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The Late Glacial in north-west Europe:

human adaptation and environmental change at the end of the Pleistocene

Edited by
N Barton, A J Roberts,
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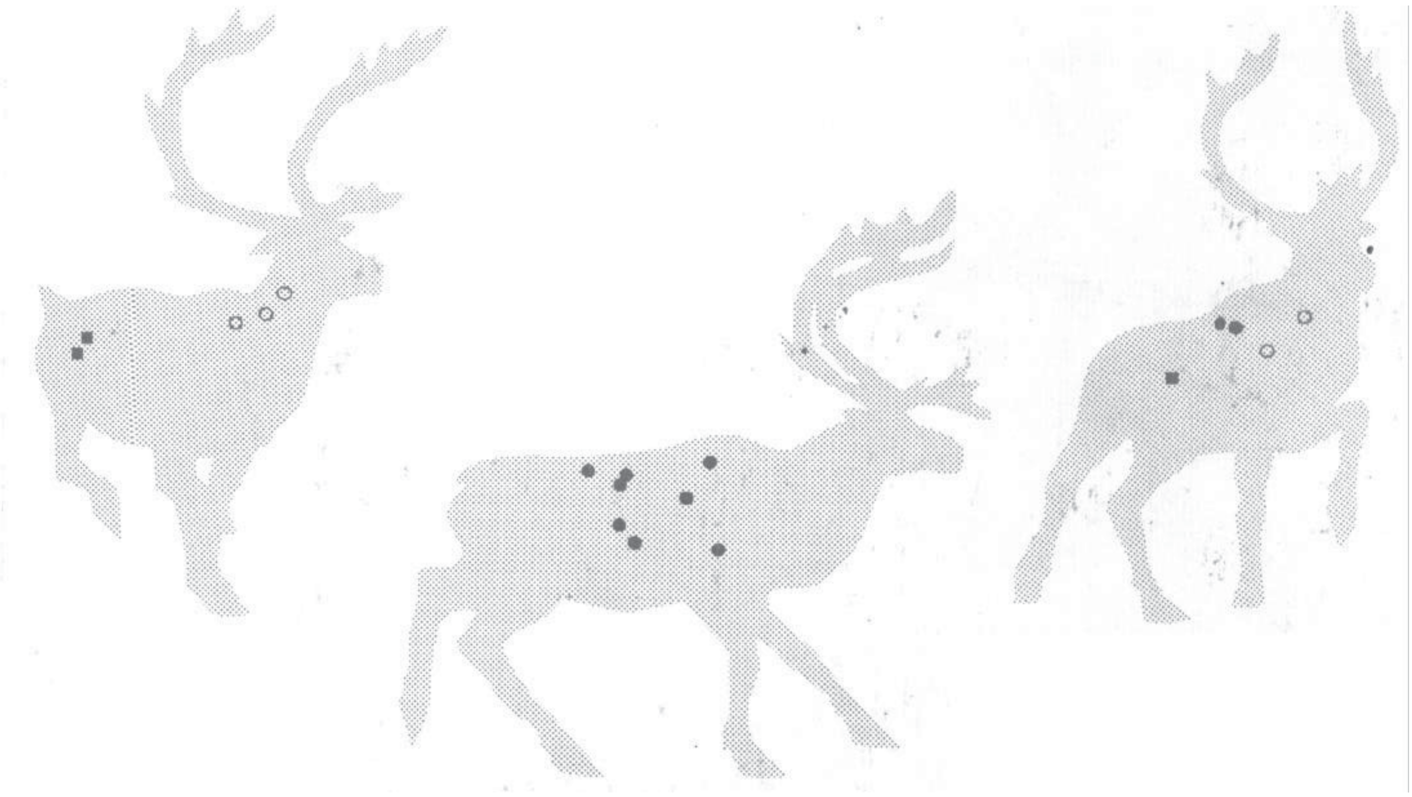

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Preface

It is well known that major climatic shifts have taken place throughout human history and that they elicited numerous, rapid and sometimes irreversible environmental responses which profoundly influenced the organisms living in those environments. The Late Glacial period of 14,000–10,000 years ago is a case of special significance, for which the evidence survives in generally good condition. It is a period of pronounced climatic upheaval and instability, being distinguished by a series of short-lived warming and cooling episodes, marking the end of the last Ice Age and the transition to the present Postglacial epoch. Although the Late Glacial in north-west Europe has been widely studied by independent specialists in the different fields of the natural sciences and archaeology, rather less attention has been given to integrating these abundant and diverse lines of evidence under a common unifying theme. This volume of papers therefore seeks to redress the balance by combining the many varied specialist interests in the Late Pleistocene while, at the same time, focusing specifically on the relationship between human adaptive behaviour and environmental stress during this period of pronounced climatic change.

This volume is mostly the product of an international conference on the Late Glacial in north-west Europe held at the University of Oxford from 19–22 September 1989. The conference was intended as a means of bringing together specialists from various related fields of Quaternary science and archaeology who had a common interest in human adaptation and environmental change at the end of the last ice age. It was attended by some 80 participants, representing a broad spectrum of disciplines, including physical anthropology, palaeobotany, mammalian and invertebrate palaeontology, Quaternary geology and archaeology. A brief summary of the conference is provided in Roe (1990).

Only a few of the invited papers presented at the conference do not appear in this volume. These include contributions on the reconstruction of Pleistocene environments by Russell Coope, Tim Atkinson, Richard Preece and John Evans and an account of ethnohistorical evidence from Greenland by Bjarne Grønnow. The contributions of the first two authors were based on a joint paper first published in 1987 (Atkinson *et al* 1987) and are not repeated here. The results of Preece's work on the Channel Tunnel Project had already been promised elsewhere, and the reader is referred to Grønnow (1988) for this author's work. Instead, space has been found for papers by Larsson, David, Lewis, and Smith and Bonsall, which were not initially presented at the conference but are highly relevant to the volume's central theme.

The volume is divided into three sections and closely follows the original format of the 1989 Oxford conference. The first section deals with changing climate and environmental conditions at the end of the last Ice Age. This forms the essential backdrop to the following two sections which are concerned with human adaptations during this period. The papers in these later sections are grouped according to period: section two deals with the early part of the interstadial and the so-called 'classic' Late Glacial hunting economies, while section three concerns the following stadial and the early Postglacial period, traditionally associated with the origins of the Mesolithic.

In preparing these papers for publication the editors have been aware of two topics where the lack of standardisation in terminology between workers in different countries could be a source of potential confusion: the stratigraphic sub-divisions of the Late Glacial and the expression of radiocarbon dates in the period concerned.

Throughout this volume, in papers dealing with the European mainland, the Late Glacial terminology and definitions are generally those used by Iversen (1954) and Mangerud *et al* (1974). For studies concerning the British Isles, authors have followed either Lowe and Gray's (1980) scheme of climatostratigraphic subdivision or a related version which includes use of the term 'Windermere Interstadial' (Coope & Pennington 1977) for the Late Glacial warm episode. The various European and British Schemes can be correlated as set out in the table below.

Some guidance is also required in the expression of radiocarbon dates used in this volume. In accordance with international convention, reaffirmed at the 12th International Radiocarbon Conference in Trondheim in 1985 (Kra & Stuiver 1986), the majority of dates quoted in the text are in uncalibrated radiocarbon years before the present (BP). The agreed zero point for the chronology (the 'present') is set at AD 1950, with the radiocarbon ages being based on the Libby half-life for radiocarbon of 5570 years. In the contributions by Housley and by Becker and Kromer calendrical dates (BC) are also cited. The use of Cal BC by Housley further identifies a date as being calibrated by means of agreed curves based on known-age samples of wood dated by dendrochronology. The discrepancy between calibrated and uncalibrated radiocarbon chronologies is discussed in the paper by Becker and Kromer.

In organising the conference, the editors are pleased to be able to acknowledge the help of the Wenner-Gren Foundation for Anthropological Research Inc (Grant No 48) and the British Academy for their most generous financial support.

British and European subdivisions of the Late Glacial

Radio-carbon years BP	**Pollen zones** (after Iversen 1954)	**NW Europe chrono-zones** (based on Mangerud *et al* 1974)	**NW Europe climato-stratigraphic units** (after Lowe & Gray 1980)	**British biozone:** (based on Gray & Lowe 1977; Coope & Penning-ton 1977)
	IV	PREBOREAL	FLANDRIAN INTERGLACIAL	FLANDRIAN
10,000				
			TRANSITION	
10,500	III	YOUNGER DRYAS		LOCH LOMOND STADIAL
			YOUNGER DRYAS STADIAL	
11.000				
11,800	II	ALLERØD		
			TRANSITION	WINDERMERE INTERSTADIAL
	Ic	OLDER DRYAS		
12,000				
	Ib	BØLLING		
			LATE GLACIAL INTERSTADIAL	
13,000	Ia			
			TRANSITION	
14,000		WEICHSELIAN STAGE	LATE DEVENSIAN/MAIN STADIAL	LATE DEVENSIAN

The editors would also like to thank the Department of External Studies, University of Oxford and Mrs Margaret Herdman for helping with the arrangements of the conference and providing the necessary facilities. Finally, they would like to thank Dr Julie Gardiner of the CBA and an anonymous referee for their helpful comments in preparing this volume for publication.

Nick Barton
Alison Roberts
Derek Roe

August 1990

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Part 1: Palaeoecology and the nature and timing of environmental change at the end of the Pleistocene

1 Palaeoenvironmental developments during the Late Glacial of the Weichselian

Else Kolstrup

Abstract

This paper attempts to integrate north-west European data from various scientific disciplines into a general outline of the environmental developments during the Late Glacial, ie, the time between 13,000 and 10,000 BP (Mangerud *et al* 1974).

Introduction

In north-west Europe today there is a diversity of soil types, relief, hydrology and vegetation, often even within short distances. As a consequence, a number of local environments and sub-environments can be distinguished. There is no reason to presume that less diversity existed during the Late Glacial. At that time the environmental conditions were apparently more unstable than today. With time, soil development took place in various substrates and time also played an important role in relation to the immigration of many plant species, in particular trees.

Palaeoenvironmental reconstructions based on botanical evidence primarily reflect environments favourable for both the growth and the preservation of plants, ie areas which have remained wet or moist till now. As a consequence, palaeoenvironmental conclusions have a tendency to become biased towards the environmental conditions in and immediately around wet areas. In the major part of the landscape, deposition of minerogenic material by wind and water, soil development or erosion took place and organic remains which represent such areas are scarce.

In order to provide a broader view of the environmental conditions during the Late Glacial, a brief survey of cover sands and periglacial features is given before the palaeobotanical records are dealt with.

Cover sands

In large parts of north-west Europe the most conspicuous deposits from the Late Glacial are cover sands, which sometimes comprise a few metres of aeolian, horizontally layered sand sequences. Figure 1.1 shows a cover sand sequence, with the older cover sand type in the lower and the younger cover sand type in the upper part of the profile (for the definition and characteristics of these sand sheets see, eg van der Hammen *et al* 1967; Kolstrup and Jørgensen 1982). Cover sand sequences may locally contain pollen-bearing horizons intercalated between sand layers. Such locations reflect unstable environments, where the vegetational development was repeatedly interrupted due to aeolian activity. A recent effort to date Danish cover sand sequences by means of thermoluminescence dating, radiocarbon dating, comparative palynological studies and litho-stratigraphical investigations (Kolstrup *et al,* in press) shows that the older cover sand type was primarily deposited during the late part of the upper Pleniglacial and the early part of the Late Glacial, but locally this type of sediment was also deposited during later parts of the Late Glacial. The younger cover sand type was deposited from the Early Dryas onwards into the early Holocene. In Figure 1.2a a tentative, relative frequency curve of cover sand deposition in southwestern Denmark is shown. In the Netherlands, Belgium, Poland and northern Germany, Late Glacial cover sand sequences are also frequently recorded, and from erosional forms Maarleveld (1964) deduced southwesterly and northwesterly wind directions for the Early and Late Dryas (or Older and Younger Dryas) respectively for the Netherlands. In southern Sweden, on the other hand, Hillefors (1969) found easterly wind directions. It should be noted that these wind directions have made recognisable imprints on 'objects', maybe during only one season, and they do not necessarily represent the dominant or prevailing wind directions at that time.

Periglacial features

In deposits dating from the Late Dryas, remains of periglacial features may occasionally be represented. A general survey of periglacial phenomena is given by, for example, Washburn

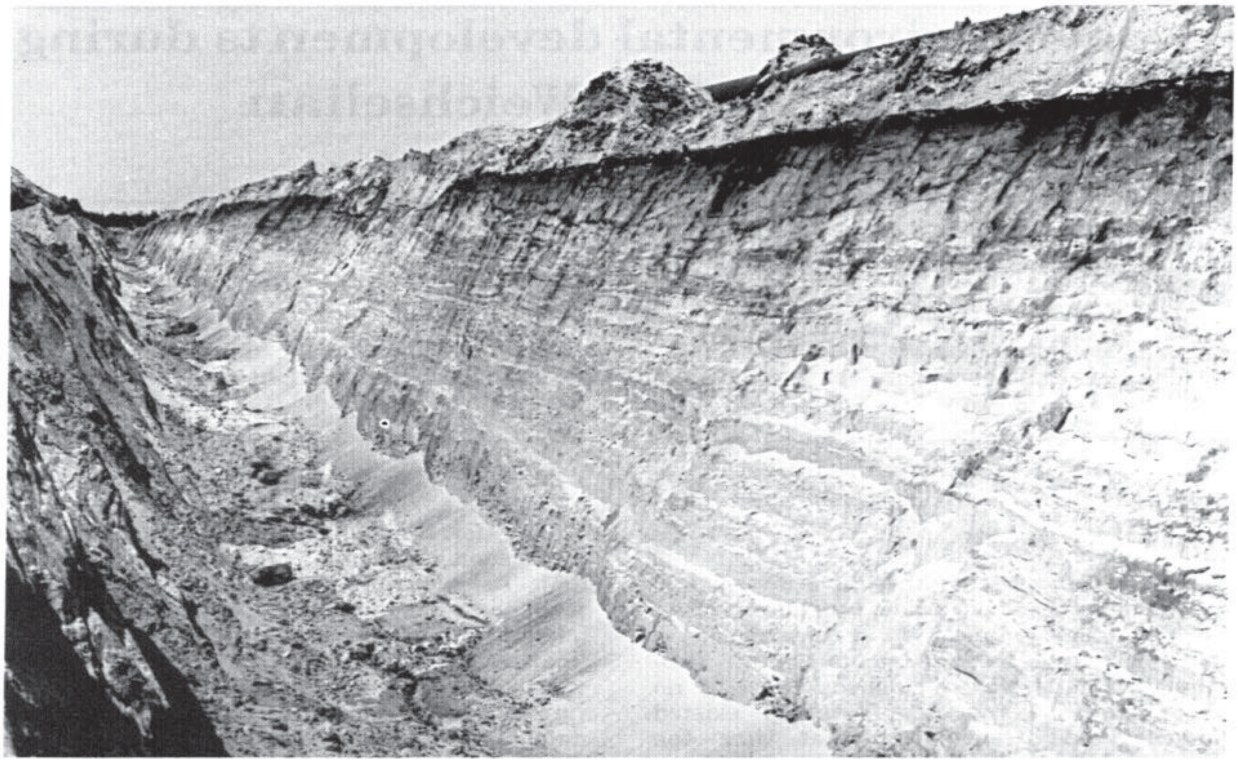

Figure 1.1 Cover sand sequence from central Jutland. The trench is c *2 m deep*

(1979). In Denmark, Wales and the Belgian Ardennes, indications of frost mounds are found (Kolstrup 1985; Pissart & Juvigné 1980; Watson & Watson 1974) and single frost wedge casts may be present (eg Maarleveld 1976). These forms point to cold soil conditions, at least during the winters, and locally/periodically the snow cover may have been thin or lacking, permitting the frost to penetrate into the ground. Where such features are found within cover sand sequences, they are usually overlain by an additional, undisturbed deposit of cover sand, suggesting that the periglacial features did not develop during the last period of cover sand deposition. In Figure 1.2b the periglacial phenomena are tentatively placed within the early to middle part of the Late Dryas.

In areas with clayey ground, solifluction and slope processes occurred, Also, glacial advances during the Late Dryas in Scandinavia and Scotland point to a period of severe climate, possibly with formation of glaciers already from the late part of the Allerød.

Palaeobotanical records

Much information on the Late Glacial environmental developments is derived from palaeobotanical records, in particular pollen diagrams. In the cover sand areas, the records are usually discontinuous and the pollen composition is dominated by types from various short plants. The late Upper Pleniglacial and the earliest Late Glacial often has some *Gentianella* (gentian) type and *Saxifraga* (saxifrage) type pollen, together with grasses and other herbs suggesting a full light, pioneer vegetation. Locally there were copses of *Salix* (willow), but in general the landscape seems to have been without tall trees during the early phase. It also looks as if trees were scarce in the drier parts of the cover sand areas during the following parts of the Late Glacial. On the other hand many plant species, including water plants, are represented in formerly moist and wet locations, and the birch *(Betula)* pollen percentage curve from such places often shows a characteristic trend through the Late Glacial (Fig 1.2c) (Iversen 1942), with a maximum during the Bølling, a minimum during the Early Dryas, a maximum during the Allerød, a minimum during the Late Dryas and increased percentages toward the end of the latter period. In accordance with the trend of the *Betula* curve, a mean July temperature trend was suggested by Iversen (eg 1973) and this is shown in Figure 1.2d. An investigation of the mutual relationship between tree birch *(Betula pubescens)* and dwarf birch *(Betula nana)* in southern Denmark and northern Germany (Kolstrup 1982; Usinger 1978) reveals that the

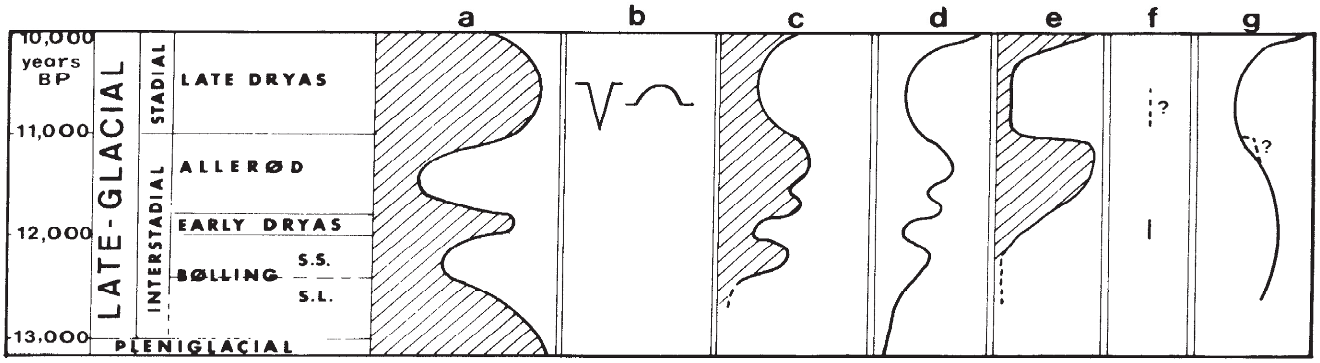

Figure 1.2 Outline of selected Late Glacial phenomena and environmental factors: a) tentative, relative frequency curve of cover sand deposits in south-west Jutland; b) periglacial phenomena; c) Betula *pollen percentage trend in relation to total pollen percentages (sum based on trees and terrestrial non-arboreal species) through the Lute Glacial in Denmark; d) mean July temperature trend according to Iversen (1954) and others; e) mutual relationship between tree birch (left) and dwarf birch (right) in southern Denmark; f) periods with possible relative drought; g) mean July temperature trend in southern Denmark partly according to Kolstrup (1982). Note that the data for the various curves are integrated from various Localities and that no absolute values are indicated*

latter was strongly dominant during the Bølling. During the Early Dryas, an admixture of tree birch is found and during the early Allerød this component increased. During the middle and late part of the Allerød it was dominant relative to *Betula nana.* During the Late Dryas, dwarf birch again dominated, until tree birch increased at the end of that period (Fig 1.2e).

Apart from the *Betula* species, a number of other trees and shrubs were present during the Late Glacial. *Pinus* (pine) grew during the late part of the Allerød in Denmark and possibly also, although to a lesser extent, locally during the Late Dryas. There was *Populus* (poplar) during the Allerød and the latest part of the Late Dryas, and *Juniperus* (juniper) may have been present throughout but is most commonly recorded in deposits from the Allerød and at the transition from Late Dryas to Holocene. *Prunus* type (a pollen type which includes a number of species, for example sloe and wild cherry) and *Sorbus* (includes mountain ash) are sporadically found in Allerød deposits, whereas *Salix* (willow) types are present throughout; and from deposits from the Early Dryas, and shortly before and after that period, *Hippophayë* (sea buckthorn) is commonly recorded.

However, it is not easy to reconstruct the frequency and the distribution of trees and shrubs within individual landscape elements for the Late Glacial. A comparison between vegetation deduced from pollen bearing cover sand localities and moist or wet depressions only gives part of the answer because, once pollen became preserved, both growth and depositional conditions were relatively moist. Consequently, even the pollen-bearing cover sand sequences do not elucidate vegetational composition and development in the driest parts of the landscape. It follows that the vegetation from the dry areas can only be deduced from wind blown pollen deposited in wet and moist sites. In this way it may be hinted that in dry sites grasses were common, locally in a vegetation pattern with mosses (eg Kolstrup & Heyse 1980) and possibly also lichens. The continued accumulation of cover sand in some areas shows that erosion took place at other locations, thus implying discontinuous vegetation cover there, probably particularly in the driest and most wind exposed parts of the landscape as well as in periodically dry parts of the river beds. In somewhat sheltered areas snow beds may have accumulated and persisted, favouring the growth of stands of, for example, *Salix.*

As a rule of thumb, it can be said that the wetter the former environment the greater the diversity of species recorded in the fossil records. It is presumed that wet spots may actually have formed the most species-rich (sub)environments and the most densely vegetated sites at any time during the Late Glacial. Such vegetational evidence is dealt with in a large number of publications, and some general surveys occur, for example those of Godwin (1984), Iversen (1973) and Pennington (1977).

The Early Dryas

Investigations of *Betula* macro-remains in Schleswig-Holstein (Usinger 1978) show that tree birch immigrated into that area during the Early Dryas. This means that the decrease in the *Betula* percentages in the Early Dryas should not be seen as a setback for tree-birch, but rather for both tree- and dwarf birch as compared to other pollen types. During the last 10-15 years, an increasing number of pollen records of relatively thermophilous plants have been found at the levels where the *Betula* percentages are at their Early Dryas minimum (eg Kolstrup 1979) and the setback of *Betula* cannot, therefore, be explained as a result of cold conditions. As an alternative explanation for this development during the Early Dryas it has been suggested that the period was relatively dry compared to the Belling and Allerød (Kolstrup 1980; 1982) (Fig 1.2f). Yet the drought was probably not extreme, because in some localities the Early Dryas decrease in birch percentages is hardly discernible (eg Kristiansen *et al* 1988, Verbruggen 1979) and in such sites a gradual vegetational development is found to take place from the oldest part of the Late Glacial until the Late Dryas. Furthermore, in some investigations the curves showing loss on ignition indicate that there was not increased deposition of minerogenic material during the period, and, consequently there is no suggestion of a relative decrease in deposition of organic matter during the Early Dryas (eg Cleveringa *et al* 1977; Jönsson 1988; Kristiansen *et al* 1988; Paus 1988).

Hints and actual evidence in support of slightly drier conditions for the Early Dryas now come from large parts of northwestern Europe and from various disciplines (Bohncke & Wijmstra 1988 (the Netherlands, pollen and geochemical analysis); Bohncke *et al* 1987 (the Netherlands, integrated study); Jönsson 1988 (Sweden, plant macrofossils, geochemistry); Kolstrup 1980, 1982 (Denmark, pollen); Kristiansen *et al* 1988, (Norway, pollen); Lemdahl 1988 (Sweden, Coleoptera); Mania & Stechemesser 1969 (Germany, molluscs)). It thus seems that a change in hydrological conditions and/or distribution of snow cover (Kolstrup 1982) may have taken place in many localities in north-west Europe between the Bølling and the Allerød. Yet it was so slight that there is an increasing tendency to include this phase, together with the Bølling and the Allerød, into a single 'Late Glacial Interstadial' (eg Björck, 1984; Paus 1988) as is the case in Great Britain (Windermere Interstadial: Coope & Pennington 1977).

Environmental conditions

During the Late Glacial Interstadial in north-western Europe, it seems that, generally speaking, a gradual soil development took place and various plant types immigrated. There are parallel trends in the development at various localities, but at the same time differences can be noted. These differences may be explained in terms of local geomorphology, geographical distribution, hydrology or other factors related to local environments and time dependent vegetational development. As a consequence, a reconstruction of the Late Glacial vegetational development is extremely complex.

It seems that the summer temperatures may not have been a limiting factor for tree growth at any time during the Late Glacial Interstadial. Instead, it is thought that delayed immigration, and possibly also insufficiently developed soils, were the reasons for the lack of deciduous trees. During the Late Dryas the change in vegetation towards more reduced tree growth was probably caused by colder conditions.

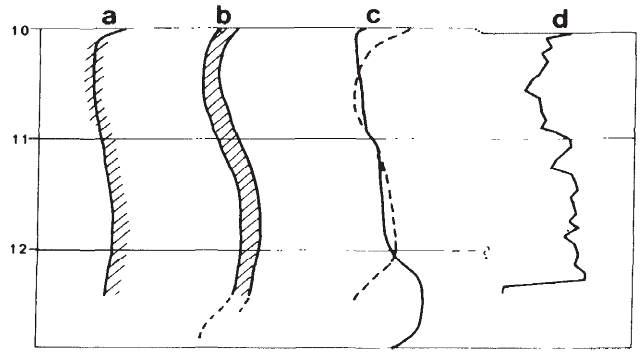

Figure 1.3 General outline of mean July temperature trends deduced from a) pollen, b) molluscs, c) Coleoptera (unbroken line — Great Britain, dotted line — southern Sweden) and d) oxygen isotopes. Scale on left in thousand years BP All curves point to relatively high temperatures until about 11,000 BP and colder conditions between 11,000 and 10,000 BP

From botanical records, a mean July temperature trend is deduced for the Late Glacial Interstadial, the Late Dryas, and the transition to the Holocene for southern Denmark (Kolstrup 1982). Figure 1.2g shows that the mean July temperature trend is rather uniform through the Late Glacial Interstadial. The temperature decreased during the Late Dryas and rose again about 100-250 years before the transition to the Holocene at 10,000 BP. The mean January temperatures were probably not extremely cold at any time during the Late Glacial Interstadial. No periglacial phenomena can with certainty be dated to that period and *Armeria maritima* (sea pink), which does not tolerate mean January temperatures below –8" C, (Iversen 1954) is present.

During the Late Dryas, the summers became colder and the winters may (periodically?) have been rather severe, thus favouring the development of frost wedges in areas without, or with only thin, snow cover. On the other hand, the continued presence of birch, as well as of species favoured by late snow beds, in a number of localities suggests that some snow was present most of the time, If dry conditions did exist during this period, they may therefore have been restricted in time and/or geographical extent (dotted line in Fig 1.2f).

A comparison between the mean July temperature trends deduced from pollen, molluscs (Johansen 1904), oxygen isotopes (Either & Sigenthaler 1976) and Coleoptera (Coope 1977; Lemdahl 1988), show agreement in the general trend of a relatively warm Late Glacial Interstadial and a cold Late Dryas (Fig 1.3). Yet there are differences in the timing of events, as well as in opinions on specific underlying causes. It is, for example, interesting to note that the temperature maximum reflected from south Swedish Coleoptera seems to be delayed as compared to the British curve, which is again different from the recently published Dutch record from Usselo (van Geel *et al* 1989). It is possible that there were differences in the environmental development in various parts of north-west Europe, and one may wonder whether changes in the representation of plant species (and animals) can be interpreted as reflecting transitions of threshold conditions (extremes or stress upon species), and if, as a consequence, changes are contemporaneous within the area.

Acknowledgements

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2 Climatic change in Scotland during the Devensian Late Glacial: The palynological record

Richard Tipping

Abstract

This review describes the general vegetational and climatic changes of the period, as evidenced in pollen diagrams. Particular attention is paid to (a) problems of radiocarbon dating, (b) climatic and edaphic factors controlling regional plant communities, (c) the 'reality' and possible ages of Late Glacial Interstadial *(sensu* Lowe & Gray 1980) climatic deteriorations, (d) the climatic changes prior to and at the beginning of the Loch Lomond Stadial, and (e) climatic differentiation within the Stadial.

Introduction

This paper attempts to describe and analyse the important changes that have taken place in our view of the Scottish Devensian Late Glacial climate in the last 10 or so years, particularly those reflected in the pollen record. The review is necessarily brief, but aims to provide an up-to-date assessment of the major research areas developed in recent years. The regional bias is intentional, since it is this part of the British Isles that has seen most progress in understanding the Devensian Late Glacial. Sutherland (1984) has recently presented a detailed discussion of the morphological and sedimentological evidence for Quaternary environmental change in Scotland; this paper reviews the biostratigraphic evidence for this critical period.

The beginning of the Late Glacial Interstadial

The retreat of the Late Devensian ice sheet in Scotland is now seen (cf Sutherland 1984) to be interrupted by a great number of minor readvances predating *c* 13,000 BP Principal among these are the Wester Ross Readvance (Robinson & Ballantyne 1979), demonstrably pre-dating the Loch Lomond Readvance, and of regional importance in north-west Scotland (Fig 2.1), but so far of unknown age; and a stand-still phase or slight readvance related to an end moraine at Otter Ferry, on Loch Fyne (Fig 2.1), which is dated to c 13,000 BP. Sutherland (1984) proposed a non-climatic cause for this, in view of the coincidence in timing of this stage and evidence for rapid climatic amelioration (Atkinson *et al* 1987), in the stabilisation on fjord sills of previously rapidly retreating ice fronts.

The biostratigraphic record appears to commence only slightly prior to 13,000 BP The earliest radiocarbon date from basal, organic-rich, lacustrine sediments is from Loch Etteridge, in the central Grampian Highlands (Sissons & Walker 1974), of 13,50±190 BP (SRR-304)(Fig 2.2). Such a date is in keeping with what is known of the northward retreat of the polar front (Ruddiman *et al* 1977), and the rapidly escalating temperature trends in the British Isles (Atkinson *et al* 1987). However, there are thought to be many inherent errors in radiocarbon dates from recently deglaciated terrain (Sutherland 1980). Early Late Glacial radiocarbon dates considered by Sutherland (1980) as relevant to Scottish ice sheet deglaciation are listed in Table 2.1 (see also Fig 2.2). Together, the dates suggest some degree of agreement, with a mean age of 12,790±190 BP. However, many of the dates have very large standard deviations, and their precision is much reduced because of this. At least one site (Abernethy Forest) is of uncertain value, since Vasari's (1977) radiocarbon date is decidedly at variance with one from the same stratigraphic context obtained by Birks and Matthewes (1978), of 11,760±250 BP (Q-1266). However, a more recent date on lacustrine deposits from Loch an- t' Suidhe, Mull (Walker & Lowe 1982), of 13,140±100 BP (SRR-1805), is in good agreement with the 'mean' age.

Sutherland (1980) argued that the good agreement in the dates indicated probable errors, since the sites lie at varying distances from the centre of the retreating Highland ice sheet, and would not be expected to be comparable. However, the assumption that such basal dates need have a close relationship to deglaciation can, perhaps, be

Figure 2.1 *Localities in Scotland, and pollen sites in the British Isles and Ireland, referred to in the text*

Table 2.1 Early Devensian Late Glacial radiocarbon dates from lacustrine sediments in Scotland

Abernethy Forest (Vasari 1977)	HEL-424	12710±270 BP
Drymen (Vasari 1971)	HEL-160	12510±310 BP
Cam Loch (Pennington *et al* 1972)	SRR-253	12960±250 BP
Loch Droma (Kirk & Godwin 1963)	Q-457	12810±160 BP
Loch Etteridge (Sissons & Walker 1974)	SRR-304	13150±190 BP
Loch of Winless (Peglar 1979)	Q-1175	12821±350 BP
Morrone (Switsur & West 1975)	Q-1291	12600±210 BP
Tynaspirit (Lowe & Walker 1977)	HV-4989	12750±130 BP

questioned. It is important to remember that what is being measured is the date of initial accumulation in lakes of organic-rich sediments. The increase in organic matter, whether from aquatic organisms or terrestrial sources, is not necessarily simply a response to deglaciation of an area, but may have some climatic trigger. At virtually all Late Glacial pollen sites there are variable thicknesses of silts and clays with a very weak organic content. At the majority of the sites, these sediments contain pollen assemblages of open- and disturbed-ground vegetation, indicating local plant colonisation some time prior to the onset of organic matter accumulation. It is, of course, unknown for how long these basins remained free of ice before the sediments became amenable to radiocarbon dating, but the possibility exists that local or regional deglaciation had little direct bearing on the basal radiocarbon date at a site.

The agreement between these radiocarbon dates might be seen as evidence for broadly synchronous increasing productivity in aquatic and terrestrial habitats, determined by the climatic amelioration at *c* 13,000 BP, recognised from Coleopteran data by Atkinson *et al* (1987). This suggestion is perhaps supported by the temporal correlation of the above radiocarbon dates on lacustrine sediments with an equally early date on wood from Roberthill, Dumfriesshire (Bishop & Coope 1977), of 12,940±250 BP (Q-643; Godwin & Willis 1964). This sample is very unlikely to have been affected by an ageing error.

There is, then, the possibility that many basal radiocarbon dates are reliable, and further, that these suggest climatic amelioration coincident with that proposed from other sources. The absence of pattern noted by Sutherland (1980) might then be taken to imply warming uniformly across Scotland, with no apparent delay (given the resolution of the dates) between south and north, as the North Atlantic polar front retreated.

This is not to deny the possibility of error in some radiocarbon dates. In this regard, attention should be paid to sites with basal radiocarbon dates far in excess of 13,000 BP, such as Kildale, in the North York Moors (Jones 1977), where a date of 16,710±340 BP (SRR-145) was obtained on plant matter within marl, surely a reading affected by hard water error. The littoral sediments at Windermere (Pennington 1977a) produced two dates, of 14,560±280 BP (SRR-681) and 14,62±360 BP (SRR-682). Radiocarbon dates from immediately above the source of these dates are thought to incorporate hard water error (Pennington 1977a), and it must be a reasonable suspicion that other dates in the sequence are similarly affected. Similar concern over some dates at nearby Blelham Bog, where the basal date has an age of 14,330±230 BP, was expressed in the initial publication by Pennington and Bonny (1970). However, at Glanllynnau (Coope & Brophy 1972) the stratigraphic context of the very early date of 14,470±300 BP (Birm-2121) is not comparable with other dates discussed, since the sample lies not at the base of the Late Glacial Interstadial sequence, but several tens of centimetres below this, in deposits laid down in a cold continental climate. There is little reason to question this date.

The early part of the Devensian Late Glacial: the palynological evidence

The sequence of vegetational changes in the early part of the Late Glacial Interstadial is now reasonably well understood. Open-ground communities, typified by *Artemisia,* gave way to open grasslands with *Rumex,* then to *Empetrum* and *Juniperus* scrub, and in northern England and eastern Scotland, to open *Betula* woodlands. It has become apparent, however, that although this succession is probably climatically driven, the changes are out-of-phase with the actual climatic (thermal) amelioration recognised from Coleopteran analyses (Coope 1977; Atkinson *et al* 1987).

Some understanding of regional differentiation in dominant plant communities can be gained by comparing the pollen records from the relatively well researched Scottish region. Figure 2.2 depicts all Late Glacial sites known to the author. Absent from this map are Birks' (1973) sites on the Isle of Skye, since Walker *et al* (1988) have shown that these sites (with the exception of Loch Cill Chriosd) are probably not Late Glacial in age. The sites of Amulree and Cambusbeg (Lowe & Walker 1977) are also not considered to be full Late Glacial sites, because of the absence of pollen and sediment stratigraphies readily correlatable with adjacent proven Late Glacial sites (see Tipping 1984); these also are not included in Figure 2.2.

In Figures 2.3 and 2.4 the maximal percentages attained by *Empetrum* and *Betula* respectively are illustrated. *Empetrum* values show a distinctly northern and north-western distribution, and are poorly represented in the west and south-west. This distribution, and the limited representation at sites in Ireland (Watts 1977), suggest that oceanicity of climate during the Late Glacial Interstadial (Brown 1971) is not the determining factor. Instead, an association with strongly acidic substrates has recently been proposed (Tipping 1989), which supports the conclusions of Pennington *et al* (1972) in north-west Scotland. Insufficient time for leaching of basic soils may explain in part its limited representation elsewhere in Scotland.

The broad picture of birch 'parkland', with subordinate *Juniperus,* over much of northern England and southern and eastern Scotland (Fig 2.4) is complicated by smaller-scale differences believed to have been induced by altitude (Pennington 1970; Sissons *et al* 1973), aspect (Lowe & Walker 1977) and soil differentiation (Gunson 1975). Such ecotypic differences may have determined the rather 'patchy' representation of high percentages in Figure 2.4. There is, however, no evidence that birch approached a climatic threshold near the Anglo-Scottish border, as suggested by Bartley *et al* (1976) and Webb and Moore (1982).

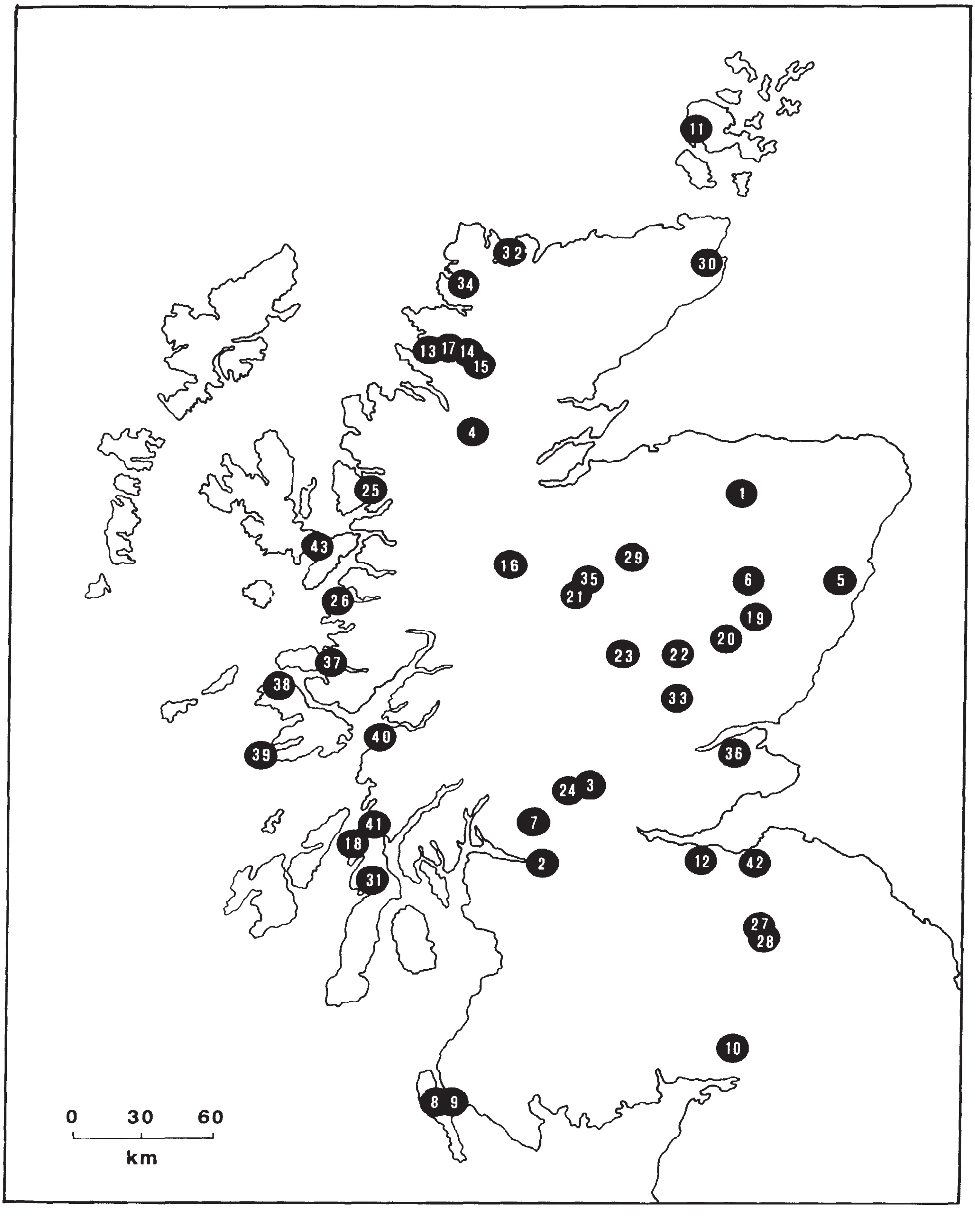
Pennington (1986) has suggested that pedological controls governed the rate of spread of *Betula* in the British Isles, and related the late expansion of birch at some sites (based on radiocarbon dating evidence) to relatively immature soils with limited water retentive capacities. Her measure of soil maturity is based on differences in water retention between soils supporting *Artemisia* communities (dry) and those under grass-*Rumex* sociations (moist). The assumption that these two communities are mutually exclusive is not, however, borne out by Late Glacial pollen sites showing good temporal resolution, where *Artemisia* communities are seen to be replaced by species-rich grasslands containing *Rumex* (above), and in general these early colonising communities are separated in time from the later expansion of birch by assemblages rich in *Empetrum* and/or *Juniperus.*

In western Scotland, Late Glacial Interstadial pollen assemblages are typified neither by *Empetrum* heath or *Betula* 'parkland', but by Gramineae-rich assemblages. These compare closely with the majority of sites in Ireland (Watts 1977; 1985). The absence of birch is not thought to have been determined by thermal or precipitation gradients, since at some sites (Jessen 1949; Watts 1977) *Betula pubescens* macrofossils are found, indicating the growth of tree birch in certain conditions, Watts (1977) and Craig (1978) explained the absence of tree birch in part by a greater degree of exposure, and this is proposed as the principal reason for its suppression in western Scotland (Lowe & Walker 1986; Tipping 1984 and in press).

The immigration of tree birch in the Late Glacial Interstadial is now widely accepted to be out-of-phase with the rapid climatic amelioration (Coope 1977; Pennington 1986). It is probable that *Betula* pollen curves are thus relatively unresponsive to changing climate (cf the pronounced expansion of *Betula* at sites in northern England and north Wales, following the downturn in climate of *c* 12,000 BP (Coope & Joachim 1980; Lowe 1981). Given the relatively prolific production and dispersal of birch pollen, such sites may not be particularly sensitive to climate change. Indeed, this appears to be the case, for recent work in areas of western Scotland, where birch was insignificant,

Figure 2.2 Locations of Scottish Devensian Late Glacial pollen diagrams known to the author

Key: *1) Garral Hill (Donner 1957); 2) Garscadden Mains (Donner 1957); 3) Loch Mahaick (Donner 1958); 4) Loch Droma (Kirk & Godwin 1963); 5) Loch of Park (Vasari & Vasari 1968); 6) Loch Kinord (Vasari & Vasari 1968); 7) Drymen (Vasari & Vasari 1968); 8) Culhorn Mains (Moar 1969b); 9) Little Lochans (Moar 1969b); 10) Bigholm Burn (Moar 1969b); 11) Yesnaby (Moar 1969a); 12) Corstorphine (Newey 1970); 13) Loch Sionascaig (Pennington* et al *1972); 14) Loch Borralan (Pennington* et al *1972); 15) Loch Craggie (Pennington* et al *1972); 16) Loch Tarff (Pennington* et al *1972); 17) Cam Loch (Pennington* et al *1972); 18) Drimnagall (Rymer 1977); 19) Blackness (Walker 1975a); 20) Rhoineach Mhor (Walker 1975a); 21) Loch Etteridge Walker 1975b); 22) Corrydon (Walker 1977) ; 23) Tirinie (Lowe & Walker 1977); 24) Tynaspirit (Lowe & Walker 1977); 25) Glasscnock (Robinson 1977); 26) Lochan Doilead (Williams 1977); 27) Beanrig Moss Webb & Moore 1982); 28) Blackpool Moss (Webb & Moore 1982); 29) Abernethy Forest (Birks & Matthewes 1978); 30) Loch of Winless (Peglar 1979); 31) Loch Cill an Aonghais (Peglar in Birks 1980); 32) An Druim, Eriboll (Birks 1984); 33) Stormont Loch I (Caseldine 1980); 34) Lochan an Smuraich (Pennington 1977b); 35) Tom na Moine (MacPherson 1980); 36) Pitbladdo (Donald 1981); 37) Salen (Wain-Hobson 1981); 38) Mishnish (Lowe & Walker 1986); 39) Loch an-t' Suidhe (Lowe & Walker 1986); 40) Pulpit Hill (Tipping 1984, in press); 41) Loch Barnluasgan (Tipping 1989); 42) Balgone House (Alexander 1985); 43) Loch Ashik walker* et al *1988)*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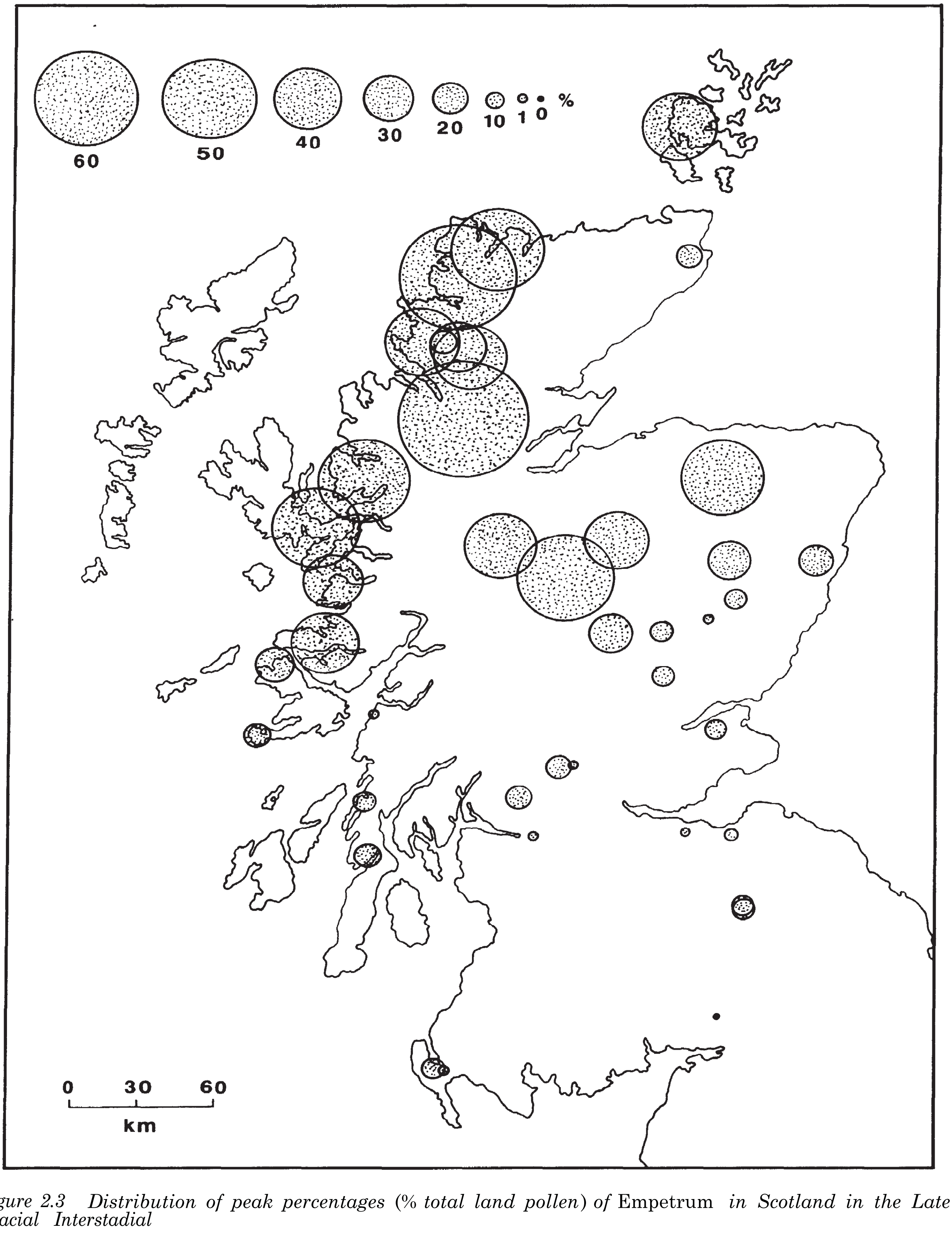

Figure 2.3 Distribution of peak percentages (% total land pollen) of Empetrum *in Scotland in the Late Glacial Interstadial*

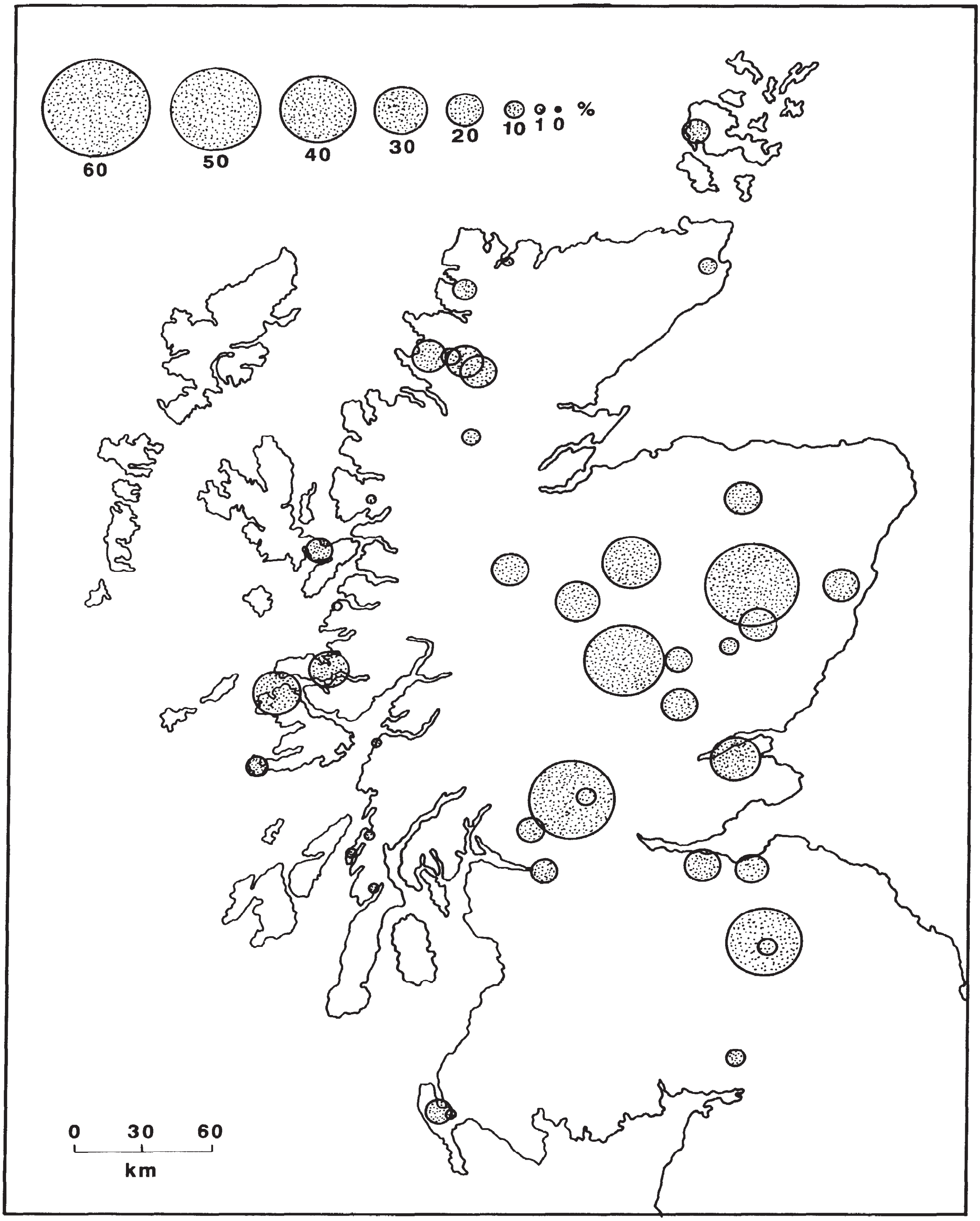

Figure 2.4 Distribution of peak percentages (% total land pollen) of Betula *in Scotland in the Late Glacial Interstadial*

Table 2.2 Pollen sites in northern Britain purporting to show a mid-Late Glacial Interstadial short-lived climatic deterioration, assessed using Watts' (1970) criteria

Site	Watts' criteria				
	(1)	(2)	(3)	(4)	(5)
Tadcaster (Bartley 1962)	no	no	yes	no	NO
Blelham Bog (Pennington 1975)	yes	no	no	?yes	NO
Blea Tarn (Pennington 1970)	yes	yes	yes	no	YES
Cam Loch (Pennington 1975)	no	no	no	no	NO
Lochan an Smuraich (Pennington 1977b)	no	no	yes	yes	?
Loch Tarff (Pennington *et al* 1972)	no	no	yes	no	NO
Loch Sionascaig (Pennington *et al* 1972)	yes	yes	yes	no	YES
Loch Borralan (Pennington *et al* 1972)	yes	yes	yes	no	YES
Loch Craggie (Pennington *et al* 1972)	yes	no	yes	no	NO
Loch of Park (Vasari & Vasari 1968)	no	no	no	no	NO
Corrydon (Walker 1977)	yes	?no	yes	yes	?
Stormont Loch (Caseldine 1980)	yes	?no	yes	no	?
Pulpit Hill (Tipping 1984; in press)	yes	?yes	yes	yes	YES
Loch an-t' Suidhe (Lowe & Walker 1986)	yes	?yes	yes	no	?

Key:
(1) A pollen flora counted to a 'good modern standard which is clearly distinct from the pollen flora contained in the underlying and overlying sediments' (Watts 1970, 144).
(2) 'Clear evidence of climatic reversion' (op cit, *144).*
(3) More than one distinctive pollen spectra.
(4) Related changes in sediments, plant macrofossils or other independent indicators.
(5) Evidence for short-lived climatic deterioration (see Tipping 1984 and in press for full discussion)

has done much to clarify our understanding of climatic change in the Late Glacial (Lowe & Walker 1986; Tipping 1984, 1989 and in press; Walker *et al* 1988).

Climatic fluctuations in the Late Glacial Interstadial

The lag between climate and vegetation in the Devensian Late Glacial makes estimates from palynological data of the rates of thermal improvement unwise. Very little work has been done within the British Isles in attempting to quantify the palaeo-temperature estimates of particular pollen types or assemblages. Conolly and Dahl's (1970) work on this was hampered by the poor database that existed then, and might be more usefully applied today, although Birks (1981) has criticised the 'indicator-species approach' in climatic reconstructions. The detection of climatic deterioration from palynological data might have a firmer basis, provided the deterioration is sufficiently pronounced to have disrupted the vegetation. In this regard, the degree of sensitivity to climatic change of the dominant pollen assemblages needs to be borne in mind, given the implication (above) that *Betula* woodlands are responsive only to changes of high intensity.

The correlation of the British Late Glacial climatic stratigraphy with the chrono-stratigraphic subdivisions proposed by Mangerud *et al* (1974) has been much discussed (Pennington 1975; Gray & Lowe 1977; 1980; Watts 1980), with particular attention being focused on the recognition of the Older Dryas phase of short-lived deteriorating climate between *c* 12,200–12,000 BP (or the revised chronology of Bjorck (1984) of 12,250–12,100 BP).

Both the stratigraphic models of Coope and Pennington (1977) and Lowe & Gray (1977, 1980) have one undivided interstadial period, the Windermere or Late Glacial Interstadial. Suggested correlations with the continental stratigraphy of particular British pollen sites, purporting to contain evidence of the Older Dryas stage (Pennington 1975), have been criticised on the basis of poorly resolved radiocarbon dating (Lowe & Gray 1980).

Watts (1970) proposed several criteria by which a climatic deterioration could be determined from biostratigraphic data (listed in Table 2.2). Utilising these, Tipping (1984 and in press) has suggested that the majority of northern British pollen sites which have been suggested as indicating a short-lived climatic downturn fail more than one of these criteria (Table 2.2). Some sites do, however, survive this test, such as Blea Tarn (Fig 2.1); Loch Sionascaig, Loch Borralan and Pulpit Hill (Fig 2.2); while others (Corrydon, Stormont Loch and Loch an-t' Suidhe (Fig 2.2) remain equivocal.

Nevertheless, it should be stressed that there is no evidence at any of these sites for temporal correlation with the Older Dryas phase of Mangerud *et al* (1974) or Bjorck (1984). Apart from the insecure radiocarbon dates from the Blelham Bog and Cam Loch sequences (see Lowe & Gray (1980) for discussion), there are no published dates. It will be shown later that at several sites these brief climatic oscillations almost certainly predate *c* 12,000 BP.

The paucity of radiocarbon dates effectively precludes discussion of Watts' (1970) two criteria for assessing the regional significance of such deteriorations, namely synchroneity and consistency between sites. However, it is becoming possible tentatively to suggest reasons why these phases are recognised at only a few sites and not at the vast majority of sites in northern Britain.

Of the five sites in Table 2.2, apparently supporting the suggestion of a short-lived climatic deterioration, four are in western Scotland. In addition to these, the majority of the five Late Glacial pollen sites on the isle of Skye discussed by Walker *et al* have thin inwashed clay bands in the early part of the Late Glacial Interstadial (Lowe pers comm). At only one site, however, are the pollen percentage changes sufficiently distinctive to warrant its recognition in the local pollen zonation, although pollen preservation and concentration changes are thought to indicate climatic deterioration. The radiocarbon chronology at this site, Loch Ashik, appears to be in error (Walker *et al* 1988).

At present it is difficult to assess the significance of these sites, but the replication of the pattern at several sites in the same region is potentially very interesting. Again, the premise of synchroneity requires testing, and the problems of radiocarbon dating at Loch Ashik must warn of the inherent uncertainties. However, there is only a limited available timespan (of around 1000 years) in the early part of the Late Glacial Interstadial within which to accommodate fluctuations in climate, assuming, first, that organic sedimentation commenced near 13,000 BP (cf above and Lowe & Walker 1986) and, second, that the distinct vegetation change at these sites (below) occurred at around 12,000 BP, which might make synchroneity more likely.

Lowe and Walker's work on Mull (1986) nevertheless illustrates some of the uncertainties involved in the recognition of this feature. Their Late Glacial site at Mishnish contains no evidence of the fluctuation tentatively distinguished at Loch an-t' Suidhe (Table 2.2), because, Lowe and Walker argued, the greater shelter from westerly winds at this site allowed the increased development of woody taxa, less sensitive to short-lived climatic change. Thus, despite the suggestion that sites on the western seaboard of the British Isles are more sensitive to Late Glacial climatic change, factors specific to individual sites may well confound regional correlations.

Palynological evidence for substantial climatic deterioration at *c* 12,000 BP

At the same time that workers on the British mainland were being made aware of the apparently severe differences in climatic interpretation between palynological and Coleopteran records (Pennington 1977a; Coope 1977), evidence was being presented from pollen sites in Ireland (Watts 1977) to show considerable agreement between those two lines of evidence. Because the majority of Irish sites lacked any significant expansion of trees (above), Watts and co-workers were able to recognise a climatic downturn in the decline of pollen of *Juniperus* and *Empetrum* and their replacement by grassland assemblages. Radiocarbon dates showed this deterioration to correspond in time to the declining temperature trends recognised from beetle remains (Coope 1977), at around 12,000 BP

Very similar events have more recently been reported from several sites in western Scotland (Rymer 1977; Tipping 1984; 1989 and in press; Lowe & Walker 1986; Walker *et al* 1988). At sites on Mull, radiocarbon dates suggest a high degree of synchroneity between western Scotland and Ireland, and this in turn suggests considerable spatial uniformity in the climatic changes taking place at this time. The recognition of this change from juniper- rich to Gramineae assemblages (often characteristically high in *Plantago maritima* pollen) at sites such as Pulpit Hill, Loch an-t' Suidhe and on Skye allows the inference that the brief climatic fluctuation or fluctuations discussed above predate *c* 12,000 BP

Nevertheless, there are particular problems in comparing the sequences in Ireland and Scotland. The course of the climatic deterioration, from its onset at around 12,000 BP to the beginning of the Loch Lomond Stadial, is poorly known. Watts (1977, 1985) has recognised at some Irish sites a period of erosion at the transition from juniper to grass assemblages, which is thought to have persisted from *c* 12,000 to *c* 11,800 BP. Correlation with the Older Dryas stage of Mangerud *et al* (1974) is unlikely, however, particularly given that the subsequent period is not comparable to the Allerød phase. Brief phases of accelerated soil erosion are not, however, recognised so far at Scottish sites. Chemical data from sites on Mull (Lowe & Walker 1986) and in Argyll (Tipping 1984 and in press) indicate that post-12,000 BP sediments are increasingly minerogenic, with accelerating amounts of soil erosion indicated, but this appears to continue without a break into the major erosive phase of the Loch Lomond Stadial, post- *c* 11,000 BP

However, this phase of continuing climatic decline appears to be interrupted at some northern British sites (Vasari & Vasari 1968; Pennington *et al* 1972; Walker 1975a; Bartley 1966; Robinson 1977) by brief expansions of *Juniperus,* which have been interpreted as representing a climatic amelioration at the end of the Late Glacial Interstadial, immediately prior to the Loch Lomond Stadial. At the majority of the sites the expansion is seen in several spectra, and at Loch Sionascaig (Pennington *et al* 1972) there appears to be a change to sediments of increased organic carbon content. This brief interlude is of uncertain significance at present, not being recognised at the majority of sites. The assumption that increases in woody taxa need represent thermal improvement is uncertain; Tipping (1984) and Bohncke *et al* (1989) have suggested that the re-colonisation of *Juniperus* may have more to do with the break-up, through intensifying solifluction, of closed grassland communities.

The timing of the Loch Lomond Readvance

At the end of the Late Glacial Interstadial, the organic sediments are generally abruptly replaced by clays and silts with a poor organic content, indicative of intense and sustained solifluction from catchment soils. Pollen spectra from these minerogenic sediments are everywhere characteristic of disturbed ground communities, as grassland or birch parkland vegetation is broken up. This dramatic climatic deterioration, seemingly much more intense than that at *c* 12,000 BP, is relatively poorly dated, partly through the inherent problems of radiocarbon dating lacustrine sediments in this period (Sutherland 1980; Lowe & Walker 1980; Lowe *et al* 1988), and possibly also through regional and local differences in the timing of the onset of solifluction (Vasari 1977). Thus, although the boundary between organic-rich and minerogenic sediments has been dated to *c* 10,700 BP at several Scottish sites (Sissons & Walker 1974; Vasari 1977; Walker & Lowe 1982), an average date for this change in northern Britain would be around 11,000 BP.

It has generally been considered that the recrudescence of glacier ice, termed the Loch Lomond Readvance, was synchronous with the period of intense climatic severity recognised predominantly in lacustrine sediments, the Loch Lomond Stadial. Peacock (1970) questioned this assumption on the basis that the time interval assigned to the phase of glacial climate (then believed to extend from *c* 11,000–10,000 BP) was too short to allow glaciation on the scale recognised in Scotland, and argued that glacier initiation or readvance would have had to predate the Loch Lomond Stadial. Recently, the temporal correlation of the two events has been re-examined (Lowe & Walker 1984; Tipping 1985; Rose *et al* 1988; Rose 1989).

The climatic deterioration at *c* 12,000 BP has been recognised in Coleopteran data for several years (Coope 1977; Coope & Brophy 1972), and some workers have suggested that the onset of Loch Lomond Readvance glaciation may have occurred markedly earlier than *c* 11,000 BP (Sissons 1974; 1979; Robinson 1977; Sutherland 1984).

Sutherland (1984) has recently reviewed the evidence for the dating of the Loch Lomond Readvance. Radiocarbon dates from ice-transported or over-ridden marine shells (Sutherland 1986) at several localities in south-central Scotland range from 12,300 to *c* 10,900 BP, indicating that the readvance maximum occurred after the latter date, perhaps between 10,900 and 10,700 BP Rose *et al* (1988) have suggested that dates from marine shells are open to biases, in the selection of large specimens for dating. These may predate the period of rapid sedimentation closest to ice readvance, while smaller shells growing at this later time are not sampled. Very recently, however, Peacock *et al* (1989) have presented radiocarbon evidence to suggest that the date of glacial maximum of one glacier in western Scotland was very close to 10,000 BP

Rose *et al* (1988) have suggested that a recently obtained date from beneath Loch Lomond Readvance till at Croftamie, in the Loch Lomond basin (Fig 2.1), of 10,560±160 BP, gives a better estimate of the date of the glacial maximum, arguing that the site was overridden by ice after 10,500 BP. The rather large standard deviation on this date does not, however, allow the glacial maximum to be dated accurately. The range of ages covered by the Croftamie date at two standard deviations (10,240–10,880 BP) can be taken as being in good agreement with Sutherland (1984) and with Peacock *et al* (1989). The differences in ages suggested from these sequences might indicate that individual glaciers responded in contrasting ways, determined perhaps by glaciological factors (cf Rose 1989).

The suggestion that the maximal extent of the Loch Lomond Readvance was reached early in the Loch Lomond Stadial is, however, supported first by a trend recognised in pollen diagrams for increasing aridity in the latter part of the Loch Lomond Stadial, and second by suggestions that the Stadial ended much earlier than previously thought, close to *c* 10,400 BP

With increasingly efficient methods of pre-treating mineral-rich lacustrine samples (Cwynar *et al* 1979; Bates *et al* 1979), the resultant more detailed pollen analyses have in many instances led to the subdivision of Loch Lomond Stadial pollen assemblages. In particular, a common trend towards steadily increasing proportions of *Artemisia,* together with Chenopodiaceae and Caryophyllaceae, has been recognised (Walker 1975a; 1977; Lowe & Walker 1977; 1986; Rymer 1977; Caseldine 1980; MacPherson 1980; Webb & Moore 1982; Tipping 1989 and in press). The suggestion that increasing numbers of *Artemisia* grains indicate increasing continentality of climate has been criticised by Moore (1980), on the basis that many species of *Artemisia* are included in the pollen taxon, not all of which are arid indicators. However, the presence of pollen types ascribed to *A norvegica, A campestris* and *A maritima* (Moore 1970; Williams 1977; Webb 1977; Webb & Moore 1982; Lowe & Walker 1986) indicates a marked continentality of climate.

Walker and Lowe (1982) presented radiocarbon data on the earliest postglacial organic sediments from sites on the Isle of Mull, that suggested climatic amelioration at or prior to 10,200 BP, dates which accord with similar early radiocarbon dates from other parts of western Scotland (Lowe & Walker 1980). However, there is a pronounced degree of variability in many radiocarbon dates from this period, and their reliability has been questioned (Sutherland 1980; Lowe & Walker 1980). However, it seems likely that climatic amelioration and deglaciation set in considerably earlier than the accepted beginning of the Flandrian at 10,000 BP (Mitchell *et al* 1973).

The early Postglacial pollen succession

The early Postglacial pollen succession in Scotland (Lowe & Walker 1977, 1981; Walker & Lowe 1980) is remarkably similar to that from the early part of the Late Glaeial Interstadial (above), and is very closely comparable to the Postglacial succession in northern England (Pennington 1978), and broadly comparable with that from Wales (Ince 1981; Walker 1982). There are no suggestions of climatic fluctuations within the early Postglacial in the British Isles. There is, however, as with the beginning of the Late Glacial Interstadial, no reason why the botanical record should have responded directly to the climatic amelioration, and there are clear indications for rapid climatic improvements prior to 10,000 BP (Atkinson *et al* 1987).

The rate of colonisation of taxa in this period may have differed from the comparable phase at the beginning of the Late Glacial Interstadial, one principal difference being the continued presence throughout the Loch Lomond Stadial of particular vegetation communities.

It is generally considered that birch and juniper disappeared from northern Britain during the Stadial. *Empetrum* is present in pollen counts from the Loch Lomond Stadial in relatively high amounts, suggesting the survival of this heather-like dwarf shrub, but some workers (Birks 1984; Lowe & Walker 1986; Tipping 1989) have argued that this pollen is not contemporaneous, but is reworked by solifluction from Late Glacial Interstadial soils, and that *Empetrum* was absent from Loch Lomond Stadial plant communities. If this is correct, the Stadial vegetation was indeed impoverished, resembling that occurring prior to the climatic amelioration of *c* 13,000 BP (above).

Efforts to understand by radiocarbon dating the rate of immigration to Britain of the major plant taxa have met with only limited success. The numbers of dates relating unambiguously to the peak in *Empetrum* pollen are too few to allow analysis, although they cluster around 10,000 BP (Tipping 1984). Over half of 70 radiocarbon dates purportedly relating to the peak in *Juniperus* pollen were rejected by Tipping (1987) as being unreliable. The remaining dates appeared not to support the idea of synchroneity in the expansion of juniper, nor showed any interpretable geographic pattern.

The uncertainties of radiocarbon dating in determining the date of regional deglaciation (above) has led to attempts at assessing the rates of retreat of Loch Lomond Readvance glaciers from pollen-stratigraphic data. Pennington (1978), MacPherson (1978) and Lowe and Walker (1981) have proposed that pollen sites exposed earliest in the Postglacial (as Readvance glaciers retreated) contain earliest postglacial pollen assemblages, rich in *Artemisia* and disturbed ground taxa, and that subsequently exposed sites will register in their basal sediments only the later stages of the vegetation succession, *Empetrum* and *Juniperus.* Such studies would allow deglaciation to be understood in great detail and subtlety, but Tipping (1988) has criticised this work on theoretical and methodological grounds, and presented evidence which suggests that such interpretations are based on sites with very limited temporal resolution. At sites with high sedimentation rates the 'full' early Postglacial pollen stratigraphy appears to be detected, regardless of distance from the glacier limit.

Correlations, causes and conclusions

Reference has been made throughout this paper to the now well established climatostratigraphic subdivision of the Late Glacial based on Coleopteran data (Atkinson *et al* 1987). There is in addition an independently derived palaeoclimatic curve for Scotland, derived from marine shell assemblages (Peacock 1981; 1983; 1989). The sequence elucidated by Peacock conforms remarkably closely to the work of Atkinson *et al*, with a change in zoogeographic province from high arctic to high- to mid-boreal, representing a pronounced climatic amelioration, dated to just before 13,000 BP. It has been suggested above that the concentration of radiocarbon dates at British lacustrine sites at around 13,000 BP may reflect this climatic amelioration in aquatic and terrestrial ecosystems.

At *c* 12,000 BP there is a slight climatic depression in the marine mollusc record, corresponding to that seen in Coleopteran data, and also recognised recently in pollen diagrams from western Scotland and Ireland. However, in the latter part of the Late Glacial Interstadial, Peacock distinguishes a short-lived climatic 'peak', apparently closer to present sea conditions than in the mid-Interstadial (Peacock 1989). The changes are not, however, thought to have been induced by increasingly warm conditions, principally because this period is not recognised in the beetle record, and instead Peacock (1989) suggests a short-lived strengthening of the North Atlantic ocean circulation in response to the southward movement of the Polar Front. The recognition at a few terrestrial sites of often pronounced increases in *Juniperus* at the end of the Late Glacial (above), may suggest that this period is one of real thermal improvement, affecting both terrestrial and marine environments. The obvious contradiction, however, between these lines of evidence and the Coleopteran palaeoclimatic curve, together with the suggestion that much periglacial activity was prevalent from *c* 11,500 BP (Sutherland 1984), makes such suggestions somewhat uncertain, and emphasises the need to explore the critical transition from interstadial to stadial climates more closely.

The recognition in deep-ocean cores of fluctuations in the North Atlantic Polar Front during the Late Glacial (Ruddiman *et al* 1977; Duplessy *et al* 1981) has had a tremendous impact on our understanding of the causes of changes in climate in this period, and these major shifts in atmospheric and ocean circulation have been invoked by many workers to explain the glaciological and terrestrial climatic record (above).

The recognition of a probable two-stage decline into the Loch Lomond Stadial, with climatic deterioration at *c* 12,000 BP and around 11,000 BP, does appear to complicate the apparent strong correlation between oceanic Polar Front southerly movement and glacier recrudescence (Ruddiman *et al* 1977). The origin of the climatic deterioration at *c* 12,000 BP is very poorly understood. The evidence from oceanic cores in the southern Norwegian Sea (Jansen 1987) suggests that warm Atlantic waters extended into areas north and east of Scotland throughout the Late Glacial Interstadial, up to about 11,000 BP. These ocean core stratigraphies are, however, poorly dated. The deep ocean cores of Ruddiman and co-workers are also affected by uncertainties in dating (Ruddiman & McIntyre 1981), and temporal correlations between land and sea are difficult, particularly when the increasing detail of the terrestrial record requires a greater degree of 'fine tuning' in the marine record. The more sophisticated models of Bard *et al* (1987), using AMS radiocarbon dates on cores from the north and mid-Atlantic Ocean, are an attempt to improve the temporal resolution of such data, and suggest the onset of southward oceanic Polar Front movement at or slightly before 11,500 BP. How this revised chronology relates to the terrestrial record requires considerably more study.

In conclusion, it is suggested that the palynological record is in good agreement with other biostratigraphic data in detecting the major climatic fluctuations of the Devensian Late Glacial. Particularly pertinent to the Scottish environment is the role of glacier ice at several discrete periods, and correlation of the several phases of glaciation (Sutherland 1984) with the palynological record is rather insecure. The Wester Ross Stage, and possibly associated stages, may predate the initiation of the biostratigraphic record at around 13,000 BP, but there still appear to be some uncertainties regarding the timing of the Loch Lomond Readvance, and of its maximal extent.

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3 Dendrochronology and radiocarbon calibration of the early Holocene

Bernd Becker and Bernd Kramer

Abstract

During the climatic oscillations of the Late Glacial period, pine and birch forests began to spread over the floodplains of our rivers. Radiocarbon dates on large subfossil pine tree remnants, sampled in Northern Italy and Southern Germany, provide evidence for a more or less continuous 3500 years of forest development, starting at 12,200 BP. Radiocarbon calibration of our 1045 year long Pre-Boreal pine series hints at major atmospheric radiocarbon variations. At 10,000 BP an at least 250 year long plateau of constant radiocarbon ages occurs, followed by a rapid decrease in the atmospheric radiocarbon content. A second plateau of constant radiocarbon ages at 9650 BP then occurs over the next 500 tree-ring years. The results indicate problems in using an uncalibrated radiometric timescale for the Late Glacial and Early Holocene.

Introduction

Late Glacial and Holocene tree-ring chronologies are sequences through time which contain information about past variations in the biosphere, hydrosphere and atmosphere. For example, the content of the radioisotope carbon 14 in tree-ring sequences can be directly related to past radiocarbon variations of the atmosphere. This report presents the Early Holocene dendrochronoloa of central Europe with absolute ages and radiocarbon calibration of the Pre-Boreal, 10,000 to 8800 BP.

Holocene oak and pine dendrochronology

The tree-ring chronology established for oak in Central Europe already covers the major part of the Holocene. The Hohenheim Laboratory has produced a continuous oak dendrochronology of the past 9928 calendar years, to 7938 BC. According to the conventional radiocarbon timescale, the beginning of this record dates to about 8900 BP.

This chronology consists of subfossil oak tree remnants from fluvial deposits of the south central European rivers (Rhine, Main, Danube, and their tributaries, see Becker 1982). This oak tree-ring record can be extended by 200 to 300 additional years, because oak reappeared in central Europe, according to radiocarbon dating of the earliest subfossil trees, between 9200 and 8800 BP.

Therefore the further extension of the European dendrochronology to the very beginning of the Holocene can be achieved by subfossil pine trees only. Like the oak, substantial remains of the Early Holocene pines *(Pinus sylvestris)* are found in fluvial gravel deposits, mainly from the Danube and Upper Rhine valleys. These pines generally date before 8800 BP. They are remnants of Late Glacial pine forests which, together with birch, covered the valley floors. Between 9200 BP and 8800 BP they vanish from the alluvia, very probably due to the fact that they could not compete with the mixed oak forest which invaded the valleys of central Europe at the end of the Pre-Boreal.

Our Pre-Boreal pine chronology consists of three floating series, covering 1129, 332 and 220

Table 3.1 Estimation of the absolute age of the Pre-Boreal

Chronology	Tree-ring period	No of ^{14}C dates	Range of ^{14}C dates
Oak master	7875—7815 BC	8	8900—8750 BP**
Pine C	1—130 tree-ring	6	9080—8930 BP
Pine B	15—300 tree-ring	17	9290—9029 BP
Pine A	915—1010 tree-ring	8	9390—9240 BP
Pine A	10—180 tree-ring	6	10,000–9920 BP

** 1 sigma variation = ±20 to ±40 years

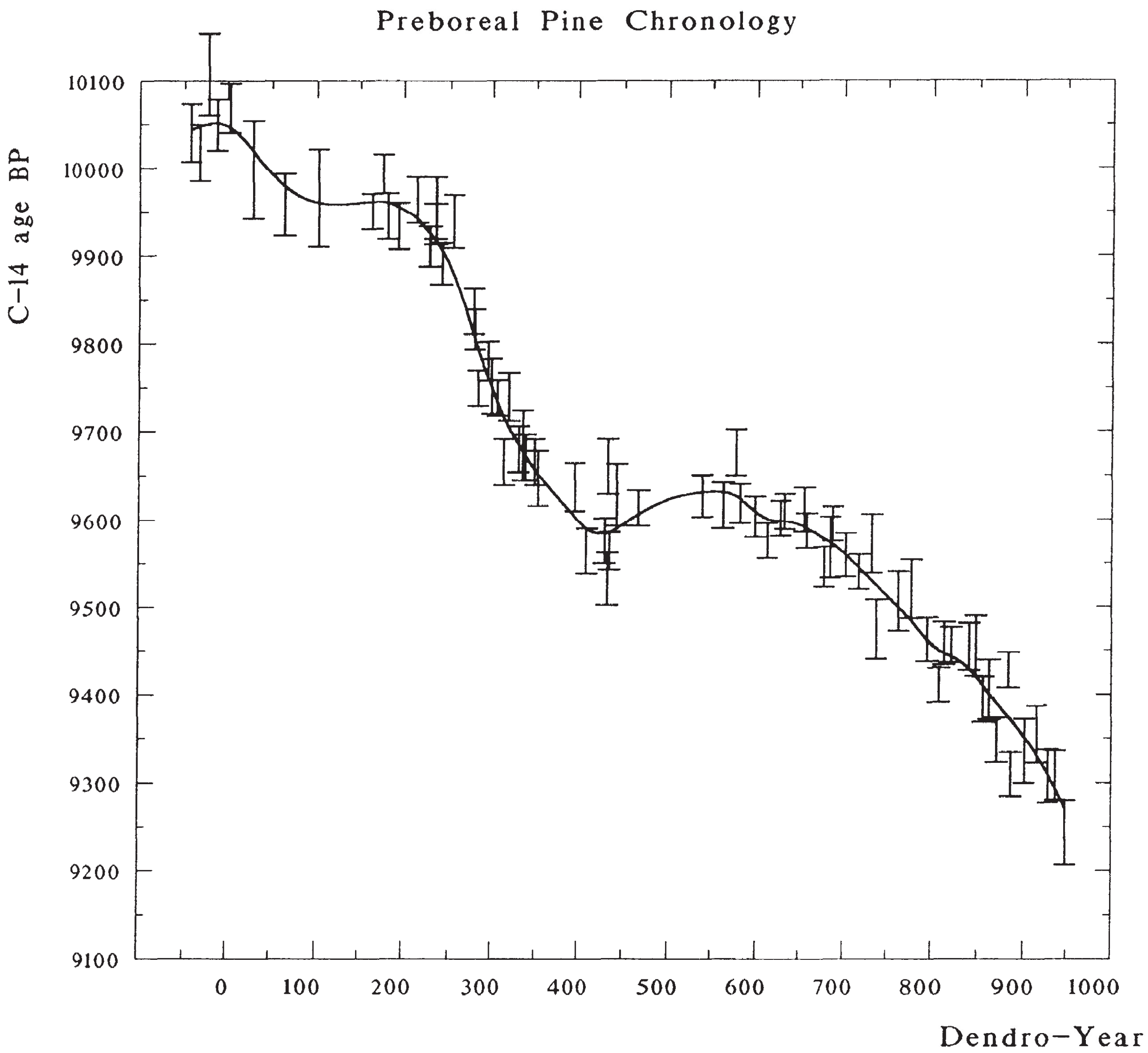

Figure 3.1 Radiocarbon variations of the Pre-Boreal derived from measurements of tree-ring samples of the Early Holocene pine dendrochronology. Two plateaux of nearly constant radiocarbon ages occur at 9950 BP and at 9550 BP

tree-rings respectively A series of high precision radiocarbon measurements dates these overlapping series between 8800 and 10,070 BP. In addition, a series of radiocarbon dated single trees or groups of replicated master-curves cover the Late Glacial interstadials. The earliest pines dated so far were growing at the end of the Bølling at about 12,200 BP; a younger series dates from the beginning of the Allerød to the beginning of the Younger Dryas. Dating of Late Glacial pine samples ends at about 10,550 BP.

Absolute age and duration of the Pre-Boreal

According to the chronostratigraphic subdivision of the Holocene described by Mangerud *et al* (19741, the Pre-Boreal dates from 10,000 to 9000 BP (conventional radiocarbon ages). Since the absolute oak chronology almost reaches the end of the Pre-Boreal, use of this information together with the Pre-Boreal pine dendrochronology enables a

Table 3.2 Calculations of the duration of the Holocene since the end of the younger Dryas

Chronology	Length (years)	Dating of period
Absolute oak	9927	Since 7938 BC corresponding with 8900 BP
Pine C	100	8900—9000 BP
Pine B	300	9000—9200 BP
Pine A	1129	9200—10,000 BP
Total years	11,456	Starts 10,000 BP, equivalent to *c* 9400 BC

determination of the absolute age and duration of this Early Holocene period to be made.

For this determination one has to consider, that the beginning of the oak chronology between 7700–7900 BC has radiocarbon ages of 8700–8900 BP. The age correction of uncalibrated radiocarbon dates at that time is exactly 1000 calendar years, (that is to say, the radiocarbon datings have to be increased by that amount). The end of the Pre-Boreal chronozone at 9000 BP therefore should coincide with a dendrochronological age of 8000 BC. The Pre-Boreal therefore must have ended more than 10,000 calendar years ago.

As can be seen from the high precision radiocarbon measurements of the Early Holocene tree-ring chronologies, there must exist overlaps between the absolute oak and the subsequent older floating pine series. The tree-ring distance between the radiocarbon ages of 10,000–9000 BP can be derived from the pine series B and C, and covers at minimum 1400 calendar years.

For the calculation of the calendar age of 10,000 BP one has to add 100 tree-ring years of pine chronology C, which dates from 8900–9000 BP and is the linkage to the oak chronology. The Pre-Boreal, according to the tree-ring records ends at 8000 BC, that is to say more than 10,000 years ago. It starts more than 11,400 years ago, at about 9400 BC, as Table 3.2 shows.

Radiocarbon variations and calibration of the radiocarbon timescale of the Pre-Boreal

The clear lack of synchronisation between the dendrochronological scale 8000–9400 BC and the radiocarbon timescale 9000–10,000 BP (1400 dendrochronological years vs 1000 radiocarbon years) is caused by two remarkable radiocarbon variations of the past atmospheric radiocarbon content.

By high precision radiocarbon measurements of the Pre-Boreal pine chronology we found that there were two periods of constant radiocarbon ages. The first plateau dates at 9550 BP and occurs within the pine series over nearly 400 years (Becker & Kromer 1986).

During the recent work to extend the oldest part of the Pre-Boreal pine chronology, a second radiocarbon plateau became obvious. Tree-ring samples of the first 250 years of the chronology have constant radiocarbon ages of 9950 BP. This radiocarbon plateau coincides with the plateau of unchanging radiocarbon ages of 10,000 BP which has been detected by accelerator radiocarbon dating of terrestrial plant fossils from Swiss lake deposits. The same radiocarbon plateau can also be identified in final Younger Dryas lake deposits which are well- defined by palynostratigraphy, as shown by Amman and Lotter (1989). Very probably the period of nearly constant radiocarbon ages observed at 10,000 BP occurred not only at the beginning of the Pre-Boreal, as can be derived from the pine tree-ring sequence over 250 years, but was also present during the end of the Late Glacial.

These radiocarbon variations cause problems for the Early Holocene chronology. One has to take into consideration, that a radiocarbon age of 10,000 BP which is the transition between the Late Glacial and Holocene chronozones, has no precise age value within a block of time that lasts for at least 250 years, and probably for more than 300 to 400 years. During the middle Pre-Boreal, radiocarbon datings of 9500–9600 again cover a calendar year range of 400 years.

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4 AMS dates from the Late Glacial and early Postglacial in North-west Europe: A review

Rupert A Housley

Abstract

Since 1983, the Oxford radiocarbon Accelerator Mass Spectrometry (AMS) facility has been dating archaeological material from Late Glacial contexts in Britain and north-west Europe. The dating has focused on a range of themes which has included the dating of human skeletal remains from Late Glacial and early Postglacial contexts; the dating of humanly modified bone and antler including both artefactual pieces and cutmarked specimens; dating a number of faunal species in order to determine their chronological distribution; and the more usual dating of charcoal and small fragments of bone from both open sites and rockshelters. A limited number of AMS dates have also been done on Quaternary samples; this work has included Late Glacial marine shell specimens from around the British Isles, together with a number of dates on plant macrofossils from Late Glacial deposits. This paper will review all of the Oxford AMS dates for the Late Glacial and early Postglacial of north-west Europe, in total approximately 300 dates, and will briefly discuss some of the implications of this sustained dating research

Introduction

Accelerator Mass Spectrometry (AMS) has been routinely used for radiocarbon dating at Oxford since 1983. A significant part of the work of the Radiocarbon Accelerator Unit has been on evidence from the Late Glacial and early Postglacial period, with attention being focused on the following themes:

- i human skeletal remains from Upper Palaeolithic contexts
- ii worked artefacts and cutmarked bone/antler
- iii Later Upper Palaeolithic and Mesolithic open sites
- iv Upper Palaeolithic rockshelters

The early work of the Unit on the above themes has already been discussed in some detail in a number of papers (bone and antler points: Cook & Barton 1986; Late Upper Palaeolithic sites in northern France and Belgium: Gowlett *et al* 1986; and human skeletal remains: Stringer 1986), and so this will not be considered here (although the earlier dates have been included in the list of dates — Table 4.1). Furthermore, since a comprehensive review of the Unit's Upper Palaeolithic dating to January 1986 was published by Gowlett (1986), the discussion in this paper will primarily concentrate on the dates done since then.

There has been some change of emphasis since 1986 within the above mentioned topics (Table 4.2). Although new dates have continued to be done on human skeletal remains, on worked bone and antler artefacts, and on British rockshelters and open sites; the dating of north French Late Upper Palaeolithic sites has been replaced by other topics, with a shift in particular to dating Late Glacial marine sequences. Prior to this change, most of the Late Glacial dating had been on bone and charcoal samples from archaeological sites; however, the extension into dating non-archaeological evidence has had several advantages. The mollusca-rich marine beds off the coast of Scotland are interesting in that they sometimes yield evidence for Late Glacial climatic events (such as the Younger Dryas/Loch Lomond Re-advance) in the form of differing fossiliferous assemblages within glaciomarine horizons. The proximity of these deposits to the Scottish glaciers make them good records of environmental change on land, as well as recording water body changes off the northern coasts of Britain. Much work has been done on the mapping of these deposits by the British Geological Survey (Browne & Graham 1981; Browne *et al* 1984; Paterson *et al* 1981; Peacock *et al* 1977; 1978; 1980), although only recently have accelerator dates been undertaken on associated mollusca from the area. By directly dating individual species from the relevant beds, information can be obtained on factors like salinity, turbidity and water temperature. Such research is valuable for correlation purposes, but is also important in helping to chart events like the penetration of warm Atlantic water into the North Sea at the beginning of the Windermere interstadial. The effect of such changes on coastal environments, and the implications for human presence in Britain, are obvious, and I shall therefore briefly mention some of this research before reviewing the chronological evidence for contemporary human occupation.

Scottish Late Glacial marine mollusca dates

The relevant marine molluscan dates are summarised in Table 4.3 (the reservoir correction is based on an apparent age of 405±40 BP for seawater — see Harkness 1983). Previous conventional radiocarbon dating (Peacock & Harkness, in press) had mainly concentrated on coastal exposures of the Clyde Beds, with little attempt at dating borehole evidence since only small quantities of shell carbonate were generally available. The accelerator technique offered the prospect of directly dating indicator species in the fauna, thus avoiding potential problems of reworking and of slow deposition. Examination of the dates indicates that warmer North Atlantic water had penetrated to the coasts around Scotland by about 13,000 BP, this amelioration marking the beginning of the Windermere Interstadial. The marine record for replacement of polar water is in good agreement with the coleoptera evidence (Coope 1977) for rapid warming in the Oldest Dryas around *c* 12,800 BP. The warmer water seems to persist around the coasts of Britain until replaced by polar water a little after 11,000 BP, although the absence of dated mollusca in the 11,000–12,000 BP period precludes confidence. Within this temperate period, there appears to be a particularly warm 'blip' around 12,400 BP, and this coincides with good evidence for considerable human occupation of Britain (see below). The following Loch Lomond Stade saw glacial readvance in Scotland, the glaciers reaching their maximum extent in the second half (10,500–10,000 BP) of this period (Peacock *et al* 1989) before a return to warmer water conditions by about 10,000 BP.

Dating of Late Glacial faunas in Britain

AMS dating of British Late Glacial sites has been twofold in character. One important aspect has been the decision to concentrate dating specifically on identified faunal specimens, particularly when dating fauna from rockshelters and caves. The purpose of this strategy, which is possible only through the co-operation of several faunal specialists, has been to chart the presence of particular species through time and space. The results of this decision can be seen in Table 4.4. Since the Late Glacial fauna is discussed elsewhere in this volume (by Lister and Currant), only a few observations will be made here.

One species for which our knowledge has increased as a result of this strategy is the mammoth. It has now been clearly documented that mammoth was present in Britain in the Late Glacial, by dated finds at four localities: Condover (Shropshire), Gough's Cave (Somerset), and Robin Hood's and Pin Hole Caves (Derbyshire). There have been dates on other specimens of mammoth, but these have all turned out to be from before the Last Glacial Maximum. The effect has been to rewrite the late Devensian history of this species in Britain (Coope & Lister 1987) as well as showing that the Late Glacial finds of mammoth ivory artefacts were not made from fossil material but from fresh ivory, although not necessarily of local origin.

Although the number of dates on reindeer is not large, the indication is that this species is not quite so ubiquitous as was first thought. With the exception of the unmodified antler from Aveline's Hole (OxA-1122) all the other dates fall outside (or on the margins of) the Windermere Interstadial. The dates on reindeer from Chelm's Coombe confirm this pattern. Red deer has a contrasting date range, since most of the dates fit in the first part (12,800–12,000 BP) of the Windermere Interstadial, with only two exceptions, which occur in the Loch Lomond Stade. *Bos primigenius* is now a well documented part of the Late Glacial fauna and is also predominantly associated with Interstadial conditions. The previously published dates for horse suggested a fairly restricted range in time but new results from Uxbridge (Lewis, this volume) and Chelm's Coombe attest the presence of this species in the latter half (10,500–10,000 BP) of the Loch Lomond Stade. Saiga antelopes are known from four localities in Britain (Currant 1987, 74), although only two have been dated and shown to be of Late Glacial age. Saigas are characteristic of dry steppe environments and the presence of such animals in the Windermere Interstadial, alongside more oceanic forest species, raises some interesting questions. It is possible that the cold, very dry Older Dryas event recorded in the pollen record was of such short duration that the radiocarbon dates are not distinguishing Interstadial faunas from Older Dryas faunas (Lowe & Gray 1980). Finally it is worth pointing out the absence of confirmed Late Glacial AMS dates for either hyaena or woolly rhinoceros. Nor have any British Late Glacial lions been dated, although a Younger Dryas example (OxA-729) is attested from Lathum in the Netherlands.

Late Glacial human presence in Britain

It was realised that dates on faunal specimens need not necessarily tell us anything about when human occupation took place, even though possibly associated stone tools were sometimes found.

Therefore, a second approach was followed. Rather than rely on potentially dubious associations between such tool assemblages and the dated fauna (or charcoal), or on typological comparisons with supposedly well dated sites, it was decided to look for bone and antler samples which displayed clear evidence of human modification, and to directly date these directly. This has meant that not only worked artefacts, but also bones which display butchery traces, were dated (for earlier work of this kind see Jacobi 1986). The results of dating human skeletal remains, worked artefacts, and cutmarked bone are summarised in Table 4.5 and represent definitive proof of human presence in Britain in the Late Glacial. As can be seen, there are many dates attesting human presence from *c* 12,600 to 12,000 BP, with *c* 12,300–12,500 BP being particularly well represented. There is a change in the form of the evidence after *c* 11,900 BP with most of the dates being on isolated artefacts, unlike the earlier dates which tend to come from cave sites. Does this represent a change in human occupation in the latter part of the Windermere Interstadial, a move away from rockshelters to open sites? The absence of AMS dates on fauna in this same period also needs explaining. Jacobi (pers comm) has suggested that this absence of faunal dates could reflect the distribution of dating research, and that AMS dating of elk could bridge this gap since this species would be expected to inhabit the Allerød/Windermere forested environment. The question of whether calibration may be affecting the number of radiocarbon dates in the 11,000 to 12,000 BP period cannot yet be answered. 'Compressions' (Gowlett 1986) seen in later periods (eg between 800–400 Cal BC), where several centuries of calendar time are represented by a single, unchanging radiocarbon measurement, could account for the concentration of dates around 12,400 BP. But to explain a dirth of radiocarbon dates (such as that seen in the latter part of the Windermere Interstadial) one would have to envisage an 'expansion', and, at present, there is very little evidence to support such a suggestion. Further discussion of the calibration issue appears below.

Sampling strategies and future prospects

It is important to emphasise that this advance in understanding has happened despite the fact that many of the bones were recovered in old excavations where documentation is often poor to non-existent. Many of the artefacts are stray finds, which could not have been dated conventionally since the associations had been lost. The decision to sample and date only the best preserved, specifically identifiable, specimens (rather than the unidentifiable bone fragments — still too often submitted for dating by some archaeologists) has paid enormous dividends. It is now almost possible to re-write the old excavation reports for such classic British cave sites as Pin Hole Cave and Gough's New Cave, by using the AMS dates as fixed points, both in time and stratigraphically, around which the remaining evidence can be fitted.

The success of this strategy has been due to a number of factors. The first is the ability of the AMS technique to use samples when only a small amount (for bone and antler: *c* 250–500 mg) could be removed. Without this ability, it would not have been possible to persuade museum curators to allow sampling of their prize display exhibits. The second factor has been the hard work of a small number of archaeologists who have spent long hours going through (almost excavating) museums collections looking carefully at every specimen of the best preserved bones, examining them for cut marks, and then tracking down whether the location of the bone is recorded in some old excavation notebook. The availability of expert faunal assistance has been important since correct identification was necessary if the results were to have any validity. The small sample requirement of AMS means that virtually all the dated specimens are available for re-examination should future research demand it. Finally, many of the specimens could not have been dated if there had not been careful analytical research into ways to detect the presence of preservatives. Contamination by preservatives is common when attempting to date old excavation specimens — particularly so with prize display pieces — and careful chemical methods had to be developed if biased dates were to be avoided.

One notable feature which comes from reviewing six years of sustained dating research is the difficulty of getting good charcoal dates on Late Glacial (and Postglacial) open sites. Where it has been possible to date a site both by radiocarbon (on charcoal samples) and thermoluminescence (on burnt flint), the TL results have frequently been archaeologically more acceptable. The Late Upper Palaeolithic site at Hengistbury Head is just such an example, since the radiocarbon dates gave ages which would fall in the Neolithic and Mesolithic periods, whereas the TL determinations (Barton & Huxtable 1983) clustered around 12.5 ka (Ox82TLfg 707a). To some extent, the radiocarbon dating of charcoal from certain types of strata on Late Glacial open sites must now be viewed as potentially suspect, and it is almost questionable whether radiocarbon resources should be allocated to such sites. A far more secure procedure, the full potential of which has still to be realised, is the dating of surviving resin and mastic on lithic artefacts. The case of the site of Rekem is a pointer to the value of such an approach, since the resin on a typical Tjonger point gave an acceptable Late Upper Palaeolithic date whereas most of the charcoal dates were considerably later.

Problems still remain, one of which being the question whether the Older Dryas (Zone Ic) can be recognised as a distinct entity in Britain. At present, there are no dates on characteristically cold taxa within the period which would equate with a composite Late Glacial Interstadial, Bølling plus Allerød and any time in between (*c* 13,000–11,000 BP), although it must be noted that there are very few AMS dates in the period *c* 11,800–11,400 BP. However, excavation in advance of the Channel Tunnel (Preece pers comm) has now revealed a palaeosol (AMS dated to 11,370 BP), below which was found a solifluction deposit. In a separate trench, an organic Interstadial deposit with tree birch pollen seems to have ceased accumulating around 11,830 BP implying the cessation of Interstadial conditions. New dates are presently being undertaken from other profiles at Folkestone to investigate this, but supporting evidence from other parts of the country is presently lacking. Radiometrically dated marine mollusca for this period (Peacock & Harkness, in press) suggest continuous temperate conditions around the coasts of Britain for the period in question, whilst the coleoptera (Atkinson *et al* 1987) indicate only a shift to conditions less warm than those in the earlier part of the Interstadial, but still temperate.

