland for 500 years and the ditch sediments of South Street long barrow record essentially open conditions since its construction at about 2,800bc (Evans 1972). Elsewhere, in the North Downs of East Kent, Godwin (1962; section 2.1.1.1.) states that the downs were extensively cleared by the early Bronze Age and this is compatible with the mollusc work at the Devil's Kneadingtrough (Kerney et al. 1964). However, as discussed in section 2.1.4. there is mollusc and pollen evidence for scrub or woodland at various times over this period from Wiltshire, Berkshire and Sussex. Indeed, there is evidence for woodland in both the Neolithic and Bronze Age 5km to the north of Winchester (Bridget and Burntwood Farms: Fasham 1980). This might support the suggestion that some of the arboreal pollen recorded at Winchester was from actual woodland rather than from isolated trees or copses. The evidence from this site tends to support the earlier conclusion based on the published work (section 2.1.4.) that the chalk supported a mosaic of communities with open country predominant, but with scrub and woodland also significant. In the Winchester area woody vegetation, though present, was clearly less abundant than in other areas such as Knap Hill (Evans 1972) and at Bridget and Burntwood Farms. Overall, it is logical to propose that the amount of land under woodland would vary over time depending upon the requirement for more intensive land uses. A number of the prehistoric soils of Wiltshire appeared to have been buried as the area was falling into disuse (Dimbleby and Evans 1974) and this may reflect a relaxation of land use as a result of, for example, depleted soils, lower population or perhaps a change in the area of exploitation. However, the limited monuments of the Late Neolithic in Hampshire may imply a different social organisation (Fasham and Schadla-Hall 1981) and possibly a different landscape. Nevertheless, the Winchester data do not seem to differ greatly from the evidence from East Kent and Wiltshire.

The chalkland palaeoenvironment of this period has commonly been designated as permanently cleared (e.g. Evans 1975; Pennington 1974) along with, for examples, parts of the coastal plain of south-west Cumbria (Walker 1966) and the Brecklands (Godwin 1975a). From this arises the problem of defining permanent: if this is assumed to mean an area remaining totally free from woodland, then as such it is very difficult to prove palynologically. The closest to this ideal that the data allows would be perhaps that open conditions dominated the pollen catchment over the period under discussion, perhaps with tree pollen less than 50%, to adopt Tinsley and Smith's (1974) figure. By this definition the Winchester pollen data imply that within the pollen source area, itself an uncertain quantity, there was indeed permanent clearance, although some limited regeneration occurred. The rich fen vegetation alone cannot adequately account for the high herb pollen spectra.

In conclusion, it is apparent that open conditions have prevailed since the Early Neolithic in at least this central area of the Hampshire Downs.

9.4.2. SNELSMORE

Core SM 2 from the terrace at Snelsmore showed a markedly different sequence below 41cm than above. This hiatus was probably a result of turf cutting, an activity undertaken on the common until the 1960s (section 3.1.3.) and this readily explains the peat's present patchy distribution on the terrace. The unconformity was not readily discernible in the stratigraphy because of considerable root penetration from above. The spectra from 42cm downwards are clearly older than those of core SM 1. However, because the counts above about 50cm in SM 2 and below about 215cm in SM 1 show similar trends the two are presented as a single diagram. The low frequencies of _Ulmus_, _Tilia_ and _Quercus_ and abundant _Betula_ at the base of core SM 2 imply an immediate post-_Ulmus_ decline date. Application of these data to the time:depth curve (Fig 4.12.) produce an acceptable chronology (see below) if the interpolated _Ulmus_ decline is placed at 3,000bc. The resulting accumulation rate is about 30yrs cm^{-1}, not greatly different from the 26.6yrs cm^{-1} for the same period at Winchester and compatible with the well humified peat and very abundant pollen although the sequence is increasingly clay-rich downwards. The time gap between SM 2 42cm and SM 1 220cm is unknown but appears to be minimal from the correspondence of the pollen curves. Confirmation of the viability of this composite diagram is impossible without radiocarbon assaying of core SM 2, but this was prevented by severe rootlet contamination (section 4.2.2.).

9.4.2.1. TOTAL REGENERATION

Period C-3 at Snelsmore is divisible into four zones SM-1, SM-2, SM-3 and SM-4. SM-1 shows a major peak of *Betula* with *Corylus* also at a maximum whilst *Ulmus*, *Quercus*, *Tilia*, *Alnus* and *Fraxinus* are low, but increasing. Herbs and Gramineae are falling. This is suggestive of a regenerating forest with an initial prevalence of *Betula* being succeeded by members of the canopy forming taxa of mature forest. As already mentioned, the low *Tilia* and *Ulmus* imply that this is immediately post-*Ulmus* decline regeneration. The existence of open ground, albeit decreasing in area, is shown by the falling Gramineae and *Pteridium* and transitory records of Chenopodiaceae, *Trifolium* type, Rosaceae undiff, *Armeria* type, *Plantago lanceolata*, Rubiaceae and *Centaurea nigra* type.

The date of the *Ulmus* decline at this site has been placed at 3,000bc (at a postulated depth of 110cm), rather than perhaps 3500bc as could be inferred from the Lambourn barrow (3415±180bc GX-1178) and Winchester (3680±90bc HAR-4342) assays. It was suggested above (section 9.3.5.) that areas more suitable for exploitation by agricultural communities will have experienced early elm decline clearances whereas more marginal areas, perhaps in terms of soils (section 9.4.2.2.), may have experienced later clearance. This proposed date of 3,000bc is more consistent with the nature of the soils at Snelsmore and the evidence from Rimsmoor and Kingswood. The date may be incorrect but in the absence of an absolute chronology it is impossible to ascertain: it does however seem to provide a reasonable fit with the archaeological data.

By the proposed chronology SM-1 records the period from 2790 to 2520bc. From the trend of the spectra the main clearance itself may therefore have lasted less than 200 years and regeneration was complete within 500 years. The figure of 200 years is compatible with data from elsewhere, including Rimsmoor and Kingswood (section 9.3.4.) although the *Betula* peak of about 500 years is rather longer than at Rimsmoor (120 to 230 years) but of similar duration to that at the end of the Neolithic at Kingswood (about 400 years). Its apparent duration at Snelsmore may in part be a result of more rapid deposit (clay) accumulation and an erroneous chronology. The coincidence of decreasing *Betula* with falling herbs may also indicate a continuing exploitation of the area after the end of the assumed main clearance. Interestingly, the end of the zone falls at about 2520bc, the period of the mid-Neolithic 'standstill' (section 9.4.1.2.) when marginal areas, of which Snelsmore appears to be an example, may have been virtually abandoned. It should be added that although the size of the birch peak implies growth on the bog surface, the behaviour of the other curves indicate that drier areas were also affected by Betula growth.

Evidence for Neolithic activity on the Berkshire Downs is limited (Richards 1978). There are about six long barrows, but these are chiefly along the scarp crest to the north (Fig 9.2.). Flint scatters are less restricted in their distribution with one find of unspecified date located less than a kilometre north-east of the site. Richards notably mentions two possible working sites of early Neolithic date exploiting the Clay-with-flints and the paucity of Later (Middle and Late) Neolithic finds in the area. This attests to the presence of cultures in this area of the downs particularly in the Early Neolithic with perhaps reduced activity in the later part of the period, data not at variance with the pollen evidence.

In zone SM-2 Betula and Corylus continue to decline whilst Ulmus, Tilia and Fraxinus are at maxima, Quercus steadily increases and Gramineae and herbs are very low. This is essentially a continuation of the trends initiated in SM-1 with the development of forest dominated by Tilia and Ulmus with Quercus, Fraxinus and Corylus. The rapidly rising Alnus pollen in the centre of SM-2 coincides with a fall of Betula suggesting that some of the local growth of birch on the bog surface was replaced by alder.

The cause of the early peak of elm pollen may be anthropogenic, reflecting renewed exploitation of the tree after an initial relaxation in this activity after the Ulmus decline clearance. Soil deterioration is an unlikely alternative explanation because Tilia and Fraxinus are not similarly affected whilst the Ericaceae are low. Throughout this period human activity was clearly at a low level: this corresponds well with the same period at Winchester when activity was lower than in the preceding and succeeding zones. The fall of Betula, rise of Alnus and peak of Fraxinus at 78cm has an interpolated date of c.2030bc, about the time when numerous round barrows would have been constructed on the Berkshire Downs (Figure 9.3.). Most of these are to the north-west although there were some in this area (Richards 1978). Charcoal is also fairly abundant. It is plausible that Early Bronze Age groups had some influence on the Snelsmore area but its precise form is difficult to assess from this single core. Selective exploitation and possibly changing water levels may account for some of the variations at this level.

Zone SM-3 is characterised by Quercus pollen at a maximum and indicates a forest canopy dominated by Quercus with Tilia and perhaps also Ilex (Scaife 1980). Alnus was probably prevalent at the site. Ulmus and Fraxinus were very much less common than in SM-2 and likewise Tilia: it falls at the opening of the zone. The zone records the period from about 1550 to 920bc and again these changes may be anthropogenic in origin: if so, then this could correspond with the Bronze Age hiatus and subsequent recovery recorded at Winchester (section 9.4.1.3.). Some selective exploitation, forest grazing or clearance of better soils might be indicated by the low Ulmus, Tilia and Fraxinus. The very low Gramineae and herb levels denote the existence of little open ground at this time within the pollen catchment area, yet slight increases of Plantago lanceolata, Chenopodiaceae, Rosaceae undiff and Pteridium may indicate a limited opening of the forest canopy. Hedera is reduced, either suggesting a loss of forest habitat or perhaps its exploitation for fodder (Troels-Smith 1960). Reduced Filicales may in part relate to loss of habitat, but also to improved conditions of preservation. The proliferation of Ilex may have been a result of woodland disturbance allowing its more general establishment or increased flowering after a reduction of shade. Charcoal is more abundant, but the reduced Corylus may suggest that fire was not used as a method of clearance: rather it represents either camp fires or charcoal blown in from outside the pollen source area.

Finally, Zone SM-4 shows fairly marked clearance of Quercus, Ulmus, Tilia, Alnus and Corylus although as the total of tree, and Corylus pollen does not fall below 65%, predominantly woodland conditions prevail (Tinsley and Smith 1974). Gramineae and herbs are raised with Ononis type, Stachys type, Campanulaceae, Spergularia type, Poterium sanguisorba and Anthemis type recorded for the first time. Within the cleared area grassland was dominant although two cereal pollen grains at the beginning of the clearance indicate some arable activity in the vicinity. The major phase of disforestation extends over about 6cm, about 180 C-14 years and thereafter woodland slowly regenerated with Betula and Pteridium in particular colonising abandoned areas. Removal of Alnus from on or around the bog permitted the establishment of Salix.

This clearance was probably around the bog itself as the pollen catchment area is small (section 4.2.2.), the peat is sandy in nature (Table 4.2.) and it seems to have resulted in the initiation of the accumulation of the main bog. It is difficult to determine when the channel incision occurred that created the 'valley' in which the main bog is located. Perhaps the most reasonable date was at about the time of the 900bc clearance. If disforestation was initially underway up-valley, then this could have provided the increased discharge required for incision. Only subsequently was the area around the present bog cleared and thus the event was actually recorded in the sequence. Such changing hydrological conditions could also explain the 41cm hiatus in core SM 2, although, as stated in section 9.4.2., this might simply be a result of peat cutting (section 3.1.3.).

Zone SM-4 lasts from about 920bc to 410bc and presumably records, therefore, the Late Bronze Age economic recovery gaining in momentum with an increased exploitation of marginal areas. As elsewhere in the chalklands, the archaeological record for the Later (Middle and Late) Bronze Age shows a marked increase in activity. This is shown particularly by field systems (Fig 9.3.) and general land organisation, although again these are concentrated to the north-west of the area (Bradley and Ellison 1975; Bradley and Richards 1978; Richards 1978). The Snelsmore region shows only a few remains of the period, illustrating the continuing avoidance of this area for the more intensive land uses. The pollen evidence is consistent with the archaeological evidence.

9.4.2.2. SOILS AND LAND USE

Throughout most of C-3 at Snelsmore tree, shrub and Corylus pollen is very high at about 95% whilst Gramineae and herbs are correspondingly low. This indicates essentially closed woodland during both the Neolithic and Bronze Age which contrasts markedly with the data from Winchester (section 9.4.1.). Nevertheless, comparisons of the two sites are hindered, because, whilst the Winchester sequence may represent several square kilometres of downland, the pollen from core SM 2 at Snelsmore may have been derived from within only 20 to 30m (section 4.2.2.). It is therefore unjustified to project this latter environment to the rest of the Berkshire Downs; even in the essentially open landscape around Winchester there was at least one wooded area (Fasham 1980). However, the low density of remains in the Snelsmore region of Berkshire implies a generally low level of exploitation. This indicates that the conditions recorded at the site may have been more widespread and not simply confined to the valley. The soils of this area of the Berkshire Downs may have been responsible for the difference: clay soils developed on Clay-with-flints and Tertiary strata are widespread and there are also patches of sandy soils overlying Plateau Gravel.

Soils could have exerted an influence in two ways. Firstly, heavy soils may be conducive to the development of dense vegetation which is harder to clear whilst sandy soils could favour light vegetation. Mellars and Reinhardt (1978) discussed this with reference to Mesolithic activity but as was mentioned in section 8.2.3. such soil vegetation relationships are not straightforward. Furthermore, clearance of vegetation on the heavier soils may indeed have occurred as suggested by the post-Ulmus decline regeneration, although this simply might indicate clearance of lighter woodland on the Plateau Gravel. A more satisfactory explanation is the second possibility, the nature of the soils themselves. The clays would have been harder to cultivate whilst these and the sandy soils in the area would have been base-deficient and thus unsuitable for prolonged agricultural use (G.W. Dimbleby, pers.comm.). The soils on the chalk would be expected, therefore, to have experienced a greater intensity of use.

As mentioned above, archaeological remains are relatively sparse in this area, which would accord with this hypothesis. Richards (1978) indeed frequently notes an apparent avoidance of at least the heavier soils of the Berkshire Downs throughout prehistory. Yet, as he admits, many of these areas are well wooded and therefore less suitable for fieldwalking or investigation using aerial photographs. This nevertheless need not be the total explanation for the Hampshire long barrows tend not normally to

"lie close to Clay-with-flints deposits"
(Fasham and Schadla-Hall 1981, 27)

and Fasham's (1980) wooded site north of Winchester is partly on Clay-with-flints. Similarly, at Black Down in Dorset (Thompson and Ashbee 1957; section 2.1.1.2.) woodland is recorded on Bagshot Sands before and during the Early Bronze Age and at New Buildings on Clay-with-flints, the Wansdyke (H.S. Green 1971; section 2.1.1.2.) was constructed in an area of woodland that had experienced only brief cultivation.

However, this hypothesis is subject to a major problem: it is not known how reliably the present distribution of deposits reflects their former extent. At Winchester, for example, the longer period of farming would have been more conducive to soil losses. Alternatively, such deposits may originally have been absent, or were very much thinner than elsewhere. The resolution of this circular argument is difficult; on intuitive grounds, given the limited efficiency of early methods of soil tillage, it is logical to speculate that areas of the Hampshire Downs, and perhaps the Dorset and Wiltshire Downs (from the density of finds), were more favoured for agriculture because of the scarcity of heavy and base-deficient soils.

The situation, however, is not so straightforward as Bell (1981a,b) found that some of the longest and most intense occupation in the South Downs was in areas with Clay-with-flints. Similarly, in east Kent, where this deposit is common, Godwin (1962) describes extensive clearance of the downs by the Early Bronze Age. For his sites in the South Downs, Bell states that one important factor may have been loess overlying the clays and in east Kent a similar explanation seems readily acceptable from observation of the Geological Survey maps (see also Smart et al. 1966). The amelioratory effects of loess on soils have been discussed by Catt (1978) and he presents a distribution map of loess deposits over 30cm in depth at the present day. It is noteworthy that the Berkshire Downs in the region of Snelsmore appear not to have such deposits whilst much of the rest of the chalklands (including, incidentally, Fasham's (1980) sites) still retain detectable quantities. It is assumed by Catt that there was,

"an originally ubiquitous loess cover, probably 1.4m thick, south of the Late Devensian glacial limit"
(Catt 1978, 18)

and its present patchy distribution is the result of natural processes in the Late Devensian and early postglacial, and late-postglacial erosion caused by agriculture. Loess is very susceptible to erosion unless protected by vegetation and this may have been hastened by the introduction of winter wheat in the Iron Age (Limbrey 1978). Indeed, as Limbrey states,

> "if loessic soils were used preferentially because of their initially good cultivation, nutrient, and moisture characteristics, they will have suffered drastic erosion as clay eluviation developed and their structure failed" (p.23).

It is tempting to speculate that significant loess removal had occurred in this area of Berkshire prior to the mid-postglacial (cf Waton 1982b). There is, however, no obvious reason why this should have happened: perhaps a more plausible explanation is that use of such areas of heavy or base-deficient soils, even if 'ameliorated' by loess, may have depended upon the general accessibility of more suitable agricultural land in relation to technology and population pressure. Thus in Berkshire and at Fasham's (1980) sites adequate land was available elsewhere, perhaps in the valley bottoms, not to necessitate exploitation of the sampled areas. In the South Downs population pressure, for example, may have been sufficient in certain areas to necessitate the cultivation of inherently heavier soils. The construction elsewhere of Neolithic enclosures in wooded areas (section 2.1.2.1.) without, at least today, Clay-with-flints deposits, may indicate locally low population density at that time. Likewise in the North Downs, where loess appears to be a widespread deposit, late clearance may be indicated by the analyses from Cudham and Keston (Kerney and Carreck 1954; Dimbleby 1962; sections 2.1.2.1. and 2.1.2.2.) and Lower Halstow (Erdtman, cited in Thorley 1971a; section 2.1.1.2.). Complementary evidence may be provided by the scarcity of Neolithic and Bronze Age monuments, although this is also apparent in East Kent where clearance had occurred by the Early Bronze Age (Godwin 1962; section 2.1.1.1.; Figs 9.2 and 9.3). This latter indicates how equivocal archaeological distribution maps can be, as discussed in section 3.7. Overall, however, these data again illustrate the importance of socio-economic factors in over-riding edaphic considerations.

Some other socio-economic factors may similarly have exerted an influence (K.E. Barber, pers.comm.). For example, the high level chalk plateaux of Wiltshire and Hampshire may have been preferred for settlement instead of the dissected landscape of the Snelsmore area of Berkshire. Alternatively the latter may have been less accessible for and from rivers, or less suitable for astronomical purposes in contrast to, for example, Stonehenge and its environs. These are, however, very difficult to quantify.

9.4.2.3. SNELSMORE: CONCLUSION

At Snelsmore the Neolithic and Bronze Age were dominated by woodland conditions. The paucity of archaeological remains suggests that this vegetation was widespread in the area and not confined solely to the valley, the pollen source area. As early as 1945 J.G.D. Clark noted that the Neolithic cultures would not have shunned the forests and that they would have been vital to the economy. This would have been especially relevant in the chalklands which apparently were extensively cleared for arable and pasture: forests will have provided timber, fuel, grazing, pannage and hunting. In general woodland may have been confined to areas of heavy or base-deficient soils, as at Snelsmore and Black Down in Dorset (Thompson and Ashbee 1957; section 2.1.1.2.) and, for example, areas of steeper slopes (Bradley 1971; Bradley and Ellison 1975; section 9.4.1.4.). This distribution will have been modified by factors such as population pressure and the availability of suitable agricultural land.

9.4.3. RIMSMOOR

The three remaining sites, Rimsmoor, Kingswood and Amberley show sequences characterised by a degree of exploitation that is intermediate between Winchester and Snelsmore. How this relates to chalkland conditions is difficult to assess because of the peripheral nature of the sites; in the following discussion comparison with the archaeology of the chalk is drawn where appropriate.

9.4.3.1. NEOLITHIC

The transitory peaks of <u>Betula</u> and <u>Corylus</u> at the <u>Ulmus</u> decline are followed in the main core, RM 1, by lower and fluctuating levels of <u>Betula</u>, reduced Ulmus, Quercus, Tilia and Fraxinus but very high Corylus at 55 to 70%. Gramineae and herbs are low at 10% or less. This suggests minimal open ground around the site, a situation persisting throughout RM-3 to the Tilia decline clearance at 1870±80bc (HAR-3921). Regeneration after the Ulmus decline may therefore have been total.

The high Corylus that characterises this zone may conceivably indicate a period of woodland management, such as hazel coppice with oak standards. Iversen (1973) notes that Corylus pollen is frequently high at this time and might have been managed for its nuts. At Ballynagilly, Pilcher and Smith (1979) from pollen evidence also speculate that management of coppice-with-standards may have been occurring in the Late Neolithic and Middle Bronze Age. Turner (1964b, 1965) at Whixall Moss in Shropshire similarly proposes that hazel was being coppiced in the Iron Age. The most unequivocal evidence comes from the Somerset Levels. Clapham and Godwin first proposed in 1948 that this was taking place and more recent evidence has confirmed the hypothesis (Coles 1978; Godwin 1960; Godwin 1975a). The pollen spectra indicate two main periods, the Early Neolithic and the Late Bronze Age and this is supported by finds of coppiced timber in the trackways crossing the Levels.

For Corylus to flower as prolifically as suggested by the high pollen levels at Rimsmoor it must have been present in unshaded situations. Growth of taller, shade-casting trees such as Quercus would be expected to exert a deleterious effect on Corylus even if it was present around the edge of Rimsmoor. It would tend to be out-competed whilst any remaining Corylus may have flowered minimally because overhanging branches from Quercus, for example, might greatly reduce the effective open diameter of the basin, which at the time had a surface perhaps 15m across. This may have prevented the establishment of a similar belt prior to the Ulmus decline. Low charcoal also indicates that this high Corylus is not a 'fire climax' (Rawitscher 1945; section 8.2.2.).

Maintenance of the relatively constant conditions of RM-3, including the high Corylus pollen, may thus plausibly indicate woodland management. It is notable how the Quercus pollen curve fluctuates regularly, rising for 10 to 30cm (40 to 115 C-14 years) and falling over a similar period; the Ulmus curve approximately follows this cycle. At Ballynagilly, Pilcher and Smith (1979) record Quercus rising over 40 to 60 years and falling in less than 20 years. At Rimsmoor, there is some suggestion of a negative relationship between Corylus and Quercus. If Quercus was being cut on a 40 to 100 year cycle then corresponding fluctuations in the flowering of the coppice layer might be expected with the variation in shade intensity. If this was indeed a system of hazel coppice with oak standards, then the coppice would have been cut on a 10 to 15 year cycle (Tansley 1949), with flowering affected accordingly. This is not discernible in the diagram because, first, the 10cm sampling interval only gives a 40 to 80 year resolution, and secondly, the pollen source area may have included several different sections of the woodland being coppiced at different times; thus only major fluctuations caused by removal of standards may be discernible.

Furthermore, if the chalk was as extensively open as the density of archaeological finds imply then the peripheral zone might have been especially important. The significance of woodland was discussed in section 9.4.2.3. and it is notable that clay and sand deposits are fewer on the Dorset chalk. This may have encouraged a denser settlement of the peripheral geologies for, in particular, woodland resources.

One major factor, however, argues against the hypothesis. This situation prevails throughout the latter part of the Neolithic, about 900 radiocarbon years, and fails to show any significant reduction in activity at about 2,500bc (the mid-Neolithic hiatus). It is difficult to envisage a peripheral area retaining its importance as a woodland resource if areas of the chalk itself may have been experiencing regeneration, assuming that this hypothesised standstill was widespread in its occurrence. The herbs recorded provide additional evidence. Tansley (1949, 311) lists a number of common herbs of recently coppiced areas and of these only Hypericum humifusum, Lysimachia nemorum, Lamiastrum galeobdolon (Spergularia type) and Rubus fruticosus (Rosaceae undiff) may be recorded. Whilst the absence of the other species may relate solely to their poor pollen dispersal, it is notable that all are common in woods generally and not necessarily diagnostic of coppice. Melampyrum, another woodland taxon, is recorded, whilst Plantago lanceolata, Rumex, Artemisia, Chenopodiaceae, Campanulaceae, Ranunculus type and Pteridium may suggest the existence of some open areas, but possibly restricted to the sides of the depression. The abundance of

Corylus could therefore indicate its presence solely around the edge of the basin. Its persistence may reflect one, or a combination of, the following:

1. the consistently unstable slopes of the depression preventing colonisation by, for example, Quercus;
2. the crossing of a shade threshold with the increasing size of the basin, permitting the flowering of a hazel belt, in contrast to the period before the Ulmus decline (this event may itself have assisted in the establishment of the community); and
3. human activity at a low level maintaining some parts of the basin sides free from woodland (perhaps for ease of access for watering) and so providing a permanent, if dynamic, niche for Corylus.

The fluctuations of Corylus and Quercus may thus reflect the statistical interrelationship of the curves, and variation in human activity and in the instability of the basin sides. Woodland dominated by Quercus and Tilia with Ulmus may thus have been prevalent beyond a Corylus belt. Corylus however will doubtlessly have also been present within the woodland in, for example, natural glades and minor clearings. The contemporary woodland recorded at Litton Cheney (Sidaway 1963; see section 2.1.1.1. for re-interpretation) and from under the Chick's Hill barrow in the Poole Basin (Dimbleby 1962) may support this model, although at both the Tilia and Corylus frequencies could have been inflated by poor conditions of preservation.

It is, therefore, very difficult to justify the hypothesis that a system of coppice-with-standards was being managed around Rimsmoor during RM-3. The spectra are readily explained by other factors. Nevertheless, it cannot be totally discounted; one centimetre interval counts may help to resolve this issue.

9.4.3.2. EARLY BRONZE AGE AND THE TILIA DECLINE

From about 900cm, c.2200bc, some disturbance is detectable. Quercus and Ulmus pollen are reduced, Corylus and Alnus are raised and Sphagnum, which tends to increase at Rimsmoor during clearance, is also higher. Herbs and Gramineae are unchanged. This may indicate some removal of oak and elm and replacement by hazel and alder and perhaps open ground.

This gains momentum at about 800cm with a minor but distinct clearance, similar in nature to that at the level of the Ulmus decline. A separate core, RM TD, was close counted and, like the Ulmus decline, shows that the event was complex.

In RM TD Quercus, Ulmus and Fraxinus fluctuate between 843cm and 815cm (subzone RMT-2) and contemporaneously Betula rises and Corylus falls. Gramineae also rises whilst herbs peak, especially Melampyrum and Plantago lanceolata, with Pteridium. Two cereal type pollen grains are recorded at the beginning of the zone with a peak of Hydrocotyle. A clay inwash occurs for 3cm immediately afterwards which coincides with a Calluna maximum and is followed by elevated Sphagnum.

Subzone RMT-2 suggests removal of Corylus in particular with Quercus, Ulmus, Tilia and Fraxinus also affected, whilst Betula and Pteridium may have been colonising abandoned areas. The area cleared was again very limited in extent, affecting only a part of the pollen source area. Pasture was predominant but some cultivation was underway initially: this could have ceased because of soil erosion. The inwash may also indicate that tillage was practised near to the site, perhaps around its edge, though it is conceivable that a surface stream carried the sediment in from a distance. The contemporary Calluna peak may represent colonisation of formerly arable areas, or surface water flow through Calluna vegetation (Roberts et al. 1973) around the depression slopes.