The question of 'compression' in the Late Glacial radiocarbon record must now be addressed. Variations over the last 7,000 years in the natural atmospheric radiocarbon content have been measured using dendro-chronologically dated wood, the result being the calibration curves (eg Pearson *et al* 1986). Such measurements have demonstrated that prior to *c* 2550 BP (620 BC), positive $\Delta^{14}C$ values prevailed, and thus uncorrected radiocarbon dates would be underestimating the calendrical age of samples by as much as *c* 1000 years at 6110 BP (5190 BC). The curves also showed periods when several centuries of calendrical time could be represented by radiocarbon dates of the same value. One such period is between 800–400 Cal BC, while Becker and Kromer (this volume) have reported others more applicable to the present review, namely one of 500 calendar years around 9600 BP and one of at least 200 calendar years at 10,000 BP. There have been attempts to extend the calibration curves back into the Late Glacial period by linking the tree-ring sequences with varve series (eg Stuiver *et al* 1986), but the errors in the curves (a few hundred years for dates before 10,500 cal BP) are too large for detailed use. The potential of further tree-ring work on pines from Central European fluviatile deposits is discussed by Becker and Kromer in this volume, and until more research has been carried out, calibration in the Late Glacial period must remain tentative. In conclusion, however, it is worth mentioning that there are now estimates for the calendrical date of the Younger Dryas/Pre-Boreal boundary — normally fixed in radiocarbon terms to *c* 10,000 BP. Three methods, simple varve counting (Stromberg 1985), ice core stratigraphy (Hammer *et al* 1986), and a mixture of radiocarbon matching and valve counting (Stuiver *et al* 1986) have suggested a calendrical (Cal BP) age for the boundary of, respectively, 10,700±50, 10,720±75 and 10,970±110 years ago. Becker and Kromer (this volume) suggest these values are underestimates and propose an absolute calendrical date of 11,330 years BP Thus the correction for the radiocarbon age of 10,000 BP is of the order of 700–1300 years. Whether this leads to compressions and significant changes in the 10,000–13,000 BP period remains to be seen.

Table 4.1 Oxford AMS Late Glacial, Late Upper Palaeolithic and Mesolithic dates from North-west Europe

Dates older than 18,000 BP have been excluded except where they form a sequence with others within the Late Glacial period.

*indicates dates which are accepted as being unreliable guides to the age of the context, even though many are sound radiocarbon measurements of the submitted sample. Contextual doubts exist for some of the other samples.

Human remains		**BP**	**±**	**ref**
Britain				
736	Robin Hood's Cave, human mandible	2020	80	AM4
1202	Gough's New Cave, human distal right humerus, IA.I/8	2850	60	AM7
814	Gough's New Cave, talus of 'Cheddar Man'	9100	100	AM4
1460	Barham, human left femoral shaft, 964–46	3860	60	AM9
630	Ossom's Cave, human proximal right ulna	4860	80	AM3
1070	Aveline's Hole, human right distal humerus, M1.13/146	8740	100	AM6
799	Aveline's Hole, human right distal humerus, M1. 13/23	9100	100	AM4
800	Aveline's Hole, human right distal humerus, M1. 13/24	8860	100	AM4
680	Badger Hole 3, human juvenile mandible	1380	70	AM4
679	Badger Hole 1, human cranial fragments	9060	130	AM4
1459	Badger Hole 2, human mandible, 1783 227 31	9360	100	AM9

535	Sun Hole Cave, human left ulna	12,210	160	AM3
1787	Kent's Cavern, human cranium, KC3	3560	70	AM9
1786	Kent's Cavern, human maxilla, KC1	8070	90	AM9
1621	Kent's Cavern, human maxilla, KC4	30,900	900	AM9
681	Paviland 2, human left humerus	7190	80	AM4
1815	Paviland 1, 'Red Lady', human bone	26,350	550	AM9
Netherlands				
616	Hummelo II, human calotte	2530	90	AM5
669	Koerhuisbeek K–2, human cranium	1460	80	AM5
726	Beegden 1, human left femur	2450	90	AM5
727	Rhenen 2, human maxilla	1640	100	AM5
728	Elst El/Am3, human mandible	2900	130	AM5
Denmark				
118	Holmegaard-Jutland, human bone	6200	130	A1+5
533	Holmegaard-Jutland, repeat of OxA-118	6080	80	AM5
Germany				
1350	Blankenese, human frontal	1510	60	AM9
1352	Blankenese, right parietal	1560	80	AM9
1351	Blankenese, left parietal	1540	80	AM9
668	Rees, cranial fragment	5160	80	AM5
1573	Ofnet, skull 3	7520	80	AM9
1571	Ofnet, skull 8	7360	80	AM9
1572	Ofnet, skull 10	7450	80	AM9
1575	Ofnet, skull 32	7560	110	AM9
1574	Ofnet, skull 34	7480	80	AM9
*615	Berlin-Schmöckwitz 1, human bone	6900	100	AM5
*725	Berlin-Schmöckwitz 2, human bone	8200	100	AM5
North Sea				
555	North Sea, St 12,4412, human pelvic bone	MODERN	108%	AM5

Worked bone and antler

Britain				
1009	Splashpoint Rhyl, antler-beam pick	6560	80	AM7
1156	Hammersmith, antler pick, A.22556	2240	100	AM7
1157	Willington Quay, antler-base pick, 1934.7 4/11	3880	80	AM7
1158	Staines, antler-beam pick, 49.107.900	5350	100	AM7
1159	Meiklewood, antler-beam pick, HLA3	5920	80	AM7
1160	Kew Bridge, antler-base pick, 49.107.897	8820	100	AM7
1161	Beddington, antler mattock	3450	80	AM7
2020	County Hall, London, antler-base mattock, A.27514	3850	70	AM10
2021	County Hall, London, antler-base mattock, A.26935	3800	80	AM10
2022	Kew, antler-base mattock, A.13684	3300	80	AM10
2023	Risga, antler-beam pick, HM. B.1951.1969	6000	90	AM10
2024	Finsbury Circus, antler-base mattock, 10561	4140	70	AM10
1947	Shewalton, biserial antler point	5840	80	AM10
1949	MacArthur Cave, biserial antler point	6700	80	AM10
1948	Druimvargie rockshelter, uniserial bone point	7810	90	AM10
500	Earl's Barton, uniserial antler point	9240	160	AM3
1427	Waltham Abbey, uniserial antler point	9790	100	AM9
517	Sproughton 1, uniserial bone point	10,910	150	AM3
518	Sproughton 2, uniserial antler point	10,700	160	AM3
1946	Porth-y-Waen, uniserial antler point	11,390	120	AM10
*956	Newbury, chisel red deer antler	8160	100	AM8
732	Thatcham IV, worked antler beam, 70.3018	9760	120	AM5
1154	Vale of Pickering, antler frontlet, no 130	9500	120	AM9
1176	Vale of Pickering, worked antler, no 56	9700	160	AM9
111	Kendrick's Cave, decorated horse mandible	10,000	200	AM2

803	Earl's Barton, Lyngby axe	10,320	150	AM4
1463	Dowel Cave, antler tang	11,200	120	AM9
1493	Fox Hole, reindeer antler rod	11,970	120	AM9
1494	Fox Hole, fragment of antler rod/point	12,000	120	AM9
1890	Cough's New Cave, 'new' ivory rod	12,170	130	AM10
1789	Kent's Cavern, bone piercer	12,320	130	AM9
North Sea				
1950	Leman and Ower, uniserial antler point	11,740	150	AM10
The Netherlands				
1942	Archem, bone point	8330	90	AM10
1944	Europoort, bone point, M–64	8060	250	AM10
1945	Europoort, bone point, M–167	8180	100	AM10
Belgium				
1943	Tielrode, bone point	8820	100	AM10
1951	Zele-Dijk, bone point, 3491	1080	110	AM10
France				
1342	Fontaine sur Somme, decorated antler axe, no 343	6540	60	AM8

Late Glacial/Late Upper Palaeolithic and Mesolithic sites

England: open sites				
*1431	West Heath, Hampstead, charcoal F1	1460	70	AM9
*1432	West Heath, Hampstead, charcoal F2	4830	90	AM9
*1433	West Heath, Hampstead, charcoal F3	4710	90	AM9
*1434	West Heath, Hampstead, charcoal F4	4810	90	AM9
*1435	West Heath, Hampstead, charcoal F5	4770	100	AM9
601	Misbourne, *Bos,* F603	6190	90	AM4
*602	Misbourne, *Bos,* F601A	3730	90	AM4
*603	Misbourne, *Bos,* F602	4070	100	AM4
618	Misbourne, *Bos,* 602	5970	100	AM4
619	Misbourne, *Bos,* 603	6100	120	AM4
*620	Misbourne, *Bos,* 603	2500	150	AM4
621	Misbourne, ?*Cervus elaphus,* 602	12,530	200	AM4
593	Broxbourne, right lower M3, *Bos*	7230	150	AM3
*398	Hengistbury, charcoal, X30 2b	8590	120	AM2
*399	Hengistbury, charcoal, Y32 2a	4770	180	AM2
*411	Hengistbury, charcoal, X30 2b	7690	110	AM2
*412	Hengistbury, charcoal, Y31 2b	8140	120	AM2
*413	Hengistbury, humics of OxA-412	7910	140	AM2
378	Kettlebury, charcoal, K1	8270	120	AM2
379	Kettlebury, charcoal, K3	7940	120	AM2
1044	West Overton, tusk, *Sus scrofa,* WO 241	8260	80	AM6
1047	West Overton, phalange, *Bos primigenius,* WO 220	8390	80	AM6
376	Longmoor, charcoal, L1	8930	100	AM2
377	Long-moor, charcoal, L3	8760	110	AM2
*1201	Thatcham III, femur, beaver	5100	350	AM8
*940	Thatcham III, humerus, pig	6550	130	AM8
894	Thatcham IV, burnt elk antler	9490	110	AM5
1030	Seamer Carr, vertebra, dog, 20561	9940	100	AM6
1788	Uxbridge VIII, horse tooth, F.309	10,270	100	—
1902	Uxbridge VIII, horse jaw, F.312	10,010	120	—
415	Pitstone 4, charcoal	10,900	130	AM5
426	Pitstone 3, charcoal	10,410	150	AM5
427	Pitstone 3, humic acids from OxA–426	10,400	150	AM5
*428	Pitstone 2, charcoal	8800	140	AM5
*429	Pitstone 2, humic acids from OxA–428	9400	140	AM5
150	Poulton-le-Fylde, metapodial, elk	12,400	300	AM2
1021	Condover, tusk, adult mammoth	12,700	160	A7+9

1455	Condover, tusk, adult mammoth	12,400	160	AM9
1316	Condover, tooth, adult mammoth	12,300	180	AM9
1456	Condover, tooth, juvenile mammoth	12,330	120	AM9
1457	Condover, insect puparia from inside juvenile	12,080	130	AM9
1591	Condover, dung beetles	11,880	130	AM9
Wales: open sites				
1412	Lydstep, pig bone, BMNH A70.3063	5300	100	AM9
1378	Lydstep, wood peat, 79 cm	6150	120	AM9
1377	Abermawr Bog, wood peat, 613 cm	5520	150	AM9
1411	Abermawr Bog, wood peat, 815 cm	7640	150	AM9
1495	Nab Head I, charred hazelnut, NH 80 01	9210	80	AM9
1496	Nab Head I, charred hazelnut, NH 80 02	9110	80	AM9
860	Nab Head II, charcoal, 81 01	7360	90	AM5
861	Nab Head II, charcoal, 82 02 D9NW	6210	90	AM5
1497	Nab Head II, oak charcoal, NH II 86 01	8070	80	AM9
1498	Nab Head II, oak charcoal, NH II 86 02	4950	80	AM9
Scotland: open sites				
*1592	Smittons, charred hazel wood, T13	730	60	AM9
*1593	Smittons, birch wood charcoal, T15a	1910	100	AM9
1594	Smittons, charred hazelnut, T3	5470	80	AM9
1595	Smittons, charred hazelnut, T1	6260	80	AM9
1596	Starr 1, Loch Doon, hazel wood charcoal	6230	80	AM9
*1597	Loch Doon, oak wood charcoal, LDFS 12 cm	3150	70	AM9
1598	Loch Doon, Rosaceae wood charcoal, LDFS 23 cm	8000	100	AM9
1599	Auchareoch firespot, charred hazelnut	7300	90	AM9
1600	Auchareoch W Quarry, oak wood charcoal	7870	90	AM9
1601	Auchareoch pit, charred hazelnut	8060	90	AM9
*1602	Dam III, Arran, charred hazelnut	3620	70	AM9
Britain: cave sites				
812	Elder Bush Cave, charcoal	9000	130	AM4
811	Elder Bush Cave, vertebra & cut ribs, red deer	10,600	110	AM4
516	Great Doward Cave, pika	10,020	120	AM3
631	Ossom's Cave, left mandible, reindeer	10,780	160	AM3
632	Ossom's Cave, antler 'spike', reindeer	10,600	140	AM3
735	Church Hole Cave, mountain hare	12,240	150	AM4
1562	King Arthur's Cave, tooth, *Cervus elaphus,* W.2.21/468	12,120	120	AM9
1563	King Arthur's Cave, tooth, *Cervus elaphus,* W.2.21/115	12,210	120	AM9
1564	King Arthur's Cave, mammoth, W.2.21/169	34,850	1500	AM9
1565	King Arthur's Cave, mammoth, W,2.21l/1185	38,500	2300	AM9
1566	King Arthur's Cave, mammoth, W.2.21/954	> 39,500		AM9
802	Aveline's Hole, shed reindeer antler	9670	110	AM4
801	Aveline's Hole, red deer antler	12,100	180	AM4
1121	Aveline's Hole, cut bovine 2nd phalanx	12,380	130	AM6
1122	Aveline's Hole, unmodified reindeer antler	12,480	130	AM6
1781	Chelm's Coombe, right metacarpal, reindeer, 7	10,600	200	AM10
1782	Chelm's Coombe, left mandibular ramus, reindeer, 9	10,140	100	AM10
1783	Chelm's Coombe, right mandibular ramus, red deer, 9	10,910	110	AM10
1784	Chelm's Coombe, right mandibular ramus, reindeer, 12	10,230	110	AM10
1785	Chelm's Coombe, left metacarpal, horse, 12	10,370	110	AM10
1464	Soldier's Hole, left metacarpal, Saiga antelope	12,100	140	AM9
463	Gough's New Cave, calcaneum, Saiga antelope	12,380	160	AM2
464	Gough's New Cave, metapodial, *Equus ferus*	12,470	160	AM2
465	Gough's New Cave, 2nd phalanx, *Equus ferus*	12,360	170	AM2
466	Gough's New Cave, metapodial, *Cervus elaphus*	12,800	170	AM2
589	Gough's New Cave, collagen of BM–2183, horse	12,340	150	AM3
590	Gough's New Cave, amino-acids of BM–2183, horse	12,370	150	AM3
591	Gough's New Cave, collagen of BM–2187, horse	12,260	160	AM3
592	Gough's New Cave, amino-acids of BM–2187, horse	12,500	160	AM3
813	Gough's New Cave, astragalus, *Bos primigenius*	11,900	140	AM4

1071	Gough's New Cave, cut bovine 2nd phalanx	12,300	180	AM6
1200	Gough's New Cave, partial mandible, arctic fox	12,400	110	AM7
1461	Gough's New Cave, reindeer maxilla, M49863	10,450	110	AM10
1119	Gough's Old Cave, right mandibular ramus, beaver	9320	120	AM6
1120	Gough's Old Cave, unmodified reindeer antler	10,190	120	AM6
588	Gough's Old Cave, bovine fragments	12,030	150	AM3
587	Gough's Old Cave, modified phalange, horse	12,530	150	AM3
1469	Pin Hole Cave, cut proximal radius, pig	3750	80	AM9
1204	Pin Hole Cave, right calcaneum, mammoth	12,460	160	AM7
1205	Pin Hole Cave, front right cuneiform, mammoth	26,700	550	AM7
1936	Pin Hole Cave, shed antler, reindeer	13,050	250	AM9
1470	Pin Hole Cave, shed antler, reindeer	38,000	2000	AM9
1466	Pin Hole Cave, partial tibia, mountain hare	10,950	120	AM9
1467	Pin Hole Cave, cut proximal radius, mountain hare	12,350	120	AM9
1468	Pin Hole Cave, partial humerous, mountain hare	14,010	150	AM9
1471	Pin Hole Cave, left astragalus, *Bos primigenius*	12,400	140	AM9
1615	Pin Hole Cave, right astragalus, *Bos primigenius*	12,480	160	AM9
1937	Pin Hole Cave, right tibia, *Bos primigenius*	10,970	110	AM9
1806	Pin Hole Cave, partial scapula, lion	27,400	700	AM9
1614	Pin Hole Cave, upper molar, woolly rhinoceros	22,500	700	AM9
1813	Pin Hole Cave, partial ulna, woolly rhinoceros	> 41,400		AM9
1206	Pin Hole Cave, left 3rd metacarpal, hyaena, LL.2222	32,200	1000	AM7
1207	Pin Hole Cave, left 5th metacarpal, hyaena, LL.2213	34,500	1200	AM7
1448	Pin Hole Cave, partial left mandible, hyaena	42,200	3000	AM9
199	Robin Hood's Cave, charcoal C3, layer LSB	> 36,000		AM3
1462	Robin Hood's Cave, fragment of mammoth ivory	12,320	120	AM9
1616	Robin Hood's Cave, cut left scapula, mountain hare	12,600	170	AM9
1617	Robin Hood's Cave, cut left femur, mountain hare	12,420	200	AM9
1670	Robin Hood's Cave, cut right humerus, mountain here	12,290	120	AM9
1618	Robin Hood's Cave, cut right scapula, mountain hare	12,480	170	AM9
1619	Robin Hood's Cave, cut right humerus, mountain hare	12,450	150	AM9
733	Mother Grundy's Parlour, *cf* bovid bone	12,060	160	AM4
734	Mother Grundy's Parlour, *cf* bovid bone	12,190	140	AM4
1501	Three Holes Cave, burnt bone fragment, 3H 57 II 8b	11,520	150	AM9
1499	Three Holes Cave, partial horse tooth, 3H 57 IL 8b	11,970	150	AM9
1500	Three Holes Cave, cut bone fragment, 3H 57 II 8b	12,350	160	AM9
1203	Kent's Cavern, partial mandible, *Bos primigenius*	11,880	120	AM7
1029	Kent's Cavern, elk, I(a)1	31,100	800	AM6
1620	Bench Tunnel, right mandible, hyaena	34,500	1400	AM9
Eire				
567	Newlands Cross, *Eupatorium* seeds, 60–65 cm	7600	900	AM4
568	Newlands Cross, *Eupatorium* seeds, 75–85 cm	7600	500	AM4
707	Newlands Cross, *Cepaea nemoralis* shells, 85–87 cm	8300	90	AM4
708	Newlands Cross, *Cepaea nemoralis* shells, 85–87 cm	8930	150	AM4
569	Newlands Cross, amorphous organic material, 110–115 cm	9720	300	AM4
France				
138	Etiolles, bone, foyer N20 N21 no 157	12,990	300	AM3
139	Etiolles, bone, foyer N20 O20 no 224	13,000	300	AM3
173	Etiolles, bone, foyer N20 O20 no 222	12,800	220	AM3
*174	Etiolles, bone, foyer N20 O21 no 332	11,900	250	A3+4
175	Etiolles, bone, foyer N20 O21 no 332A & B	12,900	220	AM3
148	Pincevent, bone, upper level IV	12,600	200	AM3
149	Pincevent, bone, lower level IV	12,400	200	AM3
176	Pincevent, bone, lower level IV	12,000	220	AM3
177	Pincevent, bone, lower level IV	12,300	220	AM3
391	Pincevent, bone, level III	11,870	130	AM3
*414	Pincevent, charred bone, level IV	8850	130	AM3
*490	Pincevent, as OxA–414, 'charcoal residue'	7140	100	AM3
*491	Pincevent, as OxA–414, humic extraction	3650	100	AM3
467	Pincevent, charcoal, level IV	12,250	160	AM3

730	Moque Panier, bone, C–151.88	12,300	160	AM4
731	Moque Panier, bone, C–15 1.122	12,240	160	AM4
*505	Le Pré des Forges, Marsangy, bone, B12–35	9770	180	A3+4
178	Le Pré des Forges, Marsangy, bone, P16	11,600	200	AM3
740	Le Pré des Forges, Marsangy, bone, Cl4 85	12,120	200	AM4
1343	Rinxent, reindeer antler, 1456	13,030	120	AM8
179	Montigny-sur-Loing, bone, Q11	22,200	600	AM3
180	Montigny-sur-Loing, reindeer bone, Q11	22,500	600	AM3
460	Belloy-sur-Somme, bone, B117, 15c upper	5255	80	AM4
*461	Belloy-sur-Somme, horse tooth, B117, S17, no.17	8010	110	AM4
462	Belloy-sur-Somme, horse tooth, B117, S18, no.44	9720	130	AM4
722	Belloy-sur-Somme, horse tooth, B117, S17, no.17	10,110	130	AM4
723	Belloy-sur-Somme, horse tooth, B131, H17, no.215	9890	150	AM4
724	Belloy-sur-Somme, horse tooth, B131, 119, no.94	10,260	160	AM4
538	Grotte de Bange, bone, couche F	12,080	180	AM3
540	Grotte de Bange, bone, couche G	12,200	160	AM3
410	Combe Saunière I, bone, IIIa top F20/G20/H20	15,750	230	AM4
459	Combe Saunière I, bone, IIIb(3) G20d	15,480	210	AM4
481	Combe Saunière I, bone, IIIc H20a 'degraded'	14,990	220	AM4
768	Combe Saunière I, bone, repeat of OxA-481	14,260	200	AM4
769	Combe Saunière I, bone, repeat of OxA-481	14,800	240	AM4
770	Combe Saunière I, bone, repeat of OxA-481	14,770	200	AM4
*482	Combe Saunière I, bone, IIIc H20a 'intrusive'	26,920	800	AM4
*486	Combe Saunière I, bone, IIIa-b H20 Dallage	22,100	440	AM4
*487	Combe Saunière I, bone, IIIa-b I20 Dallage 'intrusive'	10,140	120	AM4
485	Combe Saunière I, bone, IV(1) I18 owl	16,300	220	AM4
488	Combe Saunière I, bone, IV(1) H21d	17,700	290	AM4
489	Combe Saunière I, bone, IV(1) I18c	19,450	330	AM4
751	Combe Saunière I, bone, IV(2) H21c	15,190	200	AM4
752	Combe Saunière I, bone, IV(8) H20a	19,490	350	AM4
753	Combe Saunière I, bone, lV(9) H20a	19,630	320	AM4
754	Combe Saunière I, bone, IV(10) H20a	15,200	200	AM4
755	Combe Saunière I, bone, lV(11) H20a	14,890	200	AM4
756	Combe Saunière I, bone, IV(12) H20a	15,120	200	AM4
757	Combe Saunière I, bone, lV(14) H20a	18,860	320	AM4
758	Combe Saunière I, bone, V(3) G18b	21,640	400	AM4
Belgium				
141	Weelde-Paardsdrank, charred hazelnut	8160	150	AM2
*142	Weelde-Paardsdrank, humics from OxA-141	7090	150	AM2
*143	Weelde-Paardsdrank, acid fraction from OxA-141	3330	130	AM2
*1344	Presles, red deer mandible, PRO 728	10,950	200	AM8
942	Rekem, resin on Tjonger point, RE-7	11,350	150	AM5
*943	Rekem, charcoal, RE-5	2230	70	AM5
*944	Rekem, charcoal, RE-5	6390	100	AM5
*945	Rekem, charcoal, RE-10	9900	110	AM5
*1375	Rekem, charcoal, RE-10	5220	100	AM9
Netherlands				
729	Lathum, right mandible, cave lion	10,670	160	AM5
Germany				
984	Andernach-Martinsberg, cervid bone (Federmesser)	11,950	250	A5+6
999	Andernach-Martinsberg, repeat of above (Federmesser)	12,500	500	A5+6
985	Andernach-Martinsberg, chamois? bone (Federmesser)	12,300	200	A5+6
998	Andernach-Martinsberg, bovid? bone (Federmesser)	11,370	160	A5+6
997	Andernach-Martinsberg, cervid bone (Federmesser)	11,800	160	A5+6
1125	Andernach-Martinsberg, bone, pit 20 (Magdalenian)	12,930	180	AM6
1126	Andernach-Martinsberg, bone, pit 20 (Magdalenian)	12,890	140	AM6
1127	Andernach-Martinsberg, bone, pit 12 (Magdalenian)	12,820	130	AM6
1128	Andernach-Martinsberg, bone, pit 11 (Magdalenian)	13,200	140	AM6
1129	Andernach-Martinsberg, bone, pit 12 (Magdalenian)	13,090	130	AM6

1130	Andernach-Martinsberg, bone, pit 13 (Magdalenian)	12,950	140	AM6
Denmark				
117	Vaenge Soo II, wild boar cranium	5475	130	A1+5
532	Vaenge Soo II, repeat of OxA-117	5420	80	AM5
Late Glacial marine shells				
1345	Balure of Shian, *Portlandia arctica,* JPD87/1	10,960	120	AM8
1346	Cromarty C2 Borehole, *Yoldiella lenticula/Nuculana pernuia,* Ex-EW 8969	12,860	130	AM8
*1702	Kinneil Kerse 4 Borehole, *Cordula gibba*	8300	90	AM9
1347	Kinneil Kerse 4 Borehole, *Nuculana pernula,* Ex-3E 1414	13,360	120	AM8
1317	Witch Ground Basin, *Portlandia arctica,* 2.4–2.6 m	13,580	180	AM8
*1318	Witch Ground Basin, mixed shells, 2.8–3.0 m	21,240	280	AM8
*1319	Witch Ground Basin, *Parctical/Plenticula,* 4.0–4.2 m	14,100	170	AM8
1320	Witch Ground Basin, *Portlandia arctica,* 5.2–5.4 m	13,540	150	AM8
1321	Witch Ground Basin, *Portlandia lenticula,* 5.2–5.4 m	13,380	150	AM8
1322	Hebridean Shelf, *Portlandia lenticula*	22,400	300	AM8
1323	Hebridean Shelf, *Arctica islandica*	> 43,000		AM8
1325	Hebridean Shelf, *Macoma calcarea,* 3.90 m	11,130	90	AM8
1324	Hebridean Shelf, *Buccinium terraenovae,* 4.50 m	11,600	240	AM8
1697	Lochgilphead, *Abra alba,* Ex-EU4445	12,830	120	AM9
1698	Lochgilphead, *Abra alba,* Ex-EU4467	13,020	130	AM9
1699	Inchinnan, *Abra alba,* 88/8	12,840	150	AM9
*1701	Inverleven, *Arctica islandica,* 88/10 Ex-10E 6618	12,300	120	AM9
1700	Cromarty C2 Borehole, *Nuculana pernula*	10,410	100	AM9
*1703	Errol/Inchcoonans, *Arctinula greenlandica,* 88/12	13,090	140	AM9
1704	Barry, *Balanus* sp, 88/14 Ex-M4830C	14,350	170	AM9
1756	Stornoway, *Nucula sulcata,* 8.98-9.53 m	8640	100	AM9
1755	Stornoway, *Tridonta montagui,* 14.70–15.00 m	10,260	110	AM9
1757	Stornoway, *Portlandia arctica,* 25.74–26.00 m	11,260	120	AM9
1753	Stornoway, *Yoldiella lenticula,* 29.30–29.60 m	11,650	130	AM9
1754	Stornoway, *Yoldiella lenticula,* 36.99–37.29 m	13,185	140	AM9

Table 4.2 Late Glacial, Upper Palaeolithic, and Mesolithic AMS dates by the Oxford Facility categorised by sample type and locality. Dates obtained to January 1986 reviewed in Gowlett (1986)

	To Jan '86	Feb '86– March '90	Total
Human remains			
Britain	5	12	17
Netherlands	—	5	5
Denmark	—	2	2
West Germany	—	11	11
North Sea	—	1	1
Worked artefacts			
Britain	4	27	31
North Sea	—	1	1
Netherlands	—	3	3
Belgium	—	2	2
France	—	1	1
Late Glacial/Late Upper Palaeolithic & Mesolithic sites			
Britain (open sites)	22	40	62
Britain (cave sites)	18	51	69
Eire	5	—	5
France	48	1	49
Belgium	3	6	9
Netherlands	—	1	1
Denmark	—	2	2
West Germany	—	11	11
Late Glacial marine shells			
Scotland/North Sea	—	25	25
TOTALS	105	202	307

Table 4.3 Marine shell AMS dates from the North Sea and Scottish coast for Stade and Interstadial events in the Late Glacial

		No reservoir correction		Reservoir corrected	
Loch Lomond Stade		BP	±	BP	±
Top:					
1755	*Trodonta montagui*	10,260	110	9855	110
1700	*Nuculana pernula*	10,410	100	10,005	100
Maximum:					
1345	*Portlandia arctica*	10,960	120	10,555	120
Base:					
1757	*Portlandia arctica*	11,260	120	10,855	120
Windermere Interstadial					
1753	*Yoldiella lenticula*	11,650	130	11,245	130
1701	*Arctica islandica*	12,300	120	11,895	120
1346	*Y lenticula / Nuculana pernula*	12,860	130	12,455	130
1695	*Abra alba*	12,830	120	12,425	120
1699	*Abra alba*	12,840	150	12,435	150
1698	*Abra alba*	13,020	130	12,615	130
Base:					
1754	*Yoldiella lenticula*	13,185	140	12,780	140
1347	*Nuculana pernula*	13,360	120	12,955	120
Pleniglacial					
Terminal:					
1317	*Portlandia arctica*	13,660	180	13,255	180
1320	*Portlandia arctica*	13,620	150	13,215	150
1321	*Portlandia lenticula*	13,460	150	13,055	150
Full Glacial (Errol Beds):					
1704	*Bolanus sp*	14,350	170	13,955	170

Table 4.4 AMS Late Glacial faunal dates for selected species from Britain (excluding bone and antler artefacts).

		BP	±
Reindeer			
802	Aveline's Hole, shed antler	9670	110
1782	Chelm's Coombe, left mandibular ramus	10,140	100
1120	Gough's Old Cave, unmodified antler	10,190	120
1784	Chelm's Coombe, right mandibular ramus	10,230	110
1461	Gough's New Cave, maxilla	10,450	110
1781	Chelm's Coombe, right metacarpal	10,600	200
632	Ossom's Cave, antler 'spike'	10,600	140
631	Ossom's Cave, left mandible	10,780	160
1122	Aveline's Hole, unmodified antler	12,480	130
1936	Pin Hole Cave, shed antler	13,050	250
Red Deer			
811	Elder Bush Cave, vertebra	10,600	110
1783	Chelm's Coombe, right mandibular ramus	10,910	110
801	Aveline's Hole, antler	12,100	180
1652	King Arthur's Cave, tooth	12,120	120
1563	King Arthur's Cave, tooth	12,210	120
621	Misbourne	12,530	200
466	Gough's New Cave, modified metapodial	12,800	170
Elk			
894	Thatcham IV, burnt antler	9490	110
150	Poulton-le-Fylde, metapodial	12,400	300
Bos primigenius			
1937	Pin Hole Cave, right tibia	10,970	110
1203	Kent's Cavern, partial mandible	11,880	120
813	Gough's New Cave, astragalus	11,900	140
1471	Pin Hole Cave, left astragalus	12,400	140
1615	Pin Hole Cave, right astragalus	12,480	160
Horse			
1902	Uxbridge VIII, jaw	10,010	120
1788	Uxbridge VIII, molar	10,270	100
1785	Chelm's Coombe, left metacarpal	10,370	110
1499	Three Holes Cave, tooth	11,970	150
591	Gough's New Cave, distal metapodial	12,260	160
589	Gough's New Cave, modified atlas vertebra	12,340	150
465	Gough's New Cave, modified 2nd phalanx	12,360	170
590	Gough's New Cave, as OxA-589	12,370	150
464	Gough's New Cave, modified metapodial	12,470	160
592	Gough's New Cave, as OxA-591	12,500	160
587	Gough's Old Cave, modified phalange	12,530	150
Mammoth			
1316	Condover, adult tooth	12,300	180
1462	Robin Hood's Cave, ivory fragment	12,320	120
1456	Condover, juvenile tooth	12,330	120
1455	Condover, repeat of OxA-1021	12,400	160
1204	Pin Hole Cave, right calcaneum	12,460	160
1021	Condover, adult tusk	12,700	160
Pika			
516	Great Doward Cave	10,020	120

Arctic Fox			
1200	Gough's New Cave, partial mandible	12,400	110
Saiga antelope			
1464	Soldier's Hole, left metacarpal	12,100	140
463	Gough's New Cave, calcaneum	12,380	160

Table 4.5 Human presence in Britain: 13,000-10,000 years BP

		BP	±
111	Kendrick's Cave, decorated horse mandible	10,000	200
803	Earl's Barton, Lyngby axe	10,320	150
811	Elder Bush Cave, vertebra & cut ribs, red deer	10,600	110
518	Sproughton 2, uniserial antler point	10,700	160
517	Sproughton 1, uniserial bone point	10,910	150
1463	Dowel Cave, antler tang	11,200	120
1946	Porth-y-Waen, uniserial antler point	11,390	120
1950	Leman and Ower (North Sea), uniserial antler point	11,740	150
1493	Fox Hole, reindeer antler rod	11,970	120
1494	Fox Hole, fragment antler rod/point	12,000	120
1890	Gough's New Cave, 'new' ivory rod	12,170	130
535	Sun Hole Cave, human left ulna	12,210	160
1670	Robin Hood's Cave, cut right humerus, mountain hare	12,290	120
1071	Gough's New Cave, cut bovine 2nd phalanx	12,300	180
1789	Kent's Cavern, bone piercer	12,320	130
589	Cough's New Cave, atlas vertebra, horse	12,340	150
1467	Pin Hole Cave, cut proximal radius, mountain hare	12,350	120
1500	Three Holes Cave, cut bone fragment	12,350	160
465	Gough's New Cave, modified 2nd phalanx, horse	12,360	170
590	Gough's New Cave, as OxA-589	12,370	150
1121	Aveline's Hole, cut bovine 2nd phalanx	12,380	130
150	Poulton-le-Fylde, elk metapodial	12,400	300
1617	Robin Hood's Cave, cut left femur, mountain hare	12,420	200
1619	Robin Hood's Cave, cut right humerus, mountain hare	12,450	150
464	Gough's New Cave, distal metapodial, horse	12,470	160
1618	Robin Hood's Cave, cut right scapula, mountain hare	12,480	170
587	Gough's Old Cave, modified horse phalange	12,530	150
1616	Robin Hood's Cave, cut left scapula, mountain hare	12,600	170
466	Gough's New Cave, modified metapodial, red deer	12,800	170

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5 Palaeoecology of the Late Glacial and early Postglacial of Belgium and neighbouring areas

Jean-Marie Cordy

Abstract

This paper presents a synthesis of faunal remains recovered from Late Glacial and early Postglacial occupation sites in caves and rock shelters in southern Belgium (Mosan Basin). The interpretation of biochronological and palaeoecological evidence is based primarily on the analyses of microfaunal assemblages which often occur within relatively complete biostratigraphical sequences. This approach avoids the potential problems associated with the study of humanly predated faunas. The large number of well-dated prehistoric sites with rich faunal collections allows a biochronological and palaeoecological picture to emerge for this region from the Late Glacial to the Early Postglacial (Dryas I to Pre-Boreal). Against this frame of reference can be correlated other Late Glacial sites of north-west Europe, such as those in the Neuwied Basin (Germany) and the Paris Basin (France).

Introduction

The aim of this paper is to present a palaeoclimatical and environmental reconstruction of the end of the late glaciation in Belgium and bordering countries, which is based upon palaeoecological interpretation of the fossil mammalian faunas and their chronological evolution. This will be done firstly with the help of micromammals, mainly the rodents. Since their percentage values can be distorted by the choice of prehistoric hunters, the large mammal faunas have been studied only secondarily.

In the south of Belgium, there are many caves and rockshelters in the limestone regions of the Meuse basin and numerous archaeological excavations have been made in them from the last century until now (Ulrix-Closset 1975; Otte 1979; Dewez 1987). Thus, we can use several sites with rich mammalian faunas associated in some cases with different prehistoric occupations (Fig 5.1). About ten principal sites give definite and complementary biostratigraphical sequences. Figure 5.2 shows the chronological position of these principal sites with their different fossiliferous layers. The chronological correlations between these faunas are based upon multidisciplinary studies and include several radiocarbon dates.

At present, thanks to rich micromammal assemblages, we are able to propose a complete biozonation in Belgium from the late Dryas I to the Holocene period, thus from about 13,500 to 10,000 BP (Cordy 1974; 1975; 1985; in press; Cordy & Peuchot 1983; Toussaint & Becker 1986). Given this biozonation, it becomes possible to make inferences about the types of landscapes and climates that existed in the Late Glacial.

The results

Among all the studied microfaunas, we have here selected the more representative assemblages, the more species-rich and well-dated samples, to review the biozonation. Figure 5.3 presents the typical microfaunas with their detailed composition and the percentage values of the taxa.

In Figure 5.4, a multigraphic diagram sets out the percentage values of the different species in each typical microfauna, showing their detailed evolution from late Dryas I to the Holocene period. This diagram is more or less analogous with a palynological diagram.

From left to right, we see: 1) the typical succession of microfaunas and their chrono-stratigraphical interpretation; 2) the percentage of the Insectivora and Chiroptera with regard to all micromammals as an index of warming; 3) a ratio diagram in which all the rodent species that belong to a particular climate and biotope are added together and the sum is expressed as a percentage of the total number of species in the sample; 4) the simple percentages of the principal species of rodents; and 5) the expanded percentages of the rare species.

In a global view, the diagram shows that there is a strong correlation between the variations of

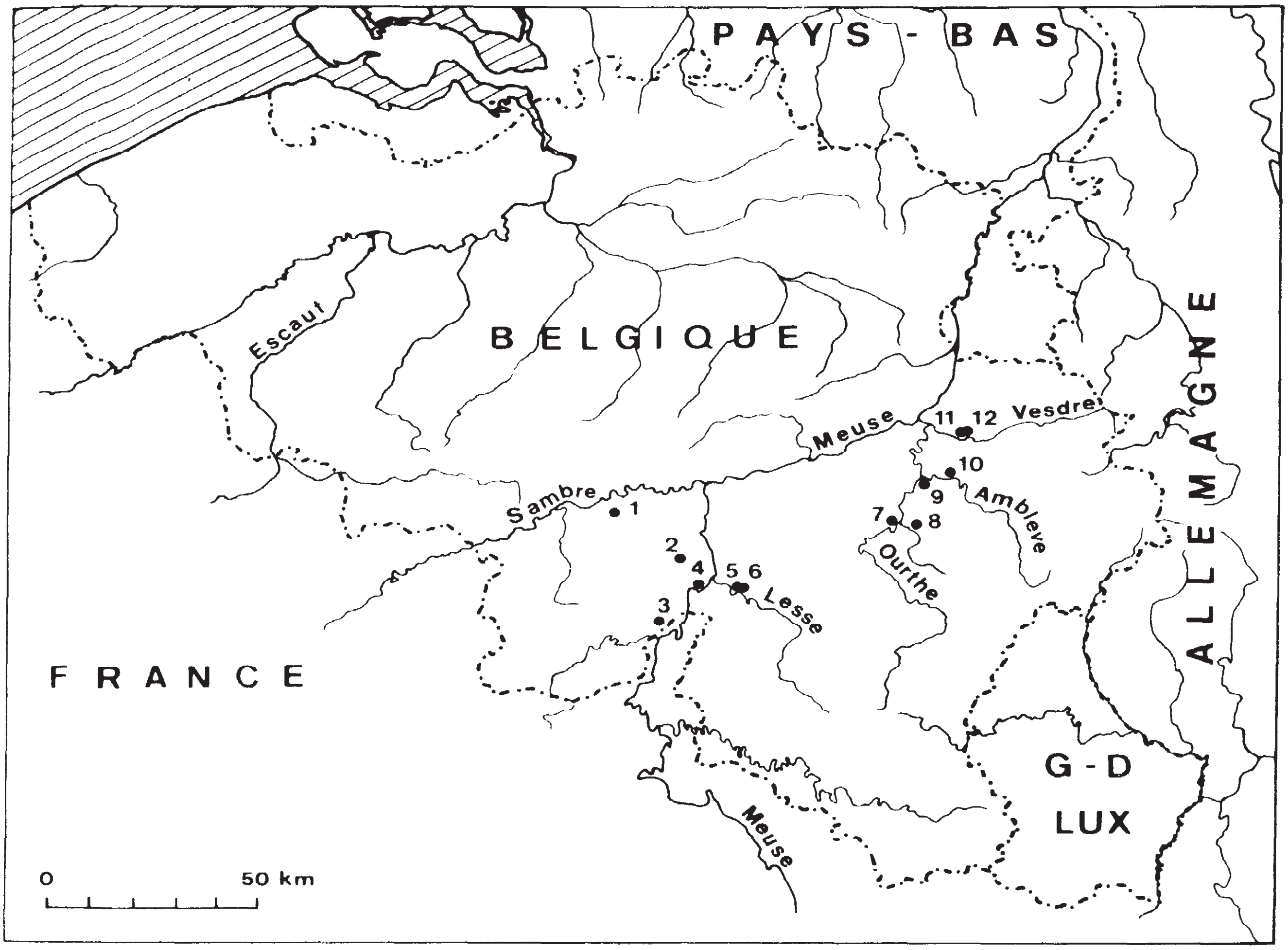

Figure 5.1 Principal palaeontological sites of the Belgian Late Glacial: 1) Trou de l'Ossuaire, Presles; 2) Caverne du Bois de la Saute, Haut-le-Wastia; 3) Trou des Blaireaux, Vaucelles; 4) Roche Al'Rue, Waulsort; 5) Trou Balleux; 6) Trou de Chaleux; 7) Grotte de Verlaine; 8) Grotte du Coléoptère, Bomal; 9) Trou Jadot, Comhlain; 10) Grotte de Remouchamps; 11) Grotte Walou; 12) Grotte des Fonds-de-Forê

micromammal assemblages and the traditional climatic sequence in continental Europe (Leroi-Gourhan & Renault-Miskovsky 1977). For example, the increase in lemmings, especially arctic lemming *(Dicrostonyx gulielmi),* which is now confined to the high arctic, typically corresponds to the different glacial stadials Dryas I, II and III. Conversely, the reduction of the lemming percentages indicates very well the diminution of the cold arctic climate in the different interstadials. It should be noted that the increasing or decreasing of the total allochthonous rodents is a good indication for these climatic variations. Also, the increase in woodland rodents and insectivora is clearly associated with the interstadial periods, such as the Bølling, Allerød and Holocene.

The different periods and their microfaunal data

Dryas I

The late Dryas I, which ends a little before 13,000 years BP, is a very cold period with a polar-like climate. The arctic lemming is prevalent, and its representation can reach almost 50%. The biotope is certainly like an arctic tundra. This lemming is associated with another rodent which favours cold, dry, continental conditions, *Microtus gregalis,* the narrow-skulled vole. Together these rodents form three quarters of the microfauna. There are no woodland rodents or Insectivora.

DATES B P	ZONATION PALYNOL	CORRELATION DES FAUNES REPERES EN BELGIQUE			
	PREBOREAL sup		TROU BALLEUX		WALOU A5
10.000	PREB inf		COLEOPT 6A	FONDS DE FORET	WALOU A6
	DRYAS III		COLEOPT 6B	REMOUCHAMPS	WALOU B1
11.000	ALLERØD		COLEOPT 7	JADOT CCSA JADOT CCSB JADOT CRM JADOT LCE JADOT CGMPhi	
12.000	DRYAS II	PRESLES ter	COLEOPT 8	JADOT CRIA	WALOU B2/3
	BØLLING	PRESLES I-II	CHALEUX		WALOU B4 som
13.000					WALOU B4
	DRYAS I sup	PRESLES III	VAUCELLES III		

Figure 5.2 Table of chrono- and biostratigraphic correlations between the typical faunas of the Belgian Late Glacial. The radiocarbon dated faunas are underlined. The palynological zonation and the dates are after Leroi-Gourhan and Renault-Miskovsky 1977

Bølling

This interstadial period is distinguished by an important and rapid reduction of lemmings which here represent no more than 5% of the rodents. On the other hand, the clear increase of the Insectivora is good proof of the relative warming. The climate was probably of continental type and allowed a weak recolonisation of forest biotopes; indeed, two woodland rodent species occur: *Clethrionomys glareolus* (bank vole) and *Sicista betulina* (northern birch mouse). However, the environment was mainly open biotopes with steppes and grasslands. In this interstadial period there were probably different climatic phases: firstly, a dry phase with the occurrence of the steppe pika *(Ochotona pusilla),* and the common hamster *(Cricetus cricetus);* later, the climate became wetter as the increase of the root vole *(Microtus oeconomus),* seems to indicate; finally, the climate became drier again with a corresponding increase in *Microtus gregalis,* the narrow-skulled vole.

Dryas II

After the Bølling warming, a stadial period is identified by a new, strong increase in arctic lemming which reaches 38%. It is the principal component of the layer 8 assemblage at Coléoptère cave. Insectivora and woodland rodents are not represented. These features clearly indicate a severe arctic climate. However, it was probably a little less severe than the previous stadial, Dryas I.

Periods	Microfaunas	*Dicrostonyx guliemi*	*Lemmus lemmus*	*Microtus gregalis*	*Microtus oeconomus*	*Microtus nivalis*	*Sicista betulina*	*Cricetus cricetus*	*Ochotona pusilla*	*M arvalis/agrestis*	*Arvicola terrestris*	*Clethrionomys glareolus*	*Apodemus sylvaticus*	Insectiv /Rongeurs	N TOTAL	Industries	Dates ^{14}C BP
Preboreal	Walou A6	-	0,7	12,1	43,1	-	-	0,7	2,1	35,9	3,2	1,8	0,4	9,6	311		9450 ± 270
Dryas III	Walou B1	5	+	20	25	-	-	+	+	35	10	5	+	+	20	Creswel -Tjong	
	Coléopt 6B	19,5	-	6,1	6,9	0,6	-	0,4	0,6	43,8	9,5	6,5	0,8	5,4	495	Ahrensb	
Allerød	Jadot CCSA	0,5	3	5,7	11,3	-	-	2	-	56,5	14	7	+	3,4	207	(Tephras)	(± 11000)
	Jadot CCSB	-	10,9	8,5	-	-	-	-	-	68,1	4,7	7,8	-	4,5	67		
	Jadot CRM	2	-	16,8	-	-	-	-	-	67,2	6	8	-	9,1	55		
	Jadot LCE	-	-	-	25,6	-	-	-	-	59,8	12,9	1,6	-	8,9	62		
	Jadot CGMPhi	0,4	-	-	16,9	0,4	-	-	-	78,3	2,8	0,6	0,6	5,5	562	Paléo final	11850 ± 160
Dryas II	Jadot CRIAa	13,5	-	5,1	6,8	5,1	-	-	-	62,7	5,1	1,7	-	-	59		12610 ± 260
	Coléopt 8	38,6	-	25	-	2,3	-	-	-	27,3	6,8	-	-	-	44	Magdal	12150 ± 150 12400 ± 110
	Walou CMFI	17,3	-	61,7	1,2	-	-	-	-	19,8	-	-	-	1,2	82		
Bølling	Presles I	1,5	0,4	55,5	36	-	0,4	0,4	+	5,1	0,4	0,4	-	14,2	317	Creswel	12140 ± 160
	Walou B4 som	-	2,9	7,1	38,6	-	-	2,9	12,9	32,9	2,9	-	-	7,9	76		
	Walou B4	14,9	2,1	38,3	4,3	-	-	-	-	38,3	+	2,1	-	7,8	51	Magdal	13030 ± 140 13120 ± 190
Dryas I	Vaucelles III	46,1	0,6	26	0,6	-	-	-	-	24,5	1,1	0,1	-	0,3	697	Paléo final	13790 ± 150 13850 ± 335

Figure 5.3 Percentages of the different rodents in each typical cave microfauna with the chronological interpretions, the radiocarbon dating and cultural associations

Arctic lemming is again associated with the narrow-skulled vole *(M gregalis),* whereas the root vole seems absent. Thus the climate was probably mainly dry with a high degree of continentality, and this assemblage also suggests a tundra-like environment.

Allerød

The period of cold climate is followed by a rapid major warming. The transition between Dryas II and Allerød is more marked than the one between Dryas I and Bølling. The regression of the arctic lemming percentage is as rapid, but it is associated with a big reduction of the percentages of all the allochthonous rodents. For the first time in the Late Glacial, the autochthonous rodents are prevalent with common vole and field vole by far the best represented taxa. The Insectivora and woodland rodents occur again, and of particular interest is the occurrence of wood mouse *(Apodemus sylvaticus).* All these features certainly indicate a strong and sudden warming which seems to be warmer than the previous interstadial. The climate is cool but certainly not arctic. Amongst the allochthonous rodents, root vole is predominant, which suggests a cold humid climate. This assemblage also points to an open, herb-rich landscape with sparsely represented but increasing woodland.

This interstadial period comprises three phases. First, as just described, the climate is rather wet with the complete predominance of root vole *(Microtus oeconomus),* amongst allochthonous rodents. In the second phase, a climatic deterioration is attested, with a small peak of lemmings, especially Norway lemming *(Lemmus lemmus).* At the same time, the climate becomes drier; indeed, the narrow-skulled vole occurs in place of the root vole. The third phase becomes again a little milder and more humid.

Dryas III

The Dryas III is again marked by the increase of arctic lemming. Nevertheless, the percentage values of this lemming reach only about 20%. In addition, the allochthonous rodents remain less numerous than the autochthonous ones, and the predominant species are field vole and common vole. Finally woodland rodents and insectivora last into this cold phase with a representation of 7%. Thus, this last stadial period is probably short and sudden and is certainly less strong than the previous Dryas. The environment is mainly open but probably less homogeneous and presents perhaps a mosaic of distinct landscapes.

Early Pre-Boreal

Palynology distinguishes two phases within the Pre-Boreal period. The early Pre-Boreal begins about 10,300 years ago and ends with the Piottino event, which dates from 10,000 years BP (Bastin 1980). On the basis of our results, this early phase is a typical transition between the last Dryas and the fully developed Holocene climate. It is an extension of the last stadial event with a sort of inertia in the climatic dynamism. We can very well observe this phenomenon, thanks to the modification of the rodent assemblages: the arctic lemming disappears, but the other allochthonous rodents remain steady, while the narrow-skulled vole and especially the root vole even increase. This recalls what we saw at the beginning of the Bølling interstadial; moreover, we also observe the reappearance of a typical triad: steppe pika *(Ochotona pusilla),* common hamster *(Cricetus cricetus),* and Norway lemming *(Lemmus lemmus).* Thus the climate seems to have been cold and humid continental-like since root vole is very developed. The biotopes are mainly open, with many wet or swampy grasslands. However, on the plateaux there are mainly moor biotopes which would allow the development of a big population of grouse *(Lagopus lagopus).* Woodlands are not very significant.

Late Pre-Boreal

After the Piottino event, the warming is again very sudden and the climate becomes similar to that of the present day. Indeed, the micromammal assemblages are the same as modern fauna. Specifically, we observe the complete disappearance of all the allochthonous rodents and the growth of woodland rodent populations. This phenomenon is clearly shown by the Walou cave sequence. At this site, there is a very rich microfauna in the A6 layer, which is radiocarbon dated to the Pre-Boreal period. Just above this layer, the microfauna changes completely: this is the real beginning of the Holocene interglacial climate. The date of 9450 BP for the cool microfauna suggests that this assemblage may perhaps last into the early Holocene.

The Late Glacial periods from the macrofaunal data

Dryas I

Two prehistoric sites in Belgium are characterised by an abundance of reindeer remains *(Rangifer tarandus),* notably female shed antlers at Presles Bed I and Vaucelles Bed I (Léotard 1985; Bellier & Cattelain 1986). Female antlers are shed in the parturition period at the end of the spring nordic migration (Spiess 1979; Gordon 1988). Thus, during the Dryas I, Belgium was situated in the polar zone. On the other hand, at Chaleux, probably underlying the Magdalenian occupation, some

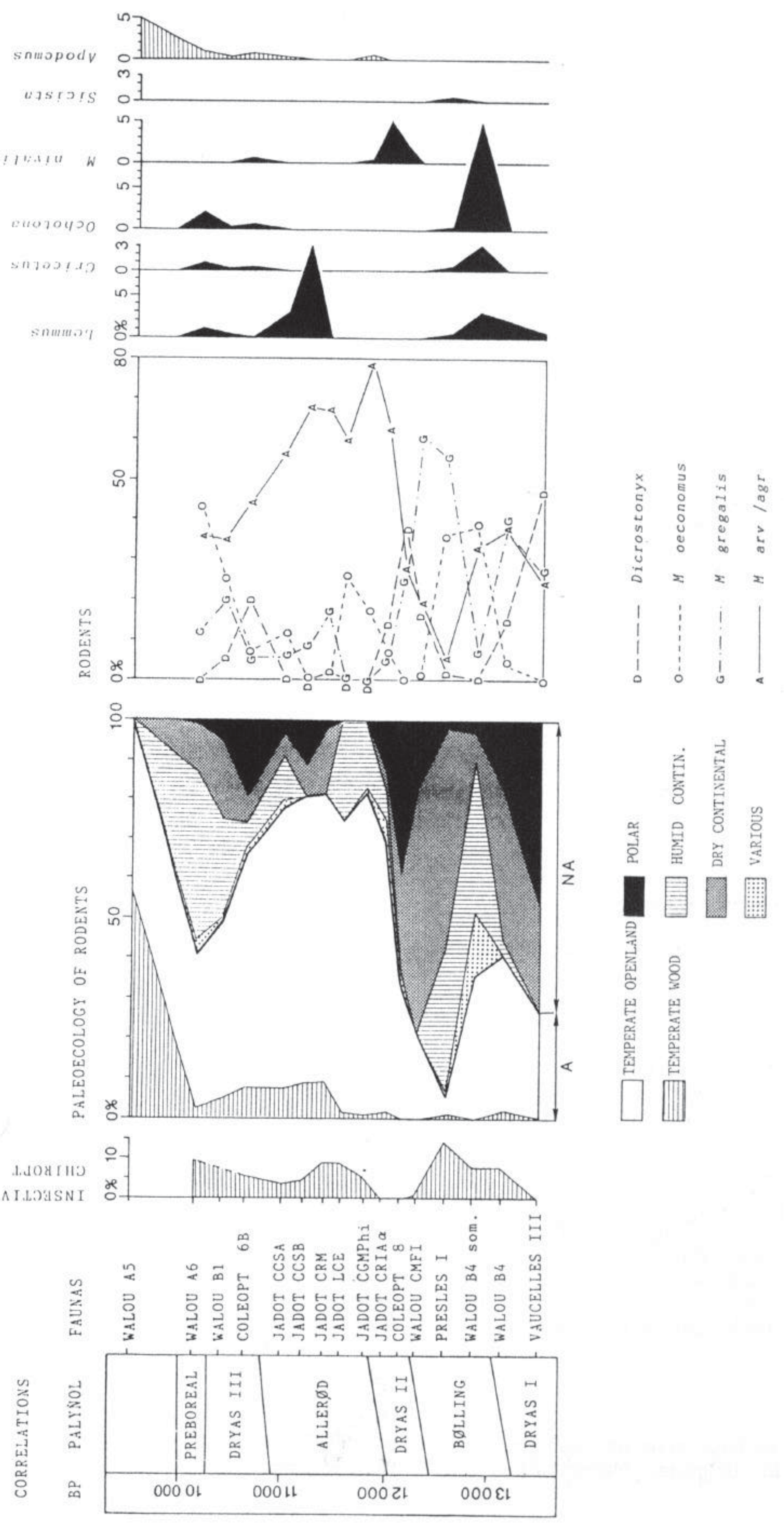

Figure 5.4 Multigraphic diagram of micromammal assemblage evolution during the Late Glacial (see text). Palaeoecology of rodents: A) Autochthonous; NA) Non-autocthonous

remains of musk ox *(Ovibos moschatus),* were found by the first excavators (Nehring 1897). All of this data corresponds well with a polar-like climate and a tundra-like environment.

Bølling

The Magdalenian occupation of Chaleux cave yielded a very rich fauna and is well-dated by several radiocarbon dates (Dupont 1872; Dewez 1987; Otte & Teheux 1986). Horse is prevalent, making up almost 60% of the total. Reindeer is very rare (barely 3%) and the fauna is dominated by forest mammals such red deer *(Cervus elaphus),* roe deer *(Capreolus capreolus),* and wild pig *(Sus scrofa),* which together form more than 10%. Another interesting feature is the appearance of the saiga antelope *(Saiga tatarica).*

The palaeoecological interpretation of this fauna is consistent with that of the Bølling microfauna. Indeed, the scarcity of reindeer and the development of the forest mammals signal a clear climatic amelioration. In addition, the importance of the horse and the Bovinae, which form three quarters of the fauna, shows the absolute predominance of open grassland biotopes. The occurrence of saiga antelope perfectly confirms the hypothesis of a rich continental steppe where the steppe pika also lives.

Dryas II

In Belgium, so far no large mammal fauna has been correlated with the full development of this stadial period. However, we think that several famous Magdalenian sites of the Paris basin region in France correspond to this period (Leroi- Gourhan *et al* 1976; Schmider 1984; Audouze 1987).

All the sites which yielded large mammal remains, such as Pincevent, Etiolles, Marsangy and Verberie are distinguished by the dominance of reindeer (percentages of up to 90% and over); the other herbivores such as horse, bison, red deer and mammoth, are very rarely represented. Numerous radiocarbon dates from these sites are situated in a time range around the Dryas II. I believe these almost monospecific faunas have a real palaeoecological significance. On the basis of my palaeoclimatic results in Belgium, I think that these faunas of the Paris region probably correspond to a tundra environment which characterises each Dryas period. In this case, the dates permit this stadial period to be ascribed to the Dryas II.

Allerød

In this case again, no large mammal fauna has yet been discovered in Belgium. Nevertheless, in Germany, in the Rhine valley, the open sites of Urbar and Miesenheim have yielded some interesting data on the first half of the Allerød (Bosinski 1979; 1983). The fauna is dominated by woodland species in a humid environment, with red deer *(Cervus elaphus),* elk *(Alces alces),* and beaver *(Castor fiber).* The warming is also indicated by the fossilised forest of Miesenheim II under the volcanic pumice dating from 11,450 BP

Dryas III

With this last glacial event, reindeer occurs again in Belgium, for example in the Ahrensburgian faunas of Remouchamps cave (Dewez *et al* 1974) and Coléoptère cave. This datum agrees with the final reappearance of arctic lemming very well.

Pre-Boreal

Reindeer seems to persist until the early Pre-Boreal, as the fauna of the A6 layer of Walou cave shows. Nevertheless, if we recall the palaeoecological interpretations of the microfauna, the environment is mainly favourable to the herbivores. Indeed, the open site of Belloy-sur-Somme in France yields a fauna dominated absolutely by horses (Fagnart 1987, and this volume).

With the late Pre-Boreal, after 10,000 BP, the climate and environment become suddenly the same as the present one. That is very clear at the site of Balleux cave in Belgium (Dewez 1981). There, a very early Mesolithic occupation is associated with a fauna where wild boar and red deer dominate absolutely, cold species are absent and wild horse accounts for only 10%. This occupation is radiocarbon dated by 10,110±120 BP

Conclusions

The mammal studies allow us to distinguish clearly different climatic periods in the Late Glacial. We can very distinctly observe the stadial periods, with the development of the arctic fauna, in Dryas I, II and III. In each of these periods the occurrence of reindeer and arctic lemming indicates a real increase in a tundra environment.

The Bølling interstadial is a clear climatic amelioration. However, the climate remains continental in type and the environment consisted mainly of open biotopes with herb-rich steppes or grasslands. The Allerød interstadial is a strong and sudden warming. The biotopes are mainly open but woodlands occur and increase. On the other hand this period was probably complex. After the maximum of the Dryas III, the early Pre-Boreal forms a transition towards the Holocene climate, there are probably many grasslands and the climate is wet and cool. But globally after 10,000 BP, the fauna and thus the climate very quickly become similar to the modern period.

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6 A Late Glacial Interstadial mammal fauna from Gough's Cave, Somerset, England

Andrew P Currant

Abstract

New fieldwork at the Late Upper Palaeolithic human occupation site of Gough's Cave, Cheddar, Somerset, in combination with reappraisal of surviving material from previous excavations and a radiocarbon dating programme, has confirmed the existence of a contemporaneous Late Glacial Interstadial mammal fauna dominated by horse *Equus ferus* and red deer *Cervus elaphus*. The fauna includes species characteristic of both temperate and boreal environments, with a continental steppe element in the form of the saiga antelope *Saiga tatarica*. Remains of reindeer *Rangifer tarandus* are notably absent from this assemblage other than as well worked human artefacts made of antler. The majority of the mammal remains are cut, broken or otherwise modified by humans. A later phase of faunal input attributed to the Younger Dryas Stadial is dominated by reindeer, but direct evidence of human presence in the Cheddar area during this cold period is lacking.

Information derived from a study of existing museum collections of Gough's Cave mammals has been presented by the author in previously published accounts (Currant 1986; 1987). Additions to the fauna resulting from a new phase of excavations have recently been recorded by Currant, Jacobi and Stringer (1989). Subsequent fieldwork has added further species to the Late Glacial Interstadial assemblage. An updated listed is given in Table 6.1. The new extensive bibliography of this site has recently been reviewed by Mansfield and Donovan (1989).

Of the species listed in Table 6.1, *Rangifer tarandus* and *Mammuthus primigenius* are only represented in the Late Glacial Interstadial assemblage by extensively worked human artefacts which may have been brought in from some distance away. A small number of unworked fossils of *Rangifer tarandus* are attributable to a later phase of faunal input (see Table 6.2). Direct radiocarbon dates have also been obtained on material belonging to *Alopex lagopus, Mammuthus primigenius, Equus ferus, Cervus elaphus, Bos primigenius* and *Saiga tatarica* showing these species to form a contemporaneous grouping. Many of the mammal bones dating from this period of human occupation have been systematically butchered. Contextural information from the latest phase of excavation shows beyond doubt that *Lepus timidus, Canis lupus* and *Lynx lynx* also belong with the Late Glacial Interstadial group. *Rangifer tarandus* is also represented in the recently excavated Interstadial material by a finely carved *bâton-de-commandement.*

The Late Glacial Interstadial assemblage has several surprising features. The aurochs *Bos primigenius* is a characteristic element of later Pleistocene temperate faunas. *Saiga tatarica,* the saiga antelope, is now found only in the continental steppe regions of the southern Soviet Union, while *Alopex lagopus* the arctic fox, is now a species of the arctic tundra. What are we actually witnessing in what we would today regard as 'mixed' assemblages such as this? One possibility is that these various indicator species were moving in and out of the Cheddar area in rapid succession as the regional environment underwent upheavals at a time of great climatic instability, each phase being so short as to be beyond the discriminating powers of the dating method employed. Another suggestion might be that the Late Glacial Interstadial was marked by so unique a combination of environmental parameters that it permitted the temporary coexistence of otherwise unlikely combinations of mammalian species. Both explanations are possible and not necessarily mutually exclusive.

There appear to be several reasons why the first of these suggestions is the least satisfactory. If there had been massive environmental changes during the period of human utilization of Gough's Cave then it is difficult to account for the continual record of red deer to the exclusion of reindeer among the human food debris. Reindeer is a common element of the north-west European mammal fauna during the Late Glacial period: its apparent local absence in the region which includes Gough's Cave during what may have been a protracted period of human occupation argues for relative environmental stability

Table 6.1 The Gough's Cave Late Glacial Interstadial mammal fauna

Lagomorpha
- Ochotonidae
  - *Ochotona pusilla* (Pallas 1769)
- Leporidae
  - *Lepus timidus* Linnaeus 1758

Rodentia
- Castoridae
  - *Castor fiber* Linnacus 1758
- Arvicolidae
  - *Dicrostonyx torquatus* (Pallas 1779)
  - *Lemmus lemmus* (Linnaeus 1758)
  - *Arvicola terrestris* (Linnaeus 1758)
  - *Microtus oeconomus* (Pallas 1776)
  - *Microtus gregalis* (Pallas 1779)

Carnivora
- Canidae
  - *Canis lupus* Linnaeus 1758
  - *Alopex lagopus* (Linnaeus 1758)
  - *Vulpes vulpes* (Linnaeus 1758)
- Ursidae
  - *Ursus arctos* Linnaeus 1758
- Felidae
  - *Lynx* Lynx (Linnaeus 1758)

Proboscide
- Elephantidae
  - *Mammuthus primigenius* (Blumenbach 1799) *see text

Perissodactyla
- Equidae
  - *Equus ferus* Boddaert 1785

Artiodactyla
- Cervidae
  - *Cervus elaphus* Linnaeus 1758
  - *Rangifer tarandus* (Linnaeus 1758) *see text
- Bovidae
  - *Bos primigenius* Bojanus 1827
  - *Saiga tatarica* (Linnaeus 1766)

There is a certain amount of inertia involved in major changes in the distribution of most mammalian species. For instance, a particularly hot summer does not bring large numbers of Mediterranean mammals flooding northwards across continental Europe. However, some species are more responsive to this kind of short term, seasonal change than others. One such is the saiga antelope *Saiga tatarica*. The presence of this comparatively exotic mammal at Gough's Cave and adjacent sites could very easily represent a very brief and unusual westward seasonal migration in response to extreme conditions in continental Europe and southern Asia (Currant 1987). Its remains are notably rare for what would otherwise have been a very attractive food source had it been available locally for any protracted period.

The later phase of faunal input at Gough's Cave, representing the Younger Dryas Stadial, is comparatively poorly represented, but material from the nearby site of Chelm's Combe fills out this part of the record very well indeed.

The 'rockshelter' at Chelm's Combe, Cheddar (NGR ST 463 545) was excavated under the direction of H E Balch in 1925/6. Late Pleistocene limestone screes, which underlay Holocene archaeological horizons, produced a small collection of mammal and bird remains and some well preserved terrestrial mollusca, the subject of a report by Jackson (1927). Work on the site progressed by the removal of arbitary one foot (*c* 30cm) horizontal spits, numbered downwards 1–22. If there was any internal stratigraphy it was not recorded, but the steep nature of the site (now destroyed by quarrying) would suggest that the excavation spits did not necessarily coincide with natural layers, presenting the same problems of interpretation as material from earlier work at Gough's Cave. In Table 6.2, the spit numbers are given purely as historical reference.

The mammal fauna is dominated by *Rangifer tarandus* and *Equus ferus*. Study of the mammals is still in progress, but the results of a recent radiocarbon dating programme including Chelm's Combe material are of sufficient interest in the wider context of sites in the Cheddar area to be included in this account.

Accumulation of the Chelm's Combe material appears to have been by the gradual build up of thermoclastic screes of purely local origin incorporating the remains of animals which died by falling over the precipitous cliffs immediately above the site. In this context the range of dates obtained on reindeer is not particularly surprising and the expected local presence of reindeer throughout much of the Younger Dryas Stadial is confirmed. Of rather greater interest with regard to the results obtained on the Gough's Cave material is the apparent continued local presence of red deer until very late in the Late Glacial Interstadial. We have here the suggestion that the rather 'temperate' mammal fauna found in Gough's Cave may have survived for 1500 years or more before the faunal reversal caused by the climatic deterioration of the Younger Dryas Stadial. Further dates on critical Chelm's Combe material are currently being sought.

Table 6.2 Age determinations on Gough's Cave mammals

OxA 815	*Sus scrofa,* right maxilla, M49839, spit 12	1740	±60 BP
Q 1581	*Rangifer tarandus,* antler fragment, spit 8	9920	±130 BP
OxA 1581	*Rangifer tarandus,* frag 1 maxilla, M49863, spit ?	10,450	±110 BP
OxA 813	*Bos primigenius,* left astragalus, M49744, spit 11	11,900	±140 BP
OxA 588	Bovini *cf Bos,* phalange, M49971, spit 15	12,030	±150 BP
OxA 1890	*Mammuthus primigenius,* ivory javelin head	12,170	±130 BP
BM 2185R	*Equus ferus,* dist metapodial, M50083, spit 13	12,200	±250 BP
BM 2184R	*Equus ferus,* right calcaneum, M50082, spit 12	12,250	±160 BP
OxA 1071	Bovini cf *Bos,* phalange, M49758, spit 11	12,300	±180 BP
BM 2187R	*Equus ferus,* dist metapodial, M50085, spit 16	12,300	±200 BP
{OxA 591	collagen fraction	12,260	±160 BP
{OxA 591	amino acid fraction	12,500	±160 BP
BM 2183R	*Equus ferus,* atlas vertebra, M50081, spit 10	12,350	±160 BP
{OxA 589	collagen fraction	12,340	±150 BP
{OxA 590	amino acid fraction	12,370	±150 BP
OxA 465	*Equus ferus,* right phalange II, M49955, spit 14	12,360	±170 BP
OxA 463	*Saiga tatarica,* right calcaneum, M49886, spit 14	12,380	±160 BP
BM 2188R	*Equus ferus,* dist metapodial, M50086, spit 18	12,380	±230 BP
OxA 1200	*Alopex lagopus,* right dentary, M13797, spit 11	12,400	±110 BP
OxA 464	*Equus ferus,* dist right metacarpal, M50024, spit 18	12,470	±160 BP
BM 2186R	*Equus ferus,* dist metapodial, M50084, spit 14	12,470	±240 BP
OxA 466	*Cervus elaphus,* dist right metatarsal, M49847, spit 13	12,800	±170 BP

The M- prefixed numbers refer to specimens in the collections of the British Museum (Natural History)

Table 6.3 Age determinations on Chelm's Combe mammals

BM 2318	*Rangifer tarandus,* metapodial, spit 12	10,190	±130 BP
BM 2431	*Rangifer tarandus,* right distal tibia spit 7	10,220	±130 BP
New Series			
OxA 1782	*Rangifer tarandus,* left dentary, spit 9	10,140	±100 BP
OxA 1784	*Rangifer tarandus,* right dentary, spit 12	10,230	±110 BP
OxA 1785	*Equus ferus,* left proximal metacarpal, spit 12	10,370	±110 BP
OxA 1781	*Rangifer tarandus,* right metacarpal, spit 7	10,600	±200 BP
OxA 1783	*Cervus elaphus,* right dentary, spit 9	10,910	±110 BP

All of the dated material comes from the collections of Wells Museum

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7 Late Glacial mammoths in Britain

Adrian M Lister

Abstract

This paper examines the radiocarbon evidence for the occurrence of mammoth *(Mammuthus primigenius* (Blum)) in Britain during the Last (Devensian) Cold Stage, on the basis of directly dated faunal specimens. Until recently the available evidence suggested that mammoth did not return to Britain after the last glacial maximum. New data, however, demonstrate unequivocally that mammoth was present at least locally between *c* 13,000–12,000 BP.

Introduction

The mammoth *(Mammuthus primigenius* (Blum)) was an important element of the mammalian fauna in the Upper Pleistocene of Europe, northern Asia, and North America. This highly-specialised, ice-age-adapted species arose from a more generalised elephantid ancestor in the Lower to Middle Pleistocene, and became extinct some time in the Late Glacial. Research interest on three continents, coupled with new dating techniques and the accumulation of stratified remains, is making possible a more detailed understanding of the mammoth's adaptations, distributional history, and extinction than is available for almost any other extinct Pleistocene species.

The most characteristic environment of the mammoth was the wide expanse of largely treeless steppe-tundra in a subarctic climate. However, it also occurred in other palaeoenvironmental contexts, ranging in Britain from temperate, partially wooded conditions, as in the deposits at Aveley, Essex, to warm but treeless interstadials, as at Upton Warren, Worcestershire, to arctic conditions as in the Lea Valley Gravels, Hertfordshire (cf Stuart 1982). In all cases, a considerable abundance of food must have been available. The popular image of mammoths subsisting on a habitat resembling modern barren-ground tundra is implausible since, by analogy with living elephants, a fully-grown mammoth would have required around 200 kg of fresh food per day. Analyses of stomach contents (Ukraintseva 1986) and dung balls (Mead *et al* 1986) show that the principal food was grass, followed by mosses, ferns, herbaceous plants, and occasional browse where available.

The extent to which Palaeolithic people hunted mammoth is uncertain. Nonetheless, whether hunted or scavenged, mammoth material was utilised by humans for a variety of purposes, ranging from the spectacular mammoth-bone huts of eastern Europe (Gladkih *et al* 1984), to ivory-working for weapons, tools or ornaments, illustrated in Britain at sites such as Kent's Cavern, Gough's Cave, and Paviland Cave (see below).

A fuller understanding of the factors limiting the distribution and abundance of the mammoth, and its availability as a resource to Palaeolithic people, requires detailed information about the presence, absence, and density of occurrence of the species in different parts of its range at different times. This information is most readily attainable for the second half of the Last (Devensian) Cold Stage, corresponding approximately to the timespan accessible by radiocarbon dating. During this period, especially in western Europe, the mammoth was subjected to very severe fluctuations of climate and vegetation, and was also witness to important developments in human occupation and technology. These events provide a dramatic backdrop against which to view the response of mammoth populations. In addition, this period culminated in the final extinction of the species some time in the Late Glacial, an event whose timing and causes are of particular interest. Assessing the relative importance of climate, vegetation and humans in precipitating extinction requires accurate dates for the latest occurrences, viewed in the context of the environmental and distributional changes which preceded them.

As a contribution to these topics, this paper reviews the radiocarbon-dated records of mammoth from Britain. Discussion has been restricted to dates obtained directly on mammoth bone or tooth. There are many additional records where circumstantial evidence of age is provided by 'associated' fauna, flora, artefacts or other radiocarbon-dated specimens, but although these provide useful background information, a detailed reconstruction of the history of the species is best restricted, at least initially, to directly-dated specimens. This is particularly true in the case of cave material, where complex stratigraphy, and various processes such as collapse of sink holes or

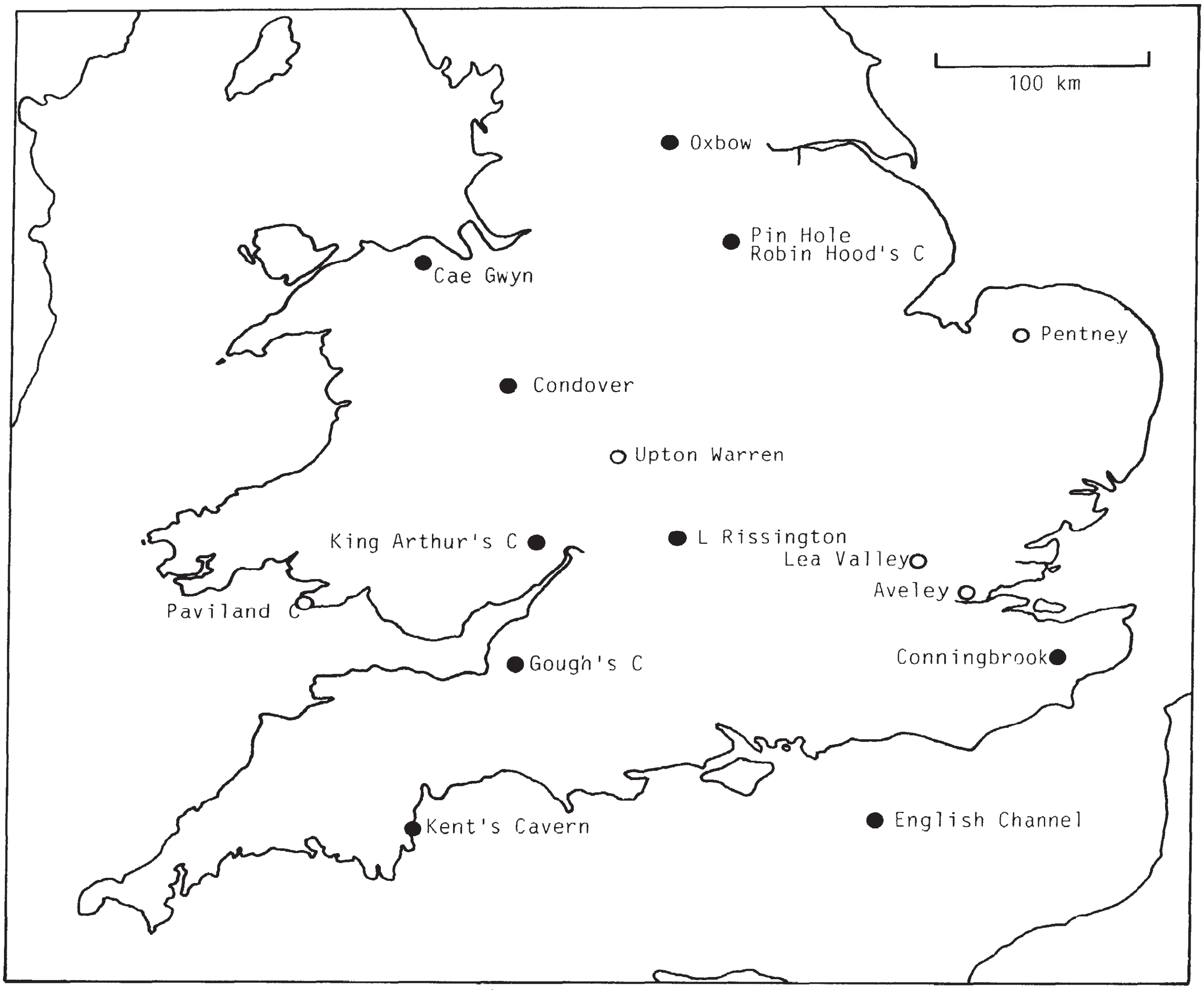

Figure 7.1 Map of southern Britain, showing the location of sites mentioned in the text. Closed symbols indicate sites for which radiocarbon dates on mammoth are available

digging by carnivores, mean that the apparent stratigraphic position of a specimen can be misleading.

Before 1987, only three British mammoth specimens had been directly dated. The youngest of these, from Cae Gwyn Cave, Clwyd, gave an age of *c* 18,000 BP, but even this is subject to some doubt (see below). Since 1987, a programme of radiocarbon dating, made possible particularly by the AMS system at Oxford University, has increased the list to approximately 20 dates from 11 different localities, so that the British radiocarbon record of mammoth is now the most extensive in Europe. In addition to describing these remains and their ages, I will also mention specimens which have been submitted for analysis but which, because they contained too little collagen or proved to be contaminated, have not been successfully dated. As well as the intrinsic interest of some of these specimens, the record of failed attempts provides a reference for future workers.

A map of sites is given in Figure 7.1, and a chart of all British mammoth dates up to December 1990 in Figure 7.2. All dates are quoted in uncalibrated radiocarbon years BP.

Early and Middle Devensian

Two dates on mammoth in the range 30,000–40,000 BP had previously been obtained, from Oxbow, West Yorkshire, and Little Rissington, Gloucestershire (Fig 7.2). These have been described by

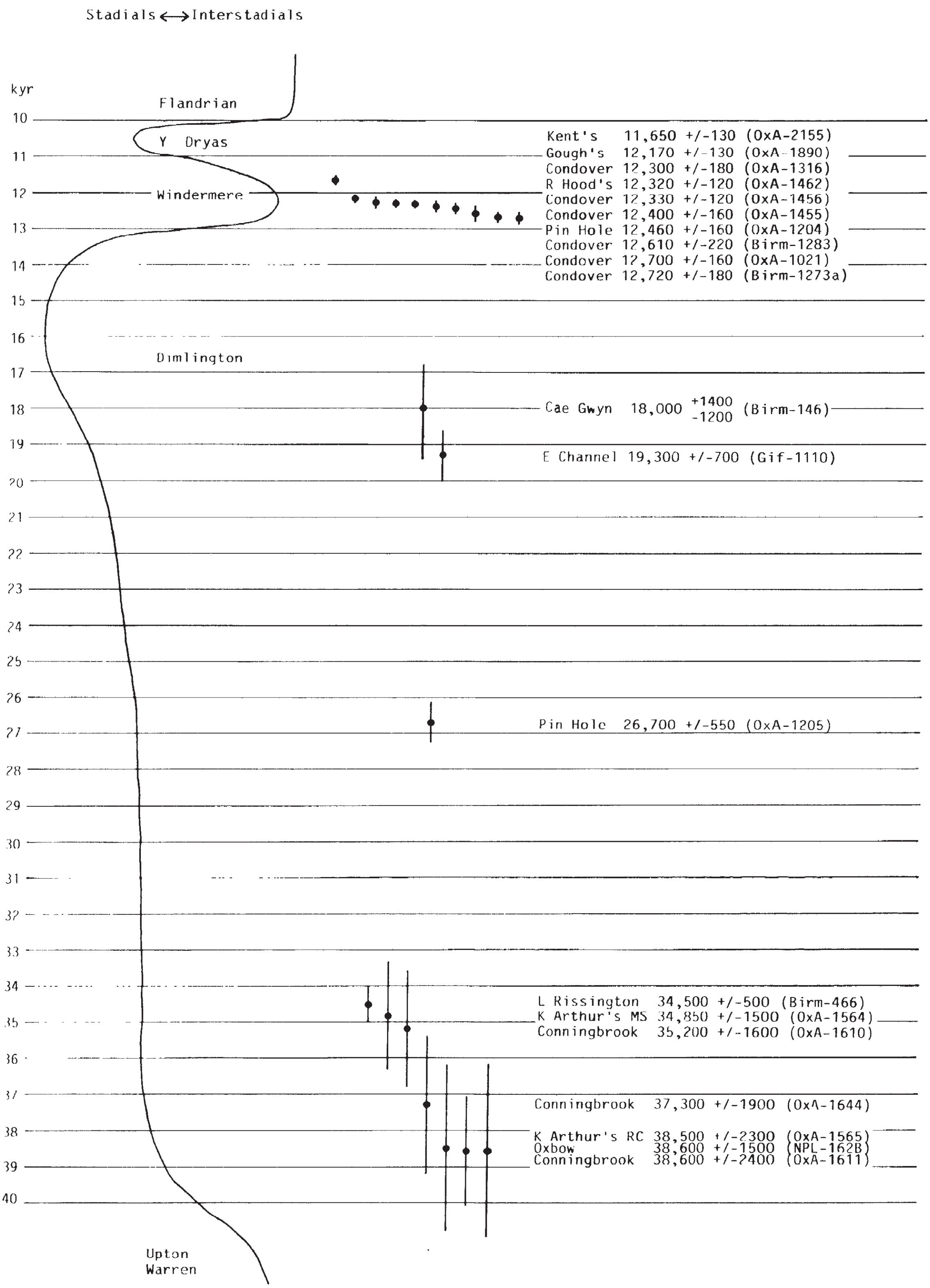

Figure 7.2 The radiocarbon record of mammoth in Britain, at December 1990. A very crude representation of climatic change is indicated, based on Coope (1977) and others

Stuart (1982, 154–5). In addition dates from two further sites in this range have recently been obtained.

King Arthur's Cave, Hereford and Worcester

Excavated by Taylor in the 1920s (Taylor 1928), this cave contained a series of Postglacial and Late Glacial levels, directly underlain by two layers (the 'Mammoth Stratum' and 'Red Clay') with a fauna including a few fragments of *Mammuthus.* Three molar fragments were submitted by the author in association with K Scott and A J Stuart. Their provenance was checked by comparing their numbers with entries in the original catalogue at the University of Bristol Spelaeological Society (C. Hawkes, pers comm). One specimen (Red Clay, UBSS no 954) gave an infinite age; the other two (Mammoth Stratum no 169 and Red Clay no 1185). are listed in Figure 7.2. These results (Hedges *et al* 1989) confirm the Early to Middle Devensian age suspected from associated fauna and artefacts,

Conningbrook, Kent

Abundant mammoth remains have been recovered from this commercial gravel quarry by Dr D L Harrison. Three dates obtained on a single mammoth bone (Hedges *et al* 1989) are listed in Figure 7.2.

Paviland Cave, West Glamorgan

This cave, excavated by Buckland (1823) and Sollas (1913), yielded a famous human skeleton which became known as the 'Red Lady'. Apparently restricted to the area of the skeleton, and closely associated with it, were a quantity of objects worked from mammoth ivory, and some unworked mammoth tusk and skull. A first age determination on the human skeleton of 18,460±340 BP (BM-374) suggested that the mammoth remains, if contemporary, might demonstrate an interesting presence of the species close to the start of the main Devensian ice advance. Two specimens were submitted to the Oxford laboratory by the author in association with P McComb. The first was taken from an ivory 'smoother' (Sollas 1913, pl 21, fig 1; Univ Mus Oxford no S.5077); the second from a pathological piece of tusk which refits to a natural ovoid of ivory which had been worked into a pendant (Sollas 1913, pl 21, fig 3; Univ Mus Oxford). It was hoped thereby both to date the record of mammoth, and to test the contemporaneity of the worked ivory with the skeleton. Unfortunately, the specimens proved both to be irretrievably contaminated with preservative, and to contain too little collagen for dating (R. Housley, pers comm). However, a new date on the human skeleton (26,350±550 BP: OxA-1815 (Hedges *et al* 1989)) suggests that the mammoth ivory, if contemporary, is older than previously believed.

Pin Hole, Derbyshire

Pin Hole, part of the Creswell Crags, was excavated by Armstrong in the 1920s and 1930s (Jenkinson 1984). Material preserved at Manchester Museum retains locational information allowing some reconstruction of cave stratigraphy. A foot-bone of mammoth identified by A P Currant and submitted by R M Jacobi gave a late Middle Devensian age shown in Figure 7.2. The fossil came from an interface between Early/Middle Devensian and Late Glacial layers (Hedges *et al* 1988).

Cae Gwyn Cave, Clwyd

A cave system in the Vale of Clwyd including Cae Gwyn and Ffynnon Bueno Caves was excavated by Hicks (1886). In Cae Gwyn, an ossiferous cave earth was overlain by a considerable thickness of tills and other glacial deposits. Rowlands (1971) obtained a date of 18,000+1400/-1200 BP (Birm-146) on a carpal bone of mammoth from the cave earth, and argued that this provided a maximum age for the Late Devensian Irish Sea ice advance which deposited the tills. To check this important late record of mammoth, a partial molar from Cae Gwyn (British Geological Survey, no 1356) was submitted to the Oxford laboratory by the author. Unfortunately, the specimen proved to have very low collagen content, so dating was not attempted, since any result would have been too prone to influence by proteins absorbed from the sediment (R. Housley, pers comm). It is suggested that for similar reasons the previous dating may itself be too young, since Rowlands (1971) states that bone collagen was very low and several attempts were required before a date was obtained. This youngest record of mammoth in Britain before the main ice advance therefore has to be treated with caution.

Late Glacial

Condover, Shropshire

The discovery in 1986 of four mammoth skeletons (one adult, three juvenile) in a kettle-hole at Norton Farm Pit, Condover, provided the first evidence of mammoth in the Late Glacial of Britain (Fig 7.3). The kettle-hole stratigraphy itself suggested that the remains post-dated the main ice advance (Coope & Lister 1987), and this was corroborated by a series of conventional and accelerator

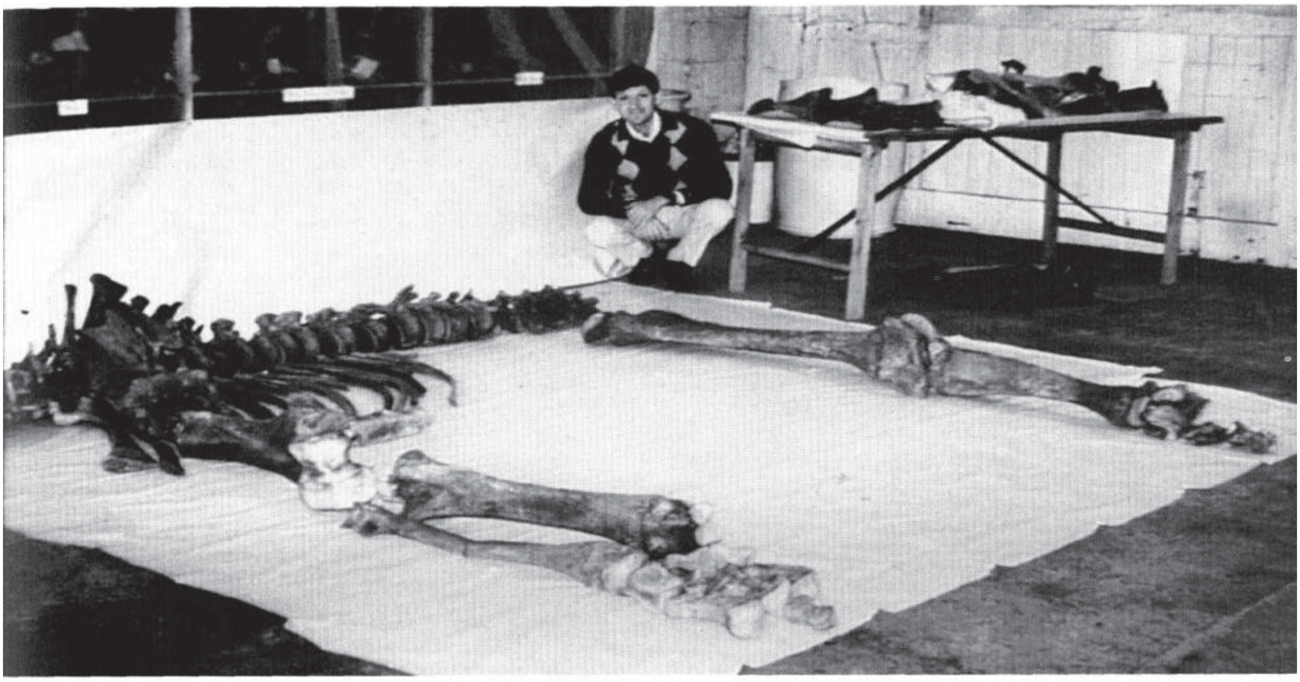

Figure 7.3 Part of the complete adult mammoth skeleton discovered at Condover, Shropshire, in 1986

radiocarbon dates listed in Figure 7.2. Five dates on adult tusk and molar enamel give a range (central values) of 12,720 to 12,300 BP, with a combined date of 12,480±96 BP; one on juvenile molar enamel gave a central value of 12,330 BP (Hedges *et al* 1989). These dates indicate an age in the first part of the Late Glacial interstadial or interstadial complex. The values obtained for the adult are instructive in illustrating the range possible from a single animal, and the necessity of taking full account of error ranges when interpreting a single radiocarbon determination.

Pin Hole, Derbyshire

A mammoth calcaneum from the upper layers of the cave, identified by A P Currant and submitted in 1987 by R M Jacobi, gave a date (Fig 7.2) of Late Glacial interstadial age, very close to the combined date for the Condover adult (Hedges *et al* 1988), and providing additional evidence of mammoth in Late Glacial Britain.

Robin Hood's Cave, Derbyshire

Robin Hood's Cave, Creswell Crags, was excavated by Mello (1876) and Campbell (1977). Breccia deposits yielded many Late Palaeolithic artefacts and faunal remains, especially mountain hare. Small pieces of mammoth ivory, trapped within a block of breccia in the British Museum collection (no +7969; Fig 7.4) were identified and submitted for dating by J Cook. The resulting date (Fig 7.2), within the Late Glacial interstadial, is close to those from Pin Hole and Condover, and is also consistent with dates obtained on cut hare bones from Robin Hood's Cave. The ivory is apparently unworked (Hedges *et al* 1989).

Kent's Cavern, Devon

Extensive deposits at Kent's Cavern were excavated in the 1860s by Pengelly, who kept careful records of the location of each of his finds. A worked ivory rod *c* 20 cm long by 1 cm wide (Torquay Museum; Fig 7.5) bears Pengelly's number 1963, which by reference to his diaries, indicates that it was found in the 'Black Band'. This was a palimpsest of hearths, 0–2 m thick, occurring in the upper part of the cave earth sequence in the 'Vestibule', an area of the cave near its northern extremity. Subsequent studies on artefacts from the 'Black Band' indicate a Late Upper Palaeolithic industry, and several radiocarbon dates on faunal remains are in the range 15,000–11,000 BP (Campbell & Sampson 1972; and more recent results). The ivory rod was

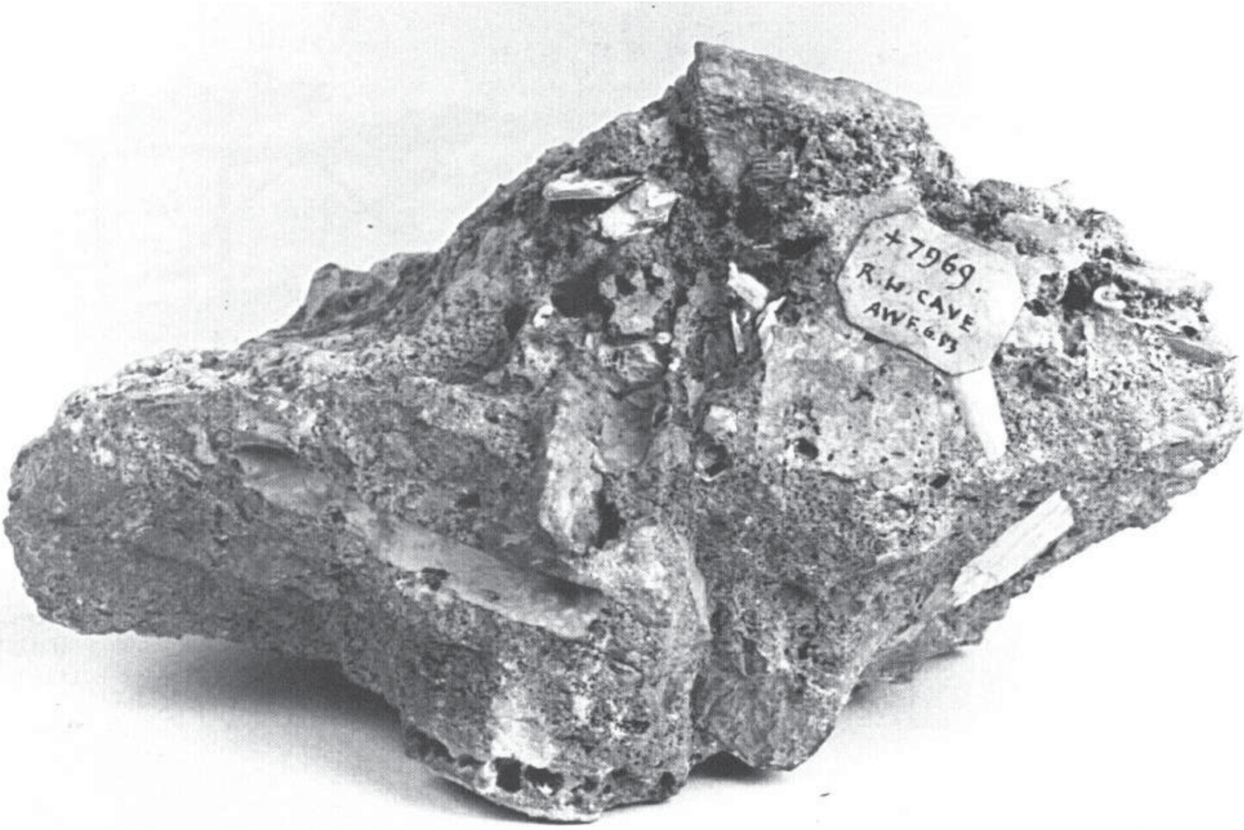

Figure 7.4 Block of Breccia from Robin Hood's Cave, Derbyshire, enclosing hare bones and mammoth ivory. Two pieces of ivory are visible toward the right of the picture. Photograph courtesy of Jill Cook, reproduced by permission of the Trustees of the British Museum

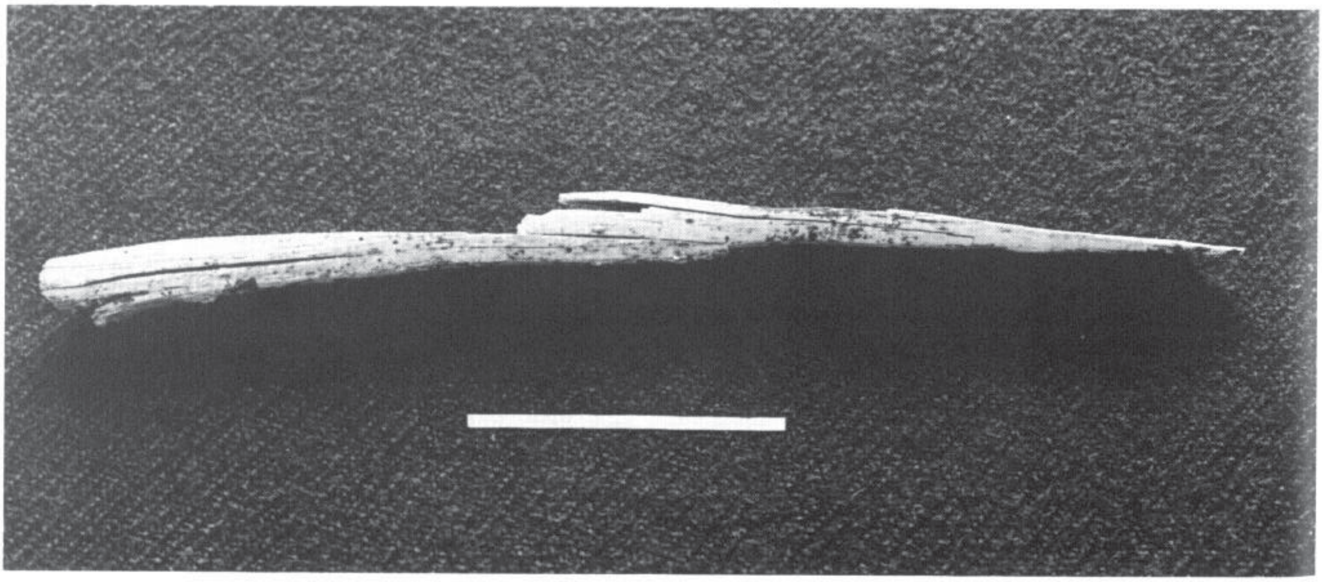

Figure 7.5 Worked ivory rod from the Black Band at Kent's Cavern, Devon. Torquay Museum, Pengelly collection no 1963. Scale bar is 5cm long

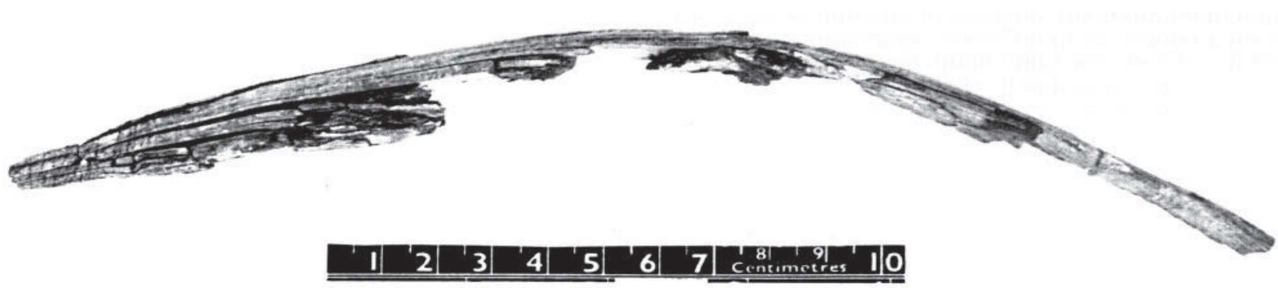

Figure 7.6 Worked ivory rod found at Gough's Cave, Somerset, in 1987, from Currant et al 1989, *fig 2. Reproduced by permission of the Trustees of the British Museum*

sampled by re-opening an old join, cleaning the exposed surfaces, and removing 0.25 g of ivory before re-assembling. The sample was submitted by the author for dating at the Oxford laboratory, where it was given extended chemical cleaning to produce pure collagen, and a date centred at 11,650 BP obtained (Fig 7.2). Some caution attaches to this figure, since it is conceivable that a small amount of fish glue, indistinguishable chemically from mammalian collagen, might have contaminated the sample. Contamination by a few percent would have made the date several hundred or even a few thousand years too young (R. Housley pers comm). Nonetheless, I believe the care taken with sampling makes an error greater than this unlikely, so that although the date should be regarded as a minimum, it can still be taken as evidence that the Kent's Cavern ivory was contemporaneous with the Black Band in which it was found, and unlikely to have been derived from more ancient tusk.