The behaviour of Tilia during RMT-2 is unique. It fluctuates, then falls between samples at the centre of the zone and at the top of the clay inwash. The position of this fall implies that its cause is related to the shift from arable to pasture. The duration of the fall may have been more than the maximum of four years implied by the accumulation rate, because the pollen may have been favoured by conditions within the clay less conducive to preservation and the accumulation rate itself may have been slower (see Ulmus decline, section 9.3.4.2.). The Tilia decline phenomenon is discussed in detail in section 10.3.

From 815 to 805cm, RMT-3, there is an increase of Quercus, Fraxinus and Corylus pollen, a peak of Betula and reduced Gramineae and herbs. This indicates woodland regeneration, yet the persistence of the Plantago lanceolata and Pteridium indicates that some open areas remained. Ulmus is reduced and Tilia is absent suggesting collection for fodder or preferential grazing.

Renewed activity is recorded in RMT-4 from 805cm with clearance of Betula, Quercus, Alnus, Fraxinus and Corylus, an expansion of Gramineae, Plantago lanceolata, Artemisia and Pteridium. Sphagnum again is increased. Two cereal type pollen grains are recorded and there is a slight increase of Pinus, Ulmus, Tilia and Fagus. The raised Pinus and Fagus may reflect increased dispersion (see section 10.6.2.) whilst the higher Ulmus and Tilia, a reduction in the importance of (woodland) grazing. Regrettably the core fails to record the end of this second clearance.

The duration of the main event, RMT-2 was of a minimum of 110 C-14 years, as far as can be judged from the mean accumulation rate of 3.84yrs cm^{-1}. If it was indeed of about this length and thus shorter than the 140 to 250 years calculated for the equivalent (RMU-2) at the Ulmus decline, then this may have been a result of soil loss as modified by socio-economic considerations. The regeneration of RMT-3 lasted a minimum of about 40 years and after this cereal cultivation was reintroduced within about 10 years of renewed clearance. The behaviour of charcoal is different from that recorded at the Ulmus decline: it is only present during the main clearance, RMT-2, presumably relating to different practices. Falling Corylus suggests that it was not used actually as a means of clearance but may simply reflect local camp fires or burning of cut wood. Much of the discussion concerning the extent of the Ulmus decline clearance is relevant here: whether only one area was cleared or the pollen represents an increasing then declining number of openings is difficult to assess from these data alone, although the former is favoured by the small pollen catchment, the clay inwash and the likely attraction of Rimsmoor as a source of water.

Correlation of the events in the two cores is hindered by their differing sampling intervals, differing locations in the bog (section 4.4.2.) and the core segment junction in RM 1. It suggests, nevertheless, that the duration of the second event may have been in the order of a minimum of 50 years. The radiocarbon sample was from material below the clay inwash (1870$\pm$80bc HAR-3921) which, when applied to the minimal values for the duration of the event, indicates that RMT-2 opened at 1860bc and the second clearance was over by about 1670bc. Chronologically, this is

Early Bronze Age and evidence for activity in the area at this time is shown particularly by numerous round barrows (Fig 9.3.). These are located both on and off the chalk and the nearest recorded are 300m to the north implying that the groups who constructed the barrows also created the clearance recorded at Rimsmoor.

Interestingly, Dimbleby has pollen analysed the buried soil beneath a barrow 2km to the south-east (Piggott and Dimbleby 1953). This showed that the woodland had been largely cleared and that heather was taking over from thickets of hazel scrub. Several other barrows in the Poole Basin showed results (see Haskins 1978, 164) similar and consistent with Haskins' data from peat deposits. This is markedly different from the Rimsmoor data where woodland prevails. Soils provide the most likely explanation for the difference: the clays around Rimsmoor will have been more resistent to degradation than the sands of much of the Poole Basin. Haskins (1978) suggests that because of soil deterioration the latter will have supported a lighter, more open vegetation and this would have been easier to clear. These brittle environments (Dimbleby 1976) would thus have been less subject to forest regeneration under a given intensity of, for example, grazing, than more clayey soils. With the reduction in activity around Rimsmoor regeneration would therefore tend to be more rapid and more complete.

The cause of the phenomenon presumably relates to increased population pressure (Fleming 1971; Jarmen and Bay-Petersen 1976) through such factors as the immigration of the Beaker cultures (Megaw and Simpson 1979) and possibly soil deterioration on the chalk (Fasham and Schadla-Hall 1981). The immediate crisis was evidently overcome, at least in the Rimsmoor area, as indicated by the subsequent reduction in activity. Withdrawal, however, was not total for in RM-4 whilst Quercus and Corylus attain their former abundance, Gramineae, various herbs, Pteridium and Calluna are greater than in RM-3. More open conditions are indicated, perhaps maintained by grazing as the absence of cereal pollen implies minimal cultivation. Whether this reflects open woodland or a mosaic of clearings and forest cannot be ascertained from these data alone.

9.4.3.3. MIDDLE AND LATE BRONZE AGE EXTENSIVE CLEARANCE

From about 600cm, c.1070bc, another clearance is apparent, but considerably more extensive than before. However, like the earlier episode changes are discernible in the pollen curves at the end of the preceding zone. These begin at about 620cm, 1130bc with falling Corylus and rising Gramineae and herbs. It gathers momentum from about 1170bc with Corylus further reduced and Quercus and Alnus pollen also falling and charcoal raised. Gramineae pollen rises dramatically and herbs, including Rumex, Artemisia and Plantago lanceolata are also increased. Pteridium is doubled in frequency and cereal pollen is recorded.

This evidence suggests that the areas first cleared were those overgrown with Corylus, perhaps indicating initially a pushing back of woodland margins. Subsequently, activity was greatly increased and there was removal of dry oakwoods, areas of Alnus and further Corylus. A small reduction in Calluna may reflect heathland reclamation and the rise of grasses and herbs show a marked expansion of pastoral farming with limited cereal cultivation, at least in the area around Rimsmoor. Tree, shrub and Corylus pollen total 25% and indicates predominantly open conditions within the pollen source area (Tinsley and Smith 1974).

Extensive disforestation is also indicated by changes in the bog flora. Potamogeton in particular rises from zero to a peak of 35% indicating that the bog surface became markedly wetter at this time, presumably from increased surface run-off. This presumably raised the nutrient status of the mire, favouring Cyperaceae and Hydrocotyle, both of which also were more abundant at the level of the Tilia decline. Sphagnum proliferated. In view of these changes it is possible that the reduction in Calluna represents in part at least a loss of habitat on the bog surface because of increased surface wetness.

The intensity of activity appears to have slowed down from about 590cm, c.1010bc with the time of maximum clearance in the local area at about 570cm, c.940bc. The main period of disforestation therefore lasted c.20 C-14 years with further removal occurring over the ensuing 50 years. This is based on the mean accumulation rate of 3.84yrs cm^{-1}, a minimum value because of the postulated increased wetness of the bog at this time. From about 560cm, c.900bc to 550cm, c.870bc there is a brief phase of regeneration of Quercus, Corylus and Alnus. Then there is renewed clearance which reaches a maximum at about 510cm, c.700bc with Quercus and Corylus most affected and cereal pollen indicating cultivation at this time. Finally there follows a phase of regeneration which persists until the end of RM-5. During this period open areas characterised by grassland and Pteridium were colonised by Corylus, Betula and Quercus in particular and possibly Calluna heathland. Some of the rise of Calluna may also be accounted for by colonisation of the bog surface which may have become drier at this time: Sphagnum is reduced, aquatics are not recorded and ericaceous remains are present in the peat. Tree, shrub and Corylus pollen total about 75% indicating predominantly wooded conditions yet Plantago lanceolata, Liguliflorae, Rumex and other herbs and some cereal pollen indicate the persistence of some open areas in the pollen catchment.

At 470cm the curves are depressed by exceptionally abundant Melampyrum, which coincides with a peak of Hypericum. As discussed in section 8.2.1. this clearly relates to temporary colonisation of the surface of the bog or its margin.

The major clearance opening zone RM-5 corresponds with the recovery of the end of the Middle Bronze Age discussed in section 9.4.1.2. It is curious that the linear ditch system, perhaps largely originating in this period, is not recorded west of Coomb's Ditch (Bowen 1978), located 9km north-east of Rimsmoor. This may indicate a different social organisation in this area but the clearance recorded shows that there was a shortage of land at this time. Coomb's Ditch itself is a defensive earthwork which was in use, against the invading Saxons, in the post-Roman period (Taylor 1970); in fact the absence of linear boundaries may be a result solely of their later destruction (section 10.6.1.). This area of downland clearly was important at the time for a type site of the Deverel-Rimbury complex (the main culture of southern England in the Middle Bronze Age), the Deverel barrow, is located 7km north of Rimsmoor (Fig 9.3.). Interestingly, Deverel-Rimbury settlement patterns show an exploitation of a wider range of environments than before, including downland valleys, rivers and coastal plains (Barrett and Bradley 1980; Megaw and Simpson 1979). The archaeological record also includes defended sites and weapons suggestive of aggressive competition

(Bradley 1979). Overall, a physical expansion of activity outwards from the chalk would not be unexpected.

The pollen sequence lends further support to this hypothesis. The form of the curves corresponds closely with Edward's (1979) Model 2 of clearance activity which he proposes indicates that it

> "was occuring as a result of one community extending its agricultural area (e.g. as a response to population pressure) or else it may denote the gradual extension of agricultural plots by several communities in the pollen source area" (p.264).

This contrasts with his Model 1, which is very similar to the changes portrayed at the Ulmus and Tilia declines, characteristic of clearance by a single group. The high resolution of the Rimsmoor diagrams makes the application of Edward's models especially viable.

The extent of the cleared area was presumably most of the pollen source area. Comparison with the clearance at 400cm and the fact that the latter is recorded at Okers suggests that the area may have been in excess of a hectare. This need not be incompatible with the Jacobson and Bradshaw model, because it was devised for basins surrounded by forest and not open land.

The subsequent regeneration implies that pressure on resources was reduced and marginal areas, in terms of soil and location, such as that in which Rimsmoor is located, were subjected to a reduced level of exploitation.

9.4.4. KINGSWOOD

The sequence at Kingswood is similar to Rimsmoor though because of the shallower depth of peat the resolution of events is considerably less.

9.4.4.1. NEOLITHIC

The Ulmus decline clearance, as already discussed, is barely distinguishable from the herbs; only the pronounced changes in arboreal, shrub and hazel pollen indicate its level. Corylus pollen, as at Rimsmoor, is approximately doubled in frequency whilst Quercus attains its former abundance. Ulmus and Alnus are both reduced but Tilia is more common.

Within the Poole Basin, the peripheral sites of Rimsmoor and Kingswood differ from the more central sites of Haskins (1978). The absence of the marked increase of Corylus is the most obvious distinguishing feature of the latter. The possibility of hazel coppicing was discussed in section 9.4.3.1. but again it is difficult to substantiate at Kingswood. Charcoal however is abundant throughout KW-3 perhaps indicating regular burning to increase the nut harvest; alternatively, it may be a result of camp fires, or of the burning of the mire surface to provide better grazing. Corylus may have been confined to the woodland edge by dense forest developed upon the more fertile, clayey soils around (Rimsmoor) or near (Kingswood) the two sites. This may have been in contrast to its more general occurrence within the open woodland hypothesised by Haskins (1978) which surrounded her sites in the more sandy areas. The pronounced recovery of Ulmus, Tilia and Fraxinus after the Ulmus decline at Kingswood and Rimsmoor as opposed to Haskins' sites similarly suggest the presence of more fertile soils around the former. Only at Kingswood, however, is Fraxinus increased after the Ulmus decline, the usual trend in pollen diagrams (Godwin 1975a) and reflecting its role in secondary woodland. At the other two sites its lower level is probably explained by woodland grazing, or replacement by Corylus, at Rimsmoor and by the general reduction of woodland at Winchester.

As already noted, the distribution of Neolithic remains off the chalk in this area is limited (see, for example, Fig 9.2). The Poole Basin was probably exploited mostly for woodland resources with those peripheral areas nearer the chalk probably experiencing the most pronounced disturbance. This probably explains, together with the assumed more fertile soils, why the Ulmus decline is a more obvious feature in the Rimsmoor and Kingswood diagrams in contrast to those of Haskins (1978) and others from the New Forest (Barber 1975, 1981b; A.R. Tilley pers.comm.). The general environment of the Purbeck chalk ridge at this time is unclear, though the single long barrow indicates some occupation. Environmental work on deposits from the ridge apparently has not been conducted: only the deposits in the Stonehill Valley (SY 930822) have been investigated and these are lateglacial in age (Lewin 1969). Like Rimsmoor, there is again no evidence for a mid-Neolithic standstill, providing further evidence perhaps for the general low level of exploitation of the areas off the chalk.

9.4.4.2. EARLY BRONZE AGE DISTURBANCE

In the centre of KW-3 there are brief and pronounced changes in the pollen curves. These span the period from about 2200 to 1800bc and, given the statistical uncertainty of the radiocarbon dates, probably reflect Early Bronze Age activity.

Betula shows a marked peak, rising from 10% to 60%, before falling to its former value. Inevitably, this must represent considerable local growth of birch, but other changes apparent in the diagram cannot be a result solely of the percentage inter-relationship of the curves. Whilst falls in Quercus, Corylus and Gramineae may reflect this, more permanent falls in Ulmus, Fraxinus and perhaps Tilia which are not followed by recoveries, suggest some preferential exploitation. A number of herbs are increased: Potentilla type, Rumex, Melampyrum, Chenopodiaceae and Umbelliferae which in part may be a result of changes in mire ecology as indicated by fluctuations in Sphagnum, Cyperaceae, Hypericum and possibly the Gramineae and Ericaceae. However, as discussed with reference to the proposed episode of Mesolithic interference in KW-2 (section 8.2.3.1.), major and temporary changes in mire ecology are only likely to occur as a result of changes in the surrounding area.

There is, therefore, evidence for a reduction in tree cover, particularly of Ulmus, and its replacement by perhaps open ground or Betula. Fraxinus and Tilia could also have been affected whilst the nature of the declines and recoveries of Quercus and Corylus indicate that these were little affected. This may show either continued use for fodder or actual clearance of better soils, perhaps around the site, on the clay step below the chalk ridge, or on the chalk ridge itself. Cereal pollen was not recorded but this does not mean that cultivation was not taking place: dispersal from small clearings would have been very restricted (section 9.4.1.2.).

The dates indicate Early Bronze Age activity and as at Rimsmoor this is supported by numerous round barrows both on the chalk ridge and on the present heathlands (Fig 9.3). The nearest are a group of three 400m south of the coring site. Interestingly, whilst at this level at Rimsmoor, Tilia was most strongly affected, at Kingswood, Ulmus was most reduced: presumably this may relate to the fact that around Rimsmoor lime was more abundant whilst elm was more common in the Kingswood area.

After this episode, the environment resumes its previous character, although a greater abundance of herbs, including Rumex, Plantago lanceolata, and Liguliflorae and the Ericaceae suggests a more open aspect than before. Oak woodland with some Ulmus, Tilia and Fraxinus was prevalent but with Corylus also abundant presumably on the forest margins. This is maintained until about 1375bc lending further justification to the argument that the main Neolithic-Bronze Age division occurs at the end of the Early Bronze Age (section 9.4.1.3.). This contrasts to a certain extent with Haskins' (1978) results which suggested, at least in the central Poole Basin, that the Early Bronze Age saw a replacement of open woodland by hazel scrub. The discrepancy again may highlight the more fertile soils and generally less brittle environment of the marginal zone. The higher herbs do indicate more activity around the two sites but woodland, rather than scrub, is more plausible from the pollen evidence, though there could have been areas of the latter.

9.4.4.3. MIDDLE BRONZE AGE CLEARANCE

The relatively low level of activity in the area around Kingswood characteristic of the Neolithic and Early Bronze Age ends abruptly at 135cm, about 1375bc, the KW-3/KW-4 boundary. Herbs, especially Plantago lanceolata, Potentilla type, Rumex, Melampyrum, Ranunculus type and Stachys type are increased with Pteridium whilst Sinapis type and Plantago media/major are recorded for the first time. Gramineae and Ericaceae are also higher. This indicates a considerable extension of open areas, notably grassland, although the records of, for example, Plantago media/major, Chenopodiaceae, Stachys type and Sinapis type may indicate some arable activity despite the absence of cereal pollen. Corylus was apparently cleared at first, representing perhaps a pushing back of the woodland margin or clearance of some pure stands and, subsequently, woodland composed of Quercus, Tilia and Ulmus. Corylus would have been easier to clear: only as population pressure grew or the soils deteriorated were the latter areas exploited.

The rapid rise of Plantago lanceolata pollen from under 0.5% to 8% over 4cm, about 100 C-14 years, illustrates the abruptness of the clearance. Soil deterioration is indicated by increased Ericaceae and the inwashing of nutrients into the bog. The latter is suggested by the transitory peaks of Alnus, Salix, Cyperaceae and Sphagnum and, in particular, the later and major rise of Myrica pollen. Betula is slightly raised and, together with the Ericaceae, presumably reflects colonisation of abandoned clearings.

Throughout most of KW-4 the amount of cleared land increases to reach a maximum at 116cm, c.875bc. During this period Corylus and Quercus especially are further reduced whilst Ulmus and Tilia retain fairly constant low levels: oak and hazel woodland was thus most affected. Herbs, however, remain static, despite increasing Gramineae. The rising Ericaceae imply that soil deterioration was causing cleared areas to develop into heathland and so necessitating further woodland clearance. At about 116cm, tree, shrub and Corylus pollen total less than 50% indicating predominantly open conditions within the pollen catchment (Tinsley and Smith 1974).

From about 116cm, c.875bc, the woodland area appears to have extended whilst the beginning of a continuous curve of cereal pollen indicates cultivation. This is similar to zone WT-6 at Winchester. Betula, Ulmus, Quercus, Corylus and Tilia are raised perhaps through colonization of abandoned grassland and heathland whilst there may have been local clearance of woodland for its more fertile and easier tilled soils. The same effect in the pollen spectra may, however, have been caused by cultivation of areas near to the bog, formerly considered too marginal for agriculture, but which, because of increased pressure on resources, then had to be farmed; the woodland extension may thus represent expansion across former arable land. Both hypotheses are plausible. Pinus is also raised indicating colonisation of some of the most degraded soils.

Thus Kingswood, like Winchester, Snelsmore and Rimsmoor also shows evidence for increased activity from about the Middle Bronze Age. Haskins (1978) similarly finds evidence for more intense land use at about this time (within the limitations of the radiocarbon technique and her proposed chronologies) which led to a change from scrub to heath within the Poole Basin. This may have been an indigenous development with a possible contributory influence from a spread of activity off the chalk, as proposed for Rimsmoor. The developing heathlands, despite representing degraded ecosystems, would undoubtedly have been useful for grazing, hunting, short-term cultivation, burial (Bradley 1978b) and fuel.

9.4.5. AMBERLEY

Discussion of C-3 at Amberley is hindered by the absence of any firm chronological framework prior to the end of the Period. Projection backwards of the time:depth curve implies that the lowest sample, 376cm was deposited at about 1760bc. However, the curve is based on two radiocarbon samples (Q-690 and HAR-4234) from the peat: C-3 is entirely in clay and so unlikely to have accumulated at a similar rate. Indeed, the density of pollen within the prepared samples implies a more rapid deposition, although this could reflect simply the greater difficulty of removing clay during preparation. Only pollen influx calculation will provide a solution. Additionally, the grains were rather more degraded, presumably through attrition, and so providing another reason for low pollen density. Nevertheless, given the estuarine nature of the basin (section 4.3.) rapid accumulation of sediment would be anticipated.

From the low level of Ulmus and high herbs, including Plantago lanceolata the clays are clearly post-Ulmus decline in date. It is probably reasonable to assume that the 376cm level was deposited during or after the Middle Bronze Age, from the foregoing discussion. Radiocarbon dates of material from the clay would be valuable. Period C-3 at Amberley is divisible into three zones, AWB-1, AWB-2 and AWB-3.

In AWB-1 the pollen indicates woodland dominated by Quercus and Tilia with Corylus, Alnus, Fraxinus and Ulmus also present in the pollen catchment area. The variable geology of this region implies that whilst Quercus may have been widespread, Ulmus, Fraxinus and possibly Tilia may have been more common on the base-rich soils to the south with Alnus more prevalent in the basin of the Arun. Herbs, like Gramineae, exceed 10%. The most common are Chenopodiaceae, Bidens type and Plantago lanceolata. The Chenopodiaceae may be largely derived from salt marsh plants, as also recorded in the Somerset Levels during the Atlantic period (Beckett and

Hibbert 1978). Bidens type similarly may have been contributed by plants of wet habitats such as Bidens, Pulicaria and Eupatorium. Plantago lanceolata pollen may also have been derived from flood plain situations, but possibly may also indicate the existence of dry open areas, perhaps also supporting the herbs recorded by pollen of Urtica, Plantago media/major, Anthemis type, Ononis type, Spergularia type, Trifolium type and Liguliflorae.

From 332cm, AWB-2, there is evidence for the creation of more open areas with a reduction in Quercus pollen suggesting clearance of oak woodland. Preferential felling of oak within mixed woodland is unlikely because of the value of the tree for pannage. Herbs are increased in abundance, especially Plantago lanceolata, but likewise Chenopodiaceae which must also indicate a proliferation of salt-marsh species. Herbs recorded for the first time include Carophyllaceae, Cruciferae undiff. Polygonum aviculare, Stachys type and Artemisia. Gramineae is slightly increased. This suggests that oakwood was felled for pasture, although the single cereal pollen grain at 280cm indicates that some cultivation may have been underway at least at the end of the zone.

In AWB-3, from about 820bc, there is a major clearance affecting Quercus, Pinus, Tilia and Corylus. Tree, shrub and Corylus pollen at a minimum of 35% indicates predominantly open conditions within the pollen source area. Gramineae and herb pollen, notably Plantago lanceolata, Liguliflorae and Umbelliferae imply that grassland was common, although local Phragmites growth may have been inflating the grass curve. Cereal pollen is not recorded suggesting relatively little, if any, cultivation nearby. The zone terminates with some regeneration of, especially, Betula, Quercus, Alnus, Fraxinus and Corylus with a corresponding reduction of Gramineae and herbs, except for Rumex (section 10.4.4.).

Assessing the probable location of the habitats portrayed in the pollen diagram is hindered both by the diverse geology of the area and the fact that the clays were water deposited. Tauber (1977) found that water borne pollen from a stream accounted for 50% of the pollen deposited on the bottom of a lake (section 2.4.3.). Thus a considerable proportion of the pollen in AWB-1 and AWB-2 may have been derived from up-river, in the Weald and from the chalk and coastal region. This effect is impossible to quantify; but inevitably interpretations must be speculative.

It is nevertheless worth noting that the assumed clearance of oakwood in AWB-2 coincides with a single record of Lobelia type pollen. This type includes L. dortmanna an aquatic not normally recorded in southern England, but significantly, L. urens and Digitalis purpurea, both species of acid soils, heaths and woods (Clapham et al. 1968). Calluna also exhibits a continuous curve during zones AWB-2 and AWB-3. As far as can be judged from these very low frequencies, it is possible that at least some of this woodland of Quercus was on soils with a tendency to acidity, as might be expected on the adjacent Sandgate and Folkestone Beds. The peak of Pteridium, a plant preferring well-drained moderately acid substrates (Braid 1959), is consistent with this hypothesis: the size of the peak also indicates local over-representation.

As already suggested, Ulmus and Fraxinus, and possibly Tilia and Corylus, may have been more common on the base-rich soils to the south, perhaps on the loams at the foot of the chalk scarp. They are relatively constant during AWB-1 and AWB-2 implying minimal disturbance. There is no evidence for the selective clearance of Tilia which Thorley (1971a) proposed happened at this time (section 2.1.1.1.). Significantly, Euonymus and Cornus are recorded in AWB-2, both taxa of chalk soils and indicating that pollen from chalkland vegetation is recorded at the site. Pinus is also increased during AWB-2 lending support to Godwin's (1962) contention that it was present in the central Weald and possibly that its pollen dispersal had been increased by clearance of surrounding woodland.

The end of AWB-2 shows a reduction in tree pollen followed by its recovery and a record of cereal pollen. A similar event occurs at both Winchester and Kingswood at about the same time, the Late Bronze Age. Again this may indicate some abandonment of formerly open grassland in favour of limited woodland clearance for arable.

In AWB-3 there is clear evidence for general disforestation, at least in the immediate vicinity of the Wild Brooks. If there was a mosaic of woodland, then it is apparent that areas cleared included the surrounding oakwoods, the Ulmus, Tilia and Fraxinus of the scarp foot, as well as some of the Pinus of The Weald. The ensuing regeneration may have been equally widespread. Tilia remains low, however, perhaps indicating continual exploitation, or grazing. Pinus is also low, possibly reflecting the maintenance of cleared conditions in the area where it was prevalent, or reduced pollen dispersal in a less open landscape.

9.4.5.1. ARCHAEOLOGICAL CONSIDERATIONS

Archaeological correlations must be tentative because of the uncertainty surrounding the origin of the pollen. It was noted how at least in the Early Neolithic there were substantial areas of woodland around both the Arun and Ouse valleys (K.D. Thomas 1982; Thorley 1981; sections 2.1.1.1. and 2.1.2.2.). The country around the Alfriston oval barrow was however open (Drewett 1975) and the faunal remains from various sites show that certain areas had been cleared. The Weald, in contrast, was apparently forested (Brandon 1974; Dimbleby and Bradley 1975).

The Bronze Age witnessed a major change in the organisation of farming and settlement that persisted into Roman times. Over 400 round barrows are recorded on the South Downs ridgeway (Fig 9.3) and Brandon (1974) notes that the Early Bronze Age activity was similar to that of the Neolithic; a system of semi-nomadic shifting agriculture. This was replaced by more settled activity, well established by the eleventh century bc and typified by the seasonally occupied Itford Hill settlement (Burstow and Holleyman 1957). Field systems of the period are fairly widespread (Drewett 1978) and there are linear boundaries similar to those recorded in Wessex (Bowen 1978). These Bradley (1971) interprets as possibly indicating a division between pasture on the hilltops, arable in the valleys and woodland on the intervening slopes, as also proposed for Berkshire (Bradley and Ellison 1975). The seasonal occupation at Itford Hill, this segregation of land use and the finds of bronzes in the Weald prompts comparison with Wessex and the possibility of transhumance (Drewett 1980; Fleming 1971; Legge 1981). By the Late Bronze Age there seems to have been a shift of activity, including cultivation, on to the loams surrounding the chalk outcrop, and locally on to the heavier soils (Brandon 1974). This is consistent with the Lewes pollen data (Thorley 1981; see revised interpretation in section 2.1.1.1.) and perhaps the evidence for a major change or recovery at this time (section 9.4.1.3.).