Gough's Cave, Somerset

Gough's Cave, Cheddar, was excavated in 25 six-inch (15 cm) layers by Parry (1929). Within layer 12 he discovered a fragmented ivory rod *c* 14 cm long *(op cit,* 113), now conserved at the Cheddar Museum. A small piece of ivory (0.25 g) was removed from the specimen, and submitted to the Oxford laboratory. A date of *c* 9000 BP was obtained, but it was clear from the pre-treatment that the sample was contaminated, and with such a small amount of material could not be submitted to more thorough chemical cleaning (R. Housley, pers comm). In 1987, renewed excavations were undertaken in cave earth filling a small fissure on the north side of the cave. These resulted in the discovery by A P Currant of a further ivory rod, fragmented but in fresh condition. The specimen (Fig 7.6), *c* 25 cm long, is believed to be a weapon head ('sagaie'), and was found in association with human remains, Late Glacial artefacts and fauna (Currant *et al 1989).* It is now conserved at the British Museum, and untreated fragments submitted for dating produced an age centred at 12,170 BP (Hedges *et al* 1990; Fig 7.2) falling within the range of a series of other faunal dates from Gough's Cave (Currant 1986).

Discussion

The radiocarbon record of mammoth available for Britain (Fig 7.2) now allows some discussion of the pattern of occurrence of the species through the Last Cold Stage. First, the clutch of dates between 40,000–30,000 BP implies Middle Devensian occurrence, although these dates should be treated with caution as they are close to the limit of effective radiocarbon dating, and it is likely that at least some of the specimens may be considerably older than the radiocarbon measurements suggest. These dates are therefore most safely regarded as undivided Early to Middle Devensian. This period included several important temperate episodes, as well as intervening phases of more typical 'cold stage' conditions (Coope 1977; Behre 1989). However, because of the uncertainty of dating, the environment of the mammoths is difficult to reconstruct. This group of sites is representative of a large number of British deposits, mostly cave sediments or glacial outwash gravels, which have yielded a fauna including mammoth, woolly rhinoceros *(Coelodonta antiquitatis)* and spotted hyaena *(Crocuta crocuta),* and an industry, where present, of Middle or early Upper Palaeolithic aspect (Stuart 1982; 1983). Mammoth remains are often abundant, and in the caves are predominantly of juvenile individuals which frequently show signs of hyaena accumulation.

The interval from 30,000–18,000 BP includes only two dates (Fig 7.2): one from Pin Hole, the other from a specimen dredged from the English Channel (Delibrias *et al* 1971). It cannot be stated at this stage whether this paucity represents infrequency of occurrence of the species in Britain; it may well be an artefact of insufficient sampling. Mammoth remains from two additional sites which may fall into this age range are currently being prepared for dating: from Pentney, Norfolk (Ventris 1985), and the Lea Valley Arctic Bed (Warren 1912) (samples submitted by the author and Dr A J Stuart).

The interval between *c* 18,000 and 13,000 BP represents the coldest part of the Devensian, and included the main ice advance. The very interesting date from Cae Gwyn Cave, which apparently indicated presence of mammoth just before or at the beginning of this phase, now has to be treated with caution as explained above. Similarly, the apparent presence of mammoth around this time suggested by the Paviland remains now needs revision. The lack of any unequivocally dated mammoth remains in the 18,000–13,000 BP interval remains striking, however, and may well indicate that mammoth was absent from Britain for much of this time, as a result of severe climate and reduced vegetation. A collation of radiocarbon dates from elsewhere in northern and central Europe (Stuart, in prep) indicates a similar hiatus in mammoth occurrence between 18,000 and 15,000 BP, with only a few records 15,000–13,000 BP

Before 1986, the available evidence suggested that mammoth did not return to Britain after the main ice advance (Stuart 1982; 1983). The discovery of the Condover skeletons has shown beyond doubt that this is not the case, and this has received support from the postcranial bone dated from Pin Hole. The records from Gough's Cave, Robin Hood's Cave and Kent's Cavern, on the other hand, are based on tusk (ivory), which as a valuable resource might have been imported into Britain from the continent (R. Jacobi, pers comm). They therefore do not unequivocally pertain to endogenous British mammoths. However, since the Condover and Pin Hole dates indicate that mammoths were available in Britain at the time, the ivory from the other sites could in principle have been native. The dating of the worked ivory specimens from Gough's Cave and Kent's Cavern also provides a minimum age for the ivory working itself. Further, since these dates are consistent with all other indicators of age in their respective horizons, and overlap the known human occupation of Britain, it seems clear that these pieces of ivory at least were not excavated as fossil by the human occupants, but came from either contemporary mammoths, or at most subfossil tusk. There is no evidence that mammoth was being hunted, however, and the very small quantity of mammoth material from the human occupation horizons is striking.

With the possible exception of the Kent's Cavern ivory, none of the British dates is younger than 12,000 BP, and this corresponds precisely with the record for the rest of northern and central Europe, where the youngest directly dated mammoth fossil, from Etiolles, France, is dated at 12,000±220 BP (Ly-1351; Evin *et al* 1979). Thus, Late Glacial mammoths in Europe appear restricted to the earlier, Bølling phase of the Late Glacial interstadial, and to have died out by the later, Allerød phase. In North America and Siberia, and possibly in Soviet Europe, extinction occurred some one to two thousand years later (Stuart, in prep).

Although the presence of mammoths in Late Glacial Europe is well established, the paucity of their remains is striking in comparison with their abundance in the Early and Middle Devensian. The record from Etiolles remains one of only three dated mammoth fossils from northern and central continental Europe in the range 13,000–12,000 BP. A few other sites, while they lack directly dated remains, provide strong circumstantial evidence for the presence of mammoths. At Gönnersdorf, Germany, bones and engravings of mammoths occur in an occupation horizon dated to *c* 12,500 BP (Bosinski 1981), and several of the parietal illustrations of mammoths in French caves may well date from the Late Glacial period. Nonetheless, relative to the total number of known sites, the impression is that mammoth remains are rare in Late Glacial Europe. There are two possible explanations for this. The first is a shortage of accumulating agents, in particular the absence of spotted hyaena in Europe after the main ice advance, which may largely explain the paucity of mammoth remains in cave deposits. Alternatively, or in addition, it may well be that mammoth was a genuinely rarer species in the Late Glacial than previously. It is very likely that the main ice advance 18,000–13,000 BP reduced the size of mammoth populations in Europe, probably squeezing them into southern or eastern refugia. It is possible that subsequently, population sizes never fully recovered. Mammoths in the Late Glacial were thus more vulnerable to whatever was the combination of human pressure and climatic change which resulted in their final extinction.

Acknowledgements

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Part 2: Classic Late Glacial hunting economies: regional variations and subsistence strategies

8 Subsistence strategies and economy in the Magdalenian of the Paris Basin, France

Françoise Audouze and James Enloe

Abstract

Reindeer hunters' settlements of the Paris Basin are studied in the light of the distinction drawn by L R Binford between 'logistical collecting' and 'foraging' as hunter-gatherer subsistence strategies. Particular reference is made to the sites of Pincevent and Verberie. The settlements themselves, in their location and layout, as well as in the artefacts found there, offer evidence relating to the hunting strategies that were used. The authors also consider various kinds of archaeological evidence relating to the processing of the hunted reindeer. Other resources important to the Magdalenian population are briefly studied, notably flint and shells, which were obtained locally.

Introduction

As flint procurement strategy and transformation and use processes in the Magdalenian of the Paris Basin (MPB) have already been discussed at the recent Liège and Chancelade symposia, this paper will be mostly dedicated to hunting and food consumption strategies with some consideration of their relations with other procurement strategies.

For years, faunal assemblages were considered as being informative only of the last stages of food consumption. It is only recently, with the developments made in taphonomy and ethnoarchaeology, that it became clear that they also reflect the earlier stages of procurement strategies. All stages from hunting to food preparation are linked as parts of a *chaîne opératoire* chosen according to the external conditions and the goals looked for. Reconstructing some of these *chaînes opératoires* may be achieved by applying appropriate ethnoarchaeological models to the data.

A model for studying reindeer hunting

Reindeer is the major game species in the MPB, illustrating once again the name given to the Magdalenian in the earliest days of prehistory *l'Age du Renne*. This species, which plays an important role in the Magdalenian economy, provides us with a special window on the organisation of prehistoric subsistence economy.

Binford (1980) proposes a very useful heuristic approach for studying the organisation of hunter/gatherer subsistence, stressing the contrast between foraging and logistical collecting. The former is characterised by high residential mobility, encounter hunting and immediate consumption, while the latter is characterised by lower residential mobility, planned hunts of larger numbers of animals, and storage for long-term consumption.

Reindeer *(Rangifer tarandus)* can be hunted in a variety of ways (Burch 1972; Spiess 1979). One is the opportunistic encounter of single animals or small groups on their summer or winter ranges, such as any other territorial game. Another is the mass kill of larger numbers of animals during the spring or autumn migrations. Thus the availability of reindeer as a resource for hunters depends on how they position themselves in the landscape relative to the migration pattern of the reindeer herds. Further, the economic organisation of subsistence for the acquisition, processing and consumption of meat will be largely determined by that landscape position. For example, a group of hunter/gatherers such as the Netsilik Eskimo (Balikci 1970) on the northern tundra has access to herds during the summer. At that time, the herds are broken down into small bull or cow/calf bands which are widely dispersed so that hunter/prey encounters tend to be opportunistic and unpredictable over time and space.

An appropriate strategy for increasing the probability of encounter is the dispersal of hunters in small bands and individual hunts over a large territory, precluding larger scale cooperative hunting. The likelihood that all hunters from a given camp would be simultaneously successful is small, so that successive reciprocity in game sharing provides a buffer against variable success rates. Further, the quantity of game brought into a camp at any one time should be relatively small, and meat can be consumed immediately. The same

Table 8.1

Sites	Location	Faunal *Quantity*	remains *Diversity*	Lithic production	Spatial organisation	Hearth shape
Etiolles	valley	scarce	diversified	blades	central hearth	flat
Marsangy N19	valley	scarce	diversified	blades	central hearth	flat
Marsangy	valley	scarce	diversified	tools	asymmetric	flat
Pincevent	valley	abundant	reindeer	tools	asymmetric	hollow
Verberie	valley	abundant	reindeer	tools	asymmetric	hollow
Ville-St-Jacques	plateau	abundant	diversified	tools	?	?

patterns of game availability, and of acquisition and consumption, should also characterise human groups occupying the winter range of *Rangifer*.

Migration is not necessarily a fixed behaviour, but is rather a function of reindeer population density, which varies cyclically like that of many species inhabiting climates of severe seasonality (eg lemmings). Under very low densities, the herd will stay in the core area year-round (Hemmings 1971; Skoog 1968). Here also, exploitation patterns should resemble foraging.

Under increasing population density, reindeer migration distance will increase proportionately (Hemmings 1975). It is specifically the phenomenon of migration that offers hunters the opportunity for an additional pattern of exploitation. With a potential large quantity of a resource available at a predictable time and place, a suitable labour force can be organised to take advantage of it. In the autumn in particular, the herd is at its nutritional and weight peak, and can supply substantial quantities of a high-quality, fat-rich, storable resource for over-wintering. This pattern of logistical collecting can be illustrated by the Nunamiut Eskimos (Gubser 1965; Binford 1978).

This model, like all models, is oversimplified. It stresses polar extremes between patterns of exploitation of the same resource. In reality, the ethnographic cases are more complex than the model, with the acquisition of numerous different resources dictating a more complicated organisation of subsistence economy. We should expect archaeological cases to exhibit similar sorts of complexity. The model serves only as a guide to investigate the organisational mix of subsistence activities.

Variability among the types of settlements of the MPB

The variability among the types of settlements of the MPB illustrates the complexity referred to above. The variations are not only concerned with the hunted game, but also with the location of the sites, the type of flint industry, and the spatial organisation when it is known. We may propose three categories of settlements in the MPB (Table 8.1).

1 Settlements located near the river, with low quantities of a diverse fauna, intense knapping activities, flat hearths, and a symmetrical spatial organisation. Etiolles is the most representative site of this type. Most of the occupation units have a central flat hearth. Large numbers of blades are produced around and close to the hearths (Taborin 1984; Pigeot 1987; Olive 1988; Julien *et al* 1988; Audouze *et al* 1988). One of the units from the site of Marsangy with a technical rather than domestic function also conforms to this pattern. However the two other occupation units have an asymmetrical configuration with an emphasis on tool production. The faunal remains (reindeer, horse and deer) are scarce (Schmider 1984).

2 Settlements located near the river, with numerous reindeer remains, a high proportion of flint tools, hollow *(creusé)* hearths, and asymmetrical spatial organisation. Both Pincevent and Verberie fit this definition. The main hearths are located outside a hut or a windbreak. They are hollow, with or without a stone lining. Lithic production focuses on tool manufacture, with most blades being immediately retouched or used (Julien *et al* 1988; Audouze *et al* 1988; Audouze 1987a). Thousands of reindeer bone fragments are scattered in the toss areas (Audouze 1988; Enloe & David 1989). With a spatial organisation conforming to this pattern but with a diversified and scarce fauna, the occupation units of Marsangy seem to be intermediate between this type and the previous one (Schmider 1984).

3 Settlements located on the edge of the plateau, rich in remains of a diversified game, and where flint tools are extremely abundant. This type of site is less well known. Sites on the plateau have been much more damaged by ploughing than the sites in the valley covered with silt.

Only one settlement fully enters this category: Ville-Saint-Jacques, known from a few trial trenches. Here, thousands of tools and a rich fauna, including reindeer and horse plus bear, polecat and wolf have been uncovered (Brézillon 1971; Valentin 1988; Degros *et al* in prep).

Though there is no indication about the fauna, there exists at least one other site located on the edge of the plateau which is characterised by the extreme abundance of tools: les Gros-Monts in the woods of Beauregard above the Loing Valley (Schmider 1971; 1982). The lack of information concerning the fauna and the spatial organisation of other sites prevents us from including them in one or the other of the categories.

If the model completely fits the data — and this remains to be proven — sites with diversified game can be considered as summer and winter sites, and those with numerous reindeers as autumn sites. It is possible to find some more variability, though of a lesser degree, between the two sites corresponding to the category dedicated to reindeer hunting (Pincevent & Verberie). This indicates an adaptation to different conditions and goals.

Reindeer hunting

Clearly, reindeer hunting in the MPB can be referred to as logistical collecting. Remains of dozens of reindeer are found in the different settlement units at Pincevent as at Verberie. The MNI (Minimum Number of Individuals) is 43 for Section 36, and 12 for Habitation 1 at Pincevent. A provisional MN1 for level 1 at Verberie is 24.

However, reindeer bones in quantity do not automatically reflect logistical collecting. This is evidenced at the site of Le Flageolet in the Dordogne (Rigaud 1982). In couche 5, an Upper Perigordian level, there is a predominance of reindeer in the fauna, which accounts for more than 95% of the identified specimens (Delpech 1975). Here the subsistence organisation seems to be more similar to that of foragers than to that of logistical collectors. Kills are distributed throughout the winter, when it would be difficult to find and kill a large number of reindeer at one time. The age distribution is dominated by prime adults, suggesting selection of individuals to be killed. At Le Flageolet although males are present, females appear to be more numerous, which is consistent with individual encounter hunting in the winter, due to their superior nutritional state after the rut. Element representation indicates a consumption location, with a heavy bias for meat and marrow utility. The removal of low utility (but usually well-preserved) parts from amongst parts of higher utility suggests deliberate body part selection or culling for transport. Cutmark locations are biased heavily in favour of skinning and disarticulation. There are no indications of planned logistical procurement in terms of hunting, processing or consumption. Although there is an overwhelming predominance of a single species, that appears to be due to climatic factors controlling availability, rather than a planned mass kill of a target species (Enloe, in press).

Conversely, three features characterising reindeer hunting at Pincevent and Verberie, along with the great number of individuals killed, point toward a logistical hunting strategy: the season of the hunt, the proximity of the kill site(s), and the parts of the game brought back to camp.

The toothwear for the one and two year old individuals indicates that the kill took place during the autumn at both sites, within a few weeks and a little later at Verberie than at Pincevent. The large size of the kill and the season point towards a hunt related to the autumn migration (at least at Verberie) (David, in press).

Both camps are presumably located a short distance from the kill sites, since all elements of the animals can be found at the campsites: vertebrae, phalanges and sternum are particularly good indicators of this. However, Pincevent and Verberie exhibit an important difference in the pattern of remains (see below): whereas at Verberie vertebrae are very common, there is a notable deficiency of them at Pincevent (9% of the amount one could expect from an MNI of 43 in section 36, and less than 1% for Habitation 1). In the latter case, we may infer that the primary butchering activity did not take place *in situ* but at a nearby kill site where the vertebrae had presumably been discarded.

The age distribution curve at Pincevent indicates a bias toward adults as compared to a natural population curve (cf Le Flageolet). At Verberie, this bias does not seem to exist or is less important since there are also remains of fawns in levels 1 and 3.

The contrast between Le Flageolet and the two MPB sites suggests the differences between foraging and logistical collecting. Two factors may be involved, seasonal and chronological.

Reindeer processing

Butchering activities

A model for reindeer butchering derived from his studies on the Nunamiut has been provided by L Binford (1983, 170) and applies very clearly to the Verberie settlement (Audouze 1987a). The butchering activity area is defined by a circular space occupied by the animal and the hunter moving around it for dismembering purposes, and by the pattern of discarded elements surrounding this area. In archaeological terms, this activity is characterised by an empty space surrounded by bones, corresponding to primary refuse (Binford 1983, 169–72, fig 109). Some empty circular areas, similar to but smaller than the Nunamiut ones, can be found mid- distance between the two hearths of Verberie (Audouze 1987b). They are surrounded by

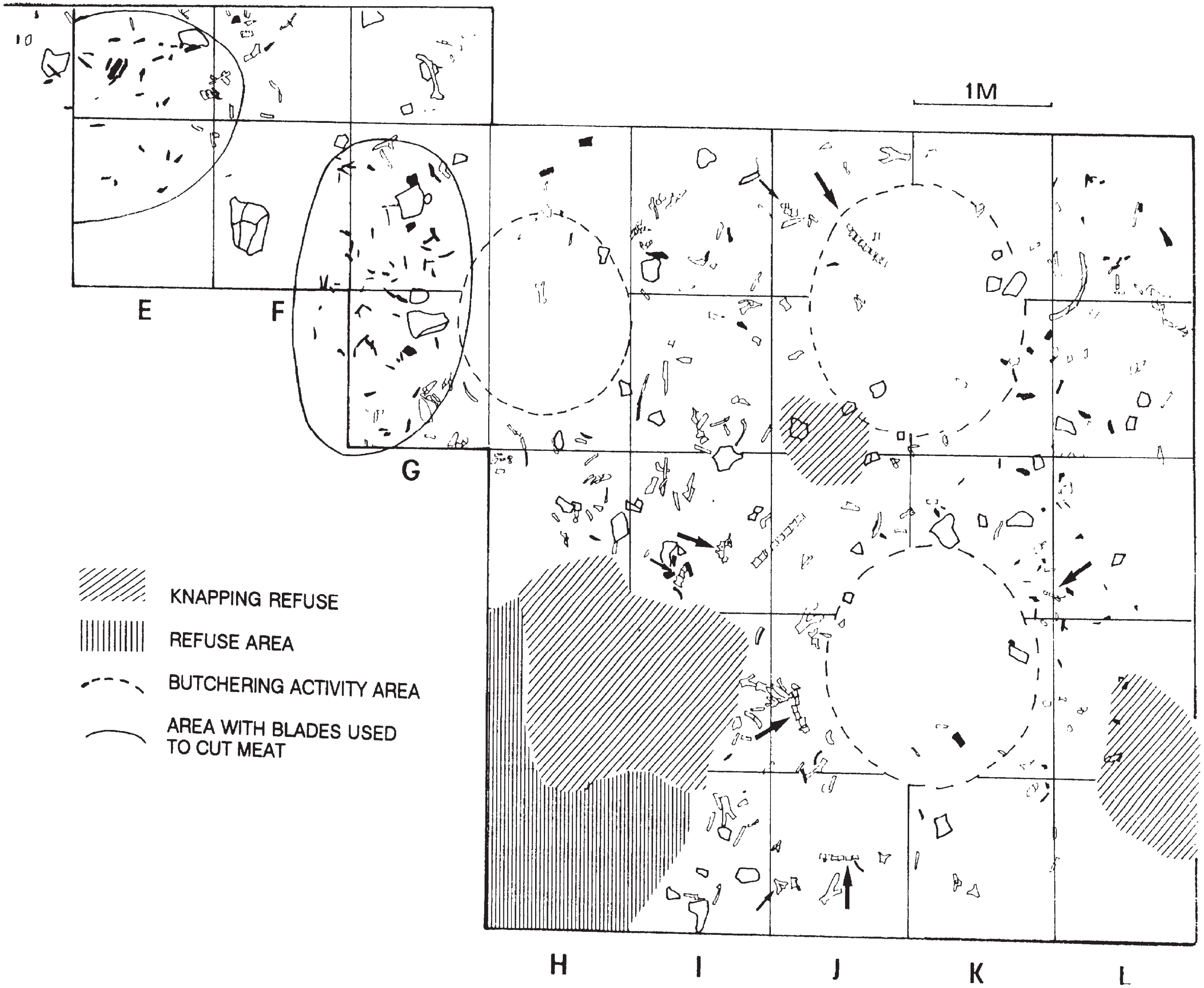


Figure 8.1 Butchering activity areas at Verberie. Empty circular spaces are surrounded by bones rejected early in the butchery process: vertebrae, sternum, coccyx, metacarpals and metatarsals (arrows indicate vertebrae and coccyx)

characteristic faunal remains which were left on the spot because they are of little use in terms of either meat or marrow: articulated vertebrae, sternum and coccyx, tarsus and carpus. Other bones are removed to other parts of the camp or placed near the hearth depending on their meat value or marrow content (Fig 8.1). Such butchering areas have not been identified at Pincevent. Their absence is consistent with the lack of vertebrae and confirms the difference in strategy at Pincevent and Verberie.

In several cases at Verberie, ribs are broken close to their proximal end which is left in connection with the vertebrae. This technique finds parallels among the Nunamiut where ribs are removed in slabs (Binford 1978, 54–60; 1983, 142–7).

Uses: consumption of meat and marrow

At Pincevent, element representation indicates local consumption, particularly of meat and marrow (special selection or culling for transport?) Most cutmark locations on the bones in both sites are biased in favour of skinning and disarticulation. Cutmarks at Pincevent also indicate meat removal.

The primary use made of reindeer was, of course, nutritional. The autumn hunts indicated by the dental eruption sequences at Pincevent and Verberie would be designed to exploit the prey in its best condition of the entire year. The summer forage would have fattened up the herd to its maximum annual weight, and even more importantly, to its highest fat content. Both meat and marrow are important for the diets of reindeer hunters. Speth and Spielmann's arguments (1983) about the desirability of fat in the diet are particularly pertinent for cold climate hunter/gatherers in the winter. The fat in marrow can supply twice as many calories per gram as protein can, and can allow efficient metabolism of the protein from meat. There are no whole bones in the faunal assemblages from Pincevent or Verberie. There are abundant impact fractures, systematically placed to open the medullary cavities for the extraction of marrow.

Meat consumption patterns appear to be more complex at Pincevent (Enloe & David 1989). Refitting of fragmented bones, of articulations, and of left-right bisymmetrical pairs can reconstruct portions of scattered individuals. Distribution of portions of individual carcasses indicate food sharing between domestic units. The right forelimb of one individual is associated with the debris from hearth V-105, while the left forelimb is associated with that of hearth T-112 (Fig 8.2a). Eight other individuals were also shared between these two hearths. Examination of the distribution of left and right pairs of hindlimb elements emphasises the amount of interaction between V-105 and T-112, but also includes hearth L-115 in limited interaction with both of them (Fig 8.2b). Distribution of metacarpal pairs gives an even clearer insight into the complexity of food sharing. While the upper portions of forelimbs which could be matched generally indicate partitioning or sharing of carcasses, the non-meaty lower portions of the forelimbs can be generally paired together beside the same hearth, suggesting that meat rather than marrow was moving between domestic units (Fig 8.2c). As Gubser (1965, 82) noted for the Nunamiut, 'A gift should be a good piece of meat, with fat on it if possible'.

Preservation for storage

Although no cache has yet been found, some data about the reindeer ribs may indicate storage processing; In both sites there exists a very marked deficiency in ribs against the MNI. However, at Verberie, the proximal ends of rib bones are comparatively numerous in the assemblage (around 30% of the preserved ribs), indicating that distal ends may have been deliberately taken away (unless they were completely destroyed). This fact, taken with the abundance of cutmarks left by meat removal, may be an indication of the processing of meat for storage (Fig 8.3).

Other uses

Reindeer not only provides meat and fat but also bones and hide which are intensively used for tools, ornaments, clothing and the construction of dwellings. Hide working is evidenced through microwear analysis (Keeley 1983, and in Audouze *et al* 1981; Plisson 1985; 1987; Symens 1986; Moss 1983). It is an important activity at Pincevent performed on both fresh and dry hide with a wide variety of tools (Plisson 1985), but is less notable at Verberie where Keeley found more traces of use on fresh hide than dry hide (perhaps indicating the first stages of the process).

Antler and bone working are known by the presence of some working debris: baguette (splinter) extraction from antlers, broken sagaies and needles. We also have some evidence of bone-working and hafting through microwear analysis (Keeley 1987).

Other nutritional resources

Though hunter-gatherers may rely solely on meat resources for short periods, they usually use complementary resources which provide other nutritional components. The lack of palaeobotanical remains deprive us of any indication on plant-food collecting. The only indirect data come from microwear analysis, which shows that less than 4% of the Verberie tools have been used for working

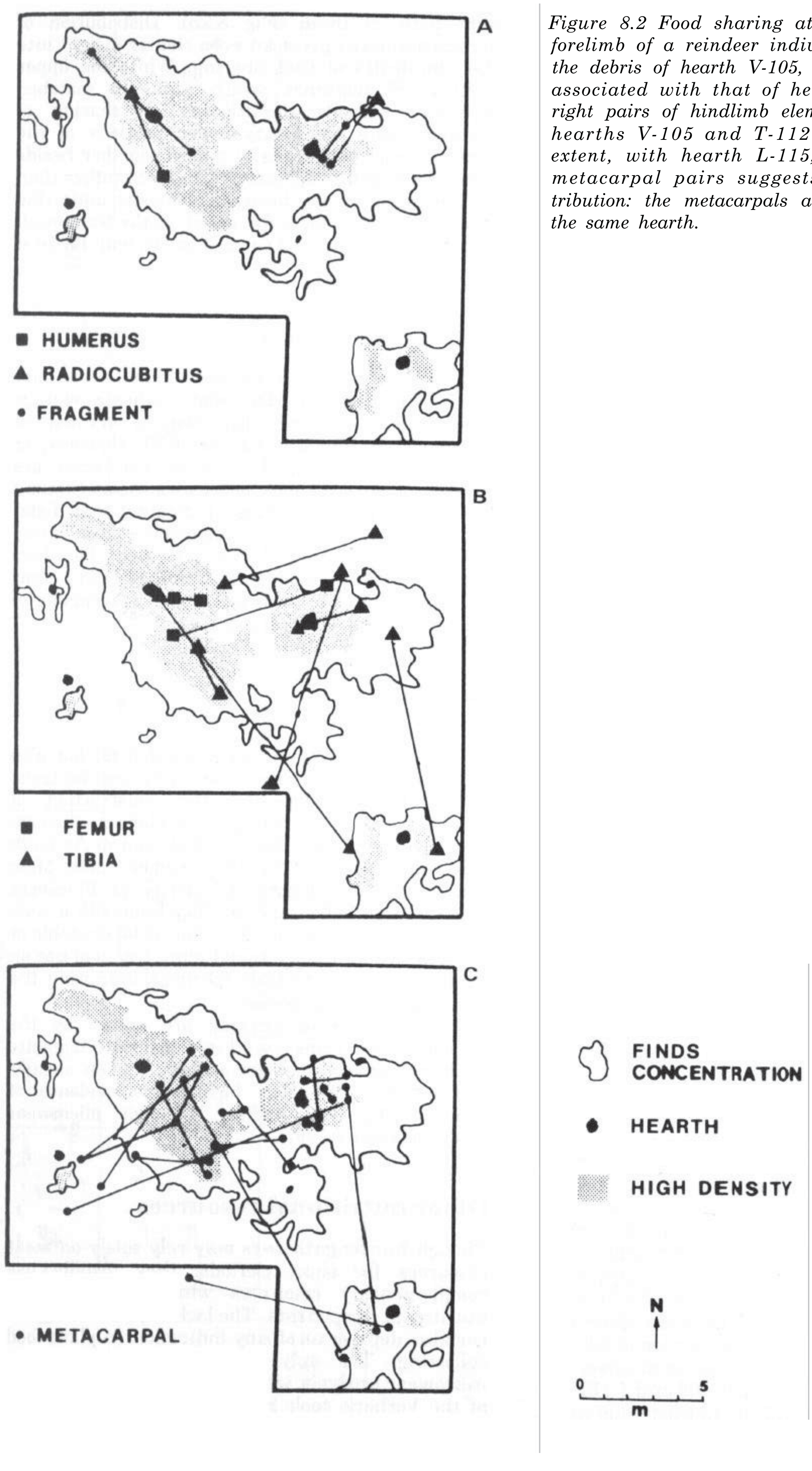
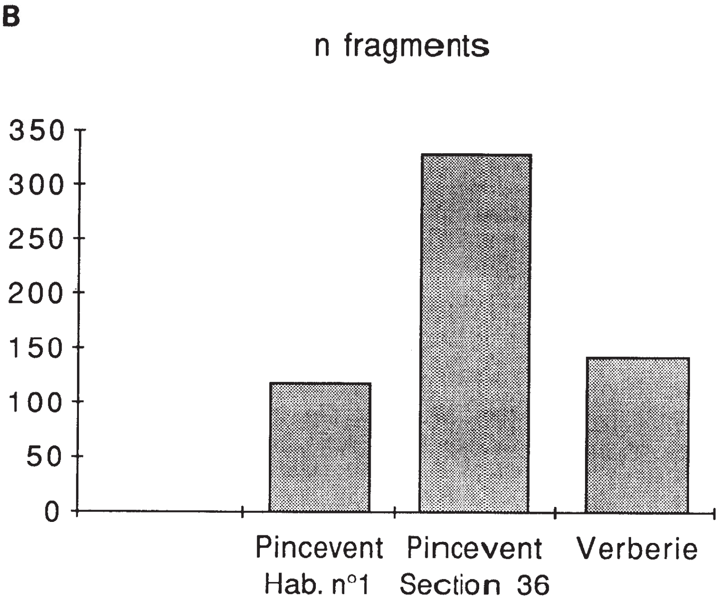


Figure 8.2 Food sharing at Pincevent: A) the right forelimb of a reindeer individual is associated with the debris of hearth V-105, while the left forelimb is associated with that of hearth T-112; B) left and right pairs of hindlimb elements are shared between hearths V-105 and T-112 but also, to a limited extent, with hearth L-115; C) the distribution of metacarpal pairs suggests another kind of distribution: the metacarpals are paired together beside the same hearth.

A

	n fragments	MNI	expected length in cm	observed length in cm	% observed /expected	proximal frag. /total
Pincevent Hab. n°1	120	12	1500		26,8	
Pincevent Section 36	331	43	4965		24,4	
Verberie	144	20	3000	636	20,2	36/144=25%

B



C

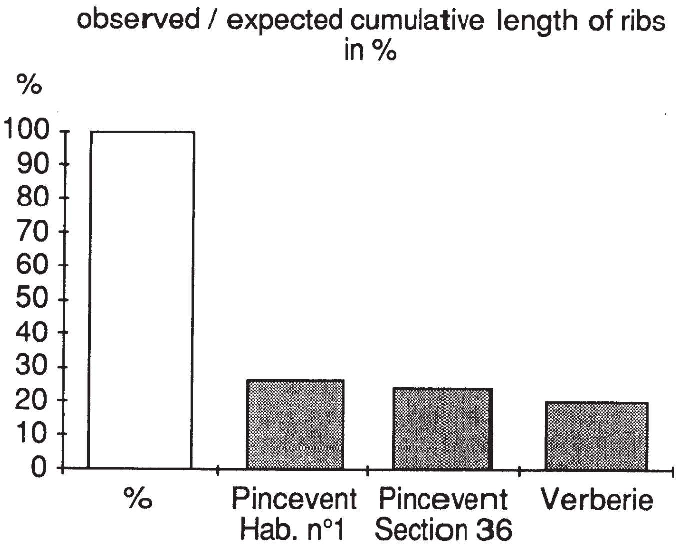


Figure 8.3 Comparative data on rib fragments from Pincevent (Habitation 1 and Section 36) and Verberie: A) MNI and observations on the expected and observed lengths of rib fragments; B) number of rib fragments. C) percentage of remaining ribs. The cumulative total is preferred to the number of fragments because it avoids the effects of fragmentation. Proximal fragments are scarce at Pincevent while they amount to 24% at Verberie.

wood or cutting plants. This is suggestive of an ancillary role for plant foods, but does not take into account the collecting of plants, grains or berries by hand.

At both sites preservation of bone is so good that we may infer from the absence of fish remains that no fishing took place.

Some rodent bones have been found at Pincevent and Verberie. A recent study by P Méniel has identified all Verberie rodent bones as belonging to a ground squirrel *(Spermophilus)*. These faunal remains belong to six individuals in the upper level and seven individuals in level 2. This ground squirrel lives in large groups, is easy to hunt with sticks and provides excellent fat at the end of the summer. Its fur can also be used.

Relations between hunting and the collection of other resources

Flint was, after food, an essential resource and its procurement was organised as an embedded strategy during reindeer hunting in the MPB. In the Paris Basin, chalk and limestone beds have been exposed by the cutting of river valleys, in which excellent to standard flint material can be recovered. Thus, valley bottoms have not only been chosen as favoured hunting grounds along the reindeer migration routes, but also as places for collecting flint material. The preferred locations are intersections between the migration trail and valleys rich in flint. The fact that Pincevent has only low quality local flint, although an excellent source exists within a 30 km radius of the site, indicates the priority given by the Magdalenians here was to hunting. The excellent quality of flint and the exceptional size of nodules at Etiolles, associated with a relative scarcity of game, indicates a reverse priority (Audouze *et al* 1988).

Though many resources, not all of them related to subsistence, must have been essential to the everyday and social life of the Magdalenians, the only other known resource consists of shells for pendants and beads. Most of them are local and all come from the Paris Basin (Y Taborin, pers comm, and in press). Thus the territory indicated by all known resources collected by the Magdalenians of the Paris Basin seems to be restricted to a rather limited area in the centre of the Paris Basin where excellent flint from the Cretaceous and Eocene beds is available in all valleys (Audouze in press).

Acknowledgements

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9 Some new thoughts on old data on humans and reindeer in the Ahrensburgian tunnel valley in Schleswig-Holstein, Germany

Klaus Bokelmann

Abstract

This paper sets out some new ideas on Hamburgian and Ahrensburgian hunting strategies based on evidence excavated half a century ago. It suggests that far from being out of date, the primary data published by Rust and others on their researches in the Ahrensburg tunnel valley can be used successfully to put forward new models and reconstruct hunter-gatherer subsistence patterns in the Late Glacial. In particular the close relationship between humans and reindeer is examined during the contrasting periods of the Meiendorf Interstadial (Balling *sensu lato)* and the Younger Dryas.

Introduction

There are only a few 'old' archaeological sites which still stimulate our thinking about the past. These sites can sometimes even provide new information from the existing finds, but hidden by our inevitably biased views. It is regrettable, however, that a lot of previously recognised archaeological information is lost over the years. An example is the recent 'discovery' of a 'new' groove and splinter technique in the Magdalenian of France (Rigaud 1984). This was in fact identified long ago in the well-preserved material from Meiendorf and Stellmoor, excavated by Rust in the 1930s (Rust 1937, 92–6; Rust 1943, 142).

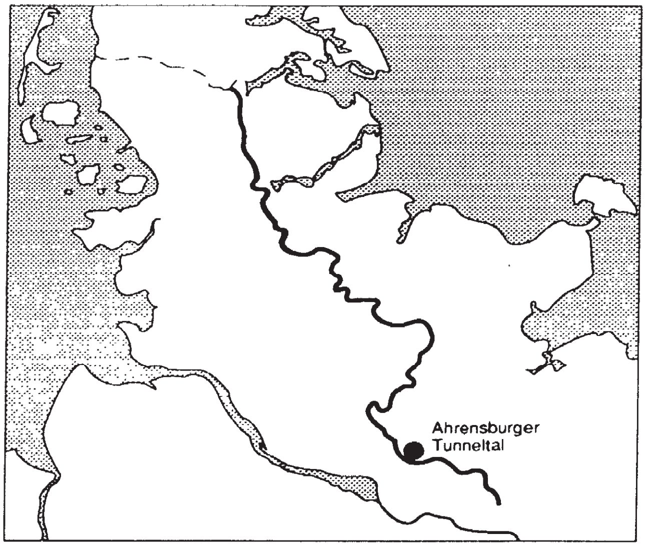

Figure 9.1 The location of the Ahrensburger Tunneltal in Schleswig-Holstein. Thick black line: the extension of the last glaciation maximum

A survey of the most important activities in the tunnel valley

Since the last major publication in 1943, much work has been done in the Ahrensburg tunnel valley. Rust himself excavated the Hamburgian sites of Hasewisch and Poggenwisch from 1946 to 1951, and subsequently he and Schütrumpf and Gripp, from the well-known tunnel valley archaeological task group, presented their results (in Rust 1958). Some minor publications by the famous excavator followed (Rust 1974; 1976), dealing with advanced ritual or religious interpretations and published in rather obscure places — hence the reason why they did not reach the professional archaeologists, and even when they did they were not accepted. But nevertheless a lot of useful facts, not available in the original publications, are to be found in such publications. Later on, under the critical eye of Rust, G. Tromnau excavated Teltwisch, an accumulation of sites between Meiendorf and Stellmoor.

The geologists Grube and Homci made valuable contributions to our understanding of the choice of sites by the stone age reindeer- hunters by coring the valley, thus defining the limits of the southern shores of the supposed dead ice lake and the distribution of other Late Glacial water holes in the neighbourhood (Tromnau 1975; Grube & Homci 1975). I received from Grube much important information from unpublished work in determining the extension of the area to be protected in the

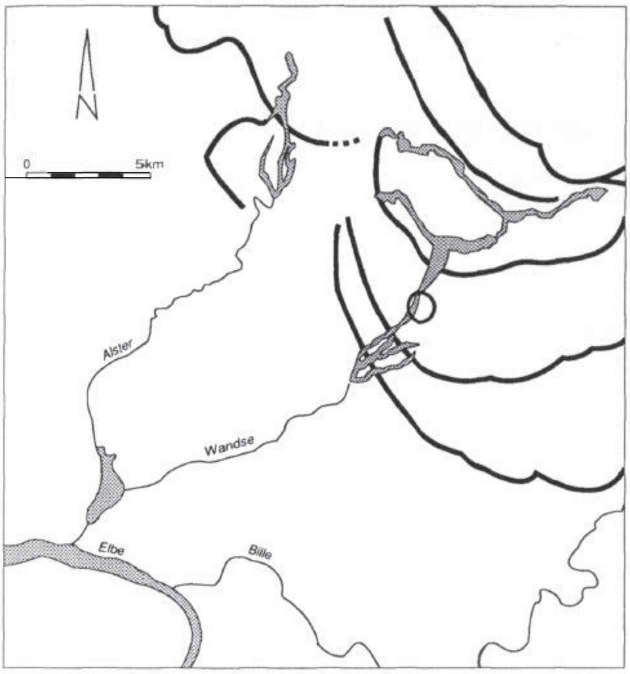

Figure 9.2 The location of the tunnel valley system (hatched areas) with the sites of Meiendorf and Stellmoor (circle) and morraines of the last glaciation (thick black lines). (After Rust 1937, Tab 1)

valley. My own contribution to the tunnel valley work, carried out in 1985, was very modest and in the end produced negative results. It was limited to the northeastern cul-de-sac of the old lake, and consisted of surveying the line of a new road crossing the valley just outside the protected area, and soon showed that there were no finds at all (cf Figure 9.3, at the south-eastern end of the tunnel valley).

In the following section I will try to give a summary of selected facts and interpretations concerning the tunnel valley and its Late Glacial landscape, and the traces of the human-reindeer relationship there.

The tunnel valley and the Late Glacial landscape

Due to the work of Grube and Homci, we can say that the tunnel valley (Figs 9.1 and 2) consists of small, deep dead ice holes and at least one long narrow lake about 3.5 km long in the southern part running from south-west to north-east and turning after 2 km to the east (Figs 9.3 and 4). One problem concerning the distribution of Late Glacial lakes and dead ice holes remains to be solved: were there more long lakes, connected with the main lake, which cut the landscape with more waterfilled 'barriers' (cf Figure 9.2, showing the total valley system) and did these determine the possible movement of humans and reindeer?

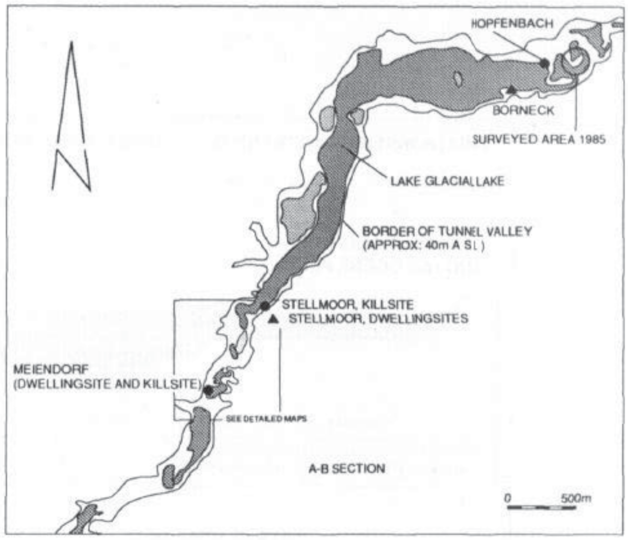

Figure 9.3 The tunnel valley showing the main sites, the long lake and the Late Glacial smaller waterholes in the south. (Partly after Tromnau 1975, Grube & Homci 1975, and unpublished in format ion)

As can be seen in Figure 9.5, the bottom of the valley is not even but shows pronounced depressions, dead ice holes within the lake itself, in the immediate neighbourhood of which the sites are situated. Rust was aware early on of this situation, and even concluded that the 'reindeer offerings' were to be found near the steps of the dead ice holes *(steilwandige Teiche,* Fig 9.4), also remarking, that the lakes were not deeper than 1-1.5 m near the shore when humans were active there (Rust 1974, 32; see also Rust 1976, 31).

From the beginning of the archaeological work in the valley the palynological record revealed a nearly treeless tundra in the Meiendorf Interval (Menke 1983, 229) during the visits of the first reindeer hunters of the 'Hamburgian Culture' to Schleswig-Holstein (Fig 9.6; Schütrumpf 1937, 26). This assumption was corroborated by the presence of birch stems measuring only 1-1.5 cm in diameter (Rust 1937, 117). Modern pollen analysis has confirmed the early results, indicating only dispersed birch trees at best in the tundra landscape (but perhaps stretching to the north as far as Copenhagen) (Usinger 1985, 23 and 36). The conditions in the tundra landscape were nevertheless rather warm (Fig 9.6) with a maximum temperature in July of +13° and a minimum temperature of -5° in January (Hufnagel 1987, 72-4). However, during the time of the 'Ahrensburgian Culture' in the Younger Dryas, the vegetation must have been quite different as a result of a lowering of temperature bringing subarctic conditions back to Schleswig-Holstein (Fig 9.6).

The presence of proper trees – pine and birch, not only dwarf birch *(Betula nana)* – has been

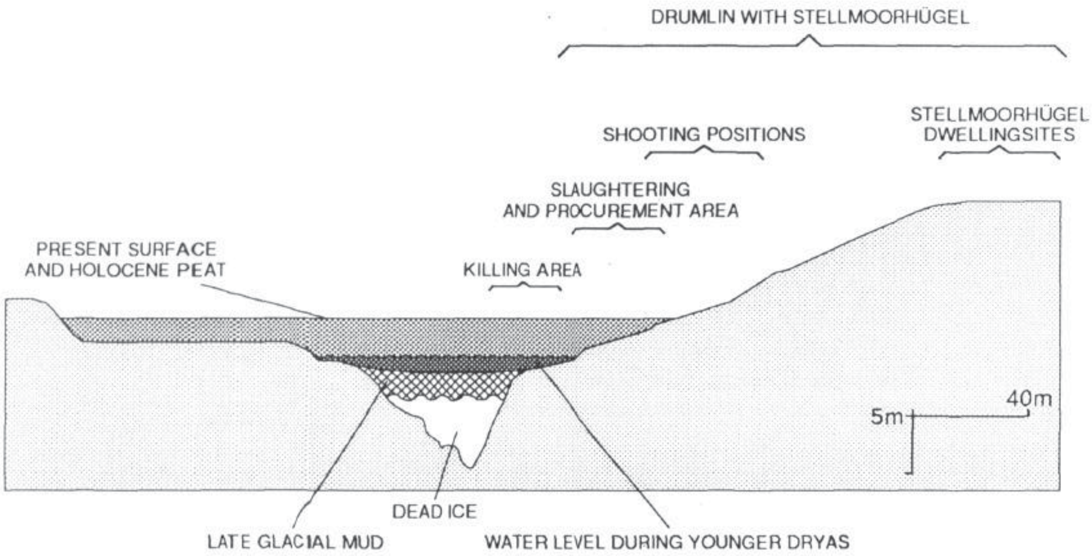

Figure 9.4 Interpretation of transect A-B (see Fig 9.3). To the right (east) the Stellmoor-Hügel with (probably) larger camps. Below this is the presumed position of the archers, followed by areas for slaughtering and retrieval of the prey and, finally, partly comprising the shore of the lake, the killing area with the wooden arrow shafts preserved in the mud. Also indicated in the small, deep, basin are the dead ice, the muds, and the remaining water depth. (All partly after Schütrumpf 1943, fig 4)

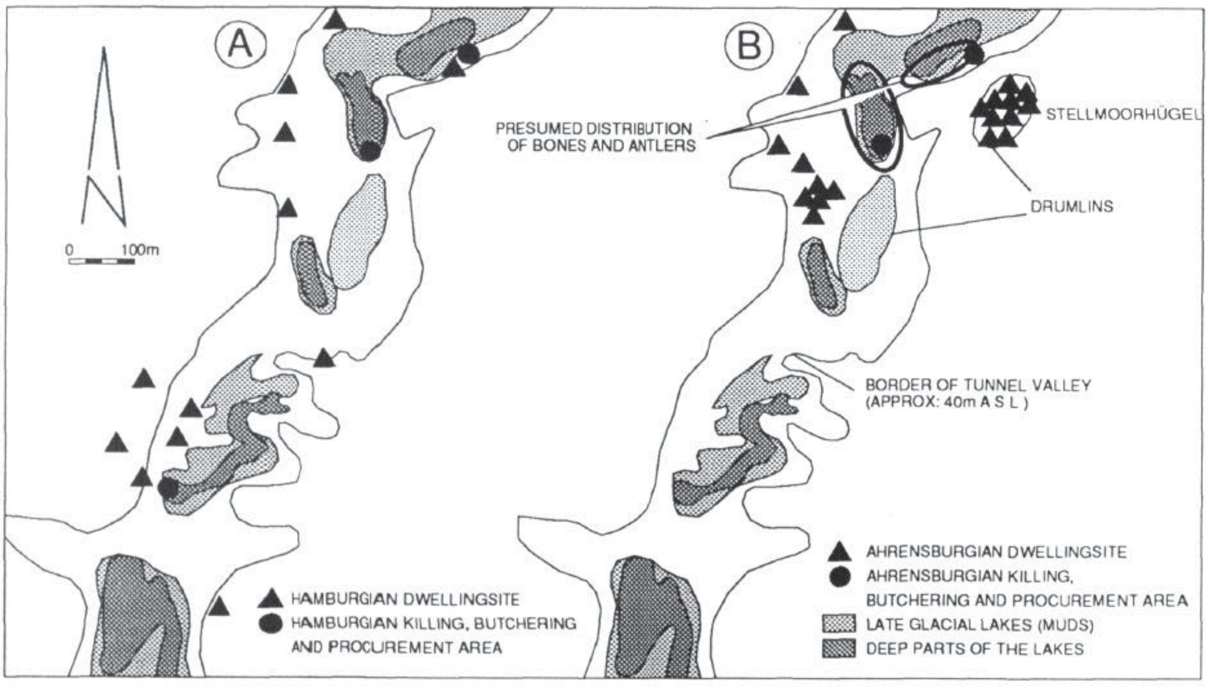

Figure 9.5 Distribution of A) Hamburgian and B) Ahrensburgian sites at the end of the long lake in the tunnel valley. The area presumed to contain large quantities of organic materials is indicated by hatching on (B). (After Tromnau 1975, Karte 1; Grube & Homci 1975, Abb 3)

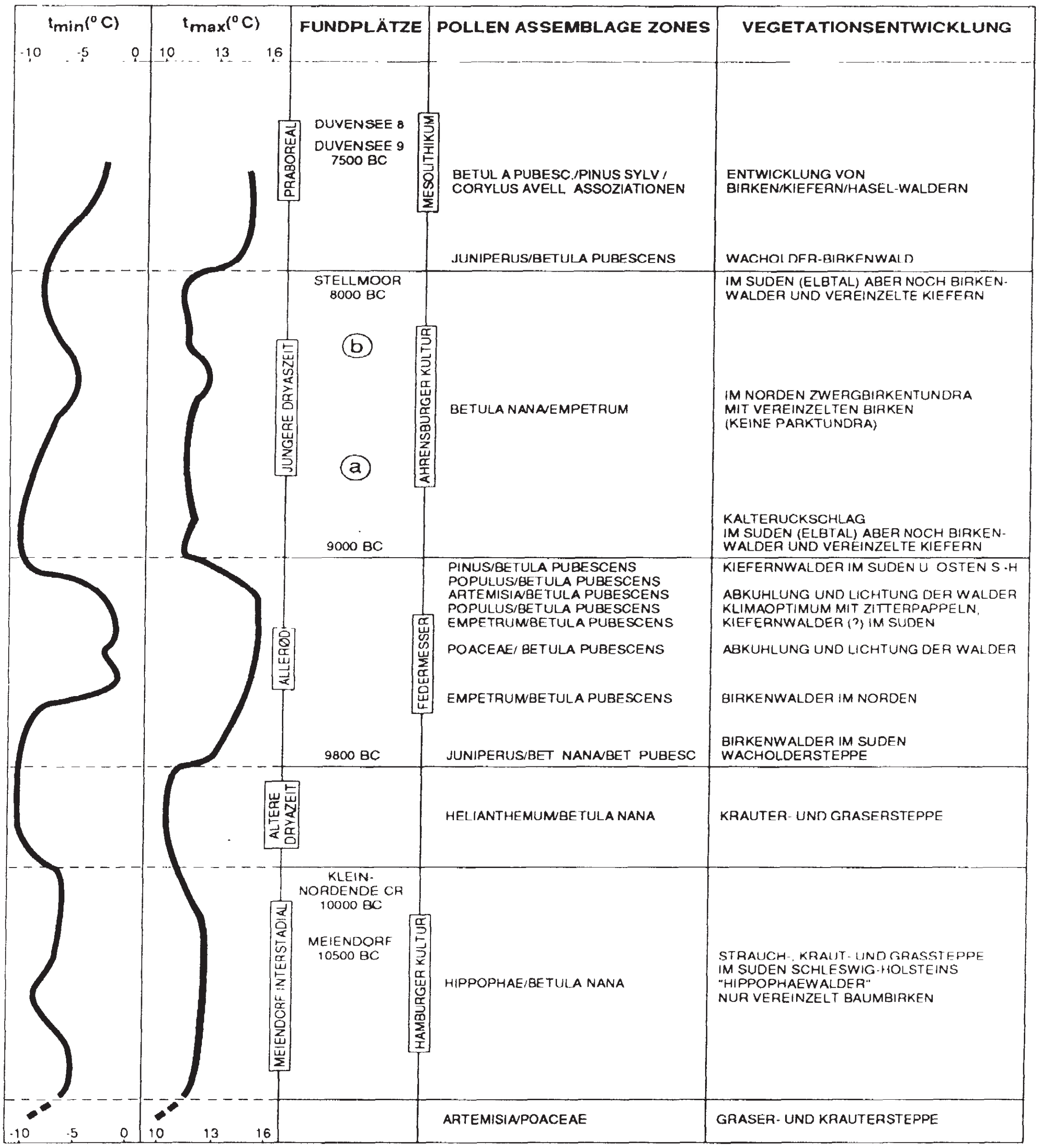

Figure 9.6 Chronological synopsis of the most important Late Glacial and very early Holocene archaeological sites in Schleswig-Holstein, with the contemporary vegetation and climate. The temperature curves are based on Hufnagel's analyses of fossil beetle assemblages in Schleswig-Holstein. (After Averdieck 1957; Bokelmann 1979; Hufnagel 1987; Menke 1983; Schütrumpf 1937; 1943; Usinger 1981; 1985; Usinger & Wolf 1981)

established by plant macrofossils remains from the relatively thick Ahrensburgian culture layer, which consists of not one but four separate strata (Schütrumpf 1943, 11). Thus it seems clear that the tunnel valley during the Younger Dryas period lay at the northern edge of the forested region, the trees penetrating the tundra landscape from the south through the river Elbe valley. Further north, there were only isolated birches in the tundra (Averdieck 1957, 50; Usinger & Wolf 1982, 40), probably not even enough to create park tundra conditions (Usinger 1981, 99).

Hints and traces of the human-reindeer relationship in the tunnel valley

Since the Meiendorf and Stellmoor publication, other contributions have appeared on the interpretation of the deposition of the finds in the lake. Most of these authors were aware that the circumstances of the finds suggest mass-hunting sites (Clark 1975; Sturdy 1975; Tromnau 1975; Bokelmann 1979; Grønnow 1987; Bratlund this volume). Their most important conclusions may be summarised as follows:

1) Contrary to Rust's opinion that reindeer in the Younger Dryas Period were hunted mainly in summer, they were in fact slaughtered in autumn. But reindeer and humans seem to have been present in the tunnel valley all year round (Sturdy 1975, 65).
2) Human occupants lived in the tunnel valley during times of scarce resources by consuming cached dried meat or stored bone grease and marrow (Grønnow 1987, 148).
3) During the Ahrensburgian stage, male reindeer antlers outnumber the female ones (Sturdy 1975, 64), whereas the bone material of both sexes is in equal proportions (Bratlund, pers comm). This fact suggests that a water-cache of strong male antlers was brought to the site from an unknown distance (perhaps the prey from bull reindeer bands) for storage and easier working (Bokelmann 1979, 21).
4) In the Ahrensburgian there were non-selective hunting drives but the prey was treated selectively (Grønnow 1987, 159).
5) In the Hamburgian there existed smaller hunting drives or perhaps only stalking occurred *(op cit,* 157).
6) In the Ahrensburgian, large (?) cow-juvenile-bull bands (Spiess 1979, 39) of reindeer were attacked in a 'head-'em-off-at-the-pass' strategy by means of bows and arrows at the Stellmoor site (Bokelmann 1979, 18), and butchered on the spot (Bratlund, pers comm and this volume).
7) According to (5) and (6), the Hamburgian sites seem to be a little bit more extensive than those of the Ahrensburgians (Bokelmann 1978, 44). However, the latter may have erected aggregational camps under favourable mass hunting conditions (eg, perhaps on the Stellmoor-Hügel itself), whereas the big hunting-group split Up into smaller units during periods of isolated stalking. An attempt was made to test this theory on a small Ahrensburgian site near the town of Bad Segeberg: unfortunately, neither bones nor antlers were found in the mud at the same level.

To these more or less well-documented ideas can be added some further observations. In the case of the Hamburgian, we do not know what weapons were used in the hunting of game. Naturally, the *Kerbspitze* (shouldered point) could have been used as an arrow tip. But there are neither bow nor arrows in the mud of Meiendorf even though conditions were right for organic preservation. One could argue, given that small pieces of wood were preserved, that the excavators might have failed to recognise arrowshafts. But this seems quite unlikely, since pinewood arrowshafts were easily identified in the Ahrensburgian layer at Stellmoor which occurred above the Hamburgian one. Therefore it seems certain that reindeer hunters during the Meiendorf-Interval (Bølling *sensu lato)* did not know this hunting weapon. But in view of the well-known-hunting lesion with a *Kerbspitze* (Rust 1937, 133), there must have been some device

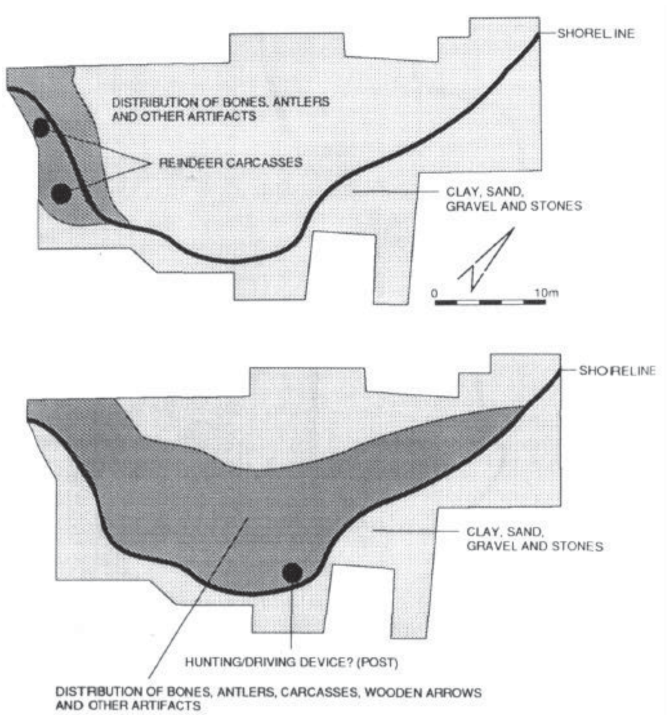

Figure 9.7 Below: the shore of the lake with the killing-site including the arrows and the waste zone of bone and antlers in the Younger Dryas (Ahrensburgian) layer at Stellmoor. The supposed wooden hunting/driving device is indicated. Above: the distribution of the lower culture layer (Hamburgian) from Sellmoor. (After Tust 1976, Abb 7)

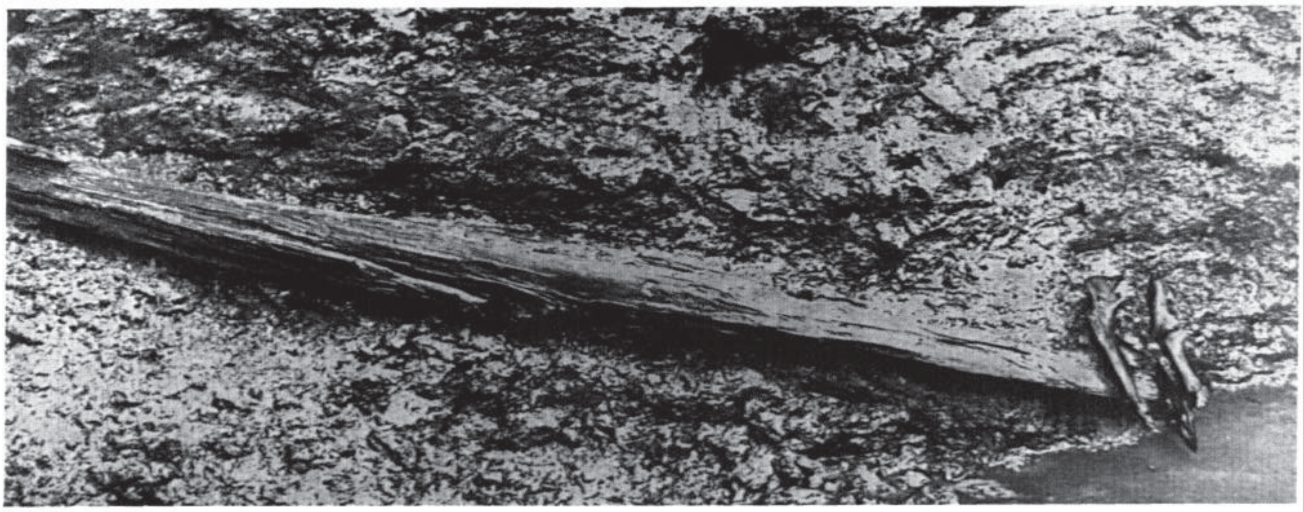

Figure 9.8 The pine 'post' (2.11 m long) and parts of the reindeer skull. This occurrence could be interpreted as part of an Ahrensburgian hunting device (?). (After Rust 1943, Tab 99)

for dispatching projectiles at high velocity, and this was probably the spearthrower or atlatl.

It is known that the spearthrower was used in the Magdalenian IV and objects such as the famous wavy-line decorated rod *Stab von Poggenwisch* (Rust 1958, 112; Bosinski 1978)) have nearly exact counterparts in the *Pyrenées aquitaines,* first recognised by P Wernert (1970, 346), so such an assumption does not seem unreasonable. Resemblances between Aquitaine and Hamburg in Late Glacial artwork were first recognised by Rust as early as 1943, in comparing the decorated *Riemenschneider* from Stellmoor with art-objects from Isturitz in the Basses Pyrenees (Rust 1943, 149).

As is shown in Figure 9.3, the original site at Meiendorf is situated just beside a small dead ice lake; the same is true of Poggenwisch and Hasewisch, whereas Meiendorf site 9 lies exactly at the narrow southern end of the long lake. The sites all seem to have been chosen for strategic reasons, with the Meiendorf *locus classicus* placed just between two smaller lakes, creating a 'bottle-neck or 'pass' situation. In this respect it is worthwhile noting in the old Meiendorf publication: *'Über die Pflanzenkost unserer Tundrenbewohner ist wenig auszusagen, da wir nur Kotballen von Tieren fanden'* (Rust 1937, 116: 'We can say nothing about the vegetable diet of our inhabitants of the tundra for we only found faeces of animals'). I believe that

Figure 9.9 Pinewood arrow (73 cm) with its foreshaft (22.5 cm — tip broken off — beside Rust's pocket knife) from the Ahrensburgian layer at Stellmoor. (After Rust 1943, Tab 91). Details of both ends of the main shaft are illustrated in Fig 9.10, on the right.

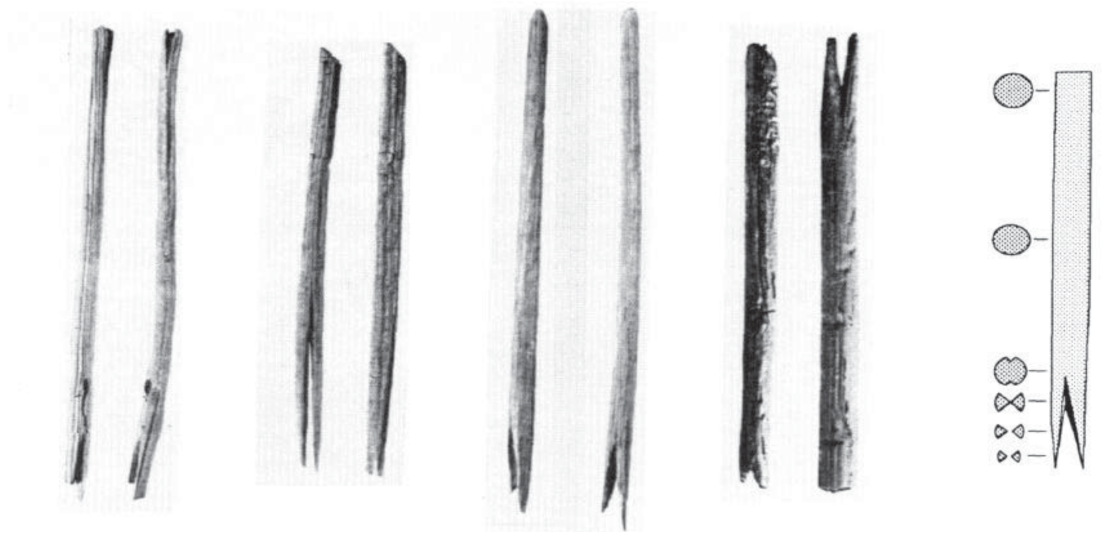

Figure 9.10 Pinewood arrows from the Ahrensburgian layers in Stellmoor. The second foreshaft from the left has preserved the tang of a broken Ahrensburgian point. The arrow in the photograph on the right is the same specimen as in Fig 9.9, showing the nock for the bow-string and the positive/negative cutting (cf *drawing extreme right). (After Rust 1943, Tab 91 and 95)*

this could be a hint regarding the hunting method: The reindeer must have been driven into the water and there fearing death or even in their death-throes the faeces were passed. The weapons used may have been darts tipped with bevel-based bone points and flint shouldered points propelled by atlatls.

The Younger Dryas levels at Stellmoor give us further insights into reindeer hunting methods. Everyone knows that Rust and his team extracted 105 pinewood arrows or arrow fragments from the mud (Rust 1943, 189), but only few people may be aware that many of them were not identified during the work. This seems understandable because the excavation did not take place from a raised working platform, and the workers therefore moved on the culture layer itself, thus probably destroying some fragile wooden objects. Rust's scientific responsibility is underlined by his statement, 'Naturally we were working carefully, but as quickly as possible, thus destroying — so I believe — more than a hundred wooden arrowshafts which we failed to recognise among the other wood' (Rust 1976, 10). And further on, he writes: *'Dass vielleicht tausend oder mehr Holzpfeile, zum Teil wohl abgetrieben, im Teich lagen, kann als mögliche Auswirkung festlicher Veranstaltungen auf der Hügelkuppe gedeutet werden?'* (Rust 1976,33: 'that perhaps 1000 or more wooden arrows, partly drifted away, were lying in the lake and could be interpreted as the possible results of festivities on top of the [Stellmoor-] hill').

Without doubt — and this is stressed by Bratlund's analyses of hitherto unknown hunting lesions (see this volume) — several of these animals were shot in the water, the targets being panic-stricken reindeer near the shore, half swimming, either trying to escape from the water or to flee through it to gain the safety of the opposite shore.

Thus it does not seem impossible that the wooden post, with adjacent parts of a reindeer skull, and lying just beside the shore of the lake, was part of a somewhat longer device for directing the frightened animals into favourable killing positions (Figs 9.7 and 9.8; assuming that the post is not an Allerød pine-beam which slid from the higher slope of the shore into the Ahrensburgian layer during the melting of the dead ice). Comparable hunting devices are known from reindeer drives in Greenland (Nellemann 1969/70, 142) and Siberia (Heptner *et al* 1966, 454). Accepting this interpretation of the post, one could imagine that the reindeer were driven into the lake from the eastern shore. This would further support Bratlund's very convincing arguments about the direction of shots (Bratlund, this volume).

The arrows from Stellmoor (sadly destroyed during the War) reveal masterly workmanship, pointing to a long tradition of manufacturing composite hunting equipment. It is quite clear that the finds belong to arrows with flint-tipped foreshafts; both parts were made from compact Pinewood, and were fitted together by special 'positive/negative' notches cut at the end of the main arrowshaft and the base of the foreshaft (Figs 9.9 and 10). Two pieces of this kind were found by Rust lying close to each other (Fig 9.9).

Figure 9. 11 Pointes à base fourchues *from Isturitz (Basses Pyrénées). These points show partly the positive/negative cutting known from the Stellmoor arrows. (After Passemard 1944, pl liii)*

It is interesting to note that a similar association of points and foreshafts or simple shafts was discovered by Passemard during his excavations of (probably) very Late Magdalenian layers in the cave of Isturitz. Here, at least some of the antler and bone *pointes à base fourchues* seem to reveal the same manufacturing detail at the zone of connection (Fig 9.11). Passemard explained this as the intention of the Magdalenian hunters to lengthen the weapons or to facilitate the repairing of broken pieces (Passemard 1917; 1944, 73). It is interesting to note that at this site spearthrowers are present in the stratum E, which contains no *pointes à base fourchues,* whereas the layer above with *pointes à base fourchues* has no atlatls. This situation is therefore comparable to the proposed succession from the hypothesised spear-throwing technology in the Hamburgian (Bølling) to the proven bow and arrow technology in the Ahrensburgian (Younger Dryas).

From ethnographic sources, we know of shafts and foreshafts made from the same material. These show that a foreshaft with a point could not be pulled out from the wound as easily as an undivided arrow by the person hit by the projectile (eg Hirschberg & Janata 1966, 195). But this is not the place to discuss the workings of foreshafts in detail (see Guthrie 1983, 289).

Arrow firing experiments with reconstructed Ahrensburgian arrows suggest one good reason for the existence of the foreshafts (fletching is not documented in the original material, but I believe that it would have been a part of the highly accurate weaponry of an advanced bow and arrow using community). As Figure 9.12 shows, the main arrowshaft is easily separated from its deeply embedded foreshaft which could be damaged at the flint tip or the zone of connection. This would facilitate repairs, and save time for the other tasks of obtaining meat and raw-material during mass-hunting.

In conclusion, I will return briefly to the point made in statement (3), that in the Ahrensburgian stage an overwhelming majority of antlers are from males, contrasting with the equal distribution of bones of both sexes (Bratlund, pers comm). This most probably indicates that there was a kill-site for reindeer- bulls, immediately south of the Stellmoor kill-site (cf Fig 9.5b). Such a suggestion does not seem fanciful, especially if one links Sturdy's analyses of the Stellmoor antlers (1975, 64–5) with seasonal variations in the fat content of caribou (Spiess 1979, 28), as is attempted in Figure

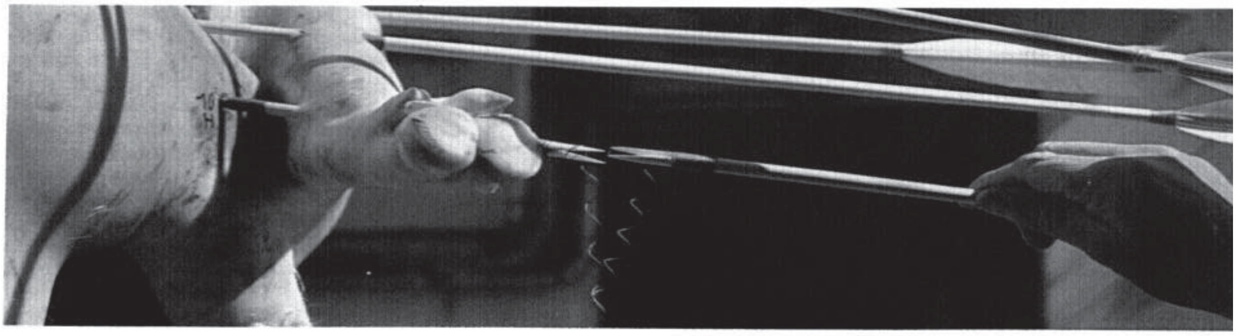

Figure 9.12 Arrow-firing experiments with copies of Ahrensburgian arrows. The photograph shows that the main shaft can easily be separated from the foreshaft which was shot through a (dead) pig's leg. The foreshaft with a tanged point, partly embedded in the animal's body, was impossible to remove. (Harm Paulson of the Gottorf Museum, the archer in this experiment, used a copy of the Danish Mesolithic Holmegard bow and made the arrows)

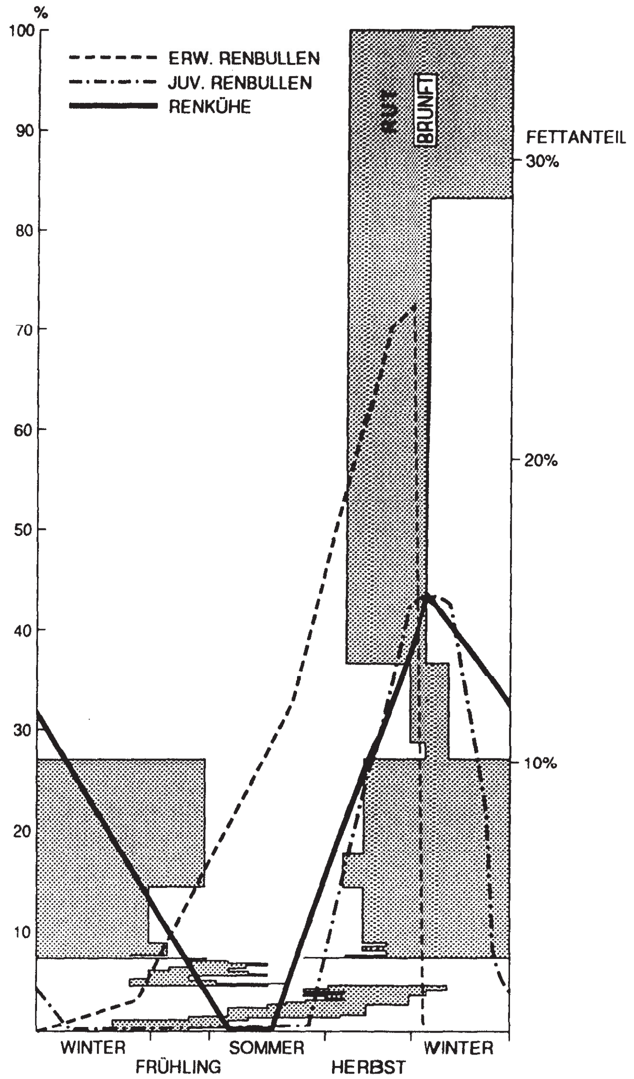

Figure 9.13 Year-round distribution of the antlers (E1241) from Stellmoor (Ahrensburgian 0-100% left side, thick-lined rectangles) and percentages (0-30% right side, solid, broken and stippled lines) of fat content (Fettanteil) of caribous (After Sturdy 1975, fig 13; Spiess 1979, fig 3-7). It can be speculated that the main hunt in autumn was mainly directed towards fat reindeer males, just before the meat lost its quality during the rut (Brunft)

9.13. In this respect it may be noted that evidence about the effect of the rut on caribou meat palatability could point in the same direction: 'Should the opening date of the [hunting-l season coincide or even slightly precede the peak rut period then undoubtedly the percentage of unpalatable animals would increase significantly' (Curnew & Lear 1980,718).

It is to be hoped that future research based on existing 'old' data, will add significantly to these and other questions with regard to the palatability of meat during the rut. I accept the weakness of making comparisons between the hunters of 10,000 years ago at old Stellmoor and recent Arctic caribou hunters. For example, it is conceivable that the fat pre-rut bulls might have been a highly desired prey during the Younger Dryas. Finally, having only presented here a local Late Glacial medley, I am convinced that the Ahrensburg tunnel valley will long maintain its position in the top ten of the archaeological charts.

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10 The Late Upper Palaeolithic site of Schweskau, Ldkr, Lüchow-Dannenberg, Germany, and some comments on the relationship between the Magdalenian and Hamburgian

Klaus Freest and Stephan Veil

Abstract

The site of Schweskau, Lower Saxony, Germany, on the shore of a former lake, has yielded a late Upper Palaeolithic flint assemblage in a 10 m diameter concentration with distinct debitage and tool areas. The tools (1%) and the unusual tool spectrum (mainly borers/Zinken and shouldered/backed points) indicate a special task camp. The assemblage is typologically and technologically in between Hamburgian and pre-Allerød Magdalenian, while situated clearly outside the range of classical Magdalenian sites. Several interpretations seem possible: Schweskau as a hitherto unknown type of special task camp within the Hamburgian, as belonging to a transitional phase between Magdalenian and Hamburgian, or representing a late Magdalenian population shift to the north during which short-term adaptive processes and contact with Hamburgian hunters in the North European plain took place.

Introduction

In 1986, rescue work was conducted at a Late Upper Palaeolithic site, where the archaeological layer had been destroyed by deep ploughing. The work involved sieving the main area of artefact concentration by square metres. The site is situated in the north German lowlands, midway between Hannover and Hamburg. The modern topography of the surrounding landscape has hardly changed since the Weichselian. Now, as then, the site lies within a broad east-west oriented marshy depression limited to the north by up to 15 m high hills (Fig 10.1). A deeply incised small valley opens immediately north of the site. Soundings have revealed that the site lies on a peninsula-like slight elevation, which had been surrounded by the waters of a lake during and after Late Glacial times.

Because of the disturbance of the 0.30–0.40 m deep archaeological layer, no detailed stratigraphic information is available, except that the artefacts were in contact with a limnic marl embedded in silty sand.[1]

By way of introduction, the main significance of this site can be summarised as follows:

1 Almost the whole of the assemblage has been recovered and is of manageable size (*c* 7000 artefacts). Therefore it seems well-suited for a detailed study of the core reduction processes and blade manufacture. The assemblage also shows the use of a special blank preparation technique (*en éperon,* cf Karlin 1972), which is unusual in contemporary assemblages from the north German Lowlands.

2 The assemblage is characterised by an unusually low number of tools (70), and a very limited spectrum of tool-classes (mainly borer-like forms and points). Thereby differing significantly from the well-known larger Late Upper Palaeolithic sites such as Deimern 42 or 44 (Tromnau 1975), and Groitzsch (Hanitzsch 1972), which contain more tools both absolutely and relatively. It also differs from small assemblages like Giebichenstein (Nowothnig 1970) and Siegerswoude 2 (Kramer *et al* 1985), which are characterised by a predominance of projectile points and are interpreted as short-term hunting camps (cf Stapert 1985).

3 Finally the assemblage apparently does not obviously match any of the established Late Upper Palaeolithic space-time-units in Central Europe, ie the Magdalenian, containing backed bladelets and situated in the upland area, and the Hamburgian with shouldered points in the northern lowlands.

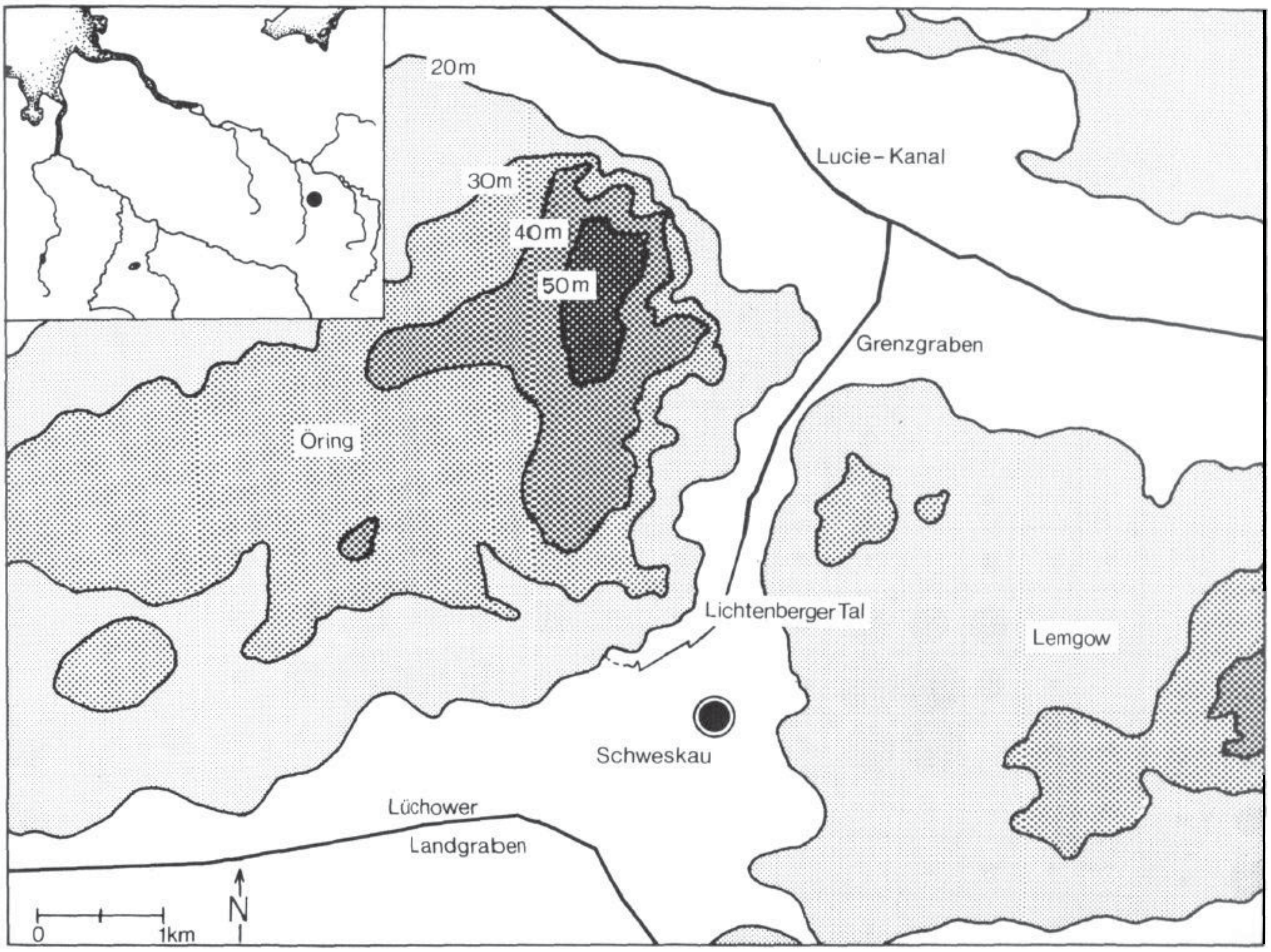

Figure 10.1 Schweskau, Landkries Lüchow-Dannenberg (Germany). Geographical position of the Upper Palaeolithic site. Drawing: B Adam

Spatial patterns

The size of the occupation area, expressed by the combined weight of the lithic artefacts from each square metre, is about 80 square metres, and in shape the concentration is oval and asymmetrical (Fig 10.2). Broken fragments of a few autochthonous stone slabs as well as some burnt flint artefacts suggest the former presence of a hearth. The concentration can be subdivided in two areas with different functions.

1 An area of core reduction and blade production, which is defined by the distribution of waste from specific phases in the blade production process: large preparation flakes (early core reduction phase), primary platform rejuvenation flakes (Fig 10.3), chips due to secondary fine platform preparation *en éperon,* and irregular blades indicating production failures or corrections of the core surface.

2 An area of tool use and discard, defined by the distribution of regular blades which can be distinguished on technological grounds *(chaîne opératoire)* and also on morphological grounds as the end products of knapping (see below). This area is further defined by the distribution of retouched forms, ie tools *sensu stricto* (Fig 10.4), especially points and borers/Zinken. Eighty percent (51) of the tools located to square meter lay outside and to the west of the core reduction and blank production area.

These spatial patterns afford additional evidence for the chronological homogeneity of the Late Upper Palaeolithic assemblage.[2]

Blade production on the site

The reconstruction of debitage patterns is based at the moment on the analysis of technological attributes on cores, flakes and blades (cf the 'dynamic typology' of Schild 1980). Refitting has not yet been systematically undertaken. In due course, these results obtained without refitting will be compared with the information gained from such work.

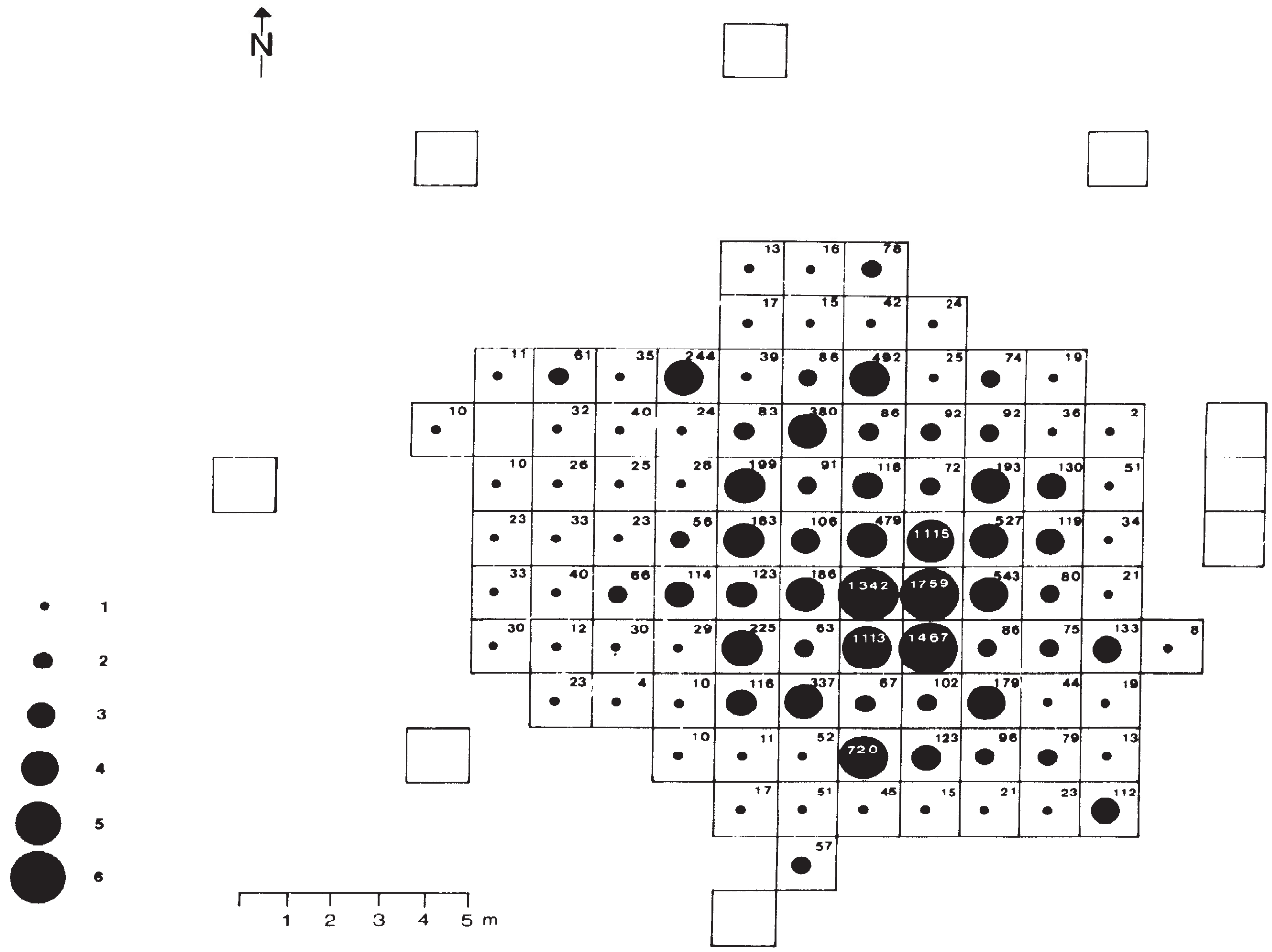

Figure 10.2 Area as indicated by the distribution of all diagnostic artefacts. Numbers indicate weight of flint artefacts in grams. Frequency classes per square metre in relation to the average frequency x = 157 g, cf Kind 1983): 1 = 2–52 g; 2 = 53–104 g; 3 = 105–157 g; 4 = 158–594 g; 5 = 595–1031 g; 6 = > 1031 g

The raw material was clearly brought into the camp. Generally, Cretaceous flint comes from the Baltic coast and was widely distributed in the lowlands by the glaciers. But its exact provenance, both today and in prehistoric times, should always be investigated in detail because of its importance for reconstructing raw material economy (ie whether a site is an extraction location or not). The site lies in a depression filled with Weichselian sands that does not contain a significant gravel component. The closest flint outcrops are situated on the hills north of the site that are formed by boulder clay and melt-water sediments. The minimum distance between the site and the outcrops is 1.5 km. Possibly the first core preparation processes took place there at the source of the flint.

General information about the amount of flint worked outside the site can be obtained by a simple calculation based on the relationship between the total weight of the artefacts from the site (ie flint volume; 20,430 kg), and the total quantity of cortex and other natural surfaces preserved on them (7857.69 square cm). This method estimates the amount of the original natural surface of the flint nodules that is' missing from the assemblage. Preserved natural surfaces are overestimated by the measuring process (length x width in mm), therefore the calculation of expected natural surfaces is a minimum figure. The extent of the original natural surface is also underestimated as it is based on the surface area of a sphere, which is more regular, and thus smaller than that of any flint nodule.

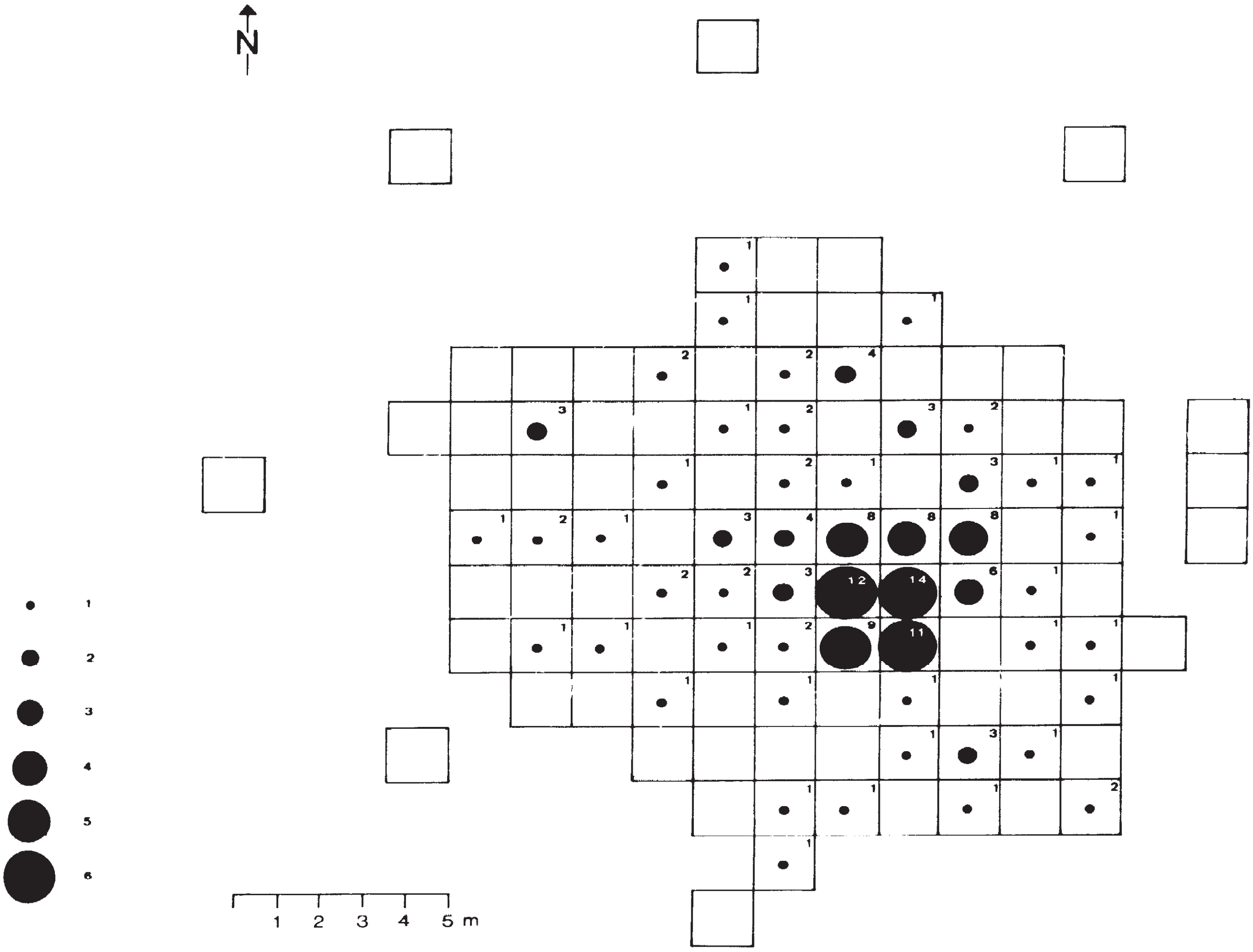

Figure 10.3 Area of core preparation and blade production, indicated by the distribution of platform rejuvenation flakes. $\bar{x}$ = 1: 1 = 1–2; 2 = 3–4; 3 = 5–6; 4 = 7–8; 5 = 9–10; 6 = > 10

Calculations based on this method show that an estimated 42% of the natural flint surfaces are missing from the site (Fig 10.5), which means that many flint working processes took place outside the excavated area. As the immediate vicinity was very carefully surveyed, the postulated extra-site activities could not have occurred that close to the site. These activities are not necessarily just primary core preparation processes, and of course, the cores probably did not arrive at the site in the same stage of production.

We have not yet obtained definitive information about the activities which took place on the site, or to the extent they occurred. For example, we have not yet taken into account the possibility that artefacts were brought into the site. Nevertheless it seems certain that blank production, and core preparation and correction took place here extensively.

It seems difficult to attribute all the waste products characteristic of core preparation, to either the initial core preparation or the correction phase necessary during blade production. Refitting will presumably help to solve this problem. Preparation flakes larger than the biggest core diameters certainly indicate an early core reduction phase, and they may even come from primary shaping.

Twenty-three of the crested blades, which correspond to an average length of 9.2 cm per core, may have been produced during the initial preparation to guide the primary blade removals (Fig 10.9, Nos 2 and 3). These crested blades are flaked unidirectionally and there is little evidence

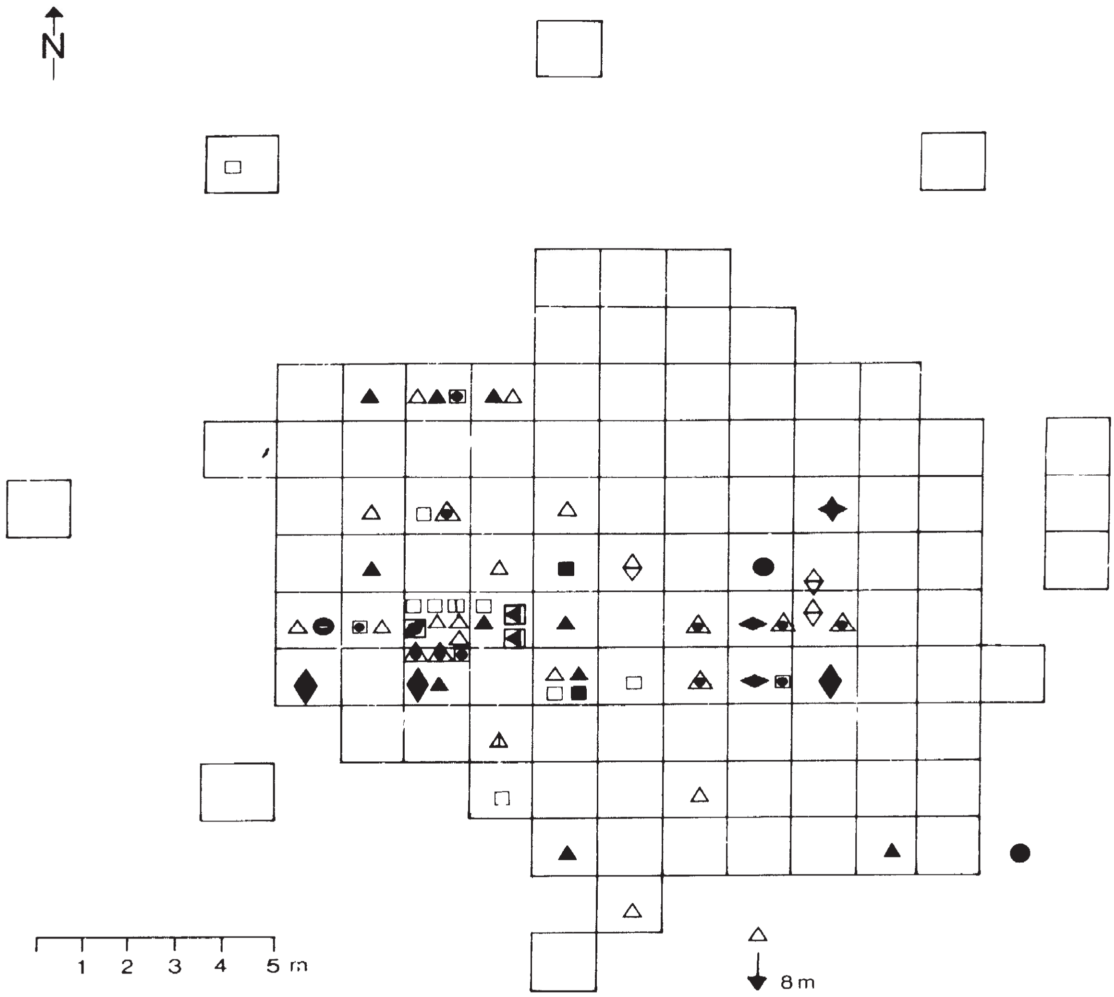

Figure 10.4 Area of tool use and discard suggested by the distribution of retouched forms. Triangles represent borers/Zinken; all other shapes represent points

for the presence of bifacially shaped core preforms. One could also conclude that artificial guide ridges were not used commonly. On the other hand one should keep in mind that certain primary preparation work may have been done before the cores were transported to the camp. The remaining crested blades (24) are only partially crested and of variable size. They may have occurred during corrections of the core. The primary platform rejuvenation flakes (Fig 10.9, Nos 6 and 7) are very numerous and represent characteristic waste of the blade production process.