The constancy of Ulmus, Tilia, Fraxinus and Corylus pollen in AWB-1 implies that in this area the loams at the foot of the chalk escarpment were not at first brought into cultivation. It seems that the shift may have been to the more sandy areas and this is supported by a pollen analysis at Rackham 1500m north-east of the coring site (Dimbleby and Bradley 1975). At this site there was minor clearance in the Late Neolithic followed by regeneration. Probably still within the Subboreal there was a phase of extensive and permanent clearance which led to the site bearing first grass heath and later Calluna heath. The geology is Lower Greensand and the pollen diagram indicated a woodland dominated by Quercus and Corylus with little Tilia implying some segregation of woodland types. It is tempting to correlate this second phase of extensive clearance with the event recorded in AWB-3, or possibly AWB-2. In the Middle Bronze Age, as recorded at the end of AWB-2, there may then have been some abandonment of these areas and thence regeneration. Contemporaneously, the slight declines in Tilia and Corylus and later, in AWB-3, the more marked falls in these and Ulmus and Fraxinus could show clearance of the scarp foot. However, at both Rackham and Amberley, precise dating of the events is not possible.

The record of Cornus through AWB-2 is notable: it is a coloniser of bare, especially, chalk soil (Lloyd and Pigott 1967; section 2.2.1.). It may attest to some abandonment of chalk upland arable as suggested by the archaeological evidence at this time.

9.5. PERIOD C-3: CONCLUSION

The five sites in this research that include a part or all of Period C-3 have shed invaluable new evidence on the vegetational history of the area. In many respects it is complementary to archaeological and other environmental studies.

The Ulmus decline phenomenon is recorded at three of the sites, Winchester, Rimsmoor and Kingswood and at the former two there is some evidence for Neolithic activity below this level. At Winchester the analysis indicates permanent clearance of the pollen source area from this level. The Snelsmore results contrast radically in showing an essentially closed woodland throughout the Period. The cause of this difference may be related to the relative intractability and base-deficient nature of the soils in this area of Berkshire as well as to socio-economic factors. At Rimsmoor and Kingswood only restricted clearances are associated with the Ulmus decline and regeneration soon follows: it seems likely that this situation may have prevailed only in the immediate environs of the sites, because of the small pollen catchments, and perhaps not to the adjacent chalklands. This is difficult to verify from the pollen data alone, but seems probable from at least the density of archaeological finds in those areas. Interpretation of the sequence at Amberley is hindered by the location of the site yet there were clearly open areas within the pollen catchment, which includes chalk, in at least the latter part of the Bronze Age.

Various features at the sites tend to support recent theories that there were economic hiates in the mid-third millennium bc and at the end of the Early Bronze Age. The continuity of the Late Neolithic and Early Bronze Age is apparent at Winchester and Snelsmore whilst at Rimsmoor and Kingswood there was pronounced, though brief activity in the Early Bronze Age. All five sites show features that can readily be interpreted in terms of a Middle and Late Bronze Age economic recovery.

In part these periods of increased activity may have been stimulated by periods of increasing population. However, at least in the Neolithic new farming practices and the introduction of pottery may in fact have led to, at times, a higher death rate because of, for example, disease from contact with domestic animals, such as anthrax, and infection from unglazed pottery (Brothwell 1971). It is probable that the population showed marked fluctuations with only a long term trend towards increase. The changing intensities of activity may thus represent some of these fluctuations as well as the crossing of critical thresholds of population size. Other factors will have contributed to these trends, a notable example being the likelihood of soil degradation and consequential, and independently motivated, population migrations.

In conclusion, it is worthwhile noting that perhaps the most important new evidence is that in the area surrounding the Winchester site open country has been prevalent since the early fourth millennium bc.

CHAPTER 10

PERIOD C-4 IRON AGE TO THE EIGHTEENTH CENTURY AD

Sites:	Winchester	WT-7, WT-8
	Snelsmore	WM-5, SM-6, SM-7
	Amberley	AWB-4, AWB-5, AWB-6, AWB-7, AWB-8
	Rimsmoor	RM-6, RM-7, RM-8
	Okers	OK-1, OK-2, OK-3, OK-4, OK-5
	Kingswood	KW-5
	Woodhay	WH-1

Period C-4 records the time from the Early Iron Age to the beginning of the eighteenth century AD. It correlates approximately with the Subatlantic of Blytt and Sernander, Godwin's (1940) Zone VIII and the latter part of chronozone Fl III of West (1970).

10.1. CHRONOLOGY

The position of the C-3/C-4 boundary was determined by the initiation of more extensive clearances and/or arable cultivation. The interpolated dates are: Winchester 650bc; Snelsmore 410bc; Amberley 420bc; Rimsmoor 350bc; and Kingswood 600bc. These conform with others from Britain indicating the pronounced influence of Iron Age cultures on the environment. At Okers and Woodhay the Period began before the initiation of peat accumulation as represented in the analysed cores.

The end of C-4 was determined by the beginning of recent afforestation, marked particularly by rising *Pinus* pollen. The approximate dates are: Winchester ad 1700; Rimsmoor, Okers and Kingswood ad 1750; and Snelsmore and Woodhay ad 1800. At Amberley the final part of C-4 is not recorded.

10.2. CLIMATIC DETERIORATION AND GENERAL VEGETATION COMPOSITION

There is considerable evidence for a deterioration of climate with lower temperatures and higher precipitation from about 1000bc (Dansgaard *et al*. 1969; Lamb 1977; Magny 1982; Osborne 1982; Van Geel 1977). It is most readily detectable in raised bog peat with a change to more rapidly accumulated peat of lower humification (Simmons and Tooley 1981).

The level at which this occurs is known as the Grenzhorizont, recurrence surface RY III, a feature common across North-West Europe and indicating the widespread nature of the climatic change. It is notable that peat accumulation begins at this time at Amberley.

The opening of the Subatlantic probably saw prevailing temperatures about 2°C lower than 5000 years earlier. The climate was also wetter and windier, overall a result of changes in the distribution of air masses (Lamb 1977; Magny 1982). Inevitably, this will have affected vegetation, for example, either directly through inhibiting reproduction because of late spring frosts, a characteristic of more oceanic conditions, or indirectly by accelerating soil deterioration. Distinguishing such effects is hindered because it coincides with the arrival of iron-using cultures in Britain. Their influence on the landscape is obvious in many pollen diagrams from across Britain.

Separation of the Late Bronze Age and Early Iron Age is nevertheless difficult: in ceramic terms there is no real division (Barrett, in Bradley and Ellison 1975) and Cunliffe (1974) traces the origin of the Iron Age to at least 1000bc. Furthermore, it has been noted how at Winchester, Snelsmore, Kingswood and Amberley (section 9.4.) the Late Bronze Age is marked by an increase in activity which is intensified in the Iron Age. This is compatible with the archaeological evidence (e.g. Bradley 1978a, 1979), although it is possible, given the limitations of the proposed chronologies, that it relates solely to the influence of iron-using groups. Nevertheless, the fact that there is an increase in activity in the sites in this thesis in the interpolated Iron Age does validate its consideration as a part of a different Period. Whilst anthropogenic factors clearly were dominant in this area, climatic deterioration may have had some influence, although at least so far as economic activity was concerned, this may have been minimal (Whittle 1982).

As Godwin (1975a) notes, the general composition of arboreal pollen in Britain is little changed between the Subboreal and Subatlantic, though the total is significantly reduced with major increases in indicators of open conditions and cultivation. At the five sites in this thesis with C-3 spectra, this situation is admirably demonstrated with some exceptions (Fig 10.1.). At Winchester, there is no major change, reflecting the already extensively open nature of the pollen catchment,

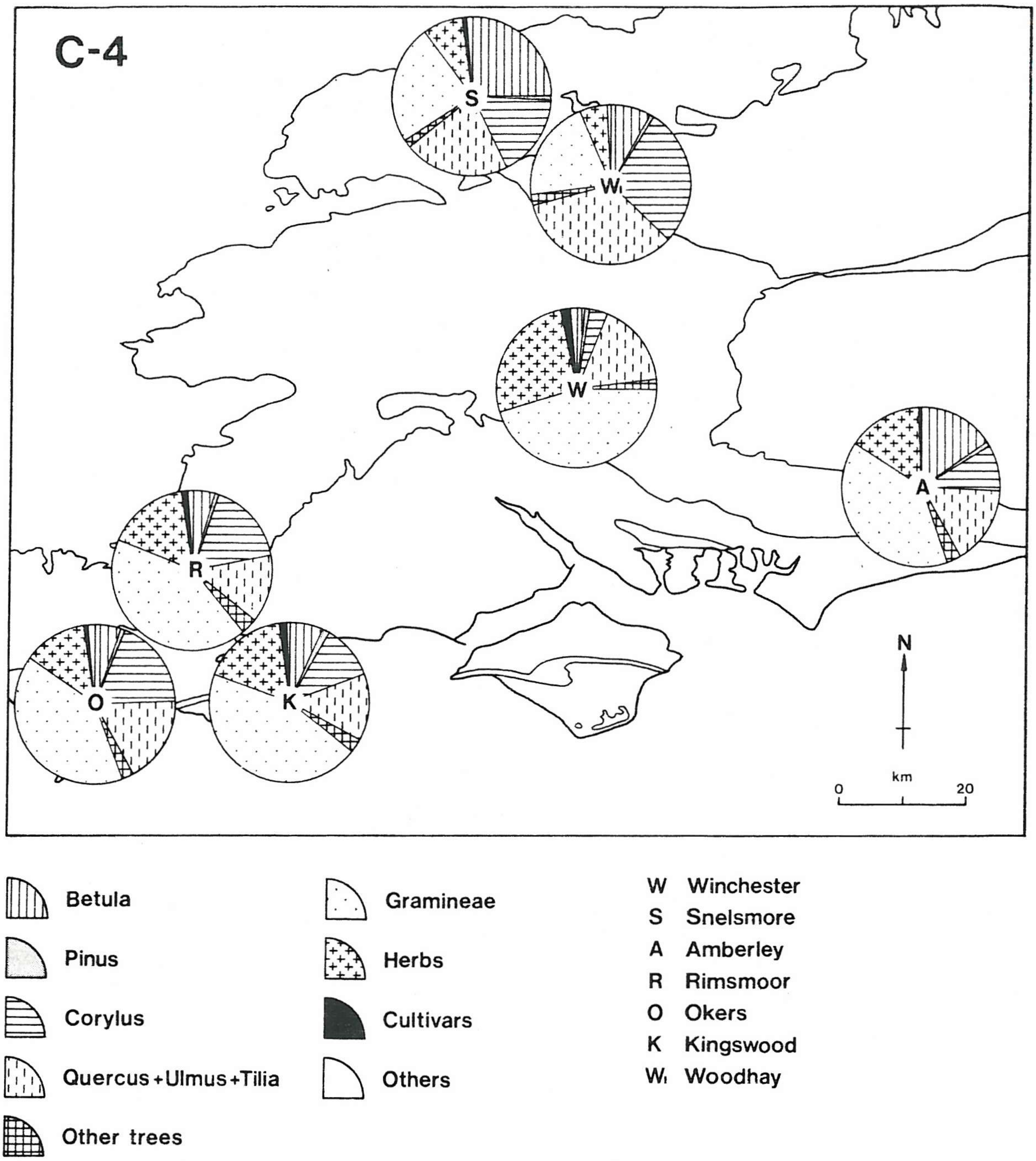


Figure 10.1. Period C-4: summary pollen diagrams

except that Quercus in particular is increased. As elsewhere in Britain Betula is higher at all sites with, by definition, those classified as late expanding, e.g. Fagus and Carpinus, and introduced species such as Juglans and Castanea. Corylus is generally lower, especially at Rimsmoor and Kingswood whilst Alnus varies from site to site depending clearly on local conditions.

All five sites show an expansion of herbs and especially cultivars. The absolute number of herbs is increased as well as the number of species and this is evident at Okers. Woodhay differs because of its very locally derived pollen (sections 4.7.2. and 10.9.).

In the following discussion of C-4 each 'cultural' period is examined separately, integrating the data from all seven sites as appropriate. The Tilia decline is, however, investigated first.

10.3. THE TILIA DECLINE

The major fall in Tilia pollen was originally interpreted to be a result of a reduction in the number of limes caused by the climatic deterioration at the opening of the Subatlantic and was thus taken as a boundary marker (Godwin 1940). Turner (1962) however found that at a number of sites the date of the decline varied from Late Neolithic to Early Iron Age and it was associated with indicators of woodland clearance. These factors suggested an anthropogenic cause, an hypothesis supported by subsequent work.

The five main sites in this thesis provide further evidence in favour of Turner's theory. The phenomenon at Winchester is the earliest major fall known to the author, occurring at the Ulmus decline (3680±90bc HAR-4342), and as a part of a major clearance. Above this level there is a brief recovery, still within the Early Neolithic, but thereafter it is rarely recorded until C-5. At Amberley it declines with other arboreal pollen at c.820bc and the continuous curve ceases at 420bc. The coincidence with clearance is repeated at Rimsmoor where Tilia temporarily falls with the Ulmus decline. However, it recovers, to experience a major and permanent reduction at about 1870±80bc (HAR-3921). At Snelsmore it is reduced at the assumed Ulmus decline, then increases to be lowered successively at 1550bc and 800bc with a final fall at ad1470. Tilia is less abundant at Kingswood but likewise is reduced at times of clearance: at the Ulmus decline, 2000bc, 1300bc and 200bc. At the two remaining sites, Okers and Woodhay, Tilia pollen is at a low frequency throughout with no obvious decline.

Other work in southern England shows a similar degree of variation. In the Isle of Wight, Scaife (1980) records dates of 2060±110bc (SRR-1435), 1330±80bc (SRR-1434) and 960±130bc (SRR-1436) from three sites, at Wingham it may be as early as 1700bc (Godwin 1962) whilst at Lewes, Thorley (1981) records various fluctuations from the Mesolithic to the Middle Bronze Age.

Lime is generally associated with base rich soils of mull humus type, though Tilia cordata and T.x vulgaris will grow on a variety of substrates (Moore 1977; section 7.3.3.). It provides leaf fodder, timber and bast fibre. On the Isle of Wight Scaife (1980) suggests that there was clearance of the better soils, on which it was growing, for agriculture and a similar explanation is favoured by Turner (1962) for some of the sites she examined. Baker et al. (1978) also invoke this theory for the late fall of Tilia (Anglo-Saxon) in Epping Forest.

This theory does not totally explain the declines at the sites in this thesis for other tree pollen types are also reduced. Perhaps most significantly, at Amberley and Kingswood declines in Tilia coincide with declines in Pinus at a single level in both diagrams, implying clearance of poorer soils as well. Contemporary falls in both Ulmus and Tilia may nevertheless indicate that within the pollen catchment some areas of better soil were being deforested; indeed at Kingswood the falls of Tilia, Ulmus and Pinus at about 200bc occur with a rise in cereal pollen some 400 C-14 years after clearance of Quercus and Corylus. This may indicate an intensification of activity with more arable on soils formerly supporting elm and lime.

At Rimsmoor the main Tilia decline occurs in the middle of C-3: it was counted at 1cm intervals and discussed in section 9.4.3.2. The curve at this site may indicate some selective exploitation. Again there is good evidence for general woodland clearance, but it is little affected until midway through the first clearance, RMT-2. It occurs after an arable phase when there may have been a shift to pastoral uses, from which it may be implied that it was either being deliberately cut for leaf fodder, or freely browsing animals were preferentially grazing the foliage presumably after pollarding. Ulmus, which is also acceptable as fodder, is perhaps reduced consistently from this level as well. However, it may reflect clearance of more fertile soils. Degeneration of the local soils, as suggested by the clay inwash, may have stimulated a move to such areas: lime and elm may well have been less common around Rimsmoor to judge from the absence of any consistent reduction at the clearance represented by the RMT-1/RMT-2 boundary. The situation is not made any clearer by the unknown influence of the clay inwash on the preservation and origin of the pollen contained therein. Selective thinning of Tilia and perhaps Ulmus is unlikely because of the herbs recorded (Turner 1962), yet this activity may have been practised beyond the cleared area.

At each site the behaviour of Tilia pollen varies after the clearances. At Winchester it is almost totally absent following the Ulmus decline clearance. In the Snelsmore sequence it repeatedly regenerates with the rest of the woodland flora after clearance, but at Rimsmoor it is not recorded in the woodland after the Early Bronze Age. Kingswood and Amberley are similar to Rimsmoor, although the dates of the declines differ. Presumably these contrasts relate to differing local vegetation communities, soils and human economies. Its absence from Winchester undoubtedly attests to the general scarcity of woodland within the pollen catchment. At Snelsmore its behaviour could indicate some selective exploitation, perhaps for fodder, or, conceivably a generally lowered level of Tilia pollen within the pollen rain as a result of clearance of the surrounding chalklands, although given the small pollen catchment this could not explain all the recorded fall in pollen. The constantly rising Calluna at Kingswood may indicate progressive soil deterioration increasingly discouraging Tilia growth whilst at Rimsmoor and Amberley continuous exploitation for fodder, or of more fertile soils may be responsible. Selective exploitation for fodder or, for example, bast fibre, may indeed be in operation at all sites, with use of the more fertile soils similarly important. Clearly it is impossible to state from these data that the Tilia decline and the subsequent behaviour of the curve has a single cause: several factors are likely to have been in operation.

10.4. THE IRON AGE

The Iron Age did not begin abruptly in the middle of the first millennium bc for certain characteristics of the period were probably in existence before 1000bc (Cunliffe 1974). It gained momentum in the eighth century bc to become most developed after about 500bc. It was during this latter phase that the environmental impact was at its peak, as recorded in pollen diagrams. Even in the highland zone of Britain where activity was generally less, it was this period which often witnessed major, extensive clearances. This is recorded, for example, at Tregaron in Wales, Thorne Waste in Yorkshire (Turner 1965), in parts of the North York Moors (Atherden 1976; Spratt and Simmons 1976) and at Ellerside Moss in the south-east Lake District (Oldfield 1963). However, the situation was not uniform with some areas unaffected by extensive clearance until the middle of the first millennium ad, to quote from two of the above papers, at Bloak Moss in Ayrshire (Turner 1965) and at Helsington Moss in the Lake District (Oldfield 1963).

The lowland zone shows a greater consistency of activity at this time with major clearance from the Late Bronze Age onwards in the Somerset Levels (Beckett and Hibbert 1980) and from 800bc at Hockham Mere in East Anglia (Sims 1978). Evidence from the published chalkland sites indicate an intensification of activity as at Wingham and Frogholt (Godwin 1962; section 2.1.1.1.). The Mollusca from a number of locations, including Bishopstone (Bell 1978; section 2.1.2.2.), Pink Hill (Evans 1972) and the Devil's Kneadingtrough (Kerney et al. 1964; section 2.1.2.1.) frequently show arable cultivation and hillwashes dating from this period (Evans 1972). Even on Clay-with-flints north of Winchester, Fasham (1980) records clearance and agriculture. The archaeological evidence indicates that cultivation was widespread with settlements such as Little Woodbury (Brailsford 1949; section 2.1.3.) attesting to the intensity of activity. Linear boundaries were probably still being constructed (Bowen 1978). There is also documentary evidence: in the first century BC, Strabo wrote that the downs were cultivated and manured, and that corn, slaves and hunting dogs were being exported.

On mainland Europe the record is similar with increased activity recorded in pollen diagrams from, for example, The Netherlands (Van Geel 1978) and in France, on the chalk of the Dordogne (Donner 1969). In the

Champagne, also on chalk, deposition of sediment was initiated in a valley at this time and the associated pollen diagram showed an extensively open landscape with abundant indicators of arable cultivation (Beal et al. 1980).

In Britain there seems to have been an increase in population during the first millennium bc (Fowler 1978) as a result of immigration and indigenous growth. This will have stimulated woodland clearance for agriculture, made easier by iron tools, whilst the need for wood for iron smelting will have resulted in further disforestation. As mentioned in section 9.4.1.3., the period continued the trends of the Late Bronze Age recovery. It was a time of agressive competition (Bradley 1979) when distinctive defended enclosures, 'hillforts', proliferated. They may have had several functions, such as stock enclosures, settlements and market towns, but by the end of the first century bc they had been replaced by proto-towns or oppida in southern England (Champion and Champion 1981; Cunliffe 1978).

10.4.1. WINCHESTER

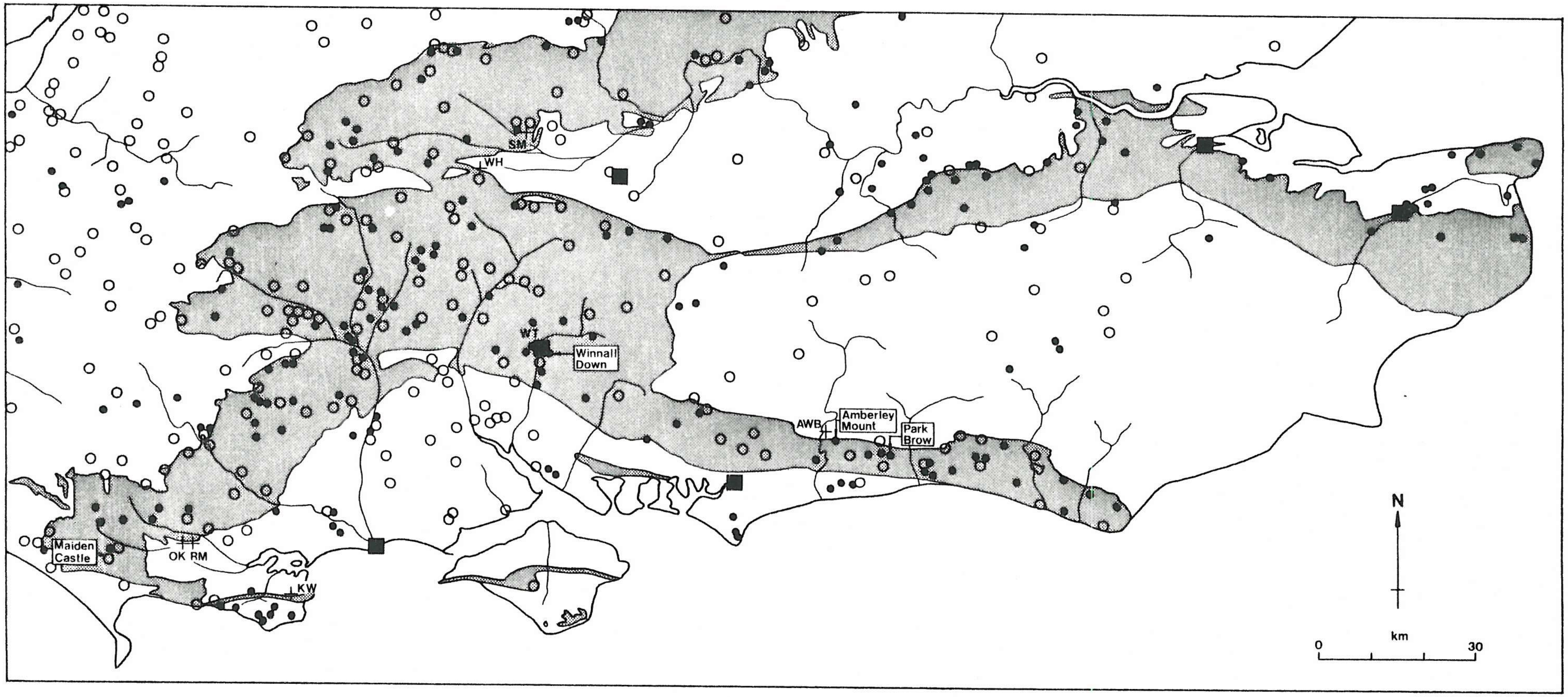
The data from the Winchester pollen diagram appear to conform with the hypothesis of a continuation of the Late Bronze Age recovery. Regrettably, the interpolated Iron Age level is represented by only three samples. Nevertheless, from the fluctuations in the curves some trends in land use may be tentatively suggested. Initially reduced cereal pollen may reflect a temporary contraction of arable arising from local changes caused by the establishment of the new culture. Cultivation was then increased, or at least took place nearer to the sampling site. It may have involved areas of former pasture, or given the intractibility of established turf (J.G. Evans 1974), either a reduction in fallow (Boserup 1965) or clearance of woodland. Precise verification of this hypothesis is hindered by the fluctuations possibly caused by locally growing species in the fen, especially Phragmites; it is perhaps significant that the peak of Gramineae coincides with a minimum of Cyperaceae. However, pH is reduced temporarily, perhaps indeed indicating cultivation of previously little disturbed (woodland?) soils.

Archaeological evidence for human activity is considerable in this area of the Hampshire Downs: 'Celtic' fields and settlement sites are prolific. On Winnall Down, about a kilometre east of the coring site, is a settlement occupied for much of the millennium (Champion and Champion 1981; Fasham 1978b) (Fig 10.2). This site, like those at Bridget and Burntwood Farms (Fasham 1980), Owslebury (Collis 1968, 1970) and elsewhere (e.g. Perry 1969) is on the chalk plateau indicating the importance of these areas. The valley, however, may not have been neglected: Champion and Champion (1981) propose that the Avon and Test might provide significant new data for the Iron Age. The Itchen is not mentioned and certainly at Winnall Moors the depth of peat and increased moss content suggests that it would have been too wet for grazing. Activity however at the drier margins of the flood plain is suggested by the pollen analysis of a sample from Brook Street in Winchester (BS 380, Murphy 1977) which indicates that in the vicinity of the present city there were arable fields. The steady rise of cereal pollen may thus relate to a gradual shift to the lower valley slopes because of, for example, soil deterioration on the high downs or population pressure as a part of, or independently of, the shift from the hillfort of St Catherines Hill to the possible oppidum of Oram's Arbour (Venta). Colluviation and alluviation may have buried much of the evidence. It is significant that in the Somerset Levels, the best grazing at the present day is on the 'hanging' at the junction of the peat and hill-slope (Coles 1978).

10.4.2. SNELSMORE

As in the Neolithic and Bronze Age, Snelsmore retained its distinctively different character from Winchester in the Iron Age, though some clearance is recorded. It begins at about 410bc, the opening of Zone SM-5, and occurs after the phase of regeneration marking the end of SM-4: this regeneration showed tree, shrub and Corylus pollen attaining nearly 80%. During SM-5 there was evidently some grassland around the bog but woodland predominated. As suggested for the reduction of cereal pollen at Winchester (section 10.4.1.) this regeneration at the end of SM-4 may similarly have been a result of a temporary 'upset' in the rural economy resulting from the expansion of iron-using groups.

The clearance in SM-5 was generally slower but of rather greater extent than that of the Late Bronze Age, SM-4. Quercus, Tilia, Alnus and Corylus were again reduced with Gramineae and herbs, notably Rumex,



■ Possible oppidum
○ Hillfort or similar defended enclosure
● Settlement

WT Winchester
SM Snelsmore
AWB Amberley
RM Rimsmoor
OK Okers
KW Kingswood
WH Woodhay

Figure 10.2. Iron Age sites
Source: Ordnance Survey 1967

Plantago lanceolata, Ranunculus type, Liguliflorae and Anthemis type indicating an extension of grassland. Tree, shrub and Corylus pollen however falls to only just below 60% so woodland is still dominant. As in SM-4, cereal pollen is recorded in the first part of the clearance indicating some cultivation, but this apparently ceased, or was reduced, by 182cm, about 100bc.

Field systems of the general period are widespread on the Berkshire Downs, but as Richards (1978) observes they show a preference for light chalk soils and avoid large patches of, in particular, Clay-with-flints. Fields have not been recorded in the Snelsmore area and although cultivation is suggested by the cereal pollen this dichotomy may be a result of the difficulty of their observation in such areas and the transitory nature of the activity. It is conceivable that it took place on the lighter soils of the Plateau Gravel in view of the small pollen source area (section 4.2.2.), and is perhaps indicated by the rising Calluna, implying soil deterioration. However, the modern sample (0cm) shows a similar cereal percentage and the nearest cultivation is on the surrounding chalk soils 500 to 1000m distant; this may also have been the location of the activity at this time, the field systems having been subsequently obliterated by ploughing.

An Iron Age presence in the area is confirmed by a hillfort located 2km to the north (Richards 1978) and this may have stimulated local farming. The cessation or reduction of cultivation at 182cm, c.100bc may be relevant in this context for many hillforts were abandoned at this time (section 10.4.). If this had occurred then there may have been a reduction in local cultivation. Verification is difficult because little is known about that particular hillfort and there was some preferential selection and growth of hillforts: the major role of Ram's Hill was superceded by the adjacent Uffington Fort in the Early Iron Age (Bradley and Ellison 1975). The fort near Snelsmore could have been obsolete long before 100bc.

10.4.3. RIMSMOOR, OKERS AND KINGSWOOD

The three sites on the margins of the Poole basin provide an interesting comparison with the chalkland analyses and the more central Poole Basin sites of Haskins (1978). She emphasises that from the Iron

Age there was a consistent difference between the heathland of the sands and gravels and the more intensive agricultural uses of the major river valleys, the marginal London and Reading Beds and possibly the shores of Poole Harbour.

At Rimsmoor the most dramatic feature of the Iron Age level is a second major and extensive clearance. As with the first (section 9.4.3.3.), it affects Corylus in particular with Quercus and Alnus. It is bracketed by two dates, 400±70bc (HAR-3922) and 130±80bc (HAR-3923) and covers the period from c.350bc until c.50bc. Woodland is progressively reduced throughout and the tree, shrub and Corylus pollen total falls to below 40%, indicating the prevalence of open conditions around the site (Tinsley and Smith 1974). Gramineae is doubled in frequency and increases are recorded in Rumex, Artemisia, Plantago lanceolata, Spergularia type and Pteridium. Further evidence for the extent of the clearance is provided by pronounced and temporary increases of Cyperaceae, Hypericum and Sphagnum which with low aquatics may suggest a eutrophication of the bog surface rather than simply flooding.

Iron Age settlements are numerous in Dorset and especially so on the chalk; the latter include the major site of Maiden Castle (Taylor 1970; Fig 10.2.). As stated in section 9.4.3.3., the form of the clearance at Rimsmoor in the Middle Bronze Age suggests a gradual extension of agriculture from elsewhere (Edwards 1979). Given the similarity of the Iron Age episode, the same is probably appropriate. Thus it is tempting to again speculate that this event also correlates with population pressure on the available resources of the chalk manifested by an 'overflow' on to surrounding areas. Such pressure seems probable from the density of settlement, fortifications and agriculture and, therefore, spatial expansion would not be unexpected. This hypothesis may be problematical, for the concentration of sites on the downs could have been a result solely of relatively subdued agriculture in the historical period. This will have led to a greater preservation of remains than elsewhere (Taylor 1970, 1972; sections 3.7. and 10.6.1.). Nevertheless, if the heathlands of the Poole Basin had already developed by this time (section 9.4.4.3.), it is likely that agricultural exploitation was already at a low level. Expansion from them would thus be improbable, implying that the present distribution is a true reflection of the original distribution. However, migration of communities from the river valleys and coasts or indigenous developments in the marginal zone and largely independent of surrounding areas cannot be discounted.

A factor that may, nonetheless, confirm the influence of chalkland socio-economic conditions is the cereal pollen record. In the pollen source area grassland was probably prevalent, yet some cereal pollen indicates the existence of cultivation. There are, most notably, continuous cereal curves at the start and end of the episode, but the pollen type was not recorded over the central 40cm (400 to 360cm, c.290 to 80bc), c.210 C-14 years. B.W. Cunliffe (pers.comm.) has hypothesised independently that a change of settlement pattern he has observed at this time on the Wessex chalklands may have been associated with a swing away from cereal cultivation. This could suggest a general and extensive, yet transitory, change in the mode of subsistence. The data from Okers (Zone OK-1) with their dominantly open pollen spectra indicate that the clearance affected an area at least up to a distance of 150m around Rimsmoor and this is probably a minimum figure in view of the likelihood of extensive chalkland clearance. It should be noted, however, that there is a risk of circular argument as a result of the chronological correlation of Okers with Rimsmoor. This emphasises the need for radiocarbon determinations from Okers. More work, as a whole, is necessary in the area of Rimsmoor before the 'overflow' hypothesis can be totally accepted.

Interestingly, the elevated Ericaceae pollen at Rimsmoor may attest to the later origin of the heath of the clay zone in contrast to that of the sandy areas of the Poole Basin (section 9.4.4.3.). In part, the pollen may be a result of the colonisation of the bog surface, yet the proliferation of _Calluna_ with its preference for drier soils indicates significant soil podzolisation at this time. Presumably this arose from woodland clearance and, most notably, cultivation.

The reduction in activity from about 100bc at Rimsmoor is similar in time to identical phenomena at Winchester and Snelsmore. As already stated, this coincides, within the limits of the proposed chronologies, with the change from hillforts to _oppida_ (Cunliffe 1978). These phenomena may be an environmental manifestation of the event, perhaps another, but minor, hiatus.

Kingswood differs in various respects. The opening of C-4, also of KW-5, is drawn at 106cm, c.600bc: there is no discernible reduction in cereal pollen in contrast to Winchester. Clearance, however, is pronounced, affecting particularly Quercus and Corylus and the increases in Gramineae and herbs, especially Rumex, Plantago lanceolata, Umbelliferae and Liguliflorae, suggest that this was primarily for pasture, yet a slight increase of cereal pollen and perhaps Anthemis type, Chenopodiaceae and Sinapis type, indicate an extension of arable. This contact zone between the chalk and clays to the south and sands to the north may have been favoured for settlement because of the range of environments that would have been available. Overall, there was a concentration of Iron Age settlement in the Isle of Purbeck (Fig 10.2).

In contrast with the other sites so far discussed, there is in fact an increased intensity of activity at the end of the millennium (95cm). Betula, Pinus, Ulmus, Tilia, Alnus and Corylus are reduced whilst Gramineae, cereals and the following herbs in particular are raised: Potentilla type, Rumex, Plantago lanceolata and Anthemis type. Quercus and Calluna both peak. This suggests clearance of more fertile (Ulmus and Tilia), wetter (Alnus) and more impoverished (Pinus) areas. The clearance at c.600bc had chiefly affected Quercus and Corylus and there is some indication that at least oak was allowed to regenerate, perhaps for pannage or tannin. Both Fraxinus and Fagus are increased, possibly within the oakwood community. Low Pteridium may indicate that little arable land was actually abandoned (Moore 1980), at least near the site, despite obvious soil deterioration. The latter is indicated by rising Calluna and also Myrica which suggests inwashing of nutrients to the bog.

The cause of this latter intensification could have been associated with the fact that this may have been a more prosperous area at this time: a number of imported amphorae are recorded in first century, possibly second century bc contexts (Peacock 1971).

Regardless of these variations, the sites of Rimsmoor, Okers and Kingswood on or near the marginal clays do testify to a more intensive agricultural regime in the Iron Age than is apparent at Haskins' (1978) more central sites. Agriculture clearly was not confined solely to the chalk soils and this contention is supported by the distribution of settlements and enclosures (Fig 10.2).

10.4.4. AMBERLEY

The sequence at Amberley also exhibits clearance during the Iron Age from about 420bc (AWB-4). As in the Late Bronze Age (AWB-3; section 9.4.5.1.) the phenomenon appears to have been widespread; Quercus and Corylus were especially affected with Betula, Pinus, Ulmus, Tilia, Fraxinus and Fagus. Gramineae is increased, but again locally growing Phragmites, the remains of which are common in the peat, may have inflated the total. This suggestion is supported by the low herbs although it may have been caused in part by the cleared areas being at some distance from the sampling point. The fluctuations in the tree pollen curves and the records of Plantago lanceolata and Pteridium attest to the clearance. Rumex is the only abundant herb and in part this may also have been inflated by species on the bog surface, such as R. hydrolapathum.

Zone AWB-4 concludes at about 80bc (180cm) with some restricted regeneration, but also extension of open land, or at least its creation nearer the sampling site. Betula and Corylus are increased whilst there is a reduction in Quercus, Ulmus and Alnus and increased Plantago lanceolata and Calluna. The phase is soon terminated with, in AWB-5, Betula and Corylus again reduced and the Gramineae, Ericaceae and herbs increased showing more general activity.

As at Winchester and Snelsmore there seems to have been some relaxation of activity in the middle of the millennium, perhaps also caused by transitory disruption caused to the economy by the arrival of iron-using people. Similarly, it is tempting to relate the restricted regeneration at c.100bc to a minor hiatus but at this site it is more readily referrable to only local regeneration (Betula) because it was a time generally, from the diagram, of the extension of open areas. A major anomaly is the absence of cereal pollen. On the South Downs there was essentially a continuation of Bronze Age farming methods with settlements and fields widespread (Fig 10.2; Brandon 1974). These included the site of Park Brow with fields cultivated for perhaps 650 years (Brandon 1974; Wolseley et al. 1927) and a farmstead on Amberley Mount, 2km to the south (Ratcliffe-Densham and Ratcliffe-Densham 1966) (Fig 10.2). Cultivation appears to have been widespread especially on the lower slopes whilst the regular spacing of hillforts indicates a division of the Downs into separate territories (Bradley 1971). Thus cultivation was practised throughout the period and the absence of cereal pollen is probably a result of its poor dispersal. The data overall indicate that parts of both the downs as well as The Weald were free from forest.

10.4.5. IRON AGE: CONCLUSION

Generally within Britain, the Iron Age was a period of land use intensification. The chalk was no exception and areas already disforested, as recorded at Winchester, exhibit an extension of the agricultural practices that were initiated in the Late Bronze Age. Other locations, particularly where the chalk is overlain by clay or sand deposits (e.g. Snelsmore and to the north of Winchester (Fasham 1980)), experienced clearance of the pre-existing forest cover. Peripheral regions as recorded at Amberley, Rimsmoor, Okers and Kingswood similarly underwent disforestation.

Several factors probably stimulated this intensification of activity. Population pressure was evidently dominant but climatic deterioration may also have been important. This will have helped to alleviate some of the problems of the dry chalk soils and of watering animals (Bradley 1978a). The increased sheep grazing recorded for the period (Cunliffe 1978) may reflect this together with the need for manure to maintain the fertility of the arable fields. The re-introduction of spelt, a wheat tolerant of cooler, wetter conditions may also have been important and actual soil deterioration may have encouraged the shift to other areas.

There is some indication from the distribution of Iron Age sites (Fig 10.2) that activity was concentrated upon the chalk. However, as mentioned in section 10.4.3. this may simply reflect the 'Zone of Survival' of Taylor (1972) and the destruction of remains elsewhere by subsequent agriculture. Taylor (1970) believes that the chalk may have been marginal land for much of prehistory and that population pressure in the lowlands necessitated periodic expansion on to the chalk. Bradley (1978) notes an early (Middle Bronze Age) expansion off the chalk, yet Bell (1981b) mentions the danger of overemphasising the marginal nature of the chalk and stresses the significance of surviving loess deposits (section 9.4.2.2.). The environmental evidence discussed in Chapter 2 in addition to that from Winchester tends to show fairly continuous agriculture throughout prehistory with a concentration of activity on the chalk. The total number of sites however is low and evidence from the Upper Thames implies that valleys, in particular, may have been fairly densely settled. (Lambrick 1978). In view of this evidence it may be hypothesised that much of the Iron Age activity was concentrated in the river valleys whilst the chalk provided a reserve of easily tilled but less productive land. The areas of clay and sand may similarly have been exploited on a more ephemeral basis for grazing, woodland resources and only occasionally, at times of land shortage, for arable cultivation. The off-chalk distribution of sites shown in Fig 10.2 attests to the utilisation of other areas. Inevitably, however, much archaeological and palaeoenvironmental evidence for dense valley settlement is buried by recent colluviation and alluviation (e.g. Bell 1981a, 1981b). Confirmation of the hypothesis is thus difficult.

10.5. THE ROMANO-BRITISH PERIOD

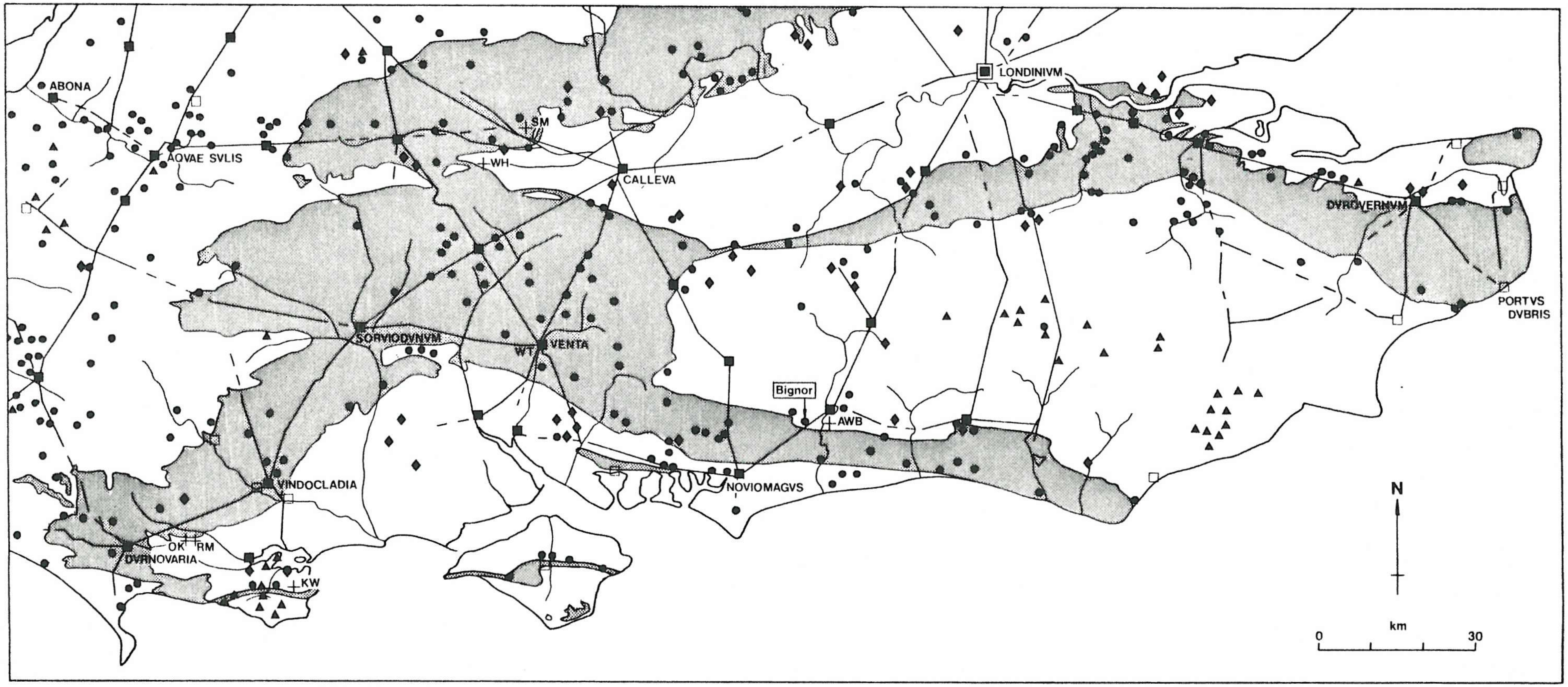
The spread of the Roman culture across Britain from AD 43 traditionally was envisaged as having had a major impact on the economy of the native population. It was seen as exaggerating the difference between the lowland and highland zones, stimulating further arable production to support Roman garrisons in the north and west. This was clearly overstressed as grain appears to have been grown locally within the highland zone because of the prohibitive costs, if not impossibility, of transport (Barber 1981a; Manning 1975). Yet cultivation must have been increased within the lowlands because of both the annona militaris and the existence of the non-agricultural populations of the newly established towns (Johnston 1981). Other factors may also have been important: Buckland (1978), for example, mentions grain losses by the newly, and accidentally, introduced weevils. However, relatively few pollen analysed sites show a significant effect at this time, most indicating a continuation of Iron Age levels of activity. There are exceptions, including Hockham Mere in the Breckland (Simms 1978) and Bolton Fell Moss in Cumbria (Barber 1981a). The chalkland sites in this thesis have given variable results.

10.5.1. WINCHESTER AND SNELSMORE

At Winchester and Snelsmore little change is discernible in the pollen record from the Iron Age. It should be noted, however, that at Winchester the Roman period is represented by only about two levels and in addition the proposed chronology is based on relatively few points (section 9.3.1.2.). More data are thus required before this statement can be totally justified, yet it appears not to be greatly at variance with archaeological work (see below).

The Winchester pollen core shows the maintenance of an essentially open landscape but with some woodland or copses dominated by Quercus with some Corylus. Gramineae pollen, perhaps inflated to some extent by local Phragmites, with herbs such as Plantago lanceolata, Liguliflorae and Centaurea scabiosa indicate areas of grassland. Cultivation was also underway, as indicated by cereal pollen at 2% with various pollen types possibly derived from cornfield weeds e.g. Stachys type, Plantago media/major, Spergularia type and particularly Centaurea cynaus which peaks at 1 to 2% during and shortly after this period. The prominent maximum of Sinapis type may similarly be from arable weeds, or alternatively and more probable, given the frequencies, from fen species. It is conceivable that it may even have been derived from local crop plants (Murphy 1977). Crops for which there is clear palynological evidence are rye (Secale type) and possibly hemp (Cannabis type) (section 10.5.4.). The Cannabis type curve notably begins at 144cm, ad110. In general at this time there may have been some slight intensification of land use, stimulated by the factors mentioned above. This is suggested by a reduction in scrub and waste areas as implied from the cessation of the Prunus type and Rubiaceae curves and low Rosaceae undiff and Sambucus nigra.

Archaeological evidence from the Hampshire Downs for Roman settlement is prolific, yet few villas, for example, have been excavated (Fig 10.3). At Bridget and Burntwood Farms north of Winchester this was a period of major change with the laying out of extensive fields (Fasham 1980) and a similar situation is evident nearby at Micheldever (Collis and Fasham 1980). The possible oppidum at Orams Arbour was abandoned and the Romans founded the town of Venta Belgarum on the present site of Winchester city (Biddle 1975a,b). Significantly, this would have stimulated agriculture in the hinterland: analysis of a second century sample from within the



■	Town or other communal settlement	WT	Winchester
□	Fort	SM	Snelsmore
●	Villa, temple, shrine or other substantial building	AWB	Amberley
▲	Mine or quarry	RM	Rimsmoor
◆	Pottery or kiln	OK	Okers
—— – –	Road	KW	Kingswood
		WH	Woodhay

Figure 10.3. Romano-British sites
Source: Ordnance Survey 1978

city showed arboreal pollen at less than 5% total pollen with herb and cereal (14.4% TP) prevalent,

> "a typical milieu of well-balanced agriculture with field crops and meadows" (Isenberg, quoted in Murphy 1977, 132).

The pollen evidence as a whole conforms with Murphy's plant macrofossil work in demonstrating that the area around the Roman town, as in the Iron Age, was almost completely disforested and in agricultural use. In both periods Sambucus nigra is recorded in the core WT 1 with Urtica in the Iron Age, nitrophilous plants of disturbed habitats for which Murphy (1977) records macrofossil remains in pre-Roman material. At the end of the period there is no significant reduction in cereal pollen, as far as can be discerned from the low resolution. This supports the hypothesis that despite the abandonment of villas, the Germanic soldier settlers continued to cultivate the same fields (Johnston 1981).

Snelsmore in contrast tends to show a lower intensity of activity during the Roman period than before. Arable cultivation, previously low (section 10.4.2.) seems to have been minimal whilst elevated herbs, notably Plantago lanceolata, Rubiaceae, Ranunculus type, Urtica and Rumex suggest some expansion of grassland and rough grazing, or its presence nearer to the site. Calluna is depressed probably through increased bog surface wetness as indicated by elevated Potamogeton with Cyperaceae and Sphagnum, rather than heathland reclamation. The replacement of Betula by Quercus and some Tilia may indicate minimal woodland disturbance.

Archaeological finds of the Roman period are relatively sparse generally, although there are two buildings 2km west of Snelsmore (Fig 10.3). However, this is probably a result of lack of systematic fieldwork: it

> "seems likely that the (Berkshire) downland acted as an agricultural hinterland to Silchester (Calleva) throughout the Roman period" (Richards 1978, 45).

Cultivation of the earlier 'Celtic' fields seems to have been maintained with the continuing avoidance of the heavier soils.

The absence of any major increase in activity at the beginning of the Roman period at these two sites may relate to their already maximum, or at least for Snelsmore, optimal, use in the Iron Age. The latter clearly remained important for grazing and as a woodland resource, as in much of prehistory.

10.5.2. RIMSMOOR, OKERS AND KINGSWOOD

The sites marginal to the Poole Basin differ with Rimsmoor and Okers showing a relatively low level of activity at this time whilst Kingswood demonstrates a continuation of trends initiated in the Iron Age.

Rimsmoor with its high resolution exhibits several phases but dating is difficult because this section of the time:depth curve (Fig 4.26) shows a reduction in accumulation rate from 3.84 to 6.92yrs cm^{-1}. A new constant rate, the straight line A in Figure 4.26 is improbable whilst an 'eyeballed' best-fit curved line B gives a date for the first appearance of Secale and Cannabis types as c.40bc, too old for these possible Roman crops (section 10.5.4.). Consequently, in the following, a mean curve, C, is applied, but the ranges provided by A and B are also shown.

After the Iron Age extensive clearance there is some regeneration of Betula, Quercus and Corylus across grassland and heathland from about 360cm, 50 bc (100bc-ad0). There was a temporary phase of cultivation of rye and hemp, as suggested by Secale type and Cannabis type pollen at about 340cm, 40ad (40bc to ad120). This was of minor extent with little effect on the regenerating forest, or may have been at some distance from Rimsmoor. It may relate to the initial period of the imposition of Roman rule. Tree, shrub and Corylus pollen however total less than 50% indicating chiefly open conditions (Tinsley and Smith 1974). This figure then rises to 70% indicating more extensive woodland of notably Corylus, Quercus and Fraxinus with Fagus and Carpinus. Indicators of grass and heathland nevertheless demonstrate continuing activity in the area. Finally, from 290cm, ad350 (ad230 to ad470) the opening of RM-7, there was major removal of Corylus, Quercus and Fraxinus until 260cm, ad540 (ad410 to ad670). Open conditions were then prevalent with grassland and arable cultivation as indicated by cereal pollen at 1 to 2% and marked increases in Anthemis type, Rumex, Artemisia, Sinapis type, Chenopodiaceae, Plantago lanceolata and P. media/major. Some expansion of heathland is also evident from the increase of Calluna, perhaps reflecting the deterioration of cultivated soils.

The Okers pollen data suggest from the proposed chronology that conditions around the site at this time were fairly open. Clearance of a presumably local copse of Quercus is recorded at about 80bc and the period, zone OK-2 ends at about ad350 with a recovery of Quercus and expansion of Betula. This is tentatively correlated with the Rimsmoor RM-6/RM-7 boundary. Grassland characterised the open area though some cereal pollen indicates cultivation in the first part of the period. The absence of regeneration at this time, which is recorded at Rimsmoor, reflects Okers' smaller pollen catchment: evidently, from the Rimsmoor data, there was advancing wood or scrub at too great a distance to be recorded in detail at Okers. Radiocarbon assays from Okers are required to confirm this hypothesis.

The evidence from Kingswood shows little major change between the interpolated Iron Age and Roman period. It is possible that the general clearance from about 95cm may be an early Roman effect rather than Late Iron Age as indicated by the time:depth curve. This nevertheless is seen as improbable given the general environmental continuity recorded at the other sites. The activity initiated at 95cm appears to have been maintained during the Roman period although declining cereal pollen suggests that agriculture contracted subsequently.

There was a concentration of Roman activity in the Isle of Purbeck: mines and quarries for shale, stone and salt were common and there were villas along the north foot of the chalk ridge (Fig 10.3.). The latter imply an exploitation of both the more fertile soils of the clays and poorer soils of the chalk and Poole Basin, an extension of Iron Age practices (section 10.4.3.). Taylor (1970) indeed states that many areas were cleared from the waste at this time. Apparently there was a contraction of settlement before the formal end of the Roman period which may account for the falling cereal pollen.

In Dorset overall the main effect of the Roman occupation was to impose peace for 400 years on the warring indigenous population, leading to accelerated population, settlement and agricultural growth (Taylor 1970). Dorchester (Dvrnovaria) was a major town and whilst many Iron Age settlements continued their existence, many new ones were created especially in the low-lying areas. Those on the downs apparently had a lower level of material culture relative to the sites of the river valleys emphasising the marginal nature of the chalk for agriculture (Taylor 1970). The Kingswood data seem to reflect the growing importance of the low-lying areas whilst the area represented by Rimsmoor and Okers may have been relatively neglected. The latter may have been a result of its location between two major river valleys (the Piddle and Frome) and near to impoverished heath developed on Bagshot sands. This area of London and Reading Beds apparently was not especially favoured for settlement at this time (cf. Haskins 1978) and this is in accord with the distribution of Romano-British remains (Fig 10.3.).

10.5.3. AMBERLEY

The pollen sequence from Amberley shows the clearance of a probably restricted area of pioneer Betula and Corylus woodland from about 80bc, the opening of AWB-5. As stated in section 10.4.4., this was probably at a time when there was a general clearance underway, as indicated by the already rising Plantago lanceolata. Tree, shrub and Corylus pollen attains a minimum for the zone and the diagram at 168cm, c.ad20 indicating predominantly open conditions within the pollen catchment (Tinsley and Smith 1974). This may have been exaggerated by lower levels of these types within the pollen rain as a result of coal and iron production within the central Weald, a major mining area at this time (Brandon 1974). Clearance was undoubtedly extensive with woodland of more fertile soils, as perhaps characterised by Tilia, Ulmus and Fraxinus, low or absent and with Calluna elevated indicating, as earlier, disforestation of more impoverised substrates. Overall, there seems to have been a continuation of the Iron Age intensity of land use.

From about ad260, the opening of AWB-6, there is a major increase of Betula. The frequencies suggest growth on the bog surface but birch wood was not encountered within the peat by myself, Godwin (1943) or Thorley (1971a). This evidently was part of a phase of regeneration on dry land as also indicated by the rising Quercus, Corylus and Fraxinus that may have included wetter areas to judge from the peak of Alnus. The event may have been initiated in the latter part of AWB-5 from the recorded increases in Betula, Ulmus, Quercus and Prunus, but greatly gathered momentum in AWB-6. Grassland clearly was reduced, although some of the fall in Gramineae and herbs will have been a statistical effect of the elevated Betula.