Blade production method

Whether and how the pre-cores were shaped cannot be deduced from the cores exploited and discarded on the site. The few regular long crested blades show that the pre-cores were usually not equipped with a guiding ridge, but it is not yet clear what the exact shape of the core was like. All but one of the 10 cores (Fig 10.9, No 1) can be regarded as discarded waste no longer usable for blank production. They show the basic principles described for the Magdalenian (Audouze *et al* 1988; Sobczyk 1984). They have been worked to an extent where the original shape of the flint nodule has completely disappeared (Fig 10.8, No 7). In one case, traces of the early core preparation are visible, directed from the main flaking face to the back of the core.

Even in the last core reduction phases the core backs and their ridges were of certain importance (cf Hanitzsch 1972, who was one of the first scholars to describe these features in the Magdalenian assemblage of Groitzsch, where he

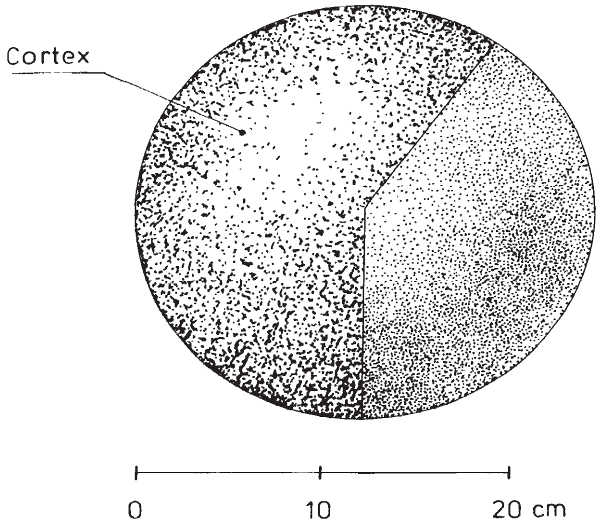

Figure 10.5 The presence to absence ratio of pieces lacking their natural flint surface (58:42) calculated from the estimated total spheroid volume of the flint assemblage (20.430 kg = 7857.69 ccm; r = 12,340 cm)

interpreted the ridges as facilities for holding the cores). Normally the cores are flat with one or two lateral ridges. Less common are cores with a single central ridge on the back. These ridges presumably played an important role during core preparation, and for controlling the main flaking face from the sides. The curvature of the main flaking face during blade production was achieved by flaking from the back or the front. The curvature was also controlled by striking peripheral blades from the core platform. The main flaking face is usually symmetrical and curved in section. Inevitable mistakes due to hinging have sometimes been corrected by removing these protrusions. Some cores show evidence of platform abrasion (Fig 10.8, No 7).

The platforms as a whole have been systematically renewed by partial or complete rejuvenation flakes, usually struck from the main flaking face, but in one case from the back. Great importance should probably be accorded to the technique of secondary fine preparation of blade platforms known as *en éperon* (cf Karlin 1972). This very interesting feature is preserved on only two cores, one of which is still usable (Fig 10.9, No 1). Most of the cores however show plain platforms without those characteristic protrusions. By contrast, however, these *éperon* features are numerous on the regular blades from the site. So the lack of evidence for secondary fine preparation on the cores is probably due to their worked-out state at time of discard.

These blades display a special butt morphology: before striking, a small protrusion or *éperon* was prepared (Fig 10.10, Nos 5–8). Depending on the condition of the core platform edge, this protrusion was usually created by striking one or several chips from the left or right or both sides. Although this method is highly correlated with primary faceting of the striking platform, faceting alone is not a necessary attribute of this method. Many characteristic wide, relatively thick chips can be identified as typical waste of this technique (Fig 10.9, Nos 4 and 5). These secondary platform preparation chips were probably intentionally struck to create a small hollow by hinging. By this procedure it was possible to obtain a very small acute platform. The butt morphology led to the formation of an acute lip instead of a bulb. The protrusions have been interpreted as an aid to the secure positioning of a punch (Weiner 1985), and the percussion attributes suggest the use of a soft-hammer and indirect technique. However, these attributes seem to be mainly determined by the morphology of the striking platform and can be replicated even by a direct and hard blow. As on the cores, evidence of platform abrasion is also rare among the blades and was perhaps not as necessary as with other blade producing methods (the Levallois blade technique does not need such reduction either).

Within the general group of blades, conventionally defined by a length:width ratio 2 and more or less parallel sides, a subgroup can be distinguished which may represent the end products of knapping (Fig 10.10, Nos 5-8). These blades ('A-blades') have symmetrical sides, are consistently thick and wide, produced mainly by the *en éperon method, and are often intentionally broken* (cf Bergman *et al* 1983). They mainly served as tool blanks, and show a different spatial distribution from the rest. A comparison between the weight of debitage and of these end products reveals an amazing disproportion: *c* 19 kg waste against *c* 1 kg blades. Even if we include the less regular blades and allow for the removal of blades from the site this relation would not be changed significantly, especially as some waste material was left elsewhere. This comparison indicates that the blade manufacturing technique demanded an abundance of raw material. Remembering that the nearest good quality flint source is located a short distance from the site, one could argue that this method has less to do with economy than with the controlled production of long regular blades.

In summary, we can conclude that the raw material was transported at least 1.5 km to the site. With one exception, all of the cores are discarded waste that are so well used that the original shape of the raw material can not yet be determined. Whether flint blocks or naturally occurring nodules were preferred during the raw material selection cannot be decided on the basis of the actual data base. The evidence for all over

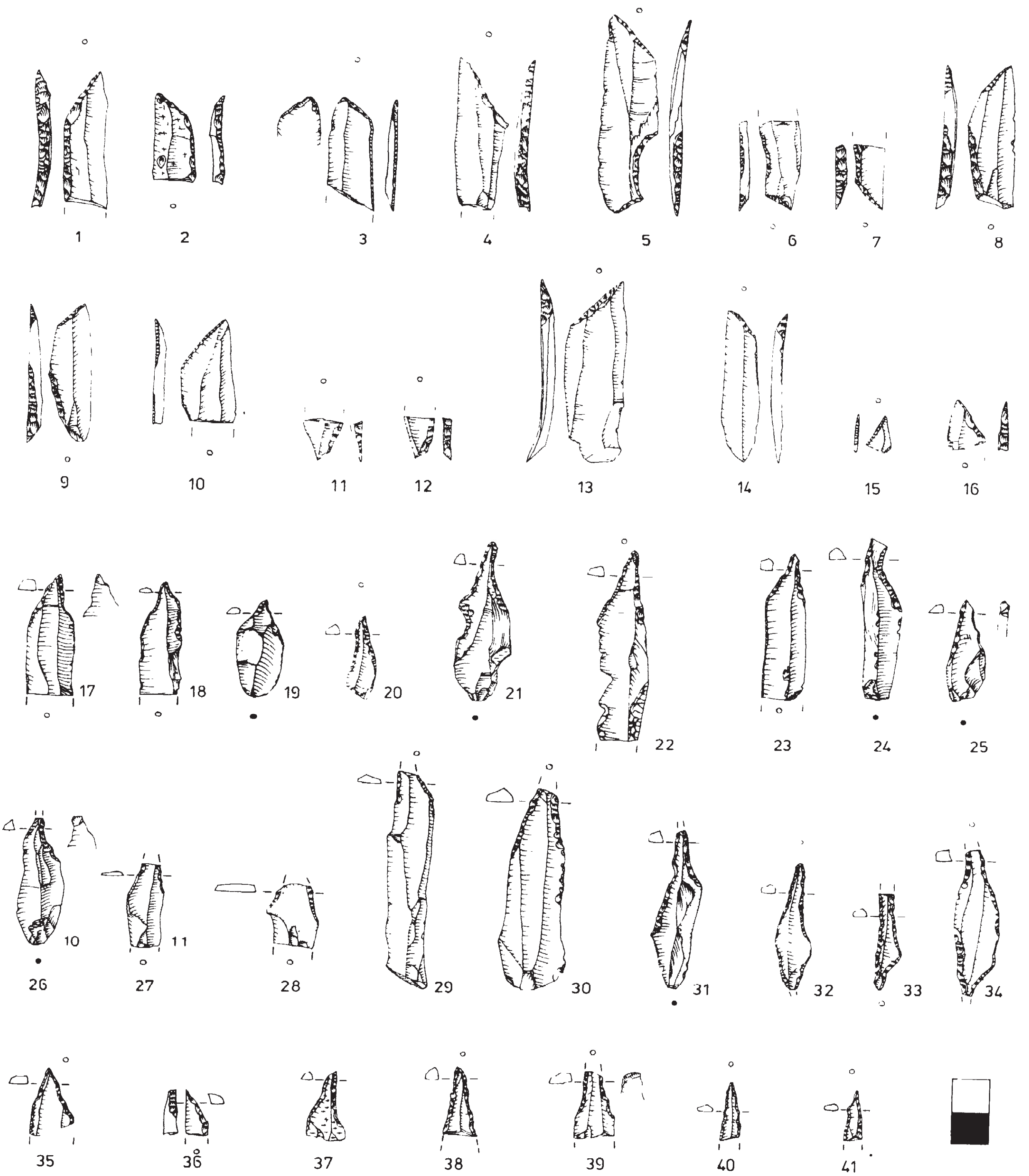

Figure 10.6 Points & borers: 1–3) backed points; 4–7) shouldered points and fragments; 8–10) Creswell points; 11, 12) fragments of presumed points; 13, 14) simple points/acute angled truncations; 15, 16) point tips; 17–19, 25–29, 35, 36) ordinary borers; 20–24, 30–34, 37–41) long borers; 26) Zinken. 2 cm scale

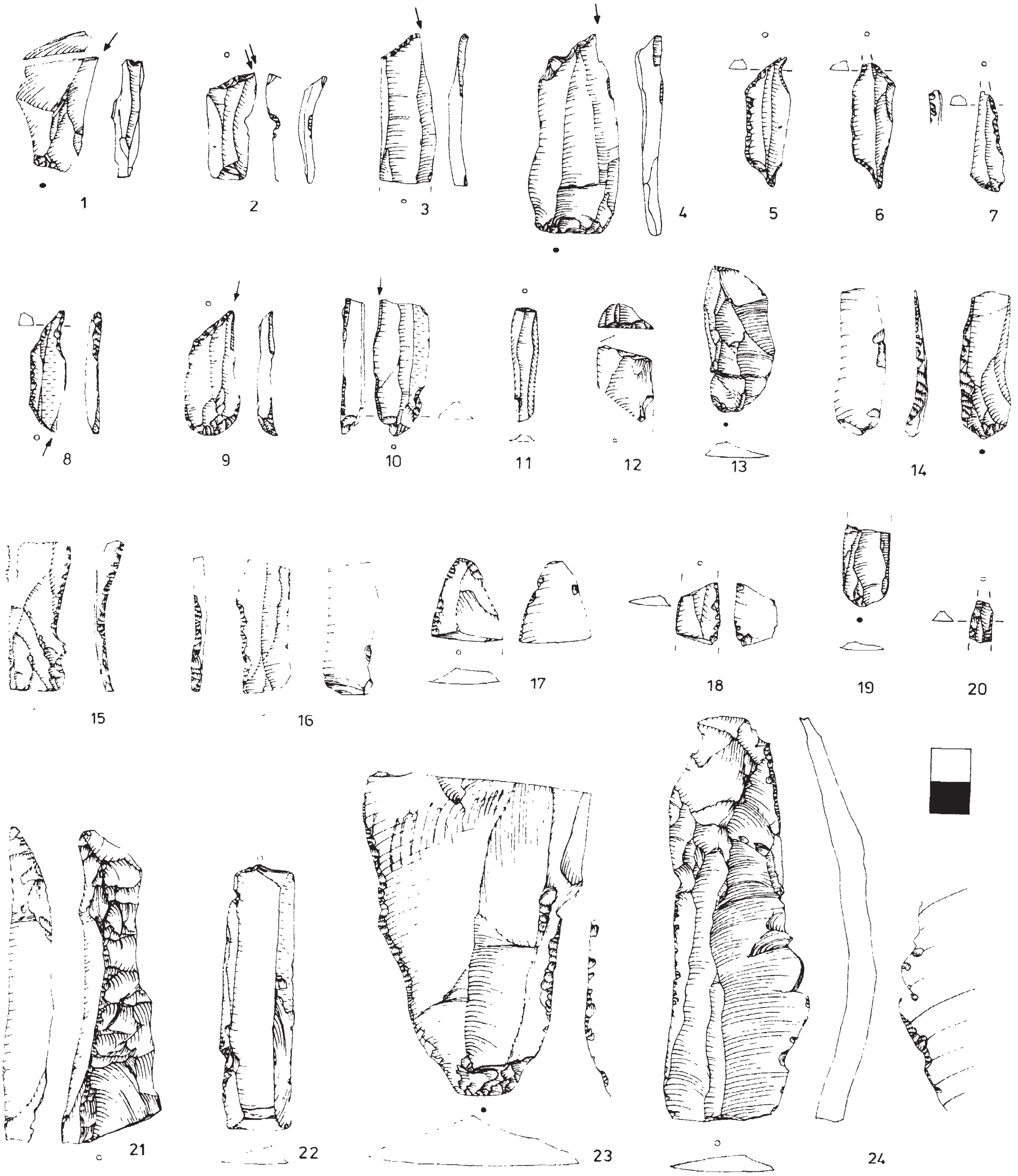

Figure 10.7 Burins, composite types and truncations: 14) burins; 5, 6) borers/Zinken; 7) borer/truncation; 8, 10) burins/Zinken; 9) burin/scraper; 11–13) truncations; 14–19, 23–24) retouched blades/bladelets; 20–22) miscellaneous. 2 cm scale

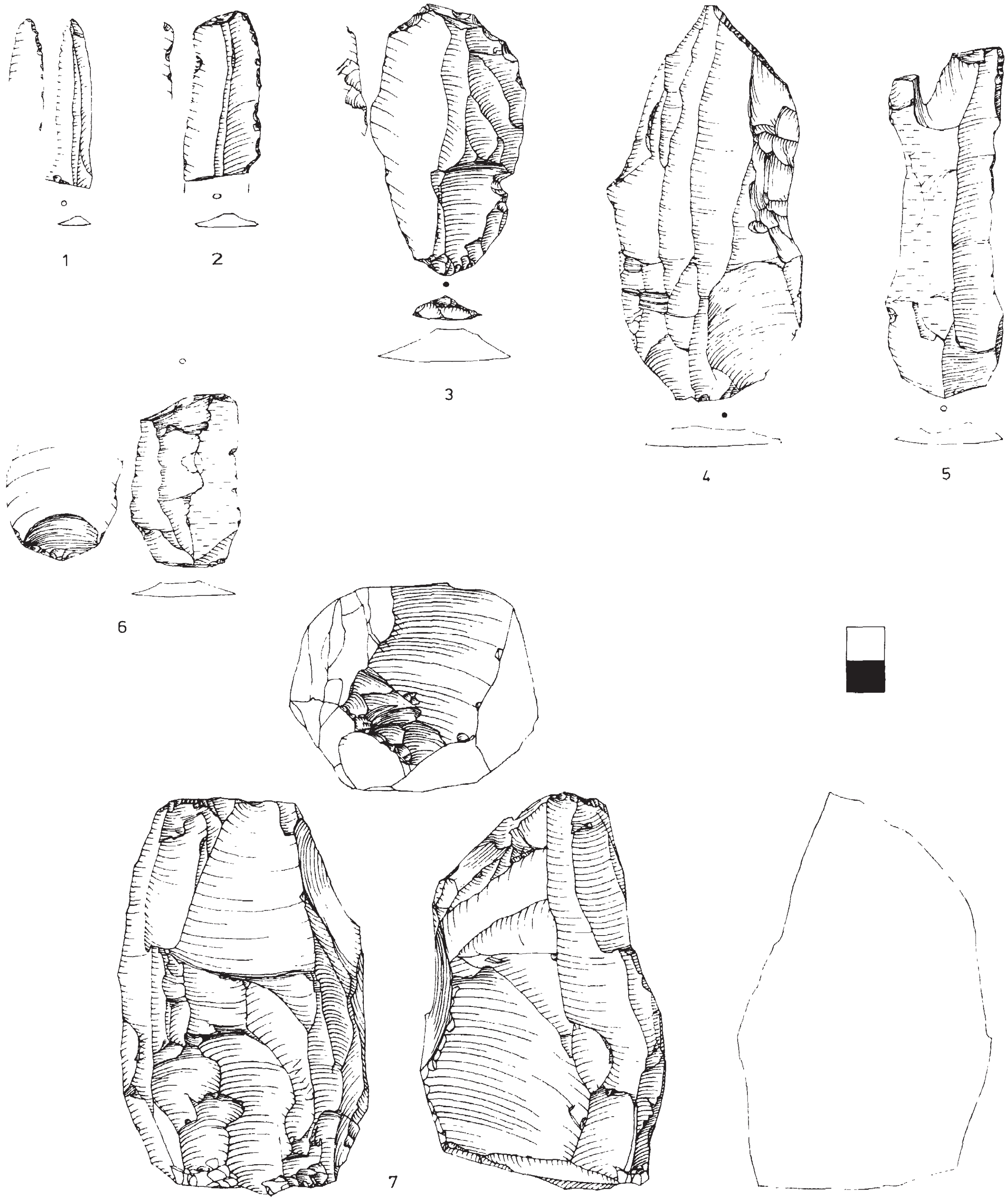

Figure 10.8 Retouched blades: 1, 2, 4, 5) retouched blades; 3, 6, 7) miscellaneous technotypes (7, blade core). 2 cm scale

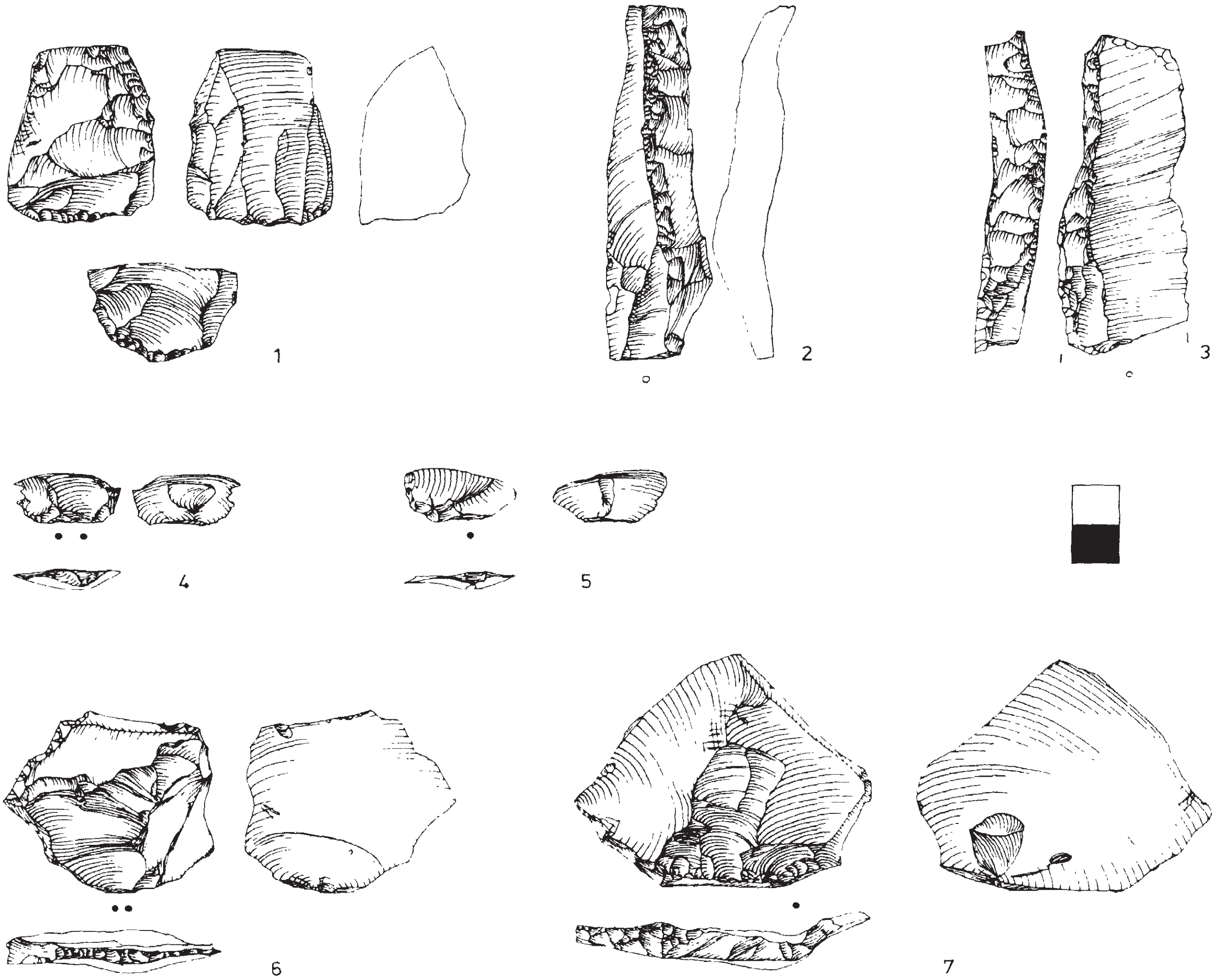

Figure 10.9 Technotypes: 1) blade core; 2, 3) crested blades; 4, 5) secondary platform preparation chips; 6, 7) platform rejuvenation flakes. 2 cm scale

shaping of cores does, however, reach far back to quite early phases of their reduction. Most of the blades were produced by a special technique of secondary platform preparation. The relationship between waste and end products indicates that this was a raw material intensive process. The main objective of this method of manufacture was presumably the production of regular fine blades.

The tools

Retouched artefacts including miscellaneous forms and fragments are absolutely and relatively rare (70 tools/6978 artefacts > 3 mm = 1.00%; 70/2194 artefacts > 30 mm = 3.19%). The assemblage is characterised by the dominance of 35 borers (Fig 10.6, Nos 17-25, 27-41) including four Zinken (Fig 10.6, No 26 and 10.7 Nos 5, 6, 8) and 16 points. The remaining tools consist of 10 retouched blades/bladelets (Fig 10.7, Nos 17-19, 23 and 24; Fig 10.8, Nos 1, 2, 4, 5) including atypical backed bladelets (Fig 10.7, Nos 14-16), seven burins on both truncations and breaks (Fig 10.7, Nos 1-4, 8-10), and a scraper (Fig 10.7, No 9). This very limited range of tool-classes probably reflects a special task camp.

Among the borers, attention must be paid to some remarkable forms with elongated points which are often broken (*Langbohrer,* Fig 10.6, Nos 20-4, 30–4, 37–41), especially one small unusual implement with retouched sides (Fig 10.6, No 33). There are various forms of points: two complete and two fragments of shouldered points (Fig 10.6, Nos 4–7); three complete and two possible fragments of Creswell points (Type AC1, cf Campbell 1977) (Fig10.6, Nos 8–12); one convex- (Fig 10.6, No 1) and two angle-backed points (Fig 10.6, Nos 2 and 3); and two very obliquely truncated bladelets or simple points (Fig 10.6, Nos 13 and 14). True Magdalenian backed bladelets are missing (cf Fig 10.7, Nos 14–16). This toolkit requires some examination of its chronological, spatial and cultural meaning.

Chronological and archaeological classificationof Schweskau

Before we look for stone artefact assemblages with similar tool types and technology, the extent to which the Schweskau material is functionally representative and comparable has to be considered. The restricted tool spectrum with its high borer component is probably related to special tasks. It indicates a camp site where tasks such as the repair of hunting gear (projectiles) and production of clothing or tent-coverings made of animal hides (borers) may have been primary occupations, while other activities such as the preparation of hides (only one scraper) and working of antler (not many burins) were perhaps only secondary or not performed at all. The lack of splintered pieces — from tools with wedge-like functions — or scrapers is probably not relevant in either chronological or cultural terms, but rather in functional ones. The lack of backed bladelets, however, must be seen in a different way. They may have been used, at least in part, for armatures in hunting weapons. One of the few concrete pieces of evidence as to their function is an antler point with biserially mounted backed bladelets from the Talicki site in the Ural Mountains (Abramova 1982; cf the results of microwear analysis on backed bladelets, eg Moss & Newcomer 1983). At Schweskau however, a different weapon technology is present based on the use of flint projectile points. Whether or not unretouched bladelets were used as armatures, as indicated on the Hamburgian site of Oldeholtwolde (Moss 1988), would need to be investigated by microwear analysis. It may therefore be suggested that these points are culturally relevant as well as the long borers and possibly the blade production method.

The Schweskau assemblage cannot be attributed to any of the well-known Late Glacial techno-complexes. Assemblages of the Tanged Point Complex are totally different. Assemblages of the Rissen type (Schwabedissen 1954) within the Backed Point Complex are also rather distant in terms of typology and technology. Comparable features are found in Late Upper Palaeolithic complexes in Central Europe, ie in the Magdalenian which is restricted to the upland landscape and in the Hamburgian/Creswellian limited to the lowlands. Schweskau is situated in the area of the Hamburgian (Fig 10.12). Apart from the probably younger Havelte group, clear affinities do exist with Hamburgian assemblages (Zinken, shouldered points with transitions to Creswell points, backed points and pointed truncations), but there are also differences (rare long borers, probably another blade production method (see below)). Affinities to Creswellian assemblages can also be drawn. Although the exact chronological, spatial and cultural definition of the Creswellian still remains ambiguous (cf discussion in Stapert 1985), it can probably be conceived of as a slightly younger complex situated west of, and partially overlapping, the Hamburgian area. Similar projectiles (eg Creswell points), are for instance present in north-west Germany at Hohenholz 1 (Bohnsack 1956) and Giebichenstein Stöckse (Nowothnig 1970). The sites of Emmerhout (Stapert 1985) and Siegerswoude 2 in the Netherlands (Kramer *et al* 1985) are notable for the amazing variety of point forms in their assemblages. However, borers are again different, and no details on Creswellian blade method are available.

Until now we have not discovered any indication of the presence or knowledge of the *en éperon* method in north-west German assemblages: Deimern 44, Hohenholz 1, Dörgener Moor (Asmus 1936), Giebichenstein, Pennwurthmoor (Langner 1979). At these sites, the quite excellent blades were struck following platform abrasion of the core, producing diffuse bulbs and a more or less pronounced lip according to the platform angle (Fig 10.10, Nos 2 and 4). The butts are mostly plain and symmetrical, but the striking platforms on the cores are sometimes rejuvenated by several small flakes (Fig 10.10, No 3). The cores show that often flint nodules of convenient shape were selected (Fig 10.10, Nos 1 and 3). It remains to be discovered to what extent this method is in fact represented on Hamburgian sites in Schleswig-Holstein (Hartz 1987). A pre-Allerød age for the Hamburgian seems to be well established (Stapert & Krist 1987; Burdukiewicz 1986b), and Creswellian sites are dated close to (Stapert 1985) or within this time (Jacobi, this volume).

In the Central European uplands there are some affinities to the Magdalenian, ie Döbritzer (Schwabedissen 1954) or Ölknitzer Gruppe (Feustel 1980). These affinities concern the presence of long borers, especially common in the Groitzsch D and in the Saaleck group in the Thüringian Basin (Hanitzsch 1972) or in the Moosseedorf variant (Feustel 1974), although they also exist in many other Magdalenian sites, for instance in the Nebra-Gönnersdorf group. The specific blade method is also present on cores or blades in many Magdalenian assemblages in Central Europe (eg Andernach, Gönnersdorf, Nebra; Groitzsch near Eilenburg (Hanitzsch 1972), and Western Europe (Audouze *et al* 1988). Magdalenian sites are limited to the Central European upland area while

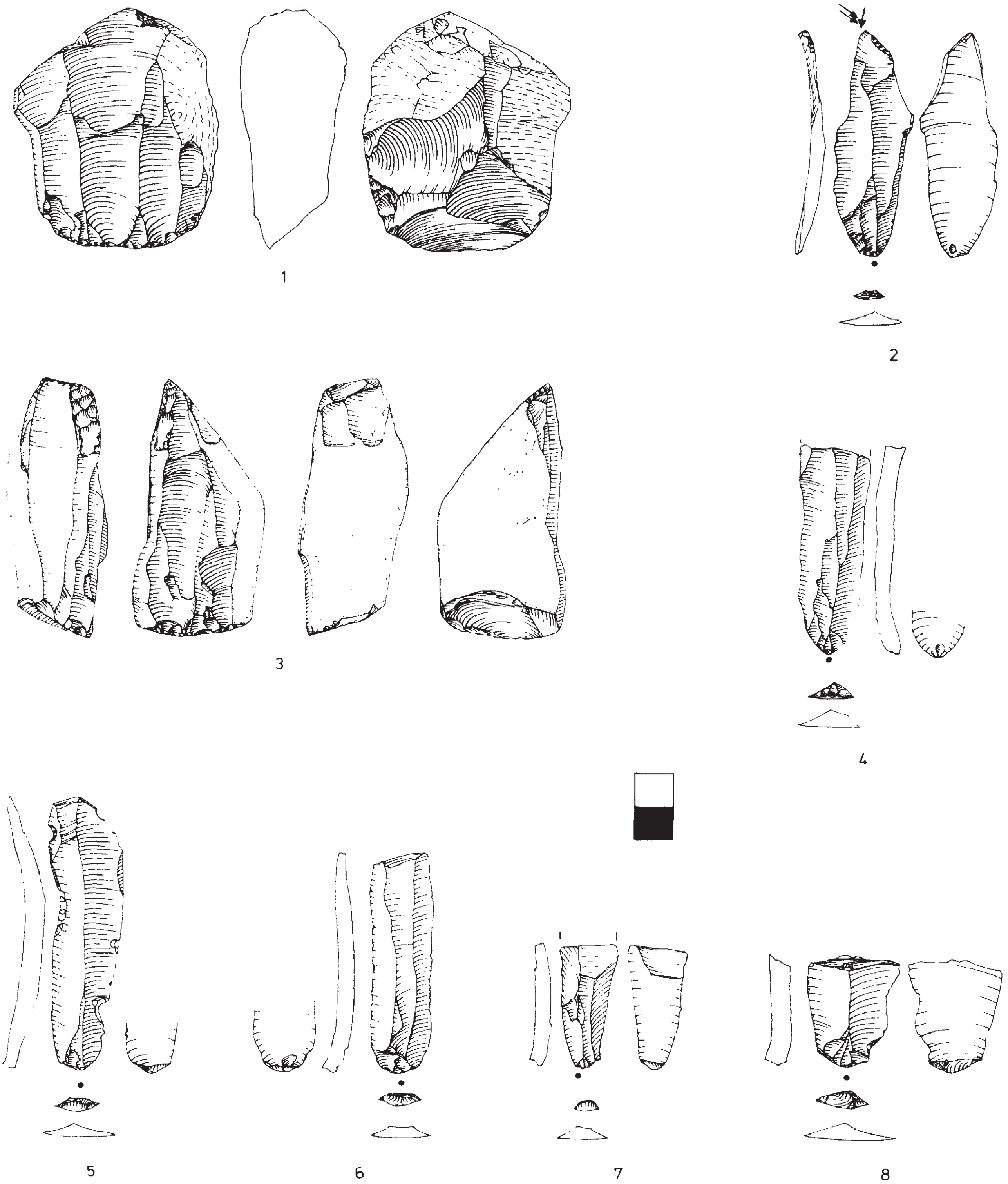

Figure 10.10 Examples of Hamburgian blade technology. Blade cores and regular blades from: 1, 2) Deimern 44, Ldkr Soltau-Fallingbostel; 3, 4) Dörgen, Ldkr Meppen, as compared to 5-8) A-blades from Schweskau. 2 cm scale

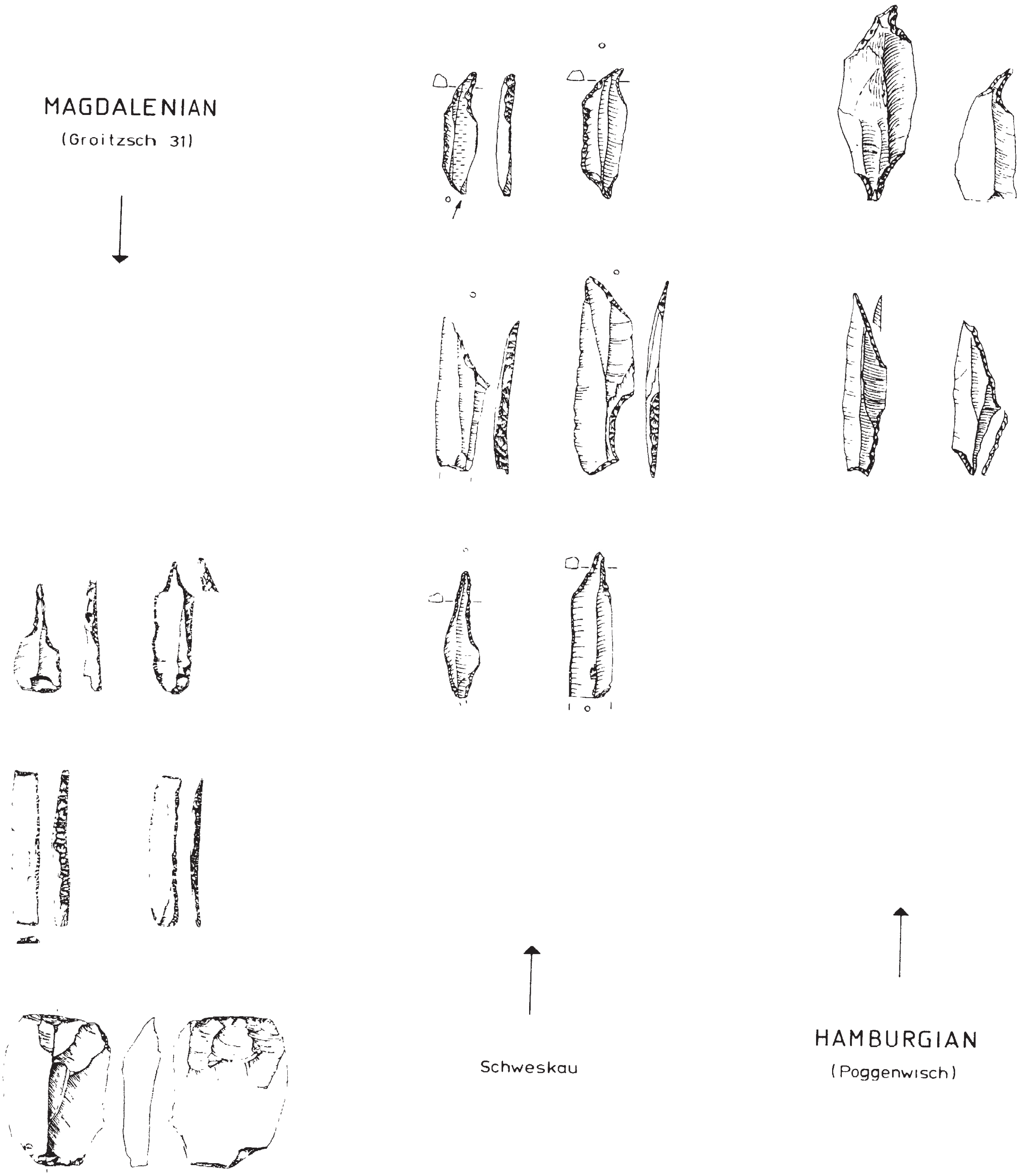

Figure 10. 11 The spectrum of typical tool types from Schweskau in relation to characteristic forms from north German Hamburgian (Poggenwisch, after Rust 1958, Tafln 42, 44) and central European Magdalenian contexts (Groitzsch D1, after Hanitzsch 1972, Tafln 61–4)

Figure 10.12 Distribution of the Hamburgian/Creswellian (black dots) and the Magdalenian (white dots) in central and north-west Europe (Schweskau shown as open triangle). (After Bosinski 1987, Abb 11 with additions. Magdalenian sites after Hanitzsch 1972 (east Germany), Weniger 1982 and Kaulich et al 1978 (south Germany), Bosinski 1988 (west Germany), Svoboda 1984 (CSSR & Austria), Cahen & Haesaerts 1984 (Belgium), Desbrosse & Koslowski 1985 (Poland), Schmider 1988 and Fagnart 1987 (north France), Bandi 1947 (Switzerland), and Arts & Deeben 1987 (Netherlands))

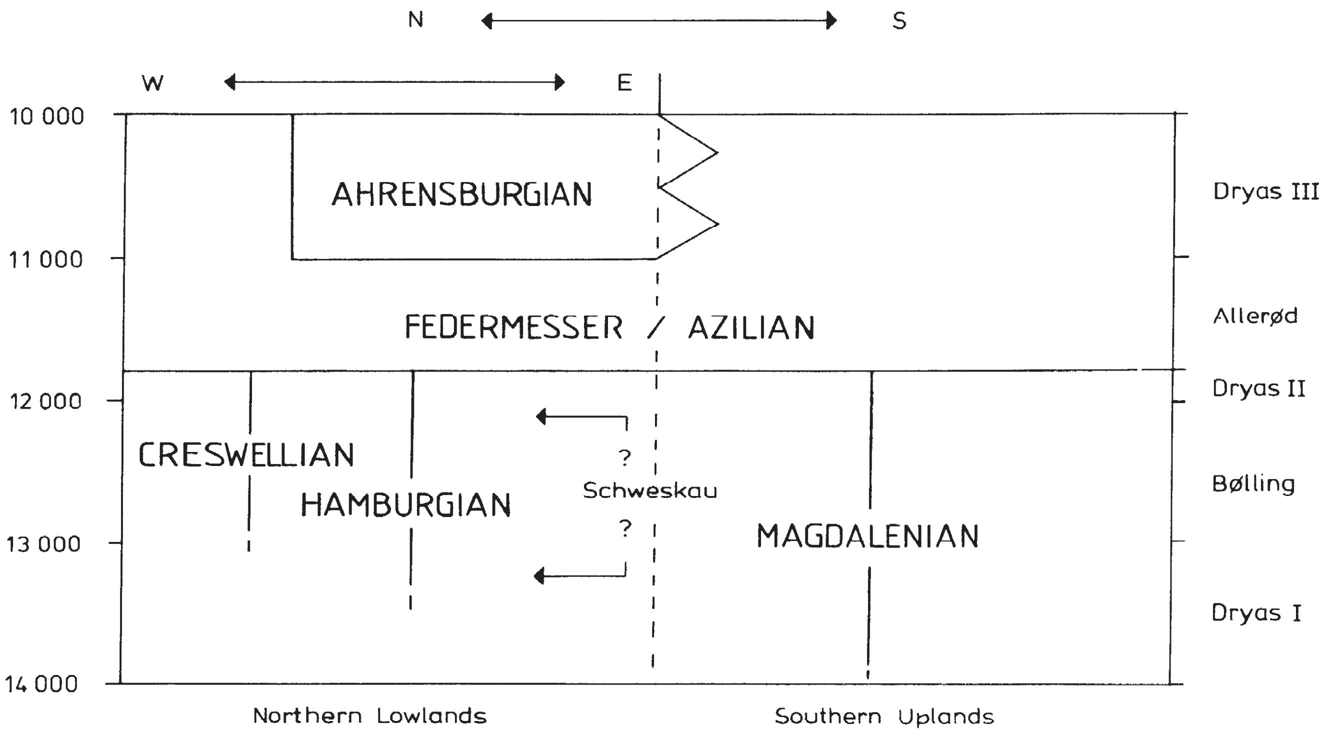

Figure 10.13 Chronological scheme for the Late Upper Palaeolithic and Palaeolithic periods in central Europe in relationship to Schweskau

Schweskau is clearly situated outside this distribution (Fig 10.12). There are good reasons for dating most Magdalenian sites to the pre-Allerød Late Glacial (cf radiocarbon date lists in Feustel 1980 and Fagnart 1987).

The lack of true backed bladelets at Schweskau is an essential difference from all Magdalenian assemblages. Their occurrence seems to be one of the very few attributes discriminating between the Magdalenian and the lowland complexes, at least the Hamburgian. With regard to shouldered and backed points, the situation is different as they occur in varying proportions, but always together with backed bladelets in the Magdalenian area. For some assemblages a Bølling or even earlier age seems possible in view of radiocarbon dates and stratigraphy: ie Petersfels, excavations in the 1930s (Mauser 1970) and P1 AH4 (Albrecht 1979, 32); Hohlenstein-Stadel III (Hahn 1985); Ranis 4/SchVI (Hülle 1977). In other cases without dating evidence, the points serve as an argument either for a similarly early age, eg Fußgönnheim I and II which also contain splintered pieces (Stodiek 1985), or an Allerød age according to the traditional dating of the Federmesser assemblages including the Tjonger group (Schwabedissen 1954) with angle-backed points as in Groitzsch C and B (Hanitzsch 1972) and Etzdorf (Feustel 1955/1956). In summary, some arguments exist that shouldered points and similar forms are an autochthonous element in an early Central European Magdalenian and should not be seen as abnormal, or to be explained, for example, by Hamburgian groups migrating into the uplands during Dryas II (Bosinski 1988; Tromnau 1981).

Thus, Schweskau appears as a mosaic of attributes not fitting exactly into any of the defined Late Upper Palaeolithic archaeological groups (Fig10.11). The following reflections are admittedly speculative, but are necessary as an approach to explaining the presence of unusual elements in the lowlands. The specific shape of the long borers is probably determined by function rather than by style. The weapon technology in the Hamburgian and Creswellian, which was presumably based on stone points apart from *sagaies* and harpoons of antler, appears as a specific answer to the need for projectiles (Fischer *et al* 1984; Moss 1988). On the other hand, the enormous variety of forms must be taken into consideration in some assemblages like Deimern 42 (Tromnau 1975). Can functional differences according to shape in fact be excluded?

Another solution is represented in the Magdalenian, in which composite projectiles with backed bladelets mounted on points of antler or other materials have been used. The morphological variation in projectile types could however reflect cultural/stylistic differences. The large scale differences between neighbouring, but partly overlapping, complexes such as the Creswellian and Hamburgian can be explained in this way (Stapert 1985).

The relevance of the blade technology cannot be judged in a satisfactory way because not enough analysis has been carried out yet. Its chronological and cultural meaning is not clear, at least in the area discussed here. The butt shapes resulting from the *en éperon* method can of course be produced by chance from time to time. Therefore even its occasional occurrence does not mean that this method was an explicit feature in one group's lithic tradition. On the other hand, the method may well have been a part of the general lithic tradition, but not applied everywhere by everyone.

How, therefore, should we understand the historical context in which the Schweskau camp site once belonged? Three scenarios will be discussed in more detail. Firstly, perhaps Schweskau was a singular type of special task camp within the general Hamburgian tradition, where different tools were used than are commonly found at other Hamburgian sites. However, this would mean that certain tool types, namely the long borers, were almost exclusively used at small sites such as this. The same assumption should probably be made concerning the blade technology. According to this first hypothesis the Schweskau assemblage could still be placed within the range of the functional variability of the Hamburgian. But, just because of the special character of the site, it should not be considered as a new phase or subgroup within the Hamburgian.

On the other hand, one could interpret the elements present in the Schweskau assemblage as components of different technocomplexes. It is possible that Schweskau is a very early, even transitional, Hamburgian site. Contrary to earlier views which saw the origins of the Hamburgian in the east (eg Rust 1943), or which interpreted it as a seasonal variant of the Magdalenian (Sturdy 1972), the Hamburgian is seen today more as an offspring of the Magdalenian (Burdukiewicz 1986b) with similarities in both the antler technology and art style (Bosinski 1978). According to these ideas, the origin of the Hamburgian would have to be looked for in territories south (Otte *et al* 1984) or south-west of its later distribution area. As has been discussed above, there is some evidence that Hamburgian weapon technology has its roots in the Magdalenian in the Bølling. Schweskau could accordingly belong to the initial phase of the Hamburgian (Fig 10.13). Weapon technology based on stone projectile points is already dominant in the Schweskau assemblage, but certain features such as the long borers and the particular blade technology are maintained, as would be expected in the areas of origin. Another argument in favour of this hypothesis can be seen in the fact that the 'Havelte' point types of the supposed younger phase of the Hamburgian (Stapert 1985) are not present at Schweskau. In contrast, the Schweskau shouldered points with basal truncations have parallels in the Poggenwisch assemblage (Rust 1958) which has the oldest consistent radiocarbon dates within the Hamburgian (Fischer & Tauber 1986)[3]. Incidentally, this hypothesis would be consistent with the eventual recognition of that specific blade technology in older Hamburgian assemblages. The long borers are however especially abundant in Magdalenian assemblages like Saaleck, which are dated rather late in the Central European Magdalenian typologically, by the presence of backed bladelets with truncations (Terberger 1987), and by the artwork (Bosinski 1982). This argument is however not convincing because of the special character of the Schweskau camp.

Finally, a third possibility that has to be considered is that the Schweskau site documents the migration of Late Magdalenian people to northern territories (Fig 10.13). They had abandoned their technology based on backed bladelets (projectiles and other forms) but still kept their basic flint technology, and continued to make certain objects for the production of which long borers were used. Weapon technology, hitherto based on backed bladelets, had been replaced by projectiles with stone points. What circumstances may have been responsible for such a population shift northwards? Why has this shift not left more traces? A possible stimulus could have been the serious ecological change at the end of the Ice Age, when birch and later spruce forests spread extensively (Overbeck 1975; Huntley & Birks 1983). Possibly the process of forestation was time-transgressive, with a south-north delay. Alternatively, perhaps a kind of moving forest front existed, or forestation started at several places independently because of supposed pleniglacial birch refugia in the north *(ibid)*, but at different intensities depending on the latitude (Overbeck 1975, 434-6). Parallel to these ecological changes a major change in archaeological material culture took place ('Azilian'). Part of the original Magdalenian population may have adapted to the changed environmental conditions, for example the shaft smoothing stone found in Niederbieber/Neuwieder Becken with a series of engraved stylised women (Loftus 1982) may indicate continuity with the Azilian. Other Magdalenians may have moved northwards where they met other bands with a different weapon technology. There are probably still other valid hypotheses than those presented above. Maybe some can be validated by further studies. A special importance has to be attributed in this context to studies of blade technology on 'small' sites, and of course to microwear analysis of stone tool use in order to understand more of the meaning of technological and typological features.

Notes

1 As yet there is no relative or absolute dating evidence available for the site. A radiocarbon date obtained from a marl sample proved to be contaminated by CO2-enriched waters (Hv 15823 8900±205 BP, M A Geyh 11.4.1989). There is also no pollen preserved in the marl. The assemblage contained no Late Upper Palaeolithic burnt flint of sufficient size to be suitable for thermoluminescence dating (J. Huxtable, Oxford).

2 A faint scatter of Mesolithic artefacts also occurred at the site, but could be recognised easily by typological and technological attributes as well as by colour and heat crazing.

3 Recent discussions with S. Hartz, Schleswig, and analysis of debitage has shown that the Hasewisch assemblage contains no *en éperon* blades, while at Poggenwisch they do occur although in very small number (*c* a dozen examples).

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11 Pioneers in deglaciated landscapes: The expansion and adaptation of Late Palaeolithic societies in Southern Scandinavia

Anders Fischer

Abstract

This paper surveys the available information concerning the Late Palaeolithic in Denmark and neighbouring countries with special attention to chronology and mode of life. The Hamburg, Federmesser, Bromme and Ahrensburg technocomplexes are considered successive cultural epochs of those pioneer societies which gradually expanded their territories northwards over the landscapes left behind by the melting glaciers. Together these complexes represent an individual, culture historical era, defined by a specific mode of life adapted to abundance of space, food and raw material and characterised by a lower level of technological and social complexity than ever since seen in this part of the World.

Introduction

The term Southern Scandinavia, is here defined as Denmark, Scania and Schleswig-Holstein, where the Late Palaeolithic was an era of pioneers. During this time Weichselian glaciers disappeared and man arrived — and stayed until the present day.

There are no traces of Upper Palaeolithic habitation in Southern Scandinavia during the period of maximum glaciation — not even in the large south-western area which was never covered by the glaciers. The beginning of the Late Palaeolithic in Southern Scandinavia can simply be defined by man's re-immigration into the area during the decline of the last Ice Age. The end of the era is defined by the introduction of the flint axe. This technological innovation seems to coincide with the environmental transition from the Pleistocene to the Holocene, ie from the Younger Dryas to the Pre-Boreal.

The Late Palaeolithic does not represent the earliest epoch of human presence in Southern Scandinavia. Traces of habitation prior to the Weichselian glaciation are also known from the area (Holm 1986; Hartz 1986). However, these finds are too damaged to be of use in the study of daily life and cultural development.

Quite the opposite applies to the finds of the Late Glacial. In fact this epoch is probably the best known period of the Danish Stone Age in terms of daily life, despite the much larger and generally much better preserved source material of the subsequent epochs. Paradoxically it is the poor state of preservation of Late Glacial cultural debris which is largely responsible for the relatively high level of information available. The lack of conspicuous material has forced scholars into refining methods of excavation, analysis and interpretation for the purpose of extracting knowledge from inconspicuous sources. These new methods have yet to be fully utilised in the study of the succeeding epochs. Furthermore the Late Palaeolithic sites seem to have been inhabited much more briefly than most sites of the following millennia, leaving generally much simpler, less blurred and more easily interpreted 'finger prints' of former activities.

The present paper consists of two parts. The first deals with the immigration of man to Southern Scandinavia after the retreat of the glaciers. This is done on the basis of the total archaeological material of the Late Palaeolithic era in Denmark and its environs. This part may be considered a nuisance of archaeological typology and chronology, but is necessary to gain a reasonably reliable impression of the dynamics of the expansion of human settlement into the area.

In the second part of the paper, the specific adaptation of Late Palaeolithic people in Southern Scandinavia is dealt with in terms of technology, subsistence and social organisation. I conclude that

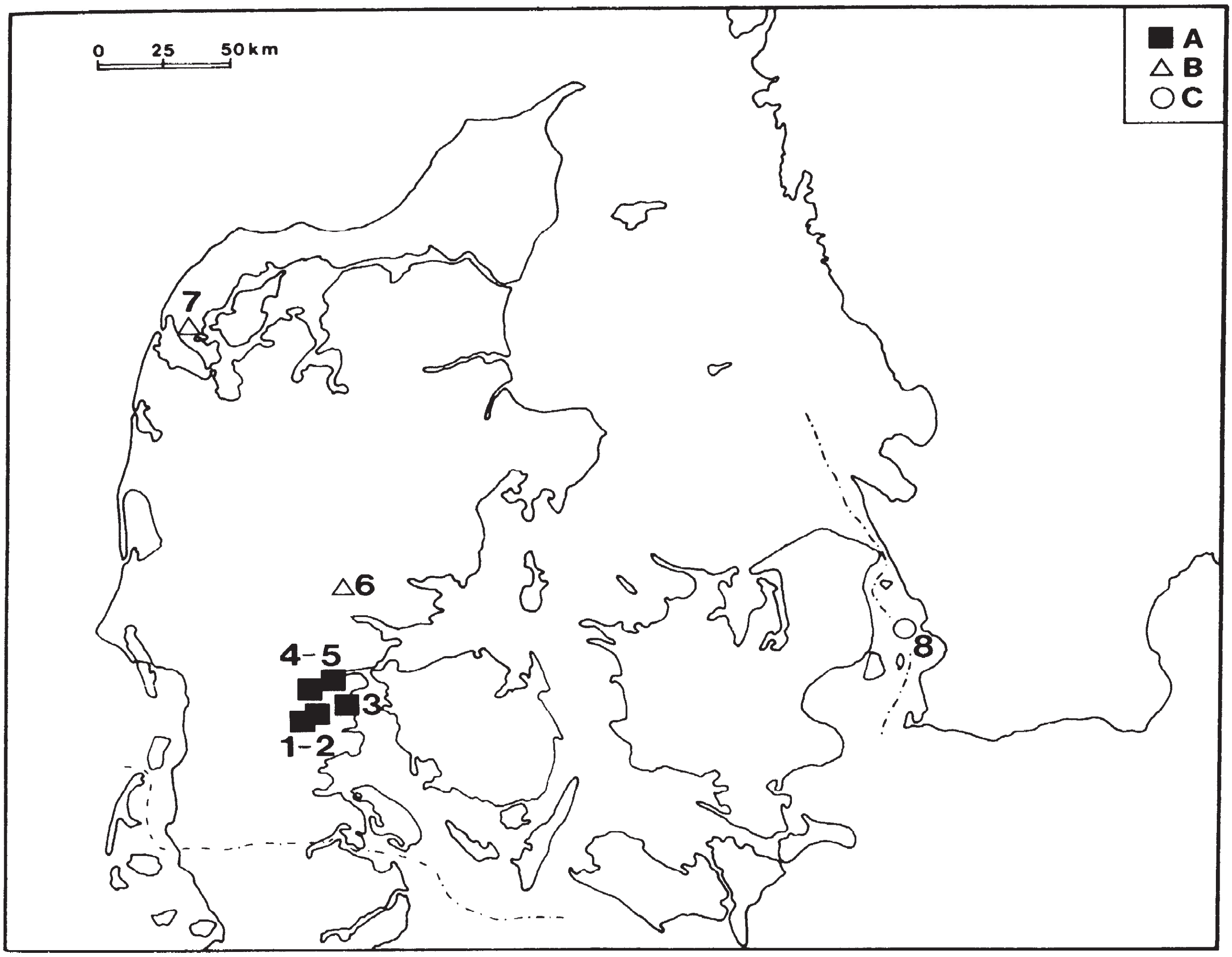


Figure 11.1 The Hamburg technocomplex in Denmark. A) settlement assemblage with shouldered point (s); B) stray find of flint point of potential Hamburgian origin; C) stray find of a reindeer antler artefact, of possible Hamburgian origin. 1, 2) Slotseng; 3) Brændøre; 4, 5) Jels; 6) Bjerglev Hede; 7) Ydby; 8) Middelgrunden

the Allerød period in Northern Europe must have been 'a paradise on Earth'.

The immigration of people to Southern Scandinavia during the Late Palaeolithic

The technocomplexes

The Late Palaeolithic artefactual material of northwestern Europe is usually divided into four archaeological groups (often called technocomplexes or cultures): the Hamburg, the Federmesser, the Bromme and the Ahrensburg complexes.

These groups are defined in the traditional way on the basis of the presence or absence of certain varieties of retouched tools, which are considered as 'type fossils'. Such definitions, however, are not ideal in the study of culture history as they prevent positive classification of many small assemblages. Furthermore they create the problem that the divisions might relate to functional (ie activity-specific), rather than chronological and/or cultural variation.

In practice, however, the grouping into the four technocomplexes seems to be confirmed by statistically reliable and culturally significant variations in the general lithic technology — most importantly the blade production technique (cf Bokelmann & Paulsen 1973; Hartz 1987; Fischer 1990a; 1990b, and in press b). The results of recent use wear studies (Moss & Newcomer 1982; Fischer *et al* 1984) are also relevant here, as they have shown that the tools defining the individual technocomplexes had more or less identical functions. This observation supports the interpretation of a cultural and/or chronological significance for these groupings. On this basis I still consider the four complexes convenient for further research.

The Hamburg complex

The type fossils of the Hamburg complex are shouldered points and Havelte points, both of which were undoubtedly used as tips of projectiles — probably arrows (Fischer *et al* 1984; Fischer 1989). Furthermore, 'Zinken' can be considered a supplementary characteristic of this archaeological grouping.

Settlements characterised by classical Hamburgian shouldered points are known as far north as the German-Danish border (Tromnau 1975). In Denmark, finds indisputably belonging to this technocomplex have appeared only recently. In the latest review of this subject Holm and Rieck (1987) list three habitation sites and two stray finds. The settlements (Fig 11.1) are well documented and all belong to the Havelte group which probably represents the latest part of the Hamburgian epoch (Stapert 1985).

The two stray finds listed by Holm and Rieck (1987) cannot be assigned to this era with the same degree of certainty. The flint point from Bjerlev Hede (Becker 1970), which may well be a classical shouldered point of Hamburgian origin, could also be classified as an Ahrensburgian point. The worked piece of reindeer antler from Middelgrunden in the strait of Øresund (Mathiassen 1938) is even more problematic, as there is no definite evidence to support its being Hamburgian — either on typological or palynological grounds. In fact, it could be relatively modern, dropped from a ship returning from Greenland or northern Scandinavia.

Tromnau (1974) records an additional Hamburgian artefact from Denmark; a stray surface find from Ydby, Northern Jutland (Fig 11.2). However, the artefact has a bifacially retouched base, which is not characteristic of the Late Palaeolithic, and its attribution to the Hamburgian is thus uncertain.

In short, the northernmost traces of definite Hamburgian habitation are represented by a few well-documented settlement assemblages from the South-Western part of Denmark.

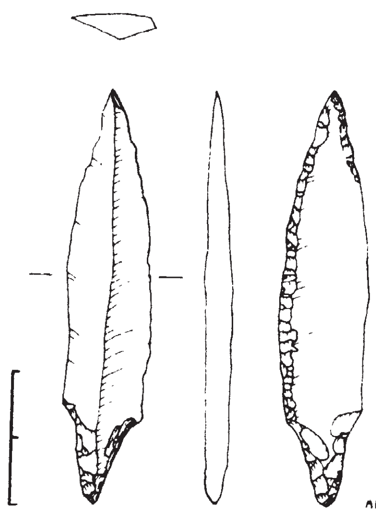


Figure 11.2 The northernmost trace of the Hamburgians? A flint point from near Ydby, north-west Jutland. 2 cm scale

The Federmesser complex

The type fossils of this grouping are steeply backed points (Rückenspitzen) and bladelets (Rückenmesser) (cf Schwabedissen 1954; Taute 1968). This group of artefacts demonstrates considerable morphological variation and overlaps somewhat with tools of Postglacial age. In the present paper the author only considers stray finds of Rückenspitzen with obliquely retouched bases as definite type fossils of the technocomplex. These flint points were probably used as tips of arrows (cf Bosinski 1983, 951, while the Rückenmessers may have functioned as tips and side edges of unspecified projectiles (arrows or spears).

Traditionally, end-scrapers with steeply retouched sides ('Wehlen scrapers') were also considered to be characteristic of the complex. However, such scrapers are now known also to be an integral part of the oldest assemblages of the Bromme technocomplex (Madsen 1983; Nilsson 1989).

Settlement assemblages combining Rücken spitzen and Wehlen scrapers are known from south-western and south-eastern parts of Denmark, as are stray finds of Rückenspitzen with obliquely retouched bases (Fig 11.3). Other types of Rückenspitzen and Rückenmesser also appear further to the north.

In several cases the 'type fossils' of the Federmesser complex have been found in combination with tools characterising other Late Palaeolithic technocomplexes. At the Hamburgian site of Jels, the occurrence of two Rückenspitzen and some Wehlen scrapers (Helm & Ricck 1987) can be explained as an accidental mixture of two chronologically distinct habitations (Fischer 1990a).

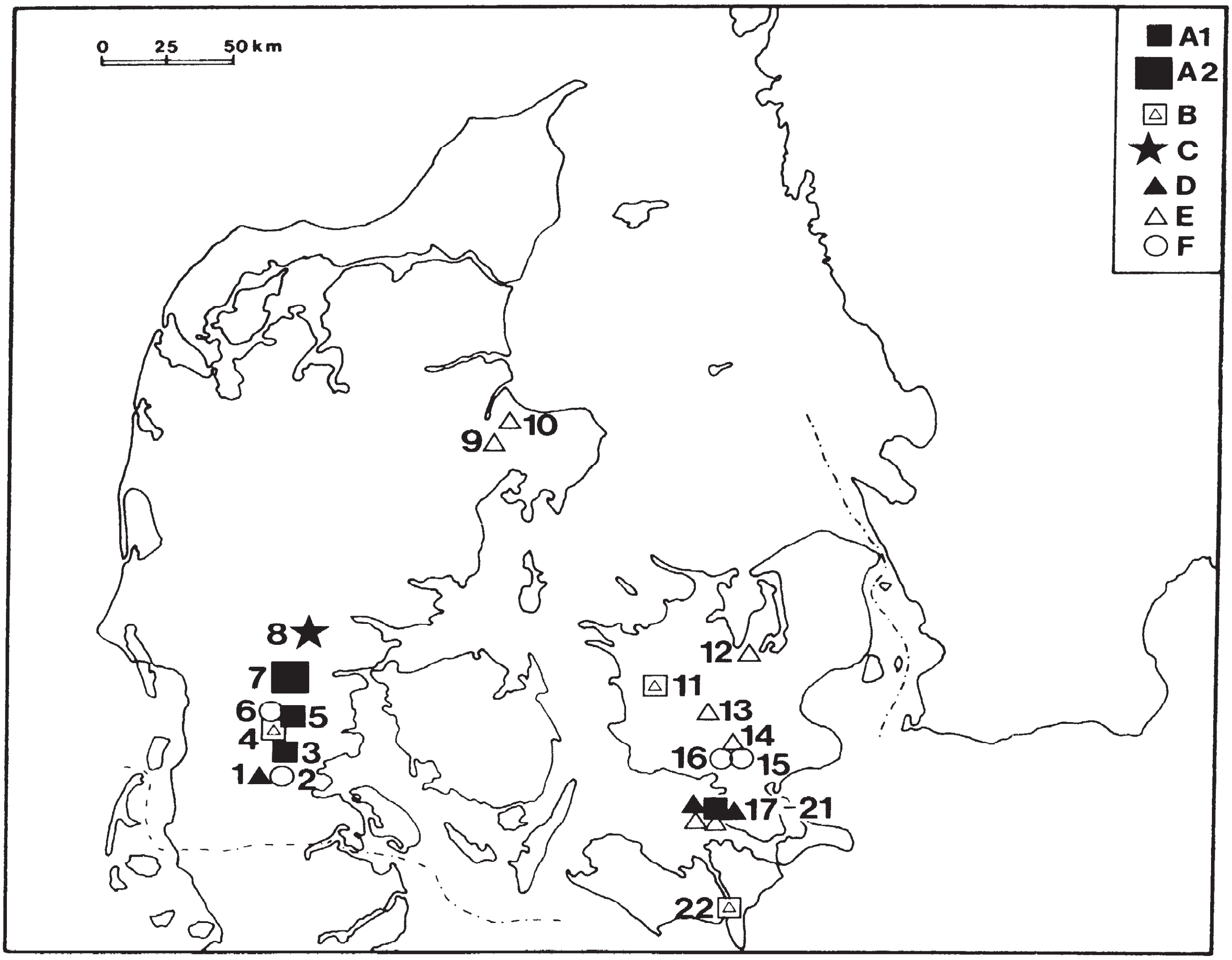


Figure 11.3 The Federmesser technocomplex in Denmark. A1) assemblage with Rückenspitze(n)/Rückenmesser and Wehlen scraper(s); A2) three or more assemblages with Rückenspitze(n)/Rückenmesser and Wehlen scraper(s); B) assemblage with possible Rückenspitze(n) or Rückenmesser; C) flint workshop, blade technology in 'Federmesser tradition'; D) definite Rückenspitze; E) possible Rückenspitze or Rückenmesser; F) Brommian assemblage including a minority of Rückenspitzen/Rückenmesser. 1, 2) Hjarup Mose (Andersen 1977); 3) Tingvadbro (Holm & Rieck 1987); 4, 5) Jels I and II (Holm & Rieck 1987); 6) Över Jels (Holm & Rieck 1987); 7) Sølyst M2 et al; *8) Egtved (Fischer 1990a); 9) Ringsø (Madsen 1982); 10) Gjessing parish (Madsen 1983); 11) Rørmose; 12) Jenslev; 13) Sigersted; 14) Broksø; 15) Stoksbjerg Vest; 16) Fensmark Skydebane; 17) Rundebakke (Fischer 1990a); 18–21) Knudshoved Odde (Fugl Petersen 1974; 22) Hasselø (Vemming Hansen 1988). In 7 and 17 a minority of the points are atypical Brommian tanged points*

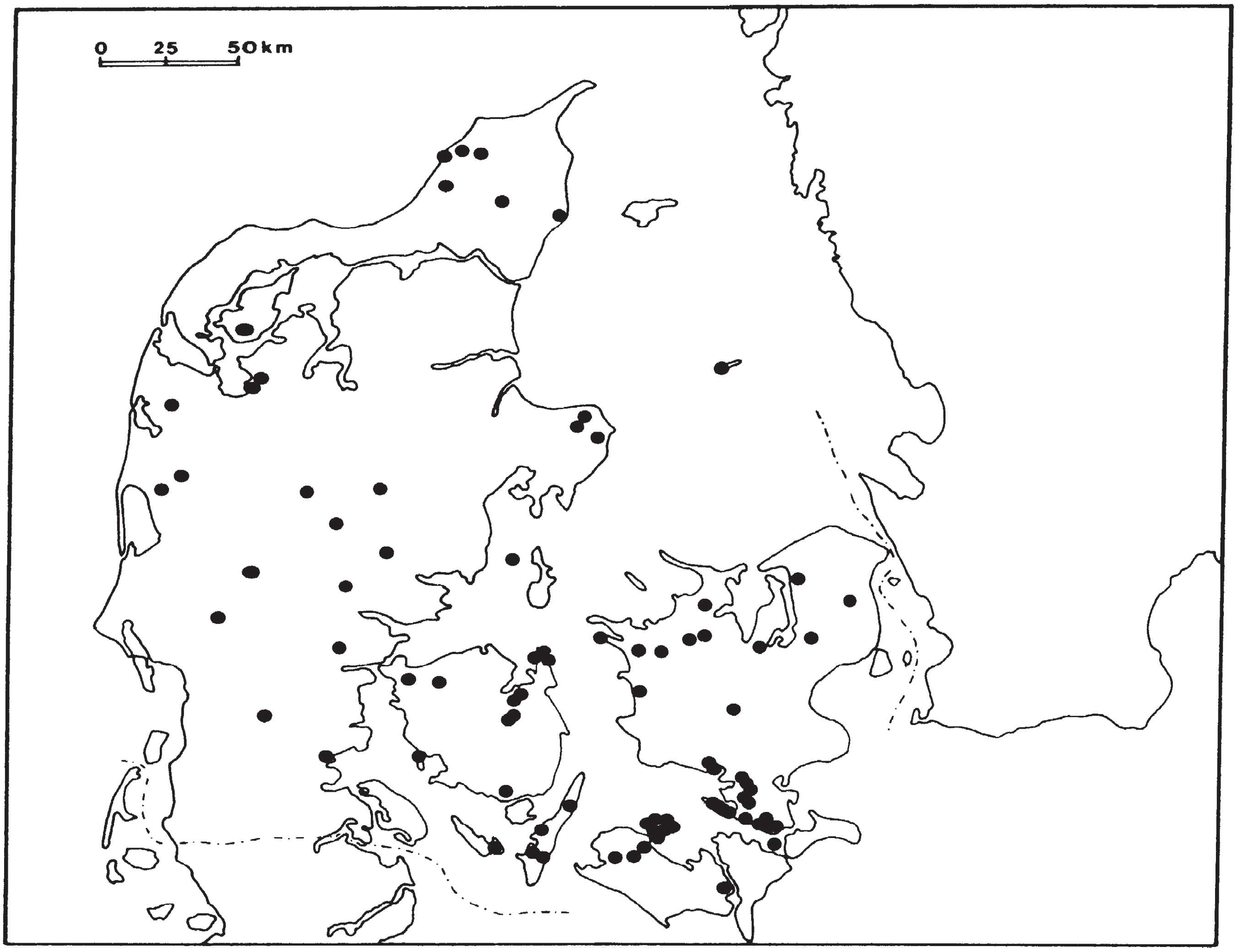


Figure 11.4 Distribution of single finds of Brommian tanged points from Denmark. Redrawn from Fischer 1985a

Taute (1968) has referred assemblages combining points of the Federmesser and Bromme complexes to the Tolk/Sprenge group. The chronological and cultural significance of this grouping is still hard to determine, since the temporal homogeneity of most of these assemblages is rather uncertain. An accidental mixture of artefacts from chronologically separate Federmesser and Bromme habitations is possible in some cases. On the other hand, such an explanation is less likely where the tanged points in question are clearly different from those of the Bromme and Ahrensburgian complexes, for example the tanged points from Rissen 14 and Borneck Mitte (Schwabedissen 1954, Taf 25.19, 20, 23; Rust 1958, Taf 1924), which have much shorter tangs than those characterising the Bromme complex. In such cases, we may very well be dealing with homogeneous assemblages which would be either the predecessors or contemporaries of the Bromme complex as defined below.

Given the occurrence of homogeneous assemblages containing the type fossils of both the Federmesser and the Bromme complexes, the distinction between the two groups has to be defined. Here, such assemblages are referred to the complex whose 'type fossils' are dominant.

Type fossils of the Federmesser technocomplex are numerous in Schleswig-Holstein and are present in the southern parts of Denmark. Finds related to the complex, or reminiscent of it, have

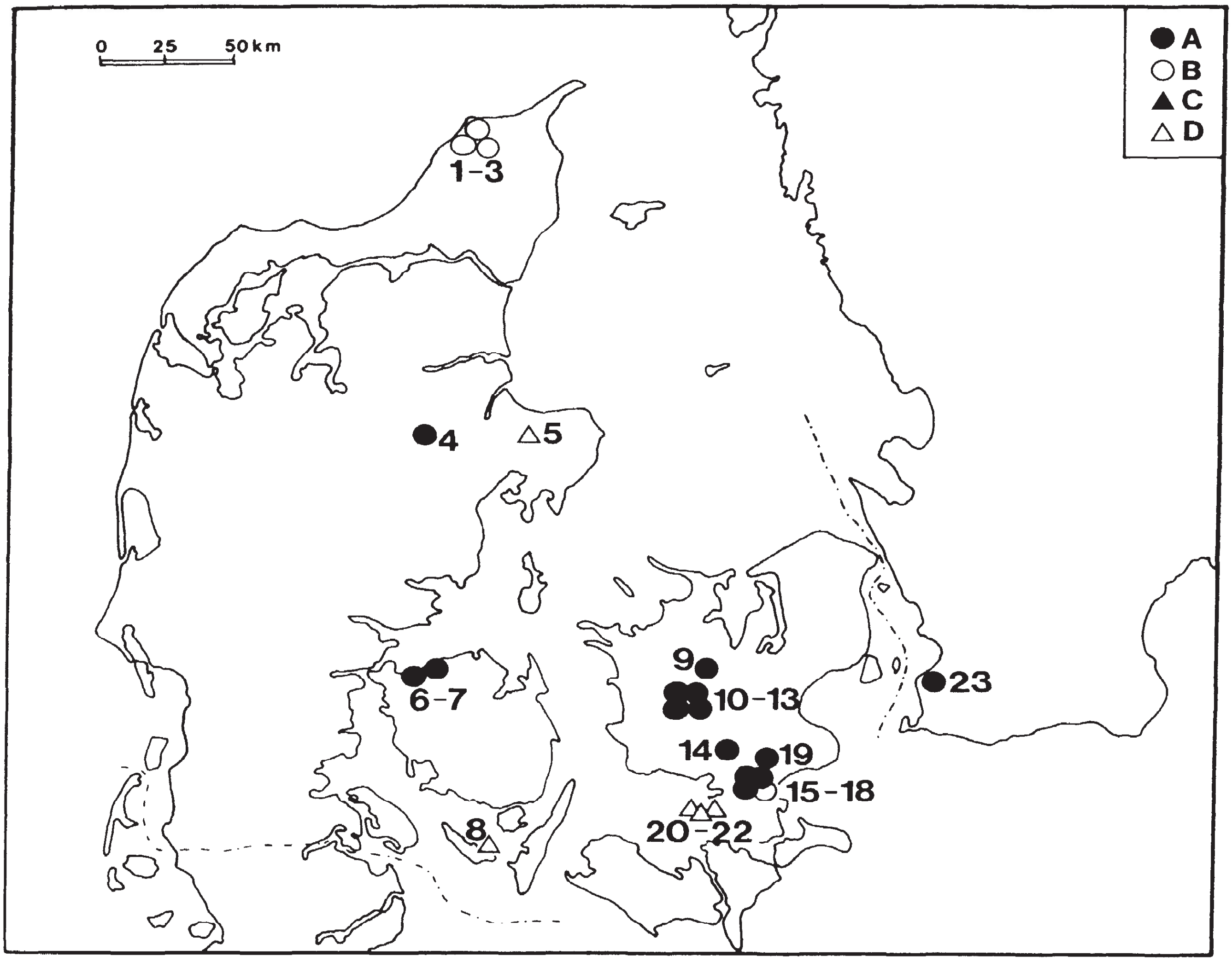
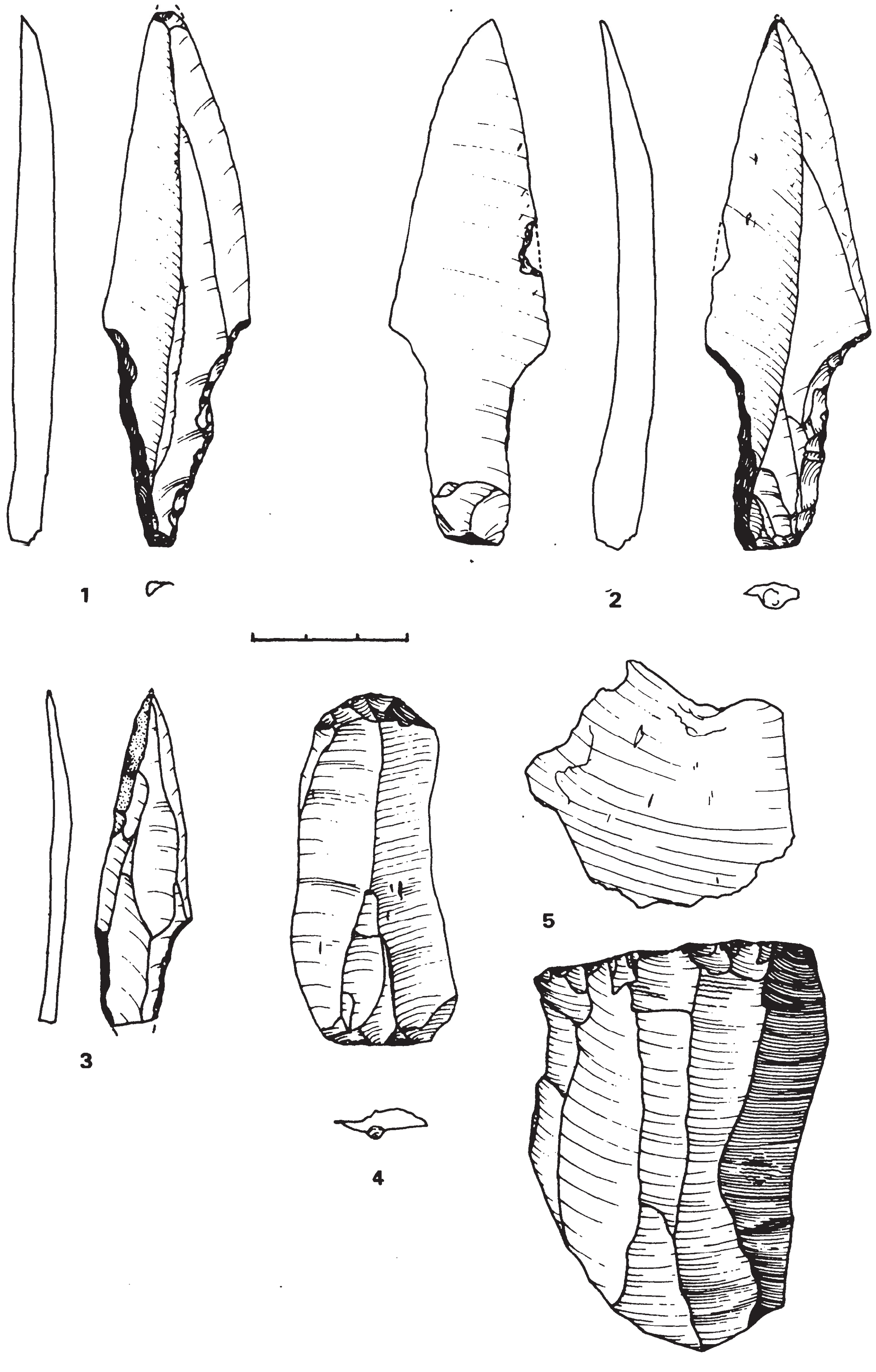


Figure 11.5 The Bromme technocomplex in Denmark and Southern Sweden. Excavated and surface collected sites with a minimum of 10 retouched tools and a representative sample of tools and cores. A, B) sites located adjacent to large lakes or rivers; C, D) sites in other locations; filled in symbols: cores constitute more than 25% of the total sample of tools and cores; open symbols: cores constitute no more than 25% of the total sample of tools and cores; 1–3) Ramsgård I, II and V (Nilsson 1989); 4) Langå (Madsen 1983); 5) Løvenholm (Madsen 1983); 6, 7) Bro I and II (Andersen 1970; 1973); 8) Ommelshoved (Holm 1972; Fischer 1985a); 9) Højgård; 10–13) Bromme A, B, C, D (Fischer & Nielsen 1987); 14) Trollesgave (Fischer, In press b); 15–18) Stoksbjerg Vest I–IV 19) Stoksbjerg Bro; 20) Æskebjerg (Rasmussen 1972); 21) Knudshoved II (Becker 1971); 22) Knudsskov; 23) Segebro (Salomonsson 1964; Larsson 1982)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also appeared further north, although none so far has been reported beyond the Danish border.

The Bromme complex

The primary type fossils of Bromme industries are tanged points, with the tang at the bulbar end of the blade (Fig 11.6; Fischer 1985a). On the basis of wear marks, these points were probably used as the tips of projectiles — probably arrows (Fischer *et al* 1984; Fischer 1985b; 1989).

As noted above, some seemingly homogeneous assemblages include typical Brommian points as well as tools traditionally considered characteristic of the Federmesser complex: Rückenspitzen/Rückenmesser, and Wehlen scrapers. In all Danish cases (Fig 11.3) Rückenspitzen/Rückenmesser are less numerous than the tanged points. Wehlen scrapers now appear to be an integral part of the oldest stages of the Bromme complex.

Nationwide distribution maps for the Bromme technocomplex were last made in 1978 (Fischer 1985), when settlement sites were known only from the central and eastern parts of Denmark. Stray finds of tanged points, however, indicated the presence of the complex all over the country (Fig 11.4). Since then several settlements have been found in the western part of the country (cf Fig 11.5).

The Bromme complex is also represented north-east of the Danish border. A few settlement sites and stray finds have long been known from Scania — the southernmost part of Sweden (Salomonsson 1961; 1964). In recent years, several more such finds have been reported from this province (Götz & Carlie 1983; Larsson 1984; 1987, and this volume).

Stray finds of flint points, considered to be of Brommian type, have been reported from further north in Sweden and Norway (eg Gjessing 1945,39; Cullberg 1972, 34; Larsson 1984, 103; Bang-Andersen 1988, 41). As far as can be determined from the published illustrations, however, these artefacts have no obvious parallels with those of the Bromme complex in Southern Scandinavia. Thus, on the basis of typology a Late Palaeolithic age for these artefacts is unlikely.

The Ahrensburg complex

The primary type fossil of the Ahrensburgian group is the small tanged point (Fig 11.7) less than 5.5 cm in length and with the tang at the distal end of the blade (cf Fischer 1978). The bulbar end of the blank is usually removed by oblique retouch without the use of microburin technique. Small Brommian tanged points are also found in many assemblages from the Ahrensburg complex. 'Zonhoven' points, obliquely retouched microblades not produced by microburin technique, may be considered a

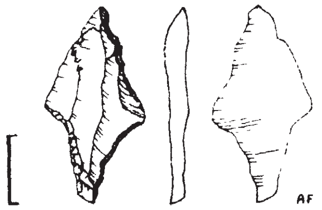


Figure 11.7 Tanged point of Ahrensburgian variety from Løjesmølle, western Zealand. Scale in cm

supplementary type fossil of the Ahrensburgian. Both point types show wear marks indicating their use as tips of projectiles (Fischer *et al* 1984). Some Ahrensburgian points have been found mounted as heads of arrows (Rust 1943). A variety of flat, unifacial bi-polar blade cores (Fig 11.8) can also be considered an indicator of Ahrensburgian affinity in lithic assemblages.

The small Ahrensburgian points are more difficult to find than the larger Bromme points. This may account, at least in part, for the scarcity of Ahrensburgian finds in Denmark (Fig 11.9). It is interesting to note that both of the known Ahrensburgian settlements were identified incidentally during field surveys following the discovery of Brommian artefacts in the area.

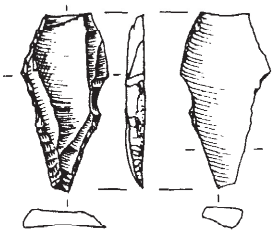
As with the Bromme, the Ahrensburg complex is represented also in southernmost Sweden (Fig 11.9). Artefacts reminiscent of Ahrensburgian tanged points likewise appear further north within the Early Mesolithic Fosna/Hensbacka complex (Taute 1968; Fischer 1978; Johansson 1990).

If the start of the Mesolithic is defined by the introduction of the flint axe (cf Schwantes 1923; Mathiassen 1947), then the latest varieties of Ahrensburgian tanged points seem to be related to this period. This association is indicated by a small assemblage from Bonderup, Eastern Denmark (Fischer 1982), and a larger industry from Deimern 45, north-western Germany. Both assemblages contain an artefact which may be considered a 'proto flake axe' (Fig 11.8; Taute 1968, Taf 15.1). In addition, both industries also contain Ahrensburgian tanged points with continual retouch from the tip to the tang which are possibly the typological predecessor of the 'one-edged points' of the Early Mesolithic Fosna/Hensbacka complex (Fischer 1978; Johansson 1990).

Relative and absolute chronology

There are few well-dated Late Palaeolithic finds from Southern Scandinavia. Assemblages dated by environmental evidence are rare, and the number of reliable stratigraphic observations even rarer. As a result, only tentative conclusions can be drawn concerning the chronological and culture-historical

Figure 11.6 Characteristic artefacts from the Brommian site of Ellensbanke, southern Zealand. 1–3) tanged points; 4) blade end-scraper; 5. blade core. Scale in cm



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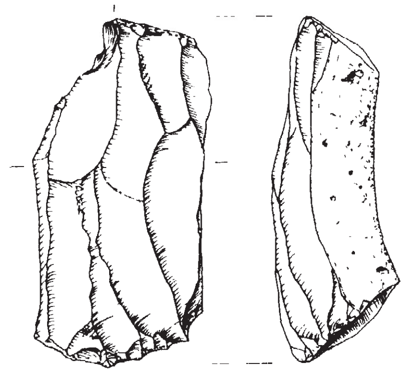

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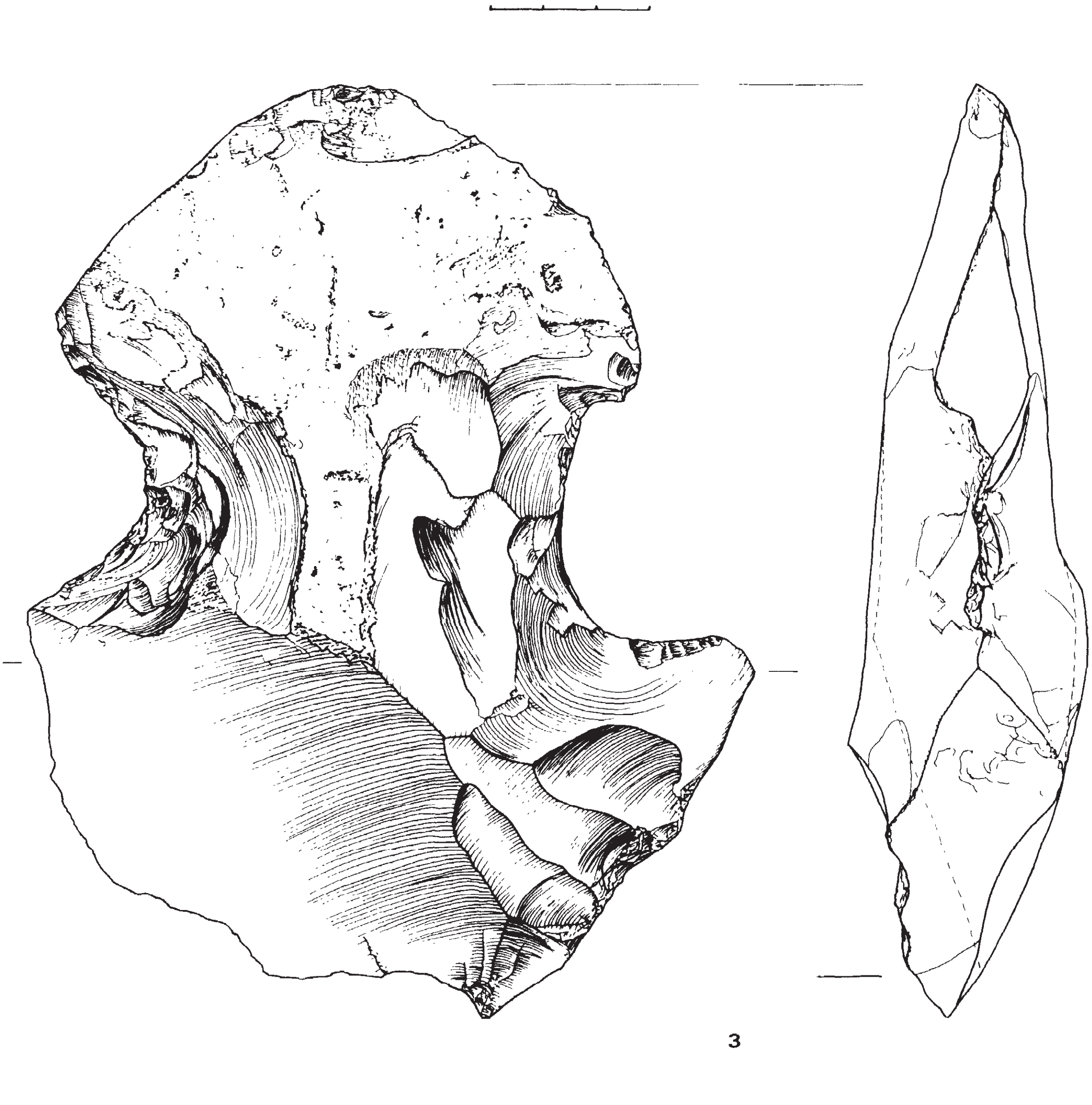

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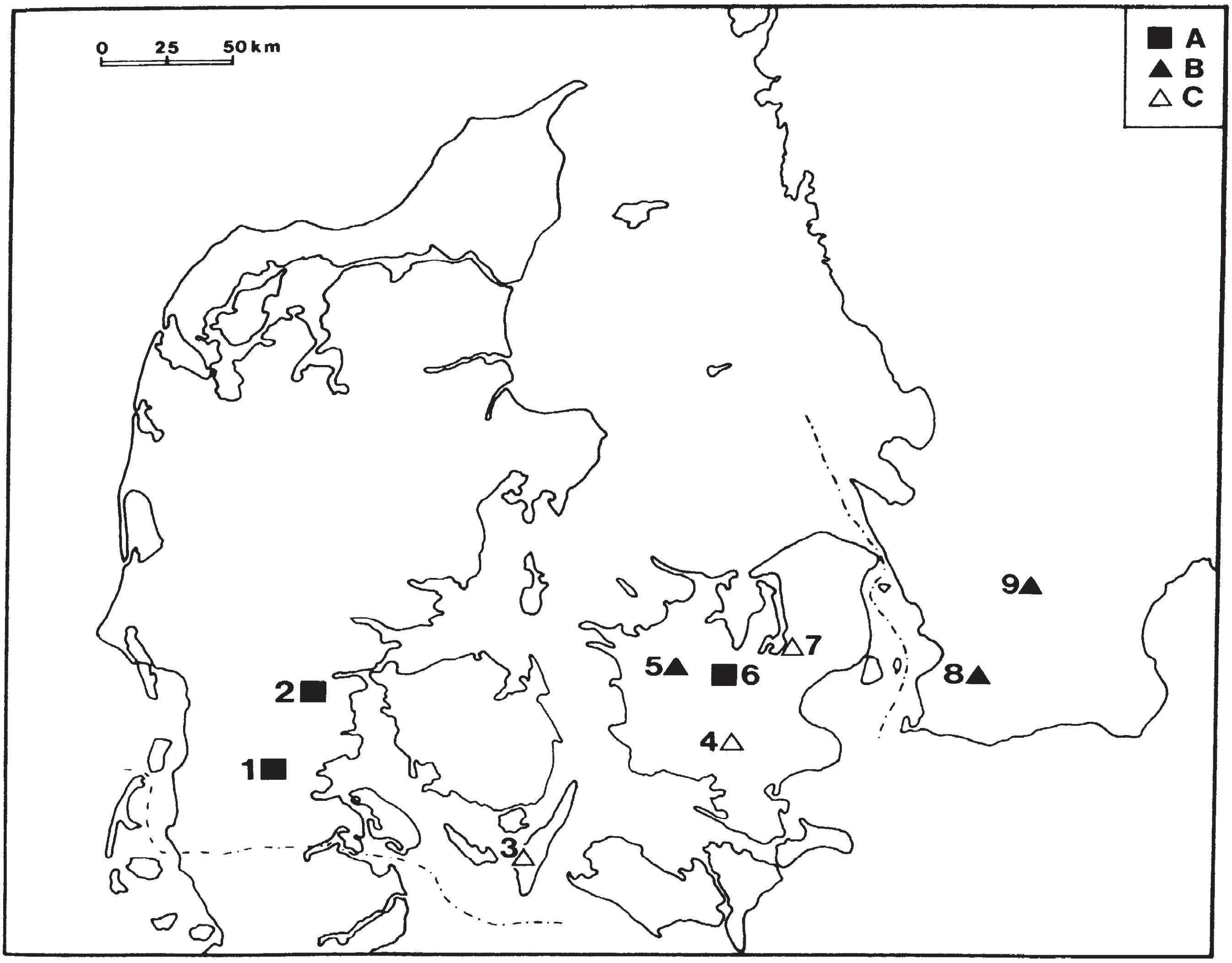

Figure 11.9 The Ahrensburgian technocomplex in Denmark and southern Sweden. A) settlement assemblage with Ahrensburgian point(s), Zonhoven point(s) and/or flat unifacial opposed platform blade cores; B) Ahrensburgian tanged point; C) stray find of an Ahrensburg-like point with tip apparently produced by microburin technique; 1) Hjarup Mose (Andersen 1977); 2) Bramdrupgård; 3) Lindelse (Becker 1971); 4) Broksø; 5) Løjesmølle (see Fig 11.7); 6) Bonderup (Becker 1971; Fischer 1982); 7) Korsbjerggård; 8) Öbacken (Welinder 1971); 9) Munkarp (Larsson 1976)

Figure 11.8 Artefacts from the transitional Late Palaeolithic/Early Mesolithic assemblage of Bonderup central Zealand. 1) Ahrensburgian tanged point; 2) unifacial opposed platform blade core; 3) 'proto-flake axe' (drawn by E Callahan). Scale in cm. (After Fischer 1982) development of the Late GlaciaL/Early Postglacial era. The following sections consider relevant chronological periods and problems, except where discussed elsewhere (Fischer 1978).

The Bromme Ahrensburg sequence

It has previously been argued that the Bromme and Ahrensburg complexes form stages of one common developmental sequence (Fischer 1978). The Brommian sites are considered the older, and Ahrensburgian sites the younger aspects of a common tanged point technocomplex. Data from recent excavations and research has further supported this hypothesis: for instance the settlement from Løvenholm and areas A, B and C of the classic Bromme site. The material from Løvenholm can been seriated as one of the oldest known Brommian assemblages.

The new radiocarbon dates for the Ahrensburgian layer at Stellmoor (Fischer & Tauber 1986) provide further evidence for the suggested typological/chronological sequence. The typology of this assemblage suggested a date in the youngest part of the Late Palaeolithic sequence. An extensive range of radiocarbon dates now establishes its age to a short interval around 10,020 BP — a date very close to that suggested for the end of the Late Glacial *c* 10,000 BP (Mangerud *et al* 1974).

The transition from the Late Palaeolithic to the Mesolithic

The recently introduced and poorly defined Bonderup stage is known from only two sites in Denmark, The Bonderup assemblage itself is dated by pollen analysis to the *'Juniperus* maximum', which represents the initial climatic amelioration at the transition between the Younger Dryas and the Pre-boreal *c* 10,000 BP (Fredskils 1982).

Only a short span of time separates assemblages such as the upper level at Stellmoor and Bonderup from the earliest typical Mesolithic sites — termed the Barmose group after the well- documented settlement Barmose I (Johansson 1990). In South Scandinavia, assemblages of this group are characterised by flint points produced by microburin technique and flake axes (Johansson 1971; 1990; Fischer 1978; Bokelmann *et al* 1981). Duvensee 8 in Holstein was the first site of the group to produce a seemingly reliable radiocarbon date, fixing its age to around 9490 BP (Bokelmann *et al* 1981). A number of conventional radiocarbon dates from Barmose I have been available for some years, but have been considered unreliable due to contamination by humus (Fischer 1978). For the purpose of this paper, the site was generously redated by the Oxford Radiocarbon Accelerator Unit. The new and highly consistent dates (average 9170 BP, Table 11.1) are younger than expected, as the assemblage was considered to be somewhat older than Duvensee 8 on the basis of typology (Johansson 1990).

Absolute dates on the Hamburg technocomplex

Some of the most important developments in the chronology of the Late Palaeolithic of Denmark and neighbouring areas concern the Hamburg and Federmesser complexes which were not discussed in my 1978 paper.

There now exists a new and consistent series of radiocarbon dates from the classic Hamburgian assemblages of the Ahrensburg Valley (Fischer & Tauber 1986), placing these sites in the time interval 12,500–12,200 BP. These dates also suggest that a time difference may exist between the assemblages of Poggenwisch, Meiendorf and Stellmoor (Fischer, in press a).

The growing number of radiocarbon dates have enhanced the possibility of establishing a relative chronology for the four Late Palaeolithic technocomplexes of north-west Europe. Table 11.2 lists those South-Scandinavian assemblages, which have reliable radiocarbon dates.

The suggestion of a possible development from the Hamburgian to the Ahrensburgian (eg Bordes 1968), now seems unlikely due to the large time gap between the two complexes. The Federmesser and Bromme groups seem to belong within this interval.

The Federmesser Bromme relationship

The Federmesser complex in northern Europe probably spans the interval from just before the Allerød period to the beginning of the Younger Dryas (eg Lanting & Mook 1977; Bokelmann 1978; Bosinski *et al* 1982; Schild 1982; Bokelmann *et al* 1983; Arts 1988; Fagnart 1988). The typological division of such assemblages from Schleswig-Holstein and neighbouring areas into a Wehlen and a Rissen group (Schwabedissen 1954) may represent chronological variations within this long period of time. Regrettably, there are too few reliable radiocarbon and pollen dates to test this suggestion thoroughly (cf Bokelmann 1978, 42). The only reasonably well-dated Federmesser site from Southern Scandinavia is Klein Nordende CR, which may be referred tentatively to the Wehlen group, and is dated to an early part of the Allerød (Bokelmann *et al* 1983).

From the Bromme complex, only the Trollesgave site (Fischer & Mortensen 1977; Fischer, in press b) has produced good dating evidence. This site is palynologically dated to the late part of the Allerød, and is dated by thermoluminescence to the twelfth millennium BP and by radiocarbon analysis to *c* 11,100 BP. Typologically the assemblage belongs to the middle or late part of the Bromme epoch (Fischer 1978, figs 2 and 3). The assemblage from the classic Bromme site (Mathiassen 1947; Fischer & Nielsen 1987) can only be dated in general to the

Table 11.1 Accelerator dates from the Early Mesolithic site of Barmose I (Zealand, Denmark)

Lab No	Inv No	Charred wood species	Association	d13C value	Years BP
OxA-2248	733	*Populus* sp	imbedded in sand, western end of hearth	–26.5%	9370±90
OxA-2249	744	*Betula* sp	imbedded in sand, western end of hearth	–24.5%	8930±90
OxA-2250	1078	*Populus* sp	in diffuse sand, northern end of hearth	–26.4%	9160±90
OxA-2251	1082A	*Populus* sp	foundation layer below hearth, central part	–26.5%	9250±90
OxA-2252	1082B	*Pinus* cf *silvestris* L	foundation layer below hearth, central part	–26.5%	9130±90

All samples are from a sand-built hearth on the bark covered floor. Samples were selected from various parts of the feature and from different species of wood to maximise the possibility of revealing any chronological inhomogeneity. The dates are given in conventional radiocarbon years BP, and were produced by Rupert Housley at the Oxford Radiocarbon Accelerator Unit. Wood identifications made by Claus Malmros of the Danish National Museum

Allerød on the basis of geological and palynological evidence. Observations from other Brommian sites (Nr Lyngby, Segebro, Bro I, Fensmark Skydebane and Stoksbjerg Vest) indicate dates to unspecified parts of the Allerød or Younger Dryas. Therefore, the Bromme complex appears to span at least the later part of the Allerød and the early Younger Dryas.

On present data it can be concluded, that the Federmesser and Bromme complexes are at least partly contemporary, with the former generally having a more southerly distribution than the latter. The two complexes could represent culturally different groups of people, or seasonal variation in the economic activities of a single group, eg winter activities in the coniferous forest of Schleswig-Holstein and further south, versus summer activities in the birch forest of Denmark and further north (cf Bokelmann 1978). However, the fact that the 'type fossils' of the two groups had similar functions, argues against a mere functional explanation. The observed differences in general lithic technology, for instance blade manufacture (Hartz 1987; Fischer 1990a), is an even stronger argument against the functional, and in support of a cultural explanation.

As mentioned above, the Wehlen group of the Federmesser complex and the earliest Brommian assemblages share the same variety of scrapers. Some of the Federmesser sites of the Wehlen group also include large tanged points, which could be typological predecessors of the Bromme points. Therefore, the Bromme complex is interpreted as an offshoot of the Federmesser which developed luring the early or middle part of the Allerød. The Federmesser sites of the Wehlen group from the Danish area (Fig 11.3, nos 3, 5, 6, 7, 17) are consequently dated to the time immediately prior to the Bromme epoch.

Summary on chronology

In Figure 11.10, the chronological (and geographical) relations between the four technocomplexes are tentatively summarised. Typological development of lithic assemblages in Schleswig-Holstein and Denmark appear to have divided into two different lines during the Allerød. In the Younger Dryas and into the early Holocene, the two geographical zones were unified again with regard to material culture.