The phase lasts until about 590±80ad (HAR-4234) and approximately covers the period when there was, in fact, a general increase in the exploitation of the loams (Brandon 1974). These included the construction of a number of villas in the scarp foot zone (Fig 10.3). Bignor is an important example, located 4km west of the Wild Brooks and at its peak of development in the fourth century about 320ha of Upper Greensand and marly Lower Chalk were cultivated (Applebaum 1972). This dichotomy is perhaps best explained by relative abandonment of the sands to the north and east of Amberley and a concentration of activity at the scarp foot; the former may thus have experienced the regeneration recorded within AWB-6.

Drewett (1978) is in agreement with Taylor (1970) in viewing the chalk uplands as marginal. He notes that the alluvial soils of the major river valleys such as the Arun, Adur, Ouse and Cuckmere may have experienced continuous cultivation. In contrast, the thin chalk soils of the downs appear to show most evidence for ploughing at times of maximum population pressure: the Romano-British period, the medieval period and the twentieth century. This is similar, for example, to the more extreme environment of Weardale in Durham: at an upland pollen site there was evidence for two distinct periods of occupation, one Iron Age/Romano-British, one medieval/modern (Roberts, et al. 1973). At Wingham (Godwin 1962) there is little cereal pollen recorded after the Middle Bronze Age which may indicate a date when the upland chalk became 'marginal'. Evidence for early cultivation of the valleys has inevitably been largely destroyed by subsequent tillage. The data from Bignor however indicate cultivation of low-lying loam soils and other evidence even indicates the restricted farming of Gault Clay at Ripe and Chalvington (Drewett 1978). Of the surviving 'Celtic' fields in the South Downs most are of this date (Drewett 1978) suggesting extensive arable cultivation, but if the soils were impoverished manuring, marling (Drewett 1977a) and long fallow periods may have been necessary. Long fallow periods, a concentration of activity in the valleys and poor pollen dispersal may account for the almost total absence of cereal pollen before AWB-7.

10.5.4. CROPS

During Romano-British times cereal type undiff pollen indicates the cultivation of wheat, barley and perhaps oats in the pollen source areas of several of the sites. Another cereal, rye, appears to have been a crop from the records of Secale type at Winchester and Rimsmoor. Indeed, at Winchester a virtually continuous curve is present from WT-6, the Late

Bronze Age (section 9.4.1.2.). These records are earlier than the Saxon date, as at Kingswood, when Secale was probably under general cultivation (Godwin 1968, 1975a). A single seed grain was, however, found at Owslebury 7km south-east of Winchester in a first century bc context (Murphy 1977) and a similarly early pollen record to that at Winchester has been recorded by F. Chambers (pers.comm.). Hillman (1978 and pers.comm.) suspects that it was present as a weed of other cereal crops before it was cultivated in its own right in the sandier districts. M. Jones (1981) has, in fact, observed it as a component of Iron Age samples free from typical cornfield weeds.

Analysis of grain samples as a whole may fail to record rye because its grain can be very similar to that of other cereals, it may ripen earlier and it is free threshing, so both the rachis and grain may be dropped during harvesting (F.J.Green, pers.comm.). At Winchester it is recorded at 0.5 to 1% from the Late Bronze Age to about the seventeenth century ad, at Rimsmoor it is first recorded at c.ad0 and at Kingswood from about the end of the Romano-British period. These data attest to the pre-Saxon presence of rye in central southern England, although because of its well-dispersed, easily recognisable pollen, the crop was, nevertheless, of little importance (F.J. Green 1981). The prevalence of soils capable of supporting the more demanding cereals may in part account for its limited cultivation.

The Cannabaceae are readily recognisable pollen analytically, but it was not possible to distinguish hop (Humulus) from hemp (Cannabis) (section 3.2.4.). Hemp as a crop was probably most widely grown from the Saxon period (Godwin 1967a, 1967b), although macrofossil remains have been discovered in Roman samples (F.J. Green 1981). The pollen evidence is inevitably equivocal with a temptation to assign pre-Saxon records to Humulus and Saxon and later discoveries to Cannabis. Thus at Winchester, the sporadic records of the pollen in the Bronze and Iron Ages may relate to wild hop. However, at Rimsmoor the first records occur at 340 and 330cm (c.ad40) and coincides with the first find of Secale at 340cm; at Winchester there is a continuous curve from 144 to 128cm, c.ad100 to ad530. Both sites may thus indicate that hemp was introduced by the Romans. It should be noted, however, that in this century Humulus is common in Dorset (Good 1948) and that the identification of Secale type pollen, by definition, need not indicate that there was rye in the respective pollen catchments. At Kingswood two continuous curves are present, one from 100cm to 76cm, (430±80bc HAR-4367) to c.ad710, and one from 64cm to 56cm, c.ad1300 to 1675. The earlier must relate, at least in part, to Humulus, whilst the later may record the period in the sixteenth century when hemp cultivation was enforceable by law (Godwin 1967b).

Pollen of cultivated flax, Linum usitatissimum was not recorded at any site.

Evidence for other crops is still harder to detect. Seeds of the grass Bromus spp. frequently occur in Iron Age grain samples and Hubbard (1975) has argued that it might have been a crop, yet any pollen from this genus will have been included in the Gramineae count. Other crops include members of the Leguminosae, e.g. Vicia faba, the Celtic bean (M. Jones 1981), and various brassicas but these, if present, will have been included in the counts of Vicia type, Ononis type or Trifolium types and Cruciferae undiff or Sinapis type (see above) respectively. Various taxa, now considered to be weeds could also have been grown for human consumption. These may have included Polygonum convolvulus, Chenopodium album and Rumex acetosella (Helbaek 1954; Pennington 1974). Again this is difficult to show pollen analytically.

Arboriculture was probable during the Roman period at least (e.g. F.J. Green 1981; Murphy 1977). Juglans and Castanea are two exotic taxa readily detectable palynologically: only Kingswood and Snelsmore record one or both in the Iron Age or Roman levels and significantly at the latter there is a continuous Castanea curve throughout the later period. At Kingswood there is a virtually continuous curve of Castanea from the Iron Age to the present day. Sweet chestnut is generally regarded as a Roman introduction (Godwin 1975a) but these data may indicate early plantings, long distance pollen transport or conceivably an incorrect chronology. In addition, the pollen could possibly have been confused with that of Lotus spp., yet this is seen unlikely because of the care taken with identification, including the use of modern reference material. Juglans is recorded at most sites, but only sporadically. Others utilised include fruit trees, the pollen of which is included within Prunus type, and native species such as Quercus for pannage and Corylus for coppice and nuts. Inevitably, demonstrating unequivocally this form of arboriculture from these data is difficult, yet exploitation of the native species would seem highly probable.

In conclusion it is apparent that cereals, including rye were cultivated at this time with, possibly, hemp. Sweet chestnut, and perhaps walnut, evidently were introduced. Other crops are likely but difficult to demonstrate from the pollen evidence.

10.5.5. ROMANO-BRITISH PERIOD: CONCLUSION

From the sites investigated in this thesis it appears that there may not have been any significant increase in the intensity of agriculture on the chalklands during the Romano-British period. The chalk presumably was already experiencing an optimal level of exploitation and if anything this was a period when the focus of activity moved to other areas. In Wiltshire for example, Bonney (1968) found that whilst most Iron Age settlements were on the chalk, 37% of the Romano-British sites were on other geologies and these generally exhibited the more advanced elements. In Britain as a whole the number of iron plough shares on heavier soils increases dramatically at this time (Rees 1978) and many villas have a low ground distribution (Bell 1981b) (Fig 10.3). All this attests to the likely marginality of the downs by the Roman period (Drewett 1978; Taylor 1970). It appears however that only in the ensuing period was there any major cessation of arable cultivation on the chalk.

10.6. ENGLISH SETTLEMENT TO THE NORMAN CONQUEST

The ox-drawn mouldboard plough introduced by the Anglo-Saxons is traditionally seen as having led to major changes in the landscape. In East Anglia the deposits at Old Buckenham Mere (Godwin 1968), Hockham Mere (Sims 1978) and Epping Forest (Baker et al. 1978) show major intensification of land use at this time. Extensive forests remained nevertheless in some areas including, for example, parts of the Midlands (Pennington 1974). In northern England Anglo-Saxon activity was limited to low-lying areas as in the south-east Lake District (Oldfield 1963); elsewhere the earlier Celtic (Brigantian) form of land use continued until Scandinavian settlement in the ninth and tenth centuries (Pennington 1970, 1974).

10.6.1. THE AGRARIAN SHIFT OFF THE CHALK

Traditionally the period of English settlement was envisaged as a time when the downs were abandoned agriculturally in favour of the low lying heavier soils. The mollusc evidence for example does show a reduction of activity on the chalk with at Bishopstone (Bell 1977; section 2.1.2.2.) grassland instead of the arable of the Iron Age and to the north of Winchester there was the abandonment of Roman fields (Fasham 1980; section 2.1.2.2.). Indeed, there is the extensive survival of assumed Roman and Iron Age fields that could only have occurred had tillage ceased.

MacNab (1965) saw chalk soil exhaustion and erosion as the motivating factor and there is considerable evidence in the form of hillwash deposits. J.G. Evans (1975), however, states that the soils could rapidly have been returned to their former condition by natural processes and manuring: he believes the technological innovation of the mouldboard plough with coulter was most significant. This permitted the cutting and turning of a sod and hence the cultivation of heavy clay soils. Taylor (1970) invokes a similar explanation in describing the contraction of settlement from the Dorset downs which was probably hastened by falling water tables. It was not a total change for, as Bowen and Fowler (1966) indicate, the lighter soils of the lowlands had already experienced cultivation. Since the Neolithic the lowlands had been an important part of the chalkland economy (Drewett 1978, 1980; Field _et al._ 1964; Legge 1981; Taylor 1970) and this is illustrated by the distribution of archaeological sites (Figs 9.3, 10.2 and 10.3). Overall, there was an intensification of activity in the lowlands with a swing to pastoral uses on the chalk.

The evidence from the sites conforms broadly with this sequence of events. At Winchester there is a slow reduction in the frequency of cereal pollen from about 136cm, c.ad310 and an increase is apparent in grassland and woodland, the latter dominated by _Quercus_, _Fraxinus_ and _Fagus_. Significantly perhaps, Micheldever Wood, located 7km to the north-east, developed largely after the close of the Roman period (Fasham 1978a). An abrupt end to cultivation is not discernible in the pollen diagram for the following reasons: the early settlers continued to farm some of the Romano-British fields (Johnston 1981); the representation of valley and upland environments in the pollen source area; and perhaps the need to supply a small, though declining, urban population at Wintancaester (Winchester; Biddle 1975b). The progressive reduction in cultivation as suggested by the fall of cereal pollen may indicate the influence of some soil deterioration as perhaps demonstrated by the rising alkalinity of the peat (to a maximum of pH 7.5). Grazing apparently became relatively more profitable.

Four of the sites show changes perhaps resulting from the shift in agriculture off the chalk: Amberley, Snelsmore, Rimsmoor and Okers. The period is represented at Amberley by zone AWB-7 which shows from 590±80ad (HAR-4234) rapidly falling Betula and a continuous curve for cereal pollen. As discussed in section 10.5.3. the Betula pollen was probably derived from birchwood in the vicinity of the Wild Brooks, perhaps on the sands to north and east. Its reduction together with Corylus is suggestive of clearance for agriculture. Some expansion of heathland is apparent from the rising Calluna pollen, probably as a result of the tillage of readily podzolised soils. As in AWB-5, it coincides with clearance indicating pollen derived from other than the bog surface. The latter was characterised by Cyperaceae, Sphagnum, Molinia and Phragmites with a wetland species of Rumex, e.g. R. hydrolapathum, to judge from the high pollen frequency. Crops cultivated included rye, perhaps on the adjacent sands, and possibly hemp. Rising Quercus and Fagus pollen may indicate woodland regeneration on the steeper chalk slopes (Godwin 1943; section 10.6.2.).

The situation portrayed at Amberley contrasts with documentary and other sources which indicate that there was little change at first (Brandon 1974). Presumably this relates to local factors and, in particular, to the already established farming along the scarp foot; the period seems to have witnessed an expansion northwards from this zone.

At Snelsmore an abrupt change occurs at about ad360 which persists until c.ad1470 (zone SM-6). Betula and Alnus are raised and Gramineae and herbs reduced, yet cereal pollen is recorded more frequently but in a sporadic manner. Place-name evidence suggests woodland clearance in this area of heavy soils in the early Anglo-Saxon period (Gelling 1978; Richards 1978). Names ending in leah are characteristic of such activity at this time and one of the closest is Chieveley 3.5km to the north. Interestingly, strip lynchets at Chieveley were in use in the tenth century (Richards 1978): these features normally originate in the post-Roman period (Taylor 1975; Whittington 1962) yet were more characteristic of medieval agriculture. It suggests that in this area there was an early shortage of farmland.

The elevated Alnus and Betula imply colonisation of a zone fringing the bog, whilst slight increases in Ulmus and Tilia may indicate some regeneration on the more fertile soils. From comparison with the surface sample, cultivation may have been practised on the surrounding chalk soils. However, it could also have been underway within the valley, because the clay and silt content of the deposit is very much higher during SM-6 than at any other time. It is perhaps analagous with the results of work on modern pollen deposition at a bog in Fife, a site ringed by woodland, but within open farmland (Caseldine 1981).

It was suspected that the change in stratigraphy at 157cm (Table 4.2) (the opening of SM-6) where a thin layer (c.5cm) of dark peat was overlain by clayey peat was a result of recent peat cutting. The radiocarbon date of 660±80ad (HAR-4236), the form of the time:depth curve (Fig 4.12) and the progressive nature of the pollen frequency changes across the junction mitigate against such a major disturbance. Only a temporary reduction in accumulation is therefore envisaged. The resulting variations could account for the early date of ad360 for the opening of SM-6, if this does indeed mark the start of Saxon activity.

Tillage may have been underway on the Plateau Gravels as possibly indicated by rising Calluna pollen; herbs such as Rumex, Plantago lanceolata and Liguliflorae indicate nevertheless that grassland was most frequent in the open areas. From about 120cm, c.ad1010, Ulmus, Quercus, Tilia, Alnus and Corylus are reduced whilst the cereal pollen record is more continuous: this could relate to the period of land pressure recorded at Chieveley by the use of strip lynchets. Charcoal is common throughout SM-6, perhaps relating to an agricultural practice, such as grain drying or plausibly the use of alder and birch in charcoal production for smelting.

In Dorset there was an increased occupation of low-lying sites from the third and fourth centuries but from documentary, burial and place-name evidence the Anglo-Saxons were excluded from the Poole Basin until about ad650. An essentially Romano-British lifestyle may have persisted until that time (Taylor 1970). The Rimsmoor data show little relationship with these trends: there is a major clearance from 290cm, ad350 (range ad230 to 470; see section 10.5.2.), attaining a maximum at 260cm, ad540 (ad410 to 670) followed by regeneration which culminates at 220cm, ad825 (ad700 to 950). There is then renewed clearance. The discrepancy probably arises from the uncertain accumulation rate (section 10.5.2.) and local variations in land use independent of overall cultural factors.

Clearance affected chiefly Quercus and Corylus, the most prevalent woodland species, but also Alnus and Carpinus. Woodland was progressively reduced and from 275cm tree, shrub and Corylus pollen totalled less than 50% indicating predominantly open conditions around the site (Tinsley and Smith 1974). Throughout the period cultivation appears to have been fairly constant, but falling woodland and indicators of grassland, and rising Calluna and Pteridium imply progressive soil deterioration necessitating the clearance of more fertile woodland soils for agriculture. Secale type pollen comprises about half of the total cultivar pollen supporting evidence from, for example, Old Buckenham Mere (Godwin 1968, 1975a) for its importance at this time. However, this may have been over-emphasised for the reasons mentioned in section 10.5.4. and the fact that many pollen sites are in the sandy, acid localities most suited to its cultivation. Hemp may also have been cultivated in the vicinity. The evidence overall tends to support Haskins' (1978) contention that one of the areas of the Poole Basin to which cultivation was confined were the marginal London and Reading Beds.

At Okers the period is represented by OK-3 c.ad350 to ad990 which opens with falling Quercus, Betula and Corylus and an expansion of grassland, assumed to correlate with the clearance at Rimsmoor dating to c.ad350. Some cereal pollen is recorded and, as for the Roman period, low arboreal pollen (generally under 30%) implies little woodland within the pollen catchment. The greater amount of tree as well as cultivar pollen recorded at Rimsmoor again reflects its larger pollen source area and the presence of woodland and cultivation at some distance from the sites. The area immediately around both sites was probably largely free from trees but at a distance there may have been a woodland edge advancing or contracting, or sporadic trees increasing or declining in number, depending on population pressure. Haskins' (1978) comprehensive survey of the documentary evidence indicates that there was little woodland at this time - timber was even imported from the north of the county - yet there may have been some confined to the London and Reading Beds. One obvious source of this pollen at Rimsmoor and Okers may have been Oakers Wood located 500m to the south at the present day. It may have been in existence at this time to judge from the place-name evidence (Brocklebank 1968; Mills 1977).

Kingswood shows little evidence for change at the end of the Roman period, if the effects of an exceptional, presumably locally derived, peak of Liguliflorae is taken into account. It presumably reflects the continuation of the Romano-British way-of-life and, in particular, the already established farming along the foot of the chalk ridge. (The ridge itself, with its steep slope, would clearly have been unsuitable for intensive cultivation.) Nevertheless, rising Betula, Corylus and Calluna, and low cereal pollen may indicate some abandonment of fields. The record of Picea at 80cm, c.525ad may be contamination, although Barber (1981a) records it at Bolton Fell Moss in Cumbria as a possible Norse introduction. Insofar as a single pollen grain can indicate actual presence of a species, this record may likewise indicate its introduction into southern England during this period.

The data from Amberley, Snelsmore and possibly Rimsmoor and Okers may attest to an agrarian shift off the chalk in the Anglo-Saxon period. Little major effect is recorded at Winchester presumably because of the diverse pollen catchment and the existence of an urban population. At Kingswood the shift had probably occurred by the Roman period.

10.6.2. THE HISTORY OF FAGUS

The beech is frequently characteristic of chalk woodlands yet palynological work (e.g. Godwin 1943, 1962; Thorley 1971a, 1981; Waton, this thesis) indicates that it is a recent phenomenon.

Various explanations have been advanced for the late rise of Fagus. Godwin (1975a) suggests that beech could only compete successfully against oak during the recolonisation of limestone soils after forest clearance. However, Thorley (1981) questions the ecological validity of this argument and instead suggests that dispersal of the relatively heavy

Fagus pollen grains would have been more effective in an open landscape. This hypothesis may be invalid nevertheless because such an effect could be offset by the reduced number of beech trees in a more open landscape. Only where a site was located on the edge of a woodland might this operate. For example, at Rimsmoor Fagus is recorded, with Pinus, during the Ulmus and Tilia decline clearances. Removal of surrounding and overhanging trees may have permitted a greater proportional representation of the regional pollen rain, which may have included more Fagus and Pinus than the local (e.g. from within 20m of the site; Jacobson and Bradshaw 1981; section 2.4.3.) pollen rain.

A form of indirect human activity probably provides a more generally applicable explanation. Tansley described in 1949 how the shallow chalk rendzinas are not conducive to the establishment and growth of oak and as a result beech is dominant (section 2.2.1.). Cousens (1974) concurs with this view. In a sense this is compatible with Godwin's (1975a) explanation: Fagus could have successfully competed with Quercus after clearance if consequential soil deterioration had rendered the soils unsuitable for Quercus. Much data have already been advanced illustrating the likelihood of soil degradation and erosion on the downs. However, beechwoods are not confined to rendzinas: on the South Downs they occur on Clay-with-flints and widely in the New Forest. Indeed, as mentioned in section 2.2.2., beech is common on well-drained clays, sands and gravels. Tansley (1949) describes how on loams and deep soils both Fagus and Quercus flourish, but beech is at an advantage as it grows at least equally tall and casts a deeper shade (section 2.2.1.). Were this the situation, then pollen diagrams from southern England might be expected to show mid-postglacial woodlands dominated by Fagus. This clearly is not so and the reason for Tansley's statement probably lies in his neglect of recent forest management. In the New Forest, for example, much of the present dominance of Fagus may be a result of the preferential removal of Quercus for ship building in the eighteenth and nineteenth centuries (Tubbs 1968). Thus only on the thin chalk rendzinas may beechwood form a climax community.

This may be demonstrated particularly well at Amberley where Fagus rises from about 100cm. This was dated to 590±80ad (HAR-4234) and, as discussed in section 10.6.1., marks the beginning of a phase of clearance of, in particular, birchwood, and there is evidence for cereal and perhaps hemp cultivation. Contemporaneously, as well as Fagus, there is increased Quercus and Fraxinus. The fossilisation of essentially Romano-British field systems on the downs (Drewett 1978), the archaeological data for an agrarian shift to lower areas (e.g. Brandon 1974) and the increased Calluna imply that the clearance may have been of woodland on the nearby sandy soils (section 10.6.1.). Thus the rising pollen of Fagus, Quercus and Fraxinus presumably relates to the expansion of these trees across abandoned arable areas: from the foregoing discussion presumably on the chalk upland. Fagus, perhaps with Fraxinus may have been prevalent on the more degraded soils of the steeper slopes with Quercus on the deeper soils and clays. This may have occurred rather earlier, during the Romano-British period, in East Kent in view of the level of the rise of Fagus at Wingham (Godwin 1962).

The hypothesis may similarly explain the behaviour of beech at Winchester and Snelsmore where it tends to be elevated during periods of regeneration. There is a continuous curve at low frequency at Winchester at the end of WT-4, the Middle Neolithic, when Quercus, Betula and Corylus are rising. It ceases in WT-5, the Late Neolithic, with general, but minor, clearance. In the expansion of woodland characterised by rising Quercus pollen in zones WT-6, WT-7 and WT-8 (Middle Bronze Age to Medieval) Fagus again exhibits a continuous curve. This may denote soil deterioration as early as the Neolithic, which indeed is implied by Fasham and Schadla-Hall (1981; section 9.4.1.1.) and is supported by a hillwash recorded in the Devil's Kneadingtrough (Kerney et al. 1964; section 2.1.2.1.). At Snelsmore, Fagus is sporadically recorded in the Iron Age, with higher, more consistent frequencies in SM-6 (c.ad360 to ad1470), both perhaps recording its colonisation of abandoned chalk soils, as well as, possibly, the Plateau Gravels. It is conceivable that the Iron Age record may owe its origin alternatively to the dispersion theory of Thorley (1981).

In the Poole Basin sites, Fagus tends to become more frequent during clearances and this is also recorded at several of Haskins' (1978) sites, for example Morden A, Rempstone and Godlingston A and B. At Rimsmoor it is recorded continuously from the beginning of RM-6, c.350bc perhaps indicating some increased representation of the regional pollen rain. However, in view of the extent of this clearance it may also record a real extension of the species, conceivably on the chalk if this clearance was a result of an overflow arising from soil deterioration, a manifestation of a dwindling resource (see section 10.4.3.). Interestingly, during the Medieval peak of cultivation (section 10.7.1.) Fagus is reduced indicating that land pressure was so considerable that areas formerly considered too degraded for agriculture were returned to arable or pastoral uses, or alternatively, the fact that by this time the soils had recovered in depth and fertility (Evans 1975; section 10.6.1.). At Okers the pollen frequency is very low yet corresponds broadly with the fluctuations recorded at Rimsmoor. Whilst during the Tilia decline at Rimsmoor the dispersion theory may have been in operation, it is conceivable, from the probability of soil deterioration as indicated by the clay inwash, that there may have been an actual local expansion of the species over degraded soils.

At Kingswood Fagus occurs sporadically in KW-4, from c.1375bc, and is most frequent during the interpolated Roman levels in KW-5. The possibly larger pollen source area (section 4.6.2.) mitigates against the operation of the dispersion theory as outlined by Thorley (1981) and thus in KW-4 a real expansion is perhaps indicated. In KW-5 it peaks with Fraxinus as Quercus is falling after a rise from 95cm c.200bc. Fagus and Fraxinus then decline as Betula, Alnus, Corylus and Calluna are rising. Throughout cereal pollen is falling, but the absence of a Betula peak before the maxima of Fagus and Fraxinus indicates that these did not expand across formerly arable areas. Precisely what was happening at this time is difficult to ascertain, yet Fagus appears to be involved in woodland regeneration within the pollen catchment. Its subsequent decline with this woodland could indicate clearance for agriculture whilst former open areas were abandoned, to experience pioneer woodland growth or heathland development. Thus at Kingswood it seems to be involved in woodland regeneration, although this is harder to explain directly in terms of increased competitive ability because of soil deterioration.

The recent expansion of Fagus is clearly a genuine phenomenon, although the pre-Ulmus decline records at Kingswood and Rimsmoor support Godwin's (1975a) and Thorley's (1981) contentions that it was a component of the Atlantic forests. The cause of the expansion apparently was intrinsically associated with human activity with soil changes and woodland management crucial. Finally, it should be mentioned that Thorley (1981) also invokes climate, viewing the phenomenon as the expansion of an Atlantic species. With human activity so pronounced in this period confident identification of a climatic influence is difficult, but it seems unlikely for this conflicts absolutely with Godwin's observations. He notes that Fagus is restricted by late spring frosts, low summer temperatures and increased precipitation, all characteristics of the Subatlantic climate (Godwin 1975a). Rackham (1980) does, however, describe the importance of weather: warm, moist summers coinciding with periods of agricultural recession may have been particularly favourable for Fagus.

In earlier interglacials, Fagus generally appears late and behaves in parallel with Carpinus; many postglacial diagrams also show late rises of Carpinus. It is only sparsely recorded at the sites in this thesis and where present as a continuous curve, as at Rimsmoor, it is recorded with Fagus. The generally low representation at, notably Winchester, but also Amberley, probably reflects its dislike of thin chalk soils and preference for sandy or loamy clays (Clapham et al. 1968; Godwin 1975a; Rackham 1980). This is further evidence in support of the role of soil deterioration in the late proliferation of Fagus.

10.6.3. ENGLISH SETTLEMENT TO THE NORMAN CONQUEST: CONCLUSION

The sites in this thesis do provide some evidence for a shift in the location of agricultural activity off the downs at the beginning of the Anglo-Saxon period. This was, however, a continuation of trends initiated in the Roman or earlier periods as indicated, for example, by the low-lying villas near Amberley and Kingswood. Rimsmoor, Okers and Snelsmore all show some increase in land use intensity during this period. The chalkland site of Winchester does not show any major reduction at this time and this is partly explained by the diverse pollen catchment which would tend to disguise any shift in emphasis away from the downland plateau.

It is apparent from the data that there was not solely a change from the cultivation of the downland to the cultivation of low-lying areas. As Bowen and Fowler (1966) indicate, the latter had been exploited previously: it was simply that the Anglo-Saxon and subsequent concentration of activity in those areas caused the obliteration of all earlier remains, whilst the pastoral use of the downs led to a fossilisation of field systems. The intensity of Anglo-Saxon settlement in this area of southern England was such that the Scandinavian activity, so readily discernible in the north, is not easily detected at the sites in this thesis.