In the Danish area, the Hamburg, Federmesser, Bromme and Ahrensburg technocomplexes possibly represent a chronological sequence. Considering the typological relations described above, at least the latter three complexes probably represent steps in a continuous cultural development.

Man and glaciers

The evidence for the Late Palaeolithic in Scandinavia is still scarce. However, available data seem to show clear trends for the overall pattern of man's immigration into the area.

The movements of the Scandinavian ice sheet have been studied intensely for many years, and there seems to be a consensus as to the periods relevant here (Andersen 1980; Mörner 1980; Berglund *et al* 1984). Figure 11.11 summarises four steps in the retreat of the inland ice and the expansion of human settlement in Scandinavia during the Late Palaeolithic. (The Ahrensburgian is

CHRONOZONES ex Mangerud et al 1974	TECHNOCOMPLEXES and some of their subgroups	Exactly dated sites, C 14 years BP
BOREAL	MAGLEMOSE	
PREBOREAL	Barmose	Barmose I 9170 Duvensee 8 9490
YOUNGER DRYAS	Bonderup AHRENSBURG	Stellmoor Upper 10 020
ALLERØD	FEDERMESSER BROMME	Trollesgave 11 100
OLDER DRYAS	Wehlen	Klein Nordende 12035
BØLLING	Havelte HAMBURG „classical"	Stellmoor Lower 12 170 Meiendorf 12 360 Poggenwisch 12 500

AF 1990

Figure 11.10 Chronological sequence of the Late Palaeolithic and earliest Mesolithic technocomplexes in Southern Scandinavia

omitted from the figure due to the limited number of finds relevant to this period.) This indicates that a wide zone of 'no man's land' existed along the border of the ice during all stages of the Late Palaeolithic.

Late Palaeolithic immigration into Scandinavia has previously been described as a movement north by people and reindeer immediately following the retreating glaciers (Becker 1969; Rust 1972; Hagen 1977). During the Hamburgian, summer settlements were presumed to be close to the ice border in order that people and their main prey, reindeer, might avoid the mosquitoes of the north European lowlands. The descendants of the Hamburgians continued this strategy and, therefore, gradually followed the retreating glaciers northwards all the way to the Norwegian high mountains where reindeer still survive today.

This traditional explanation for Nordic peoples' appearance in Scandinavia is no longer in accordance with the archaeological record, and we must consider other reasons for the immigration into the area. Perhaps the way of life of these people was much too pleasant to inspire them to follow the first best reindeer into the soaking and inhospitable lands left behind by the melting glaciers.

Life in Southern Scandinavia during the Bromme epoch

The Bromme epoch is the part of the Danish Late Palaeolithic which is richest in sites and archaeological data. Therefore, the following preliminary analyses of the adaptation of the pioneer societies in deglaciated Southern Scandinavia are limited to this cultural group.

Material culture

The Late Palaeolithic inhabitants of Southern Scandinavia made use of a very simple material culture as compared with the rest of the European Stone Age, at least with regard to the lithic industry. During most of the Brommian epoch, people in Southern Scandinavia had only three types of retouched tools — one of the poorest epochs of the European Upper Palaeolithic and Mesolithic in terms of assemblage composition.

At the same time, blade technology was simpler in terms of technical refinement than those of the preceding and following epochs (Fischer 1990a; 1990b; in press b; cf Hartz 1987). Blade manufacturing technology is known in detail from the intensively refitted flint assemblage from the Bromme site of Trollesgave (Fig 11.12). The detachment of blades was done by the simplest of techniques, direct percussion with hard hammerstones. There is no evidence for the use of soft hammers. Cores were prepared simply by removing heavy flakes from the platform, or by partial unifacial cresting. The technique of long bifacial cresting was not practised. Platform preparation was also as simple as possible, usually utilising a primary flake scar. Faceting and *en éperon* technique were not used by the Brommian flint knappers.

The technology used to produce the Trollesgave assemblage can be characterised as wasteful and simple. Considering the techniques applied, however, the lithic residue from Brommian sites shows a relatively good quality of work. Obviously it was not lack of ability that prevented the people of this epoch from using more efficient and complex techniques. Instead, the highly uneconomic blade technology can be explained as being a tradition adapted to the abundance of flint in the young moraine areas of Southern Scandinavia.

Subsistence

Food remains

The nutritional basis of Late Palaeolithic societies in Southern Scandinavia is only known in outline as most settlement sites are located on well-drained sandy soils where organic remains are usually not preserved. From Denmark, the only food remains available are some bones from the sites of Bromme, Trollesgave and Langå (Mathiassen 1947; Fischer & Mortensen 1977; Madsen 1983; Fischer and Nielsen 1987; Andersen 1988; Aaris-Sørensen 1989). Elk is the dominant species and the only one represented in all three assemblages. The habitation areas at Bromme have also yielded remains of reindeer, beaver, wolverine, swan, pike and perhaps roe deer. Finally two marrow split bone fragments of either red deer or elk derive from the Late Glacial sediments of Trollesgave.

Outside Denmark, only the Brommian site of Segebro has been reported to contain faunal remains (Salomonsson 1964). The bone fragments, however, may now be considered to be later intrusions from the overlying Mesolithic level (cf Larsson 1982).

Use wear on numerous flint points from the various sites confirm the impression of the importance of hunting of large game (cf Fischer *et al* 1984; Fischer 1989).

Topographic location

Due to poor conditions for the preservation of small bones, the role of fishing in Brommian subsistence can not be determined through physical remains actually found at the sites. However, the topographical position of the settlements hints that it was practised. The majority of large Brommian settlements are located at good fishing locations by contemporary lakes and streams (Fischer 1985a, in press a). This trait probably relates to fish being a very reliable food source for much of the year.

Assemblage composition

The economic activities that took place at the sites can also be studied through the composition of the lithic assemblages (Fischer 1976). Since the settlements of the Bromme technocomplex usually contain only three types of retouched tools, their relative tool composition can be shown as a triangular diagram (Fig 11.13). Each spot in the diagram represents one site from which a representative sample of tools has been collected. The assemblages appear to form two major clusters: In one group tanged points represent 20% or less of the tools; whereas in the other, they constitute more than 40%. The latter would have been more pronounced, if assemblages with less than 10 retouched tools were included.

The amount of flint waste on the sites correlates strongly with tool composition. Assemblages where cores represent more than 25% of the combined number of tools and cores are defined as being rich in flint debris and are shown on Figure 11.13 by filled-in symbols. Sites dominated by scrapers and burins are generally rich in flint waste, while those dominated by points have little or no flint knapping debris. In short, Brommian sites form two distinct groups with regard to artefact composition: one characterised by domestic refuse, and the other by hunting equipment.

The significance of these two groups is enhanced by the topographic situation of the sites. All the sites dominated by domestic refuse are located near to a contemporary large permanent freshwater source (circles in Fig 11.13). The Trollesgave site on the edge of the former Holmegard lake is typical of this group. In contrast, sites dominated by hunting

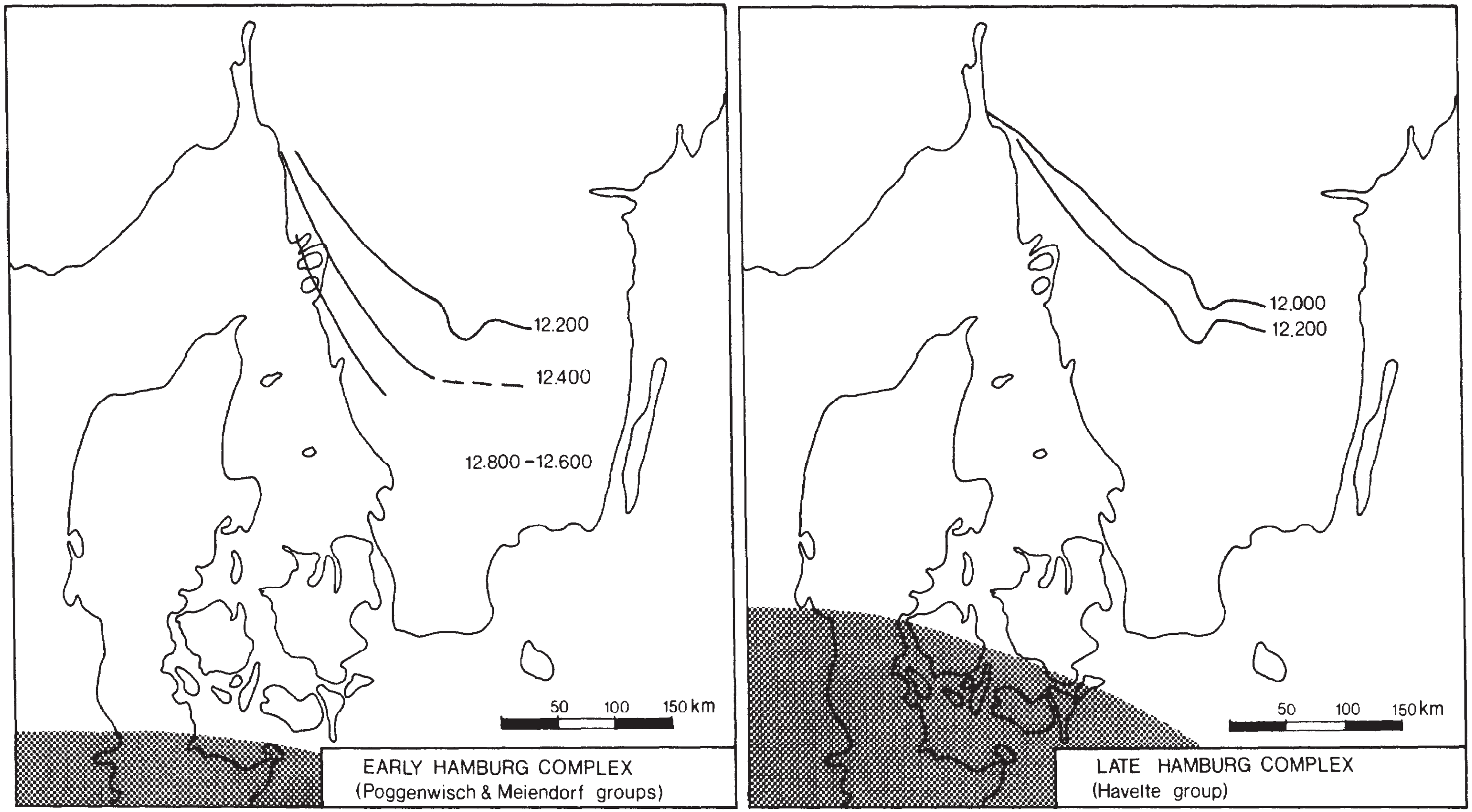

Figure 11.11 Retreating inland ice and expanding human settlement in Scandinavia during the Late Palaeolithic era. Ice margins from Berglund et al 1984. The tentative extent of human settlement is based an known cultural remains and information on the extent of the ocean (K S Petersen 1985; Schrøder 1986)

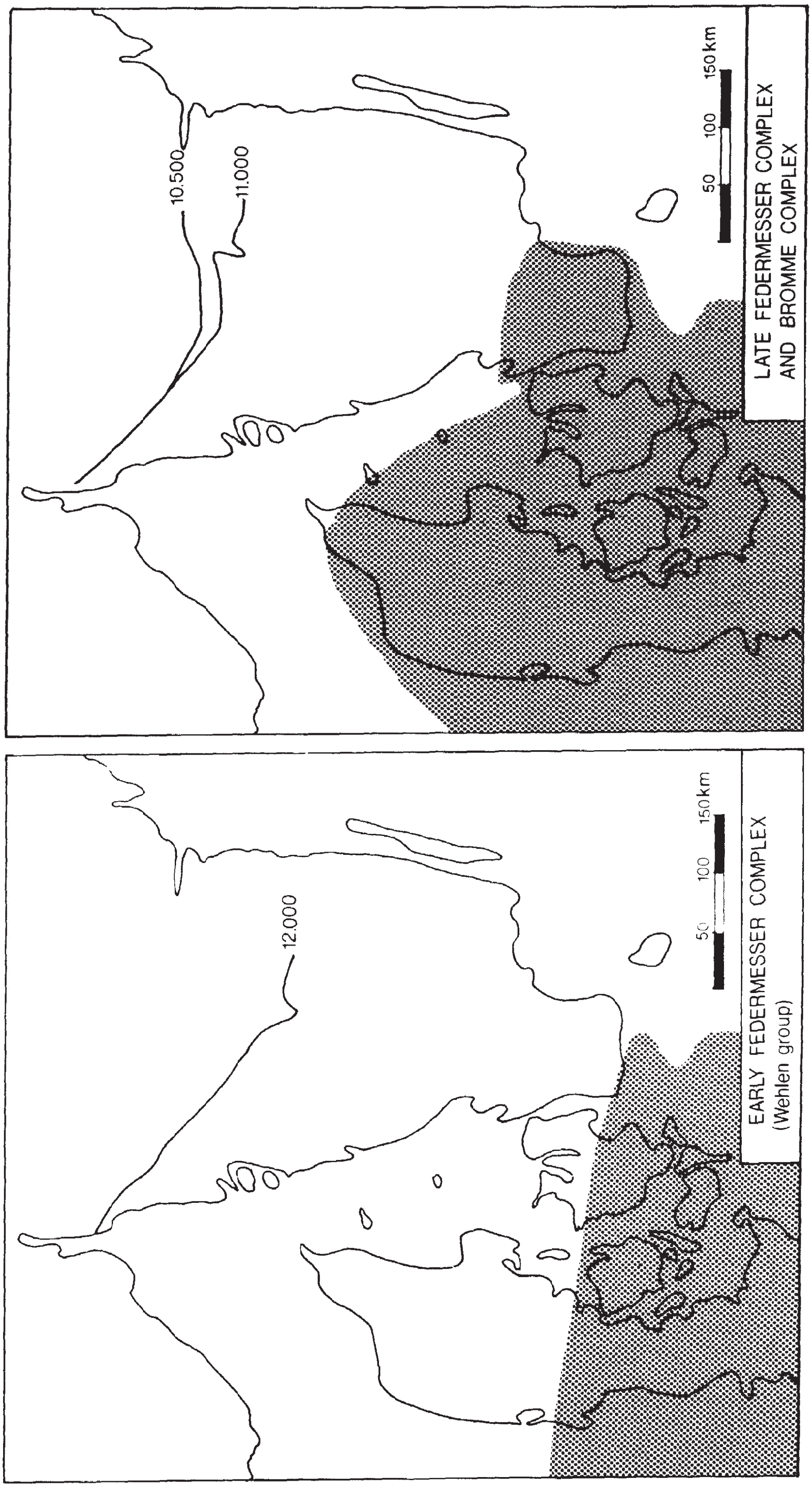

Figure 11.11 continued

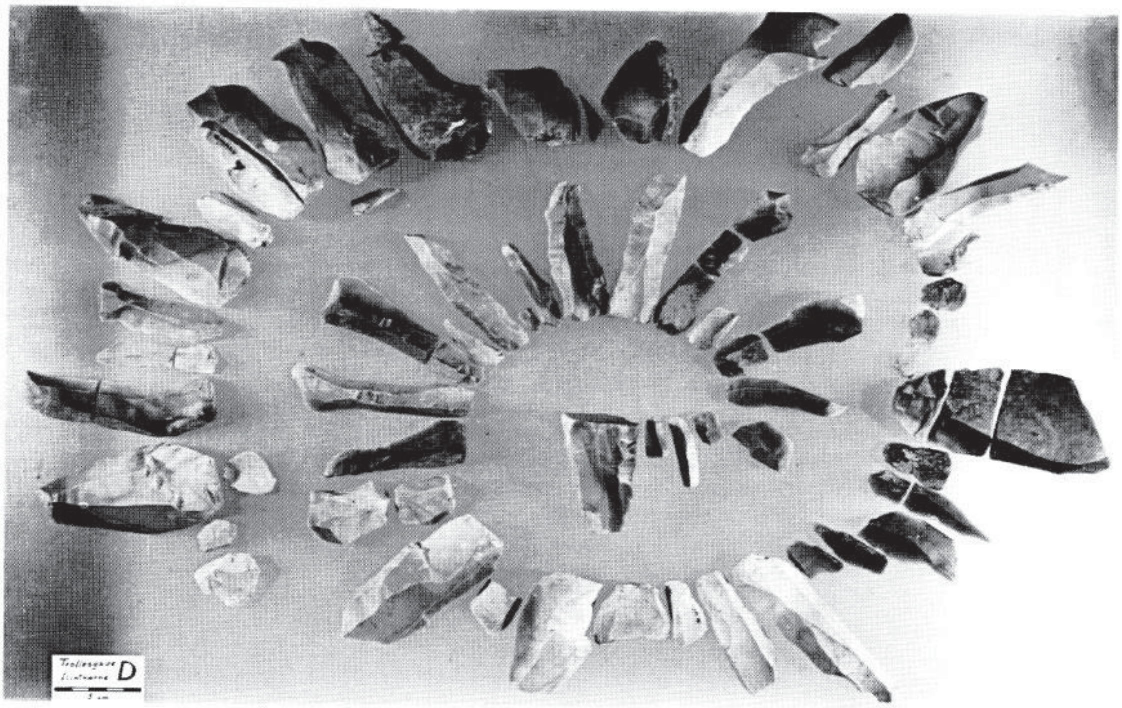

Figure 11.12 Example of the wasteful blade technology of the Bromme culture. Refitted flakes and residual core from the workshop of the 'master knapper' at the Trollesgave site. Almost all the larger flakes of the blade production sequence are present. Due to the use of unsophisticated techniques, this high quality flint nodule, originally weighing c *3 kg, yielded only seven reasonably successful blades. Scale in cm*

equipment are usually situated at relatively elevated spots in the landscape (triangles in Fig 11.13) (Fischer 1987). The best example of this group of sites is Ommelshoved (Fig 11.5, no 8) situated at the foot of a hill, and with an assemblage consisting of 110 tanged points, seven blades and a scraper from an area of less than 5 x 25 m (Holm 1972; Fischer *et al 1984).*

Social organisation

The size and spatial organisation of the sites forms the major source of information about the social organisation of the epoch. Most of the extensively excavated sites belong to the group dominated by domestic refuse. These sites can all be divided into similar large concentrations of artefacts, *c* 50 square meters in extent, each with a central hearth around which tools and flint waste cluster in a recurrent horizontal pattern (Fig 11.14; Fischer & Nielsen 1987). This spatial arrangement has been interpreted in terms of social organisation (Fischer 1976). By comparison with ethnographic data, the concentrations were proposed to reflect one family households of the size of nuclear families — equal to those known from the simplest of modern day hunter-gatherers ('band societies').

Recent analysis of the Trollesgave assemblage has supported the interpretation of these sites as having been inhabited by family groups. The intensive refitting of flint artefacts singled out the work of three contemporary flint knappers. One of these was apparently a child working under the instruction of a 'master knapper' (Fischer 1990b, in press b).

There have been few excavations of sites dominated by points. Most of those that have taken place are of a too preliminary nature to provide information as to the general size and internal organisation of this group of sites. Therefore, the available data is not sufficient to draw conclusions concerning group size and group composition at this type of sites.

To summarise, there seem to be two socio-economic categories for the larger Brommian sites:

Group 1: Water-associated, multi-activity sites which were probably inhabited by nuclear family groups;

Group 2: Hill sites, centres of hunting activities, which may only have been inhabited by adult males.

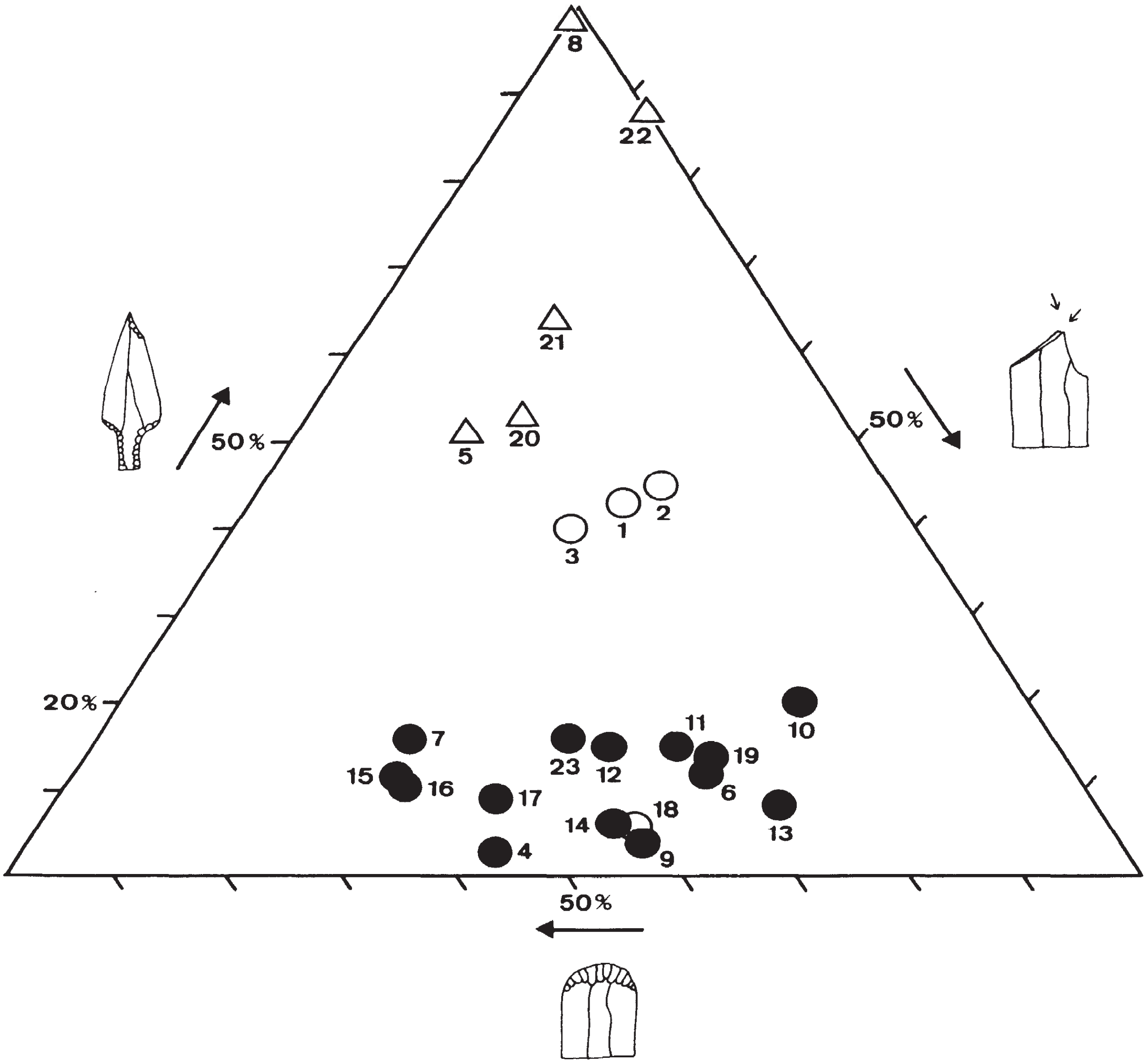

Figure 11.13 Assemblage composition and topographic location of the Brommian sites plotted in Fig 11.5. Each symbol represents one site. Filled-in symbols: cores make up more than 25% of the total sample of tools and cores; open symbols: cores make up no more than 25% of the total sample of tools and cores; circles: sites located adjacent to contemporary large lakes or streams; triangles: sites in other topographical locations

Conclusion

The northward movement of human settlement during the Late Palaeolithic need no longer be considered as the result of conservative attempts to continue the traditional life of reindeer hunters. Instead, it may be seen as a rebellion against that traditional way of life, made possible by the rapidly improved living conditions north of hitherto inhabitable land.

The South Scandinavian Late Palaeolithic, especially the Brommian epoch of the Allerød period, seems to demonstrate a cultural degeneration as concerns technology, art and social organisation. However, this degeneration of culture probably represents an advance in conditions of life as there was more space, food and raw materials than in previous periods in the north European Upper Palaeolithic. Since life was easy, there was no incentive for the people to utilise adaptive strategies such as complex raw material saving

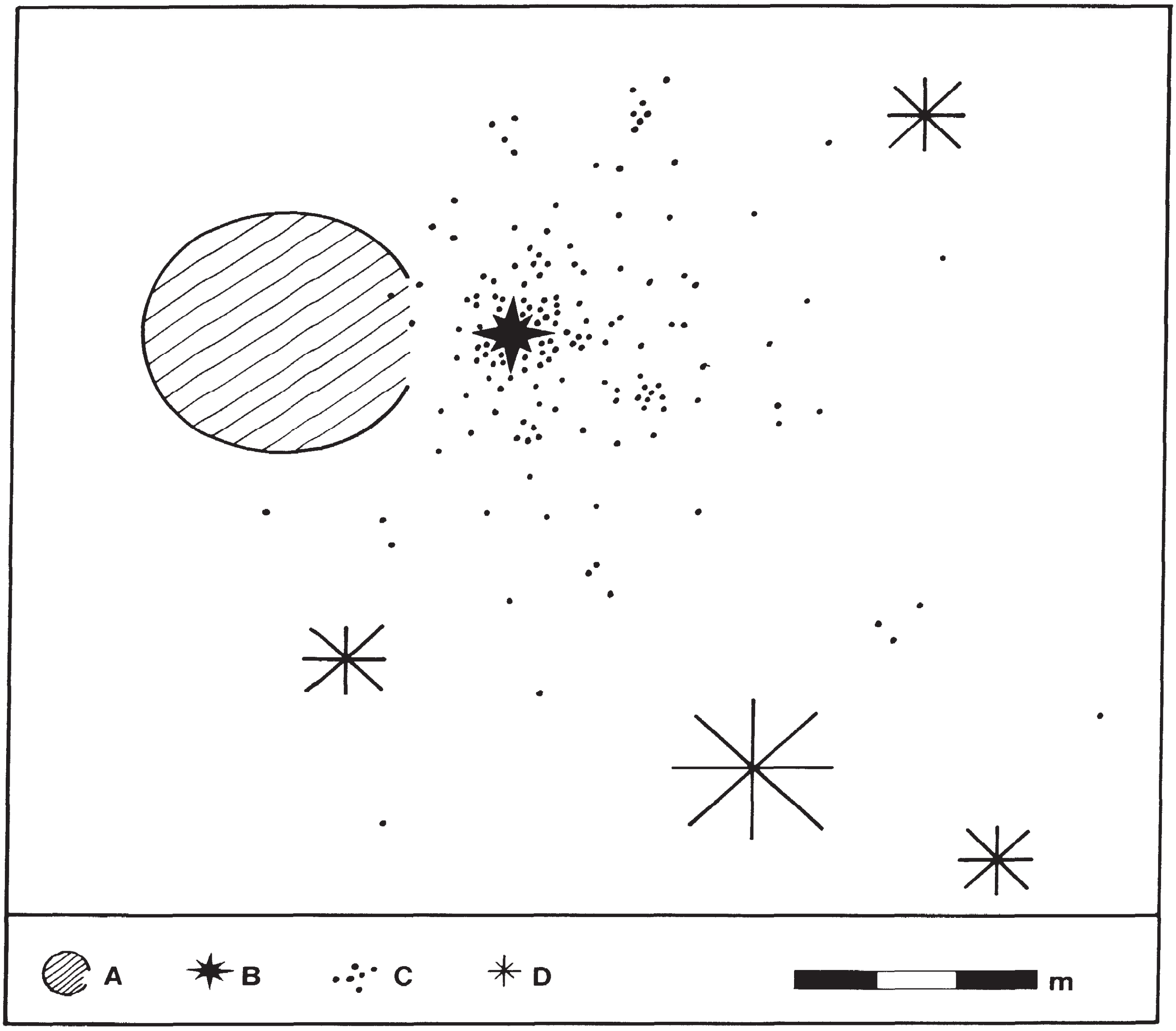

Figure 11.14 Model of the internal organisation of Brommian lake-side sites. Four kinds of activity areas are shown: A) dwelling; B) fireplace; C) multi-activity area (residues of communal and individual activities); D) satellite areas for special activities. (After Fischer & Nielsen 1987)

technology, decorative art and far reaching trade relations.

In some ways the situation would be comparable to that of the simplest of modern day hunter-gatherers who usually lived in a 'paradisial situation' characterised by affluence of food, easily produced material culture, and few neighbours to cause problems (Lee & DeVore 1968; Sahlins 1972). However, Keeley (1988) has pointed out that periods of severe hunger was a snake in their paradise.

In other ways, the situation during the Late Palaeolithic of Southern Scandinavia does not fit modern analogies. Firstly, the population density must have been extraordinarily low compared to the carrying capacity of the area. Secondly, the environment was much more oceanic and reliable (Iversen 1973) than that in the areas where simple hunter-gatherers have survived until the ethnographic present. Therefore, the Late Palaeolithic of northern Europe, especially deglaciated Southern Scandinavia, during the warm and moist Allerød period may be considered 'a paradise without snakes'.

Comparable situations of suddenly declining demographic stress can probably only be found in those few cases where wide areas of unpopulated land rich in food suddenly became open to immigration. Thus, the groups that first populated Australia and America in the late Pleistocene would probably be the closest parallels to the Late Palaeolithic pioneers of northern Europe.

In Southern Scandinavia, the pioneer situation of extremely low natural and demographic stress seemingly vanished during the first millennia of the Mesolithic. A gradual growth in the number of tool types and in the complexity of lithic technology can be identified in the various stages of the Early and Middle Mesolithic (Bonderup, Barmose, classical Maglemose and Kongemose stages — cf Fischer, in press b).

Several environmental and social factors are probably responsible for this elaboration of material culture. For example, the growth of dense forest cover must have diminished the availability of terrestrial game. Possibly expanding population size also added to stress this situation. Most importantly, the rising sea level rapidly decreased the inhabitable land of the north European lowlands to about half their previous size during this period. In short, the flood of the melting Late Pleistocene glaciers may be considered the main reason for the loss of a Paradise.

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12 The Late Palaeolithic in southern Sweden: Investigations in a marginal region

Lars Larsson

Abstract

New finds of artefacts in northern Scania indicate a more northerly extension of human settlement than previously known in southern Sweden during the Late Glacial. Analysis of faunal evidence and radiocarbon dates suggest that the reindeer was widely hunted in the Younger Dryas using toolkits which included small tanged points of 'Ahrensburg type'. Evidence of earlier occupation in this area is in the form of large 'Bromme type' tanged points, possibly associated with a different hunting adaptation.

Deglaciation

Detailed studies in the areas of Quaternary geology and biology have been carried out over the last decades in relation to the Late Glacial in southern Sweden. The considerable number of examined sites throughout southern Sweden means that we now have a very good idea of deglaciation and palaeoecology. This can be combined with a number of radiometric datings which have been placed in relation to the varved clay chronology (Berglund 1976; 1979; Berglund & Rapp 1988; Björk *et al* 1988; Lagerlund *et al 1983;* Mörner 1969).

The province of Scania was the first part of southern Sweden from which the ice disappeared at about 13,500 BP Figure 12.1 shows how the deglaciation process can be monitored as far as middle Sweden, where the melting of the ice ceased

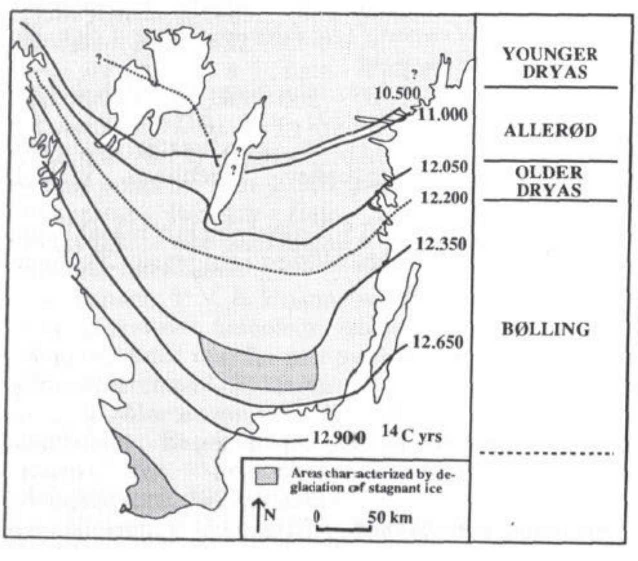

Figure 12.1 Deglaciation in southern Sweden. Based on Björk et al 1988 and Berglund & Rapp 1988

as the temperature fell during the Younger Dryas period. Deglaciation continued again after this period. It will be apparent from Figure 12.1 that the Swedish west coast becomes ice free earlier than the eastern Baltic coast. A certain delay in the melting of the ice occurred in the central area included in the South Swedish Upland, an area of primary rocks; Very rapid melting occurred mainly during the Belling period, at a rate which is estimated to have been at the most about 50 km per century.

Flora and fauna

Pollen analysis of the oldest known layers in the south-west of Sweden points to an ice-free Bølling period, with vegetation consisting of steppe tundra with elements of birch and willow (Berglund & Rapp 1988; Björk *et al* 1988). An analysis of the insect fauna in the Late Glacial deposits in Scania (Fig 12.2) indicates that southern Sweden was subject to a noticeable rise in temperature at the end of the Bølling period (Lemdahl 1988). The rise in temperature was not, however, on a par with that reported in England (Atkinson *et al 1987).* This can be explained by the fact that the adjacent land ice had acted as a moderating factor. The degree of consistency with the results of the analyses made in England is very much better, however, during the remainder of the Late Glacial period. There is evidence of a certain decrease in temperature during the Allerød period and a distinct minimum temperature during the Younger Dryas period, and also of a noticeable increase in temperature during the transition to the Postglacial period.

Of particular interest to our understanding of the Late Glacial fauna are the finds of sub-fossils of, *inter alia,* mammoth and reindeer. Of the former, four finds of tusk fragments have been the subject

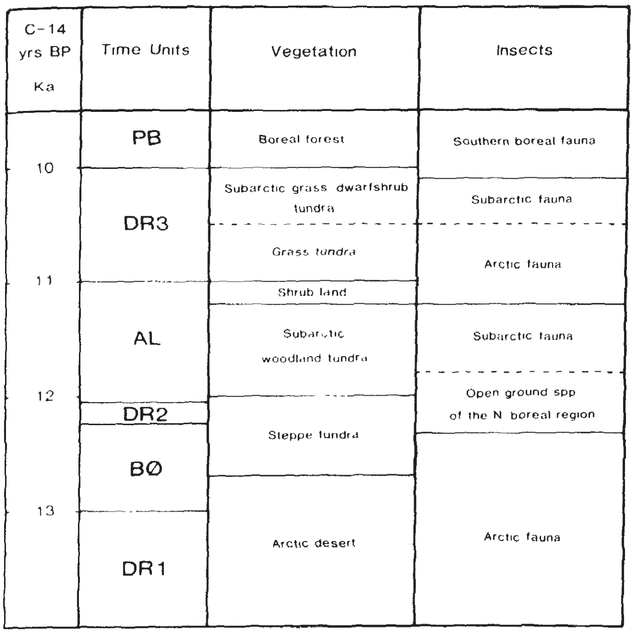

Figure 12.2 The vegetation of the Late Glacial period in south-west Sweden, based on an analysis of pollen, macrofossils and insect finds. After Lemdahl 1988

of radiocarbon dating (Berglund *et al* 1976). Three of these finds are older than the most recent glaciation, whereas the fourth, from Lockarp in south-west Scania, has produced values in the range 13,360±95 to 13,09±120 BP (Lu-796, Lu-865 and Lu-796:2). This indicates that the mammoth was living in Sweden during the period of deglaciation.

Numerous reindeer finds have been made in small lakes, most of them so-called 'dead ice holes', in south-west Scania (Clark 1975, fig 5; Liljegren 1975). Most are pieces of reindeer antler. Whole skeletons and skeletal parts have been recovered in some cases. A proportion of the antlers had been shed, indicating that reindeer had lived in the area throughout the year. They had probably ended up in the water when cleaning their horns against the tree and shrub vegetation around the water hole.

In relation to the total number of finds, only a few are dated. Earlier pollen analyses, the results of which suggest that reindeer were living in the south of Sweden until the Boreal period (Isberg 1930), have proved to be totally misleading. A pollen analysis of the sediments adjacent to the findspot of a number of antlers has revealed that several of these belong to the Younger Dryas period Welinder 1971). Two radiocarbon datings of reindeer antlers produced the values 11,170±110 and 9,810±95 BP (Lu-1059 and Lu-1060) (Ekström *et al* 1989), ie the latter belongs to the Pre-Boreal period. Danish datings also show that reindeer were still living on the Baltic island of Bornholm, to

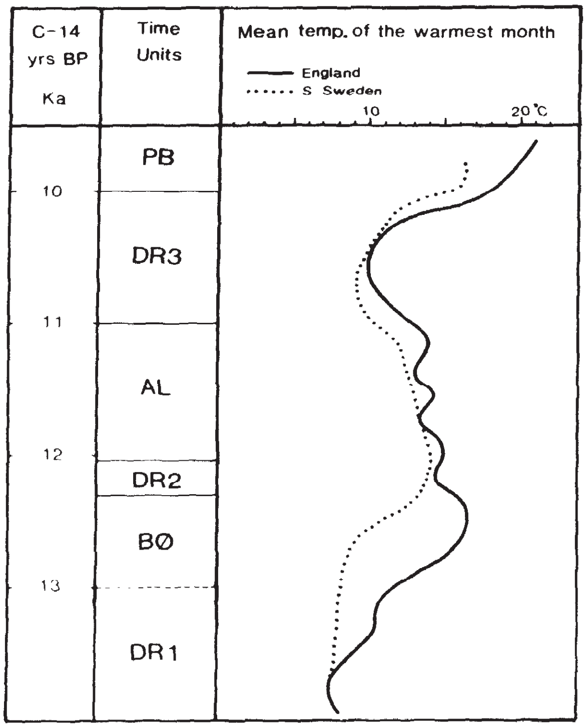

Figure 12.3 Correlation between average July temperatures for the timespan c *13,500–9500 BP. After Lemdahl 1988*

the south of southern Sweden, up to the Pre-Boreal period (Aaris-Sørensen 1988, 108f).

Remains of settlement

As far as traces of settlements are concerned, the position is still that only a single site has been excavated — this is at Segebro in south-west Scania. It was discovered by chance during excavations of a Mesolithic site in 1960 (Salomonsson 1964). The artefact material and the distribution of the finds agree very closely with the numerous site finds in Denmark which belong to the Bromme culture (Andersen 1973; 1988; Fischer & Mortensen 1979; Mathiassen 1946). The remains which have been found are on a scale suggesting the presence of a group of the size of a family. A depression in the central part of the site was interpreted as the base of a tent. On the basis of new analyses of the eponymous site of Bromme, on Zealand (Fischer & Sonne Nielsen 1987), the Segebro site probably belongs to an older part of the Bromme culture, when the majority of the tanged points still have the bulb of percussion preserved, in spite of the retouching of the tang.

Salomonsson in his preliminary report on the Segebro site mentions a couple of locations where tanged arrowheads have been found. In the period since excavation of this site, excavation work relating to the Late Palaeolithic period has taken place on a very limited scale, with no objective work having been done. Material dating from the Late Palaeolithic period has been found, however, on a few occasions (Salomonsson 1962).

A new excavation of the Mesolithic site was carried out at Segebro in 1976 (Larsson 1982). This also included the excavation of the bottom sand in which the Late Palaeolithic remains had been found. The sand was found to contain a remarkable collection of waste material, probably from a production site, at a point 10 m from the area which had previously been identified as the boundary of the site (Larsson 1982, fig 77).

New investigations

A start has been made during recent years on a new inventory, with a view to collecting data concerning Late Palaeolithic finds. This included visiting the previously known sites where tanged points had been found for the purpose of establishing whether these are nothing more than the locations of individual finds, or whether the discoveries might mark the position of Late Palaeolithic sites. New studies of museum collections have also resulted in the identification of a number of Bromme points. Unfortunately, the accompanying information is usually of such a general nature that it has not been possible to pinpoint the precise locations of the finds (Larsson 1984). Contacts with amateur archaeologists have also led to several finds being made. Three tanged points were found at each of two locations, and it is probable that these mark the position of camp sites (Larsson 1986). Only a very limited number of worked flints was found at each site, and they are probably the remains of camp sites used only for a short period. The possibility that these were sites at which damaged arrowheads were fitted with new shafts is discounted by the fact that the points are not in the severely damaged state that would be expected in such a situation.

The new finds of tanged points have contributed to a major extension (Fig 12.4) of the distribution of finds of Bromme points, which were previously known only within south-west Scania (Salomonsson 1961). One find was made as far north as the south side of the South Swedish Upland (Westergren 1979, 34*ff*). Further finds in northern Scania have confirmed that this find was not an isolated northerly marker of remains associated with humans (Carlie & Götz 1983). What is particularly interesting is the occurrence of several Bromme points close to Lake Finjasjön in northern Scania. A couple of interesting sites of finds in this area will be the subject of excavations in the near future.

These new finds are also interesting when considered from the point of view of the topography of the find spots. Certain points were found adjacent to the inlets and outlets of lakes — a site location which is highly typical of Danish finds (Fischer 1976). Others were found at the edge of tunnel valleys or on higher ground in undulating countryside. One group of three arrowheads, which presumably mark the site of a short-duration camp, was found on the edge of a tunnel valley. Another group was found on a small raised area near a large lake, although at a distance of several hundred meters from it and with the direct line of sight to the lake actually obstructed by a hill closer ta the shore.

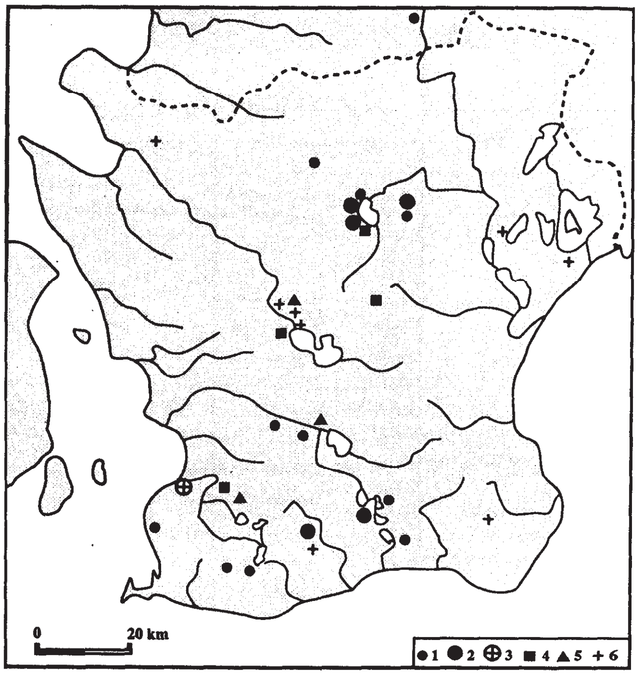

Figure 12.4 Distribution of finds from the Late Palaeolithic. 1) single find of tanged point of Bromme; 2) site with at Least three finds of tanged points of Bromme type; 3) excavated Late Palaeolithic site (Segebro); 4) single find of tanged point of the Ahrensburg type; 5) single find of implement made of reindeer antler; 6) single find of coarse-barbed harpoon

From a south Swedish point of view, there is one factor which is of critical importance when identifying Late Palaeolithic tanged points; the resemblance of certain examples of blade arrowheads from the Pitted Wear Culture (Fischer 1985). There can be no doubt, however, that the large examples of tanged points mentioned above, all belong to the Bromme culture. Nevertheless small Bromme points and certain Ahrensburg points can easily be mistaken for the earliest forms of Neolithic blade arrowheads (Lidén 1940, 32*ff*).

A small number of finds from southernmost Sweden mark or suggest the presence of settlements belonging to the Ahrensburg culture (Fig 12.4). Only in a few cases was a tanged point of Ahrensburg type found in association with more extensive site remains. In the case in question, Öbacken in the south of Scania, the artefacts were

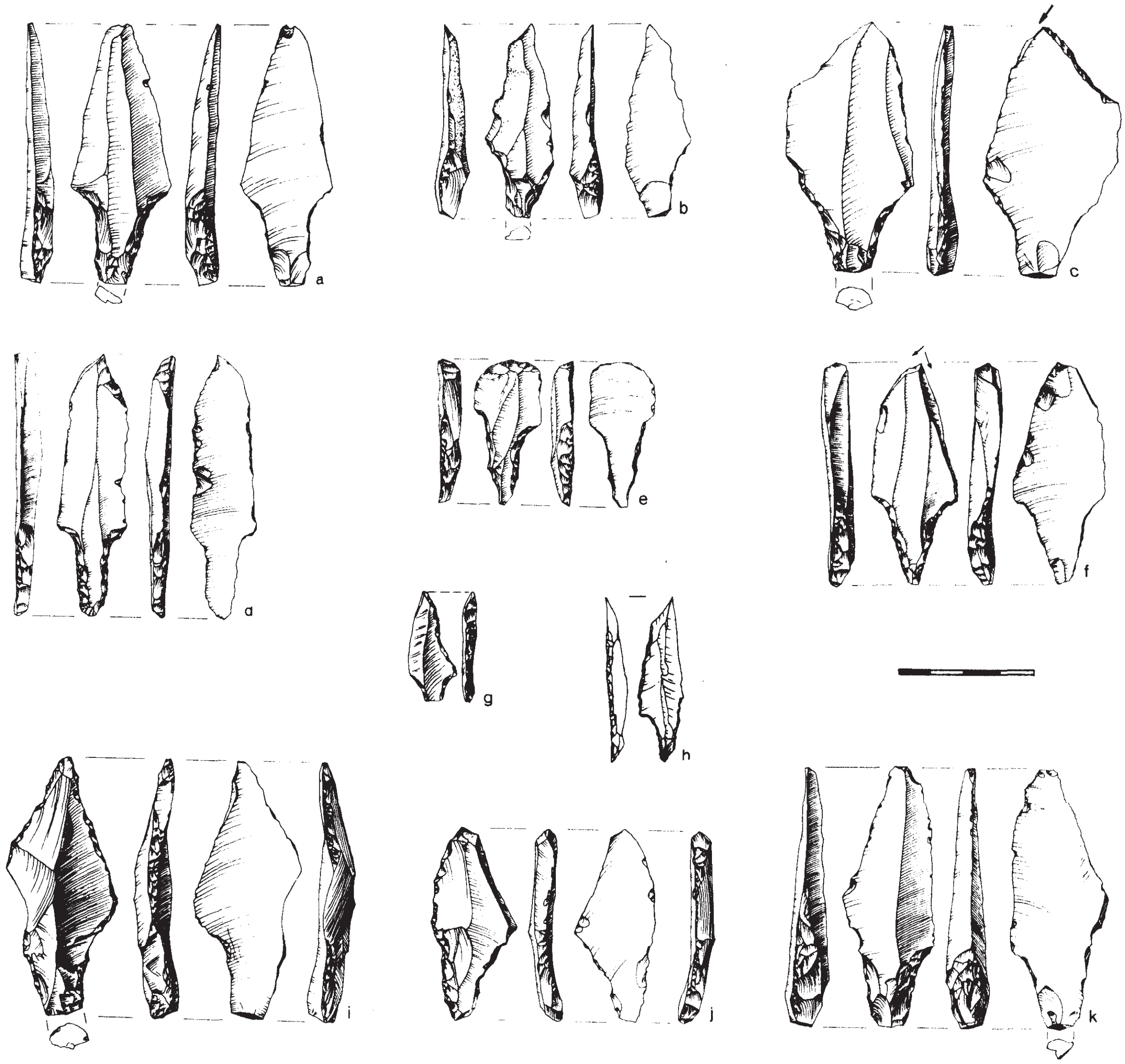

Figure 12.5 Tanged points from Scanian sites: a-c) Annavälla; d-f) Karlsro; g) Store Mosse; h) Fairyhill; i, j) Finjamaden; k) Röke. Scale in cm

found in a layer which can be dated to the Pre-Boreal period, which in this case should be regarded as providing a *terminus ante quem* (Welinder 1971, 87*ff*). Indications of the Ahrensburg culture consist of a small number of finds of antler implements of the Lyngby type. (Althin *et al* 1950) and coarse-barbed harpoons (Larsson 1978, 62*ff*). In one particular case a Lyngby antler artefact was found in such a position that it could only be dated to the Younger Dryas period (Larsson 1976b). In order to form a better idea of the chronological position of these bone and antler implements in the Late Palaeolithic period, certain of the objects will be the subject of radiocarbon dating with a tandem accelerator.

The finds from the subsequent Pre-Boreal period are of very limited number in south Sweden (Welinder 1971), although they do point to a change in the material culture which can be compared with that in the Danish area (Brinch Petersen 1966). The late datings within the Younger Dryas period of the finds from the Ahrensburg culture at the classic type-site of Stellmoor (Fischer & Tauber 1986), and the dating of the reindeer to the Pre-Boreal period, indicate that Late Palaeolithic societies survived into the early part of the Pre-Boreal period (Fischer 1978; 1982).

A find of worked reindeer antler in the northern part of Öresund (Mathiassen 1938), which separates Denmark from south Sweden, was for a long time regarded as being of major significance to the interpretation of the human colonisation of the area in question (Holm & Rieck 1987, Abb 1). At the time of publication the age was given as the Older Dryas, which meant that the artefact was the earliest known from that part of south Scandinavia.

However, radiocarbon dating has subsequently shown the object to be of a more recent period (Å Fischer, pers comm).

A shafted, spirally-ornamented reindeer antler implement, which was found in a bog site dating from the Late Boreal period, is believed to have come from an area in south Norway, where reindeer were living during the Mesolithic period, rather than being a collected Late Palaeolithic implement (Larsson 1976a).

It is not possible, from a south Swedish point of view, to draw any clear distinction between the material remains of the Late Palaeolithic culture in southernmost Scania and in Denmark, which one would scarcely expect to be the case anyway, since such movement was facilitated by a land bridge which existed between the two areas. Only sporadic traces of settlement associated with the coast (Aaris-Sørensen 1988, 108) are found in these same areas, since the coastal area of the time became submerged during the Postglacial period (Larsson 1983). As can be appreciated from Figure 12.1, the topographical conditions would have supported early settlement along the Swedish west coast. Distinct land elevation has occurred in this area since deglaciation, interrupted only by occasional transgressions during the Atlantic period (Mörner 1969; Persson 1973). A Late Palaeolithic coastal settlement could have existed, therefore, along the Swedish west coast, and could have continued into southern Norway, although no definite finds which predate the Pre-Boreal period have yet been made. A few stray finds of large tanged points, which exhibit certain similarities with the Bromme points, have been made in this area (Bang-Andersen 1988; Fredsjö 1953). In one particular case, Tosskär in the province of Bohuslän (Fredsjö 1953, 60 *ff)*, an arrowhead of this kind occurs in a site context together with so-called 'one-edged arrowheads'. This type of arrowhead exhibits major similarities with the Ahrensburg points, and is very likely a direct development of these. The finds from the Swedish west coast may reflect an industry which has a strong Late Palaeolithic tradition, but with distinct regional characteristics.

Concluding observations

The major climatic changes during the Late Palaeolithic period must have had a great effect on the composition of the fauna and consequently on the living conditions for humans. It is not possible to provide any kind of satisfactory answer to the question of the role played by reindeer in the economy. In view of the considerable fluctuations which can be traced in the size of recent reindeer populations (Grønnow *et al* 1983, fig 9), the economy of the societies of the Late Palaeolithic period was presumably much more varied than indicated by the limited species composition at a few sites in north Germany and in Denmark (Mathiassen 1946; Rust 1937; 1943). For instance, no explanation has been offered as to the importance of elk as prey during the Allerød period. Hunting based on reindeer and elk must be pursued in rather different ways, and accordingly calls for the flexible organisation of society. Furthermore, the position of sites next to the inlets or outlets of lakes indicates that fishing, for example of salmon, may have been a major activity.

The Late Palaeolithic period in southern Sweden is an interesting field of research, not least from the point of view that it was very much a European marginal region at the time in question.

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13 The Creswellian, Creswell and Cheddar

Roger Jacobi

Abstract

This paper explores some of the problems of the current definition of the 'Creswellian' (Garrod 1926a; b): notably the heterogeneity of the four main Late Upper Palaeolithic site collections from Creswell Crags on which the term is based, and the question of flint point variability in Late Glacial assemblages. Contrasted with the Creswell Crags sites (East Midlands) are those in the Cheddar Gorge (south-west England), including Gough's Cave, which have produced better contexted collections capable of offering greater potential for defining individual toolkits of the Late Upper Palaeolithic.

Introduction

The present research project is aimed at archaeological material collected before about 1980, and believed to date to within the last cold stage (Devensian/Weichselian). It aims to document this material, mostly collected from caves and made from stone, bone, antler or ivory, and to set it within a more secure chronological framework. Where feasible, an attempt is also being made to assess contemporary fauna and to distinguish human predation of that fauna. Our knowledge of the archaeology of this timespan, however, remains so slight that where and when are still more apposite than questions of how or why.

This research would have been impossible prior to the advent of AMS radiocarbon dating and the sample selection which this technology makes possible (see Housley, this volume). This study also profits from being inextricably linked to the research interests of others, perhaps most closely to those of Andrew Currant and Chris Stringer both of The Natural History Museum.

This research does not aim to contribute any startling theoretical developments. Rather, it aims to assess the existing database and provide an interpretation of it which, it is hoped, will survive testing against the results of future fieldwork, for example that recently initiated in the Torbryan Valley, in Devon.

There can be little doubt that the study of museum collections is unfashionable, and this clearly shows in much that is written about our past.

Contrary to popular belief, the uniqueness of caves as repositories of information on early man was fully appreciated even very early on. Accordingly, most early exploration of bone caverns was undertaken by highly qualified observers and in an attempt to answer very clearly defined questions. By and large, these observers made every attempt to record their work. The total of resulting publications is prodigious, although most recent researchers have done little to seek these out.

Perhaps it was the singularly unfortunate choice of *Cave Hunting* by Dawkins as the title for his book on cave archaeology (1874) which has done so much to encourage the belief that their exploration was a sport. Nothing could be further from the truth.

A point which should also be stressed is the continuity of capable curation generally accorded the material resulting from this early exploration work. Again, contrary to popular belief, relatively little appears to have been misplaced since excavation. Whatever success the present project has had results from long acquaintance with many museum staff and their knowledge of what I am seeking.

It may seem curious not to ignore these earlier discoveries and aim at their replacement by freshly collected material whose context should be so much better known. While there can be no doubt that fresh sampling can produce important contextual data, as at Gough's Cave (see below), no one person can ever hope to replace the results of over 150 years of collecting shared between numerous individuals and distributed over many different parts of Britain.

It is only very recently that I have begun to feel confident in extrapolating from the existing database to those sites, and where within those sites, fresh sampling could most profitably be undertaken. My choices would be very different from those made by McBurney (1958–60) and Campbell (1968–69) where, perhaps unavoidably, excavation was very early written into the research design.

In this paper I want to briefly outline some of the parameters within which British Late Glacial archaeology needs to be considered and then to go on to discuss whether the concept of a 'Creswellian' is in any way still a useful one.

Environmental background

Late Glacial environments are, of course, considered in other contributions to this volume. However, it may not be wholly unreasonable to generalise Late Glacial time after about 13,000 radiocarbon years ago as a period of warming (Interstadial) followed by a short stadial event (Lowe & Gray 1980). This (Younger Dryas) stadial immediately precedes the present highly atypical warming event — probably better termed the Holocene.

The time 13,000–12,000 radiocarbon years ago may be regarded as one of more open and more arid environments, except perhaps in western Britain (Coope & Joachim 1980). Contemporary fauna is best documented at Gough's Cave where its age is confirmed by numerous radiocarbon dates (Currant 1986, and this volume; Housley, this volume). Saiga antelope (Currant 1987) and mammoth (Lister, this volume) are both recorded for this timespan.

From 12,000–11,000 radiocarbon years ago appears a time of falling temperatures, reduced aridity and more wooded environments. Nothing is known of this woodland fauna, except that it included elk (Blackburn 1952).

The remaining time, from 11,000–10,000 radiocarbon years ago, appears one of sharply lowering temperatures (Atkinson *et al* 1987), deepening snowfall (Buckland 1984) and generally open landscapes. The large mammals most often directly dated to this timespan are reindeer and horse (Housley, this volume).

Distribution of Late Glacial findspots

Late Glacial findspots can only be confirmed beyond ambiguity for England and Wales. The most northerly are in Cumbria (Salisbury 1988) and in Wensleydale (North Yorkshire). Biological considerations would suggest that Ireland was already an island (Jacobi 1987, 167). While the sea-crossing almost certainly lay within the capability of Late Upper Palaeolithic groups, it does not appear to have been made. It is unclear how the seeming absence of Late Glacial findspots from Scotland should be interpreted. One suspicion is that the contents of public and private collections are less well researched than their counterparts south of the 'Border'.

To date, approximately 150 findspots have been recorded for lithic material which appears to be of Late Glacial, or potentially Late Glacial age (Fig 13.1). This total does not include finds of 'great' or 'giant' blades (*sensu* Taute 1968) or of cores discarded while still of sufficient volume to have produced such blades. Nor does it include finds of small stemmed flakes and blades some of which, like the 'great' and 'giant' blades, could also date to about the transition of the Pleistocene to the Holocene (Barton, this volume).

A decreasing proportion of Late Glacial findspots (only about one in three) are to be associated with caves. Very many consist of no more than single artefacts amongst more substantial collections of later prehistoric lithics. Few of these chance discoveries have been followed up by surface survey or excavation. The clearest exception to this generalisation is, of course, Hengistbury Head (Barton, in press).

Radiocarbon dating of Late Glacial findspots

Perhaps the most significant achievement of the last few years has been the progress made towards an objective chronology for Late Glacial human presence in Britain. This has been achieved through direct radiocarbon dating of human fossils, artefacts made from bone or antler and bones marked by stone tools during butchery. Wherever possible, use has been made of bones which could be confidently identified as to species — so effectively obtaining two dates for the price of one! All this would have been impossible prior to the advent of AMS dating (Housley, this volume, Table 4.5).

So far, there is no confirmation of a Late Glacial human presence earlier than sometime between 13,000–12,000 radiocarbon years ago. Radiocarbon dating would seem to suggest closely similar ages for the earliest resettlement of Britain and North Germany following the last ice maximum (Fischer & Tauber 1986), and in neither area is there any Late Upper Palaeolithic material whose typology indicates it as certainly older than the oldest of these dates.

It would, needless to say, fit the spirit of this conference to see in these dates from Britain and Germany an effectively synchronous human response to the greater warmth and increased biomass of the Late Glacial Interstadial. Neat as this coincidence may appear, it could also be suspected that with in creasing latitude destruction of the archaeological record by periglacial activity would have been both more severe and, arguably, longer lasting. It is interesting to note, for example, that while Late Glacial habitation sites survive in flood-plain sediments in the Paris Basin (Audouze, this volume) the oldest analogous sites to survive in Britain appear only to date to about the Pleistocene/Holocene boundary (Lewis, this volume). That the archaeological record for Scotland could be similarly foreshortened, as a result of its proximity to ice-growth late in the Late Glacial (Tipping, this volume), may help explain a seeming commencement only early in the Holocene (Jacobi 1982).

The second point which clearly emerges from these dates is that our Late Glacial archaeological

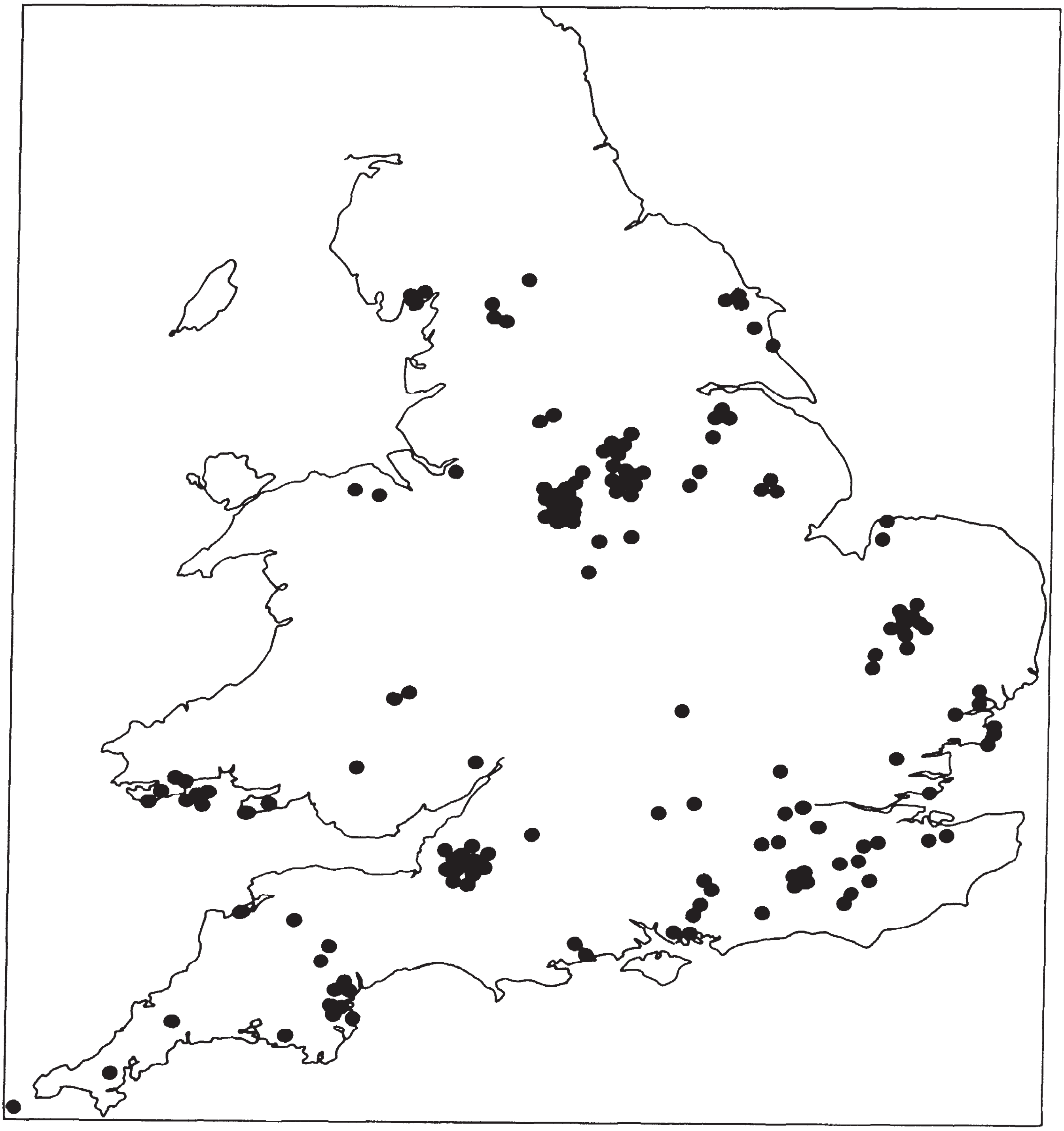

Figure 13.1 Findspots and probable findspots of Late Upper Palaeolithic flint and chert artefacts

record has to be recognised as spread over up to 3000 radiocarbon years. However, recent comparison of radiocarbon ages with Uranium-Thorium ages for corals from the Barbados (Bard *et al* 1990) has provided some measure of calibration for the period with which this brief paper is concerned. It suggests that the archaeological record may be distributed over rather *more* than 3000 calendar years with the most noticeable foreshortening of the radiocarbon timescale equivalent to the (Younger Dryas) stadial.

It is, of course, unknown whether a human presence was continuous or episodic. Whichever, common sense suggests that considerable change should be visible in the archaeological signature over such a lengthy span.

The third point which requires emphasis is the 'unbalanced' nature of the present radiocarbon database. Two-thirds of the dates have central values of between 13,000 and 12,000 years ago. Almost all of these are for cutmarked bones collected along with other cultural materials from caves at Creswell Crags or Cheddar Gorge. All but one (OxA-150) are from within caves.

With one exception (OxA-811) all the dates with central values falling between 12,000 and 10,000 years ago are for 'formal' artefacts. With only a single possible exception (OxA-1493), none of these results can be extrapolated to collections of lithic artefacts. It is also worth noting that relatively fewer of these dates are for objects recovered from inside caves, and that none are for samples submitted from either Creswell Crags or Cheddar Gorge.

It remains to be seen whether this apparent patterning will survive further dating work. To my mind it will. I suspect also that the changed distribution of radiocarbon dates will eventually be found to correspond to successive human adaptations — firstly to the woodland hunting of elk and then to the exploitation of a tundra/steppe landscape.

The 'Creswellian and Creswell Crags

The term 'Creswellian' was created by Dorothy Garrod to describe the British Late Upper Palaeolithic (1926a; b).

It sought to reconcile an apparent association of bone, antler and ivory artefacts of well-known 'Magdalenian' types with lithic forms which, according to the contemporary version of culture history propounded by Breuil and Burkitt, were directly descended from a local 'Upper Aurignacian'. This flawed version was eventually to lead Leslie Armstrong, who spent many years working at Creswell Crags and other Upper Palaeolithic and Mesolithic sites in the East Midlands, to total terminological disaster.

It would not be unreasonable to suggest that Garrod's interpretation of the British Upper Palaeolithic sequence is now primarily of historical interest, although her monograph (1926a) will remain of lasting importance in that it documents collections lost to us through wartime action. Her conclusions were written against the background of a very different European database to that available to us over 60 years on. For that reason Garrod's definition of the 'Creswellian' which sought to demonstrate the dissimilarity of a part of the British Upper Palaeolithic from both the broadly contemporary, but geographically distinct ('classical') Magdalenian of South-West France and from the chronologically distant ('true') Upper Aurignacian is likely to be of little help to us when what we are attempting is to understand the finer points of north-west European Late Glacial human geography.

Is there any part of Garrod's (1926a) discussion which could still be of relevance in helping interpretation of this demographic patterning? The one straw at which perhaps we might grasp is the emphasis that she placed on a single artefact type — a '... semi-geometrical ... derivative(s) of the Gravette point, of which the most characteristic is an elongated trapeze' (1926a, 191). This provided the typological link between the (Late Upper Palaeolithic) 'Creswellian' and the (Early Upper Palaeolithic) 'Aurignacian' which was its supposed ancestor. This particular aspect of Garrod's discussion is clearly no longer relevant.

Such trapeze, or more correctly trapezoid, shaped backed pieces are what have more recently been termed 'Cheddar points' (Bohmers 1956, 11) – although use-damage consistently indicates that they were mounted as side- blades rather than as tip pieces. Therefore, they are here referred to as 'blades' rather than 'points'.

They display considerable variation with the shorter margin between the two divergent truncations sometimes wholly, and sometimes only partially, modified. There may be a clear projection where one or both truncations contact this modification. Where this lateral modification is only partial the unmodified portion may, or may not, form a clear shoulder. When it does so, the piece becomes terminologically a 'shouldered point'. One variant grades into another and their outlines merge with those of so-called 'Creswell points' *(ibid)* where the need was felt to modify only one extremity by means of an oblique truncation.

The various forms of these trapezoidal blades are known from only 20 British findspots (Fig 13.2). Most are cave sites, and they are recorded from all but two of the caves with evidence of Late Upper Palaeolithic use and considered by Garrod (1926a). Hence the impression gained from reading Garrod that such blades are ubiquitous in British Late Upper Palaeolithic collections and that most British Late Upper Palaeolithic findspots could therefore be termed 'Creswellian'.

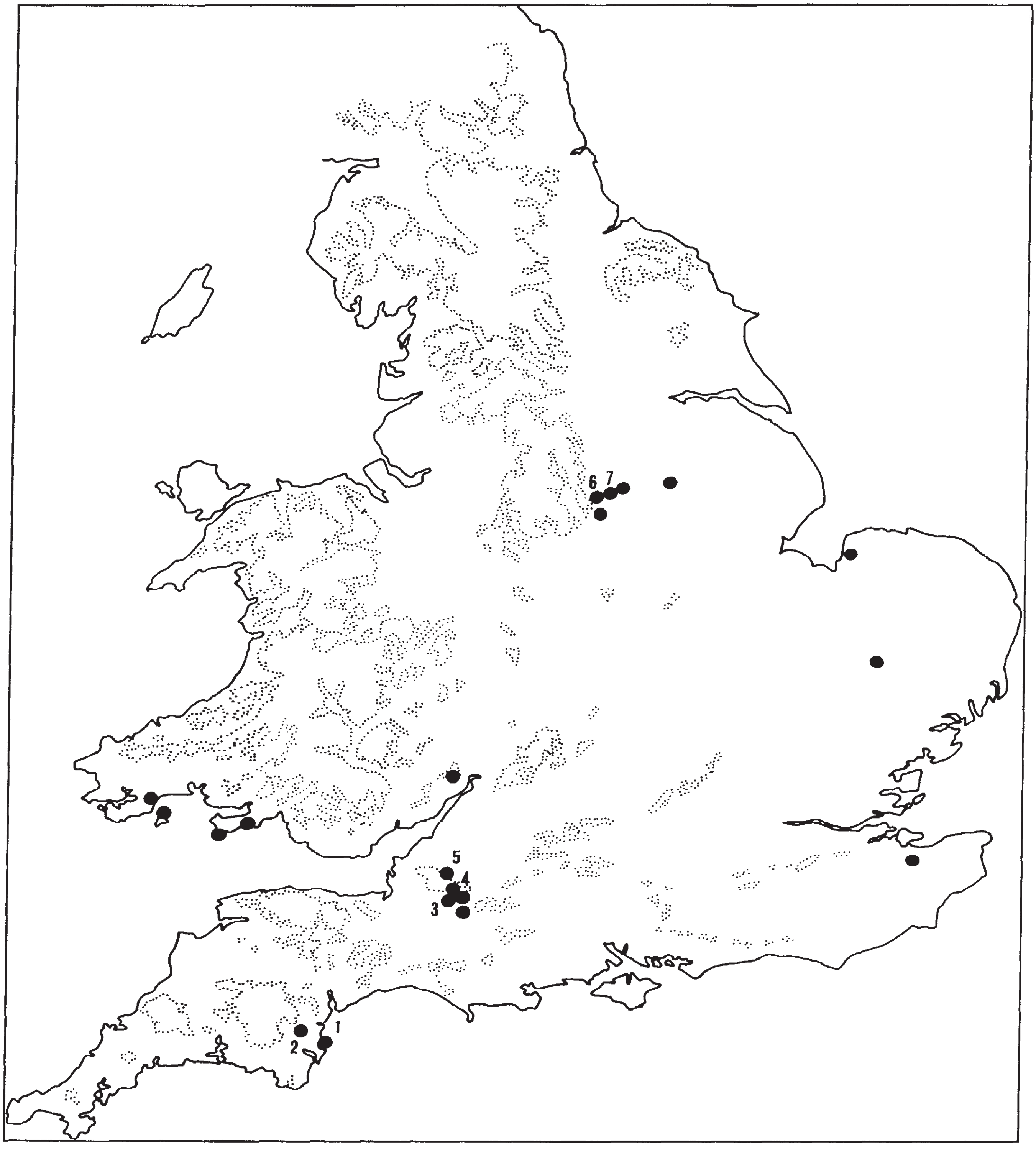

Figure 13.2 Findspots of trapezoidal blades. Findspots with radiocarbon dates for human fossil or humanly modified materials: 1) Kent's Cavern; 2) Three Holes Cave; 3) Gough's Cave; 4) Sun Hole; 5) Aveline's Hole; 6) Pin Hole; 7) Robin Hood Cave

Table 13.1 Radiocarbon dates for human fossil and humanly modified materials from findspots with trapezoidal blades. Sources: Housley, this volume, Table 4.5; Bowman *et al* 1990. Findspots marked on Figure 13.2

1	OXA 1789	Kent's Cavern: bone piercer	12,320±130 BP
2	OXA 1500	Three Holes Cave: cut bone fragment	12,350±160 BP
3	OxA 1071	Gough's Cave: cut bovine phalange	12,300±160 BP
	BM 2183R	Gough's Cave: cut horse atlas	12,350±160 BP
	OXA 589	Gough's Cave: as BM 2183R	12,340±150 BP
	OxA 590	Gough's Cave: as BM 2183R	12,370±150 BP
	OxA 465	Gough's Cave: cut horse phalange	12,360±170 BP
	OxA 464	Gough's Cave: cut horse metapodial	12,470±160 BP
	OxA 466	Gough's Cave: cut red deer metapodial	12,800±170 BP
4	OxA 535	Sun Hole: human ulna	12,210±160 BP
5	OxA 1121	Aveline's Hole: cut bovine phalange	12,380±130 BP
6	OxA 1467	Pin Hole: cut hare radius	12,350±120 BP
7	OxA 1670	Robin Hood Cave: cut hare humerus	12,290±120 BP
	OxA 1617	Robin Hood Cave: cut hare femur	12,420±200 BP
	OxA 1619	Robin Hood Cave: cut hare humerus	12,450±150 BP
	OxA 1618	Robin Hood Cave: cut hare scapula	12,480±170 BP
	OxA 1616	Robin Hood Cave: cut hare scapula	12,600±170 BP

The largest number of such blades from a single findspot are from Gough's Cave, Cheddar. Where 'Cheddar' and 'Creswell points' occur together the former seem always to outnumber the latter — even at Creswell Crags! Many of the pieces classified in the past as 'Creswell points' are no more than fragments which can be demonstrated through break refits to be parts from blades with a pair of divergent truncations. This observation should be borne in mind when seeking to use the 'statistics' presented by Campbell (1977). Thus, the 'Creswellian' is not to be identified solely on the basis of 'Creswell points' as is sometimes assumed — particularly by those attempting to trace its extension onto the European mainland.

Interestingly, for every findspot from which trapezoidal blades are recorded, and for which there are also radiocarbon dates on human bone or on humanly modified bone, the central values of these dates are always greater than 12,000 years ago (Table 13.1). This coincidence appears a strong hint that such blades may only belong to the first third of the 3000 (radiocarbon) year timespan suggested for our Late Upper Palaeolithic archaeology (Housley, this volume; Table 4.5).

A very similar range of design variation (to that noted for our 'Cheddar' and 'Creswell Points') can be seen amongst so-called 'Hamburgian points' except that where these are modified at both extremities the resultant outline more often resembles a rhomboid than a trapezoid. Recent dating of 'Hamburgian' findspots in North Germany suggests that these too date to before about 12,000 radiocarbon years ago (Fischer & Tauber 1986), and the individual determinations are indistinguishable from a number of their British counterparts. If some of the British and German findspots are *genuinely* of the same age, then the difference in preferred outline may be of stylistic significance — intended or unintended.

The radiocarbon record further suggests that use of the British findspots from which such trapezoidal blades have been recovered could overlap in time 'Magdalenian' findspots with a rich microlithic inventory (Audouze, this volume).

Whether all these findspots are really of the same age, whether there is a compression in the radiocarbon chronology for this time or whether lithic change was outstripping the capability of radiocarbon dating to produce a sufficiently fine-grained chronology, remains unresolved. While it has long been appreciated that some bone, antler and ivory artefacts attributed to the 'Creswellian' have very close analogues in mainland 'Magdalenian' contexts (Garrod 1926b, 300), this does not, of course, demonstrate that the British and Continental findspots were strictly contemporary one with another — only that both were used at sometime within the timespan over which these particular artefact types were current.

While a reading of Garrod inevitably gives the impression that such trapezoidal blades are very much a distinguishing feature of British Late Upper Palaeolithic findspots, analogous artefacts can be recognised in collections from findspots over a much wider geographical area. Some of these collections have been attributed to the 'Creswellian' (see for example data in Léotard & Otte 1988), and others to the 'Magdalenian' (Schmider 1988) or to a 'tardi-Magdalenian' (Bolus *et al* 1988, 478–9) depending upon the structure and composition of the lithic inventories with which they appear associated.

While pieces from as far away as the Paris Basin or southern Germany and northern Switzerland still preserve a broadly trapezoidal outline, subtly different proportions and, most particularly, changes in the position of the widest point in relation to the long axis, give these pieces a slightly 'foreign' look. This variability is, however, no more than one might expect from different individuals and in different areas aiming at the same artefact type.

Garrod's choice of Creswell Crags to lend its name to a part of the British Upper Palaeolithic was probably inevitable. Exploration from 1875 onwards had produced a substantial haul of Late Glacial and other artefacts, and excavation work had just begun again (1923) — this time directed by A. Leslie Armstrong. Garrod dug with him at Pin Hole in 1925 and the two had corresponded over his finds both from here and from the nearby Mother Grundy's Parlour.

Garrod also chose Creswell Crags because, in her own words, Late Upper Palaeolithic material could be '... found in greatest abundance *and variety...'* (1926a, 194, author's emphasis). This latter remark neatly pinpoints why data from Creswell Crags should provide such an *unsatisfactory* basis for describing a Late Glacial technology.

The Creswell site has been used by man at different times over perhaps 70,000 years. Where some of the resultant occupation residues have spread laterally into the protection of the different caves or fissures a part of this archaeological record has been preserved. The archaeological 'sequence' within each of these caves or fissures is different from that of any of the others and it is clear that no one sampling location preserved either a complete sedimentary or archaeological sequence. Each has its own particular interpretive problems.

Traces of Late Glacial occupation(s) have been sampled at four points — Pin Hole, Robin Hood Cave, Mother Grundy's Parlour and Church Hole. The collections from each of these four caves contain artefacts of very different ages and, for the most part, separation of the Late Glacial component depends on typology and preservation state rather than on contextual data.

At Pin Hole, where Armstrong's recording of the main passage has preserved many clues to unravelling the archaeological and palaeontological sequence at the Crags, Late Upper Palaeolithic tool-forms were few. However, several different 'point' types can be identified. These include a single complete trapezoidal blade, four small 'penknife points' (two with very clear distal impact damage) and several 'Tjonger points' strikingly similarly to that from Rekem directly dated by its adhering resin to 11,350±150 radiocarbon years ago (OxA 942: Gowlett *et al* 1987, 126; Lauwers 1988, fig 8, no 3). Identical 'Tjonger points' are unknown from any of the other Creswell caves.

If these different types are of different ages (which I strongly suspect to be the case) there is no clear stratigraphic patterning to confirm this, nor is it possible to re-articulate the components from individual occupation events. However, refitting of lithics and faunal elements confirms considerable separation of contemporary materials within the 'Upper Cave Earth'from which Armstrong collected these Upper Palaeolithic artefacts. Radiocarbon dating (Hedges *et al* 1989, 212–13) also demonstrates stratigraphic overlaps between materials of very different ages. Indeed, contrary to the oft stated belief, it is impossible to separate the residues of Early and Late Upper Palaeolithic occupation events which overlap stratigraphically in the lower part of the 'Upper Cave Earth' filling of the main passage.

Nor, sadly is there any certain support for the molluscan bio- stratigraphy recently suggested for this part of the cave (Hunt 1989, fig 10). An observed conflict between the results from Pin Hole cave and those derived from open air and waterlogged deposits of Late Glacial age *(ibid, 99)* appears more easily resolved by reference to stratigraphic overlaps of the kind already noted than by niche selection on the part of the molluscan taxa concerned. Significantly, all the samples of wood charcoal examined from the 'Upper Cave Earth' contained, or were wholly made up of, species not to be expected in this area earlier than some point within the Holocene (Anne Miles, pers comm).

At Robin Hood Cave many artefacts were collected by Campbell from immediately in front of the West entrance. Section drawings with artefacts projected onto them (Campbell 1969, figs 3 and 4) do not support division of this material in terms of a series of discrete occupation events (Campbell 1977, 174–5), nor is there any typological evidence that more than one Late Upper Palaeolithic technology is represented within this artefact cluster.

The sample of 'backed pieces' is small, and almost all are fragmentary. However, with the exception of one item of rather uncertain typology (*ibid,* fig 153, no 16), every piece is, or could be, from a blade with either one or a pair of oblique truncations — ie from a so-called 'Creswell' or 'Cheddar point'. That these Late Upper Palaeolithic residues could all be of one age is clearly shown by radiocarbon dates on cutmarked hare bones from various depths within the artefact cluster (Table 13.1; Hedges *et al* 1989, 213).

Differing preservation types correlate well with identifications to species in showing that the fauna from the same excavation contexts as these Late Glacial tool forms is not of one age. Part of it is clearly very much older. Failure to appreciate this point has led inexorably to the fantasy of local

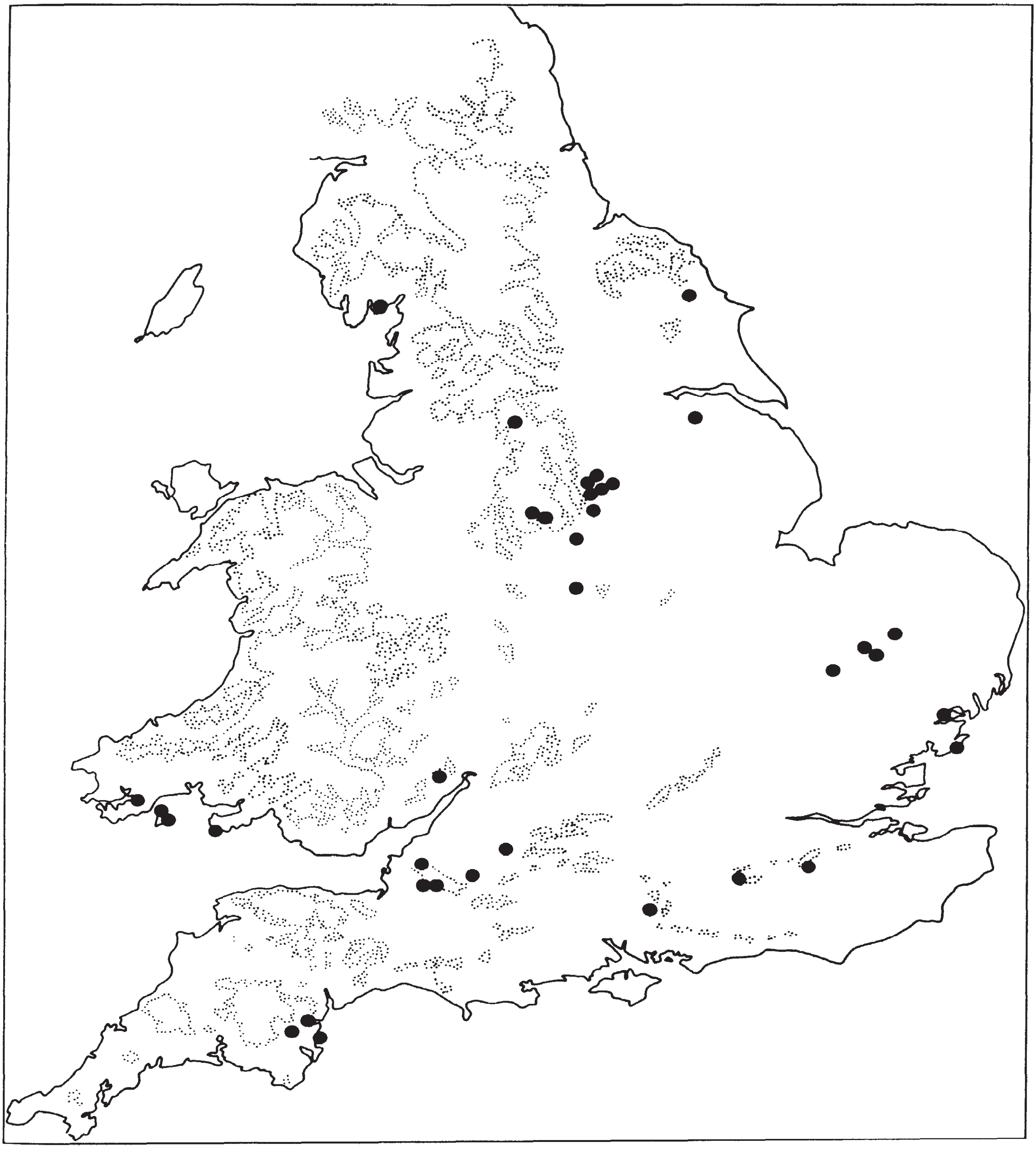

Figure 13.3 Findspots of *'penknife' points*

consumption, if not hunting, of woolly rhinoceros in the Late Glacial (see discussion in Charles 1990). Observations on typology, raw materials and preservation types also confirm a background noise of Middle Palaeolithic artefacts mixed with those clearly of Late Glacial age.

Mother Grundy's Parlour has traditionally contributed to discussions of the 'Creswellian'. Indeed, it is clear from correspondence between the two that Garrod was eagerly awaiting the publication of Armstrong's report on this site (1925) so that she could reproduce the illustrations from it in her monograph.

There has never been any disagreement that both Late Upper Palaeolithic and Mesolithic type artefacts are present in collections made from the platform in front of this cave and a persistent *Leit-motiv* in past discussions of these has been that they might somehow document a local evolution from one to the other (for similar interpretational problems see Gob, this volume). While, so far, only human use of the cave for burials has been directly dated it seems improbable that the Mesolithic artefact types belong to the earliest stages in the evolution of such a technology, a point which was fully appreciated by the late Charles McBurney, who excavated here in 1959-60 (see also Barton, this volume). Nor is there any compelling reason to believe that the Late Upper Palaeolithic artefact types recovered at the same time date to the very latest part of the Late Glacial. Equally plausible would be to envisage use of the platform in both the Upper Palaeolithic and Mesolithic, and with an as yet unmeasured interval of time separating these events.

Excavations by McBurney and Campbell (1969) have confirmed Armstrong's observation (1925) that Mesolithic artefacts would be found to cluster closer to the centre of the platform, while those of Upper Palaeolithic type were localised at its western end where a former projection in the roof-line provided more shelter. This Palaeolithic occupation had been sampled by Knight in 1878.

Despite this slight spatial 'offset' assemblage integrity is poor, and refitting of both artefacts and fauna across sediment boundaries can be demonstrated. In the case of artefacts such refitting links items attributed respectively to Late Upper Palaeolithic and Mesolithic 'assemblages' (Campbell 1977). This is what we might perhaps term the 'Hengistbury' effect (cf Barton & Bergman 1982). Clearly the age range of materials within individual sediment units can be further investigated by direct dating, an approach which may contribute to resolving the other *Leit-motiv* of past discussions of this site — the possible local survival of native wild horses until relatively late within the Postglacial.

A further uncertainty, and possibly irresolvable on the basis of the contextual data presently available, is whether the Late Upper Palaeolithic artefacts from Mother Grundy's Parlour are all of one age. While they include a number of backed blades indistinguishable even in quite small points of detail from their equivalents at Robin Hood Cave, there are also many so-called 'penknife points' (identical to specialised forms of 'Azilian' or 'Tjonger point'), as well as short and round scrapers whose morphology, raw material and preservation type make them unlikely to be Mesolithic. Such scrapers are unrecorded for Robin Hood Cave.

'Penknife points' are recorded from more British findspots than trapezoidal blades (Fig 13.3). As at Pin Hole some show evidence of damage received when hafted as the tip piece to a hunting weapon. While, as at Mother Grundy's Parlour, 'penknife points' are recorded from some of the same locations as trapezoidal blades this is not the case for the greater number of findspots (see also David, this volume). They are, for example, completely absent from the very large collection of lithic artefacts from the caves in Cheddar Gorge. Where both are recorded for the same findspot there is sometimes a hint from whatever contextual data are available that they need not have belonged together (as at Kent's Cavern) or that the sediment in question contained Late Glacial materials of very different dates (as at Three Holes Cave), The greater number of findspots for 'penknife points' are in the open air, rather than in caves. Thus, the points found nearest to Cheddar Gorge are from the surface of Callow Hill and at Long Wood near Charterhouse. This difference could, of course, have a functional explanation as well as, or instead of, a chronological one.

For the moment, therefore, there appears genuine uncertainty as to how the Late Glacial component of the Mother Grundy's Parlour collection should be interpreted. Such is the uncertainty that further fieldwork appears necessary before we can be certain that the trapezoidal blades which have formed the subjects of this paper also once formed part of a lithic technology whose overall structure may more closely have fulfilled definitions of an 'end'- or 'late'- rather than a 'young- Palaeolithic (*sensu* Taute 1973; 1975).

It would seem, therefore, that while material from Creswell Crags can undoubtedly make significant contributions to an understanding of broader aspects of the palaeontology and archaeology of the East Midlands, the present database offers very little beyond 'probabilities' when it comes to attempting the definition of individual Late Upper Palaeolithic toolkits.

Cheddar Gorge

Cheddar Gorge appears to offer more hope in this respect, although it is only very recently that we have been able to gain fresh insights as to other artefact types which belong to that part of the Late Glacial prior to about 12,000 years go.

Part of these new data come from sampling of sediments on the North side of Gough's Cave (Currant *et al* 1989). Here, lithic artefacts recovered from amongst a localisation of animal (Currant, this volume) and human bones (Cook, this volume) include an intact trapezoidal blade and a pair of end-scrapers — one long and one short, but both with trimming along their margins. With these was a *bâton de commandement* of reindeer antler, part of a double bevelled javelin head of mammoth ivory and an awl made from the proximal tibia of a mountain hare. While all the sediment was fine-sieved under water and the residues sorted indoors, no microlithic backed-bladelets were recovered — although finds made in this way include the distinctive spalls from splintered pieces and some minute fragments of ivory with groups of delicate incisions — so-called 'tallies' (Charles 1989).

The bâton resembles two found during earlier work in the cave both in its raw material and in having helicoidal grooving inside its perforation (for the earlier finds see Gray, in Parry 1929). Pieces of shaped mammoth ivory had likewise been found during earlier work at Gough's and ivory artefacts are known from other British Late Glacial findspots (Lister, this volume).

The pointed tibia of mountain hare is of particular interest. Not only does it confirm a Late Glacial context for examples found previously at Gough's, but awls made from the identical anatomical part are known from Church Hole, Pin Hole and Robin Hood Cave. These awls thus provide a further and previously unsuspected typological linkage between Cheddar and Creswell.

On the opposite side of Cheddar Gorge is Sun Hole, explored at different times from 1926 onwards by the University of Bristol Spelaeological Society. Of especial note is a group of 18 chipped flints and an irregularly fractured flint block recovered between 1951 and 1954 and from a maximum area of nine contiguous yard squares inside the cave (Tratman 1955).

These flints include a trapezoidal blade (Campbell 1977, fig 128, no 4), a broken long scraper with some marginal trimming (*ibid,* no 7), a piercer *(ibid,* no 8) and a broken blade with distal truncation *(ibid,* no 1). There are three blades truncated and worn at one or both ends (*ibid,* no 9) and identical to examples described by Lenoir and Terraza (1979) from the Late Magdalenian. Of the six preserved butts three are en *éperon* (N. Barton, pers comm, cf Karlin 1972).

The remaining items figured by Campbell are earlier uncontexted finds, and only no 5 is clearly Upper Palaeolithic. None of the radiocarbon dates reported from this cave can be related stratigraphically to these flints.

Amongst the poorly contexted material collected earlier from Gough's, long outnumber short scrapers and most are trimmed along their margins. Piercers are also present, as are numerous pieces with truncated and worn end(s). So too are many *en éperon* type butts. Interestingly, this butt type has turned up in every collection with trapezoidal blades and where a specific search has been made for them.

The importance of this small group from Sun Hole is, therefore, to demonstrate the association of several lithic types/features noted in earlier collections from Cheddar, but not so far encountered in the sampling work begun in 1986.

Conclusions

While an enormous amount still remains to be rescued of past work on the British Late Upper Palaeolithic, many of the conclusions which can be drawn from it will remain as no more than probabilities. These probabilities can only be tested by fresh sampling of carefully selected Late Glacial sediments.

The total of known Late Upper Palaeolithic findspots is increasing all the time, although loss of contemporary coastlines almost certainly means that we have also lost the areas of densest and most continuous settlement (see Keeley, this volume). Evidence for such settlements presently survives only in the form of sea-shells brought into the hinterland as, for example, to Gough's Cave. Although suitable samples of human osteological material now exist, no attempt has yet been made to investigate their chemistry for possible evidence of a marine dietary input.

Recent dating work demonstrates that use of this hinterland was distributed over almost 3000 radiocarbon years and, therefore, over major changes in temperature, vegetation cover and fauna. It should be noted that this knowledge is derived from the dating of samples from both cave and open air findspots. The dating of materials from just one or the other would not have yielded this information.

Garrod created the 'Creswellian' to describe the British Late Upper Palaeolithic. Her discussion, however, was aimed at addressing an interpretational problem now only of historical interest. Late Upper Palaeolithic collections from Hengistbury Head (Barton, in press) and Brockhill, near Woking in Surrey (Bonsall, in prep), are so clearly unlike anything considered by Garrod that the term 'Creswellian' cannot reasonably be applied to them. The term cannot, therefore, continue to be used as a synonym for the British Late Upper Palaeolithic.

Still further typological and structural diversity can be predicted as soon as we begin to sample others of the quite numerous Late Upper Palaeolithic findspots which certainly exist (Fig 13.1). We might, for example, expect to find equivalents of the continental 'Tjongerian'.

The most distinctive components of the 'Creswellian', as described by Garrod, were its trapezoidal backed blades — latterly termed

'Cheddar' points. Such blades are known from relatively few British findspots (Fig 13.2) and radiocarbon dates (Table 13.1) are here interpreted as indicating a life-span for this artefact type restricted to sometime between 13,000 and 12,000 radiocarbon years ago. The difference in the species chosen for dating as between Cheddar Gorge and Creswell Crags is an accurate reflection of what appears a very real contrast in the purposes for which the two localities were used — at least as far as can be deciphered from cutmarks on bones.

The stone tool technology from these findspots differs most clearly from the majority of those attributed to the 'Magdalenian' in the absence of microlithic backed bladelets, and from the 'Hamburgian' in the style of its backed blades ('points'). Like both of these, collections from Cheddar Gorge which most nearly match the various elements of Garrod's description are structurally 'young' rather than 'end' or 'late' Palaeolithic.

Whether parts of all three technologies are truly of the same age, as often assumed, is perhaps better considered undemonstrated — at least for the present — given all the uncertainties in assessing a radiocarbon record built up over 40 years and therefore combining results produced at very differing 'states of the art' and on a range of materials with widely varying levels of relevance to what they were supposed to be dating: all this over and beyond possible problems of compression. If we are ever to fine-tune the relative chronology for the Late Glacial (re)settlement of north-west Europe we will need much better stratigraphic controls on the sequence of appearance and disappearance of individual artefact types and style features.

It has to be said that Bohmers' term 'Cheddarian' (1956, 23-4) is in some ways preferable to that of 'Creswellian'. It side-steps the gross contextual problems presented by Creswell Crags and it implies, albeit coincidentally, the importance of trapezoidal blades ('Cheddar' points) as markers of a human presence at this time, as well as their numerical significance in structuring these artefact collections. Finally, it draws attention to the fact that Cheddar Gorge is presently the site where, not only has much information been recovered relevant to the archaeology of this timespan (13,000–12,000 radiocarbon years ago), but where it is also likely to be significantly enhanced by further sampling.

It is, however, also worth pondering whether a cultural name is either useful or appropriate for this British material. None of the elements which go to make up British Late Glacial technologies prior to about 12,000 radiocarbon years ago is unique to Britain and many are to be found in both so-called 'Magdalenian' and 'Hamburgian' contexts. Equally 'Hamburgian' artefact forms are to be found in 'Magdalenian' contexts and vice-versa.

Again, it is worth facing up to the fact that truly we do not know how the British archaeological record for this timespan should be interpreted. It may, as so often for the Pleistocene, represent only that part of a much denser settlement pattern which cave environments have protected from some of the effects of subsequent periglaciation. Certainly, the trend of recent literature has been to envisage a 'Creswellian' techno-territory contiguous with those of the 'Magdalenian' and 'Hamburgian' and with which, by definition, it is usually considered a contemporary (but see above).

On the other hand, would the archaeological and radiocarbon records look so very different if what we have sampled were to represent only the wanderings of a single group (see for example Binford 1983, fig 52)? Interestingly, tests of significance for the data displayed on Table 13.1 indicate that they show the pattern which one would expect two-thirds of the time from a set of dates for one limited episode (Kenworthy, pers comm).

Such an interpretation is further attractive in that it offers an immediate explanation for the quite astonishing similarities visible between individual artefacts from different British findspots. Skin types for the translucent flints used in these technologies are also strikingly similar from findspot to findspot. Clearly, whether the flint types are genuinely the same can be tested for and remains an urgent priority. Finally, the wanderings of a single group would offer an explanation for why the technology which they left behind represents such a particular and peculiarly weighted selection of tool types — each of which is known from a wide area of northern Europe and from various other technological configurations.

So, what of terminology? Given a personal conviction that existing 'cultural' divisions may well prove considerably less clear-cut as more pre-Allerød Late Glacial findspots are sampled, there appears little merit in seeking to bolster such a framework. Equally, if one of the purposes of this conference was to consider human biogeography, there appears no value in creating or supporting a terminology which might help preclude recognition of possibly far-flung genetic linkages. I would, therefore, simply suggest that we might talk in terms of a 'Young Palaeolithic technology with trapezoidal side blades' — and perhaps qualified as 'lacking microlithic backed bladelets'.

Perhaps then our southern German and northern Swiss colleagues will glance again at this part of our Late Glacial archaeology.

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14 Late Glacial archaeological residues from Wales: A selection

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Abstract

It is now becoming possible to reassess the evidence for the Late Glacial human inhabitation of Wales in the light of recent developments in radiocarbon chronology and environmental studies for this period. In particular, the greater precision with which certain ('Creswellian') artefact assemblages have been defined, for instance at Gough's Cave, Cheddar, allows some confidence in the attribution of equivalent Welsh material — such as that from Hoyle's Mouth Cave — *c* 12,800–12,000 BP. The evidence for occupation later in the interstadial, or even during the Loch Lomond stadial, is however, more uncertain. This account includes a description of finds of lithic material from south-west Wales and speculates on their possible Late Glacial nature.

Introduction

Just before the publication of Garrod's *The Upper Palaeolithic Age in Britain* (1926), Mortimer Wheeler was able to open the first attempt at a full description of Welsh prehistory with an entire chapter devoted to 'Cave-Man' Wheeler 1925). His account relied then, as now, on only the meagre information available from caves such as Ffynnon Beuno and Cae Gwyn in north Wales and Hoyle's Mouth near Tenby, and the Cower caves — particularly Paviland — in the south. Although research and some fresh excavation has taken place since then (McBurney 1959; Savory 1973; Van Nédervelde *et al* 1973; Campbell 1977; Jacobi 1980; Green 1986a; b; Davies 1989a; b), the database has changed little. Since the last major review (Jacobi 1980), however, striking refinements have been made in the understanding of British bio- and chronostratigraphy and, most significantly, in the accelerator (AMS) radiocarbon dating of human prey animals and organic artefacts. Problematic though the situation still is for the understanding of the Welsh Late Palaeolithic, the opportunity is taken here of reviewing some of the data in the light of this new information, especially from the Late Glacial of south-west Wales.

The Glacial maximum

Now that the Red Lady of Paviland seems undisputedly to pre-date the glacial maximum (Hedges *et al* 1989) there remains no concrete evidence for any human presence in Wales over the nine millennia or so (*c* 22,000–13,000 BP) of the onset and decline of severe glacial conditions. There are, however, several instances where items of fauna have been dated to within this period (see Table 14.1).

None of the specimens listed in Table 14.1 can be shown to have any valid association with humanly derived deposits or artefacts. Even so, if Palaeolithic hunting at this time cannot be demonstrated by such direct evidence, the presence of such prey animals shows at least that it could have been taking place (Green 1986b). The alternative proposal of an *hiatus* in exploitation this far north ignores the possibility that Late Palaeolithic hunters may have been better able to cope with severe climate than has hitherto been believed (Campbell 1986). Hunters and prey may have been scattered widely over the European tundra-steppe (Jacobi 1986a), even encroaching to within a few kilometres of the ice front. Such a thin and dispersed exploitation cannot be expected to leave the substantial archaeological residues that characterise the more favourable southerly latitudes on the continent. Equally, there is little evidence so far that lithic items from more northerly hunting and settlement at this time need be particularly distinctive — possibly, therefore, remaining unrecognised amongst undifferentiated British artefact collections.

If we are, therefore, poorly informed about Upper Palaeolithic activity in Wales during (and preceding) the glacial maximum, the database improves somewhat for the succeeding period of Late Glacial warming.

The Late Glacial interstadial

The climatic and vegetational changes which succeeded the glacial maximum were no less rapid

Table 14.1 Radiocarbon determinations on Devensian faunas from Wales

Ogof-yr-Ychen, Dyfed			
Woolly rhinoceros	22,350±620BP	(Birm-340)	Ref 1
Cae Gwyn, Clwyd			
Mammoth	13,000±1400/-1200 BP	(Birm-146)	Ref 2
Little Hoyle, Dyfed			
Barnacle goose	22,800±300 BP	(OxA-1027)	Ref 3
Ungulate	17,600±200 BP	(OxA-1026)	Ref 3
Bear	20,050±900 BP	(ANU-4347)	Ref 4
Bear	17,800±950 BP	(ANU-4348)	Ref 4
Reindeer	17,350±850 BP	(ANU-4349)	Ref 4
Bear	19,950±650 BP	(ANU-4350)	Ref 4

References:
1 Shotton & Williams 1973
2 Shotton & Williams 1971; Rowlands 1971
3 Hedges *et al* 1987
4 Rae *et al* 1987

and complex in Wales than they have been shown to be elsewhere in Britain. The Principality is fortunate in possessing some extremely well documented Late Glacial biostratigraphies (eg Coope & Brophy 1972; Lowe 1981; Walker 1982; Lowe & Lowe 1989; Walker & Harkness 1990) which provide considerable local detail as well as allowing a more general picture of such changes to emerge.

Radiocarbon determinations for organic horizons at several pollen-sampling sites in the uplands of Wales provide dates for an onset of thermal warming approximately coincident with the retreat of polar water at *c* 13,500 BP (Ruddiman & McIntyre 1973; 1981), At Glanllynnau, on the Lleyn peninsula in north Wales, deglaciation was probably complete by as early as *c* 14,500 BP, and coleopteran evidence indicates a marked thermal improvement from this time (Coope *et al* 1971). Rather later dates of 13,200±120 BP (SRR-1705) and 13,200±75 (SRR-3455) are recorded respectively for the earliest sedimentation at Llyn Gwernan, Gwynedd (Lowe 1981; Lowe & Lowe 1989), and at Llanilid in the Vale of Glamorgan (Walker & Harkness 1990). Following pioneering colonisation by taxa such as *Cyperaceae, Rumex* and *Artemisia,* the subsequent appearance of *Juniperus,* dated at Llyn Gwernan to 12,970±130 BP (SRR-1704), has been widely recognised throughout western Britain as a response to a climatic amelioration which coleopteran evidence demonstrates to have peaked at *c* 12,500 BP (Atkinson *et al* 1987). Tree cover at this time, when summer temperatures were at least as warm as those of today (Coope 1977), seems to have consisted especially of *Betula,* in lowland and some upland areas (Moore 1977), as well as by *Empetrum* and *Salix.*

Contextual records for the fauna which shared the Late Glacial landscape with humans are, as for the entire Welsh Pleistocene, conspicuously poor. Despite the very abundant finds of vertebrate remains in many Welsh limestone caves over the last 150 years, the activities of carnivores and latter-day cave hunters have left a legacy of such disarray that it is now barely possible to distinguish to which part of the Pleistocene they belong. Table 14.2 represents an attempt to list the principal Devensian mammal species recognised from Wales, a compilation which can only hint at the former wealth of these cave sites.

Although it has been suggested that fresh mammal populations would have had to re-immigrate into Britain at the onset of deglaciation (Stuart 1982), it is apparent that at least some vertebrates were present in Wales at about the glacial maximum (see above, and Table 14.1). Bear and reindeer can be included amongst these, as recorded from Little Hoyle (Longbury Bank Cave), Dyfed. Also, given the unexpected Interstadial dating of mammoth remains from the English sites of Condover, Pin Hole and Gough's Cave (Hedges *et al* 1987b; 1989; Lister, this volume), this and other species may also have been present in Wales. So far, however, no radiometric determinations are available for Wales which bridge the gap between the series from Little Hoyle (above) and the AMS date of 10,000±200 BP (OxA-

Table 14.2 Records of Devensian mammalian faunas from Welsh Caves (including King Arthur's Cave, Herefordshire). For relevant radiocarbon dates see text

	A				B	C			D																			
	Paviland, Gower	Cae Gwyn/Ffynnon Beuno, Clwyd	Ogof-yr-Ychen, Caldey	Long Hole, Gower	Little Hoyle, Dyfed	Cathole (layers MSB, LOB), Gower	Worm's Head Cave, Gower	Kendrick's Cave, Gwynedd	Cathole, Gower (pre-1968)	The Hoyle's Mouth, Dyfed	Priory Farm Cave, Dyfed	'Caldey Caves', Dyfed	Daylight Rock Fissure, Caldey	Potter's Cave, Caldey	Llandybie Caves, Dyfed	Coygan Cave, Dyfed	Nottle Tor, Gower	Leather's Hole, Gower	Deborah's Hole, Gower	Spritsail Tor, Gower	Bosco's Den, Gower	Lewes Castle Cave, Gower	Gop Cave, Clwyd	Lynx Cave, Clwyd	Plas Heaton Cave, Clwyd	Ogof Pant-y-Wennol, Gwynedd	King Arthur's Cave, Herefordshire	
Hare				+	+	+																					+	*Lepus spp.*
Steppe pika																											+	*Ochotona pusilla*
Suslik																												*Spermophilus spp.*
Beaver																												*Castor fiber*
Common shrew					+	+																						*Sorpx araneus*
Arctic lemming					+	+	+																	+			+	*Dicrostonyx torquatus*
Norway lemming					+		+																					*Lemmus lemmus*
Bank vole						+	+																					*Clethrionomys glareolus*
Water vole					+																							*Arvicola terrestris*
Field vole						+																						*Microtus agrestis*
Northern vole					+																			+				*Microtus oeconomus*
Tundra vole					+	+	+																				+	*Microtus gregalis*
Woodmouse						+	+																					*Apodemus sylvaticus*
Wolf	+	+					+	+			+	+									+	+					+	*Canis lupus*
Arctic fox				+		+																						*Alopex lagopus*
Red fox		+	+	+	+	+	+			+										+	+							*Vulpes vulpes*
Brown bear					▲	+	+	+		?	+		+				+		+	+	+						+	*Ursus arctos*
Cave bear	+									+		+					+										+	*Ursus spelaeus*
Spotted hyaena	+	+	+	+					+	+	+	+	+				+	+	+	+		+	+			+	+	*Crocuta crocuta*
Lion		+										+	+				+										+	*Panthera leo*
Wild cat																												*Felis sylvestris*
Northern lynx																								+				*Felis lynx*
Glutton																									+			*Gulo gulo*
Mammoth	+	▲		+					+		+	+	+			+	+	+		+		+					+	*Mammuthus primigenius*
Wild horse	+	+		+	+	?		▲		+	+	+	+	+		+		+		+			+			+	+	*Equus ferus*
Woolly rhinoceros	+	+	▲	+		+			+			?	+	+				+				+	+			+	+	*Coelodonta antiquitatis*
Giant deer	+	+		+		+				?			+														+	*Megaceros giganteus*
Red deer						+						+					+										▲	*Cervus elaphus*
Elk												+			?													*Alces alces*
Reindeer		+	+	+	▲	+	+			+	+		+			+				+	+	+	+	+		+		*Rangifer tarandus*
Bison/Bos	▲	+	+	+				?		+	+	?	+				+			+	+		+				+	*Bison sp./Bos sp.*
Musk ox																												*Ovibos moschatus*
Unidentified					▲																							

Key: A) Sites with radiocarbon and/or stratigraphic data indicative of the Mid-Devensian. Only the species with radiocarbon dates can certainly be attributed to this period; B) fauna associated with a pooled radiocarbon date of 18,450±430 BP (Green 1986b); C) sites with radiocarbon or stratigraphic data, or faunal association (Worm's Head Cave), indicative of the Late Devensian; D) sites with unattributable faunal remains ofprobable Mid- to Late Devensian type

111: Gillespie *et al* 1985) for a decorated horse mandible from Kendrick's Cave, Gwynedd, north Wales (see below).

Welsh cave biostratigraphies are largely unhelpful. The fauna recorded from layers LOB and MSB at Cathole in Gower suggests only the possibility that reindeer may have been present in the Late Glacial, along with fossils identified as bear, arctic fox, red fox, lemmings and other small mammals. John Campbell has suggested that with these can be included the horse, red deer and giant deer recorded during earlier investigation of the cave (Campbell 1977; McBurney 1959). Since, however, this cave has produced artefacts of several ages, such interpretations, unsupported by radiometric dating, must be treated with caution. Equally ambiguous are records of red fox, lemmings and other rodent species recovered, along with a few flints and a juvenile human cranium, from a breccia in Worm's Head Cave, Gower (Davies 1981; 1982; 1989a; Currant, pers comm).

Given the lowered sea levels of the Late Glacial and the probable wide ranges of both humans and animals at this time, it is reasonable, when faced with such scant evidence from Wales, to look to neighbouring areas for equivalent faunal information. At Gough's Cave, in Cheddar Gorge, mammal species directly dated to the Interstadial are arctic fox, wild horse, red deer, wild cattle and saiga antelope. From the same site come steppe pika (possibly of Loch Lomond Stadial age), arctic hare, norwegian lemming, water vole, wolf, red fox and brown bear (Currant 1986a; this volume). With the exception of the saiga antelope and steppe pika, all these species are recorded from Welsh sites and must be considered likely to have formed part of the local Late Glacial fauna there also. The larger species would between them have provided valued sources of fat, meat, pelts, bone and antler: cutmarks preserved on bone make it clear that at least arctic hare, wild cattle, red deer and particularly wild horse were sought and butchered by humans.

Despite this now clear picture from Cheddar and the similar situation that might be expected further west along the dry Bristol Channel and into Wales, it should not be considered surprising if future research were to reveal further variety. For instance, one member of the British megafauna known to have been exploited by humans at least in north-west England during the Interstadial is the elk (Hallam *et al* 1973; Jacobi *et al* 1986), but this animal is unrecorded at Gough's Cave and cannot be verified for Wales (Table 14.2; Lister 1984).

If the evidence for land mammals is sparse, that for birds, fish, molluscs and marine mammals is thinner still. Grouse, greylag goose and pipit are recorded from the Later Upper Palaeolithic layers at Cathole (Bramwell 1977). From apparently Late Glacial deposits at Potter's Cave, Caldey Island, D. Bramwell has identified large goose, peregrine or gyr falcon, puffin, manx shearwater, woodpigeon and duck (M Davies, pers comm). Amongst these, however, it is possible that at least puffin and shearwater, with their habit of nesting in burrows, are of more recent age. More certainly Late Glacial is the avifauna from Gough's Cave where bones of ptarmigan and swan had been utilised by humans (Harrison 1986; Jacobi 1986b). Especially since the Irish Sea was open at this time (Devoy 1985), marine mammals, molluscs and both sea and freshwater fish may be expected to have had a role in the Late Glacial subsistence economies. This is particularly difficult to assess, however, when the sea itself, rising from perhaps as low as -100m at 13,000 BP (Fairbanks 1989), has removed or submerged the sites and situations where such evidence may have existed.

Despite such massive land-loss, however, about 150 archaeological findspots in Britain can be attributed to the Late Glacial (Jacobi, this volume), 16 of them in Wales. The latter are mainly restricted to the limestone outcrops to the north and south of the Cambrian mountains (Table 14.3; Fig 14.1). In addition, just on the English side of the border is the important site of King Arthur's

Table 14.3 Findspots of apparently Late Glacial artefact(s) from Wales, Herefordshire and Shropshire

North Wales:	
Lynx Cave	(SJ 1976 5933)
Ogof Tan-y-Bryn	(SH 7994 8159)
Plas-yn-Cefn Cave	(SJ 0202 7053)
Kendrick's (Upper) Cave	(SH 7800 8283)
Shropshire:	
Porth-y-Waen	(SJ 2590 2339)
South Wales:	
Paviland Cave	(SS 4372 8588)
Cathole Cave	(SS 5377 9002)
Worm's Head Cave	(SS 3836 8770)
Carn Fach, Rhigos	(SN 944 025)
Gwernvale	(SN 211 192)
Herefordshire:	
King Arthur's Cave	(SO 547 157)
Arrow Court	(SO 279 545)
West Wales:	
Nanna's Cave, Caldey Island	(SS 1458 9698)
Potter's Cave, Caldey Island	(SS 1436 9707)
Ogof-yr-Ychen, Caldey Island	(SS 1468 9691)
'New Cave', Caldey Island	(SS 1470 9688)
Priory Farm Cave	(SM 9789 0184)
Little Hoyle Cave	(SS 1118 9998)
Hoyle's Mouth	(SN 1120 0033)

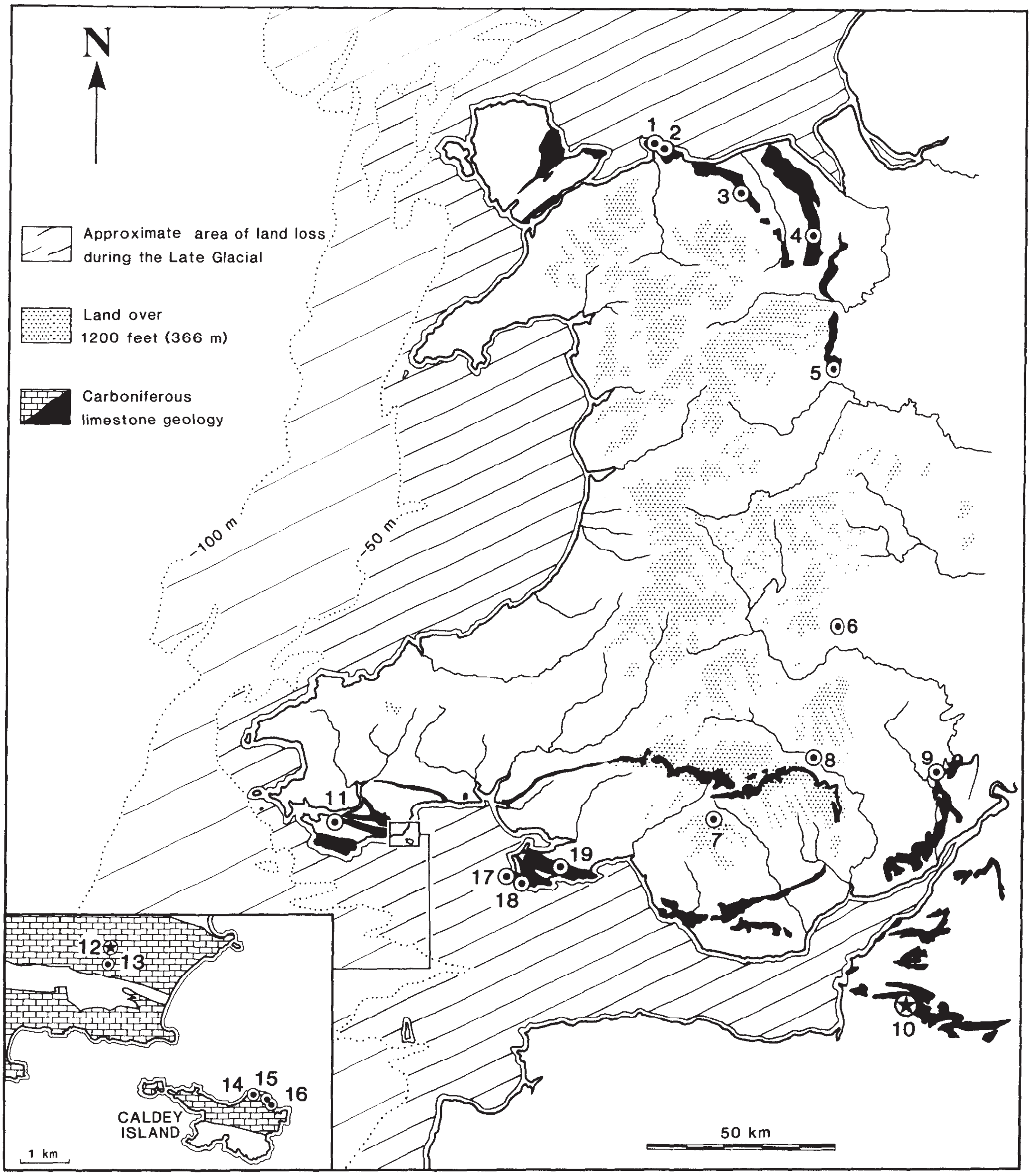

Figure 14.1 The location of findspots of potentially Late Glacial artefacts from Wales and adjacent areas: 1) Kendrick's Cave; 2) Ogof Tan-y-Bryn; 3) Plas-yn-Cefn Cave; 4) Lynx Cave; 5) Porth-y-Waen; 6) Arrow Court; 7) Carn Fach, Rhigos; 8) Gwernvale; 9) King Arthur's Cave; 10) Gough's Cave; 11) Priory Farm Cave; 12) Hoyle's Mouth Cave; 13) Little Hoyle Cave; 14) Potters Cave; 15) Nanna's Cave; 16) Ogof-yr-Ychen; 17) Worm's Head Cave: 18) Paviland Cave; 19) Cathole Cave

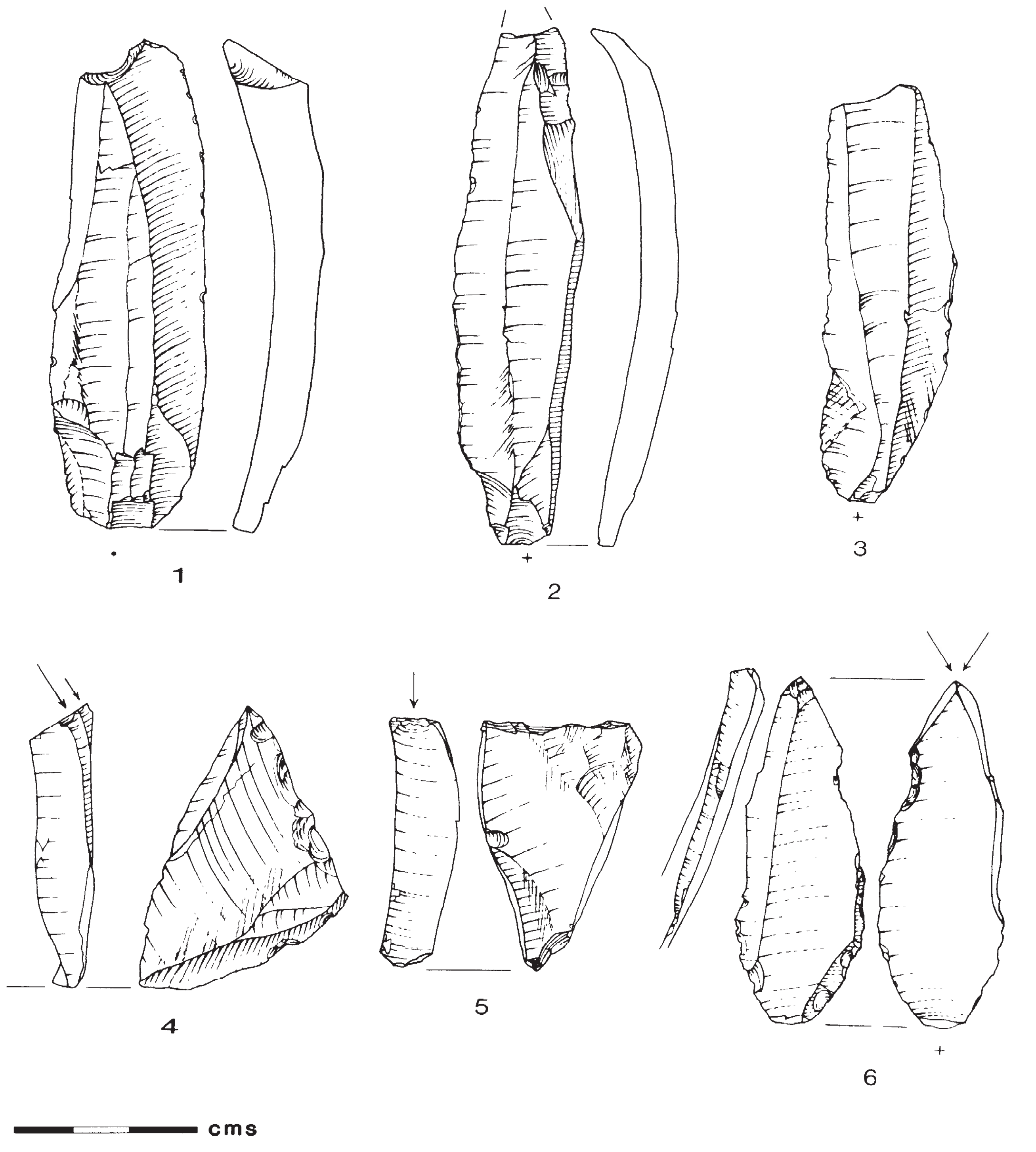

Figure 14.2 Non-flint artefacts from Hoyle's Mouth: 1–3) blades; 4–6) burins. Nos 1–5 are of so-called 'adinole' and No 6 is of igneous stone: the rock types of these and other pieces from the cave have yet to be precisely identified. Scale in cm

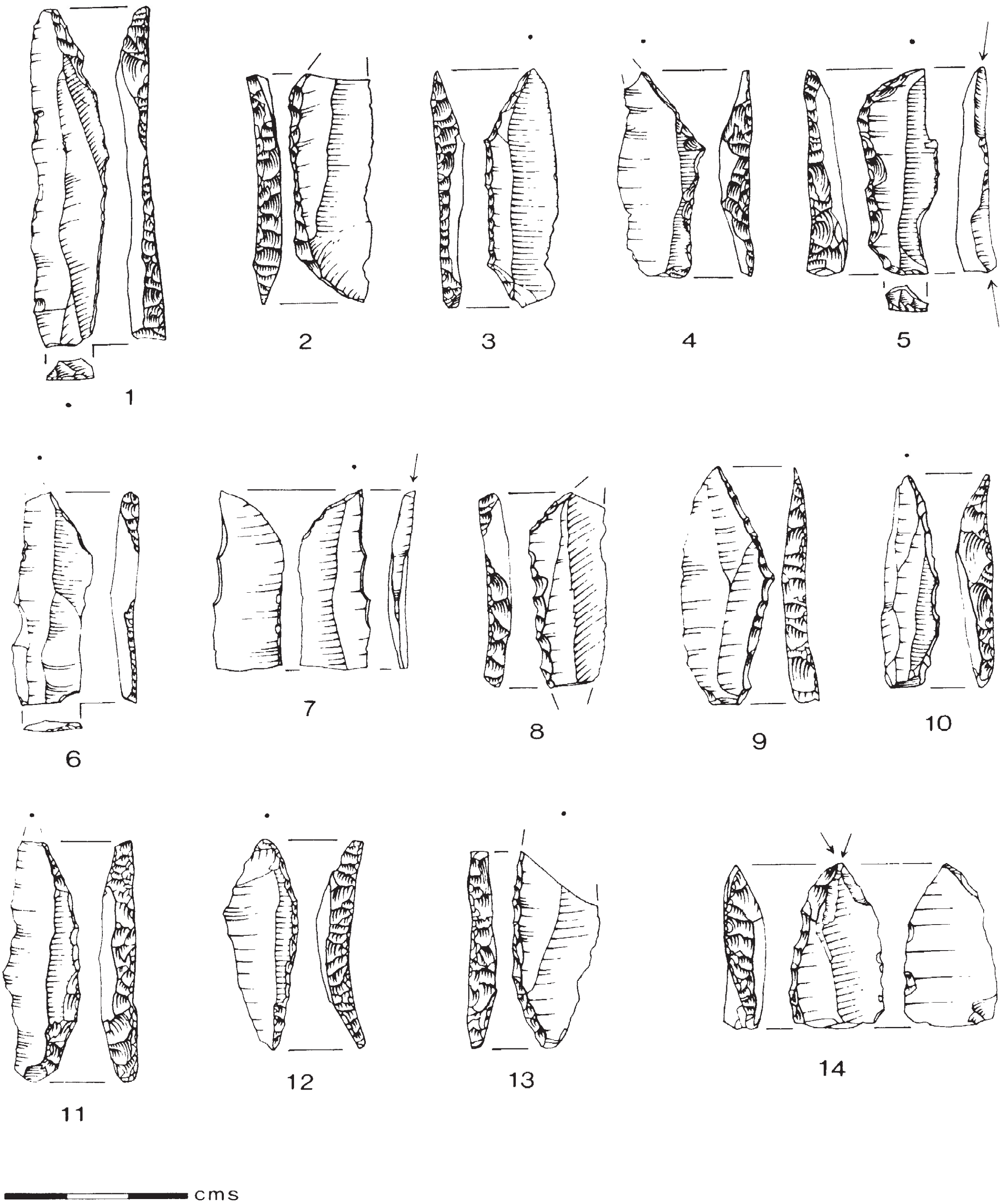

Figure 14.3 Hoyle's Mouth, Dyfed: 15) Trapeziform blades ('Cheddar points'); 6, 8) shouldered and truncated blades; 9) angle-backed blade ('Creswell point'); 10–14) convex-backed blades. (Nos 5 and 7 have been reworked as burins. Scale in cm

Cave, Hereford and Worcester. From the same county are fragments of flint backed points from two separate findspots near Arrow Court (Campbell 1977, fig 130, 1 and 2). Of special significance, also, is the unassociated — but now AMS dated (see below) — find of a barbed antler point at Pen-y-Waen, Shropshire (Britnell 1984).

Rather than examine each of the locations listed in Table 14.3 in detail (see David 1990) it is intended here to consider closely only the important group of findspots in west Wales.

This area has a history of cave exploration going back at least to the mid-nineteenth century. Limestone quarries on Caldey Island revealed copious Pleistocene bone deposits at this time (Leach 1916) and, in the 1840s–70s, more ancient bones — with stone artefacts — were found in the mainland caves of Hoyle's Mouth and Little Hoyle (Longbury Bank Cave) near Tenby (Smith 1860; 1862; Laws 1888; Rolleston *et al* 1878). In the present century, continuing explorations have resulted in further discoveries on Caldey (Lacaille & Grimes 1955; Davies 1989a) and on the mainland, for instance at Priory Farm, Monkton, near Pembroke (Grimes 1933). Latterly, renewed excavations by H S Green of The National Museum of Wales, at Hoyle's Mouth and at Little Hoyle are providing important new data.

The problem is that little survives from the earlier discoveries and supporting documentation is either absent or minimal. The most substantial collection of artefacts to come down to us, through a lengthy history of periodic excavation, is that from Hoyle's Mouth (Campbell & Bowen 1989, 78-80). In sum, only 361 chipped items from the cave, including those excavated by Green (up until 1986), can now be accounted for. Amongst these are some 52 tools of apparent Late Glacial character — a figure only exceeded in Britain for Hengistbury Head, Gough's Cave, Robin Hoods Cave and Mother Grundy's Parlour. This then is easily the largest group of potentially Late Glacial artefacts from Wales.

The cave has long been recognised as relevant to the Late Palaeolithic ('Creswellian') following the recovery of elements of an appropriate fauna and retouched stone tools very similar to types already well known from the Creswell and Mendip caves (Garrod 1926). The presence of woolly rhinoceros and hyaena would suggest the cave was also open earlier in the Devensian — a proposition supported by a recent AMS determination on unidentified bone of 27,900±900 BP (OxA-1024: Hedges *et al* 1987a).

None of the surviving artefactual or faunal material can be satisfactorily related to either *in situ* or intact sediment contexts. The richer deposits were evidently found within the inner recesses of the cave in sediments formerly sealed by stalagmite. Excavations on the outer platform in 1968 (Savory 1973) revealed largely mixed deposits. Green's excavations in the entrance in 1986 have recovered further unstratified material, but showed that undisturbed basal layers still exist.

Flint makes up the majority (83%) of the total extant artefact collection — the remaining pieces being of 'adinole' (49), unidentified igneous stone (11) and Cretaceous chert (1). The flint, now heavily patinated, is largely of good quality and was apparently the preferred raw material for most retouched pieces. Suitable sources may have been accessible in the Bristol Channel area, although its relative scarcity is suggested by the adaptation of broken tools to secondary uses, and by the use of alternative local materials. The largest surviving flakes and blades are of *adinole* (Fig 14.2, Nos 1-3) — probably deriving from southern Welsh Cambrian shales. Although flawed, this material could evidently be worked as dexterously as flint. This being so, it may be significant that there are no cores, backed implements or scrapers made from adinole, there being an apparent preference for its use in the manufacture of burins and blades.

Table 14.4 lists all the recognisable tools and tool fragments from the cave. Amongst these is an unambiguous example of a *burin busqué* (Fig 14.4, No 13) — a most significant identification which means that Hoyle's Mouth should now be added to the small number of British 'Aurignacian' findspots. Since we know little about the lithic tool-types which might have accompanied such potentially earlier type-fossils, it is possible that other early artefacts may be lost amongst those seemingly of Late Glacial type. Further interlopers are certainly present in the collection in the form of unpatinated artefacts made predominantly on beach pebbles. These are common to many local cave collections and are considered most likely of Holocene age.

Even when both earlier and later components of the collection are discounted, one is still left with what would appear to be the residue of a formerly substantial assemblage in which many acknowledged Late Glacial lithic types are represented. There is, for instance, no significant tool form amongst the very much larger collection at Gough's Cave which is not present at Hoyle's Mouth. True *Zinken* and splintered pieces are missing, but all the other forms described by Jacobi (1986b, 76–7) can be identified. That the two caves should share such a characteristic suite of stone tools strongly suggests that they are contemporary.

Within this tool inventory, the complete and nearly complete backed pieces (Fig 14.3) form a tightly defined group made up of angle-backed ('Creswell'), trapeziform ('Cheddar') and convex-backed blades, together with two shouldered and truncated blades. Their outlines are defined by abrupt retouch which is often bi-directional, indicating the use of an anvil on the thicker portions of some blades. A characteristic noted by Jacobi on some of the Mendip trapeziform points is a small protrusion (or 'gibbosity') at the angle

Table 14.4 Composition of the lithic collection from Hoyle's Mouth, Dyfed

i)	*backed blades:*	
	trapeziform blades ('Cheddar points')	5
	angle-backed blades ('Creswell points')	2
	fragments of angle-backed blades	2
	obliquely truncated & shouldered blades	2
	fragments with oblique truncation	5
	convex-backed blades	3
	fragments of convex-backed blades	2
	obliquely backed microliths	2
	unclassified backed fragments	7
ii)	*Scrapers:*	
	long end-scrapers	5
	short end-scrapers	4
	broken end-scrapers	7
	'thumbnail' scrapers	7
iii)	*burins:*	
	burins on truncations (1 used as a 'twist drill')	3
	angle burins	2
	burin busqué	1
	?burins	2
	(burins on former backed pieces, classed under i)	(2)
iv)	*other tools:*	
	piercers	3
	'twist drills'	3
	('twist drill' on burin, classed under iii)	(1)
	retouched & truncated pieces	2
	retouched pieces	2
	retouchedutilized fragments	18
	notch at distal end of blade	1
Total of all tools & fragments of tools		90

Collections used to compile Table 14.4:

Museum	*Excavator*	*No artefacts*
Tenby:	G N Smith (?and others)	65
	H N Savory	134
Cardiff (NMW):	H S Green	80
Manchester (M(U)M):	E L Jones W Boyd Dawkins	60
Bristol (CM):	H H Winwood	22
	Total:	361

formed at the junction of the lateral retouch and one or both of the oblique transverse truncations. This possibly stylistic feature, identified at Gough's Cave, can also be seen here (Fig 14.3, Nos 3 and 4). Two fragmentary pieces (eg Fig 14.3, No 14) exhibit spalling at their tips which might be interpreted as impact damage (Barton & Bergman 1982; Fischer *et al* 1984). Notable for their absence from Hoyle's Mouth, as also from Gough's Cave, are convex-backed blades with an oblique basal truncation — so-called 'penknife' points.

There are 16 end-scrapers, all of flint, which may be associated with this Late Glacial occupation. Most are broken, but at least four are clearly developed on blades and share with the shorter examples a general likeness to items from known Late Glacial contexts (Fig 14.4, Nos 1-12). A semi-abrupt marginal retouch is present on most, which — again by analogy with the Mendip material — may be taken as distinguishing these scrapers from early Holocene artefacts of otherwise similar morphology

Burins from the site display considerably more variety than the tool-types described above. Two, if not three, raw materials have been used and there is little or no technological or morphological consistency in the group. Most similar to one another are two pieces, one of which is double-ended, that are interpreted as burins worked on former backed blades (Fig 14.3, Nos 5 and 7). Their narrow burin facets and supports are yet again very reminiscent of examples from Gough's Cave and are suggestive of a precise and delicate usage — perhaps on bone or antler. Our knowledge of the functions of burins is so limited, however, that it is not possible to speculate with any real optimism on the significance of the various implements identified as such at Hoyle's Mouth. One burin on a truncated blade (Fig 14.5, No 1) has clear indications of having been used as a piercer — lateral damage to the burin facet together with worn angles showing that the nose of the tool has at one stage been rotated within the worked material. This is what Jacobi has termed a 'twist-drill'.

Amongst the remaining tools, two more 'twist-drills' (Fig 14.5, Nos 2 and 3) exhibit the same wear and damage as the burin described above. There are three additional piercers (eg Fig 14.5, Nos 4 and 5) . Two flakes and a blade have their distal ends retouched to a narrow prismatic point. Other formal tools include a blade and a fragment, both of which show extensive semi-abrupt marginal retouch with a distal truncation (Fig 14.5, Nos 7 and 8). There is also the heavily worn proximal end of a broken retouched flake or blade (Fig 14.5, No 10). All these features recur consistently amongst the Gough's Cave collection.

Overall, therefore, the group of artefacts from Hoyle's Mouth, albeit probably a fraction of what once existed, can be seen to share typological, even stylistic, traits dated elsewhere to *c* 12,800–12,000 BP— that is, close to the thermal peak of the Late Glacial Interstadial. It is all the more regrettable, in sensing the former richness of the cave's archaeology, that so little of this survives intact and

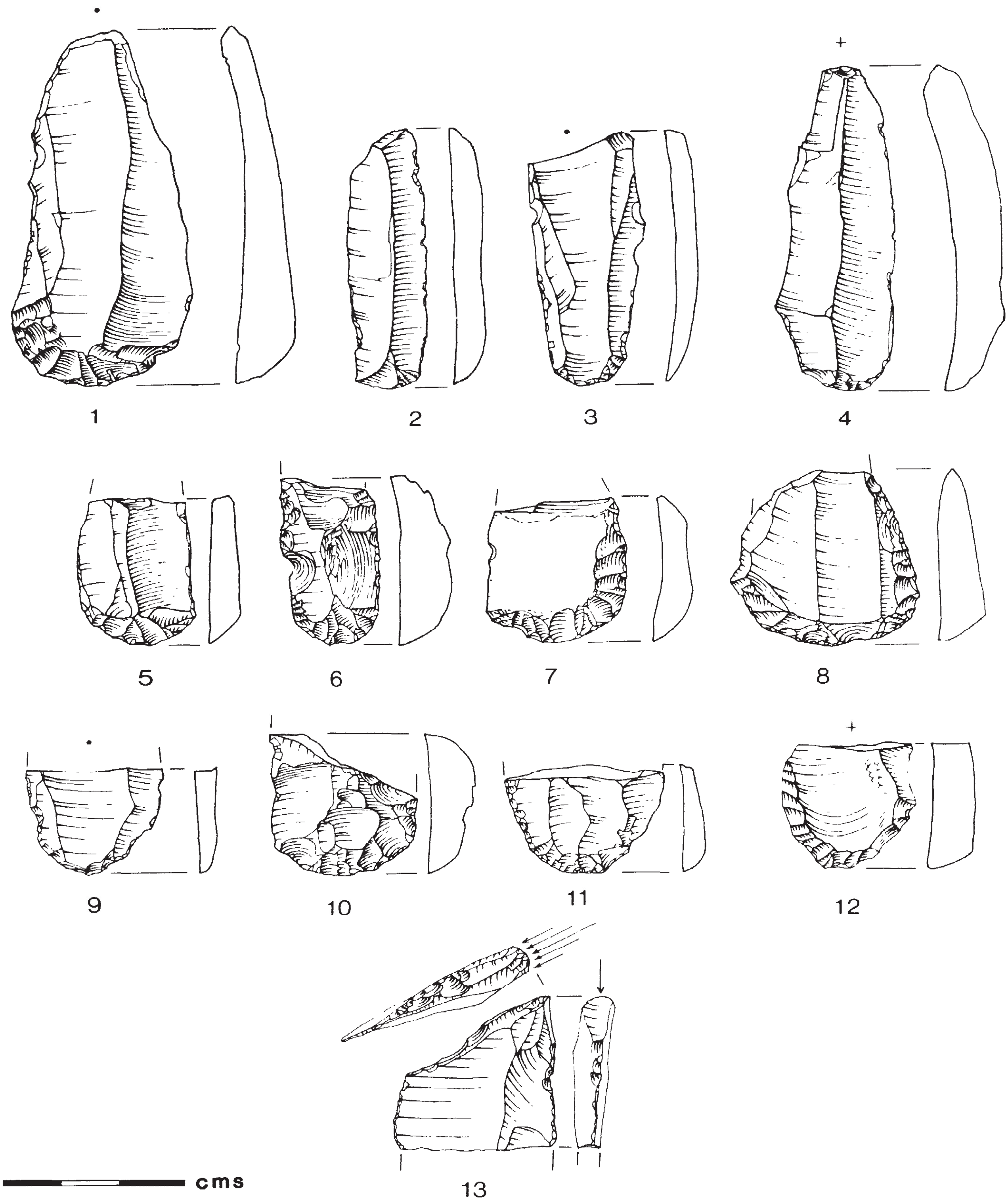

Figure 14.4 Hoyle's Mouth, Dyfed: 1–12) end-scrapers; 13) burin busqué. *Scale in cm*

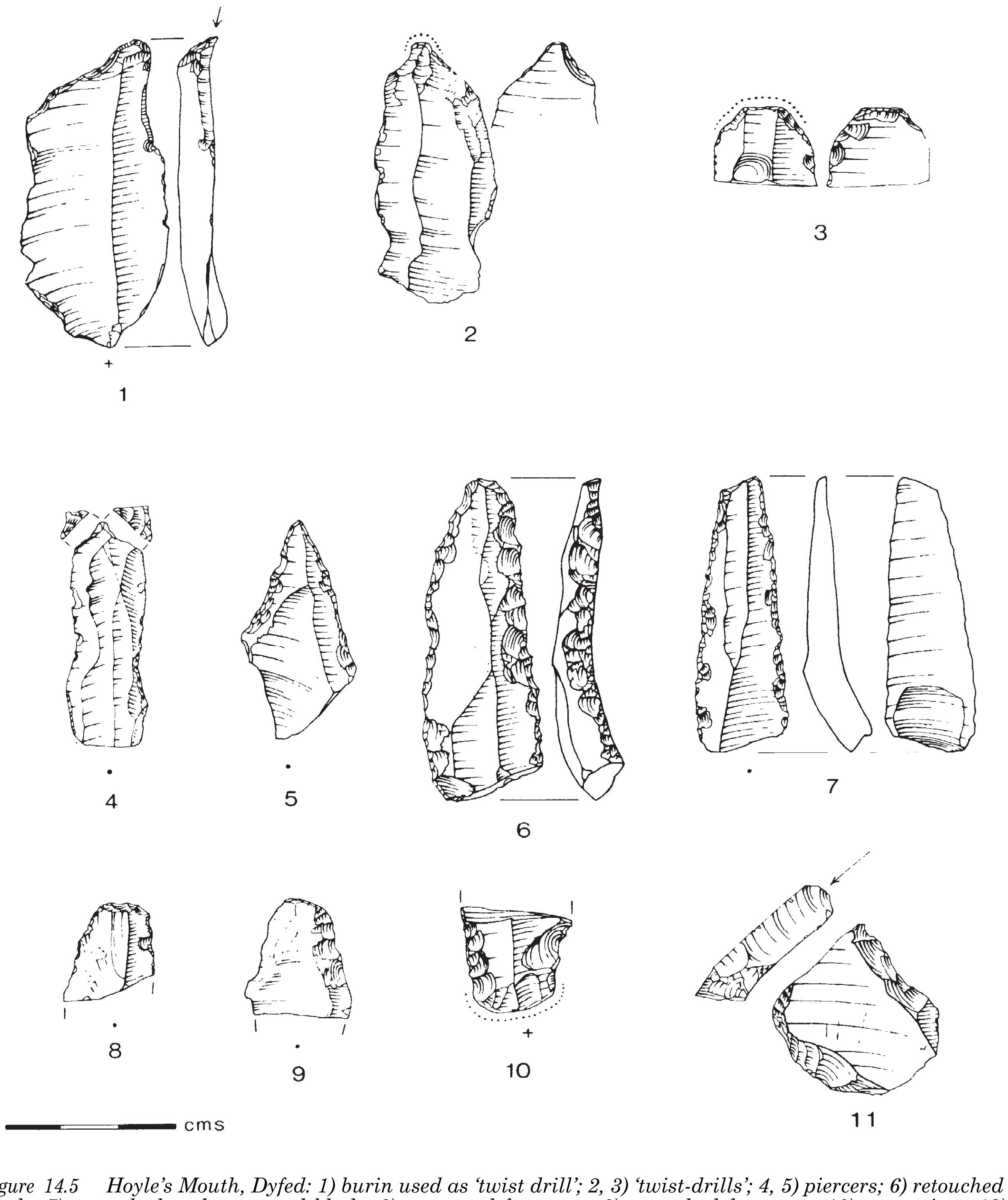

Figure 14.5 Hoyle's Mouth, Dyfed: 1) burin used as 'twist drill'; 2, 3) 'twist-drills'; 4, 5) piercers; 6) retouched blade; 7) retouched and truncated blade; 8) truncated fragment; 9) retouched fragment; 10) worn piece; 12) atypical burin. Scale in cm

Table 14.5 Lithic artefacts of possible Late Glacial and Mesolithic age from Nanna's Cave, Caldey Island, Dyfed (compiled from various sources)

Artefact type	Context				Total
	Basal silty sand	*red loam*	*spoil*	*other*	
Trapeziform blade ('Cheddar point')	1				1
Angle-backed blade ('Creswell point')	1				1
Convex-backed blades	3				3
Convex-backed blades with basal retouch ('Penknife points')	3		2		5
Fragments of backed pieces	4	6	2		12
End-scraper	1				1
Truncation burins	1	1		1	3
?Piercer		1			1
Retouched flakes	3	3	1		7
Utilized flakes/blades	2	1			3
Microliths and fragments of	?1	5	3		9
Flakes/blades/fragments	9	4			13
Cores	2				2
Crested piece	1				1
Burin spalls	2		1		3
Microburins		2	1		3
Total	34	23	10	1	68

that there should be no recorded linkage between fauna, stratigraphy, and artefacts. It is therefore possible to guess only in the broadest terms at the status of the human activity that took place here. That tool manufacture was involved would seem certain, and the variety of processing equipment might be taken as indicative of 'passive' or 'seasonal gear' (Binford 1979), not inconsistent with Campbell's suggestion of a base-camp (1977, 167).

Having, by analogy, thus identified a group of artefacts dating to the Late Glacial Interstadial at Hoyle's Mouth, one could suspect that other finds of the same general type from Cathole, Paviland, and Plas-yn-Cefn (north Wales), are of similar age. More locally, it is possible to look elsewhere in the neighbourhood of Tenby for finds attributable to about the same time, or perhaps later in the Late Glacial.

Only a few minutes walk away from Hoyle's Mouth is Little Hoyle (or Longbury Bank Cave), where a large convex-backed blade (55 mm x 13 mm) was found by McBurney in a sediment (Upper Scree) which also contained remains of reindeer, bear and fox as well as 'lumps of charcoal' (McBurney 1959). The more recent excavations by Green have added hare and collared lemming (Currant 1986b). Further artefacts from the cave, but without reliable stratigraphic provenance, are two flint blades, an 'adinole' scraper and a bone 'bodkin' (Green 1986b, Fig 28). The two latter are almost certainly of Postglacial age. There are, as yet, no Late Glacial radiometric dates.

These meagre finds from only a small cave could perhaps suggest the caching of a limited number of items — the 'insurance' gear stored perhaps at many dispersed localities for convenient use when out hunting or foraging (Binford *ibid);* although the distribution of finds at the Little Hoyle is inconsistent with such an interpretation (H S Green, pers comm). Caching might, however, account for the small series of 18 flint and chert artefacts found in 1907 at the entrance to Priory Farm Cave, 13 km to the west (Grimes 1933). Although some backed fragments may be Mesolithic, there is in addition a group of four 'penknife' points (Fig 14.6) — perhaps a cache of spare projectile heads. The remaining pieces include blades and a burin developed on a pointed flake of Carboniferous chert. Unfortunately, none of these artefacts can now be associated with the Pleistocene fauna also recorded from the cave and no radiometric dates are available.

Such problems are endemic amongst these Welsh cave sites, and nowhere more so than on Caldey Island (Fig 14.1), where much evidence for a formerly rich early prehistory has been lost. Most to be regretted, perhaps, is Nanna's Cave where a stratigraphy extending from the Late Glacial to the Romano-British period certainly existed (Leach 1916; Lacaille & Grimes 1955; van Nédervelde & Davies 1977a; Davies 1989a, and references therein). Curiously, there are no records of any consequence for Pleistocene fauna although the presence of distinctive backed blades demonstrates

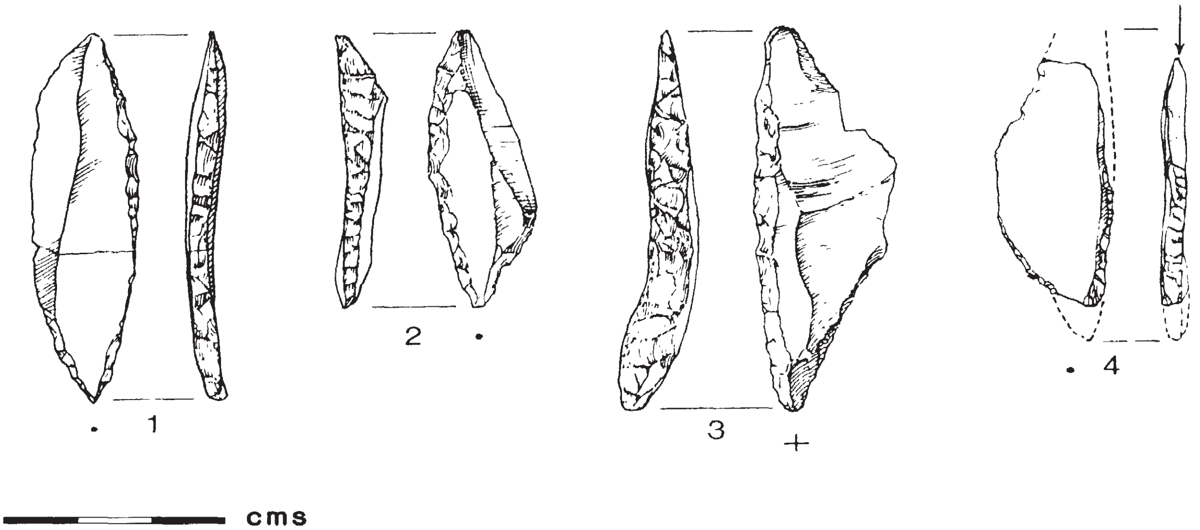

Figure 14.6 Priory Farm Cave, near Pembroke, Dyfed: convex-backed blades with an oblique basal truncation ('Penknife points'). After Grimes 1933. Scale in cms

that a Late Glacial occupation probably took place. Amongst the latter are finds from a basal 'silty sand', documented by Lacaille and Grimes (1955, figs 14 and 15). To these can be added items from overlying deposits and spoil whose typology indicates that they may have derived from Late Glacial occupation(s). Although finds from the cave are now widely dispersed, some 500 flint and stone items can be traced in various collections. Table 14.5 is an attempt to list those pieces of probable Late Glacial and early Postglacial (Mesolithic) age. Of these, the suggested Late Glacial backed pieces are illustrated in Figure 14.7.

Not far from Nanna's Cave are the remnants of a cave system — Ogof-yr-Ychen — largely destroyed by quarrying, but partially surviving as small interconnected chambers and rifts precariously located high in the limestone cliff. The adjacent New Cave (Ogof-y-Benglog) was probably once part of the same system.

Almost the entire contents of Ogof-yr-Ychen were dug out within a period of seven months (June-December 1970: van Nedervelde 1972; 1973; Davies 1989a). A rich mammalian fauna was recovered, ranging in date from at least the Late Devensian (van Nédervelde *et al* 1973) to the Holocene (Bateman 1973). About 130 flaked flint and stone artefacts were found, as well as potsherds and human remains. Amongst the lithic items is a large backed point, found near the base of Chamber 4 (Fig 14.8, No 1). Although this piece, together with a backed fragment and a truncated flake (Fig 14.8, No 2), may be suggestive of Late Glacial activity, other flints from this chamber include a microlith and various undiagnostic flakes. Inspection of the lithic collection from the cave certainly indicates both earlier and later Mesolithic activity (including a possible human burial, which now awaits AMS dating) as well as Neolithic/ Bronze Age usage. In the adjacent remnant of a cave — New Cave (Ogof-y-Benglog) — a fragment of a backed point (Fig 14.8, No 3), perhaps a part of an early Mesolithic obliquely- backed point, was found stratified below a leaf- shaped arrowhead.

With equally uncertain contexts are the four flint tools found during the 1970s at Potter's Cave on the north side of the island. These are illustrated in Figure 14.8, Nos 4–7 and comprise a large backed blade (No 4) and a convex-backed blade (No 6), both recovered from a brown clay layer below stalagmite within the cave, The two other flints — a 'penknife' point and a broken retouched bladelet — were found outside the cave where sediments also yielded a (?mixed) Pleistocene fauna of horse, woolly rhinoceros and hyaena. The 'penknife' point and the large backed blade would certainly appear to be Late Glacial in type, although the other pieces could as readily be Mesolithic. In addition, and also quoted as occurring within a Pleistocene brown clay, is a bone implement 79 mm long with 'a notch or groove, possibly used for rubbing along a thong, and . . . one end smoothed into a sharp, narrow blade or scraper' (van Nédervelde & Davies 1977b, fig 2, no 1). This has not been seen by the author.

Of these caves on Caldey, only Nanna's is likely to be physically intact, albeit now almost empty of deposits. It is shallow and open — more like a deep rock-shelter than the relatively more penetrating, cramped and tortuous caves elsewhere. It has a sheltered eastward aspect with a sizeable platform and would have commanded extensive views over formerly dry land. One need hardly be surprised,

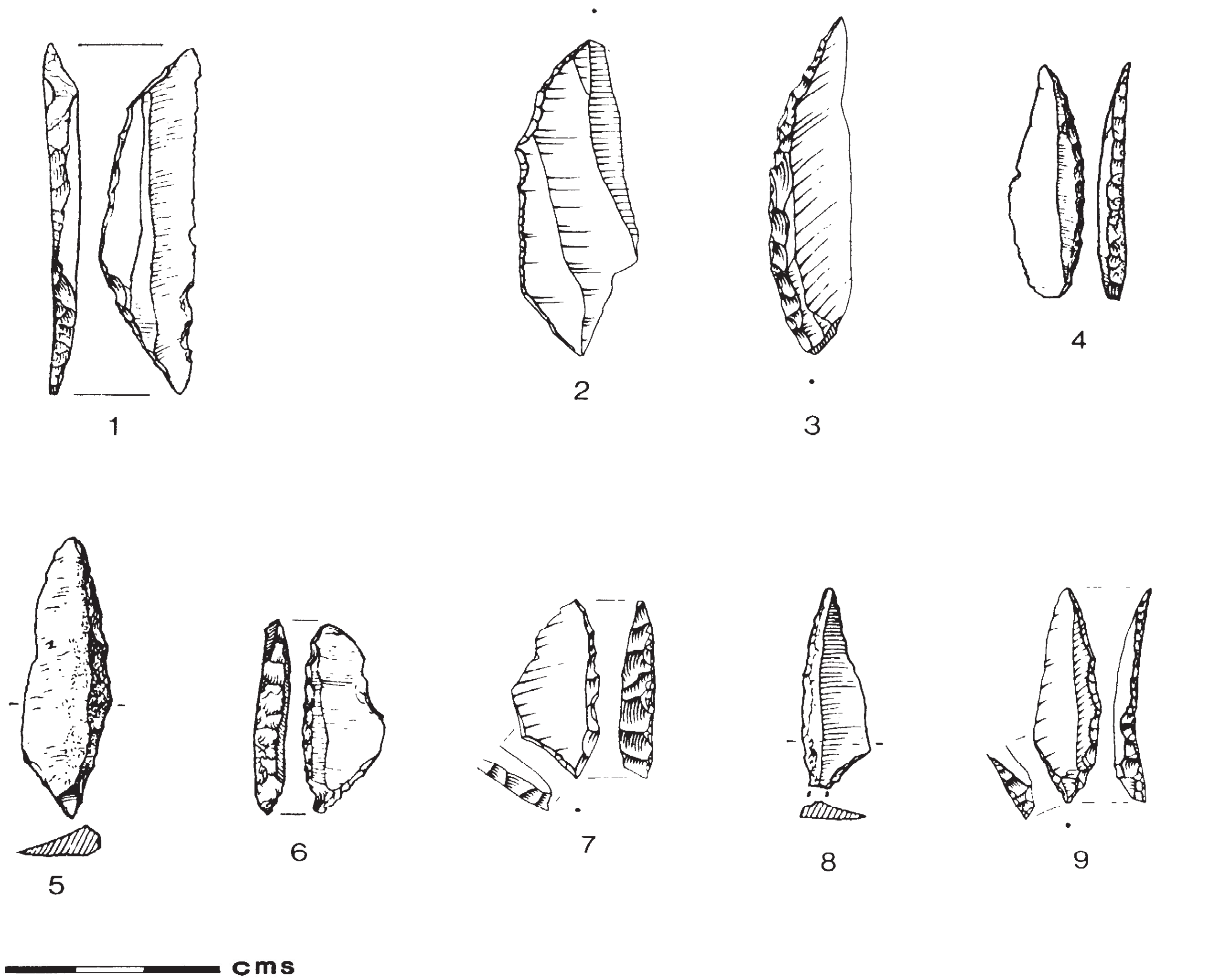

Figure 14.7 Nanna's Cave, Caldey Island, Dyfed: 1) trapeziform blade ('Cheddar point?; 2–4) convex-backed blades; 5–9) convex-backed blades with an oblique basal truncation ('Penknife points'). Nos 1, 4–6 and 8 after Lacailte & Grimes 1955). Scale in cm

therefore, at the longevity of its human occupancy and, in particular, its attraction — at least as a temporary base — for Late Glacial hunters. Potter's Cave and Ogof-yr-Ychen, however, whilst seeming less hospitable, are less easy to classify and interpret as regards their possible Late Glacial function: look-outs, stop-overs, caching, or burial sites, perhaps?

Interstadial transition and the Loch Lomond Stadial

A lack of adequate dating and archaeological associations from the caves so far described seriously inhibits any recognition of Palaeolithic activity in Wales for the periods following *c* 12,000 BP Various indicators all now suggest that climate had already begun to deteriorate from *c* 12,500 BP, a fitful worsening that would culminate in a brief return to sub-polar conditions during the Loch Lomond stadial (*c* 11,000–10,000 BP).

After about 12,000 BP summer temperatures may have remained approximately constant at around 14° C for some 500 years, before cooling from about 11,400 BP to about 10° C at close to 10,500 BP. Winter temperatures dropped more sharply towards a nadir of at least –17° C at about 10,500 BP (Atkinson *et al* 1987). During this transition to full stadial conditions, birch woodland still survived, at least in south Wales (Walker & Harkness 1990) although contracting in extent as

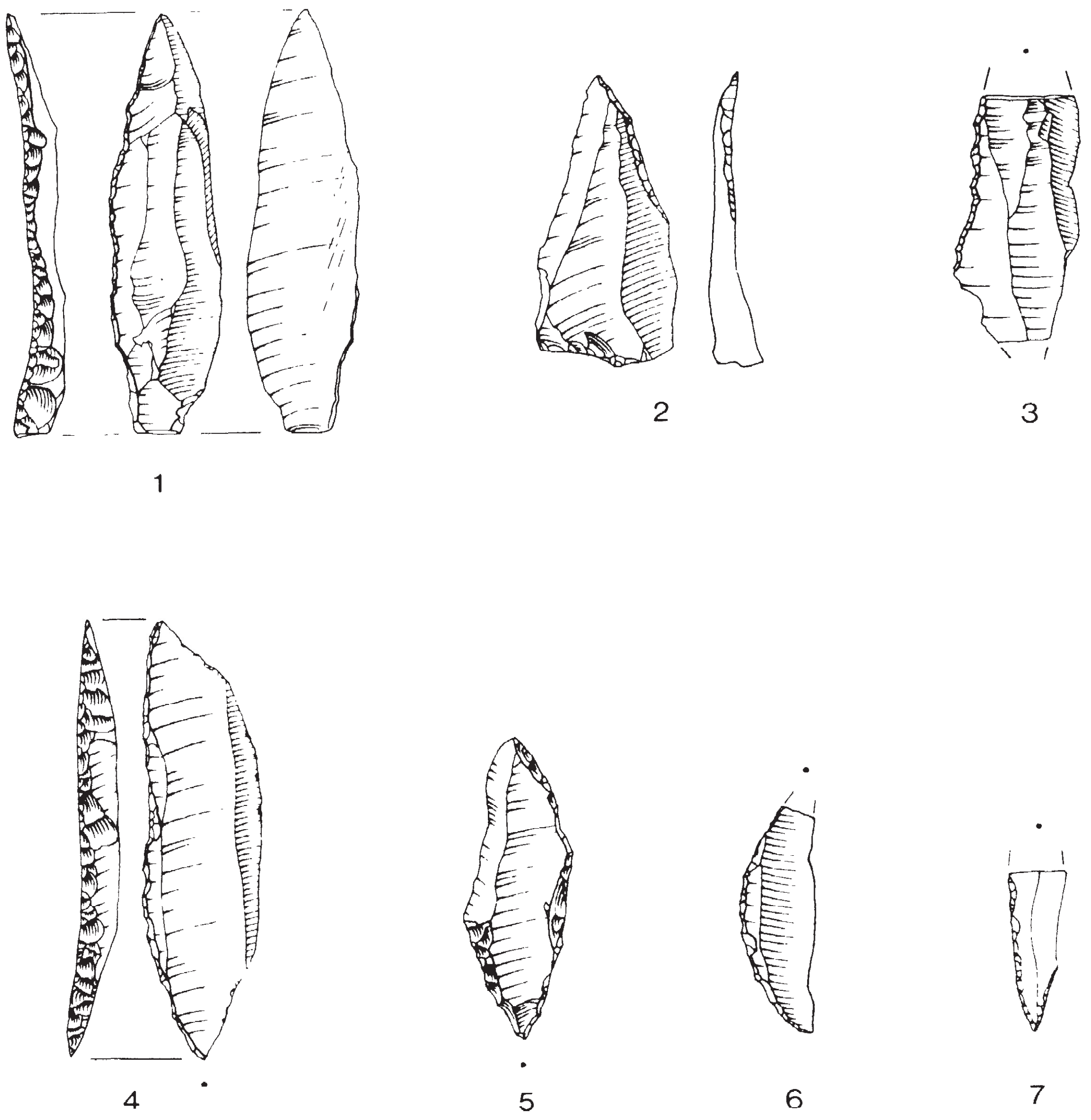

Figure 14.8 Selected flint tools from Ogof-yr-Ychen (1, 2); 'New Cave' (3) and Potter's Cave (4–7), Caldey Island, Dyfed: 1) convex-backed blade; 2) truncated flake; 3) backed blade fragment; 4) backed blade; 5) 'Penknife point'; 6) convex-backed blade; 7) backed fragment (?microlith). Scale in cm

temperatures declined. Despite ever more rigorous winters, therefore, it could nevertheless be argued that environmental conditions were tolerable enough to support a continuing human presence, at least in summer. Jacobi has argued (1988) that limestone topography may have been relatively less attractive at this time and that abandonment or loss of lithic equipment may have occurred further afield, and more sparsely, than had been the case earlier in the Interstadial. If this were so, both the sites and their lithic components would be expected to be elusive and uncharacterised. Indeed, the British evidence for Late Palaeolithic activity between about 12,000 and 11,000 BP is noticeably sparse: one of the few certain instances, however, is provided by the unassociated barbed antler point from Porth-y-Waen, Shropshire (Britnell 1984), now dated to 11,390±120 BP (OxA-1946: Bonsall &

Smith 1989). This chance find, isolated though it is, must nevertheless imply that Wales would have been exploited to some degree at this time.

It may be worth noting here that extensive fieldwalking of coastal areas of western Dyfed, searching for Mesolithic sites, has not brought to light any finds which are likely to be Late Glacial. However, the fortuitous location of such artefacts below the cairn at Gwernvale (Healey & Green 1984), undated though these are, must at least strongly suggest that open air activity occurred and remains almost totally invisible to us (see below).

To guess at the nature of contemporary occupation is a somewhat empty exercise in the absence of direct data. The nearest site that allows at least some speculation is King Arthur's Cave in Hereford and Worcester. Remains of red deer from the 'yellow rubble' and 'second hearth' on the platform in front of the cave would appear to date close to *c* 12,200 BP (Hedges *et al* 1989). However, other fauna apparently from the same units includes open landscape types such as horse, steppe pika and lemming — suggestive, perhaps, of accumulation still later in time. Lithic remains from the uppermost unit — the 'yellow rubble' — are of particular interest since angle-backed or trapeziform blades appear to be absent. Instead, there are straight-backed blades (Taylor 1928, fig 6) together with a 'penknife' point. Such a context would be in keeping with Jacobi's observation that since 'penknife' points are absent from Gough's Cave, they might be indicative of rather later technologies than those occurring at the peak of the Interstadial. Evidence from Mother Grundy's Parlour, Creswell, suggests that short and round scrapers could also be included with this latter technology (Jacobi 1988, 438). If this is so, such a technology has yet to be placed more accurately within the likely limits of *c* 12,200–11,000 BP. Compatible lithic material — 'penknife' points and straight- backed blades — occur stratified just below stadial deposits in the east of England, at Seamer Carr, North Yorks (Schadla-Hall 1987, 52; Cloutman 1988, 28), and 'penknife' points occur below coversands at Risby Warren, south Humberside (Jacobi, *ibid).*

Returning to west Wales, one could perhaps extrapolate such apparent typological hints to some of the finds discussed above. Most striking is the apparent mutual exclusion of angle-backed/trapeziform blades and 'penknife' points, demonstrated by the collections from Hoyle's Mouth and Priory Farm Cave. However, on Caldey the relationship of the 'Cheddar' point from Nanna's cave, with the 'penknife' points from the same site is unknown. The dating of the latter, as well as the other potentially Late Glacial artefacts from the island, and their relationship with the mainland collections seems set to remain unresolved.

During the Loch Lomond stadial, West Wales experienced a climatic regime reminiscent of the rigours of the glacial maximum (Donald 1987). Extreme winter temperatures may have descended to minima of –25° C. The timing of this event in South Wales has been shown at Traeth Mawr to fall between radiocarbon dates of 10,620±100 BP and 9,970±115 BP (Walker 1980), giving a duration of some 650 years. However, at Llanilid, also in south Wales, the equivalent event falls between dates of 11,160±70 BP and 9,920±65 BP (Walker & Harkness 1990), confirming that harsh conditions had already set in by *c* 11,000 BP. For west Wales, the start of the Younger Dryas remains undated, although evidence from annual sediment laminae from basal deposits in a kettle hole at Dolau-duon, Dyfed, suggests a duration of at least 400 years (Donald 1987). Vegetation at this time was predominantly herbaceous with localised growth of dwarf birch and willow, particularly inland. Snowfall may have been moderate, although not covering the entire landscape, whilst the extremities of west Wales will have been exposed, as always, to relatively high winds *(ibid).*

Discontinuous permafrost is indicated by pingo remnants (Handa & Moore 1976; Watson 1977), whilst numerous small corrie glaciers developed in the uplands of north and south Wales (Gray 1982; Robertson 1988). Periglacial processes surely contributed to a modification of the landscape unparalleled at any time since. Solifluction, in particular, was extensive and this, combined with Holocene alluviation, must be held accountable for much of the 'invisibility' referred to above, of any preceding and possibly con temporary Late Palaeolithic open air activity.

Evidence for the exploitation of this stadial environment by Palaeolithic hunters is uncertain for Wales, although the supposition that such occurred must be strengthened by rare finds of seemingly contemporary artefacts in eastern England (Barton, this volume). The exact identification of stadial deposits at Cathole is equivocal (Jacobi 1980, 57) and any contemporary occupation at this cave remains undemonstrated.

Although the composition of the Welsh fauna at this time is unclear, one could argue — as for the Late Glacial maximum (above) — that if appropriate species were present, then so may have been their human predators. However, we still have little idea of the appearance of the lithic components of the latters' toolkits and, therefore, whether any of these are likely to be amongst the artefacts discussed above.

What is certain, however, is that humans were present at the close of the stadial. This is demonstrated for north Wales by a radiocarbon date of 10,000±200 BP (OxA-111: Gillespie *et al* 1985) for the decorated portion of a horse mandible from Kendrick's Upper Cave (Sieveking 1971). Other finds from this cave which might (but cannot be proved to) have been associated with the mandible include nine pierced and decorated bovid and deer teeth, a pierced and decorated wolf canine

(Davies 1979) and two pierced and decorated bear canines (Dawkins 1880, fig B, but now lost). The bear canines and the horse mandible were reportedly found associated with the remains of three adults and a child (Dawkins 1880, 156; Eskrigge 1880, 154). Although 'a few flint flakes' are mentioned, none of these can be traced today.

The dating of this burial coincides uncannily with the formal division between the Pleistocene and Holocene. Basal Holocene organic sediments have now been dated at several Welsh sites, most of which are synchronous at about 10,000 BP. For west Wales, dates of 10,090±240 (GU-1328) and 10,145±195 (GU-1393) have been obtained at the pollen sites of Cilgwyn and Hendre Fach in Dyfed (Donald 1987). Very similar dating has also been obtained from sites in south Wales (Walker 1980; Walker & Harkness 1990). Climatic warming from about this time was so abrupt (Dansgaard *et al* 1989) that amelioration may have briefly outpaced the ingress of woodland, thereby encouraging survival into the early Holocene of mammal species such as reindeer and horse (Clutton-Brock & Burleigh 1983). A Palaeolithic 'tradition', as evidenced by the Kendrick's finds may also have lingered on for a generation or so, yet in the absence of contemporary lithic assemblages, there is no evidence for any continuity at a typological level with Welsh Early Mesolithic artefact assemblages which are now shown to date from at least 9200 BP (David 1990).

Acknowledgements

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15 Preliminary report on marked human bones from the 1986–1987 excavations at Gough's Cave, Somerset, England

Jill Cook

Abstract

Preliminary research on a new sample of damaged and marked human bones excavated from Gough's Cave, Somerset in 1986–1987, indicates that human corpses were dismembered by the Late Glacial inhabitants of the site. Macroscopic and microscopic observation of marks made by stone tools indicate that dismemberment took place at or shortly after the time of death and some patterning is evident in the method of defleshing. Interpreting the significance of this activity in terms of human behaviour is difficult at present.

Introduction

Gough's Cave is part of a phreatic underground system truncated by the Cheddar Gorge, which forms part of a dry valley system deeply incised into the limestone on the western edge of the Mendip Hills in Somerset (Fig 15.1). The cave was discovered in 1890 and from that time until the present, there have been periodical excavations resulting from the need to improve and extend the site as a tourist attraction. During excavations at the site organised by Dr R M Jacobi (Nottingham University) and directed by Mr A P Currant and Dr C B Stringer of The Natural History Museum in 1986–1987, a new sample of human remains was recovered in association with Late Upper Palaeolithic (Creswellian) artefacts and Late Pleistocene fauna. The well-preserved, fresh surfaces of many of the cranial and postcranial bones in this sample show a patterned distribution of distinct, single or discretely grouped, linear incisions. These marks have provided a basis for further research into the question of post-mortem dismemberment of corpses by the late Devensian occupants of Gough's Cave. The preliminary results of this research are presented below.

Sample and method of research

During the 1986–1987 excavations, about 120 human cranial and postcranial remains were recovered from a small area of deposit near the entrance of the cave (Currant *et al* 1989). In addition to the cranial elements summarised in Table 15.1, numerous teeth and crania-facial fragments were found. These remains represent at least four adults and one juvenile, but this first estimate of the minimum number of individuals represented may have to be revised when the work of refitting all the fragments has been completed. By comparison, postcranial remains are certainly under-represented as the sample contains only five vertebrae, at least 17, possibly 37 ribs, various small fragments of limb and pelvic bones, a metatarsal and a cuboid bone.

Although all of the bones are damaged and many are merely fragments, their surfaces show little or no alteration resulting from high energy taphonomic processes or diagenetic change (Andrews & Cook 1985; Cook 1986a). Unlike the surfaces of the human bones in the old collections from the site (Cook 1986b), those in the new sample are not obscured by an overlay of modern toolmarks or preservative. Consequently, it has been possible to examine the marks on their surfaces both macroscopically and microscopically (Andrews & Cook 1985; Cook 1986a; b) in order to assess their origin.

Description of the cranial remains

Adult calvaria, GC87/190: This specimen lacks both temporal bones and the inferior part of the occipital below the highest nuchal line, but the frontal and parietals are complete. Except for some slight pitting in the region of the sagittal suture, the bone is in good condition and unmarked except for some distinct groups of incisions which occur on the frontal and on the parietals, on and well below the superior temporal line, sloping slightly upwards from front to back (Fig 15.2). It is evident that these marks were present on the skull before it was broken because incisions on the parietals have been truncated by damage and by the loss of

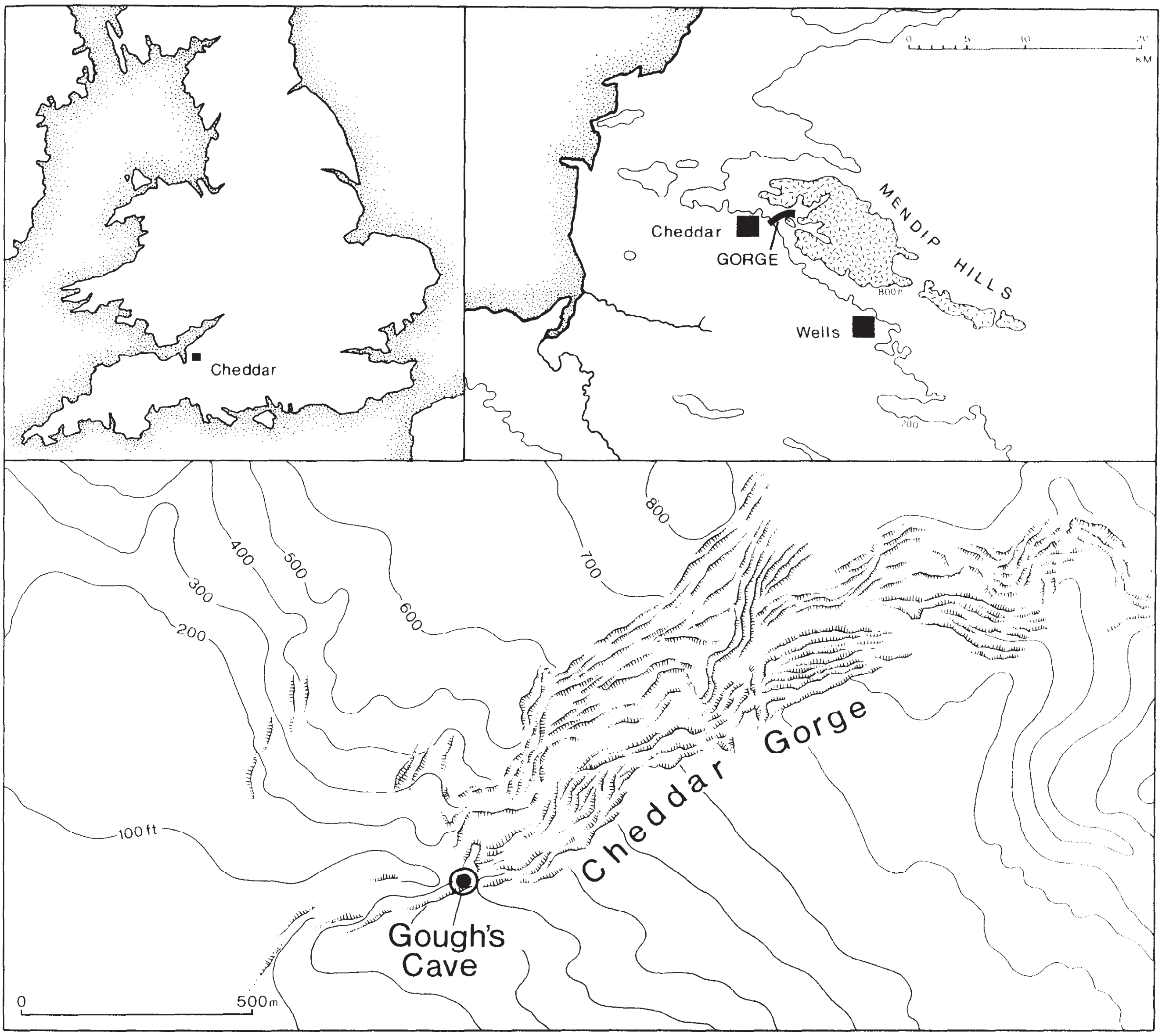


Figure 15.1 Location of Gough's Cave, Somerset

the temporal and sphenoid bones. In addition, a crack caused by compression of the skull during burial interrupts and clearly post-dates incisions on the right side of the frontal (Fig 15.2), indicating that the incisions were present before post-depositional alteration of the specimen took place.

On examination using a hand lens and binocular light microscope, the incisions can be seen to have asymmetrical cross-sections with remnants of displaced bone along the steeper edge adjacent to the deeper part of the incision. Internally, the incisions show parallel striations intermittently crossed by tiny 'faults'. These features are characteristic of incisions made by sharp stone edges on fresh bone (Bromage 1984; Cook 1986a; Shipman 1981). Furthermore, the consistent orientation of the faults indicates that the incisions were made with the skull in a constant position and the stone moving from the front towards the back (Bromage 1984; Bermúdez de Castro *et al* 1988). Linked with the discretely patterned distribution of the marks which occur particularly in areas of muscle attachment, this evidence suggests that the incisions were made deliberately by a human using a stone tool and are not the result of natural processes effective during and after burial (Andrews & Cook 1985). There are no marks on the endocranium.

Adult right frontal fragment, GC87/90 This piece of bone has been refitted from five small fragments. In the supraorbital region, the bone surface has been affected by diagenetic change and no marks are apparent. The small, superficial scratches in the postorbital region are lighter in colour than the surrounding bone and are clearly the result of

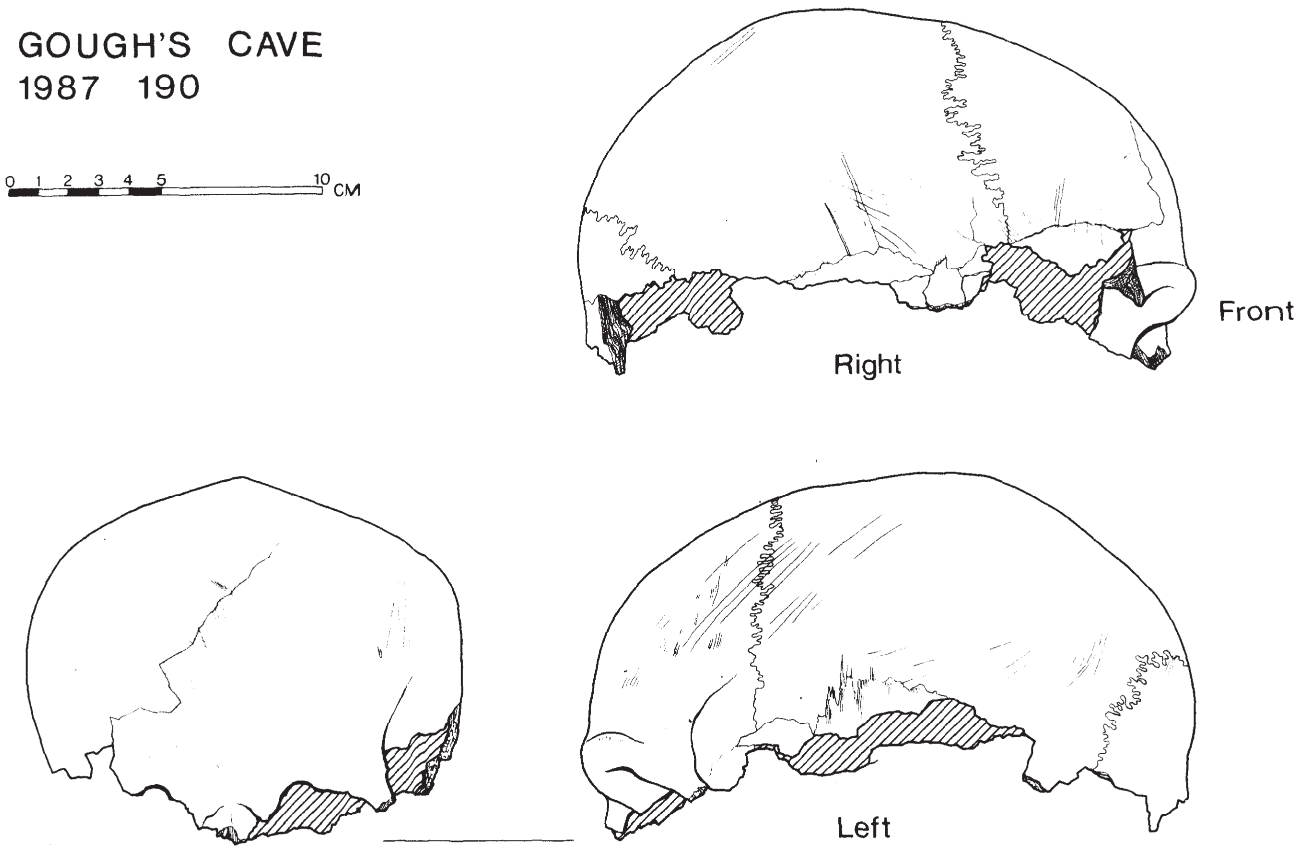


Figure 15.2 Distribution of cutmarks on the adult calvaria (GC87/190)

modern handling. This fragment refits to the Gough's Cave 2 calvaria (Stringer 1985) from which ancient marks are also absent (Cook 1986b).

Adult maxilla, GC87/139 This well-preserved specimen exhibits no marks and little damage. The dentition is complete and the only break occurs in the region of the erupting right third molar which was found in 1986 and refitted to the main portion of maxilla found in 1987. The break appears to be the result of natural processes which affected the bone following its deposition.

Adult right hemi-mandible, GC87/253 This specimen is in good condition although it is broken across the ascending ramus from the gonial angle to the top of the coronoid process and retains only a worn first and second molar (Fig 15.3). The break across the ascending ramus interrupts a group of consistently oriented incisions on the coronoid process. These occur above a line of short, parallel incisions, slightly inclined towards the anterior edge of the ascending ramus and continuing along the oblique line on to the horizontal ramus (Fig 15.4a). At least one incision runs along the base of the horizontal ramus and on the lingual surface, distinct groups of short, parallel, diagonally oriented marks occur on the inferior border of the back of the horizontal ramus and along the mylohyoid line.

On examination in an ISI 60A scanning electron microscope (SEM), the incisions could be seen to pre-date both the breakage of the bone and its burial. The SEM also revealed the diagnostic characteristic of cutmarks made by a sharp stone edge on fresh bone. As the marks have a non-random distribution on specific areas of the bone, it is clear that the incisions must have been made deliberately by a human using a stone tool to cut through the temporalis, masseter and buccinator muscles where they attach to the ascending ramus, as well as the mylohyoid and medial pterygoid muscles where they attach to the lingual surface. Such dissection would permit the detachment of the mandible from the skull and the removal of the tongue.

Juvenile maxilla, GC87/25: This specimen is in good condition, although much of the right side has been broken away and both sides lack the frontal process. Incisions are clearly visible on both sides of the maxilla on the margin of the nasal notch and on the anterior surfaces (Fig 15.3). Examined under a binocular light microscope, these incisions can be seen to possess the characteristics of cutmarks made by stone tools and their positions are related

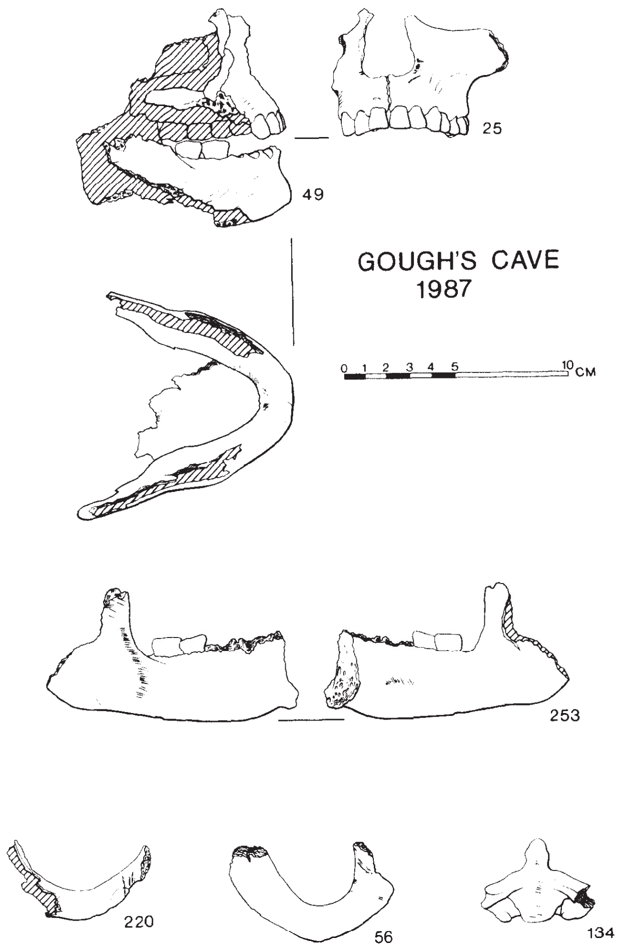


Figure 15.3 Distribution of cutmarks on a juvenile maxilla (GC87/25) and mandible (GC87/49), adult right hemi-mandible (GC87/253), ribs (GC87/220, GC87/56), and axis vertebra (GC87/134)

to the areas of attachment of the levator and nasalis muscles.

Juvenile mandible, GC87/49: This mandible of a boy estimated to be about twelve years old, matches the maxilla GC87/25 and undoubtedly comes from the same individual. It is in good condition but lacks the ascending rami on each side. Damage related to the loss of the ascending rami also extends along the base of the mandibular body on both sides. On the buccal surface, this damage interrupts long, parallel incisions sloping downwards towards the back of the mandible on the mandibular body and from the oblique line towards the ascending ramus. On the lingual surface, short, vertically oriented groups of parallel incisions occur in the area of the diagastric fossa and along the mylohyoid line. The antiquity of these marks is evident from their condition and relationship to the areas of damage on the bone. In addition, the microscopic characteristics of the incisions are consistent with their having been made by a sharp stone edge on fresh bone. This evidence and the discrete positioning of the marks in areas of muscle attachment suggest that they were inflicted by a human using a stone knife.

Other crania-facial fragments: Incisions like those present on the calvaria, mandibles and maxilla have been recorded on five out of about twelve skull fragments identified so far.

Description of the marked postcrania

Although some of the human postcranial material undoubtedly still remains to be identified from amongst all the bone excavated in 1986-1987, it is clear that the postcrania are under-represented. Moreover, many of the elements present are damaged or fragmentary, two pieces may be burnt and about 26 out of just over 100 currently recognised specimens show discrete incisions on otherwise unmodified surfaces. In every instance examined to date, these incisions can be confidently ascribed to human activity rather than to natural causes. The positions of these marks are described below.

Vertebrae: Only three vertebra fragments and one compete axis vertebra have been recovered. Incisions occur on one of the fragments, which comes from a cervical vertebra, and on the ends and body of the axis vertebra (Figs 15.3 and 15.4b). The latter are clearly the result of cutting through the muscles at the back of the neck.

Table 15.1 Cranial remains from Gough's Cave, 1986-1987

Element	Excavation number	Description
Calvaria	GC87/190	Adult
Right frontal fragment	GC87/090	Adult male, refits to Gough's Cave 2 (Stringer 1985)
Maxilla	GC87/139	Young adult
Right hemi-mandible	GC87/253	Adult
Maxilla	GC87/025	Juvenile, *c* 12 years
Mandible	GC87/049	Juvenile, articulates with GC87/025

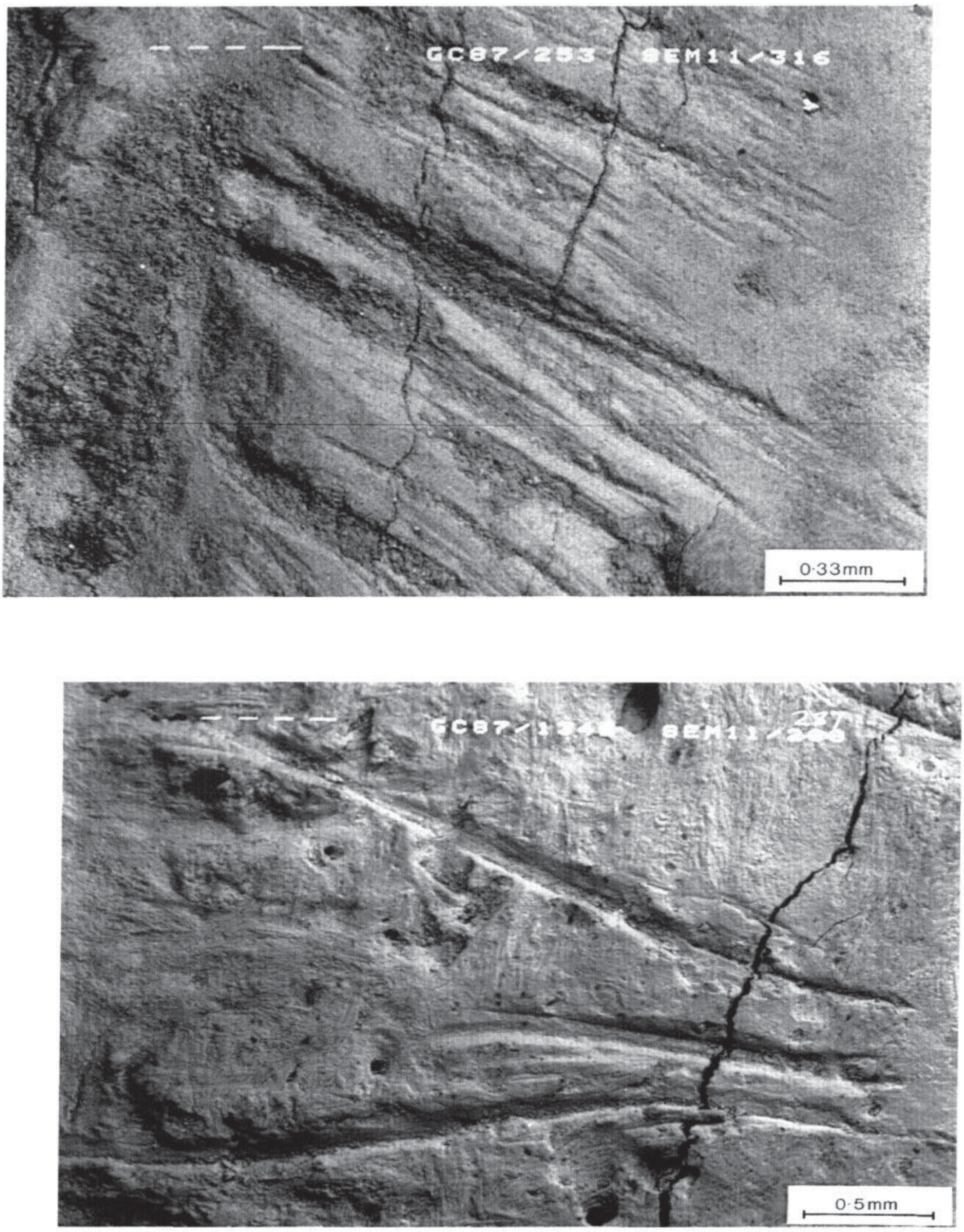
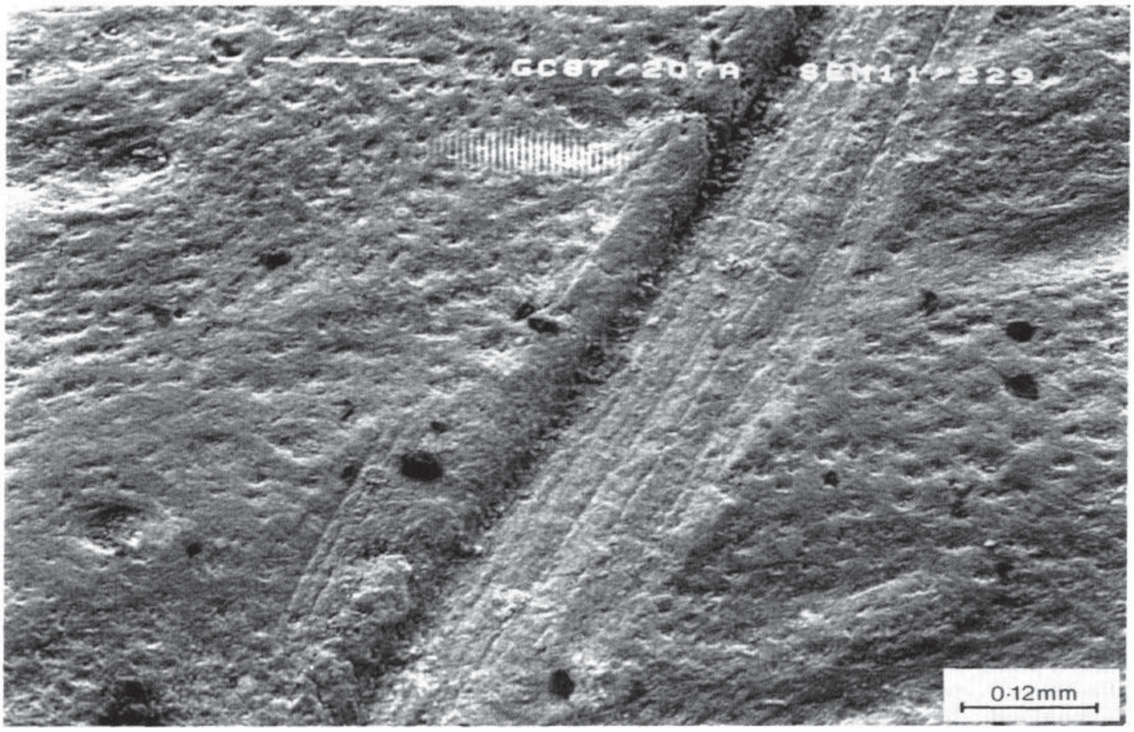


Figure 15.4 *a) Cutmarks on the ascending ramus of adult hemi-mandible; b) cutmarks on the body of the axis vertebra (GC87/134)*



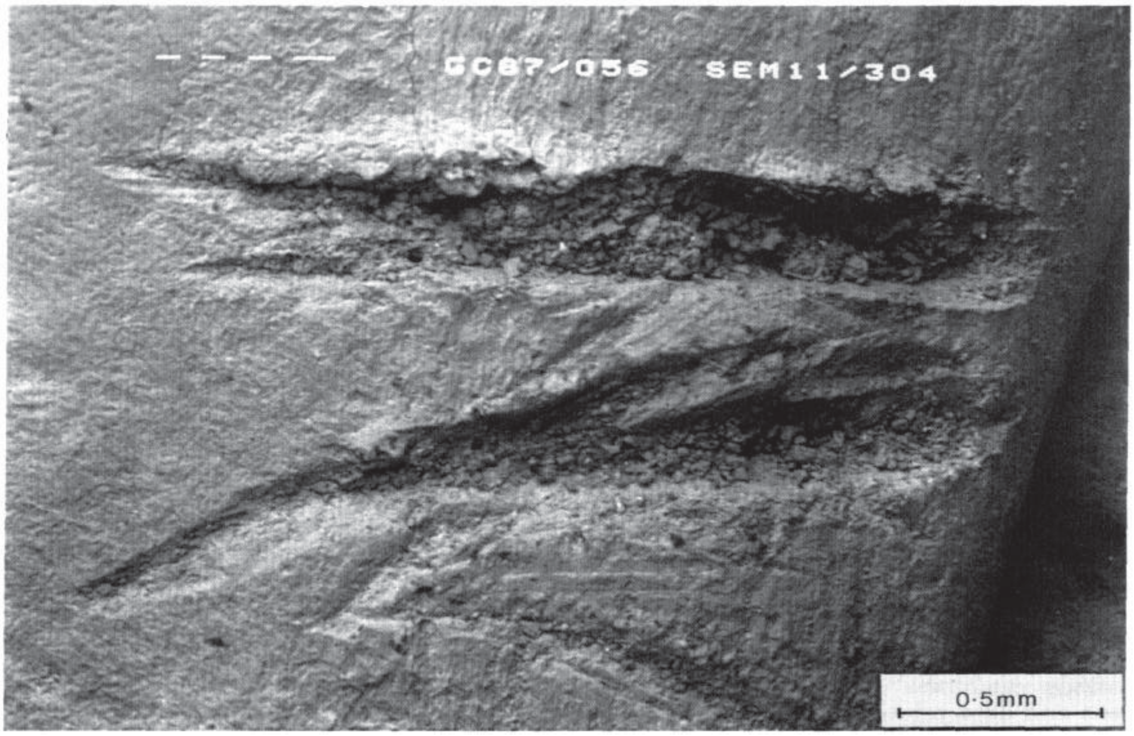


Figure 15.5 Figure 15.5 a) Cutmark showing the characteristic features produced by a sharp stone edge used with a slicing action on the external surface of a rib shaft fragment (GC87/207a); b) Deep, symmetrical marks produced by a sharp stone edge used with a chopping action on the neck of a rib (GC87/56)

Ribs: The majority of specimens in the sample of up to 37 ribs are shaft fragments some of which show the type of damage which results from movement and pressure during and after burial. At least eight of these fragments exhibit discrete groups of incisions oriented vertically or, slightly diagonally on the external surfaces of the bone (Fig 15.5a). Three of the more complete ribs (GC87/56, GC87/207 and GC87/220) are marked on the necks and tubercles (Fig 15.3). Examination in the SEM showed that these marks did not possess the characteristic features of cutmarks made by a slicing action, as was the case with the shaft fragments (Fig 15.5a), but are deeper, more symmetrical marks (Fig 15.5b) of the kind which result from using a blade with a chopping action. In each of these examples, the head of the rib is damaged.

Limbs and pelvis Identification and refitting of fragments which may belong to upper and lower limbs and the pelvis have only just begun and although some pieces do show incisions, it has not yet been possible to determine any patterned distribution.

Interpretation

In his description of the human bones discovered in Gough's Cave between 1905 and 1970, Tratman (1975) referred to cutmarks and bone breakage which he attributed to anthropophagic practices *(ibid,* 21). In the absence of proper justification for this conclusion, the bones were subjected to more rigorous investigation by the present author in 1984. The results achieved did not permit unequivocal interpretation. Many of the putative cutmarks recognised by Tratman proved, on examination, to be either natural or recent in origin, whilst others were so thickly covered with preservative that their characteristics could not be discerned (Cook 1986b). The only indisputable evidence for post-mortem human interference with a corpse was found on the mandible of an adult male, Gough's Cave 6 (Stringer 1985). In this case, in addition to natural marks on the ascending ramus and buccal surface of the mandibular body, discrete groups of parallel incisions were recorded on the lingual surface of this specimen in the region of the diagastric fossa and along the mylohyoid line. The positioning and microscopic characteristics of these marks allowed the conclusion that they had been inflicted by use of a stone artefact. However, it would have been imprudent to use this limited evidence as a basis for interpreting any particular human behaviour at the site, especially as the finds had not come from controlled excavations and data relating to their depositional context and associations were entirely lacking. Fortunately, the new collection does not present these problems, although the research work has not yet gone far enough to allow any but the most tentative conclusions.