The initial expansion of Fagus appears to have been a result, most notably, of the abandonment of degraded chalk soils.

10.7. THE MEDIEVAL PERIOD

For the purpose of discussion the Medieval period is regarded as lasting from 1066 to 1350. It thus begins at the Norman Conquest which saw the creation of the Royal Forests, the introduction of rabbits and the compilation of the invaluable but equivocal document of the Domesday Book. It was a time of climatic warmth with temperatures almost of the levels prior to 1500bc (Barber 1982; Lamb 1977, 1982). Population may have doubled (Fowler 1978) but in the early fourteenth century deteriorating climate, economic recession and finally the Black Death reduced it by up to a third.

10.7.1. SNELSMORE, AMBERLEY, RIMSMOOR AND OKERS

Five of the sites show, from elevated cultivar pollen, increased arable at this time. At Snelsmore, the cereal pollen record is more continuous from 120cm, c.ad1010, the latter part of SM-6. Contemporaneously, Quercus, Tilia, Corylus and Alnus pollen are reduced and Betula is increased. Gramineae and herbs are higher, notably Rumex, Plantago lanceolata, Sinapis type and Ranunculus type. Essentially there was little change from before with Betula and Alnus still abundant in the valley, but the reduction in other tree pollen types and higher herbs suggest some disforestation. This may have taken place in the surrounding clays although it is difficult to determine from the single core.

Richards (1978) envisages a fully settled late Saxon landscape so that demographic or economic pressures may have been reflected in more intensive land use. Scatters of thirteenth century pottery, however, also may indicate the temporary cultivation of poorer soils, such as those at Snelsmore. From the Domesday Book it appears that there were numerous villages in the Lambourn and Pangbourne valleys and in this southern part of the Berkshire Downs pasture and arable were common (Darby and Campbell 1962). Extension of open areas and arable at Snelsmore would thus be compatible with the documentary evidence. Apparently, activity remained at a low level, but perhaps this is exaggerated by the locally wooded or carr condition of the valley bog. Interestingly, according to the Domesday Book, the clays of the Wiltshire, Hampshire and Dorset chalk remained under woodland (Darby and Campbell 1962; Darby and Welldon Finn 1967).

Rimsmoor provides the most concise evidence for increased cultivation. From about 220cm, c.ad825 (range ad700-950; section 10.5.2.) Corylus is markedly reduced with falls also in Betula, Ulmus and Quercus indicating general woodland clearance. This progressive clearance persists until 160cm, near the end of RM-7 with peat from 150 to 175cm dated to, significantly, 1340±60ad (HAR-3924). At 160cm tree, shrub and Corylus pollen total only 25% implying that the pollen catchment was extensively free from woodland. Cultivar pollen rises rapidly from 200cm, c.ad995 (ad880-1110) to a peak at 160cm, c.ad1350, and is dominated by cereal type and Cannabis type pollen with Secale type reduced. The parallel movement of cereal and Cannabis types suggest that hemp was being cultivated. In total the cultivars attain 13.6%, the highest recorded at any of the seven sites for any period, yet application of Turner's (1964b) and Roberts et al. (1973) arable/pasture ratios still indicate predominantly pastoral conditions (section 3.2.6.). However, there was clearly a considerable increase of cultivation at this time and Haskins (1978) maintains that the London and Reading Beds were one of the areas in the Poole Basin that had been most cultivated since the Iron Age. This factor with the date mitigates against the phenomenon being a result of solely a shift of agriculture nearer to Rimsmoor.

The evidence from Rimsmoor is reinforced by Okers where OK-4, c.ad990 to 1400, is characterised by cereal pollen at up to 3%. It indicates rather less cultivation than in the Rimsmoor pollen source area. Rising Betula and Corylus and falling herbs, for example Rumex and Plantago lanceolata, show that at least around Okers there was some reduction in the intensity of land use later in the period. Falling Calluna may indicate some reduction of heathland, yet this could be a result of its retreat from the bog surface: it may have become wetter at this time from the increasing Potamogeton and Sphagnum.

In Dorset generally the chalk was largely free from woodland and under pasture with settlement and arable concentrated in the valleys. The central heathlands were probably used chiefly for pasture and as a source of furze, alum and copperas (Darby and Welldon Finn 1967; Haskins 1978; Taylor 1970). The use of furze as a fuel and continuing imports of wood from the New Forest (Haskins 1978) indicate the overall paucity of woodland. The Domesday Book records some marginal woods, and these may have included Oakers Wood (section 10.6.1.). Woodland contraction as recorded at Rimsmoor may attest to clearance of parts of this, whilst disforestation as a whole and the increase of farms on the margins of the Poole Basin is compatible with the documentary evidence (Darby and Welldon Finn 1967; Taylor 1970). In this area of Dorset the founding of Cistercian houses, such as Bindon Abbey, probably had little significant effect on landscape history (Taylor 1970). This is in marked contrast to parts of the highland zone where, for example, at Tregaron (Turner 1964b) and in the south-east Lake District (Oldfield 1963) the establishment of the monasteries are readily shown by an intensification of farming in pollen diagrams. In Dorset the areas occupied were already subject to agriculture.

The reduction of rye and increase in hemp cultivation may indicate the edaphic preferences of the crops in an area of clayey soils. Secale is better suited to sandy soils and Cannabis to the more fertile loams (Stevenson 1815).

The period at Amberley is represented by zone AWB-8 which extends from ad1060 to about ad1400. Cultivars again peak and this is mainly accounted for by Cannabis type pollen. It was hypothesised in section 10.6.1. that the Anglo-Saxon times witnessed a greater cultivation of the sands in particular and reduced farming on the downs. This appears to have been perpetuated into the Medieval period with the possible cultivation of the Gault Clay belt. The falling Quercus may imply some clearance of oakwood on this outcrop and the soils could have been suitable for hemp cultivation. The Cannabis type pollen probably relates to hemp because the date implies a crop, rather than its derivation from wild hops, and the fact that hops were not cultivated for use in brewing until about the early sixteenth century (Parker 1934). This would also conform with the Domesday Book which records numerous villages, a high population and a large number of ploughs in the scarp foot zone and in the river valleys. The Vale of Rother extending westwards from the Wild Brooks in particular was fairly prosperous with mills, meadows and some fisheries (Darby and Campbell 1962). After the Domesday Survey population increased and there was continuing clearance and marsh reclamation (Brandon 1969, 1974).

Falling Cannabis type pollen from about 16cm indicates that at least locally agriculture was contracting by c.ad1270. Woodland regeneration is apparent before this date from the increasing Betula, Quercus and Corylus whilst rising Calluna may indicate an extension of heathland on the adjacent sands of the Folkestone Beds. The latter could also reflect colonisation of the bog surface by heather. Changes at this time in the bog vegetation are indicated by a transitory peak of Cyperaceae, increasing Sphagnum and falling Rumex, possibly R. hydrolapathum (section 10.4.4.). The area of grassland was presumably also reduced as perhaps suggested by lowered Plantago lanceolata and Liguliflorae although these, like Chenopodiaceae and Artemisia, may also have been weeds in arable fields (e.g. Behre 1981).

10.7.2. WINCHESTER AND KINGSWOOD

At Winchester and Kingswood there is no clear evidence for increased arable cultivation during Mediaeval times.

The period is represented within the first part of WT-8 when arboreal and cereal pollen are falling. Only the sample at 104cm is referable directly to the Medieval yet the trends of which it is a part last throughout WT-8 (ad1060 to 1700) so this need not hinder interpretation. The archaeological evidence shows that the town of Winchester had, by 1066, become a major commercial settlement, the ancient centre of the Kingdom of Wessex, and that it continued to flourish until the end of the eleventh century (Biddle 1975b; Hughes 1981). It was, furthermore, surrounded by a concentration of settlement (Hughes 1981). The Domesday Book shows that the downs had the highest population and number of plough teams in Hampshire and both were most common in the valleys of, notably, the Itchen, Test and Meon (Darby and Campbell 1962). Strip lynchets proliferated, although many may have originated between 400 and 800ad (Smith 1980; Taylor 1975; Whittington 1962) and renewed hillwashing is recorded in, for example, the South Downs (Bell 1978, 1981a), Wiltshire (Evans 1972) and Hertfordshire (Waton 1982a).

The evidence for widespread cultivation at this time perhaps implies that the peak of cereal pollen at about 136cm should date to c.ad1200 instead of the interpolated ad310. Re-aligning the time:depth curve to this scheme gives the start of the cereal curve at 184cm a date of 360bc which would be compatible with the beginning of Iron Age agriculture as recorded at, for example, Frogholt (Godwin 1962; section 2.1.1.1.). This, however, is seen as unlikely in view of the archaeological correlations already discussed and the necessity for a doubling of the accumulation rate after the proposed ad1200 level, 136cm, for which there is no pollen or stratigraphic evidence.

The most feasible explanation for the anomaly is that the flood plain in this section of the valley was, because of extensive fen development, unsuitable for arable agriculture. In this it may have contrasted from areas upstream and downstream. Similarly, and perhaps as indicated by the continuing decline of cultivars, the long period of clearance and farming in the area had rendered the soils of the chalk too degraded for extensive cultivation. However, it may be significant that at 96cm cultivar pollen is not recorded: this level has an interpolated date of c.ad1390, perhaps correlating with the fourteenth century recession.

At the Winchester site the most pronounced manifestation of land pressure is declining woodland shown especially by falling _Quercus_ pollen and the extension of grassland as indicated by rising Gramineae, _Plantago lanceolata_ and Liguliflorae. This is seen as a genuine effect for changes in solely the fen vegetation are unlikely to have led to the fall in _Quercus_ pollen. _Viscum_ interestingly peaks at this time, as during the regeneration in WT-6: an explanation for this may relate to better pollen dispersal during periods of woodland change. Woodland continues to contract and grassland expand throughout most of WT-8 and this presumably records the growth of sheep farming on the downs. Nevertheless, it is possible that some of the clearance was for cultivation, although one market, the city of Winchester, was in decline from 1100 (Biddle 1975b). The location of any arable may have been at too great a distance from the sampling site for the poorly dispersed cereal pollen to be recorded.

As mentioned above, the Kingswood data fail to show convincingly an increase of activity at this time. This may inevitably have been a result of the low resolution of the diagram for the period is represented by only two counts, 64 and 68cm, c.ad1280 and 1075 respectively. The sample at 68cm does show 1% cereal pollen but as this is an isolated peak it could have been a result of stochastic factors. Betula and Quercus pollen however are temporarily depressed so this could indicate some limited clearance for cultivation. Rising Corylus and, later, Betula and Quercus however indicate that overall there was a reduction in the open area, particularly heathland, but with trees, shrubs and Corylus at about 30% open conditions still prevailed in the pollen catchment.

The absence of any more marked effect at this time plausibly may have been caused by the removal of the peat deposited during this period by peat cutting. Such activity is evident from the stratigraphy and present vegetation at, for example, Godlingston Heath (Haskins 1978) and in parts of the Kingswood bog (section 4.6.2.). However, the only obvious change in stratigraphy of the Kingswood pollen core is at 123cm where clayey mid-brown peat overlies dark-brown Molinia peat. The pollen curves, though, fail to show any major changes at this level (cf Godlingston A, Haskins 1978, and Blelham Bog, Oldfield 1970b) other than continuing progressive clearance. The contention that this level was not a cutting junction was supported by an assay of material from 95 to 104cm which gave a date of 430±80bc (HAR-4367). Furthermore, this date, from the form of the time:depth curve (Fig 4.36) implies that the material above also has not been disturbed by cutting, an hypothesis supported by the consistent trends in the pollen curves. Inevitably, it can only be confirmed by further radiocarbon determinations.

The inverse relationship of Corylus and Myrica in C-4 and C-5 at Kingswood is worthy of comment for this may imply confusion in identification. The work was undertaken before publication of the results of Edward's (1981) experiment which demonstrated that it was difficult to separate Corylus and Myrica pollen with confidence using light microscopy.

However, it was found that at this site two distinct populations of 'Coryloid' grains were found and these were separated into Corylus and Myrica respectively (section 3.2.4.). Replicate counts of the C-4 and C-5 levels repeated the inverse relationship. This may be accounted for by the consistency of the single operator and locally distinct populations of Corylus and Myrica giving rise to distinctly different pollen grains. Two of Haskins' (1978) sites, East Stoke Fen and Luscombe, incidentally, show similar changes in Corylus at the same time and there is also an ecological explanation for the behaviour of the curves. The peak in Corylus coincides with maxima in Betula, Ulmus, Quercus and Alnus at Kingswood and minima in Gramineae and herbs implicating its part in a period of general woodland regeneration. This would have led to higher infiltration and less surface run-off of nutrients into the bog and thus a reduction in their availability for Myrica; bog myrtle is usually present in flushes as in the case of the modern community at Kingswood (section 4.6.1.). With the reduction in broadleaved species in KW-7 and thus increased run-off, Myrica again proliferated on the bog.

10.7.3. THE MEDIEVAL PERIOD: CONCLUSION

Four of the sites in this thesis show clear evidence for an extension of arable farming during the Medieval period. Comparison with the modern surface samples suggests that at two, Rimsmoor and Amberley, cultivation was more extensive during that period, at least within the pollen catchment, than at any time before or since. Both, particularly Rimsmoor, clearly record the fourteenth century recession that culminated in the Black Death, a palynological phenomenon foreseen by Godwin in 1975 (Godwin 1975a, 478). The evidence from Winchester shows falling cultivation, perhaps reflecting the degraded nature of the local soils, and the early expansion of sheep farming.

Much of these data are unique because in lowland Britain peat cutting, as at Cranesmoor in the New Forest (Barber 1975, 1981b; Seagrief 1960), has caused the loss of these levels. Most of the comparable evidence for an extension of arable farming is from other regions; for example, Old Buckenham Mere in East Anglia (Godwin 1968), Tregaron in Wales (Turner 1964b) and the Lake District (Oldfield 1963; Pennington 1970).

10.8. MID-FOURTEENTH TO EIGHTEENTH CENTURIES

Historically, the period from the mid-fourteenth century was one first of recession after the collapse that culminated in the Black Death, and subsequently slow recovery, notably from Tudor times. This took place against the background of the climatic deterioration of the 'Little Ice Age' (Lamb 1977; Dansgaard et al 1969). None of the sites shows all the expected trends illustrating the influence of local factors.

10.8.1. RIMSMOOR, OKERS AND KINGSWOOD

It is noticeable at Rimsmoor that at the maximum of cereal pollen at 160cm, c.1350ad, *Cannabis* type pollen is already declining from a peak at 170cm, c.ad1250 (range ad1210 to 1290). This presumably reflects a necessary emphasis on food crops at a time of rising population and also of the successive bad harvests that characterised the early fourteenth century (Donkin 1976). From 160 to 150cm in core RM 1, cereal pollen falls from 13.6% to only 2.2% whilst *Calluna* and Gramineae pollen rise, indicating an expansion of heath and grassland over formerly arable fields.

The date of the 150cm level in core RM 1 is equivocal because at this level the peat is overlain by a clayey deposit. It is younger than ad1340 because the radiocarbon sample was derived from 150 to 175cm: projecting a straight line (A in Fig 4.26) from dates HAR-3922 and 23 through HAR-3924 suggests ad1430. A line extending backwards from the surface through core RM 2 and taking the rise of *Pinus* at 105cm as ad1750 (section 11.5.) gives a date of c.ad1600: the curved line (B) from HAR-3922 and 23 was aligned on this point. As was discussed with reference to Amberley (section 9.4.5.), the projection backwards of peat accumulation rates through clay is of dubious value, and this is relevant at Rimsmoor for the pollen appears dilute. Thus the date of c.ad1600 for the clay/peat interface is undoubtedly a *terminus ante quem*.

The reason for the change in stratigraphy is itself equivocal. It was originally believed that the bog had been cut over and that the clay represented inwashing after the cessation of this activity (Waton 1980). Peat cutting clearly took place on Bryants Puddle Heath for it is mentioned repeatedly in the Frampton Estate Diary (1732-1778:DRO D29/E 68) and Okers has undoubtedly been affected (section 4.5.1.). It is not, however, recorded in the Tithe Award of 1839. An attempt may have been made to drain the bog as indicated by the outlet in the east side: this is approximately the same depth as the stratigraphic junction (c.150cm). It is now thought that even after this action, the peat would have been too wet and incohesive for cutting (K.E. Barber, pers.comm.). Furthermore, all the pollen curves show little change across the interface; only Calluna and Quercus vary significantly and this may relate to the differing locations of the two cores within the bog. Comparison with Okers, zone OK-5, lends additional justification to this statement because of the similarity between OK-5 and RM-8 and the end of RM-7.

An alternative explanation proposed by Brocklebank (1968, pers.comm.) is that this is the site referred to in the Frampton Estate Diary as Starmoor. The Diary records that Frampton thought it might be useful if Starmoor was flooded by the construction of a dam. It fails to record whether the work was actually undertaken, although this type of activity was undertaken and is shown by a similar statement elsewhere in the Diary and the present existence of Millicents Pond at SY 827922. If Rimsmoor is indeed Starmoor then the best location for a dam would have been around the southern and south-eastern edges. The existing banks, however, are 5 to 20m in width, very much wider than would have been necessary for a dam, and furthermore, in cross section they are approximately aligned with the slope of the hill north and west of Rimsmoor. Four pits also failed to show any obvious stone wall or major soil differences that could be equated with the construction of an artificial bank. Damming of the present outlet cannot be discounted (see below). However, a re-assessment of the Frampton Diary suggests that it may have referred to the present Oakers Bog (Fig 4.19) rather than Rimsmoor. This is consistent with the clays that dominate the stratigraphy. The place name evidence is not helpful: the name 'Rimsmoor Pond' is first recorded in the First Edition One Inch Ordnance Survey Map of 1811. It is probably derived from rima meaning rim or edge and mōr, a moor or fen (Ekwall 1960; Mills 1977). I am indebted to Miss J. Brocklebank for the discussion and investigation of her theory: I alone am responsible for the views expressed.

An alternative explanation is provided by the reduction in the post-

Iron Age accumulation rate and observations of the intermittent nature of doline subsidence (Sperling _et al_. 1977). The former implies that the subsidence of Rimsmoor had been markedly reduced from about 2.6mm yr^{-1} to about 1.4mm yr^{-1}. The following sequence of events may be hypothesised: a threshold was crossed resulting in abrupt subsidence of one to two metres as indicated by the depth of the peat/clay interface; consequential flooding of the entire peat surface characterised first by the landslip from the oversteepened north-west side (section 4.4.1.) and, secondly, by the deposition of sands, silts and clays from the unstable basin sides (the _Potamogeton_ peak and Typhaceae record also attest to open water at this time); reduced deposition of inorganic material as the basin sides were vegetated and reduced in angle; and finally, renewed peat accumulation at a rate equivalent to about 2.2yrs cm^{-1} by encroachment of vegetation from the edges of the basin. Traces of sand, clay and silt within this peat, in contrast to that underlying, attest to the continuing loss of material from the basin sides.

This latter explanation is more plausible in view of the stratigraphic evidence yet human interference is inevitable. The outlet is critical in this respect for it must be man-made if this hypothesis is correct. An unsuccessful attempt at drainage may have been made, or alternatively and more likely in view of the Frampton's interest in pond-making, more precise control of water depth undertaken by sluice installation, itself perhaps intensifying flooding. Remains of sluices could not be found in the outlet, although these could have long since decayed.

The date of the proposed major subsidence remains unclear but some time between ad1600 and 1750 would seem reasonable. Assuming that the clay in RM 2 accumulated more rapidly than the overlying peat then this phenomenon may have occurred as late as the early 1700s. Peat accumulation prior to the event evidently took place in very wet conditions as indicated by the low humification (humo 1) and preservation of plant remains.

The Kingswood evidence shows some continuation of the regeneration evident from the Mediaeval period. _Betula_, _Quercus_, _Castanea_ and _Corylus_ are higher and _Calluna_ is reduced. Herbs overall, and including _Rumex_ and _Plantago lanceolata_, and _Pteridium_, are little changed suggesting that woodland expanded largely at the expense of heath. This contrasts with the data from Rimsmoor and Okers where the area of woodland may have remained fairly static whilst grass and heathland expanded across former arable fields. However, at all three sites a low intensity of cultivation is indicated by records for cereal and, at Rimsmoor and Kingswood, Cannabis type pollen.

The initial reduction in cultivation recorded at Rimsmoor and Okers, and perhaps at Kingswood, accords well with the evidence of a major recession in the mid-1300s. Taylor (1970) records that in Dorset as a whole there was at this time a contraction and abandonment of settlements especially on the chalk and in the Piddle valley. He envisages that this was caused by the Black Death, soil deterioration on the chalk and general economic decline. The county was badly affected by the plague which entered the country through the Dorset port of Melcombe Regis in 1348. Farmland in the Poole Basin continued to be concentrated in the valleys and on the marginal London and Reading Beds. Haskins (1978) suggests that during this recession much of the farmland in these areas was allowed to revert to pasture and this is supported by the evidence from Rimsmoor. Continuing records, however, for cultivar pollen at the three sites indicate that cultivation continued at least on a small scale. This was of predominantly cereals but at Rimsmoor and Kingswood hemp may also have been grown, which would accord with the Tudor legal enforcement of its cultivation (Godwin 1967b).

An agricultural recovery is evident, from historical sources, from about 1500 (Baker 1976) and was manifested by further downland grazing, increased enclosure, heathland reclamation and, from c.1600, the creation of water meadows (Taylor 1970). This clearly had little effect in the two areas represented by the three sites for there are no detectable changes at this interpolated level. Heathlands were extensive during the period and in c.1750 they covered about 60% of the Poole Basin (Haskins 1978). High Calluna at the three sites attest to this yet its greater frequency in the Iron Age at Rimsmoor and the Roman period at Kingswood suggest that at last in these areas heathland may have been more abundant at these times. Communities on the bog surfaces may, however, have been inflating the frequencies.

None of the sites shows any great quantities of charcoal indicating the maintenance of heathland by cutting and grazing, rather than burning.

Fuel was indeed scarce at this time and wood was still being imported from the New Forest (Haskins 1978): furze, turf and peat would have been vital resources. Haskins' (1978) extensive investigation of the documentary evidence indicates that woodland was also restricted to the river valleys and marginal London and Reading Beds. She contends that this was composed chiefly of Quercus and Corylus because of their economic value. Rising Corylus and significant Quercus at all three sites support this proposal. Coppice-with-standards was probably prevalent. Similarly, there is no reason to reject her belief that Alnus was more frequent in the valleys whilst Betula was prevalent on the heaths.

Hutchins (1861), interestingly, records that in the fourteenth century a lime kiln at Corfe Castle was supplied with brushwood from King's Wood, the wood at present on the north slope of the chalk ridge overlooking Kingswood bog (section 4.6.). This implies the longevity of the wood and possibly its contribution to the pollen recorded in the bog. Fraxinus is present at about 2% in the modern sample and this wood appears to be the closest source of the pollen. If this correlation is correct then the rising arboreal pollen in KW-5 and its peak in KW-6 may indicate an expansion of this woodland to a maximum, or at least an extension towards the bog, in KW-6, ad1750-1850 (section 11.5.).

10.8.2. WINCHESTER AND SNELSMORE

The Winchester core does not show any major reduction in arable after the mid-1300s because of the already low level of cultivation within the pollen catchment (section 10.7.2.). Any real trends may however have been disguised by the fact that the period is represented by only two counts, yet this is seen as unlikely because of the consistency of the trends in the curves throughout WT-8. As before, woodland, especially of Quercus, continues to be reduced and grassland is extended, although the herb fluctuations are perhaps equivocal: Plantago lanceolata and Rumex are lower whilst Ranunculus type, Rubiaceae and Stachys type, which include fen species, are elevated. The fall is continued in pH, presumably as a result of surface run-off.

Settlement contracted during this period with Winchester markedly affected by its decline as a seat of temporal power in the fifteenth century (Barton 1981). Little actual desertion seems to have occurred until after c.1550: the number of settlements in 1300 and 1500 was similar (Hughes 1981). Of greater importance according to Hughes was the emparking movement and the building of country houses between 1500 and 1800, together with the Dissolution. These led to settlement shifting or depopulation. Hughes believes an additional factor may have been the lowering of the water table in the chalklands where 50% of the known deserted settlements of Hampshire are located. Indeed, the importance of the Black Death in leading to the abandonment of villages appears to have been greatly overstressed; as has already been discussed, other factors may have exerted a greater influence (Beresford and Hurst 1971; J.G. Evans 1975; Taylor 1970). These changes apparently had little major effect on the chalkland environment with grazing, particularly of sheep, centrally important to the rural economy. This is compatible with the evidence from Winchester, whether or not the area of grassland actually increased over this period.

J.G. Evans (1975) correlates the swing from arable to grazing with the climatic deterioration and labour shortage after the ravishes of the plague. At Winchester, this change probably began before ad1060 (section 10.6.1.) so at least in this area of downland other factors were in operation: soil deterioration has been proposed as perhaps the most important. Records of cereal pollen throughout WT-8 nevertheless show that cultivation was still underway, either on a limited scale, or at a distance from the sampling site.

The Snelsmore data show no discernible reduction in cultivation from the interpolated ad1350 level (100cm). This perhaps complies with the observation that few villages were abandoned between AD1316 and 1488 although there was some shrinkage and nucleation (Richards 1978). It may also reflect the greater resistence to degradation of the surrounding clay soils in contrast to those developed on the chalk.

From 93cm c.ad1470, SM-7, woodland clearance is recorded with Tilia and Alnus most affected, but also Betula, Quercus, Fraxinus and Corylus. Contemporaneously, Gramineae, Plantago lanceolata, Spergularia type, cereal, Cannabis type and Calluna are increased. Two phases are discernible separated by the brief recovery of Betula and Corylus, and a reduction of Gramineae. Tilia does not recover until this century suggesting either browsing or that clearance was of several soil types, including a fertile loam (if the pollen is from T. platyphyllos) which remained in use whilst the others were abandoned. The reduced Alnus and Betula imply clearance around the bog and the brief recovery of Betula, the colonisation of abandoned areas on drier soils with Corylus. There appears to have been some increase in local soil stability for the stratigraphy is markedly more organic: Sphagnum is common whilst Potamogeton indicates very wet conditions. Tree, shrub and Corylus pollen total less than 50% indicating extensively open conditions within the pollen catchment (Tinsley and Smith 1974). This is largely accounted for by reduced local Betula so in part the elevated cereal pollen may reflect reduced filtration (Tauber 1965) because of the removal of fringing Betula and Alnus. However, the changes in the other pollen curves and in the stratigraphy attest to significant alterations in land use at this time. The peak of Calluna may well indicate the proliferation of heath on the Plateau Gravel but an effect possibly exaggerated by reduced pollen filtration.

The period from about 1500 was one of general economic and agricultural recovery in Britain, as mentioned in section 10.8.1. It is detectable pollen-analytically especially in northern England as, for example, in the South-East Lake District (Oldfield 1963) and at Bolton Fell Moss (Barber 1981a). In southern Britain few sites record this event, perhaps because of the establishment already of fairly extensive agriculture. Snelsmore thus appears to be an exception, and this is probably because of a previously low level of exploitation. Within Berkshire enclosure began at this time (Richards 1978), possibly stimulated in part by the growth of London (J.G. Evans 1975; Roden and Baker 1966). Grassland was extended at the expense of wood and heathland conforming with other evidence for the pastoral use of the downs. Cultivation however seems to have been underway, perhaps on the surrounding clay and chalk soils that had previously supported, for example, Tilia.