The human bones found in 1986–1987 were excavated from a narrow fissure just inside the entrance. The bones had not been deliberately or carefully buried but were randomly distributed with animal bones and flint, bone, antler and ivory artefacts in a variably cemented deposit of angular limestone clasts in a matrix of red silt grading upwards into a fine gravel (Currant *et al* 1989). Close groupings of articulating animal bones suggest a low energy depositional environment but there is still some uncertainty as to whether the archaeological material is in a primary context or has been derived from another part of the cave system. However, even in the absence of evidence for burial or *in situ* accumulation of a charnel deposit, it is evident that the human bones had a common origin and can be regarded as a sample. Further refitting work will undoubtedly confirm this and may even tie in specimens from the old collection.

Within the new sample, the incisions referred to in this report are sufficient to indicate that human corpses were dismembered at or shortly after the time of death. This is determined by the absence of any signs of sub-aerial weathering, root or moss growth and rodent or carnivore gnawing on the bones, as well as by the microscopic characteristics of the marks. On the calvaria (GC87/190) the marks which occur outside areas of muscle attachment, such as the group which extends from the frontal across the coronal suture onto the left parietal (Fig 15.2), may be related to the removal of the scalp. However, the concentration of incisions on the parietals in the area of attachment of the temporalis muscle suggests that the head was completely defleshed and the mandible detached. The incisions on the juvenile maxilla (GC87/25) and other crania-facial fragments indicate that such defleshing of the head may have been practised on more than one individual. This is also reflected in the evidence from the mandibles. Like the Gough's Cave 6 mandible from the old collection, both the hemi-mandible (GC87/253) and the juvenile mandible (GC87/49) from the new collection are marked with incisions which relate to the severing of the temporalis and masseter muscles to detach the jaw from the head, as well as the cutting of the mylohyoid, geniohyoid and genioglossus to remove the tongue.

Much of this dismemberment seems to have taken place with the face of the corpse uppermost, whereas the incisions on the axis vertebra and complete ribs (Fig 15.3) suggest that at least one body was decapitated and cut into from the back. However, further evidence for the dismemberment of bodies is limited. It is possible that damage to the rib heads might be the result of snapping them from the vertebral column after stripping away the flesh, rather than cutting through the musculature of the back but this speculation cannot be supported with any certainty at present. It is equally difficult to interpret the absence and fragmentation of limb bones. Indeed, if any evidence is forthcoming, it will undoubtedly be derived from research on the damage and breakage patterns, as yet to be ascertained from an attempt at systematic refitting, rather than from the cutmarks themselves.

Overall, the evidence from the preliminary research on the bones from Gough's Cave indicates that the Late Glacial inhabitants of the site dismembered their dead. What this activity means in terms of human behaviour is a much more difficult question to answer. Although one interpretation may be preferred on grounds of circumstantial evidence, none can be proved beyond reasonable doubt. Dismemberment of corpses may take place as a means of disposing of the body, as in the case of the so-called 'sky burials' still practised in Tibet, or may occur in instances of secondary reburial, as in the example from the Grover Hand Site, South Dakota, described by Bass and Phenice (1975). However, at Gough's Cave the human remains appear to have been casually discarded in the same manner as the animal bones and this has caused some speculation about cannibalism. This is difficult to confirm or refute from the evidence available. The apparently casual disposal of dismembered remains, fragmentation of the postcrania and possible indications of burning on two of the rib fragments might be taken to support the cannibalism theory as put forward for the Neolithic site of Fontbregoua Cave (Villa *et al* 1986). However, at present such evidence must be regarded as inconclusive as much remains to be learned about the taphonomy and mode of deposition at Gough's Cave and no attempt has yet been made to compare the butchery and disposal of the animal bones with the methods applied to humans. In general, the animal remains seem less fragmented than the human bones but there may be a similar scarcity of limb bones amongst the former as among the latter (Currant 1986; Parkin *et al* 1986). The significance of this bias is uncertain and taphonomic explanations cannot be ruled out at this stage but if cannibalism is implied, its practice could not have been a dietary necessity because plenty of food seems to have been available at the site throughout the period of occupation.

Conclusion

Preliminary research on the assemblage of Late Pleistocene human remains from Gough's Cave has produced indisputable evidence for the dismemberment of corpses. Further work, currently in progress, will provide more information about this activity but these data are unlikely to reveal the motivation behind the activity. Consequently, any explanation of the remains in terms of human behaviour will be a matter of supposition and interpretation incapable of proof.

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16 Nutritional constraints and Late Glacial adaptive transformations: The importance of non-protein energy sources

John D Speth

Abstract

Most studies of prehistoric foraging adaptations assume that protein, especially the protein from animals, was the single most important nutrient and that foraging strategies were primarily directed toward maximising the acquisition of meat. This paper explores the possible detrimental effects of consuming diets containing an excess of protein, and suggests that upwards of 50% of total calories must be obtained from non-protein sources. This upper limit to the safe intake of dietary protein forced foragers to adopt subsistence strategies that may have bypassed lean animal resources, regardless of their abundance or ease of procurement, in favour of fat-rich or carbohydrate-rich resources. This nutritional constraint concerning the ingestion of protein must be taken into consideration in reconstructions of Late Glacial foraging adaptations. Ethnographic evidence is used to illustrate a discussion of the options available to Old World Late Glacial and early Holocene hunter-gatherers in coping with these nutritional problems.

Introduction

As the many papers in this volume testify, northern Europe witnessed dramatic climatic and environmental changes during the final stages of the last glaciation, changes which totally eliminated many plant and animal species from the region and drastically altered the distribution and abundance of others. These transformations of the European landscape have been documented over the years in great detail by geologists, palynologists, zoologists, botanists, and prehistorians, and many studies have explored their probable impact on the adaptations and subsistence strategies of the region's prehistoric foragers (see, for example, the recent volumes edited by Bonsall 1989; Rowley-Conwy *et al* 1987; Zvelebil 1986). What has emerged is a vivid picture of shrinking tundras and expanding forests, of migratory reindeer herds being gradually replaced by more dispersed, often solitary forest dwelling species, and of rising sea levels that drowned coastal areas and drastically altered regional drainage patterns. These evolving landscapes in turn gave rise to new foraging economies, which increasingly focused on plant foods such as seeds, nuts, and fruits in the forests and marsh lands, as well as on red and roe deer, aurochs, wild pigs, migratory waterfowl, freshwater fish, and a variety of marine resources (Price 1989).

My purpose here is not to question the specifics of this by now classic scenario. I am anything but an expert on the Late Glacial and early Postglacial prehistory and palaeoenvironment of northern Europe, and in these matters I gladly defer to the regional specialists. Instead, my principal objective here is to suggest that the models usually invoked by archaeologists to account for these shifts in subsistence strategies ignore certain subtle but nevertheless extremely critical nutritional constraints which may have played a key role in determining which resources these Late Glacial and early Holocene foraging economies would have exploited, in what quantities, and at what season or seasons of the year. These nutritional constraints must be incorporated into our models if we are to achieve a more satisfactory and comprehensive understanding of the processes that underlay these fascinating economic transformations.

Current approaches

Whether based explicitly on arguments from optimal foraging theory, or instead on more qualitative or intuitive criteria, most contemporary approaches to modelling forager subsistence practices emphasise resource parameters, such as return rates, package (or prey) size, abundance, distribution, and spatio-temporal predictability, to account for the food choices of both prehistoric and contemporary hunters and gatherers (see, for example, Hill *et al* 1987; Jochim 1976; Keene 1981; Simms 1987; Winterhalder & Smith 1981). I will focus here primarily on the first of these parameters — package size. A fundamental assumption underlying most studies is that, in choosing which resources to pursue and which to ignore, foragers select foods largely on the basis of the number of calories they yield, or put more precisely in the parlance of optimal foraging theory, they choose foods that will maximise the net rate of energy return per unit of time or energy expended in their acquisition (Winterhalder & Smith 1981). Not surprisingly, resources that come in large packages generally contain lots of calories; hence the emphasis on large mammal hunting in most models of forager diet, regardless of whether the models are couched explicitly in terms of optimal foraging theory or not.

There is no doubt that large mammals are important to most foragers and that the size of an animal, and hence its overall energy yield or return rate, is a reasonably good predictor of its overall ranking as a food (Jochim 1983). But there are striking anomalies in the behaviour of foragers toward hunted resources which suggest that total energy yield may not always accurately predict the ranking of animal resources. More specifically, there are many examples in the ethnographic and ethnohistoric literature, and tantalising evidence from the archaeological record as well, that foragers at certain times of year, particularly during times of stress, may not pursue lean or fat-depleted animals even if the hunters have already invested considerable search time in locating the prey; and that they may only partially exploit or even abandon entirely an extremely lean animal after killing it, despite the fact that the foragers themselves may be short of food (see discussion and examples in Speth 1983).

These anomalies suggest that, under certain conditions, the ranking of an animal resource depends neither on its total calorie content nor on its yield of high-quality protein, but instead on the quantity of lipids (or lipid-derived calories) in the carcass (ignoring in this discussion non- food uses such as hides). Understanding the specific circumstances under which lipids become more critical to a forager than protein or protein- derived energy may help us better understand the food choices and seasonal structure of forager subsistence strategies during the Late Glacial, and the subsequent transformations that gave rise to Mesolithic foraging economies at the close of the Ice Age (Hill 1988; Speth & Spielmann 1983; Speth 1989; 1990).

Protein and fat as macronutrients

In exploring the ethnographic and ethnohistoric literature, Katherine Spielmann and I some years ago noted the widespread tendency of foragers selectively to seek out fatty meat and marrow (Speth & Spielmann 1983; Speth 1987; 1989; 1990; see also Hayden 1981; Jochim 1981). There are many reasons why foragers show such a decided preference for lipids. First, fatty foods taste good and they produce a feeling of satiety that other foods do not. Moreover, fat is a highly concentrated source of energy, supplying 9 kcal per gram, while protein and carbohydrate each provide only 4 kcal per gram. Fat is also more efficiently metabolised than protein. And finally, fatty foods carry important fat-soluble vitamins and are sources of essential fatty acids. While foragers may be unaware of the nutritional importance of these micronutrients, they nonetheless experience a feeling of health and well-being when they consume sufficient quantities of lipids (Mead *et al* 1986; Speth 1987; Stefansson 1944; 1956).

However, there is another extremely important and under-appreciated nutritional reason why fat (and carbohydrates) may become more critical to foragers than protein, especially during periods of resource stress. Although there has been relatively little research on the subject, there appears to be an upper limit to the total amount of protein (both plant and animal) that an individual can safely consume on a sustained basis without serious health consequences. This limit — the total number of grams of protein per unit of lean body mass that the body can safely handle — is about 300 g or roughly 50% of one's normal total daily caloric intake. Prolonged protein intakes above this threshold may exceed the rate at which the liver can metabolise amino acids, and the body can synthesise and excrete urea, leading to serious impairment of liver and kidney function and a variety of other disorders, and ultimately death (Noli & Avery 1988; McGilvery 1983; Speth 1987; 1989; 1990).

The effective safe limit may actually be considerably less than 300 g or 50% of total calories in situations where protein intakes oscillate rapidly between very low and very high levels; such situations are common to many foraging groups that face alternating periods of 'feast' and 'famine.' Bursts of meat-eating may exceed the rate at which the body can adapt to suddenly elevated amino acid loads (Speth 1990).

Perhaps of greatest significance for the success and long-term viability of foraging groups, however, is the recent suggestion by nutritionists that for pregnant women the safe upper limit to total protein intake may actually be considerably lower than 300 g. A woman's protein needs, of course, increase during pregnancy, and these requirements must be met in order for her to produce a viable, healthy offspring. Extremely low maternal protein intakes, below about 5% to 6% of calories, may be detrimental to the health of the foetus, leading to declines in birth weight and in extreme cases to a variety of birth disorders and even death (Martorell & Gonzalez-Cossio 1987; National Academy of Sciences 1985; Winick 1989). As maternal protein intakes increase above this minimum threshold, birth weight and foetal health generally improve noticeably. However, several recent studies suggest that supplementation of maternal diets with protein in excess of about 20% of total calories (ie above about 100–150 g of protein), even in diets that are otherwise balanced and calorically adequate, may lead to declines, not continued gains, in infant birth weight, and perhaps also to increases in perinatal morbidity and mortality and even cognitive impairment. Premature infants appear to be most vulnerable to high maternal protein supplements (Rush *et al* 1980; Rush 1982; 1986; 1989; Worthington-Roberts & Williams 1989, 88).

Birth weights may also decline, of course, when the mother's total calorie intake is restricted (Brooke 1987; Lechtig *et al* 1978; National Academy of Sciences 1985; Wray 1978), but the decline appears to be most extreme when her diet is both low in energy and high in protein (Martorell & Gonzalez-Cossio 1987; Rush 1989; Winick 1989). This is dramatically demonstrated, for example, by data from Motherwell, a small community in Scotland, where for 30 years pregnant women were advised to consume a diet consisting of about 1500 kcal and 85 g of protein *(c* 23% of total calories). Birth weights of infants from Motherwell over this period were, on average, about 400 g lower than those of infants born in Aberdeen during the same period (Kerr-Grieve *et al* 1979; Winick 1989). Such a large decline in average birth weight is comparable in magnitude to the decline seen in Holland at the close of World War II (Rush 1989).

The potentially detrimental effects of high protein intakes on the health and survival of the foetus may help to explain the widespread taboos among foraging societies against the eating of meat by pregnant women (Spielmann 1989; Speth 1990). It may also help to explain the nausea experienced by many pregnant women during the first trimester of pregnancy, a response that is often triggered by the ingestion of meat, or even just by its smell (eg Dickens & Trethowan 1971; Hook 1978; Profet, in press; Tierson *et al* 1985).

One must immediately wonder, of course, how pregnant women among traditional Eskimo societies kept their average protein intake below the 20% threshold. Numerous studies point to average protein intakes among Eskimos in excess of 30% to 40% of calories, though rarely higher (eg Draper 1977; Mann *et al* 1962; Speth 1989). Unfortunately, I am unaware of any data that would help to clarify this issue, and we must be content here with speculation. One possibility, of course, is that pregnant women were not able to keep their dietary protein intake below the 20% level, and therefore suffered the consequences in terms of lowered birth weights and higher infant mortality. Another possibility is that the Eskimos have evolved a unique set of physiological and metabolic adaptations that allow pregnant women to consume large amounts of protein with impunity. Finally, it is also possible that the traditional diet of pregnant Eskimo women contained higher quantities of carbohydrates and fat than did the normal diet of men and non-pregnant women.

Most studies play down the importance of plant foods in Eskimo diets, pointing to the obvious scarcity of edible vegetable foods in most arctic and subarctic habitats (Draper 1977; Hunn 1981; Mann *et al* 1962; Nickerson *et al* 1973; Oswalt 1957). But one dietary practice that appears to have been widespread, if not universal, in the Arctic was eating the partly digested contents of caribou and reindeer stomachs, as well as the innards of a variety of birds and sea mammals (eg Bogoras 1904–1909; Eidlitz 1969). Kelp harvesting, even through the ice in winter, was also important, at least among some Eskimo groups (Eidlitz 1969; Harriet Kuhnlein pers comm). Despite the ubiquity of these dietary practices, I am unaware of any quantitative data on the caloric importance of these specific carbohydrate resources, or whether women had any significant degree of preferential access to them when they were pregnant (see Giffen 1930 for tantalising suggestions that women may at times have made greater use of carbohydrates than did men). This is clearly a topic where we are in need of further input from arctic specialists.

It must be pointed out that the potentially deleterious effects of high protein intakes on the health and survival of the foetus remain controversial. All of the presently available studies suffer from flaws in research design and measurement precision, and the actual mechanisms involved remain to be spelled out (Rush 1989). Moreover, it is also not yet clear whether high protein intakes are deleterious throughout the course of a pregnancy or only during a particular trimester. Nevertheless, if these arguments do ultimately stand up to further scrutiny, they have important implications for understanding the subsistence behaviour of hunters and gatherers, past or present. In essence, adult foragers must normally get well over half of their calories from non-protein sources — either from fat or carbohydrate — in order to remain healthy, and pregnant women must get considerably more, perhaps up to 80% or more of their total daily energy intake.

These nutritional factors clearly place serious constraints on the food choices made by foragers. The package size of resources, and their abundance and spatio-temporal predictability — the principal variables employed in most optimal foraging models — while important, are clearly only part of the story. During summer and fall, when animals are in prime condition and have substantial body-fat reserves, or when oil- or carbohydrate-rich plant foods are abundant (so long as the plant foods themselves are not excessively rich in protein), foragers have considerable latitude in their choices, but during seasons, or inter-annual periods, of food shortage, when vegetable resources dwindle and many wild animals become very lean, finding adequate non-protein energy sources may become increasingly difficult. It is these seasonal or inter-annual resource 'bottlenecks' (Wiens 1977), and the strategies and technology available to foragers for coping with them, that in my opinion hold the key to understanding the emergence of Mesolithic economies at the close of the Late Glacial in northern Europe.

The Late Glacial of northern Europe

Since I am not an expert on the Late Glacial prehistory and palaeoclimate of northern Europe, what I will attempt to do here is to point in very general terms to the kinds of strategies that contemporary foragers in temperate and northern latitudes use to avoid excessive protein intakes during the late winter and spring. I hope that this discussion will provide regional specialists with clues to the strategies that may have become increasingly critical to northern European foragers at the end of the last glaciation, and perhaps also point to ways in which archaeologists may be able to identify these strategies in the prehistoric record.

The nature of the climatic changes themselves provide some important insights into the kinds of stresses that foragers might have experienced at the close of the Ice Age. Contrary to what one might expect, ameliorating temperatures at the end of the Pleistocene may have had a detrimental effect on local foraging populations, not just because the large herds of reindeer, bison, mammoth, and horse disappeared, but also because under warmer climatic conditions most large mammals, on average, would have carried far less total body fat than did their Ice Age predecessors. This means that there may have been a significant decline in the total amount of lipids available to foragers year-round. Any increase in regional human populations during the Late Glacial, of course, would have exacerbated this trend. A reduction in the overall availability of lipids would have forced Late Glacial foragers to rely more and more heavily on plant resources, particularly those rich in oils or carbohydrates. In my view, it is this shift toward plant foods, particularly varieties rich in starch, that lies at the heart of the so-called 'broadening food spectrum,' a transformation in foraging patterns that seems to have taken place throughout the northern temperate latitudes of both the Old and New World by Late Glacial or early Holocene times (eg Flannery 1969; Binford 1968), and perhaps somewhat earlier in more southerly regions (eg Hillman 1989; Edwards 1989).

This decline in available animal fat may have been exacerbated in the late winter and spring if, as some scholars have recently argued, post-Pleistocene climates, on average, became more sharply seasonal than those of the preceding glacial period (see, for example, Martin & Martin 1987; Kutzbach 1983). This would have forced animals to mobilise a proportionately much greater amount of their body-fat reserves each year in order to survive through the annual low point in resource availability. When combined with the more dispersed distribution of most larger mammals during the early Holocene, these changes may have made terrestrial large mammal species, such as red deer, roe deer, and aurochs, much less attractive to foragers as a late winter and spring resource, when alternative non-protein energy sources would have been scarce or unavailable.

Perhaps the most obvious strategy open to foragers to avoid excessive protein intakes during the winter and spring is for the hunters to become increasingly selective in the animals they hunt and in the body parts they consume, discarding those parts (or in some cases whole animals) that are too lean (Speth 1983; Speth & Spielmann 1983). This means more systematically targeting females in the summer and fall, but avoiding them when they are pregnant or nursing, and going after males in the late winter and spring, but avoiding them after the rut, It also means avoiding very immature animals, which normally have extremely little body fat. And it also means selectively culling body parts that retain the highest fat reserves, which by the late spring (especially during an unusually bad year) may be found primarily in the brain, around some of the internal organs such as the kidneys, and in the marrow deposits of the distal limbs and mandible (Speth 1989).

Patterns of selective hunting and processing are clearly visible in the Late Glacial and early Holocene archaeological record of northern Europe, as demonstrated by a number of recent faunal studies (eg Legge & Rowley-Conwy 1988; Grønnow 1987), but many more studies of this sort are needed before we will be able to monitor subtle changes in these patterns through time.

Another important strategy available to foragers to increase their intake of non-protein calories in the spring is to invest increasing amounts of effort to extract grease from the cancellous tissue of limb epiphyses and vertebrae (Speth 1989). This is done by smashing up the bones and boiling out the lipids. However, prior to the introduction of ceramic vessels, which could be placed directly on a fire, this would have been an extremely labour-intensive and time-consuming undertaking, accomplished by heating stones and transfering them one-by-one to hide, gut, bark, or basketry containers (which for support are often set in pits in the ground) to bring the contents to a boil (Binford 1978). The heated rocks fracture and disintegrate with repeated use and are usually dumped out next to the pit, along with the pulverised bone meal.

It would be extremely interesting to learn from regional specialists when the technology of stone-boiling first appeared in northern Europe. It would also be interesting to learn from faunal specialists whether the appearance of stone-boiling in the region went hand-in-hand with changes in the degree of bone fragmentation in residential sites, the presence of boiling pits in processing sites, and more consistent removal of large mammal vertebrae from kills (for ethnographic cases of foragers transporting the vertebrae of large mammals, including even those of giraffe, see Bunn *et al* 1988; and O'Connell *et al* 1988). My hunch is that stone-boiling may be a Late Glacial or even an early Holocene development in northern Europe. Prior to its development, animal resources may have played a rather different role in the region's foraging economies, particularly as food sources during periods of stress.

While selectivity and grease-rendering are both extremely important ways for foragers to obtain non-protein calories, by themselves they may not be adequate. This possibility is suggested, for example, by the Kalahari San or Bushmen, who routinely boil every scrap of animal bone they acquire to extract the grease (Yellen 1977). Despite these efforts, during the dry season the total amount of lipids they are able to obtain from the carcasses of larger mammals appears to be inadequate to compensate for diminishing overall caloric returns. By the height of the dry season, these foragers may be forced to consume almost 2 kg of lean meat per person per day (roughly 420 g of protein), and yet their body weights continue to decline to their lowest values for the year (Lee 1982; Speth 1989; Wilmsen 1978; 1982). This astounding meat intake means that protein at times may contribute up to 70% or more of the San's daily calorie intake, a level far in excess of the amounts seen in traditional Eskimo diets and well in excess of the 300 g suggested earlier as the safe upper limit, and therefore almost certainly a sign of nutritional stress, not affluence, as many anthropologists once thought (eg Lee 1968; Sahlins 1968). One might argue that these high meat intakes actually reflect a successful way for the San to cope with shortages of other foods. While the calories provided by lean meat obviously do help to keep them alive and functioning, for pregnant women such excessive protein intakes may contribute to their high rates of infant mortality (Speth 1990).

Thus, if ameliorating temperatures and increasing seasonality of climate in Late Glacial Northern Europe gave rise to recurrent periods of stress in which lipids from large terrestrial mammals no longer provided foragers with adequate and reliable sources of non-protein calories, we can expect other strategies to have come into play that were geared to help them through these nutritional bottlenecks. One such strategy is to target other animal species, usually smaller ones, that retain high fat levels during the spring (Speth & Spielmann 1983). These probably would have included a variety of waterfowl, beaver (especially the tails), wild pigs, perhaps insect larvae, certain species of fish, particularly just prior to or during their spawning runs and, for foragers close to the coast, a variety of fish, shore birds, marine mammals such as seals and beached whales, and even certain types of molluscs (Rowley-Conwy 1984). It should be emphasised that this diversification in prey types from larger to smaller animals is not necessarily caused by scarcity of the larger ones, as most archaeologists would assume, but by the inadequacy of the lipid supply that can be obtained from the larger animals during the spring low point.

Coastal resources deserve special comment. Despite access to an abundance of marine mammals and a veritable bonanza of blubber and oil, ethnohistorically documented coastal Eskimo adaptations in the Arctic appear to have been notoriously unstable, and seasonal stress, failure, and even total collapse were recurrent phenomena (Buikstra 1976; Cove 1978; Minc 1986; Piddocke 1965; Suttles 1968). Failure occurred for many reasons, including severe storms or early breakup of the ice that rendered whaling or seal hunting unproductive or impossible, or that led to declines or relocation of caribou herds, or that interfered with annual fish runs. Buffering responses to such calamitous events included food exchange with inland groups, relocation of entire communities to other areas, and occasional starvation and even local group extinction.

Reliance on marine resources poses other problems that also merit closer comment. As discussed above, groups living along coast lines have access to a large variety of marine resources, some of which may be extremely abundant (eg anadromous fish) and some of which may be rich in lipids (eg fish oil; seal oil). But reliance on these resources may not be as reliable and straightforward as anthropologists and archaeologists often assume (see discussion in Yesner 1987). First, many species of fish (both marine and freshwater) are extremely lean, carrying significant amounts of fat, if at all, only during the spawning period. When lean, these fish may be of little value to foragers, particularly in the spring, regardless of their abundance. The same may be true of many species of molluscs.

But even in species that are high in fat, either seasonally or throughout the year, their utility as a stress period resource may be more limited than archaeologists would generally suspect. Fish meat and marine oils, because they contain lipids with very high percentages of polyunsaturated fatty acids, have notoriously short shelf-lives, seldom more than a few months (Labuza 1982; see also Soffer 1989, 723). The actual 'shelf-life' depends on a variety of factors, including species, season of catch, methods of handling and preservation, storage temperature, moisture, and bacterial load. Ironically for foragers depending heavily on fish as a backup resource for seasonal shortages, in general the fattier the species the shorter its 'shelf-life' (Labuza 1982, 442, 452). While traditional techniques of smoking and drying may provide coastal foragers outside of the Arctic (ie in areas where long-term freezing is not a viable option) with a resource that will last for several months, sufficient to see them through a single spring low point, it is unlikely that fish meat and marine oils can be stored long enough to carry them through a string of two or three bad years in succession. Groups relying heavily on freshwater fish face essentially the same problem.

Thus, even coastal foragers who have access to resources that are both seasonally abundant and high in fat are still likely to place considerable emphasis on non-protein energy sources that have longer shelf-lives. The ideal candidates, outside of the Arctic, are plant foods, particularly starchy seeds and nuts (Labuza 1982; Soffer 1989). Unlike fish meat and marine oils, many of these resources can be stored for years using traditional techniques of preservation, and hence provide a much more reliable backup resource than marine foods.

The factors discussed above suggest that coastal adaptations during the Late Glacial and early Holocene in northern Europe, like those documented ethnographically in the Arctic, were probably also subject to periodic instability, failure, and even collapse, again due to severe storms and other unpredictable climatic events. And their buffering responses may have been broadly similar to those seen ethnographically in the Arctic, including food exchange, relocation, periodic hunger, and possibly even local group extinction. However, northern European Late Glacial and early Holocene coastal foragers, unlike the contemporary arctic cases, very likely also had access to plant foods that were high in carbohydrates and oils and that could easily be stored for extended periods, and these resources probably played a very significant role in their buffering strategies.

Returning now to our discussion of the subsistence options potentially open to non-coastal foragers, if the types of animals available to them in the summer and fall cannot provide a reliable surplus of lipids sufficient to carry them through the period of stress in the spring, they may instead 'underexploit' animal resources during the warmer months of the year in order to acquire surpluses of plant foods. The foragers can then either consume these surpluses immediately and 'store' them as body fat, or cache them for winter and spring use in some sort of pit or above-ground facility (in reality, some combination of these two strategies is likely). Each strategy has obvious costs as well as benefits. By consuming the surplus immediately, the foragers avoid inevitable storage losses, which under traditional techniques may be quite severe, at times in fact in excess of 20% to 30% (Brenton 1989; Dugdale & Payne 1987). This strategy, by not tethering the foragers to fixed storage locales, also allows them to remain mobile through the lean season. But they are forced to carry the 'surplus' around as extra body weight, which is an inefficient use of calories, and they are unable to ration the calories in such a way that the surplus is used primarily during the toughest period late in the spring. Storing the surplus in some sort of facility allows the foragers to save the resources until they are most needed, but at the risk of substantial losses through decay and possibly theft (DeBoer 1988). This form of storage also has obvious costs in terms of mobility.

If plant foods are cached for winter-spring use, the nutritional arguments outlined above suggest that the foragers are likely to target forms that are particularly rich in oils or carbohydrates but, perhaps contrary to expectation, ones that are comparatively poor in protein. While many varieties of nuts and seeds seem like ideal candidates, many are also extremely high in protein (see, for example, the tabulations in Jones & Earle 1966; Barclay & Earle 1974; Munson 1984; Speth 1989, 335–6, and references therein) and therefore, like meat, may be problematic for pregnant women if consumed as staples. Interestingly, in the ethnohistoric south-eastern United States, Native Americans often pulverised nuts — shells and all — and then boiled them, either skimming off just the oil that floated to the surface, or consuming the oily broth or 'milk' but discarding the remaining solids (Swanton 1946, 365*ff*). This seemingly wasteful practice may in fact be an effective way of maximising the yield of lipids while at the same time avoiding excessive protein.

Seeds, nuts, fruits, leaves, stems, and roots may pose other nutritional problems as well, For example, some nuts, especially certain types of acorns, are extremely high in tannins (Basgall 1987; Petruso & Wickens 1984); many grass seeds, particularly the cereals, but also various legumes and nuts, contain phytates (Harland & Oberleas 1987; Reddy *et al* 1982); and the leaves, stems, and roots of many plant species contain calcium oxalates (Hodgkinson 1977). These and many other plant secondary compounds block the absorption of critical micronutrients, such as calcium, iron, and zinc. Considerable processing, therefore, may be required to remove or neutralise these anti-nutritive compounds before the food can be safely consumed (Katz 1982). The starches found in seeds, nuts, roots, and tubers may also require extensive processing, including parching, grinding, and boiling, to render them more digestible (Stahl 1989; Basgall 1987).

These arguments suggest that while plant foods may have become increasingly critical to the survival of Late Glacial and early Holocene foragers in northern Europe, their effective use may have entailed far more than simply collecting or harvesting them. Many of these vegetable resources may have required time-consuming and labour-intensive processing before they could be safely consumed or stored, and these investments should be clearly visible to the archaeologist in the technological innovations of the time. Stone-boiling may have been one of the most important of these.

The relatively early and perhaps indigenous development of ceramics among foraging groups in many parts of the world, including northern Europe (eg Ertebølle, Jomon, coastal south-eastern United States), may in part be a response to these same needs (Braun 1983, 116–7; Brown 1989).

Finally, exchange with farmers provides foragers with an extremely attractive strategy for gaining access to reliable supplies of carbohydrates, as evidenced by the frequency of mutualistic relationships between the two economic systems among the world's extant foragers, particularly in areas where wild carbohydrates are in short supply or require extensive processing to detoxify them or to make them palatable and digestible (eg Bailey *et al* 1989; Headland & Reid 1989; Speth & Spielmann 1983; Spielmann 1986). In many cases, as foragers enter into these relationships, they become increasingly specialised in the procurement of hunted or other resources which they target explicitly for exchange with farmers for carbohydrates. Many also perform agricultural labour and other menial tasks for farmers and receive carbohydrates as recompense (Bailey & Aunger 1989).

Most ethnologists today view these forager/farmer interactions as highly asymmetrical and exploitative, with the hunter-gatherers caught in a position of inferiority and virtual servitude by the politically and economically dominant farmers (eg Wilmsen 1989). While I certainly agree that these interactions are usually asymmetrical and the foragers almost invariably the weaker participant of the two, the nutritional arguments outlined earlier make it clear that foragers do gain significant benefits from these relationships by having access to a reliable source of non- protein energy which might be far more difficult for them to procure in the absence of the farmers.

While farming obviously did not appear until quite late in northern Europe (eg Zvelebil 1986), once farmers had penetrated into the region, mutualistic relationships between them and the region's Mesolithic foragers are likely to have emerged as soon as alternative non-protein sources of calories, plant or animal, that were relied upon by the foragers during the late winter and spring, became less secure or more costly to procure than the farmers' carbohydrates (Rowley-Conwy 1984; Speth & Spielmann 1983).

Conclusions

Perhaps the most important conclusion of this paper is that anthropologists and prehistorians have placed far too much emphasis on protein or protein-derived calories in their modelling of forager subsistence systems and have not recognised that, during periods of stress, non-protein sources of energy may be far more critical. It appears that the nutritionally most vulnerable members of foraging societies are the pregnant women, and for them maintaining not just adequate total caloric intakes, but adequate intakes of calories provided by macronutrients other than protein, may prove to be one of the key adaptive bottlenecks faced by Late Glacial hunters and gatherers. In my view, it is attempts to cope with precisely this problem that lay at the heart of the so-called 'broadening food spectrum,' not merely an increasing dietary eclecticism forced on foragers as total animal biomass dwindled or as herd animals vanished to be replaced by more dispersed, solitary species. Clearly, this shift toward starchy and oily plant foods, a shift that seems to have begun at more or less the same time throughout the north temperate latitudes of both the Old and New Worlds, set the stage for later attempts to protect, encourage, and manipulate the more productive of these plants and ultimately for their cultivation and domestication.

We may be better able to understand the economic transformations at the end of the Pleistocene, in northern Europe and elsewhere, if we can work out how Late Glacial climatic and environmental changes altered the availability of non-protein sources of calories during the late-winter and spring stress period, and what specific kinds of alternatives became available. As a first step toward this end, we need to move beyond simple tabulations of the plant and animal species exploited by Late Glacial foragers to a clear understanding of their non-protein macronutrient composition and how that composition varied seasonally.

We also need to explore more carefully the changes that were simultaneously taking place in the technology by which foragers processed these resources and stored them for future use. Too much emphasis to date has been placed on the procurement technology of Late Glacial foragers (eg hunting weapons, fishing equipment), leaving large gaps in our understanding of the seemingly more mundane technology by which foragers processed and cooked their foods, and the impact of these techniques on the foods' digestibility, nutritional value, toxicity, and 'shelf-life' in storage.

In conclusion, seasonal or inter-annual resource bottlenecks are likely to have been the locus of intense selective pressures for Late Glacial foragers, and hence a critical locus of adaptive response and change (Wiens 1977). In my view, therefore, the strategies and techniques used by Late Glacial foragers to cope with these bottlenecks are likely to provide us with the clearest window into the processes that underlay the dramatic transformations occurring globally in the north temperate latitudes at the end of the Pleistocene.

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17 Ethnographic models for Late Glacial hunter-gatherers

Lawrence H Keeley

Abstract

A recent study by the author (1988) has established that ethnographic hunter-gatherers show two distinct types of socio-economic organisation. These two types were distinguished by a number of variables: relative population density, dependence on storage, degree of sedentism, social stratification and continentality of the climate. The absence of intermediate groups in the ethnographic sample implies that the transition from 'simple' to 'complex' socio-economies is unstable and rapid. The archaeological characteristics distinguishing these two types are outlined and applied to two areas of late Magdalenian settlement in north-west Europe. The role of terminal Pleistocene climate changes in the development of complex socio-economies is discussed.

Introduction

This paper has three goals: 1) to review the features that characterise, what will here be termed, 'simple' and 'complex' hunter-gatherer economies, as known from ethnography; 2) to discuss the aspects of the archaeological record that document some of these ethnographic features; 3) to apply these archaeological criteria to two regions within the Magdalenian 'culture area'.

Simple and complex hunter-gatherers in the ethnographic record

The basis for the following list of contrasts between simple and complex hunting-gathering economies is a statistical analysis of a cross-cultural sample of 99 ethnographic hunter-gatherer groups. Some of this data, on an earlier sample of 94 groups, has already been published (Keeley 1988). However, the figures included in this paper exclude all tropical hunter-gatherers (N = 17) for several reasons. All tropical hunter-gatherer groups show simple economies and therefore none of the variation pertinent to the topic. Also, Bailey *et al* (1989) argue that hunting-gathering in tropical rain forests cannot exist independent of agriculture. While this conclusion may be suspect, it is certainly true that almost all recent hunter-gatherers in tropical forests received substantial amounts of food from adjacent agricultural groups. Finally, adaptations to the tropics are likely to be of little relevance for analogies with Late Glacial north-west Europe.

Key distinctions

The central differences between simple and complex hunter-gatherer economies involve variations in residential mobility or sedentism, reliance on stored food, and the degree of population pressure on resources. Figure 17.1 shows the relationship between measures of these three variables. *LNY* is a measure of population density relative to ecological productivity (see Keeley 1988, 385 for details of its calculation). *STAY* is merely the length of stay, in months, in a winter village or camp. *STOR* is a code for degree of dependence on stored food ranging from 0 = none to 5 = high; 2 is a mixed code meaning that stored food either predominates in diet for less than a month during the winter or is only supplemental to fresh food during that season (see Keeley 1980, 388), while code *3* indicates that stored food predominated in the diet over the winter but that the late winter/early spring was usually a 'hungry time'. The plot shows a strong linear relationship between all of these variables. But there is also a clear separation into two groups with few transitional instances. These two groups I shall designate 'simple' and 'complex' hunter-gatherers. Thus, simple hunter-gatherers stay less than five (usually less than four) months in winter camps, are at low population density relative to productivity, and rely very little on stored food. Complex hunter-gatherers show opposite characteristics.

Environmental differences

One peculiar difference between the two economic types is that simple hunter-gatherers appear in the most continental climates (Fig 17.2). The reason

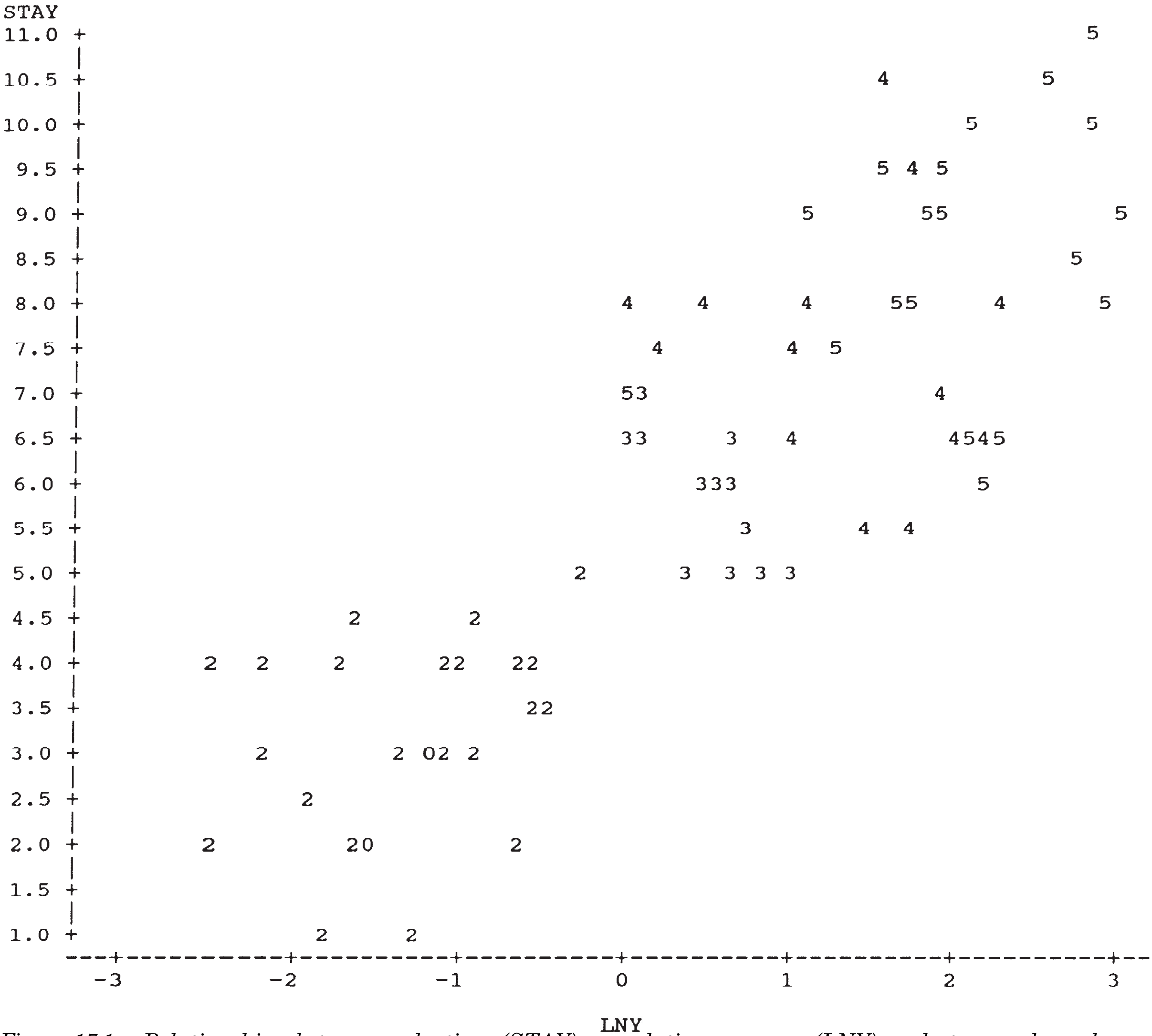

Figure 17.1 Relationships between sedentism (STAY), population pressure (LNY) and storage dependence (STOR). On the plot, each group is represented by its storage dependence code. Cluster in upper right of plot represents 'complex' economies while cluster at lower left consists of 'simple' groups. Note that nine observations had missing values; four observations hidden by other values

probably lies in the high amplitude of variations from year to year in temperature and precipitation in such climate regimes. Terrestrial primary productivity is directly dependent on solar radiation, temperature and soil humidity or 'water balance' (Rosenzweig 1968). Thus, continental climates should show a higher amplitude of changes in primary productivity than less continental climates. Indeed, the northern continental regions of North America are noted for the dramatic fluctuations in faunal populations. Hunter-gatherers in such climates must face these rapid and extreme changes in carrying capacity. Figure 17.3 shows a schematic diagram of two hunter-gatherers populations facing different amplitudes of depression in carrying capacity and diminishing returns. The population overreaching carrying capacity must starve out its excess numbers while that exceeding diminishing returns faces only an impetus to change. Indeed, hunter-gatherers in continental climates show a high incidence of fatal famines, while those in

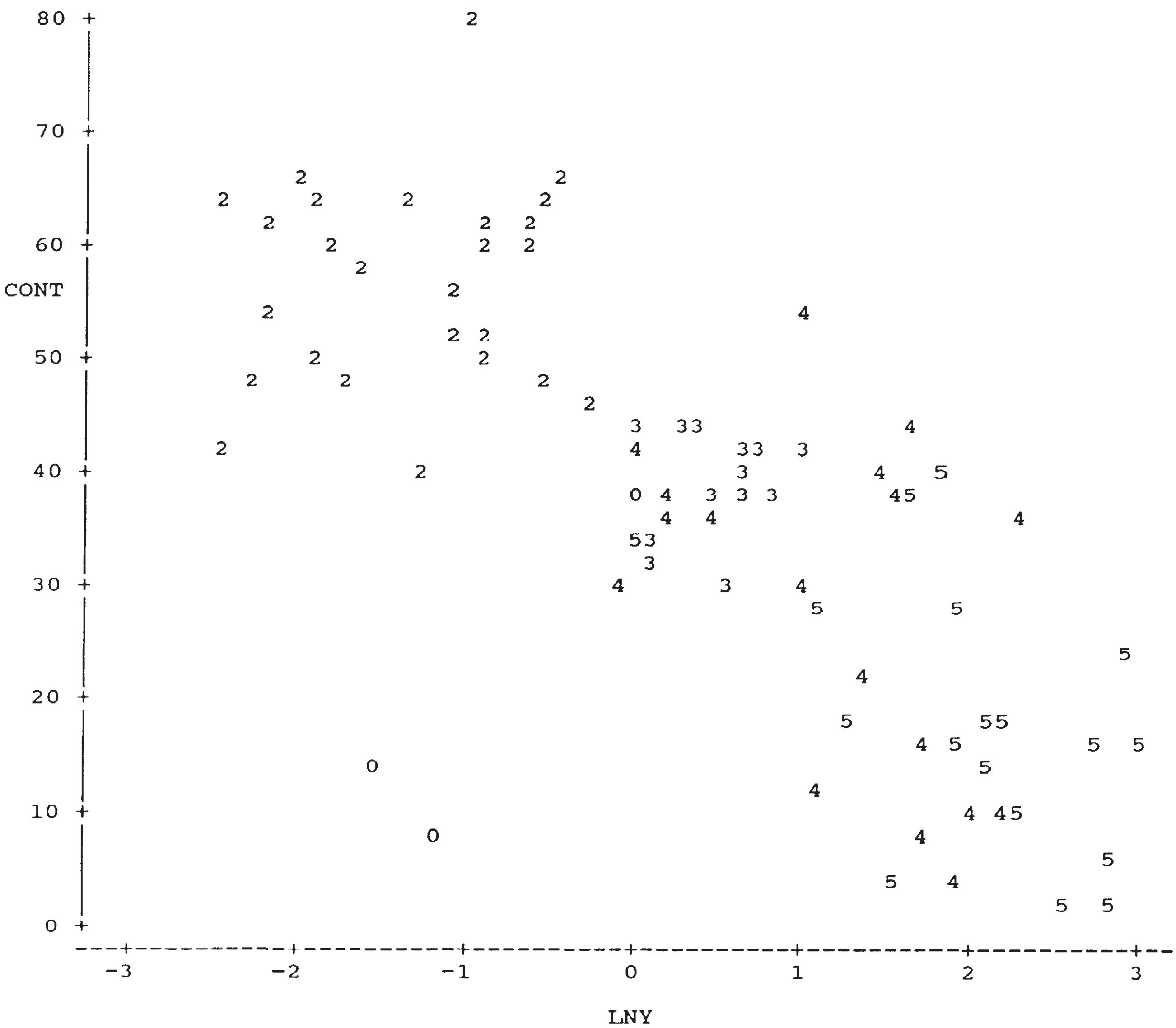

Figure 17.2 Relationship between continentality of climate (CONT), population pressure (LNY) and storage dependence (STOR). On the plot, each group is represented by its storage code. Note that four observations are hidden by other values

maritime climates almost never experience famine (Fig 17.4). In other words, the periodic famines created by continental climates keep hunter-gatherers populations there well under the level of diminishing returns (eg at low population pressure) and of any impetus to change. There are some exceptions to these climate-economy relationships. The Tareumiut Eskimo of Point Barrow lived in an arctic continental climate but had a complex socio-economy while Yaghan and Tasmanians lived in maritime climates with quite simple ones. I have already suggested (Keeley 1988) that the Tareumiut exception is explained by their reliance on whales and the ease with which the latter could be stored by freezing in such a climate. The Yaghan were dependent on marine resources, but lived in an climate where severe and prolonged storms prevented their getting food and brought famine with some frequency. But the Tasmanians seem truly exceptional, even unique. They used the simplest technology known to ethnography, were highly mobile, had a low population density, practised no storage and tabooed the eating of scaled fish. The mutual avoidance and hostilities between them and Europeans allowed few observations of their subsistence economy and the

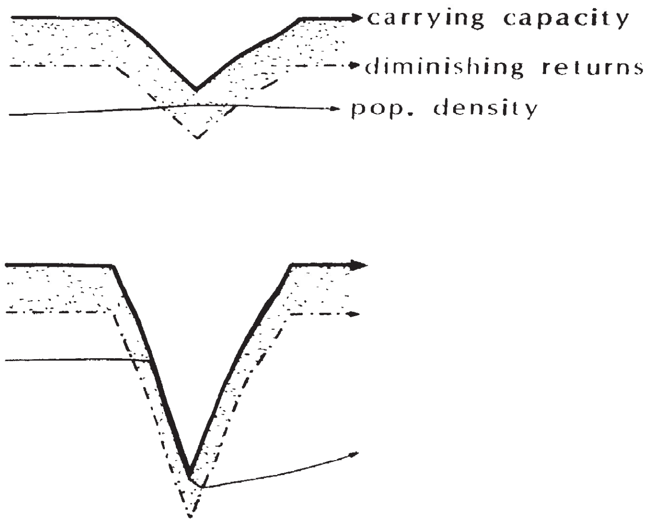

Figure 17.3 Schematic diagram of the consequence for hunter-gatherer populations meeting low amplitude (above) and high amplitude depressions (below) in carrying capacity and diminishing returns

incidence of famine before their destruction. Their eschewal of fish would certainly have limited their ability to develop a storage economy in a temperate forested environment (see below). Readers are referred to R. Jones' (1978) explanation of this peculiar feature of their economy.

Another environmental factor related to economic complexity is forest coverage. In forests, much of the annual productivity is 'locked away' in inedible wood. The complex groups that do occur in closed forest environments, even with maritime climates, are all highly dependent on aquatic foods. Such groups are then either coastal or, if inland, located on large rivers with large drainage systems. Thus, the ideal conditions for the development of socio-economic complexity would be found inland in open environments with less continental climates or coastal locations.

Dietary differences

The diets of simple hunter-gatherers contain a high proportion of terrestrial animals while those of complex groups rely much less on hunting (Fig 17.5; see also Hayden 1981). Among complex groups, terrestrial animals are replaced in the diet by plants or aquatic animals, depending on latitude (Lee 1968; Keeley 1988).

Social features

There also appears to be a difference between simple and complex hunter-gatherers with regard to their use of cultural population controls. It seems that simple hunter-gatherers do not use abortion and only commit infanticide or senilicide when under the stress of starvation, that is, their use of such methods is 'situational'. On the other hand, complex hunter-gatherers often use abortion and commit infanticide categorically (ie all twins killed, all first births, etc). It seems then that simple hunter-gatherers try to reserve fertility while complex hunter-gatherers try to suppress it. But this apparent difference has yet to be confirmed by a statistical study and remains impressionistic.

Simple groups are egalitarian societies while complex ones are stratified in to wealth or wealth-descent classes (Fig 17.6; see also Testart 1982, and Price & Brown 1985). There are a few exceptions to this rule: three simple groups have wealth classes (Nunamiut, Han and Kutchin) while nine complex groups show no evidence of stratification. The Nunamiut were closely socially and economically involved with the wealth-stratified Tareumiut, while the incipient class systems of the Han and Kutchin are probably a post-contact development fuelled by the fur trade. Most of the unstratified complex groups (N = 5) had marginal storage economies (STOR = 3); of the remainder, two are probably ethnographic errors (Coast Yuki and Tubatulabal), leaving only the Angmassalik and MacKenzie Delta Eskimo as true exceptions.

Simple groups use no medium of exchange while complex groups commonly use primitive monies (Fig 17.7). Such monies are usually shell beads of clamshell or dentalium. There are also exceptions to this correlation. Three simple groups (Micmac, Panamint and Nabesna), adjacent to money-using groups, shared the trait. The nine complex groups without mediums of exchange are all geographically isolated from other complex groups.

Simple hunter-gatherers seem to have few or no 'calendric' rituals and most of their rituals are of the 'crisis' variety. If they conduct any calendric rituals these tend to occur during the warm season when fresh food is abundant. Calendric rituals are more common among complex groups, especially in early or mid-winter when stored foods are abundant. This distinction is based only on the preliminary analysis of a small sample (N = 18) of groups.

Most human deaths in the non-tropics tend to occur (even today) in the late winter-early spring. Simple groups are quite mobile during this season and therefore scatter their burials around the landscape. Complex groups, on the other hand, usually still reside at their winter village and thus tend to have cemeteries or permanent cremation piles. The relationship between sedentism and cemeteries has been statistically confirmed.

Material culture

Among simple groups there is little or no part-time craft specialisation, while this is common among

Table 17.1 Relationships between artistic production and socio-economic complexity among Eskimo groups

Group	Art prod rank*	STAY	LOGY**	STOR
Angmassalik	1–2	8.0	1.06	4
Bering Straits	2	8.0	0.46	4
Northern Alaska (Tareumuit)	2	9.0	1.84	5
West Greenland	2–3	7.0	?	3–4
Central Eskimo (Iglulik)	3	3.0	–0.91	2
Copper Eskimo	4	3.5	–0.55	2

* *from McGhee 1976, 210*
** *measure of population pressure (see Keeley 1988, 385–6)*

complex groups (Price & Brown 1985). This is another impression yet to be confirmed statistically.

There is evidence that the decoration of utilitarian items of material culture is relatively rare among simple hunter-gatherers but common among complex groups. But this distinction is relative within the cultural tradition. For example, even the simplest Eskimo groups, such as the Copper Eskimo, seem to decorate items as much as the most complex Athabaskan groups, such as the Ingalik, because the Eskimo tradition is more 'decorative' than the Athabaskan one. But within the Eskimo tradition the complex groups, such as the Tareumiut, decorate items much more than the simple ones, such as the Copper (Table 17.1; see also McGhee 1976). It is clear that the richer, more decorative material cultures of complex groups are the result of the concentrated, predictable 'free-time' available to such groups in the winter when they subsist primarily on stored foods (Keeley, nd). This contrast has some statistical support.

Non-utilitarian items, especially ritual paraphernalia, are much more common in the material cultures of complex groups. This is because of the greater number of calendric rituals held by such groups, and because their economies concentrate the 'free-time' mentioned above. However, this contrast between the economic types requires statistical confirmation.

Cautions

We find, then, that ethnographic hunter-gatherers occur in two distinct economic types which are distinguished from one another by material cultural, demographic, social and ceremonial features, and which tend to occur in different environmental contexts. Nevertheless, it must be kept in mind that the terms 'simple' and 'complex' as used here refer only to socio-economy; *not* to kinship organisation, religious beliefs, or any aspects or expressions of mental culture. Nor do they refer to political organisation *sensu stricto.* The few political variables I have included in some analyses are not strongly correlated with any of the demographic or economic variables. While it is true that 'big men' and chiefs only occur among complex groups, there are many socio-economically complex groups that do not show these features. Political complexity cannot be reliably inferred from knowledge of economic complexity.

The archaeological visibility of the distinguishing features

To be of any interest to prehistorians, the ethnographic features that distinguish simple and complex hunter-gatherers from one another must be archaeologically visible. Therefore, what follows is a review of each of these features for such visibility.

Reconstructing prehistoric demographic variables is a notoriously vexatious business. Population densities can be roughly estimated from systematic surveys, if the results are cautiously evaluated. For example, considering that highly mobile hunter-gatherers tend to occupy more sites in a single year than sedentary complex groups, simple site frequencies cannot be used. Primary productivity can be estimated from palaeoclimatic reconstructions of annual temperature, precipitation or, ideally, water balance data. Thus, from the estimates of primary productivity and population density, some estimate of population pressure could be derived. Famine mortality would be almost impossible to reconstruct unless there were exceptional finds of human remains suggesting catastrophe. Famine frequency may be determined from Harris lines in human bones or other evidence of cyclic nutritional deficiencies. The methods of cultural population control would be archaeologically invisible.

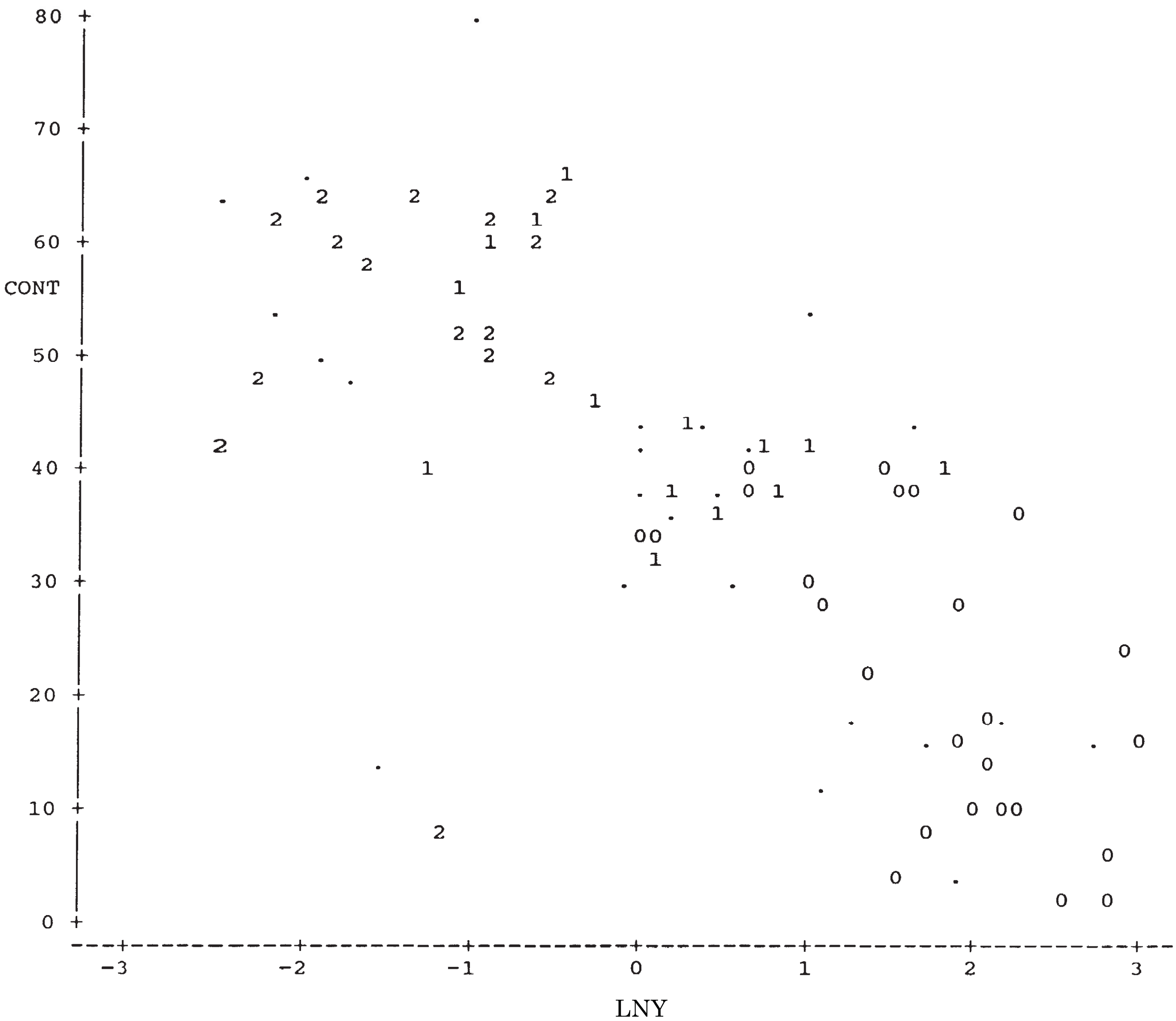

Figure 17.4 Relationship between continentality (CONT), population pressure (LNY) and incidence of famine (FAM). On the plot, each group is represented by its incidence of famine code (FAM): 0 = no famines; 1 = famines occasional or simply noted as occurring with no mention of frequency; 2 = famines common. Note that four observations are hidden by other values

Food storage is difficult to document archaeologically unless the prehistoric group used pit storage. However, the extensive use of stored foods by complex hunter-gatherers will have a peculiar effect on the 'seasonal indicators' found among the food remains. Most of the food consumed at the winter village of a complex group will consist of plants and aquatic animals taken during the warm season. This means that the 'seasonal signature' among the plant and animal remains will be predominantly warm season (especially summer and autumn). If some desultory hunting and fishing are carried on during the winter, then the signature will appear to be year-round. The warm season sites of both simple and complex hunter-gatherers will have similar seasonal signatures. But the seasonal signature of complex winter villages should consist of predominantly aquatic animals and plants taken during the warm season with a few winter-killed fish and terrestrial animals. The winter camps of simple hunter-gatherers should only yield winter-killed fish and animals.

Regarding sedentism, again the warm season settlements of both simple and complex hunter-gatherers will be difficult to distinguish. Such sites

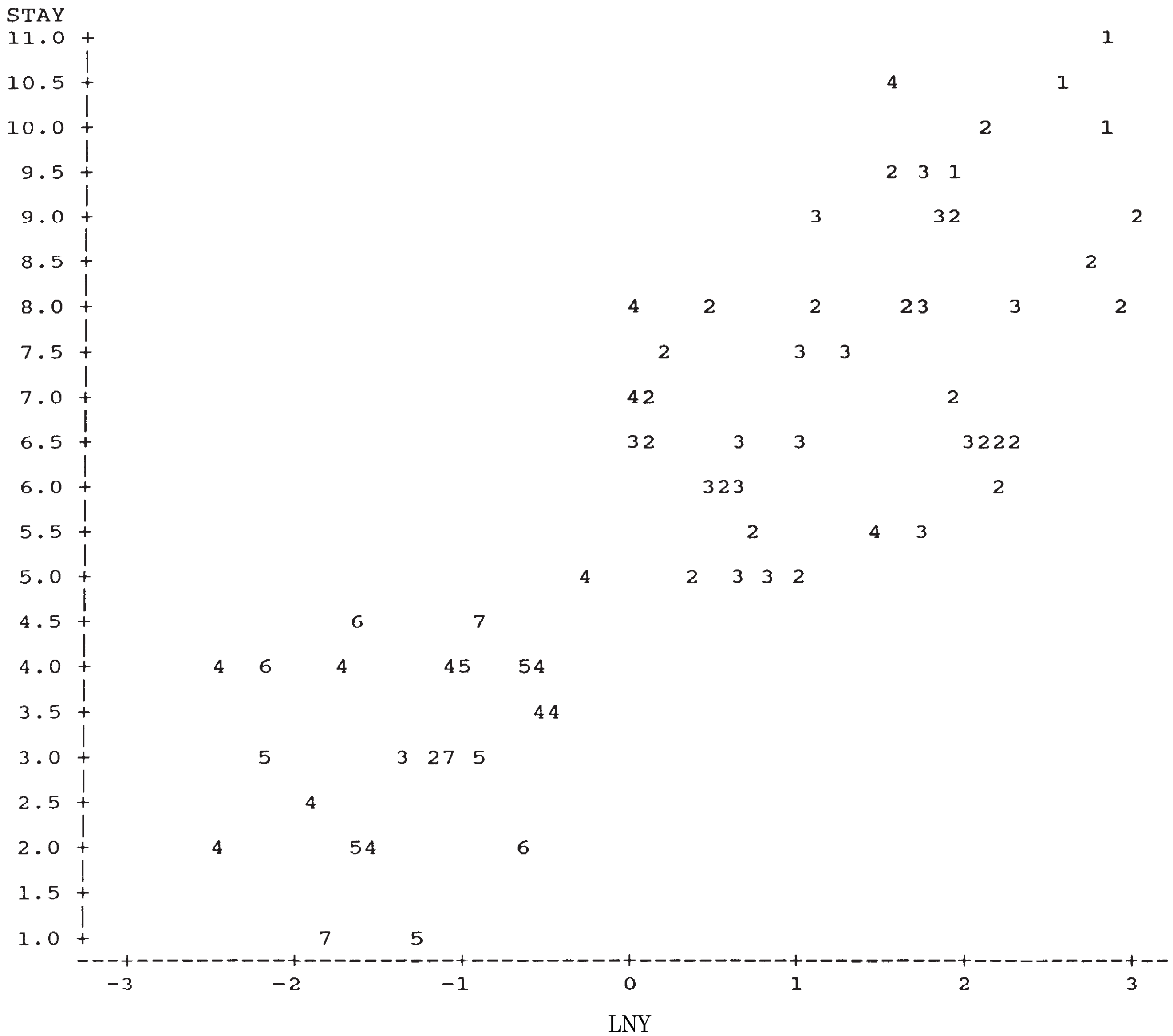

Figure 17.5 Relationship between sedentism (STAY), population pressure (LNY) and proportion of terrestrial animals in diet (H). On the plot, each group is represented by its diet code (H): 1 = 6–15%; 2 = 16–25%, etc. Note that nine observations had missing values; four observations hidden by other values

will have only lightly- and quickly constructed habitations, little midden accumulation and relatively specialised artefact assemblages. The primary difference will be in the winter sites. Those of simple groups will show much the same character as the summer sites in terms of the labour cost of the habitations constructed, light midden accumulation and low diversity in artefact inventory. Winter villages will have substantial, labour-expensive houses, heavy midden accumulation and diverse artefact inventories. It is important to note that there can be no absolute standard for what is a 'substantial' house. The winter house of some southern California groups is no more substantial than the summer house of some groups on the Plateau; the summer house of some Central Eskimo groups is as substantial as the winter house of groups on the Plateau. Thus, the latitude and general climate must be taken into consideration. As well, cemeteries or cremation piles will be found near winter villages.

As several papers in this volume attest, the key climatic parameters including the amplitude of temperature variations, can be reconstructed. Most

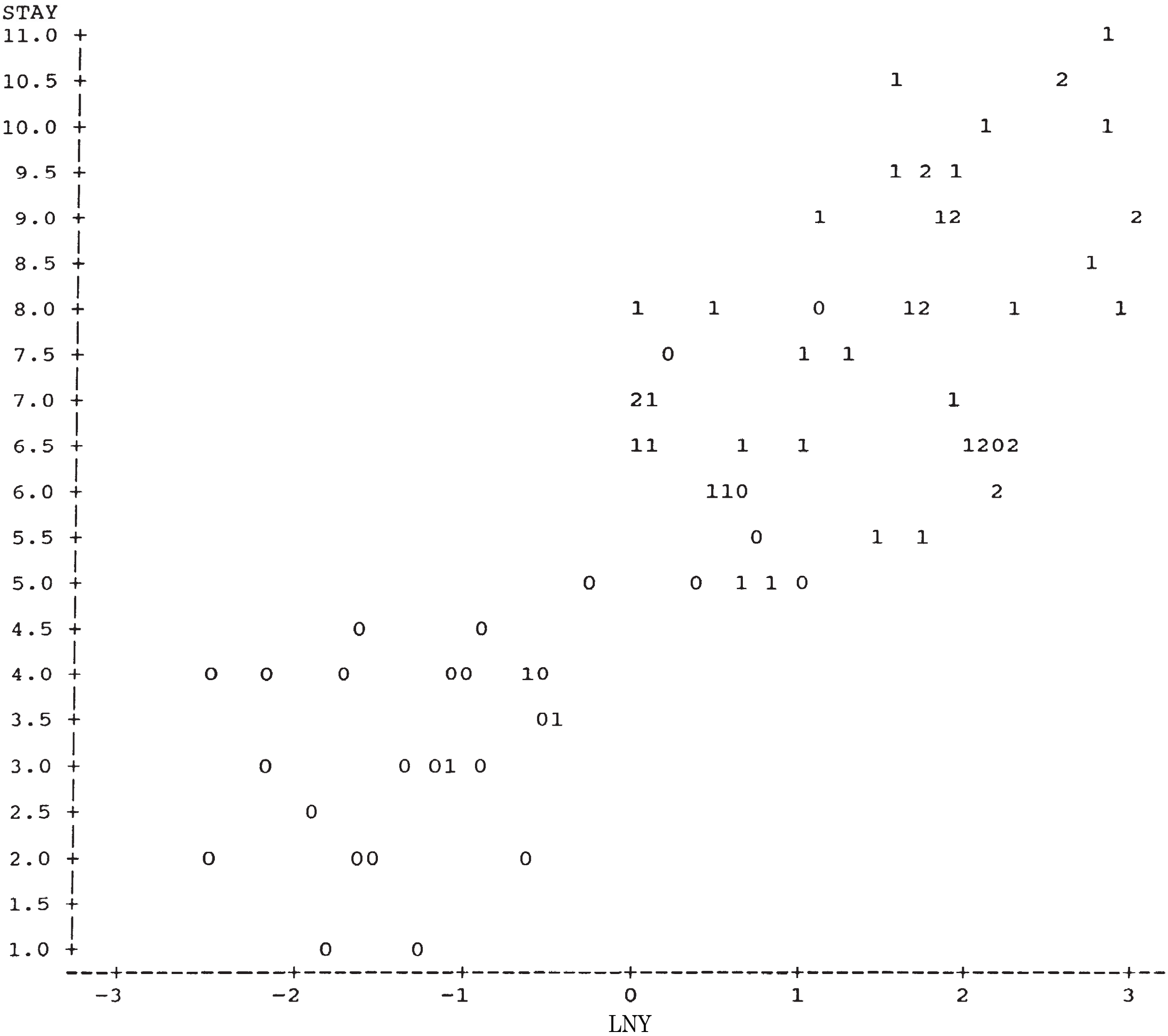

Figure 17.6 Relationship between sedentism (STAY), population pressure (LNY) and social stratification (CL). On the plot, each group is represented by its social stratification code: 0 = no stratification; 1 = wealth classes; 2 = descent classes. Note that nine observations had missing values; four observations hidden by other values.

archaeologists assume prehistoric diets are easy to reconstruct but the data presented here suggests that the key dietary variables are the proportions of fish or plants eaten. Unfortunately, fish and plant remains are much less likely to be preserved in or recovered from archaeological contexts than the bones of terrestrial animals. The expanding work on diet reconstruction from bone chemistry (ie carbon isotope ratios, strontium abundance, etc) offers some hope for better diet reconstructions in the near future.

The archaeological literature on methods for uncovering the existence of social stratification, via mortuary analysis and inter-house differences in size and artefact inventories, is extensive and need not be reviewed here. The archaeological visibility of this aspect of prehistoric foraging groups is high, given that we have the appropriate data from a large number of burials and excavated house features.

The concept of prehistoric media of exchange has received little attention in archaeological literature.

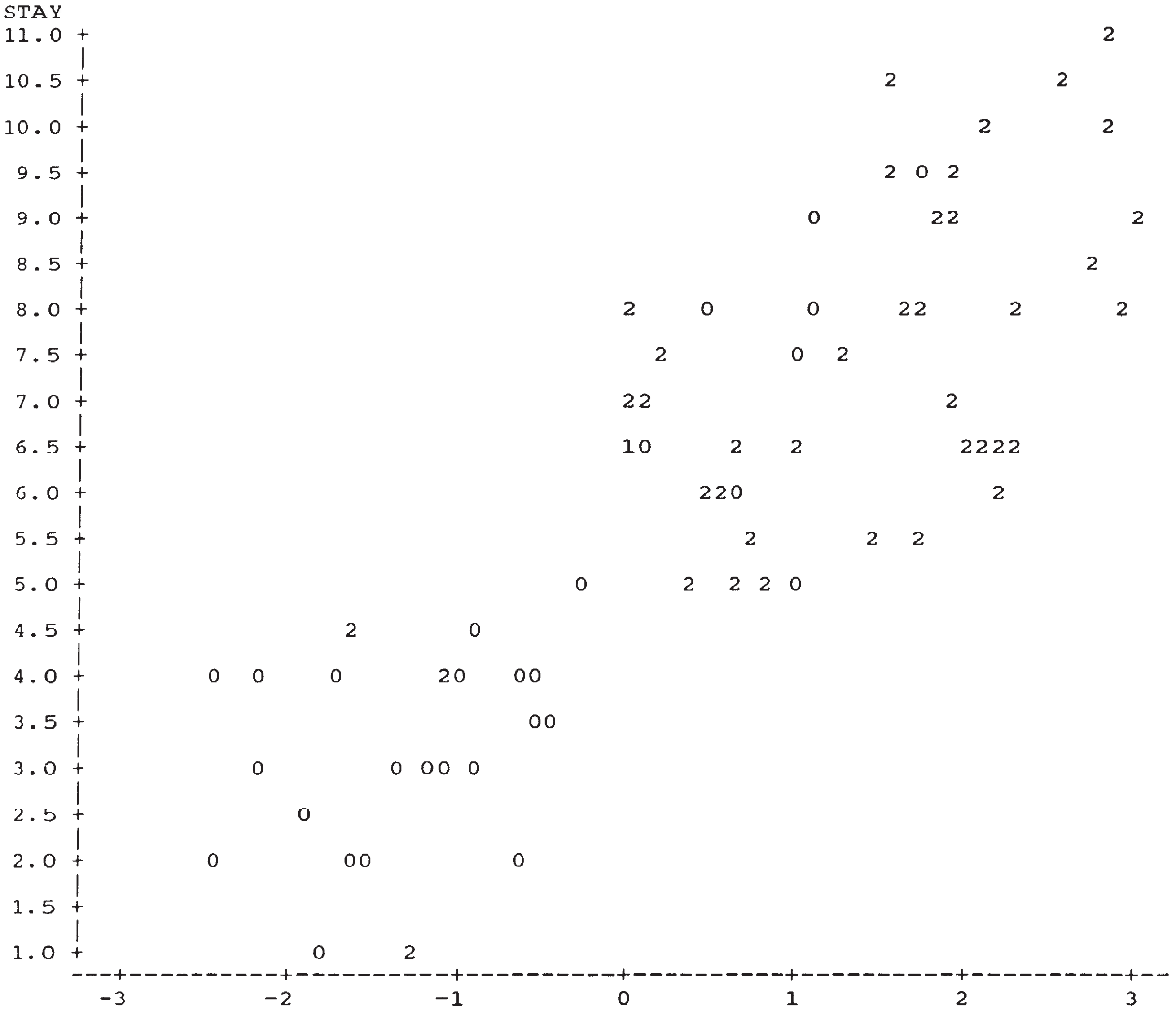

Figure 17.7 Relationship between sedentism (STAY), population pressure (LNY) and use of medium of exchange (MON). On the plot, each group is represented by its medium of exchange code: 0 = none; 1 = domestically useful items medium of exchange; 2 = items of conventional value or 'primitive monies'. Note that nine observations had missing values; four observations hidden by other values

Ethnographic examples suggest that common finds at several sites of standardised beads of shell (or other materials) or of a small, easily strung shell such as cowry or dentalium, may indicate the existence of a medium of exchange.

As predictable calendric rituals are more common among complex groups, they often construct special structures (eg dance houses, men's houses, shaman's lodges, etc) in which to conduct them. Such structures may also be the habitations of headmen or shamans or 'clubhouses' for the men of the village. These are usually larger and better-constructed than the common house. Such structures do exist among some simple groups (eg the kina lodge of the Yaghan) but are associated with warm season sites.

There is a large literature on craft specialisation. I will not review it here but only note that, despite some difficulties, the archaeological visibility of craft specialisation is high. The differences in the amount of decoration on utilitarian items are obvious, if such items survive in archaeological context. However, as noted above, comparisons within material culture traditions are more reliable than comparisons across such stylistic boundaries. Given that the conditions of preservation are equal, the rarity of 'ceremonial objects' or items of decoration should be a clear clue to the simplicity of the economy. While the characteristics of prehistoric material cultures are the most archaeologically-visible of all the differences between simple and complex hunter-gatherers, these distinguishing features should never be used alone to make the contrast.

Indeed, before any label regarding socio-economy is applied to a prehistoric situation, several lines of evidence should be examined. This caution is advisable for two reasons: 1) the correlations between the key economic and other more archaeologically-visible variables are not all equally strong, and 2) one goal of comparisons between the ethnographic and archaeological cases is the discovery of the differences between the present and the past.

Simple and complex hunter-gatherers in Late Glacial northwest Europe

As an example of both the usefulness and difficulty of applying the criteria described above to archaeological cases, I will examine the palaeoclimatic and archaeological records in Late Glacial north-west Europe for the features that distinguish simple from complex hunter-gatherers.

For much of the period 15,000–10,000 BP, the climate of north-west Europe would have been of a highly continental character such that the only probable complex hunter-gatherers would have been found at the immediate coast, if they could have relied on whales. These coastal zones are presently underwater and archaeologically unknown. There is a period of climatic amelioration 13,000–11,000 BP which is traditionally divided into a cold phase (Dryas II) separating two warm phases, the earlier Bølling and the later Allerød. Several papers in this volume make it clear that although the summer temperatures were equally warm during the Bølling and Allerød, the winter temperatures were significantly colder during the latter phase. In other words, the Bølling is the only period during the Late Glacial when a non-continental climate occurred in inland areas of north-west Europe. The palynological data suggest that vegetation was open during the Bølling but closed during the Allerød. From these data, we would only expect complex gatherers in favourable inland locations in our region during the Bølling (essentially 13,000–12,000 BP). The coastal locations that might also have harboured complex hunter-gatherers are, of course, now under water.

I will concentrate on two regions where several sites have been subject to intensive excavation and analysis — the Middle Rhine and the Paris Basin. But comparing these two regions directly is made difficult because there are no sites in the Middle Rhine region that date immediately before or after the Bølling while none of the Paris Basin sites date to the Bølling.

The Middle Rhine

The data used here comes mainly from the famous sites of Gönnersdorf and Andernach, which sit directly across the Rhine from one another (Bosinski 1978; 1979; 1982; Viel 1982). Gönnersdorf has yielded dates between 12,380 and 12,660 BP, placing it in the middle of the Bølling interstadial. The fauna suggests an open steppic environment.

Regarding regional population density there is little data, except perhaps the proximity of the two sites. Although the faunal remains are dominated by horse, the diet included fish and aquatic birds. No features that might have functioned as storage facilities were found. The small pits that were present have been plausibly interpreted as stone-boiling pits.

Many beads have been found including some from as far away as the Mediterranean. Many of these beads were fossil shells from the Mainz Basin or dentalium from the Mediterranean (which incidentally is also the well- beloved 'money shell' of north-western North America). These types of shell beads seem to be distributed over a broad area of western Germany during the Bølling (Weniger 1989).

Non-utilitarian items are extremely common at Gönnersdorf and include quasi-female figurines and engraved palettes. As there are no known cemeteries and a severely limited sample of houses, it is impossible to say anything about the degree of social stratification or craft specialisation. The house features found at both sites indicate relatively substantial structures with many supporting posts and sunken floors paved with schist slabs. On the basis of the faunal remains, some of these houses were argued to have been occupied in the winter. Because of a number of finds of the foot bones of horse colts, one house at Gönnersdorf is regarded as having been occupied in the summer. This latter interpretation would be contrary to expectations based on ethnography, since almost no recent hunter-gatherer group built a summer house as or more substantial than its winter house type. The only exceptions would be those Central Eskimo who used a semi-subterranean house in the autumn/early winter but used the igloo out on the sea ice during full winter. Since many groups save hides taken in the autumn, after a brief cleaning, for full processing during the winter, and since foot bones are often taken with the hide of smaller mammals, it possible that the seasonality interpretation of this house is incorrect. Indeed, Weniger (1989) argues that these sites were winter occupations.

Thus, we have in this region, especially at Gönnersdorf, several of the distinguishing features of complex hunter-gatherers: use of aquatic foods, substantial houses, numerous non-utilitarian artefacts, and beads, exotic enough to be valuable, but in sufficient quantities that they may represent a medium of exchange. The only characteristics of complex hunter-gatherers missing are those for which the data is absent or insufficient: food storage facilities, cemeteries, social stratification and craft specialisation. We also note that these evidences of socio-economic complexity occur in an environment that the ethnographic data indicates is optimal for such developments. Thus, the probability that complex hunter-gatherers existed in the Middle Rhine region about 12,500 BP must be regarded as extremely high.

The Paris Basin

The four famous sites of Pincevent, Verberie, Etiolles and Marsangy in the Paris Basin, are the focus of this discussion. Most of the information on these sites included here is more completely summarised by Audouze (1987 and this volume). The relative dating of these sites seems clear: from earliest to latest, Etiolles, Pincevent, Verberie and Marsangy. However, their absolute dating is not so clear. The radiocarbon dates range from 12,000 to 10,000 BP but thermoluminescence dates are systematically earlier by as much as three thousand years. But, whichever absolute dates are preferred, none of these sites seem to date to the Bølling. Regarding the seasons of occupation, the data from the various floors and hearths at Pincevent exclude any mid-winter occupations, although some hearths appear to have been used into the early winter or initiated in the early spring. If these data are taken literally (which is probably reckless), they suggest that the winter camp or camps, wherever they may have been, were not occupied for more than a few months.

As the fauna at the best preserved sites (Pincevent and Verberie) is dominated by reindeer, the environment appears to have been a rather continental one and the vegetation of the cold steppe type. Despite excellent bone preservation at some of these sites, and extremely meticulous but extensive excavations, no evidence for the use of fish or aquatic birds has been recovered. The warm season is the optimum time for taking such creatures. Since all of these sites are regarded as having been occupied, at least in part, during this portion of the year, this must be regarded as evidence that such animals were unimportant to or even missing from, the diet of their inhabitants.

As in the Middle Rhine, no clear judgement about the population density of this region at this time can be made. I only note that no two of the four best-known sites are in such close proximity to one another as Gönnersdorf and Andernach. There are no possible storage features at any of these sites. However, it has been argued from the faunal analysis at Verberie that rib 'racks' were probably taken away from the site for later use. It is also clear that marrow (and possibly 'bone grease' extraction) occurred at Verberie. As Speth (this volume) points out, such intensive processing is most likely to occur in the late winter/early spring, to compensate for immediate nutritional deficiencies rather than for future use. However, the presence of young reindeer is certainly a persuasive argument for an autumnal occupation (Audouze, this volume).

The evidence for habitation structures at Pincevent, Verberie and Marsangy is circumstantial, indicating that, at best, they were very insubstantial constructions. At Etiolles, several hearths had rings of large stones around them but nothing that indicates structures as substantial as those on the Middle Rhine.

No beads or clearly non-utilitarian items have been recovered from any of these sites. As on the Middle Rhine, the absence of burial data prevents any inference about social stratification. Several hearths or 'habitations' are known from the same land surfaces at Pincevent but the variations between them in associated remains have been interpreted as possibly reflecting spring *vs* autumn occupations and the variations in the term of use of each hearth. There is no evidence of craft specialisation except the piles of flaking waste found at Etiolles. This abundance of debitage probably does not reflect any degree of specialisation, but merely the proximity of an exposure of high-quality tabular flint.

Direct comparison of these sites with the Rhenish ones is difficult for two reasons: 1) none of them has been interpreted as a mid-winter occupation, and 2) none of them clearly dates to the Bølling. Nevertheless, in contrast to the Middle Rhine, the sites of the Paris Basin have yielded none of the features that characterise complex hunter-gatherers. Even granting that the latter sites were not occupied during the most 'diagnostic' season, winter, the complete absence of the remains of aquatic animals, non-utilitarian items and beads, despite good preservation, careful excavations and large exposures, seems highly significant. It thus seems rather improbable that the Paris basin harboured complex hunter-gatherers during Dryas I or the Allerød.

Discussion and conclusions

One implication of both the ethnographic data and the archaeological data reviewed here is that climate changes can have dramatic effects on the socio-economy of hunter-gatherers. But only certain aspects of climate are significant – just those that affect the annual variability of ecological productivity or the accessibility of production for human foragers are important.

Thinking about hunter-gatherer adaptations only in terms of annual averages is not very useful. The mean annual temperature is less significant than the annual range. The degree of forest closure is more significant than the actual plant species present. The moral for the Glacial and Early Postglacial periods might be simply stated as 'Warmer is not necessarily better'. Also, there is no necessity that the transition between a simple and a complex socio-economy be unidirectional. An increase in continentality or an increase in forest coverage or both, as in the case of the Allerød period in our region, should entail an increase in mobility but decreases in population density, storage dependence and the proportion of aquatic foods in the diet. Also expected under such a change would be a decrease in the amount of decoration on artefacts and an increasing rarity of non-utilitarian items. In short, we should expect rapid alternations in the complexity of hunter-gatherer economies as the important environmental variables shift.

If the assessments of the Magdalenian economies of the Middle Rhine and Paris Basin are correct, then this serves as a warning that just because regions share the same technological tradition it does not mean that they share similar socio-economies. Nor should we expect that the Magdalenian inhabitants of these regions would maintain the same economic organisation in the face of the dramatic climate changes that characterise the Late Glacial period. Complex groups may have existed in the Paris Basin during, and simple ones in the Middle Rhine after, the Bølling. The existence of both simple and complex economies among the Eskimo and Subarctic Athabaskans, even in close proximity as in Alaska, are ethnographic examples of this phenomenon.

To summarise, then, ethnographic hunter-gatherers show two contrasting types of socio-economic organisation that have here been called simple and complex. These two types differ over a wide range of ecological, demographic, economic and social variables. Many of these variables are archaeologically visible. As a demonstration, these archaeological criteria were applied to groups of Magdalenian sites in the Middle Rhine Valley and the Paris Basin. This survey suggests that the socio-economy of the Middle Rhine during the Balling was complex but that that of the Paris Basin either before or after the Bølling was of the simple type. This conclusion and many ethnographic examples warn that stylistic similarities given by shared traditions are independent of economic complexity.

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Part 3: The Pleistocene/Holocene transition: human adaptations and chronological studies

18 A study of hunting lesions containing flint fragments on reindeer bones at Stellmoor, Schleswig-Holstein, Germany

Bodil Brutlund

Abstract

As a result of the investigation of cutmarks and marrow fracturing of reindeer bones from Stellmoor, Schleswig-Holstein, north Germany, the number of recorded hunting lesions containing fragments of flint projectile points has increased considerably. The purpose of this paper is to re-examine the criteria for distinguishing hunting lesions from other categories of bone fractures and to reconstruct the tactics used in hunting reindeer at Stellmoor (*c* 10,000 BP) based on the flint fragments embedded in bone remains.

Introduction

The study of faunal assemblages has long proven a valuable instrument for obtaining information about prehistoric hunting strategies. Not only can the examination of bone-waste from archaeological sites reveal which animals were preferentially sought and during which season of the year they were killed, but also exceptional finds can sometimes directly help to show the hunting methods employed. One of the most important find-categories in this respect are those rare cases, in which the actual contact between the game and the hunters' weapons can be documented by flint points embedded in animal bones.

From the important Late Palaeolithic site of Stellmoor, situated in the Ahrensburg tunnel valley near Hamburg, such hunting lesions have long been known, two being recorded from the Hamburgian find level, and another two from the Ahrensburgian levels (Rust 1943, 133 and 186; Möller 1975, 93).

As a result of a re-examination of the extensive reindeer bone material from Stellmoor, the total of hunting lesions containing flint fragments has risen dramatically. Thus the known specimens have been supplemented by two more from the Hamburgian level and 25 further examples from the Ahrensburgian levels, bringing the total number of flint containing hunting lesions from Stellmoor to four specimens from Hamburgian and 27 specimens from Ahrensburgian find contexts respectively.

The purpose of the present paper is twofold:

a) to re-examine the criteria for distinguishing hunting-lesions from other categories of bone fractures, and

b) to propose a reconstruction of the hunting tactics used in the Ahrensburgian at Stellmoor, based on the information provided by the hunting lesions containing flint fragments.

Aspects of the identification of hunting lesions

In his excellent publications of the Stellmoor and Meiendorf sites, Alfred Rust reported a number of alleged hunting lesions primarily found in reindeer shoulder blades (Rust 1937, 108; 1943, 132 and 186). His primary argument in favour of their significance centred on the conformity between the outline of some of the fractures and the cross-sections of hunting implements found at the sites, eg harpoons and flint-tipped arrows. Just as important, however, seems to have been his assumption that this fracturing could only be assigned to human interference. In fact, Rust does not stand alone on this issue; several other Stone Age studies emphasise shoulder blade fractures, and interpret them as traces of hunting.

If, however, bone materials from other periods are examined, shoulder blades can be seen, displaying very similar fractures, which in a Stone Age context would most likely be classified as hunting lesions. For example, such shoulder blades from domestic cattle have been published from the Roman town of *Augusta Raurica* in Switzerland and the castella Zwammerdam in the Netherlands. In accordance with their cultural context these fractures were interpreted as being caused by the hanging of beef for smoking. As contemporary written sources stress the importance of preserved meat in the soldiers' rations, this interpretation is very credible (Van Mensch & Ijzereef 1977, 148;

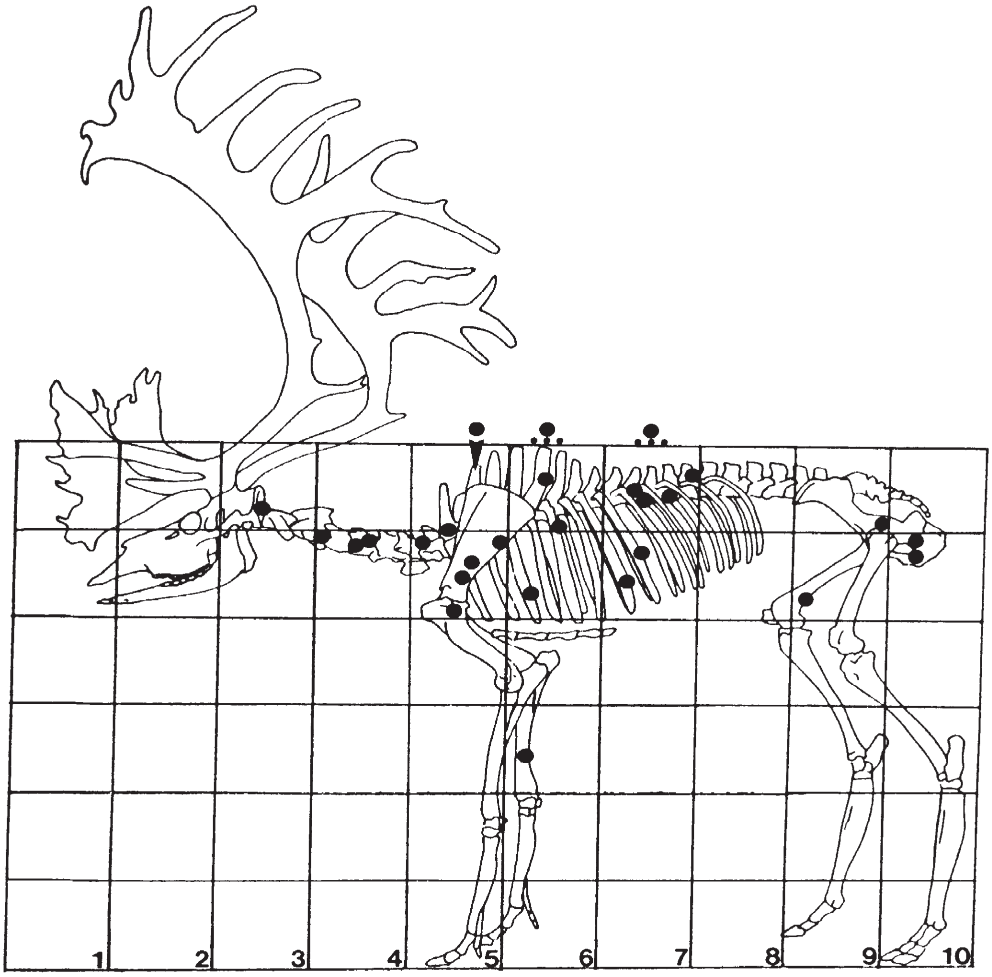

Figure 18.1 The impact points of all hunting lesions with embedded flint fragments from Stellmoor, Ahrensburgian levels. The points are represented schematically on the left side of a reindeer (each grid square is c 20 x 20 cm. Key: (dot) impact point; (dot and arrow) impact point in second thoracic vertebra under the scapula; (dot and smaller dots) impact points in fragments of vertebrae, not identifiable to a specific number but within a range of three neighbouring segments

Schmid 1972, 43). Accordingly, it cannot be ruled out, that scapulae from Stone Age contexts were damaged in connection with activities other than hunting.

The published Late Glacial and Mesolithic hunting lesions from South Scandinavia and north Germany basically fall into two groups: a) fresh or healing fractures containing flint fragments, and b) similar fractures without flint.

In the first category, flint fragments can often be recognised as belonging to artefacts, which are supposed — or through finds of hafted specimens have been shown — to be arrowheads. Additionally, many of these fractures carry small flint fragments pierced so deeply into the bone matrix, that only a light and powerful weapon like the bow and arrow would be a likely cause of such wounds. Considering the power needed to leave a recognisable cutmark on a bone surface (Walker & Long 1977, 609) and the available technology, fractures containing flint fragments are most likely to have been caused by the impact of flint-tipped arrows".

While the group of fractures with embedded flint fragments can be characterised as hunting lesions with some certainty, the reasons for assigning the other bone fractures to this category are less clear; their location, preferably in the shoulder blade, and the general outline of the fracture being the most concrete arguments. However, neither of these can be regarded as very good criteria. The apparent dominance of alleged hunting lesions in the shoulder blade gives an impression of a great many astonishingly precise shots, and seen in relation to the most vulnerable parts of the animals, in the

Figure 18.2 a) Lesion in reindeer cranium. Stellmoor. No 1, scale in cm; b) close-up of (a). Scale approx 1:10 (copyright Archäologisches Landesmuseum, Schleswig)

wrong place. In Figure 18.1 all the hunting lesions containing flint fragments from the Ahrensburgian levels at Stellmoor are shown imposed on a reindeer skeleton. Here the first impression is that of a general scatter over much of the body, with the vertebrae actually carrying the largest proportion of hits. It thus appears that arguments which identify lesions on the basis of location presuppose an unduly high degree of precision-shots.

In her study of the Mesolithic hunting lesions from Denmark, Nanna Noe-Nygaard notes the differences in the distribution of unhealed lesions over the cervid shoulder blade between Rust's Stellmoor sample and her own, general Mesolithic, sample. Rust's fractures show a very scattered distribution, whereas the Mesolithic ones are concentrated in the thinnest area of the shoulder blade. Considering that the shoulder blades of reindeer, red deer and roe deer are of similar fragility, this should indicate 'that the concentration of the unhealed fractures on shoulder blades from the Mesolithic material is not due to mechanical fracturing' (Noe-Nygaard 1974, 239 and fig 22a, b). When the distribution of shots reported by Rust is compared to the scatter of the hunting lesions which contain flint fragments (Fig 18.1), the first impression is that their patterns show some concordance. This actually supports the idea that at least some of the shoulder blade fractures may be shot holes. The alleged Mesolithic hunting lesions, on the contrary, are conspicuously concentrated in the very thinnest, and thus most fragile, part of the blade, that is, just where a naturally caused fracture would be most likely to occur, and where the distinction between artificial and natural breakage is least likely to be practicable. As a matter of fact there are no simple procedures by which to decide whether fracturing was caused by humans or other agencies. Especially the thin parts of shoulder blades contain so little bone matrix that fracturing by impact is very difficult to separate from simple breakage. In the rare cases of well-preserved, whole skeletons, like the Vig aurochs, fractures of the underlying ribs would support the interpretation of the scapula fractures as being caused by hunting — and their total absence would be an argument against it. For the normal, mixed butchering waste from Palaeolithic or Mesolithic sites, such possibilities of correlating evidence from different parts of the body of the same animal of course do not exist.

If, however, we accept that the healing lesions from the Mesolithic sample were derived from hunting wounds, their distribution all over the scapula conforms to Rust's sample and to the expected scatter — whereas only the fresh fractures seem to concentrate in one area. The argument that this is a consequence of differential severity of the wounds is not convincing as the possibility of shots puncturing the scapula and piercing the lungs or arteries is the same for all parts of the bone.

Caution against the emphasis put on only one skeletal element is justly warranted. The distribution pattern of the lesions on this element should at least be compared to that of the entire animal, before being accorded significance in terms of hunting technique.

Consequently, a most important issue must be to define the technical criteria by which to separate hunting lesions from fractures of another origin. Based on the Stellmoor evidence some basic standards for the analysis of hunting lesions can be proposed:

a) The fracture in question must be demonstrated to have been caused by the hunters' weapons. In this respect, the presence of fragments of projectile point in the lesion must be regarded as conclusive. Otherwise, it must be shown that the fracture shows morphological characteristics which could only be obtained by contact with hunting implements — anything else remains at best a good guess. The point is that it is virtually impossible to distinguish between fractures on subfossil bones inflicted shortly before or after death. In the case of the lesions which contain flint fragments, it must be presumed that the hunters did not fire arrows at dead prey, thus restricting the lesions to the actual hunting activity.

b) Interpretation of the distribution of lesions should be based on an analysis of the bones of the whole skeleton of the animal species in question, and ideally, only include specimens from the same locality or at least cultural context. The pooling of evidence from different localities and dates extends the basic data too much for most relevant questions, by letting important related information like vegetational and topographic setting, or hunting implements turn into variable factors. Besides, no single skeletal element can *a priori* be expected to show the range of tactics directed towards an animal or a group of animals.

The material from the Ahrensburgian levels at Stellmoor

I have attempted to use the principles outlined above in the current analysis of the hunting lesions from the Ahrensburg tunnel valley. In order to keep as many variables as possible constant, only the flint-containing lesions from the Ahrensburgian levels at Stellmoor are considered.

Introduction

The hunting lesions were all found in the well-preserved bone material from the lacustrine site at Stellmoor. This material, comprising some 18,000 bone and antler fragments of reindeer, is considered to represent the accumulated waste of a hunting and meat processing camp primarily used in the autumn (Grønnow 1987; Sturdy 1975). During the excavations, four Ahrensburgian find levels were noted in a pollen profile, but no attempts were made to keep the finds separate (Schütrumpf in Rust 1943).

Recent radiocarbon dates span a narrow time-interval *c* 10,100–9900 BP (Fischer & Tauber 1986, 7). Radiocarbon calibration of a dendrochronological series of Late Glacial and Pre-Boreal pine has, however, revealed an at least 250-year long plateau of constant radiocarbon ages at 10,000 BP (Becker & Kromer, this volume), thus emphasising the difficulties in using radiocarbon dates for inferences concerning the period of use of Late Glacial sites.

It is by now impossible to reconstruct to which exact level (or occupation-unit) the bones carrying hunting lesions belong, but we can determine that in all levels the same animal species was hunted by members of the same archaeological culture, in the same topographic setting and most probably within the same season of the year. Therefore, for analytical purposes it seems reasonable to treat the 26 flint containing hunting lesions as one sample.

Distribution

The distribution of the lesions is shown superimposed on the left side of a reindeer skeleton in Figure 18.1. Lesions in vertebrae and ribs dominate over those from the rest of the skeleton, with the upper part of the reindeer showing most of the recognisable lesions.

The bone fractures

In only two cases was the bone fracturing not the result of a primary impact, but followed skidding of the point over the bone surface, thus creating a trace before possible impact.

Only a few of the remaining fractures resulting from primary impact were the result of direct hits. The edges of these fractures are all sharply cut, and the outline shaped like a triangle or trapeze. Mostly, the embedded flint fragments of these pieces comprise the whole tip of the arrow point, broken near the bone surface (Figs 18.2, 4 and 5).

In the large majority of the Stellmoor hunting lesions a combination of sharply cut rims opposite chipped rims determines the outline of the fractures. The most often encountered form is like a triangle or a trapeze shape, occasionally made more like an half-moon by chipping.