10.8.3. AMBERLEY

The Amberley sequence is truncated: the time:depth curve derived from dates Q-690 and HAR-4234 (Fig 4.18) indicates that the surface, 0cm, is c.ad1430 and that about 60cm may be missing from the deposit. It is also suggested by the following: the cultivar pollen levels of AWB-8 are greater than would be expected for the last 300 to 400 years; the absence of any major rise of Pinus pollen in this zone (section 11.2.); and the impossibility, from the orientation of the time:depth curve, that the increased accumulation of the last 200 years characteristic of the other sites, could have occurred at Amberley,

The cause was not climatic, although the area is marginal for raised bog development: this requires a minimum annual precipitation of about 1040mm (Hibbert 1978) and that at Petworth Park Gardens, 7km to the north-west, is about 879mm (mean for 1916 to 1950: Meteorological Office 1958). In fact, the period when accumulation may have ceased marks approximately the opening of 'The Little Ice Age' (Lamb 1977). This will have led to a raised precipitation/evaporation ratio that would have been more conducive to raised bog growth. Human activity provides the most feasible explanation. This involved control of water levels in the Brooks and especially drainage to improve grazing and to enable peat cutting. There is considerable evidence for the latter in the West Sussex Record Office from as early as AD1612 to 1614 (P. Brandon, pers. comm.). Indeed, this continued up until 1961 (Chelmick 1976).

Accumulation of peat at Amberley was therefore probably slowing down from at least the seventeenth century. The entire Wild Brooks, including most of the peat deposit, is shown as pasture or meadow in the tithe awards for Amberley and Greatham of 1846 and 1837 respectively. It had evidently ceased by then, although Vaccinium oxycoccus was profuse up to the 1940s (Chelmick 1976) and Sphagnum was recorded in the north-east part as late as 1970 (Ministry of Agriculture, Fisheries and Foods 1978). Peat cutting seems not to have occurred in the area from which core AWB 1 was taken from field observations of the depth of peat, its relative height and the absence of the parallel ridges and ditches seen elsewhere (section 4.3.1.). Thus the lack of recent peat is probably a result of reduced surface wetness which led to a cessation of accumulation and, ultimately, peat shrinkage and oxidation.

Little can be deduced from the uppermost samples. The surface count, 0cm, is probably contaminated by present day pollen deposition so 8cm, c.ad1360 may represent the latest uncontaminated sample. As discussed in section 10.7.1. agriculture may have been contracting from ad1270, although peat shrinkage could account for this relatively early agrarian decline, more usually associated with the fourteenth century. From this level, 16cm, there may have been some contraction of woodland, as shown by falling Betula, Quercus, Alnus, Fraxinus and Fagus. It could, however, be a statistical effect caused by the peak of Gramineae resulting from, for example, locally growing Molinia. This is supported by the macrofossils (Table 4.4) and the low herb total. Such an expansion of grassland may, nevertheless, not be unexpected, if the 16cm level represents about 1350, recording the swing towards grazing from this time. The low herbs might be explained by poor pollen dispersal. It would also comply with the record (AD1612 to 1614; see above) for peat cutting which P. Brandon (pers.comm.) interprets as indicating that woodland was becoming scarce: an early shortage of fuel might account for this renewed woodland clearance from the late-fourteenth century. Documentary evidence on the whole indicates no new clearings or villages after 1348 and, in fact, increased woodland and some settlement desertion (Brandon 1974). The discrepancy probably reflects how there were local variations from a regional trend.

10.8.4. FOURTEENTH TO EIGHTEENTH CENTURIES: CONCLUSION

The evidence from the six sites demonstrate that there was considerable local variation from the general scheme of fourteenth century recession and major sixteenth century recovery. This presumably reflects the differing characteristics of the areas surrounding each site and variations in local population levels.

At Winchester the evidence is not at variance with the concept of envisaging the downs as extensive pasture for sheep at this time. Similarly, that from Snelsmore may conform with sheep grazing, although within the pollen catchments of both sites cereal cultivation was practised. In the Poole Basin, the location of Rimsmoor, Okers and Kingswood on the more fertile margins similarly shows that cultivation was underway, though at a much reduced intensity. After the fourteenth century these latter areas experienced expansion of heath or woodland. Amberley provides little evidence for the period except data indicating the recession of the early 1300s and possibly a scarcity of woodland by c.1600.

Snelsmore is unique in providing fairly strong evidence for agricultural expansion in the 1500s. It may relate to the relatively close proximity of growing urban centres, such as, for example, London.

10.9. WOODHAY

The pollen data from Woodhay are difficult to interpret because the relatively constant spectra and the absence of a radiocarbon determination preclude the formulation of a precise chronology. However, a tentative scheme is proposed. The opening of Period C-5, WH-2, has been placed at 34cm as Pinus pollen shows a continuous curve from about this level. This is used in preference to, for example, 10cm where Pinus pollen is is more frequent for the following reasons: the resulting accumulation rate of 5.3yrs cm^{-1} from 34 to 0cm is consistent with the incohesive and sandy nature of the peat (Table 4.12); it is more comparable with the rates for the other sites in this period (Winchester 3.3, Snelsmore 2.4, Rimsmoor 2.2, Okers 6.6, Kingswood 4.3); and in the interpolated C-5 at Snelsmore, the essential form of the Pinus curve is similar. These factors are considered to be more important than the likelihood of the initially low frequencies of Pinus being a result of solely a greater representation of regional pollen during the local clearance recorded in WH-2. This may, nevertheless, have occurred, but it is proposed in section 11.4. that this limited clearance took place in the early nineteenth century.

Zone WH-1 may be dated by extending backwards interpolated accumulation rates of 15, 20 and 30yrs cm^{-1}, broadly comparable with the other sites. These provide dates for the initiation of peat accumulation at about 105cm of ad730, ad370 and 350bc respectively. Which is the more appropriate is difficult to assess yet given the more compact nature of the peat, a date nearer the early end of the scale is expected. This conceivably could correlate with the more general clearances of the Iron Age which might be expected to have led to waterlogging and thus local peat accumulation. Regrettably, clearance, or rather regeneration, is not discernible in the base of the peat, although this might have been present between 98 and 105cm, which could not be sampled (section 4.7.2.). The shallow depth of the peat and low Ulmus and Tilia tend to suggest development over a period which would not be at variance with an Iron Age or later origin.

Regardless of the precise chronology of WH-1, the zone is notable for its relatively constant pollen frequencies. Very high Alnus and Salix (the latter suppressed by the former) indicates that alder and willow carr has been prevalent at the site, although Quercus, Betula, Fraxinus and Corylus with some Ulmus, Tilia, Ilex and Hedera were also present. Consistent Gramineae with herbs such as Plantago lanceolata, Spergularia type, Artemisia and Liguliflorae and also Pteridium nevertheless attest to the local existence of open areas. The absence of any major clearance phase indicates that the valley bottom itself has not been cleared of trees since accumulation began. From the single core it cannot be determined whether the open areas represented were in the form of a single large clearing at a distance or a number of smaller clearings nearby.

Place-name evidence suggests that restricted clearance was underway at least in the Anglo-Saxon period, perhaps providing further evidence for a shift off the chalk at this time. The name Woodhay, referring to the settlements, West and East Woodhay, 1 and 5km to the south-west, is derived from the Old English wudu-gehaeg, an 'enclosure in a wood' (Ekwall 1960). The small fields and high density of roads also attest to the late settlement of a forested area.

By the time of the Domesday Survey of 1084 there was evidently less woodland. In the western part of this vale where there is most clay, population and the numbers of ploughs were higher than in the area of sands to the east. They were still lower, however, than on the downs to the south (Darby and Campbell 1962). The valley of Prosser's Hanging, from which core WH 1 was derived, is in the transition area between the sands and clays. It tends to indicate that this wet boggy valley was left as woodland. Elevated herbs such as Plantago lanceolata, Urtica and Rumex from about 70cm may indicate an extension of pasture on the surrounding drier slopes. This could have entailed the removal of Betula and Corylus fringing the valley bottom woodland, as indicated by the reduction in these pollen types, and may have been associated with Medieval land pressures, yet cultivation seems not to have occurred sufficiently near to the site to be recorded. There is little that can be correlated with the sixteenth century recovery, although given the uncertain chronology, the elevated herbs from 70cm could relate to this period; it could equally well, however, originate from the Anglo-Saxon period.

In Dorset it was notable how around Rimsmoor the London and Reading Beds experienced a fairly high intensity of exploitation, especially in the Mediaeval period. These strata outcrop in the Woodhay area yet were not so greatly utilised. This may have been a result of more frequent sand and gravel deposits or lithologically differing strata, less seriously degraded soils or lower population pressure.

10.10. PERIOD C-4: CONCLUSION

The period from the Iron Age onwards represents the time of the most extensive and intensive exploitation of the British landscape. In general, the sites under discussion show that this hypothesis is appropriate for central southern England, although at several the main increase in activity began in the second half of the Bronze Age: there was only an intensification at this time. The chalk as represented at Winchester experienced a similar sequence of events except that both arable and woodland may have been extended at the expense of grassland. The Roman period is not readily distinguishable from the Iron Age in the pollen diagrams yet for the Anglo-Saxon times there is some indication of reduced downland arable and an extension of activity in low lying areas. This agrarian shift, however, had clearly been underway from the Iron Age, if not the Early Bronze Age as reflected in the proliferation of barrows on the sandy strata.

A notable feature of the Rimsmoor and Amberley pollen diagrams is the pronounced maximum of cultivation in the Mediaeval period and its recession in the fourteenth century. Most of the sites show that cultivation continued, not surprisingly, after this date. At Winchester there is evidence that is compatible with extensive sheep grazing from at least the eleventh century. All sites, but especially Woodhay and Snelsmore, show the continuing importance of woodland to the economy.

The behaviour of Fagus seems to be closely associated with human activity from the pollen diagrams. In particular its late expansion appears to have been a result of its increased competitive ability over Quercus on degraded soils and the recent preferential selection of Quercus for, most notably, ship building.

CHAPTER 11

PERIOD C-5 NINETEENTH CENTURY TO PRESENT

Sites	Winchester	WT-9
	Snelsmore	SM-8, SM-9
	Rimsmoor	RM-9
	Okers	OK-6
	Kingswood	KW-6, KW-7
	Woodhay	WH-2

Period C-5 represents approximately the last two hundred years. Rising tree pollen, most notably of Pinus, is diagnostic.

11.1. CHRONOLOGY

The opening of the Period is defined by the start of a sustained increase of Pinus pollen. It is associated with the general afforestation, particularly with pine, that has been undertaken since the eighteenth century. Documentary evidence (see below) provides dates of 1750 and 1800 for this rise of Pinus at the differing sites.

During C-5 a markedly increased accumulation rate is discernible at Winchester, Snelsmore, Rimsmoor and Kingswood and seems probable at Woodhay (section 10.9.). At all sites except Winchester this indicates the significance of compaction in earlier deposits, although at Rimsmoor and possibly also Snelsmore, Kingswood and Woodhay the sites became wetter leading to a real increase in accumulation rate. Clay deposition at Winchester attests to, similarly, a more rapidly accumulating deposit, but one that will not be subject to compaction. Inevitably, there is unlikely to have been an abrupt increase in the accumulation rates at all sites at the opening of C-5 so there will be some distortion of the interpolated dates at about this level.

11.2. GENERAL VEGETATION COMPOSITION

The pie diagrams for the Period (Fig 11.1.) illustrate the expansion of Pinus pollen at all sites. Data are not available for Amberley where the sequence is truncated (section 10.8.3.). Pennington (1974) records

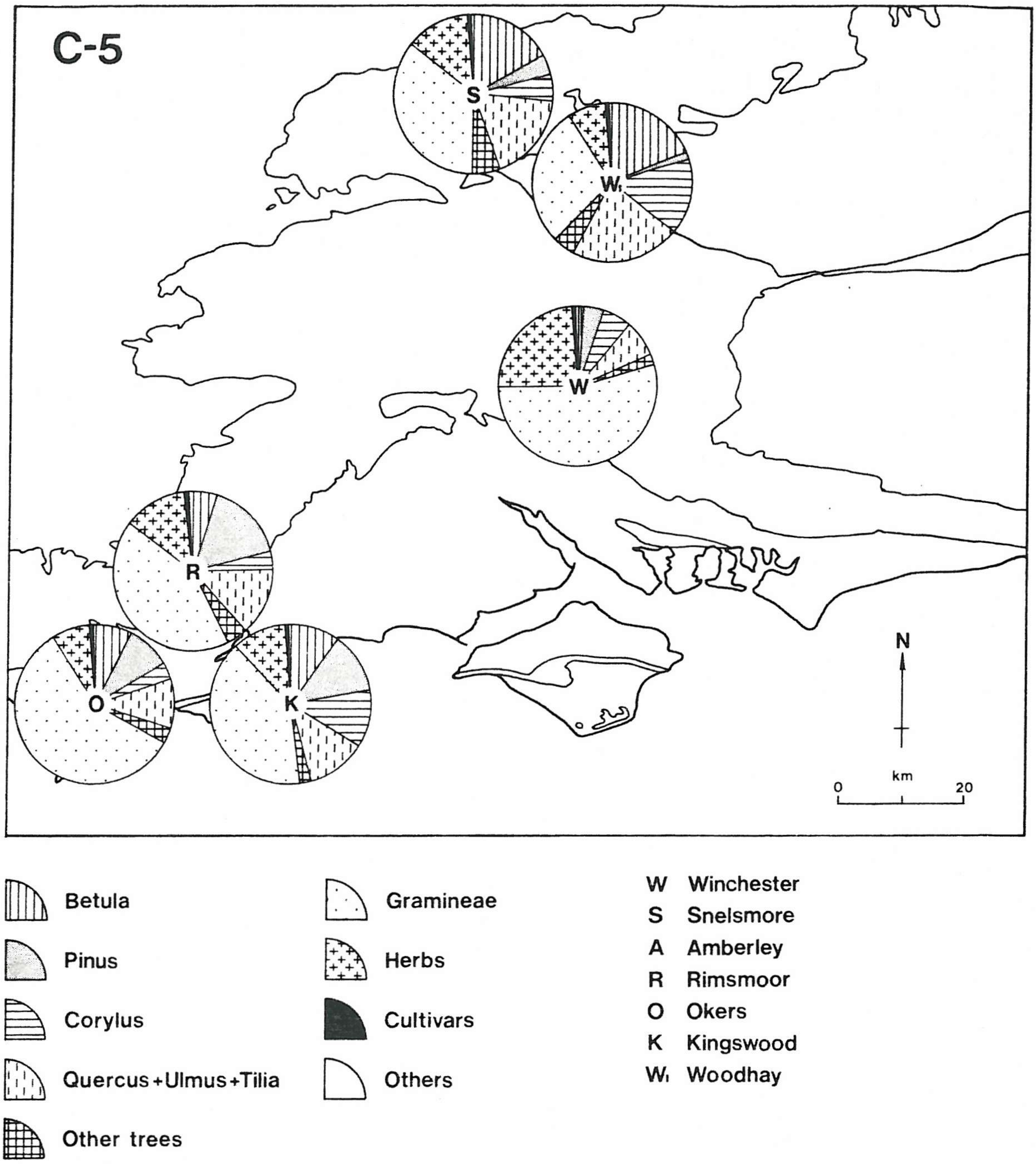


Figure 11.1. Period C-5: summary pollen diagrams

how in the 1700s many landlords started to preserve and extend woodland by planting and enclosure to exclude grazing animals. Bolton Fell Moss in Cumbria demonstrates this admirably where documents fully support the pollen evidence (Barber 1981a). Plantings included the native broadleaved species and conifers as well as introductions such as walnut and sweet chestnut. Rising arboreal pollen is frequently recorded in British pollen diagrams which include the analysis of surface horizons: for example, those from the Isle of Wight (Scaife 1980), Poole Basin (Haskins 1978), the New Forest (Barber 1975, 1981b), Tregaron (Turner 1964b), and Malham (Pigott and Pigott 1959). Of the six sites representing the Period in this thesis only two show this phenomenon.

The two sites with increasing arboreal pollen are in the Poole Basin (Rimsmoor and Kingswood) which accords with Haskins' (1978) work. It reflects the extremely low agricultural potential of the coarse sandy soils and their most profitable use for timber production. In the pie diagrams from Kingswood, the rise in Pinus is matched by a fall in Gramineae and herbs, though reference to the pollen diagram indicates a contraction of heathland has also occurred. At Rimsmoor, similar contractions are evident in grass and heathland but Corylus is also reduced as Pinus expands. Okers is anomalous despite its close proximity to Rimsmoor as it shows slightly lower arboreal pollen in the pie diagrams. This is largely a factor of a maximum of this pollen at the OK-2/OK-3 boundary (C-4) yet in OK-6 (C-5) there is an appreciable increase discernible in the pollen diagram. Local factors continue to have a significant effect on this small site.

The Winchester pie diagram exhibits raised Gramineae and herb levels with a Quercus, Ulmus and Tilia total about one half of that of C-4. This reflects in particular their relative abundance in the earlier Period and their removal in WT-8. Corylus, rather exceptionally, is higher. Snelsmore likewise exhibits an extension of open areas, yet the latter part of C-5 (and SM-8 and SM-9) does show markedly rising arboreal pollen, especially Betula. At Woodhay, recent activity in the valley bottom accounts for the reduced tree pollen.

At most sites, late expanding species such as Fagus, Fraxinus and Carpinus, by definition are more common. Cultivar pollen is reduced at all sites illustrating the greater importance, at least around the sites, of cultivation in Period C-4.

11.3. WINCHESTER

The upper 84cm of the deposit in the Winchester core is regarded as being within C-5, although the markedly different stratigraphy poses problems of interpretation. At 88cm there is a chalk band which overlies mid-brown clayey peat and above the clay content rises considerably with a light brown clay prevalent from 76 to 10cm. The uppermost 10cm is dark brown rootlet peat (Table 4.1.). A maximum pH of 8.2 is reached at about 20 to 30cm.

The clay horizon clearly developed when Winnall Moors was exploited as watermeadows: the surface of the present fen has the characteristic ridges and troughs of this system of agriculture. They are not simply a result of ridge and furrow farming (e.g. Bowen 1961) because of their location in a floodplain, and there is also documentary evidence. Dating the period of operation is paramount in enabling interpretation of the pollen spectra. In Wiltshire they were in use from the late-seventeenth century (Kerridge 1953) and in Dorset from earlier that century (Brocklebank 1968; Taylor 1970). A similar date, or possibly even the sixteenth century, seems appropriate for Hampshire (Sheail 1971; Tubbs 1978); Driver and Driver, in a text published in 1794 mention that the county was famous for its watermeadows. In the Itchen they were initially concentrated below Winnall because the peats of the upper valley were thought less suitable yet Tubbs (1978) records that even these were floated from about 1800. Documentary evidence in the Hampshire Record Office, the Deanery and Winchester College relating to Winnall Moors is limited. However, the earliest map that could be found showing the unmistakable water courses of the system was dated 1701 (HRO 27 M62/2). This indicates that it was in progress by this time, a century earlier than the date proposed by Tubbs. This could have been a consequence of the proximity of Winchester and may have received an additional impetus with the late eighteenth century revival of the town and the effects of the Napoleonic Wars (Barton 1981; Biddle 1975b). The base of the clay deposit is therefore unlikely to be later than AD1700.

During C-5, WT-9, *Pinus* is increased whilst *Ulmus*, *Tilia*, *Quercus*, Alnus and Corylus initially rise, then fall. Gramineae is fairly constant but Bidens type, Cruciferae undiff, Plantago lanceolata and Liguliflorae are higher and cereal pollen is recorded sporadically. Although pollen degradation is more pronounced later in the zone, the absence of any parallel changes in the frequencies of susceptible and resistent grains suggests that these fluctuations reflect real variations in pollen deposition. A similar explanation is appropriate for Filicales, though some inflation of the frequencies may have arisen through its resistence to degradation. The clay itself suggests that 50% (Tauber 1977; section 2.4.3.) of the pollen may have been waterborne. This might indicate a different origin, i.e. up-valley (cf the Alnus peak at 333-343cm, section 7.3.2.), from before and thus perhaps no change in the vegetation in the immediate vicinity. This possibility cannot be discounted although afforestation was clearly underway.

Vancouver (1813) discusses in some detail arboriculture in the early nineteenth century. He describes woods on the chalk composed chiefly of hazel, withy, oak, ash, maple, white-thorn, beech, elm and wild cherry and coppicing was widespread. The pollen evidence implies that this increased in importance from 1700 with Ulmus, Tilia and Corylus locally common. Fagus in this area was of little importance. The continuous curve for Castanea may attest to its planting in the vicinity; Vancouver (1813) records this near Christchurch.

Pinus, the 'Scotch fir', is also mentioned by Vancouver (1813) as a taxon being planted in Hampshire, though he fails to state when this began. In the New Forest the first plantings were at Ocknell and Boldrewood in 1776 (Tubbs 1968) and an earlier date seems appropriate for parts of Dorset (section 11.5.). A search of documents in the Hampshire Record Office did not produce any information on the time of its introduction to the Winchester area, yet the rise of Pinus pollen from the level of the initial floating of Winnall Moors suggests an early date. Interestingly, the Pinus pollen frequencies fall briefly, before a more consistent rise from about 52cm: this is c.AD1800, the same date allocated to the New Forest Pinus rise (Barber 1975, 1981b). The early, 1700 rise, could be a result of faunal mixing although this is not supported by the form of the other pollen curves, nor the depression of the Pinus totals at 56 and 64cm. It may therefore represent very early experimental plantings: this could only be confirmed by more extensive documentary searches. _Pinus_ is generally less than 10% in C-5, reflecting the preference of this taxon for more acid soils and, perhaps also important, the extensively cleared nature of the pollen catchment.

From the low frequency of cereal pollen, cultivation at this time may have been minimal, especially in relation to the Late Bronze and Iron Ages. There is no clear peak at c.1800 when much downland was converted to arable in response to the Napoleonic Wars (Fussell 1952), although the cultivation of turnips (_Brassica napus_ or _B. rapa_ ssp _rapa_) (Pelham 1953) could have contributed to the Cruciferae count. This may indicate the degraded nature of the downland soils, the unsuitability of the flood plain for tillage and perhaps the poor dispersal of cereal pollen. The slight increase discernible between 8 and 0cm may however reflect the present day tillage of former downland, stimulated by socio-economic factors. The general reduction of tree pollen, especially _Ulmus_, _Quercus_, _Tilia_ and _Corylus_ may also indicate the extension of farmland, including the felling of small copses and removal of hedgerows, over the last hundred years. The greatly reduced _Corylus_ pollen in particular probably records the decline of coppicing. The absence of _Secale_ type pollen is consistent with rye's preference for sandy soils and its very low level of cultivation in the Hampshire of 1801 (Pelham 1953).

Grassland has probably been most prevalent within the pollen catchment over the last 250 years as indicated by the low arboreal and cereal pollen. An actual extension of downland pasture, as perhaps implied by the rising herbs, is unlikely as this is probably accounted for by the reclamation of the fen for watermeadows. Most of the recorded herb pollen, including _Ranunculus_ type, _Potentilla_ type, _Rumex acetosa_ type, Umbelliferae, _Bidens_ type, Cruciferae, _Ononis_ type and Liguliflorae could have been contributed by species of this habitat (Tansley 1949). Even the record of _Plantago lanceolata_ may be from higher and thus drier reclaimed areas. The conversion of the flood plain itself, from fen to meadow, is shown in particular by the fall of Cyperaceae from its previously high levels. Records of _Potamogeton_ and Typhaceae attest to its seasonal flooding whilst the environment as a whole may have become more favourable for _Alnus_, perhaps along newly cut and stabilised watercourses.

The watermeadow system fell into decline from the late-nineteenth century because of, for example, labour shortages and the availability of cheap artificial fertilisers (Sheail 1971; Tubbs 1978). This is recorded in the stratigraphy by a resumption of peat accumulation from about 10cm and by changes in the pollen spectra. These record how, in the absence of management, the meadows have reverted to fen. Drainage is evidently less efficient now, as indicated by the decline of Plantago lanceolata and at the same time, flooding is less frequent from the absence of the aquatics. Three of the currently most abundant species are Angelica sylvestris, Filipendula ulmaria and Phalaris arundinacea and the former two are clearly represented in the surface sample by peaks of Umbelliferae and Filipendula respectively. Much of the pollen from the meadow grasses presumably has been replaced by that from Phalaris. The maximum in Rosaceae undiff may be a result of the prevalent Rubus spp on the ridge east of the coring site. Bidens type and Lysimachia type may refer to Senecio aquaticus and Lysimachia vulgaris respectively, both recently recorded (section 4.1.2.). Salix, Alnus and Betula also appear to have been favoured by the reversion to fen.

Pteridium declines steadily throughout C-5 at Winchester with no record in the modern sample which accords with its present scarcity in the area. It was clearly more common in the past from this diagram, yet today is confined within the downs to outcrops of Clay-with-flints. This may indicate that this deposit was formerly more extensive (but see section 9.4.2.2.), or is further evidence for the former existence of deeper, less calcareous soils overlying the chalk. A peak of Pteridium is however recorded in WT-8 (ad1060-1700) after major soil deterioration may have occurred as hypothesised in Chapters 9 and 10. The sporadic records of Ericaceae pollen and Sphagnum spores may be relevant in this context. It was observed during fieldwork how river gravels in the Test valley (SU 373383) currently support a markedly calcifuge vegetation. This included Rhododendron ponticum, Calluna vulgaris and Erica spp. Vegetation on similar gravels in the Itchen valley may thus have been the source of these types, although at least one species of Sphagnum, S. squarossum, is base-tolerant. Verification is difficult because of the scarcity of these deposits at the present time: this may be a result of burial through peat development and alluviation and also agricultural reclamation. It is plausible, therefore, that whilst Pteridium may have been present on soils overlying the chalk it has more recently been confined to superficial deposits such as Clay-with-flints and valley gravels.

11.4. SNELSMORE AND WOODHAY

The date of the rise of Pinus pollen and hence the opening of C-5 is also uncertain at the two Berkshire sites. Documents deposited in the Berkshire Record Office yielded little information other than a set of miscellaneous papers from the Englefield Estate, located 16km east of Snelsmore (BRO D/EBg E 99). These included a list of measurements and values of Estate trees, including pine, spruce and sweet chestnut, dating to about 1850. Mavor (1809), however, mentions recent plantings of firs at Ufton, 18km east-south-east and at Lambourn, about 15km north-west of Snelsmore. Using broadly the same criteria as Barber (1975, 1981b) for the New Forest, the rise of pine pollen is thus placed at c.1800.

At Snelsmore the period covers zones SM-8 and SM-9. The opening of SM-8 is characterised by several gradual changes, notably falling Betula, Corylus and Calluna and rising Quercus, Fraxinus, Gramineae, herbs and cereal pollen. More marked increases are recorded in Pinus, Ulmus and Fagus. Several of these trends are reversed in the latter part of SM-8 and in SM-9 peaks are recorded in Betula, Pinus, Quercus, Tilia, Alnus and Corylus with low Gramineae and herbs.

The tithe maps of 1839 and 1840 show the central Plateau Gravel as 'waste' and the fringing clays as wood and pasture. The nature of the 'waste' may have been heath with birch and, if so, then the pollen evidence suggests that there was some reclamation of this for pasture. Mavor (1809, 331-333) discusses methods of 'improving waste' and this may have taken place at Snelsmore. He also describes plantings at that time of various trees such as oak, elm, larch, beech, pine and in particular advocates the value of sweet chestnut. This likewise may be reflected in the rising pollen of Pinus, Ulmus, Quercus, Fraxinus, Fagus and Castanea perhaps indicating plantings on the surrounding clays. Part of these increases are doubtlessly a statistical effect of the reduced Betula and possibly a consequence too of reduced pollen filtration caused by the removal of a belt of Betula fringing the bog. Coppicing of Corylus was widespread at this time so its reduced pollen representation may indicate actual removal or reduced flowering as a result of the hypothesised plantings of shade-casting trees.

This activity clearly led to increased surface runoff and this is shown by the pronounced peak of Potamogeton, the incohesive peat and postulated accumulation rate of 2.43yrs cm^{-1}. The bog flora included, as now, Narthecium ossifragum attesting to flushing of nutrients into the mire (Summerfield 1974).

The fairly continuous curve of cereal pollen at 1%, with, perhaps, various herbs such as Sinapis type, Spergularia type, Anthemis type, Plantago media/major, Polygonum aviculare and possibly Onobrychis type (of which Onobrychis viciifolia can be a relic of cultivation: Clapham et al 1968) indicate cultivation within the pollen catchment. The tythe maps and modern sample indicate that this may have been underway on the chalk soils beyond the surrounding clays. This is at a distance of at least 500m and indicates how pollen source area may be affected by woodland clearance (cf the values predicted from the Jacobson and Bradshaw (1981) model, section 4.2.3.). Mavor (1809) mentions that rye was an unimportant crop and grown mainly for fodder and this corresponds with the sparse pollen record in SM-8. He makes no mention of hemp, but states that whilst hop cultivation had been widespread, by the early 1800s it was confined to hedgerows as a ruderal. Thus the sporadic Cannabis type record, including a find in the surface sample, relates most probably to wild hops. As at Winchester there is no clear peak of cultivation at about 1800.

From about 34cm, c.1900, Betula pollen rises rapidly, and this is continued into SM-9, from c.1930, which exhibits, in particular, elevated Alnus and Corylus, and reduced indicators of open ground. It records the most recent phase of woodland extension, especially the invasion by birch scrub of heathland. Quercus, Tilia and, most recently Fagus, have also expanded and raised Filicales and Polypodium may reflect the general proliferation of woodland habitats. This was largely a result of reduced grazing on the Common since the last century with an increased use by the military and exploitation for gravel (Williams 1969). Pinus pollen generally in C-5 is low implying little planting on the Common although the increased percentages of the uppermost two samples record its only very recent establishment in the valley.

Zone SM-9 shows a temporary maximum of Corylus reflecting its recent coppicing (Williams 1969). Pollen from various exotics are recorded in C-5 and suggests the presence in the region of Juglans, Picea, Abies and

Aesculus. Castanea pollen in particular shows a pronounced peak at about the turn of the century - correspondence with the warden of the Park and Newbury District Council failed to provide any explanation for this phenomenon - it could record simply the life of a single tree near the bog.

As discussed in section 10.9., the opening of C-5 has been placed at 34cm in the Woodhay pollen diagram. Various changes occur in WH-2 with higher and fluctuating Betula and Gramineae and reduced Quercus. Herbs, especially Plantago lanceolata, Rumex and Potentilla type are raised. High Alnus and Salix indicate the continuing prevalence of carr at the site.

There is little documentary evidence available in the Berkshire Record Office that is relevant to Prosser's Hanging. However, "A map of West Woodhay belonging to the Rev. John Sloper" dated 1831 had been lodged and this names the present boggy area 'Peat Bottom' and indicates by pictorial symbols that woodland was then, as now, confined to a strip along the valley bottom. In the pollen diagram, from about 24cm, c.1850, there is a reduction in Quercus and Corylus and an expansion of Gramineae and herbs with a record of cereal pollen from 16cm. The total of tree, shrub and Corylus pollen does not fall below 60% indicating that woodland remained dominant in the valley bottom. The event probably records a pushing back of the woodland margin to increase the area of grassland and perhaps arable on the adjacent hillslopes. Fluctuations in Alnus and Betula and reduced Cyperaceae nevertheless may reflect disturbance of the carr woodland and it seems probable that this was a result of attempts to drain the area. Peat cutting is possible yet unlikely in this well wooded area.

From about 16cm, 1850, there is some recovery of woodland as shown by rising Quercus, Fraxinus and Fagus. This could indicate planting on the surrounding hillslopes shown as open ground in 1831 but currently wooded, or only recently felled. The last event may indeed be demonstrated by the reduced counts for Quercus and Fagus in the surface sample. The later rise of Pinus from 10cm, c.1920 could be as a result of the afforestation in c.1900 of the valley slope to the east.

In the surface sample Alnus and Salix are reduced whilst Fraxinus is elevated and this probably attests to more successful recent drainage. The current abundance of _Fraxinus_ in the woodland is evidently a phenomenon of only the last ten or twenty years and this is in accord with the age of the trees. The present abundance of ferns is shown, likewise, to be a recent event.

11.5. RIMSMOOR, OKERS AND KINGSWOOD

In the Poole Basin the level of the _Pinus_ rise can be dated with confidence because of the extensive documentary evidence researched by Haskins (1978). She records that in the early 1700s a variety of trees were planted on Brownsea Island and between 1733 and 1777 James Frampton of Moreton afforested considerable tracts of the heaths near Rimsmoor. Firs (_Pinus_) were most common but deciduous taxa such as _Ulmus_, _Quercus_, _Fraxinus_, _Castanea_, _Acer_, _Betula_ and _Corylus_ were also planted with other conifers including _Picea_ and _Larix_. Over time it was found that the deciduous species often failed because of the poor soils and conifers, especially pines, were increasingly grown. Pressures on the area of heathland were intensifying from the 1500s through not only afforestation, but also agricultural reclamation, urban growth, mineral exploitation, grazing and military uses. Haskins (1978) estimates that in c.1750 there were about 40,000ha of heathland in the Poole Basin but by c.1820 this had fallen to 30,000ha. With the most recent phase of Forestry Commission plantings, the total for 1973 was 6,100ha.

Having reviewed this evidence, Haskins (1978) places the start of the pine rise in her diagrams at c.1700. However, it is felt that this date is too early as the first plantings were in the first half of that century. To allow a sufficient time for the trees to mature (cf Barber 1975, 1981b) and for the pollen to be represented to a significant degree in the pollen rain, a date of 1750 is probably more appropriate. This has been applied to the pollen diagrams.

At both Rimsmoor and Okers tree taxa with increased pollen frequencies in C-5 are _Betula_, _Pinus_, _Ulmus_, _Quercus_, _Fraxinus_, _Fagus_ and _Carpinus_; at Rimsmoor only _Juglans_, _Picea_, _Acer_, _Castanea_, _Abies_ and _Aesculus_; and at Okers only, _Tilia_. These changes attest to the plantings of these species in the locality: Frampton, for example, records that in 1776,

"Above sixty thousand trees of different sorts as Fir Larch Birch Beech Chesnut oak ash and maple were planted at Clouds Hill, Spyway plantation, in Lashmore, yearlings and Hoppers wood, etc."
(DRO D29/E 68).

This contrasts with Haskins' sites which show that the only deciduous tree to increase was Betula, which she relates to the general failure of these other taxa on the impoverished soils of the Poole Basin. It indicates the continuing greater fertility of the London and Reading Beds on which Oakers Wood, parts of which were re-planted by Frampton, and various other areas of woodland are located. Oaks today are still common as 'deciduous oases' in the larger dolines within the now prevalent coniferous plantations.

Contemporary with the rise of arboreal pollen, there is a major reduction in herbs, especially Plantago lanceolata, Liguliflorae, Artemisia and Anthemis type, and in Calluna. Afforestation clearly affected both grass and heathland. Cereal pollen at Rimsmoor is more frequent in the first part of the Period, perhaps as a result of the vigorous reclamation of heathland for agriculture during the Napoleonic Wars (1793-1813); 64% of all Parliamentary enclosures in Dorset took place at this time (Haskins 1978). The subsequent decline of cereal pollen is probably a result of the later recession of agriculture, statistical effects from the rise of arboreal pollen and also an increased filtration of the pollen (Tauber 1965) by surrounding trees. The frequency of Pinus is more than doubled in the final 10cm of the Rimsmoor core and probably records the most recent phase of planting in the 1950s actually around the two sites. The size of this increase is probably responsible, through the percentage interrelationship of the curves, for the reduction in Ulmus, Quercus, Fraxinus and Fagus pollen. The tithe map of 1839, early Ordnance Survey maps and an aerial photograph of 1950 (Dorset County Council Planning Department) show that heathland was prevalent around the sites prior to that date.

In the uppermost samples at Rimsmoor, from about 10cm, Gramineae is at over 30% despite the surrounding coniferous plantation. Low herb totals and the current prevalence of Molinia on the bog surface indicate a chiefly local origin for this pollen; i.e. the mire itself. The tree, shrub and Corylus pollen total is 60% justifying Tinsley and Smith's (1974) contention that values of 50% or more indicate woodland within

100m of the site. Pteridium is low (1%) despite the abundance of bracken around the edges of the depression. It was sporulating (personal observation), but Andersen (1970) found dispersal to be poor; it would appear that any more substantial percentages may indicate its more general occurrence in the landscape.

As at the other sites, Corylus is low in the surface samples from Rimsmoor and Okers: there is, notably, a derelict hazel coppice with oak standards at SY 805928, 800m north-west of the sites.

Thomas Hardy refers to both sites in, 'The Return of the Native' (1878). In response to a question from Mrs Yeobright as to whether Rimsmoor Pond was dry that summer, Johnny Nunsuch replies,

> "'Rimsmoor Pond is, but Oker's Pool isn't, because he is deep, and is never dry...'" (p.349).

This part of the Poole Basin is Hardy's Egdon Heath, an area of which he had an intimate knowledge and it is indisputable that he is referring to the two analysed sites. However, his description of Rimsmoor is unlikely to be correct for the novel probably refers to the years 1842 to 1843 (Woodcock, in Hardy 1878). This is an interpolated depth of about 70cm where the stratigraphy is little humified Sphagnum peat and thus indicates a continuation of the very wet, if not pool, conditions initiated at the RM-7/RM-8 boundary. Potentially the most useful documentary source to confirm this proposal is the tithe map of 1839, but this fails to show not only the sites, but even the prominent Culpepper's Dish. Hardy is known to have changed facts to add interest to a tale and it seems most probable that this explains the anomaly.

A tale relating to this period and firmly entrenched in local oral history is that a complete coach and four were lost in Rimsmoor. Documentary evidence for this could not be found nor was anything encountered in the stratigraphic investigations that could be related to such an incident!

The pollen evidence from Kingswood is similar to that from Rimsmoor and Okers with Betula, Ulmus, Quercus, Tilia, Alnus and Corylus all increased with Pinus in the first part of C-5, KW-6. General afforestation is indicated, or conceivably regeneration and its diversity attests to the presence of more fertile soils in the area. The influence on Myrica was discussed in section 10.7.2. and Cyperaceae seems similarly affected by the reduced inflow of nutrients. From 34cm, c.1850, the opening of KW-7, there was some contraction of woodland, especially of *Betula*, *Alnus* and *Corylus* but also of *Ulmus*, *Quercus* and *Tilia*. Heath and grassland increased and arable farming appears to have been more prevalent. The date of 1850 is too late for the Napoleonic stimulus to agriculture and too early for the heathland reclamation of this century: it might reflect local activity independent of national trends, or an interpolated chronology based erroneously on an assumed constant rate of peat accumulation. The latter is perhaps favoured by the records of *Cannabis* type and *Fagopyrum* pollen which suggest a date early in the 1800s. Hemp was probably cultivated until the middle of the century (cf Godwin 1967b; Oldfield 1969; Stevenson 1815). Such a date for the KW-6/KW-7 boundary would perhaps complement the finds of charcoal from 20cm: it may record the recent practice of heathland management by burning. This has only been undertaken on a large scale since improved transport, especially the railways, made the gathering of the low heat producing heathland fuels unnecessary.

Fraxinus, *Fagus*, *Castanea* and *Quercus* are less affected by disforestation in KW-7 than *Betula*, *Alnus*, *Salix* and *Corylus*. This could indicate that King's Wood, on the north slope of the chalk ridge where ash, oak and sweet chestnut are common (section 4.6.) was largely untouched. The reduced *Betula*, *Alnus* and *Salix* is most readily explained by heathland reclamation and an intensification of grazing. *Pinus* pollen at only 20% is perhaps low in view of the abundance of the tree in the area, including a plantation 500m north of the coring site. It may illustrate Turner's (1964a) discovery that a pollen sample needs to be within 300m of a plantation before it is detectable; the 20% recorded may be her β or background level. A location downwind may have reinforced the effect.

11.6. PERIOD C-5: CONCLUSION

Afforestation is exhibited in Period C-5 at most of the sites investigated. At Woodhay and Winchester the evidence is more equivocal: at the former some extension of open areas is indicated, as well as the creation of plantations, whilst the data from Winchester reflect the continuing agricultural significance of at least this area of the Hampshire

Downs. *Corylus* pollen is reduced overall at all sites indicating the decline of coppicing with either a grubbing-up of hazel or reduced flowering caused by a proliferation of former standards. Contributory factors have been the removal of hedgerows, soil deterioration and heathland expansion (Haskins 1978) and generally within the Subatlantic period, reduced flowering caused by late spring frosts (Van Geel 1977).

Behre (1981) notes how the mould board plough has led to a change from perennial to annual weeds in arable crops and since c.1810 deep ploughing has reduced the abundance of *Artemisia* in particular (Oldfield 1969). Detection of such changes is obscured by the general reduction in herbs associated with woodland expansion. Even at Winchester where arboreal pollen is relatively constant throughout C-5, the situation is confused by the use of the fen as a watermeadow. Indeed, at this site, *Artemisia* in C-5 is only recorded in the samples above 24cm, c.1900.

CHAPTER 12

SUMMARY AND CONCLUSIONS

12.1. SITES

The central concern of this research was an investigation of the vegetational history of the chalklands of southern England. It entailed, for the first time, a comprehensive and systematic examination of peat deposits within and around the chalk outcrop to assess their suitability for pollen analysis. It was found that for reasons of high pH and water table fluctuations conditions generally were not conducive to pollen preservation. Nevertheless, seven separate deposits were sufficiently polliniferous for detailed analysis.

Two were located in the area of the chalk outcrop. The more important was north of the city of Winchester: the extent of the peat suggests that much of the preserved pollen was derived from vegetation on the surrounding downlands. The second site, Snelsmore, was very much smaller and located in the Berkshire Downs where the chalk is overlain by deposits of clays and gravels.

The remaining five sites were just peripheral to the chalk outcrop. The derelict raised bog at Amberley provided data on the vegetational history of that area of The Weald and the South Downs. An exceptionally deep (1800cm) mire, Rimsmoor, was discovered in Dorset and an adjacent and similar bog, Okers, was also analysed to assist in its interpretation. A third site in Dorset, Kingswood, was investigated and like the other two produced evidence contrasting with that from the more central Poole Basin sites of Haskins (1978). The final site of Woodhay, north of the scarp of the Hampshire Downs was more equivocal.

12.2. GENERAL CONCLUSIONS

Winchester records the period from about the early Boreal to the present day. It indicates that the early and mid-postglacial woodland of that area of downland was not greatly different from elsewhere in southern Britain, although _Alnus_ may have been less common in the Atlantic. From an unusually early _Ulmus_ decline (3680±90bc HAR-4342) it appears that open conditions have prevailed within the pollen source area.

There is clear evidence for cereal cultivation in the Early and Middle Neolithic and from the Late Bronze Age. Inevitably, however, some distortion of the actual sequence of events may have been caused by pollen from taxa growing on the flood plain.

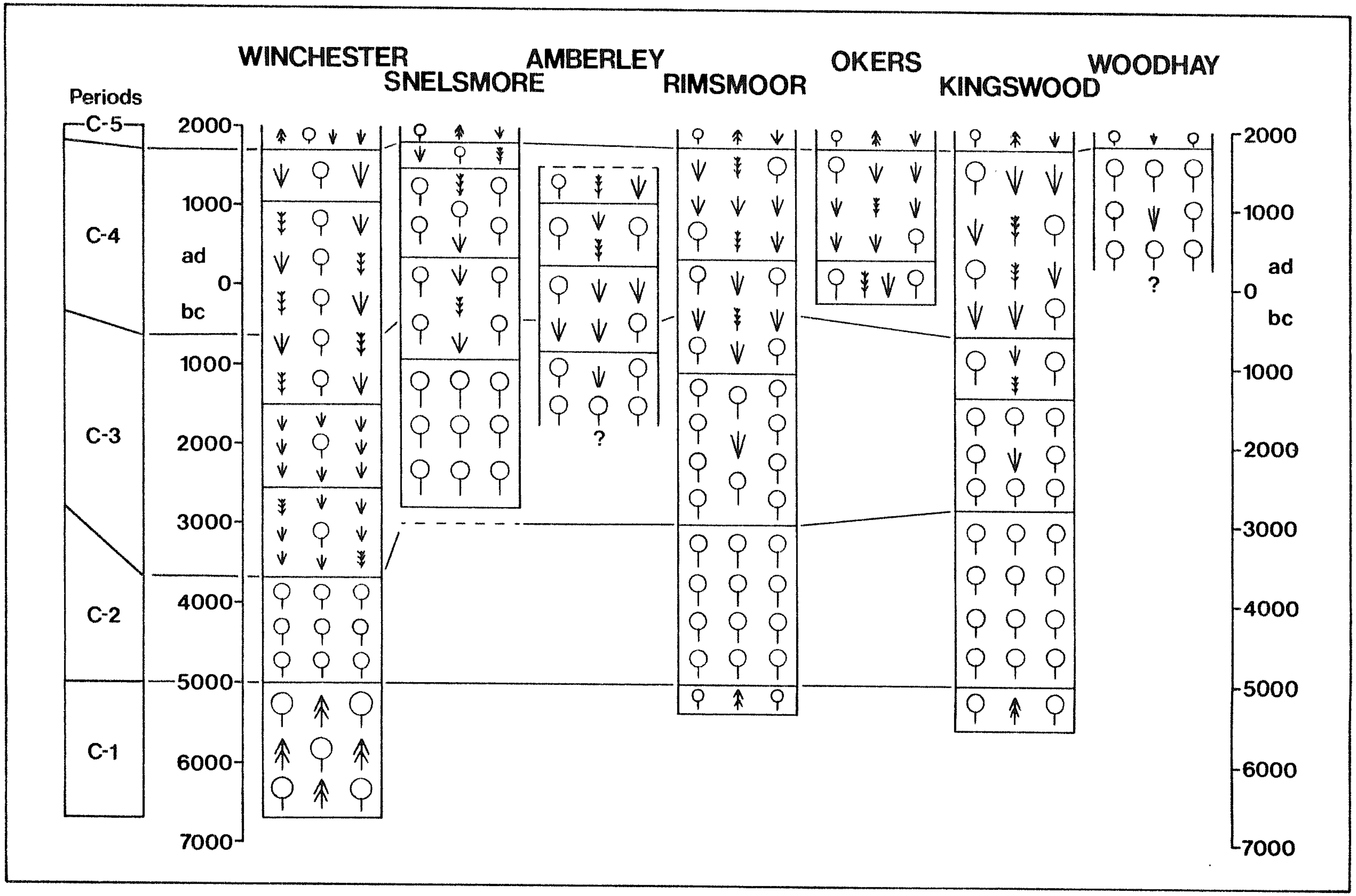
At Snelsmore the record extends from the immediate post-Ulmus decline period to the present. The spectra contrast to those from Winchester in showing a predominance of woodland, although some clearance is apparent. This is consistent with archaeological evidence for a lower intensity of exploitation of this area of the Berkshire Downs.

The peripheral sites provide data that are harder to relate to chalkland conditions because of the contribution of pollen from vegetation growing on other geologies. Apart from Woodhay, they show phases of clearance and regeneration in post-Ulmus decline levels which to a certain extent can be correlated with the results of local archaeological research. Rimsmoor may indeed record periods of pressure on chalkland resources when population overflowed on to the surrounding areas. The pollen spectra from Woodhay are consistent with other evidence for the late clearance of the Kennet Vale.

The data from each site are summarised in Figure 12.1.

Five clear phases, designated Periods, could be discerned in the pollen diagrams. Period C-1 represents the Boreal mixed woodland and Period C-2, the deciduous forest of the Atlantic, recorded at Winchester, Rimsmoor and Kingswood. All three sites show phenomena that could attest to Mesolithic activity. Period C-3 opens with the Ulmus decline clearance which is represented at the same three sites. It ends in the mid-first millennium bc and shows conditions varying from the predominantly open at Winchester, to the closed forest at Snelsmore, or the clearance and regeneration episodes recorded at Rimsmoor, Kingswood and possibly Amberley. Period C-4 exhibits markedly elevated cereal pollen and records the time from the Iron Age to the eighteenth century AD. At Rimsmoor and Amberley there is a pronounced maximum of cultivar pollen that can be related to Medieval 'land hunger'. Period C-5 records the last two centuries, characterised by afforestation.

From these new data and published work it is apparent that the downlands were once forested and that the composition of this forest may



Grassland
Arable
Deciduous trees and shrubs
Pines

Figure 12.1. Diagram summarising the environments portrayed at each site over time. At this level of generalisation, the C-3/C-4 boundary is not readily distinguishable at most sites

not have been greatly different from that on other geologies. It is unfortunate that no site recorded the early development of the chalkland flora from the Late Devensian. The central downlands of Hampshire, Wiltshire and Dorset may have been extensively cleared of forest, and remained so, from the Early Neolithic. However, there is evidence for episodes of at least local scrub growth and restricted woodland regeneration. Extensive clearance in parts of the North, South and Berkshire Downs was later, occurring from perhaps the Bronze Age. It is proposed that soil conditions may have been important in this context. Local levels of population, especially in relation to the available resources, will also have been contributory.

From the Winchester data in particular, it appear that the chalklands may have experienced a high level of exploitation in the prehistoric period. Environments on other geological outcrops were also utilised, especially from the Early Bronze Age, and this may have been stimulated in southern England by soil deterioration on the chalk. There are some indications of an agrarian shift off the downs at the end of the Roman period, but this may not have been as pronounced as has been believed; it was clearly a continuation of trends underway since the Bronze Age. The recent expansion of *Fagus* has evidently been associated with this event, probably arising from an increase in its competitive ability after soil deterioration. The recent preferential exploitation of *Quercus* has also contributed to its present abundance.

12.3. FUTURE WORK

The two most important sites in this research are Winchester and Rimsmoor. Winchester may be unique for its representation of chalkland conditions: there is clear potential in close interval counting and radiocarbon dating. The investigation of further cores from the deposit, subject to pollen preservation, would be invaluable to illustrate the location of differing land uses and the significance of pollen from taxa actually growing on the flood plain. At Rimsmoor more close sampling could realise the full potential of high resolution studies at this site, especially if technological innovation permits the extraction of a less segmented core.

Palynological research in southern England in general has been sparse, although the deficiency is rapidly being remedied by recent work. The potential, however, remains considerable and this includes the chalklands. More sites are urgently required from the latter to clarify, in particular, many of the points raised in this thesis. Suitable deposits are undoubtedly rare, but, nevertheless, the Winchester site testifies to their existence. Therefore, it should be emphasised that the search for more polliniferous sites in the chalklands must continue with vigilance.

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WINCHESTER

POLLEN PERCENTAGE DIAGRAM

SNELSMORE

POLLEN PERCENTAGE DIAGRAM

ANALYSIS P V WATON 1980

AMBERLEY WILD BROOKS

POLLEN PERCENTAGE DIAGRAM

RIMSMOOR

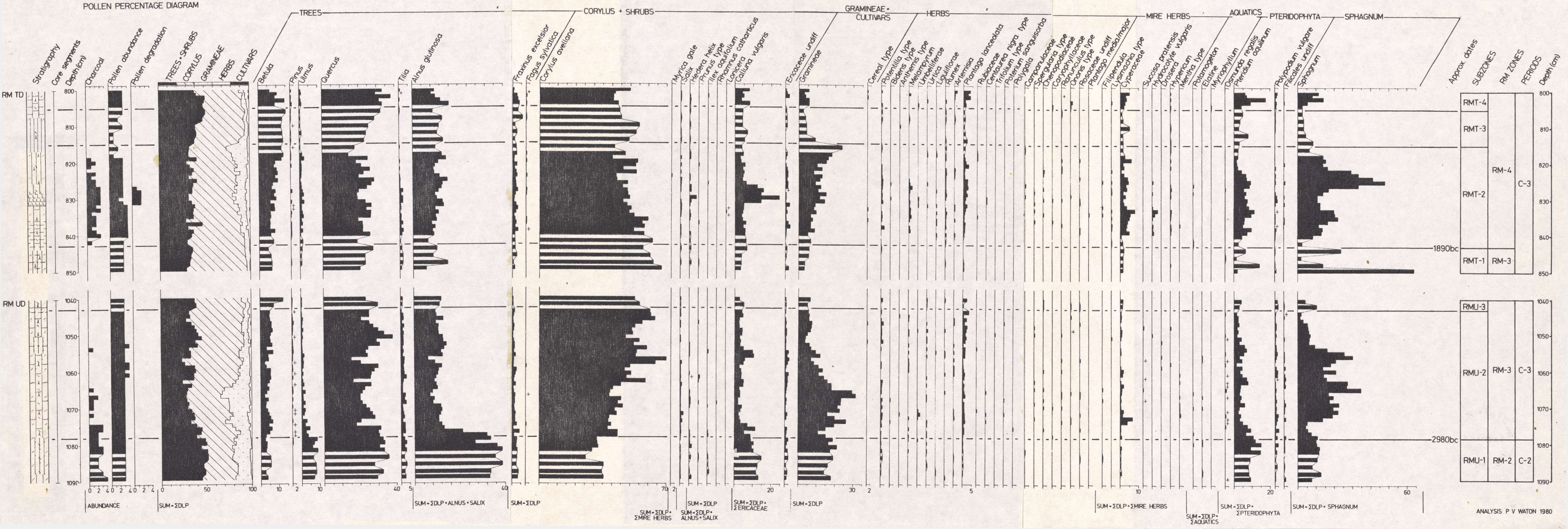
MAIN CORE

POLLEN PERCENTAGE DIAGRAM

RIMSMOOR

ULMUS DECLINE/TILIA DECLINE

POLLEN PERCENTAGE DIAGRAM



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POLLEN PERCENTAGE DIAGRAM

KINGSWOOD

POLLEN PERCENTAGE DIAGRAM

WOODHAY

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