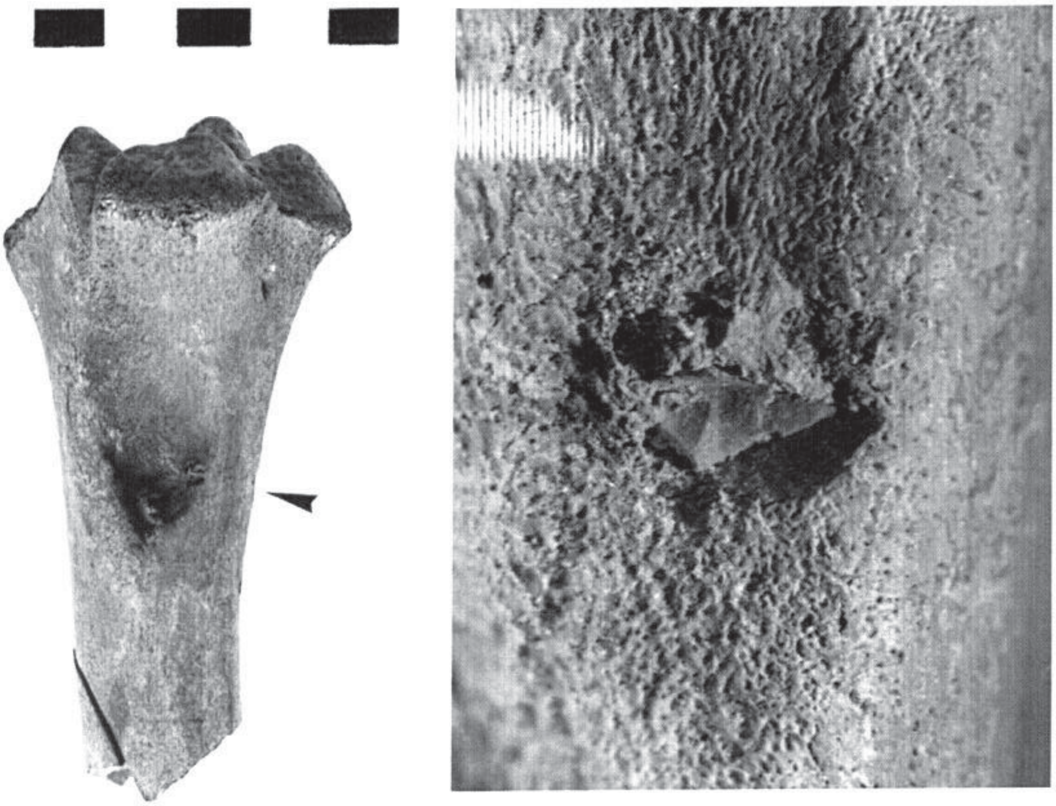

Figure 18.3 a) Lesions in femur of subadult reindeer, Stellmoor. No 24. Scale in cm; b) close-up of (a). Scale approx 1:10 (copyright Archäologisches Landesmuseum, Schleswig)

This chipped, uneven outline owes its shape to the arrowheads. On impact, the flint point in most cases pierces convex or concave bone surfaces and the more or less overhanging substance is wedged away. The characteristic element of the hunting lesions in the Stellmoor sample is thus the presence of the sharply cut side, or two such facets in an acute angle opposing an irregularly chipped edge. The sharp cuts are best described as being like blows from an axe or metal knife (Fig 18.6).

In the Stellmoor material similar deep distinctive cuts were not encountered in the examination of the cutmarks from butchering. A small group of fractures showed these high-power blows but lacked embedded flint fragments. Accordingly, they have been recorded as possible hunting lesions. The nature of these alleged lesions conforms largely to the hunting lesions which do contain flint fragments. They were, however, generally characterised by comparatively large fractures. This might imply, that the sample of flint-containing hunting lesions is somewhat biased in favour of the fractures which caused less bone damage.

The morphological characteristics of the Stellmoor lesions can be assumed to hold good for arrows mounted with pointed flint-tips. They do not, however, necessarily apply in detail to other types of arrow. Other kinds of flint tip, for example transverse arrowheads, which work on different principles of damage and penetration, can be expected to display quite different fraction patterns. Moreover, points made from more elastic materials like bone, antler or wood are bound to leave less distinct lesions than flint armatures. In order to define the fracture patterns of different materials and designs of arrow point more experimental work is needed.

The flint fragments

The sizes of the lesions, as well as their embedded flint fragments, vary greatly. The fractures measure between 2 and *c* 10 mm. In general, the larger flint fragments are found in the larger fractures. However, some of the larger fractures or

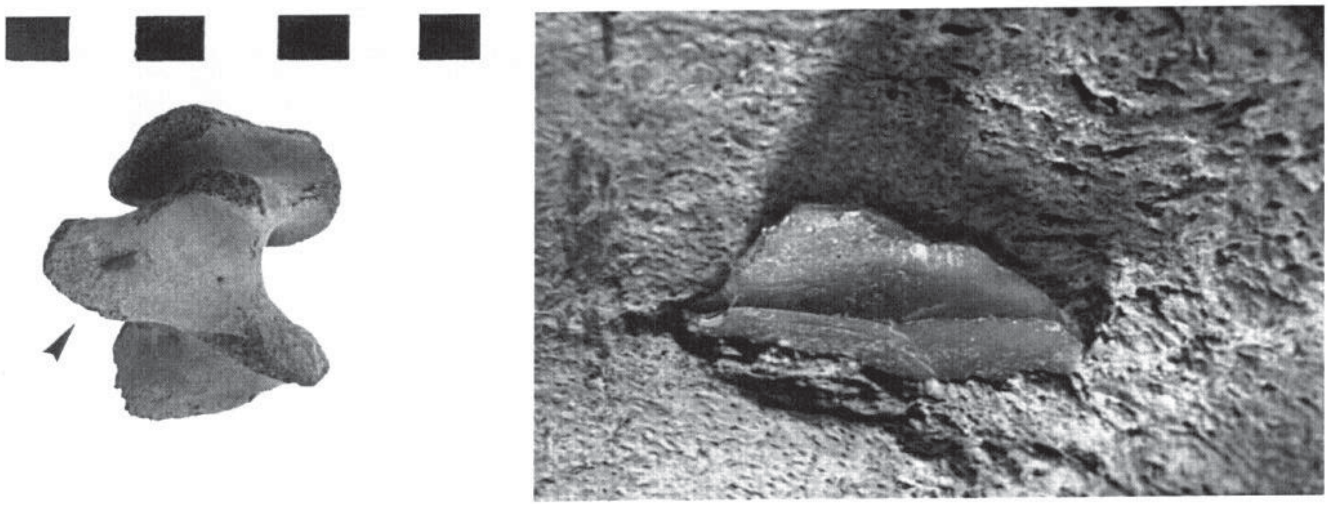

Figure 18.4 a) Lesion in seventh cervical vertebra of reindeer, Stellmoor. No 3. Scale in cm; b) close-up of (a). Scale aprrox 1:10 (copyright Archäologisches Landesmuseum, Schleswig)

impact-scratches only carry minimal splinters. The measurements and impact angles of fractures and flints from the individual lesions are listed in Appendix 18.1, and some of the more interesting specimens are shown in Figures 18.2–6.

In addition, the flint fragments found in the lesions vary in size. The best preserved ones consist of an arrow tip with a clear breakage pattern. The majority of the flint fragments, however, are only small 1, 2 or 3 mm long spin-offs or splinters. It must be considered likely that only a fraction of the 27 lesions would have survived in a recognisable state by now, had the conditions of preservation for the bone matrix not been so excellent.

An attempt was made to classify the flint fragments according to the typology of Fischer *et al* (1984, 23). As their work is concerned with breakage patterns on experimentally used arrowheads, the types referred to are the corresponding negatives of broken tips (see Table 18.1). The most important result is, that even if the majority of the flint fragments show breaks considered diagnostic for use as arrows (ie the bending-fractures 2B and 2C), undiagnostic breaks (eg the snap-fracture 2D) occur as well — which is in good agreement with the experiments. Mostly, however, the arrow tips in the lesions were splintered beyond typological assessment.

As most of the fractures are rather small, their detection during routine handling of faunal remains must be considered unlikely. Only eight or nine of the specimens, that is, those containing light-coloured flint fragments larger than 3.5 mm, could be expected to be detected without means of magnification. Comparison with other assemblages in terms of the quantity of hunting lesions thus presupposes that these materials have also been scrutinised for cutmarks or other microtraces. So far as qualitative characteristics are concerned, comparison to the material from the Danish Mesolithic is allowable as this is at present the only European faunal material providing a large enough sample of hunting lesions.

Lack of healing fractures

At Stellmoor no hunting lesions show traces of healing, as all had sharply cut or splintered rims. Compared with examples from the Danish Postglacial, — nine specimens, of which six were healing when the animals died (Noe-Nygaard 1974) — the total absence of such features in the Stellmoor sample is conspicuous. If the hunting lesions from the Pre-Boreal, Boreal or Atlantic periods are considered separately, the unhealed and healing lesions amount to only three specimens from each period — represented by one aurochs skeleton (Vig), one boar skeleton (Aldersro), and two single red deer bones from settlement refuse at Kongemose and Ringkloster respectively (Noe-Nygaard 1974). These fractures are all large and comparatively distinct. The discrepancy between the Ahrensburgian and later samples might perhaps be due to many smaller Stellmoor fractures healing without complication, and within a relatively short time, thereby becoming unrecognisable. This reservation, however, would not account for the larger fractures, which should stand as good a chance as the Mesolithic ones of remaining recognisable for a long time, if not for the rest of the animal's life, as in the Mesolithic examples.

Thus apparently, the re-encounter rate for reindeer at Stellmoor was low compared to the conditions affecting Mesolithic game. The reasons for this could very well lie in the differences in

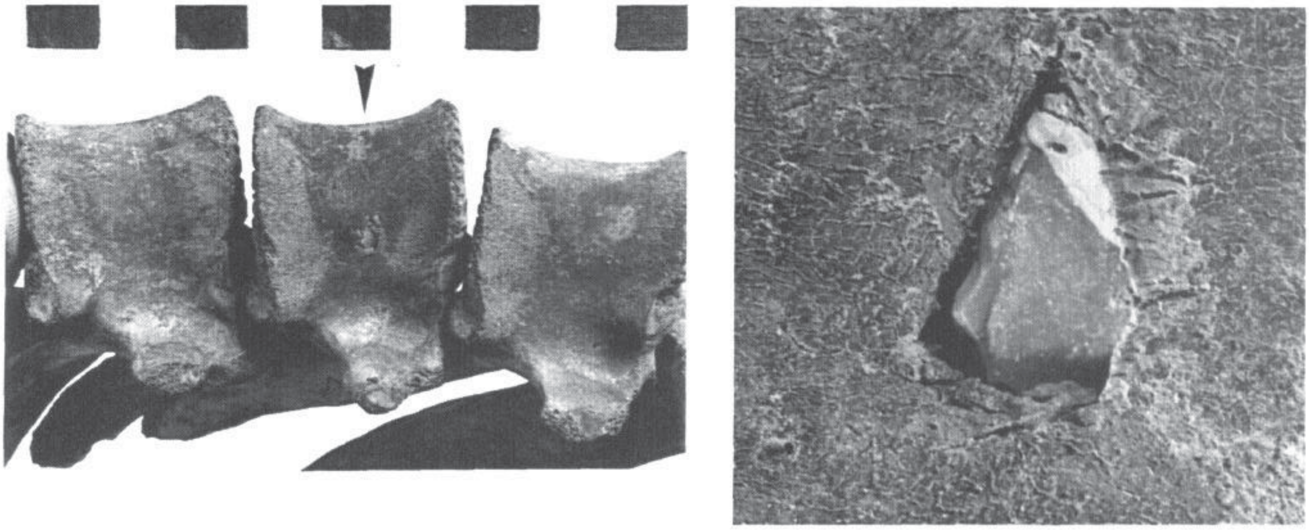

Figure 18.5 a) Lesion in tenth thoracic vertebra of reindeer, Stellmoor. No 6. Scale in cm; b) close-up of (a). Scale approx 1:10 (copyright Archäologisches Landesmuseum, Schleswig)

vegetation cover and mode of life of the animal species concerned, and consequently the degree of probability that the animals would escape a first attack (Noe-Nygaard, 1974).

Fatality

Of the whole sample of 26 hunting lesions, only eight can be considered to have been immediately fatal, or to have lamed the reindeer beyond flight. In Figure 18.7 the arrow-impact points are drawn superimposed on a reindeer seen from above, thus displaying the horizontal plane, the fatal shots are marked with a double line.

Table 18.1 The fracture patterns of the arrow tip fragments from the hunting lesions. The different types of fracture are described according to the terms used in Fischer *et al* 1984

Bending fracture	Step terminating bending fracture	Snap fracture	"Spin-off"	Splinter
2B	2C 2C + Splint 2C?	2D	2F	----
1	4 4 2	1	7	8

As all the reindeer bones with hunting lesions come from the site waste, it follows that those reindeer which received non-fatal shots must have been shot at least twice. In other words, in a minimum 18 of the 26 cases, an additional attempt was necessary to kill the animal – and it was evidently possible for the hunters to deliver more than one shot before the animal got out of reach. It seems very questionable whether this could have been achieved at all or on a regular basis by single hunters. Additionally, the vast bone accumulation at Stellmoor, as well as the dominance of antlers from autumn or early winter, hint at the existence of communal drive-hunts of migrating animals, such as ones documented ethnohistorically for many reindeer and caribou hunters. The Stellmoor hunting lesions would certainly support such an interpretation, as the material strongly suggests the presence of several participants in the reindeer hunting.

Aiming

The extent to which the hunting lesions represent the hunters' efficiency in general must be considered rather low. Our evidence consists only of those shots which ended in a bone, and which by the impact did not damage it so much that the fracturing became indistinguishable from other kinds of breakage. Furthermore, most of the lesions are found in the spongier bone, eg the vertebrae, the elasticity of whose tissue is probably of advantage in the retention of the flint fragments.

It is obvious, that not all fatal shots needed to hit bone. Even in the primary high-risk area behind

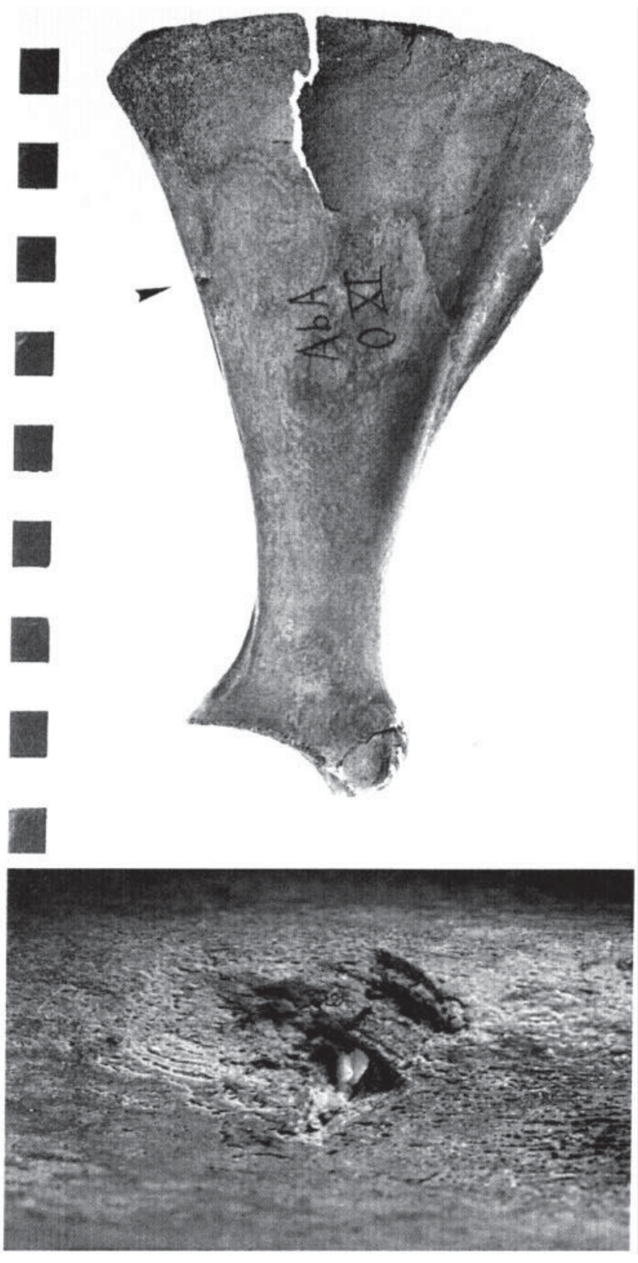

Figure 18.6 a) Lesion in scapula of a juvenile reindeer; b) close-up of (a). Scale approx 1:10 (copyright Archäologisches Landesmuseum, Schleswig)

the shoulder blade the chances of hitting a rib or not should be about equal. Considering the rather powerful hits documented, it is most likely that shots could splinter light bones like the ribs by impact completely, leaving only uncharacteristic fragments. The material is therefore most probably biased in favour of the less damaging, less efficient shots.

It is very tempting to try to characterise the hunting lesions as to hits, 'good misses' and more or less chance-shots. Undoubtedly, all arrows fired represent attempts to stop the reindeer. Judging from their location and non-fatal nature, some of the hunting lesions give the impression of being 'last-chance' shots. This may for instance be reflected by a lesion like Figure 18.2, No 1. In this case, a rather powerful shot must have been fired from behind and from the right side at *c* 165°, and also most probably from some 55° above. The arrowhead was buried *c* 10 mm into in the back of the head of the reindeer, hitting it just behind the left ear. This is a most unlikely spot to aim at, as the chance of doing real damage is very poor. The shot can be explained, though, if seen as an unsuccessful attempt at the shoulder and lower neck region. When the reindeer is seen from behind this rather vulnerable area is only partly visible and the head is seen closely adjacent in this perspective. The apparently unlikely head shot can thus be assumed to represent a perfectly reasonably directed one and, considering the small target area, not a bad miss.

In addition to this example several hunting lesions seem to involve a high degree of chance if judged by the most rigorous standards, accepting only hits in the heart-lung-artery region as being meaningful.

According to the rough estimate outlined above, the damaging effects of the recognised hunting lesions were generally poor. It would, however, be unjust to blame this on the skills of the Ahrensburgian hunters alone. Considering the distribution of bone surface in relation to the most vulnerable parts of the reindeer, as well as the mechanics of bone and flint-tipped arrows, it was concluded, that the lesions were likely to be only a part of the original total of bone damaging shots, the less successful ones most probably being over-represented.

It thus becomes highly relevant, whether this sample may still be relied upon to shed some light on the hunting tactics, and help to show the intentions of the Abrensburgian hunters at Stellmoor.

In terms of the position of lesions in relation to the high-risk organs of the reindeer body, they probably represent many near-misses, but in terms of absolute distance to the nearest possible effective target-area, they were not such bad efforts (Table 18.2). Using the *c* 20 cm division of the horizontal axis of the grid imposed on a standard reindeer profile (Fig 18.1), the results of the distance-estimates can be summed up for each vertical column, thus giving the values for each 20 cm 'slice' of reindeer. Only the major arteries, heart and lungs are here considered as high-risk'. This estimate is probably too conservative. A shot (No 18) which pierced the belly and left a small lesion

Table 18.2 The estimated distance between high-risk target areas of the reindeer body (heart, lungs and major arteries) and the hunting lesions found in the bones

Nos 1–10 refer to the columns of the gridded reindeer skeleton in Fig 18.1

Distance	Number	1	2	3	4	5	6	7	8	9	10
0 - 5 cm	15	-	-	-	2	4	2	7	-	-	-
5 - 10 cm	6	-	-	-	1	3	2	-	-	-	-
> 10 cm	6	-	-	1	-	-	1	-	-	2	2

on the inner side of the pelvis must necessarily be classified as fatal, even without contact to the primary high-risk areas.

If we now consider the estimates in Table 18.2, the impression of the hunters' marksmanship is improved considerably. If we presume that the hunters' intentions were to stop, if not necessarily immediately kill, as many reindeer on the spot as possible — and the firing of arrows consequently to have been rapid — then the high quality of the near misses must be admitted. The elevated position of many of the fractures, ie in the vertebrae, becomes more understandable seen in connection with the lungs and the artery running below the spinal column. By directing the arrows more to the upper part of the body the possibilities for hits would be somewhat extended along the body, instead of relying only on the heart region behind the shoulder blade.

The lesions of the neck and shoulders predominantly originate from shots coming from behind and above at quite acute angles, as will be discussed below. Very likely they represent 'last chance' attempts to shoot fleeing animals with only an outside chance of a fatal hit.

Impact angles

The spread of impact points over the reindeer body must be regarded as less chaotic than on first impression. It should thus be justifiable to proceed to an examination of the impact angles of the lesions, and to expect this analysis to provide some information about the hunting tactics.

For this purpose, the impact angles of all the flint-containing lesions were estimated in three planes, with the bone in question being placed in its anatomical position in a standing reindeer, this being the most convenient way of standardising the database. In the interpretation, it must be borne in mind that the impact angles are only rough estimates of the contact line between hunter and game. The first difficulty is the underlying assumption that the arrows have a straight flight — and hit the bone without being deflected from this line. Unfortunately, no controlled experiments can be called upon to correct for these factors, therefore we must use qualified estimates. For practical purposes, I regard a basic tolerance of *c* 10° in all planes as justifiable, as well as the presumption that the arrows went straight into the bone.

A second potential reservation applies to the contrast between using a reindeer (skeleton) standing at rest as the basis for describing the relative positions of the target animals, who can hardly be expected to have remained static. Reindeer do not, however, move in an uncontrolled manner, and it is possible to assess the necessary additional tolerance in estimates of impact angles for the different parts of the body. Basically, it must be expected that the possibility of shooting at reindeer, who were neither standing, running nor swimming would have been rare.

As long as the reindeer is on solid ground on its own four feet, the difference in impact angles due to movement between a standing and a trotting reindeer must be judged to be negligible for the trunk — with the values for ribs and vertebrae of the chest calling for no additional tolerance. The shoulder blade, however, moves back and forth when the animal is running, and this influences estimates in the horizontal and anterior-posterior plane. When galloping, the movement affects the whole body and no part can be expected to conform to that of standing at rest. As reindeer seem to gallop only when panicking, and normally proceed at a trot, being partly hindered by group-movement, we can assume the impact angles for lesions of the ribs, dorsal vertebrae and pelvis to be good estimates. The shoulder-blade lesions need an added tolerance of no more than 10° of the anterior-posterior angle. For the wounds in the neck and head, caution must be applied, as these parts have a high degree of free movement. In order to use the lesions in these areas at all, we have to assume that they were inflicted in the normal reindeer stance, which is not far from the position of neck and shoulders shown in Figure 18.1, though perhaps a bit more nose-up in swimming. Four of the lesions must be omitted, namely one on the scapula as the impact angles imply shooting a fallen animal, and the lesions of the front and hind legs as these parts have a high degree of movement.

From the remaining sample of 23 hunting lesions, none showed impact angles incompatible with a standing, running or swimming reindeer.

For all lesions the impact angles were measured in three planes:

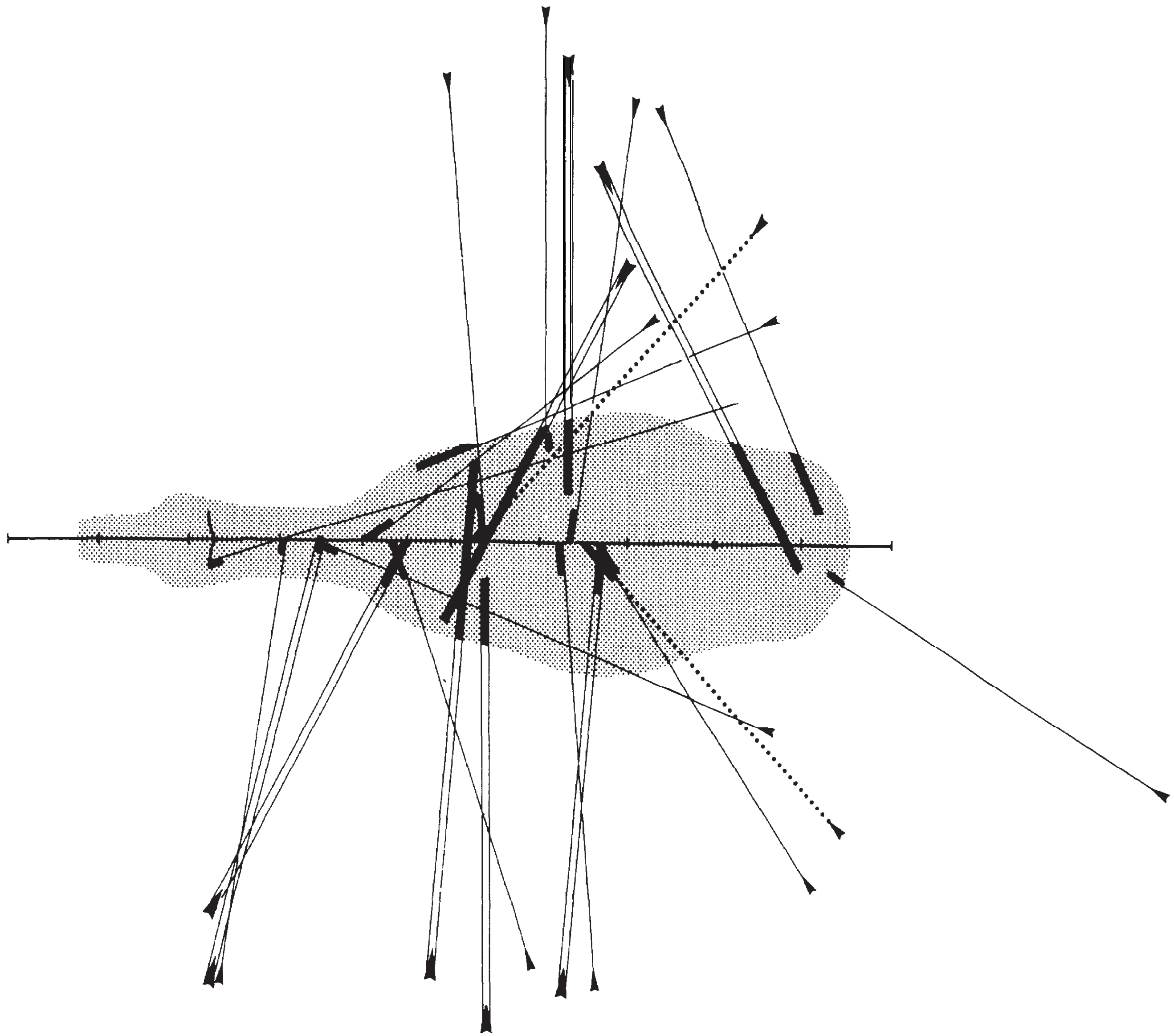

Figure 18.7 The impact angles from the horizontal plane imposed on the same reindeer outline. The medial axis corresponds to the grid in Fig 18.1. Key: (single line) non-fatal or, at least, not immediately lethal shots; (double line) fatal shot, causing death or instant laming of the reindeer; (dotted lines) impacts in vertebrae, only identifiable to a group of three segments. The tolerance is thus +5 cm along the medial axis; (broad lines) line of penetration in the body of the reindeer

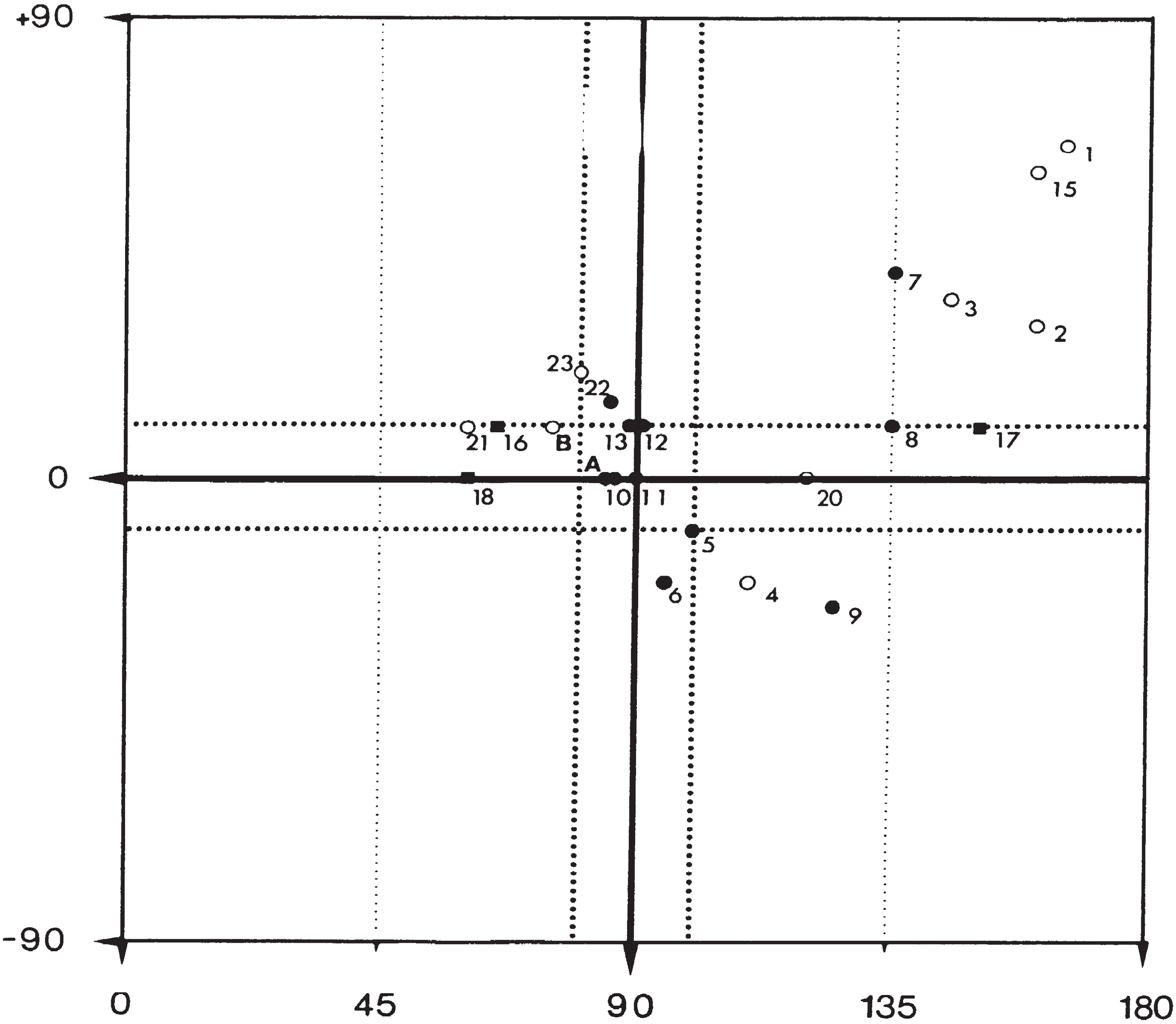

Figure 18.8 Horizontal vs *left-hand impact angles of the lesions. X-axis shows the values for the horizontal plane, the y-axis those for the Left-right plane (0-line: horizontal). Key: (circle) impact point from head, neck and shoulders (corresponding to the columns 1–5 in Fig 18.1); (dot) impact point from the anterior trunk behind the shoulder blade (corresponding to the columns 6–8 in Fig 18.1); (square) impact point from the posterior trunk (corresponding to columns 9 and 10 in Fig 18.1)*

a) a horizontal plane, showing from which side and at which angle shooting was carried out: facing, from the side or from behind the reindeer. In this plane, 0° was facing, 90° directly from the side, and 180° from behind,

b) a left-right plane showing from which side, and at what angle the reindeer was shot, whether from above, below or in the same plane. Here, 0° corresponds to exactly from the side, +90° vertically from above, and –90° vertically from below.

c) an anterior-posterior plane at right angles to the ones above, acting largely as a control for them.

When the values of the impact angles of the horizontal and the left-right plane are combined (Fig 18.8), the different positions from which shots were aimed become clearer. Going from the right to the left in the diagram, the angle of aiming turns from slightly in front of the animal (45–80°), to the side of it (80–100°) and subsequently ends behind it (100–180°). The opposite axis indicates whether the

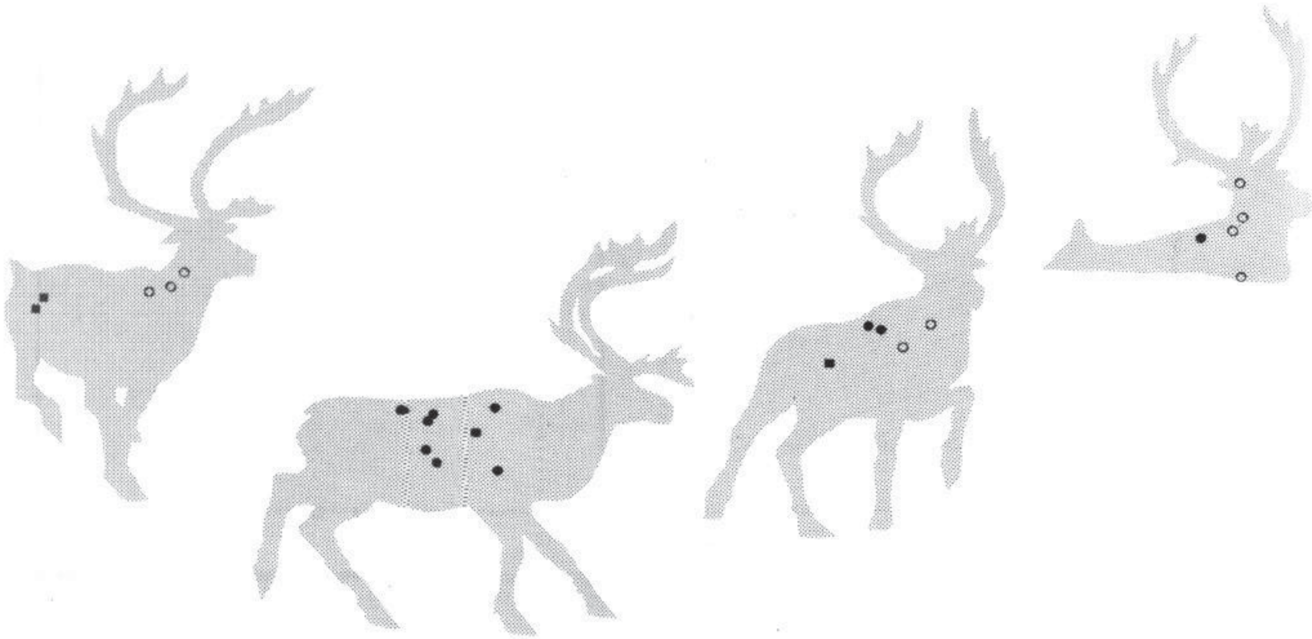

Figure 18.9 The impact points shown on reindeer, corresponding to the impact angles. Symbols as in Fig 18.8. From left to right: a) facing, level ground (horiz axis 45–80°, left-right axis: below +20°); b) side, level ground (horiz axiz: 81–100°: left-right axis: below +20°); c) rear, level ground (horiz axis 101–180°, left-right axis: below +20°); d) swimming (horiz axis: 145–180°, left-right axis: more than + 20°)

shot came from above or below the horizontal plane.

The first group of shots slightly from the front (45–80° in the horizontal axis) all hit the neck and the posterior part of the trunk, whereas the following group (80–100°) only comprises shots to the rib-cage. The shots coming from more than 100° from behind are found in all areas of the body.

Interpretation of the aiming angles

The shots from slightly in front and from the side of the animal were all near or slightly below the horizontal plane, suggesting a position of the hunter at about the same level as the reindeer. The shots from behind consist of a group coming not only from extreme positions from behind, ie from more than 135°, but also some from more than 30° from above. These shots are all found in the neck and shoulders.

The shots in the horizontal plane or slightly below it would be consistent with hunters aiming at passing reindeer from a standing or kneeling position at about the same level as the animals (Fig 18.9a–c). This situation does not, however, account for the last mentioned group of shots coming from above and behind the animals. As the topography around Stellmoor does not display the extreme relief which would be necessary to place the hunters on so much higher ground than the reindeer, the only possibility is that the reindeer were situated below the hunters. As the shots from above only reached the reindeer in extreme angles from behind, the hunters were obviously not able to get to an optimal position, ie to the side of the animals. The only situation at Stellmoor meeting these requirements is the lake. The shots coming from an extreme position above and behind the animals can thus only be the results of the last shots at reindeer trying to escape by swimming to the other side of the lake. The distribution of these lesions supports this interpretation, as they only consist of shots to the neck and shoulder (Fig 18.9d), these being the most visible parts of swimming reindeer.

To summarise, the majority of the hunting lesions are in agreement with animals running past hunters who were standing or kneeling at the same ground level. No shots were fired until the reindeer started passing the hunters, thus increasingly exposing the side of its body. This allows the hunters to take advantage of the larger target area and the full exposure of the areas of vital organs. Should the reindeer be part of a herd, this approach has the additional advantage of not provoking the following animals to turn, as frontal shooting might do. A small group of lesions can only represent shots at the reindeer swimming away from the hunters standing on the beach above the animals, but unable to follow them.

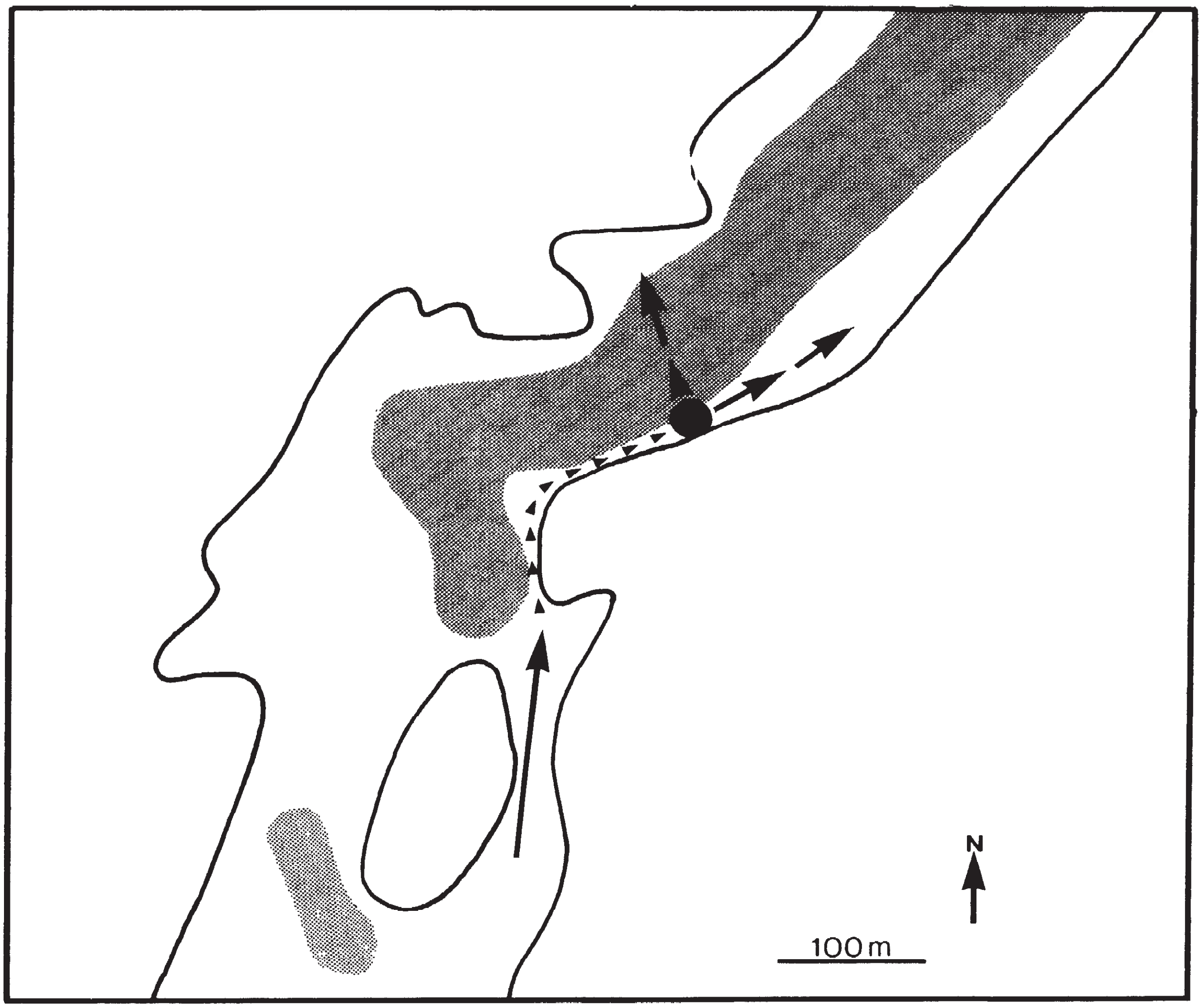

Figure 18.10 Map of the Ahrensburg tunnel valley. Key: (dot) Stellmoor; (hatched) lake sediments; (single line) the present 40 m contour asl (arrows) suggested migration route of reindeer heading north for wintering in the south Scandinavian area

Proposed reconstruction of the hunting at Stellmoor

Returning to Stellmoor, it is now possible to propose a picture of the hunting tactics, showing how the patterning in the hunting lesions could be accommodated in the topographical setting of the Ahrensburg tunnel valley in the Late Glacial.

The Stellmoor site (Fig 18.10) is situated within a larger lake system in the Ahrensburg tunnel valley. The exact location is on the southern side of a long, and at this place narrow, lake (cf Bokelmann, this volume). East of Stellmoor, the lake becomes wider, running north-eastwards. Opposite the site it is almost east-west in alignment until it turns sharply southward *c* 200 m west of Stellmoor, where it ends after some 500 m. Stellmoor thus lies within a *c* 90° angle of the lake. Behind Stellmoor, to the south and east, and to the north-west, higher hilly terrain encloses the valley. Due to peat growth and erosion the present map cannot be taken as a true representation of the Late Glacial relief. For want of better documentation, the present-day 40 mcontour was chosen as an approximate borderline between the hills and the valley bottom for the map in Figure 18.10.

Presuming the higher drier slopes to be more or less covered with scrub, if not a light forest of birch and fir, this leaves the broad meadowy stretch between lakes and hills for the unimpeded movement of migrating reindeer. A north-north-east movement of groups of reindeer would eventually bring them within the angle of the lake at Stellmoor, where further movement necessitates either crossing the lake or turning north-east past the hills, the location thus being a natural ambush situation created by topographic features.

In consequence, it can be imagined that hunters posted on both sides of the northwards trail would first shoot as many reindeer as possible on dry land, and as the reindeer tried to escape by crossing the lake, would continue to shoot at the swimming animals.

The large number of arrows found in the lake sediments (Rust 1943, 188–93) would be in good agreement with the picture of shooting at swimming reindeer (Bokelmann, this volume). Since arrows have very rarely been found outside Stellmoor, even in other large lakeside deposits with good conditions of preservation, these can hardly be considered normal site-waste. The suggestion that the Stellmoor arrows were lost in action could explain their unusual abundance[2].

At Stellmoor the locations for the hunting, and for the subsequent butchering and the discharge of primary bone-waste must thus be considered identical.

Notes

1 The lesion containing flint on the wild boar cranium from Aldersro is interpreted as having been inflicted with a blow from a core-axe (Noe- Nygaard 1974).

2 Similar finds of implements lost at the place where they were used are rare. The best parallel is at present seen in the submerged Ertebølle- site of Tybrind Vig. At least in one place, outside the prehistoric reed-belt, several leister-prongs were found standing vertically or at an angle in the mud, presumably lost during fishing (See Andersen 1985, 59).

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Appendix 18.1 Details of the Stellmoor hunting lesions with embedded flint fragments

1	2	3	4	5	6	7	8	9	10	11
A	13. vert thor	[illegible]	[illegible]	[illegible]	0	0	2C	Fa	1–5	7
B	4. Vert thor	15.7	4.3	285	10	15	2C	Fa	0–5	4
1	Cranium	10.2	9.8	165	125	155	2C+sp	nf	>10	3
2	4. Vert cerv	1.8	<1.0	200	30	135	sp	nf	5–10	4
3	7. Vert cerv	6.4	6.4	145	145	145	2B	nf	5–10	5
4	1 Vert thor	4.9	<1.0	250	340	255	sp	nf	0–5	5
5	10. Vert thor	4.8	3.7	100	190	185	2C+sp	nf	0–5	7
6	10. Vert thor	4.8	3.9	265	340	265	2D	nf	0–5	7
7	4–6. Vert thor	3.6	1.7	135	140	150	2C+sp	nf	5–10	6
8	11–13. Vert thor	8.4	4.0	225	10	170	2C?	nf	0–5	7
9	12. Vert thor	4.4	<1.0	235	335	200	so	nf	0–5	7
10	4. Costa dx	2.1	<1.0	275	0	0	sp	Fa	0–5	6
11	6. Costa sin	2.8	<1.0	270	0	0	so	Fa	0–5	6
12	8. Costa dx	4.4	1.8	90	170	90	so	nf	0–5	7
13	9. Costa dx	2.2	<1.0	90	170	90	so	Fa	0–5	7
14	Scapula sin	5.6	2.9	215	340	225	so	nf	0–5	5
15	Scapula dx	4.6	<1.0	160	120	150	sp	nf	0–5	5
16	Pelvis dx	3.3	2.6	65	170	40	2C	nf	>10	10
17	Pelvis sin	—	<1.0	210	10	160	sp	nf	>10	10
18	Pelvis sin	2.9	1.2	60	180	0	sp	Fa	>10	9
19	Radius dx	1.6	<1.0	240	0	180	so	nf	>10	6
20	Scapula sin	6.0	1.8	120	180	180	2C?	Fa	0–5	5
21	2. Vert thor	—	<1.0	300	10	10	so	Fa	0–5	5
22	5. Vert thor	—	<1.0	85	165	95	sp	nf	5–10	6
23	Axis	5.4	5.4	280	20	30	2C	nf	0–5	4
24	Femur dx	3.1	3.1	110	150	160	sC+sp	nf	>10	9
25	Humerus dx	4.5	<1.0	310	0	0	sp	nf	5–10	5

1 Registration number. (A) published by Rust (1943); (B) published by Möller (1974); 1–25 new finds.
2 Skeletal element
3 Maximum width of impact lesion in the bone (mm)
4 Maximum width of the largest embedded flint fragment (mm)
5 Impact angle in horizontal plane (0: *en face*; 90:direct from right; 180: from rear; 270: direct from left side)
6 Impact angle in left-right plane (0: direct from the left side; 90: from above; 180: from the right side; 270 from below
7 Impact angle in anterior-posterior plane (0: *en face*; 90: from above; 180: from rear; 270: from below)
8 Type of fracture. See Table 18.2, cf Fischer *et al* 1984
9 Seriousness of the wound. Fa: fatal; nf: non-fatal, that is, not preventing flight
10 Approximate estimated distance to fatal target area (cm)
11 Column number in Fig 18.1

19 Late Upper Palaeolithic and Mesolithic chronology: points of interest from recent research

Christopher Smith and Clive Bonsall

Abstract

The paper discusses the significance of Oxford Accelerator radiocarbon dates on nine bone and antler barbed points from Britain. The authors propose a classification for Late Upper Palaeolithic and Mesolithic points, and discuss the dating of the major types. This represents a modification of previously accepted interpretations.

Introduction

Hitherto the chronology of the Late Upper Palaeolithic and Mesolithic periods in Britain has been based on a combination of archaeological dates derived from studies of implement typology and conventional radiocarbon dating. In practice, these two approaches have been closely linked, for if implement typology is to provide anything other than a relative sequence examples of various types of implements have to be found in datable contexts. However, there can often be some doubt as to the degree of association between the material sampled for radiocarbon dating and the implements for which a date is sought. Where the implements themselves can be directly dated such problems of association can be avoided, for the implements, as examples of human activity, provide their own context. The direct dating of artefacts has the potential to provide a far more rigorous temporal framework than conventional methods.

The majority of artefacts recovered from Late Upper Palaeolithic and Mesolithic contexts, being made from flint, are generally unsuitable for direct dating. The thermoluminescence dates for burnt flint artefacts from Hengistbury Head (Barton & Huxtable 1983, 133–5) and the radiocarbon date for resin adhering to a Tjonger point from Rekem in Belgium (Gowlett *et al* 1987, 126) are exceptions to this rule, but such instances are rare. However, two categories of Late Upper Palaeolithic and Mesolithic artefacts, barbed points and mattocks, being made of bone and antler, have proved suitable for direct dating.

Until recently, such direct dating had been precluded by the size of the sample required, which was often more than 100 g. Accelerator Mass Spectrometry (AMS) radiocarbon dating requires less than a gram of bone or antler, and dates can be obtained from a wide range of artefacts formerly considered too valuable to sacrifice to conventional radiocarbon dating. Since 1983, several examples of both barbed points and antler mattocks have been dated by the radiocarbon accelerator at Oxford (Cook & Barton 1986; Bonsall & Smith 1989; Smith & Bonsall, in press). In this short paper we offer some preliminary comments on the dates obtained so far for barbed points, and on the significance of the implement dating programme for Late Upper Palaeolithic and Mesolithic chronology.

Nine barbed points from British sites have so far been directly dated by the Oxford accelerator, and it is hoped that further dates will become available in the future, while a parallel programme to date barbed points from the Low Countries has been pursued by Verhart (1989). The nine dated British specimens are listed in Table 19.1.

A further eight points have been recovered from contexts for which conventional or AMS radiocarbon dates are available and these are listed in Table 19.2. The reliability of the association between the material dated and the barbed points varies considerably. At one extreme the association can be very good. This was the case with the points from Poulton-le-Fylde (Fig 19.1, Nos 1 and 2) which were found (Hallam *et al* 1973) in direct association with the skeletal remains of an elk *(Alces alces),* which have subsequently been directly dated. Less good, but nonetheless acceptable, is the degree of association between a barbed point (Fig 19.1, No 6) and the dated bone piercer from the 'black band' at Kent's Cavern. Both items are from the same context, although the time-span of the black band is unknown. Two other points (Fig 19.1, Nos 4 and 5) are reported as having been found in the same general area of the cave, but not actually within the black band (Evans 1872, 459–60; Garrod 1926, 40). The chronological relationship between these two

Table 19.1 Directly dated barbed points

Site name	Material	Date	Lab code	ref	Fig 19.1
Leman and Ower	antler	11,740±150	OxA-1950	1	7
Porth y Waen	antler	11,390±120	OxA-1946	1	8
Sproughton 1	bone	10,910±150	OxA-517	2	9
Sproughton 2	antler	10,700±160	OxA-518	2	10
Waltham Abbey	antler	9790±100	OxA-1427	1	11
Earl's Barton	antler	9240±160	OxA-500	2	15
Druimvargie Rockshelter	bone	7810±90	OxA-1948	1	16
MacArthur Cave	antler	6700±480	OxA-1949	1	17
Shewalton	antler	5840±80	OxA-1947	1	19

Sources: (1) Bonsall & Smith 1989; (2) Gowlett *et al* 1986, 120

implements and the bone piercer is therefore more problematical. Reservations are also necessary with the dates quoted for the barbed points from the 'Obanian' shell middens at Risga and Cnoc Sligeach (Fig 19.1, Nos 18, 20). In the former case, the date is for another artefact within the midden and in the latter for redeposited midden material. Such midden deposits may have accumulated over centuries and the association between the dated material and the barbed points is only general. In the case of Aveline's Hole, the association between the biserial barbed point (Fig 19.1, No 3) and the date quoted has been assumed. Radiocarbon dates for this site (Gowlett *et al* 1986, 209–10; Hedges *et al* 1987, 290) indicate occupation *c* 12,380 BP and between *c* 9150–8750 BP. The barbed point, which no longer survives, has been compared to finds from late Magdalenian sites elsewhere in Europe (Campbell 1977, 163) and on this basis is likely to relate to occupation of the cave during the Late Glacial.

The largest group of barbed points from the British Isles is the 191 specimens from Star Carr. The two conventional radiocarbon dates available for this site are included in Table 19.2. The Star Carr points exhibit a wide degree of variation and the association between any of the excavator's five types and the radiocarbon dates is general. However, on stratigraphical grounds Clark felt able to suggest that at least Types E (eg Fig 19.1, No 12) and A (eg Fig 19.1, No 14) were chronologically distinct (Clark 1954, 3, 126–7).

The 17 individually dated points are illustrated, along with their date ranges at two standard deviations, in Figure 19.1, which also includes a token sample of three points from Star Carr; namely P150 (Type E) (Fig 19.1, No 12), P86 (Type B) (Fig 19.1, No 13) and P178 (Type A) (Fig 19.1, No 14).

Bone and antler projectile points exhibit a range of variability, the origins of which may be technical, functional or stylistic, as well as chronological. Points may be made of either bone or antler and a variety of techniques were employed in their manufacture. The blanks from which the finished points are carved were produced either by the groove-and-splinter technique or by the simple process of splitting longitudinally the shaft of a long bone or a section of antler beam, though it is difficult to establish the form of the blank from simple inspection of the finished implement. Points also differ according to whether they have one or two series of barbs and in the ways in which the barbs are formed as well as their spacing, prominence and robusticity. Points also vary according to size, length of tang and the presence in some instances of a means of attaching a line.

The function of barbed points is very difficult to ascertain and few have been found in contexts which shed any light on this matter. Clark (1952, 79; 1954, 47; 1975, 130) reports several from northern Europe being found in association with the remains of fish and marine mammals while the few barbed points recovered with elk remains are the only associations with terrestrial prey (Hallam *et al* 1973; Clark 1975, 130–1). It may be assumed that those points provided with a means of attaching a retrieving line were intended for use as harpoons, while those with simple tangs were intended to be permanently fixed to arrow- or spear-shafts (cf Stewart 1973; Bockstoce 1977).

Most of the British examples are incomplete, which makes comparison on morphological grounds difficult. It is especially the case that most examples lack the proximal end of the shaft and accordingly their status as harpoons, or spear or arrowheads cannot be determined. Classification by size is also a problem with incomplete specimens. But in most cases it is possible to determine whether the point was uniserial or biserial, the form of the barbs, and the manner in which the barbs were made. Lastly, while it is not always apparent from which animal the material came, or whether it is bone or antler, some points were clearly made on slender blanks while in other cases the blanks used were broad. No two barbed points

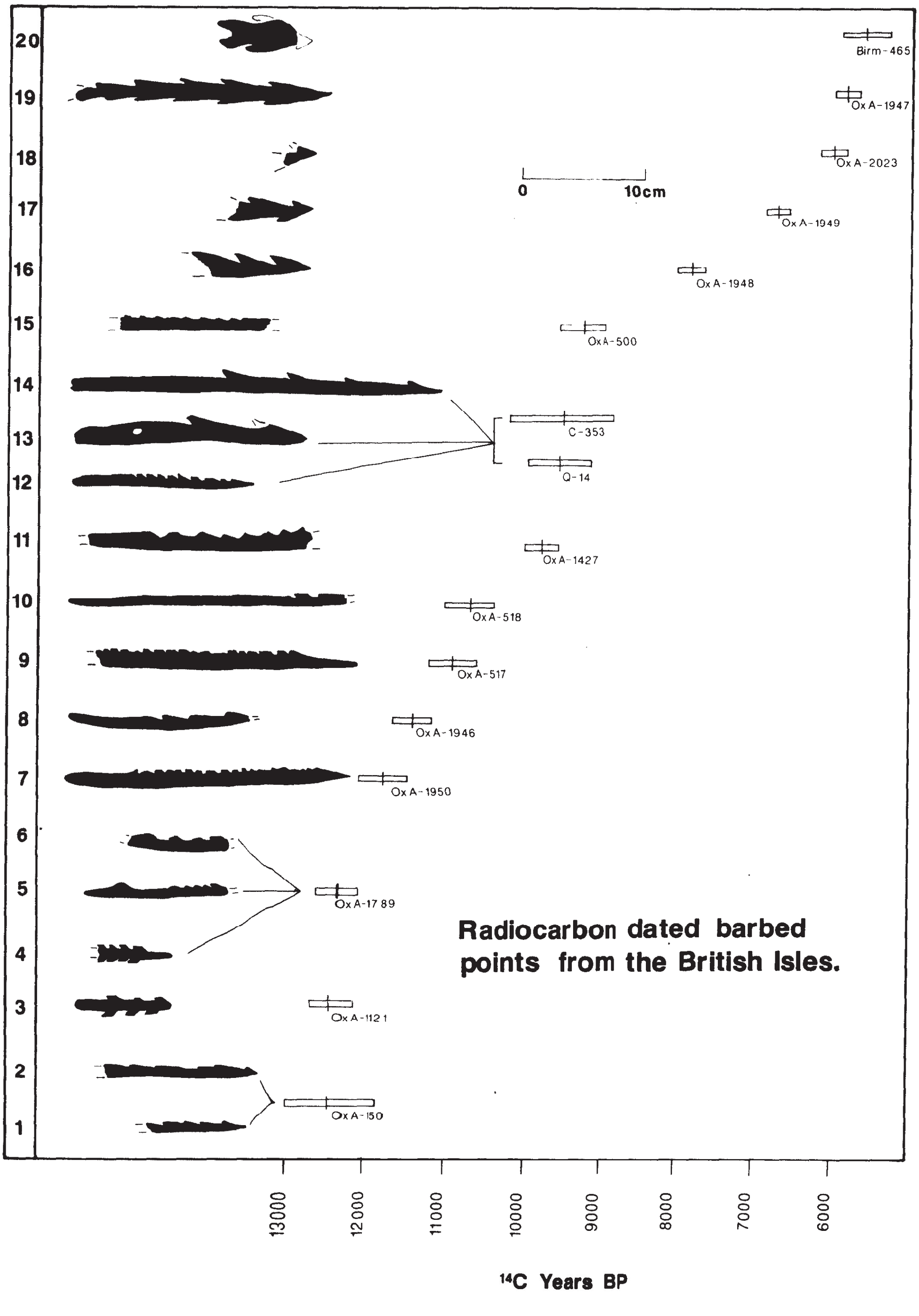

Figure 19.1 Radiocarbon dated barbed points from the British Isles

Table 19.2 Points dated by association with conventional radiocarbon dates

Site name	Point	Material	Date	Lab code	Ref	Fig 19.1
Poulton	uniserial	bone (1)	12,400±300	OxA-150	1	1
	uniserial	bone(2)				2
Aveline's Hole	biserial	bone	12,320±130	OxA-1121	2	3
Kent's Cavern	biserial	bone	12,320±130	OxA-1789	3	4
	uniserial	bone (1)				5
	uniserial	bone (2)				6
Star Carr	uniserial	antler (1)	9557±210	Q-14	4	12
	uniserial	antler (2)	9488±350	C-353	4	13
	uniserial	antler (3)				14
Risga	biserial		6000±90	OxA-2023		18
Cnoc Sligeach	biserial		5605±155	Birm-465		20

Sources: (1) Gillespie *et al* 1985, 238; (2) Hedges *et al* 1987, 290; (3) Hedges *et al* 1989, 215; (4) Clark 1954, 12, 67

are precisely the same, but amongst the well preserved and dated examples six types can be recognised.

Biserial barbed points

Points with two series of barbs can be divided into two types, with dated examples falling at opposite ends of the time-range:

(i) The first type comprises the points from Aveline's Hole (Fig 19.1, No 3) and Kent's Cavern (Fig 19.1, No 4). They are small and have widely-spaced, projecting barbs, and resemble Upper Magdalenian forms from France. Although not securely dated, they are probably older than 11,000 BP

(ii) Points of the second biserial type appear to have been made on broad, flat blanks, assumed to have been obtained by splitting long bone shafts or sections of antler beam. The barbs are prominent, robust, and made by oblique cutting from each face, as opposed to the lateral edge. This type is represented by examples from MacArthur's Cave (Fig 19.1, No 17), Risga (Fig 19.1, No 18), Shewalton (Fig 19.1, No 19) and Cnoc Sligeach (Fig 19.1, No 20) which have a date range extending *c* 6700–5600 BP.

Uniserial barbed points

Points with a single series of barbs can be grouped according to the form of the blank on which they were made. Types (iii), (iv) and (v) are all made on slender blanks, which in many cases are assumed to have been obtained by the groove-and-splinter technique. The barbs tend to have been formed by sawing or cutting inwards from the lateral edge as opposed to the face, and all known examples with complete tangs appear to have been fixed points rather than harpoon heads. They may be further subdivided as follows:

(iii) This type has simple notches cut into the stem leaving triangular (eg Waltham Abbey (Fig 19.1, No 11)) or trapeze-shaped (eg Star Carr P99 (Clark 1954, 150)) 'teeth'. Dated examples belong to the time-range *c* 9800–9250 BP.

(iv) True barbs formed by oblique cuts or notches distinguish this type. They exhibit considerable variation in the shape, spacing and prominence of the barbs and have a long time-span *c* 12,400–9500 BP. The majority of the points from Star Carr fall into this category.

(v) A rather specialised type with closely-spaced, non-projecting barbs or teeth defined by simple criss-cross cutting. The two dated examples, Sproughton 1 (Fig 19.1, No 9) and Leman and Ower (Fig 19.1, No 7), are of Late Glacial age.

(vi) Lastly, points of our Type (vi) are made on relatively broad, flat blanks and have prominent barbs formed by oblique cuts. There are two dated examples of this type, point P86 from Star Carr (Fig 19.1, No 13), which is clearly a harpoon, and a broken point from Druimvargie Rockshelter (Fig 19.1, No 16).

Concluding remarks

The dates now available for barbed points imply that some previously held views on their typology, such as the priority of antler over bone, and the relatively late dating of points with barbs formed by criss-cross cutting (Clark 1954, 181; Clark & Godwin 1956, 13) are no longer tenable. Some temporal change is, however, apparent. For example, while uniserial points on slender blanks have a broad chronological range, *c* 12,400–9200

BP, most points on broad, flat blanks post-date 9500 BP. Biserial points on flat blanks post-date 6700 BP and are the only type of point dated to this period. However, the majority of flat barbed points come from coastal sites. If they were used primarily for hunting marine mammals, their absence from Late Glacial/Early Flandrian contexts may be a reflection of preservation bias, as coastal sites belonging to this period only survive in northern Britain and none have good organic preservation.

While we expect these suggestions will need modification as further dates become available, we believe the results presented here illustrate the potential of direct dating to provide a more rigorous chronological framework than has hitherto been possible on the basis of conventional typology. Viewing the directly dated specimens within the broader context of implements with conventional radiocarbon dates enables that framework to be tentatively extended into periods and regions from which direct dates have not yet been obtained.

Acknowledgements

We should like to express our thanks to the various museum curators and individuals who have allowed barbed points in their care to be sampled, and to the staff of the Oxford Radiocarbon Accelerator unit for dating the samples.

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20 New observations on the Late Upper Palaeolithic site of Belloy-sur-Somme (Somme, France)

Jean-Pierre Fagnart

Abstract

Recent excavations at Belloy-sur-Somme have revealed the presence of two different Late Upper Palaeolithic industries lying on the same surface in deposits overlying the lowest of the Somme terraces. The earlier of the two, with white patinated artefacts, is attributed to the Tjongerian variant of the *Federmesser* complex and probably represents a small hunting encampment. The younger industry (Blue Patinated Series) dates from *c* 10,000 BP on radiocarbon evidence, and consists of widespread flintworking areas, where large, heavy blades were produced from the abundant high-quality local flint. Many of the blades have bruised edges, resulting from robust use at the working site on some hard material such as antler (though the only faunal remains recovered were a few bones and teeth of horse). Formal tools are extremely scarce in this industry, while cores and other working debris are present in huge quantities: this was not a site where domestic activities took place. The site of Belloy and its stratigraphy are discussed and the two industries are then described. The nature of the occurrences is considered and comparable finds in Britain and north-west Europe are noted.

Introduction

The Late Upper Palaeolithic site of Belloy-sur-Somme was discovered at the end of the nineteenth century during surface prospection. In 1905, V Commont carried out soundings and subsequently, from 1907 to 1910, major excavations, in parallel with his research on the classic sites of Saint-Acheul and Montières. Commont records (1908, 1913) having excavated 916 m² over the four seasons. Two archaeological levels of Upper Palaeolithic age were recognised during these early excavations. The lower level, occurring over a very small area and rather poor in artefacts, produced a few borers as well as two bitruncated pieces. The upper level, which was much richer, was characterised by an abundance of large blades with bruised edges.

Following a series of successful soundings in 1983, further areas of this huge site were excavated over six seasons (1984–89). Since the research is not yet complete, the results in this report are preliminary and provisional.

Two Palaeolithic occupations have been recognised during the recent excavations, one of which corresponds to Commont's upper industry although the other is apparently different from Commont's lower industry.

Location

(Fig 20.1)

The site of Belloy-sur-Somme is situated on the Cretaceous strata at the north-west periphery of the Paris Basin. This privileged location, in a region rich in Chalk flint, is important for the understanding of the site.

The site is located on the right bank of the Somme, some 15 km north-west of Amiens, at a place called *La Plaisance*. It lies on the lowest terrace, a few metres above the modern valley floor which, in this stretch, is about a kilometre wide (Hallencourt 3–4 1:25,000 map, Lambert co-ordinates 584.40/251.86, 18 m amsl).

The site is very large, with finds occurring discontinuously in a band *c* 250 x 20 m, elongated north-west-south-east, parallel to the present course of the Somme. Artefacts are abundant at the riverward edge of the lowest fluvial terrace but are particularly concentrated where this terrace is incised by a minor dry 'valley' or trough. It is also in the vicinity of this trough that the stratigraphy is best developed.

Since 1984, some 1100 m² have been excavated at Belloy, 800 m² of which form a block around the trough (sectors 138, 139, 144, 145, 150 and 151).

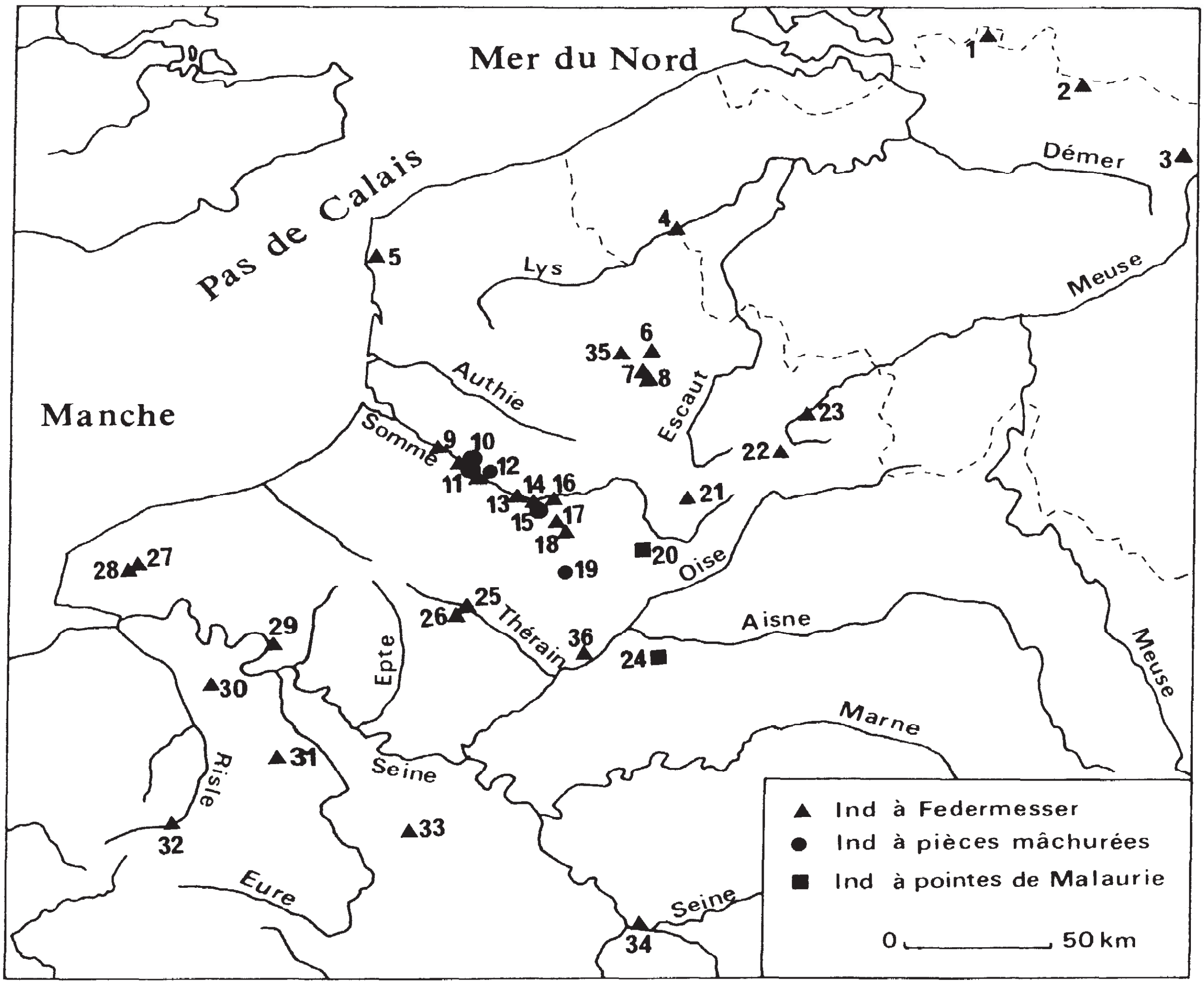

Figure 20.1 Geographical location of the site of Belloy-sur-Somme and the major sites of Late Glacial age in northern France and Belgium. Key to symbols: (triangles) Federmesser assemblages; (circles) Assemblages with pièces mâchurées *(bruised flakes and blades); (squares) Assemblages with Malaurie points — 1) Meer II; 2) Lommel; 3) Rekem; 4) Harelbeke; 5) Wimereux; 6) Férin; 7) Hamel; 8) Ecourt-Saint-Quentin; 9) Longpré-les-Corps-Saints; 10) Hangest-sur-Somme; 11) Flixecourt; 12) Belloy-sur-Somme; 13) Dreuil-lès-Amiens; 14) Amiens-Etouvie; 15) Amiens-Montières; 16) Amiens-Saint-Acheul; 17) Boves; 18) Thennes; 19) Villers-Tournelle; 20) Ercheu; 21) Attilly; 22) Vénerolles; 23) Maroilles; 24) Vieux Moulin; 25) Saint-Just-des-Marais; 26) Aux-Marais; 27) Vattetôt-sous-Beaumont; 28) Mirville; 29) Gouy; 30) Saint-Pierre-du-Bosguérurd; 31) Evreux III; 32) Ambenay; 33) Les Blanchères; 34) Pincevent (horizon III); 35) Vitry-en-Artois; 36) Houdancourt*

Lithostratigraphy (Fig 20.2)

The stratigraphy of the site was established from many vertical sections within the excavations, supplemented by a series of profiles recorded in the former gravel quarry at Belloy (presently the municipal football ground).

The excavations lie at the river-ward edge of the lowest terrace of the Somme, at the contact between silty slope deposits and valley bottom formations of the Late Glacial (silts) and Holocene (silts, peats, tufas).

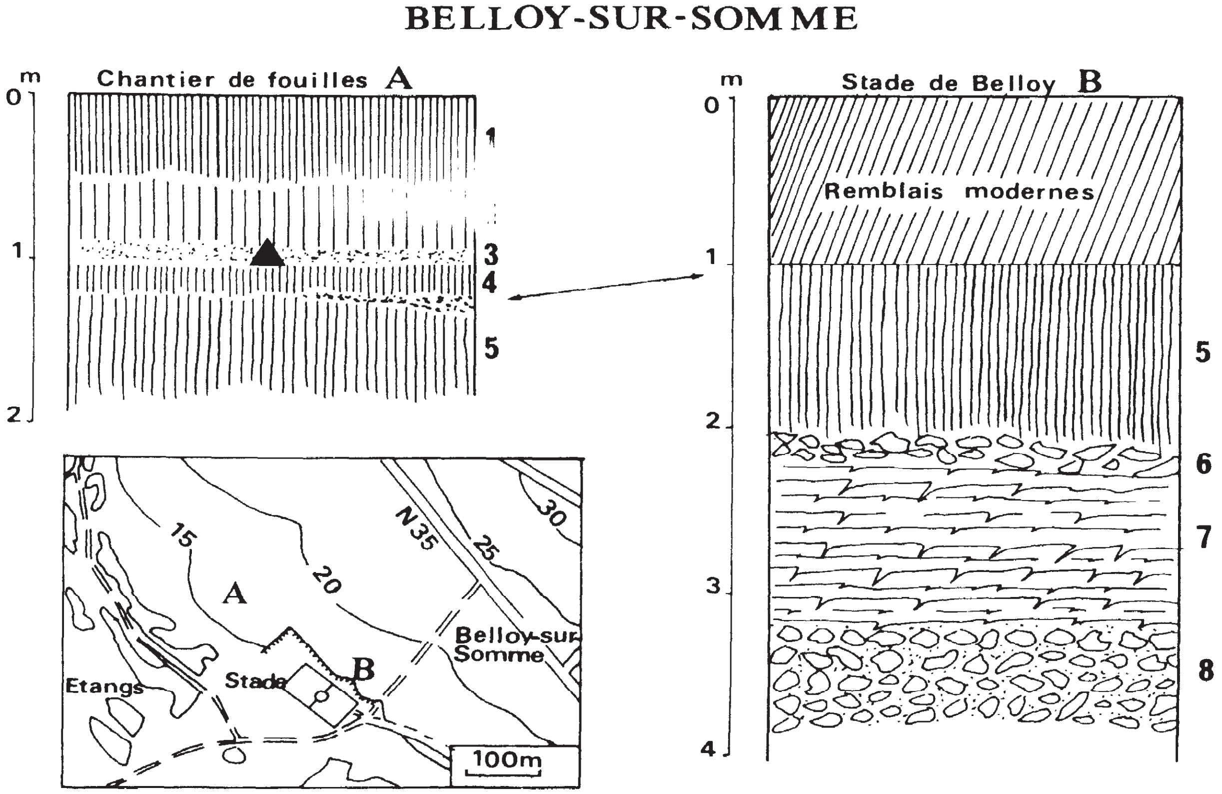

Figure 20.2 Belloy-sur-Somme (France, Somme). Geographical situation and stratigraphic sections (see text for details): A) recent excavations (1984–9); B) section at the football ground

Section descriptions

The stratigraphy is here presented as a general summary covering only the main points. Description is limited to the slope sequence, since the links with the valley bottom deposits remain to be confirmed in detail after further soundings.

Starting at the top, the following units appear (Fig 20.2):

1 Colluvial silt, blackish brown (10YR 2/1), poorly calcareous, at the top of which is developed the modern humic horizon; modern ceramics, and flints with traces of iron oxide; 0.50 m thick.

2 Humic silt, blackish (10YR 2/1), crumb structure, decalcified; strong bioturbation; 0.20 m thick.

3 Silt, whitish grey (10YR 7–8/1), decalcified; in sectors 113 and 117, an industry with flaked axes, *ciseaux* and end-scrapers in yellowish flint, dated to 5255±80 BP (OxA-460), lies in the upper part of this unit; 0.10-0.20 m thick.

4 Humic silt (1.12% organic matter), blackish (10YR 3/2), completely decalcified, interspersed with a few small rolled and shiny flints; this humic silt, preserved only in the trough (sectors 138–50), passes laterally into a minor orange (10YR 6/4) illuvial horizon on the slope; 0.10–0.20 m thick.

The Late Upper Palaeolithic level, in fact comprising two occupations represented by several tens of thousands of artefacts, lies directly on the surface of the humic silt and, locally, on a minor brownearth beyond the trough (sector 114).

5 Calcareous silt, greyish (10YR 7/1) with orange (10YR 7/6) oxidation mottles; 1.00–1.50 m thick.

6 Stony unit, strongly cryoturbated, composed of frost-shattered flint with a white to bluish patina and chalk granules; 0.30 m thick.

7 Stratified silt and sand formations, with numerous small syngenetic ice-wedge casts, showing alternation between lighter coloured (10YR 7/4) silty beds and darker (10YR 6/3) sandy beds; 0.90 m thick.

8 Fluvial gravel with rolled flint in a greyish sand matrix, representing the lowest terrace of the Somme, overlying the Cretaceous Chalk.

The five upper units can be seen in the main archaeological excavations, whilst the lower four have been recorded in the immediate vicinity in the old Belloy gravel workings. The correlation between the two sequences is provided by the Unit 5 loam which is present at all points above the lowest terrace at Belloy-sur-Somme.

Stratigraphic interpretation

The different profiles recorded by Commont (1913) or during the recent excavations represent the stratigraphy of the lowest terrace of the Somme and of the silty deposits capping its riser. The stratified formations (Unit 7), attributable to the Middle Weichselian, lie directly upon the gravels of the lowest terrace. The overlying cryoturbated stony layer represents an important erosion event generally observed above the stratified formations in the absence of the lenticular Kesselt horizon (Antoine 1989). The upper oxidised loess (Unit 5) is related, despite its degraded characteristics resulting from its low position in the valley, to the cover loess of the Upper Pleniglacial. Its upper portion is illuviated, and this illuvial horizon passes laterally into a humic soil in the trough. The pollen samples taken by A V Munaut from this horizon seem to have been contaminated by infiltration of recent pollen. Radiocarbon dates (see below) indicate an age greater than 10,000 years for this soil (Allerød Phase?). The uncertain mode of emplacement of the grey silts which cover the Upper Palaeolithic industries raises many questions. They could represent a colluvial or even an alluvial episode dating from some period from the Dryas III to the Atlantic. That chronological range is currently indicated at Belloy by the archaeological industries which bracket the deposit. The sequence is capped, within the trough, by a black humic soil with a crumb structure, sealed by anthropogenic colluvium which can be linked with certainty to recent cultivation of the slope.

The Late Upper Palaeolithic occupations

The recent excavations have allowed the recognition of two principal Late Upper Palaeolithic occupations. The two occupations are not in stratigraphic superposition but lie on the same surface (Unit 4 of the present stratigraphy).

It is easy to tell the two Series apart by their physical aspect (patina) and by their well defined technological and typological characteristics. Furthermore, the spatial distributions of the elements of the two Series are different.

The White Patinated Series

The artefacts in this series have thick patination ranging from grey to heavy white, and they show patches of surface alteration suggesting burial in a humic sediment. The nodules have a relatively thin cortex, and are of homogeneous texture. The raw material is good-quality Coniacien flint, which outcrops close to the site in the valley bottom.

The Blue Patinated Series

The artefacts in this series have a thin patina, coloured from dark blue to bluish-white. Even when there is an overlap of colour with the other series the slightly lustrous, silky surfaces of the Blue Patinated Series flints prevent any risk of confusion. The nodules have a generally thick and unbleached cortex, and sometimes contain geodes and inclusions. The flint is Upper Turonian which outcrops close to the site, and comes from a different exposure from that used by the makers of the White Patinated Series. Unlike the White Patinated Series the nodules are of consistently much larger size and there are differences in the appearance of the cortex. However, it is possible that the variation in nodule size between the two Series represents different raw material procurement strategies. The Turonian deposits outcrop only in the main valley bottoms, elsewhere being masked by more than 50 m of Senonian Chalk.

The occupation associated with the working floors (Blue Patinated Series)

Spatial organisation

After the study of a total area of 1100 m², it may be said that the material from the Blue Patinated Series is organised in a comparable manner in the different sectors excavated. The flints are concentrated into numerous piles with diameters rarely exceeding a metre. The abundance of cores, waste material and manufacturing by-products, as well as the frequency of chips in certain piles, would suggest knapping scatters. Tools, most commonly bruised pieces, are numerous within or immediately beside these concentrations. The absence of hearths and of all burnt elements is remarkable. This deficiency explains the rarity at Belloy of the classic Upper Palaeolithic tools (end-scrapers, burins, projectile points) which one usually finds in large numbers within domestic areas.

General typological characteristics

The Blue Patinated Series at Belloy-sur-Somme comprises several tens of thousands of artefacts, including 679 tools of which 436 (64.22%) are bruised pieces. Notches and denticulates are also common (29.60%). The rest of the assemblage (6.18%) is composed of end-scrapers, burins and rare obliquely blunted bladelets.

General technological characteristics

There is a systematic flaking method producing wide, straight-profiled and relatively thick blades. The longer blades measure 15–20 cm, rarely 25 cm, whilst the longest blade recovered at this site measures 27 cm and weighs one kilogram. Medium sized blades measure 8–15 cm and the smallest measure 4–8 cm.

The artefacts were struck from prismatic cores with two opposed platforms inclined in opposite directions. The back of the core may either have one or two postero-lateral crests or simply the remains of cortex. The discarding of so many elongated prismatic cores, still some 18 cm in length and therefore representing significant raw material, shows that the flaking method was oriented towards standardisation: straight profiled, wide blades of specific dimensions. However, there are also cores of the same type but smaller *(c* 12 cm), which show more advanced reduction.

The groups refitted by A. Boucher are extremely instructive, from the point of view of both technology and the understanding of spatial organisation. The various refits generally show that, following the initial shaping of the core, a frontal crest is prepared. The main knapping sequence is controlled by the alternating use of two opposed platforms, allowing the production of straight profiled, wide blades. The blades usually occupy two thirds of the length of the flaking face; only the crested blades pass from one end of the core to the other.

The flaking mode is apparently mixed, the core preparation as well as a part of the blade production being carried out by hard hammer, the main knapping sequence, or at least part of it, by soft hammer. The butts of blades are very often plain and wide but are sometimes faceted. Butts faceted *en éperon,* so well represented in the Upper and Final Magdalenian of the Paris Basin, are here totally absent.

Several hard hammers were recovered during the recent excavations. These are subspherical or spherical flint nodules, 8–16 cm in diameter and weighing between 270 and 1820 g. Certain cores have also been re-used as hammers and show characteristic percussion traces on extremities and sides.

Descriptive study of the lithic assemblage

Bruised pieces (Fig 20.3, nos 1–4)

The 436 bruised flakes and blades (Bordes 1967; 1969; 1970; Barton 1986) constitute the characteristic component of the industry from the Belloy knapping floors. These are the large blades and flakes with lateral crushing noted by Commont (1913). They are *a posteriori* tools without true retouch, simple plain blanks chosen by the Palaeolithic people according to certain very specific criteria. Only the strong use wear (bruising) which affects them, on one or two edges, allows them to be classified as tools.

These bruised pieces consist of large flakes (23.17%) and blades (75.92%) or, more rarely, blocks and cores (0.91%). The largest bruised piece measures 229 mm and weighs 315 g. The blanks are the products of core preparation (flakes) or of the earliest stages of reduction (common crested blades). Heavy and robust blanks are favoured.

The bruising, which results from violent use, is characterised by major splintering and crushing which very often affects both surfaces of the artefact. The more the piece has been used, the greater the edge has been crushed, and in some cases it is completely destroyed and rounded.

The bruising, often placed mesially (84.89% of cases), shows no preference for either the left or right edges of blanks. Traces are very often limited to one edge (73.39%) but can also occupy both edges of the tool (26.62%). In the latter case, the bruising is offset or symmetrical, sometimes giving a 'strangled' form (Fig 20.3, No 2). Finally, about a third of the bruised pieces have shapes that are particularly well adapted to prehension (natural or cortical back opposed to the bruised edge, thick crested blade, large cortical areas, etc).

The function of these bruised pieces remains problematical. The presence of a patina on the whole of the Belloy industry prevents a use wear analysis although, happily, such an analysis is still possible at other sites in the Somme basin, such as Flixecourt, Hangest-sur-Somme or Villers-Tournelle. The experiments carried out by Barton (1986) clearly show that bruised pieces may result from violent use, notably by percussion against a hard material such as antler. Wood is too soft to produce bruising comparable to that seen at Belloy. Bordes (1971) showed that certain very resistant woods, such as box *(Buxus),* can produce bruising on flints. Although interesting, this observation cannot be valid for the Late Upper Palaeolithic of northern France, since box is unknown from the pollen spectra of the Late Glacial of north-west Europe.

Further important information is provided by the spatial distribution of these tools. They are generally found within or immediately beside the knapping scatters. Numerous refits show clearly a continuity from the knapping operations, to the

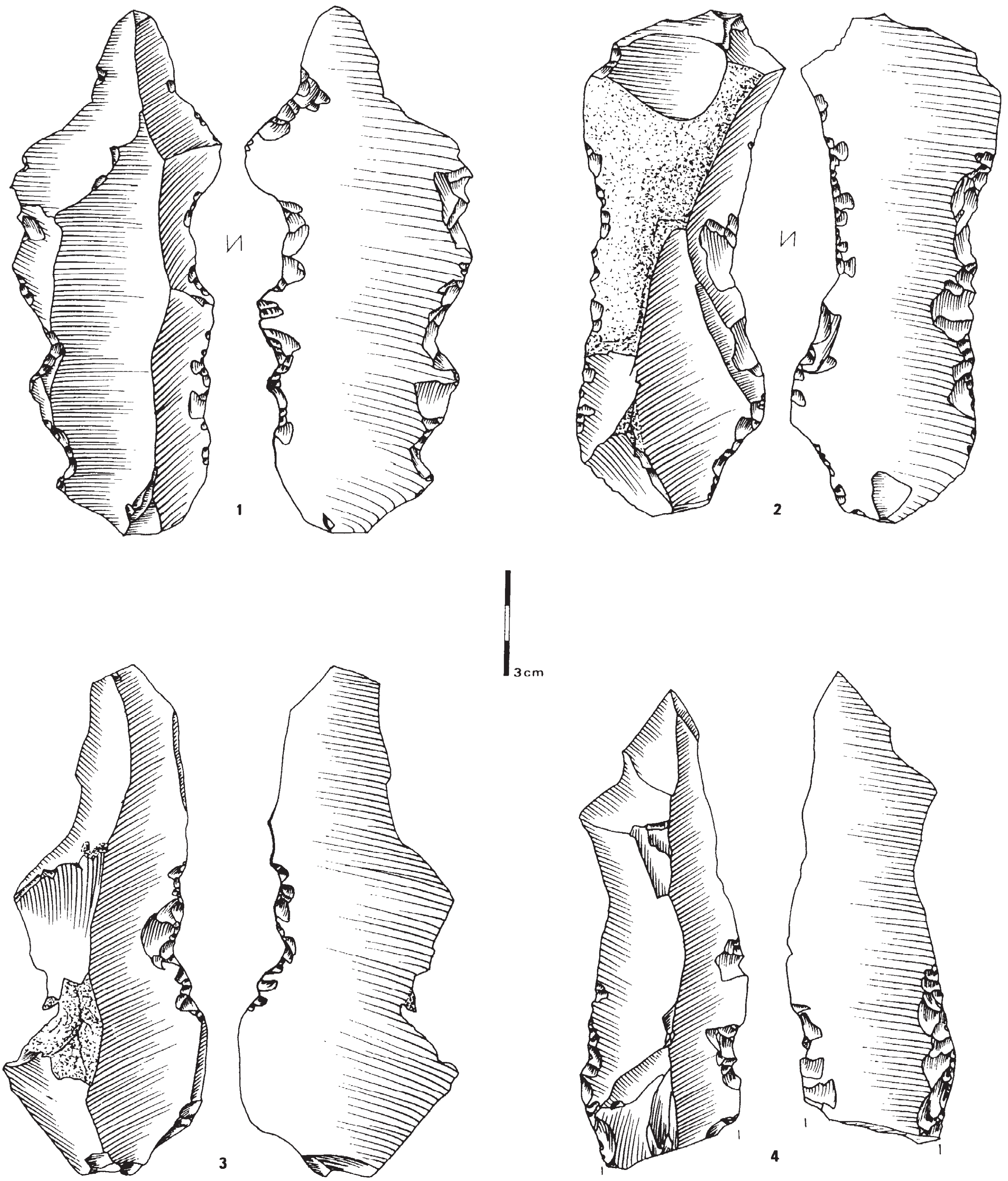

Figure 20.3 Belloy-sur-Somme. Flint industry (Blue Patinated Series): 14) large blades with bruised edges

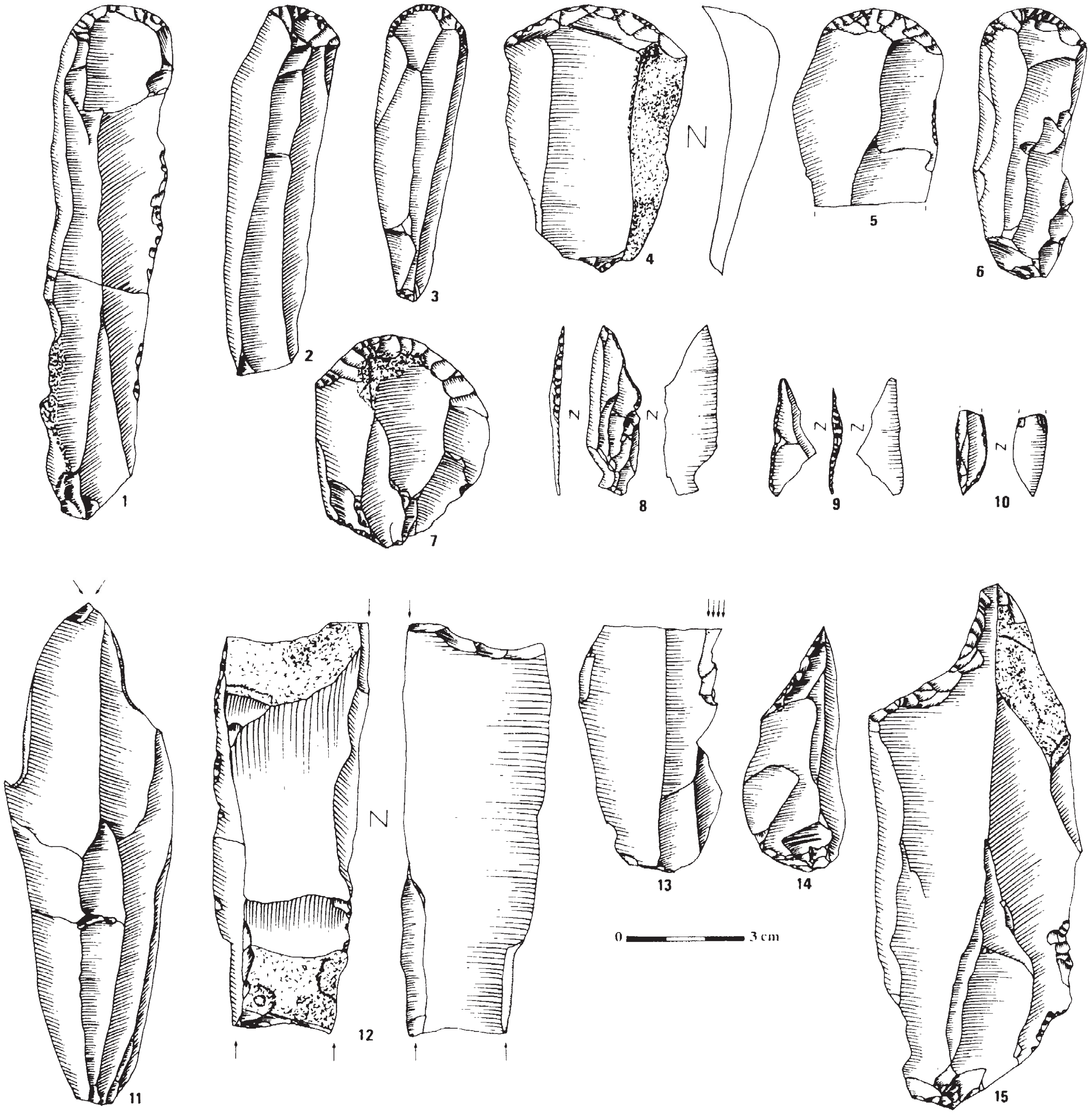

Figure 20.4 Belloy-sur-Somme. Flint industry (Blue Patinated Series): 1–7) end-scrapers; 8–10) projectile points or similar pieces; 11–13) Burins; 14, 15) truncated blades

selection of appropriate blanks, to their use and finally to their discard on the working floors themselves. There is therefore no spatial or temporal interruption in the chain of events. The flint piles of Belloy thus correspond to activity zones linked also to the use of bruised pieces. One obvious possibility is that they were used in operations associated with knapping (repair of soft hammers?), but there may be other possible uses actions whose nature and significance presently escape us. Although recent experiments might have suggested antler working, the total absence of the remains of reindeer or red deer at Belloy necessitates the greatest caution. The fauna recovered at Belloy, which in any case is relatively sparse, is essentially composed of the remains of horse.

New experiments, coupled with use wear analysis, may eventually allow the resolution of the question of the relationship between the typology and the function of the bruised pieces from Belloy.

Notches and denticulates

Notches and denticulates are numerous (201 examples representing 29.60% of the assemblage) but their identification as intentionally retouched tools is not certain. The notches are often atypical, shallow and rather wide; the retouch is scalar or marginal, very oblique to abrupt. There are some Clactonian notches. There is usually a marked disproportion between the blank, which is sometimes of considerable size, and the retouch, which is often very localised. Moreover, the blanks are very heterogeneous, as much from the point of view of morphology as of dimensions. The smallest weigh a few grams, the largest some 400 g. Notches do not show preferential localisation on the blanks. With rare exceptions, the denticulates are similarly atypical and are often produced by small indentations.

In summary, this category of tools includes rare characteristic forms but also numerous pseudo-tools probably resulting from accidental blows or crushing in the working floor environment. It is equally possible that some of the notches and denticulates may represent spontaneous use wear, which would mean that they are *a posteriori* tools linked to a specific activity.

The abundance of notches and denticulates in the working floors of later Upper Palaeolithic sites of the North European plain might be explained by analogous processes.

End-scrapers (Fig 20.4, Nos 1–7)

End-scrapers (27 examples representing 3.98% of the assemblage) are four times more common than burins. Two-thirds of the scrapers are on blades, with the remainder on flakes. There are a few scrapers on the end of long blades of a type common in the Upper Palaeolithic but, very often, the supports are shortened blades or laminar but hardly elongated pieces (Fig 20.4, Nos 4 and 5). One of the stylistic characters of the group, present in a certain number of cases, is a curved profile to the support behind the scraper edge, that is, uniquely in the distal section of the tool. The retouch of the scraper edge is often semi-abrupt, but sometimes abrupt; the retouch scars are short and lamellar in appearance. Retouch is always limited to the scraper edge and never extends onto the edges of the support.

Burins (Fig 20.4, Nos 11–13)

Burins, represented only by seven examples (1.03%), are very rare. One is on a flake, with the remainder on blades. The group includes two dihedral burins, a multiple burin on concave transverse truncations, an oblique burin on lateral retouch, and three angle burins on breaks, one of which occurs on a fragment of a bruised piece.

Truncated blades (Fig 20.4, Nos 14 and 15)

There are two examples with very oblique, concave truncations.

Piercers

Although this type is very rare in the industry, there are two examples with poorly defined working extremities. One is on a cortical flake and the other on a distal blade fragment.

Backed blade

There is a single example with partial backing retouch of a laminar blank.

Projectile points (Fig 20.4, Nos 8–10)

Although poorly represented, this class is important for the diagnosis of the cultural affiliation of the industry of the Belloy working floors. The pieces are obliquely blunted bladelets. The largest (Fig 20.4, No 8), perhaps closer to a truncated bladelet than to a projectile point, was discovered within a knapping scatter, whilst the other (Fig 20.4, No 9) was found amongst the finer debris during the excavation of another scatter. They are proximal points, that is, the unretouched base is formed by the natural distal end of the support bladelet. The angle of the point is in both cases less than 45°.

A third microlithic element (Fig 20.4, No 10) is a fragment of a rather atypical spindle-shaped point; the broken distal extremity shows small 'burinating' scars which could be interpreted as impact damage characteristic of projectile points.

Retouched flakes and blades

Retouched flakes (65 examples) and blades (34 examples) are numerous. The retouch, never very extensive, very often occupies a small proportion of the perimeter of the blank. It may occur on any part of the blank and is generally direct, varying from semi-abrupt to abrupt.

Utilised flakes and blades
These *a posteriori* tools show weak to very weak traces of use wear visible to the naked eye. There are 33 utilised flakes and a hundred or so blades and fragments.

Fauna

Bone remains associated with the working floors are far from abundant. Most of the fauna comes from a restricted area, measuring some twenty square metres, at the boundary between sectors 113 and 117. P Auguste has carried out a preliminary study of this material. Out of 147 identifiable pieces, almost two-thirds are teeth. The material shows strong geochemical alteration which implies very marked differential survival. The fauna is exclusively composed of the remains of a small horse *(Equus caballus gallicus)*. A minimum of four individuals, three adults and a young animal, were killed in the vicinity by the Palaeolithic people of Belloy. Cervids, and most notably the reindeer, are totally absent.

The rarity of the fauna cannot be explained uniquely by the differential survival of the remains. The conditions for faunal preservation are poor at Belloy but they are not hopeless. The absence of habitation structures on the one hand, and the abundance of flint (several tens of thousands of artefacts) on the other, seem to indicate a site function linked to technical operations involving flint (lithic working floors). Daily subsistence activities were presumably carried out elsewhere, outside the site or at least beyond the large areas explored since the beginning of the excavations.

The small concentration of bone material, at the boundary of sectors 113 and 117, exceptional in itself, appears to reflect a repeated process, possibly even a single event. Indeed, these 20 m^2 which produced fauna contrast sharply with more than 1080 m^2 which were totally devoid of palaeontological remains.

Several dates on the faunal material (Gowlett *et al* 1986) give an age at the end of the Dryas III *or* the beginning of the Pre-Boreal for this archaeological site with its industry characterised by bruised pieces.

OxA 462	9720±130 BP
OxA 722	10,110±130 BP
OxA 723	9890±150 BP
OxA 724	10,260±160 BP

Affiliations of the bruised piece industry of the Blue Patinated Series

The industry with bruised pieces from the Belloy working floors can be paralleled at several sites in the Somme basin (Fagnart 1988) and in southeast England (Barton 1986; 1989, and this volume) which was joined to the continent during the Last Glacial.

For the moment, the chronological placing of this industry at Belloy is defined by its superposition above a Federmesser industry, and by the coherent series of radiocarbon dates around 10,000 BP, at the boundary between the Late Glacial and the Holocene.

A similar late chronological position for comparable material is known in England from the sites of Sproughton (Wymer 1976; Rose 1976), Avington VI (Barton & Froom 1986), Springhead (Jacobi 1982), and most recently Uxbridge, where an industry with bruised pieces, associated with the remains of horse and possibly of reindeer, is also dated to around 10,000 BP (Lewis, this volume).

If the chronological position of the working floors with bruised pieces at Belloy is relatively well established, the cultural affiliation remains problematical. As we have seen, the retouched tools which are the most culturally significant are quite rare in the working floor assemblage. The only diagnostic tools are the obliquely blunted points, which are also found in the British sites. At Avington VI (Barton & Froom 1986), obliquely blunted points are accompanied by a point retouched on one edge and with a straight back, reminiscent of Blanchères points (Rozoy 1978), and by an Ahrensburgian point.

According to Barton (1989), the sites of south-east England and northern France belong to an extension of Ahrensburgian territory where, in western parts, there is typically a drop in the number of Ahrensburg points themselves, with obliquely truncated points (Zonhoven points) becoming the most widespread characteristic form. It is indeed interesting to note that bruised pieces are also present in the classic Ahrensburgian sites of northern Germany (Rust 1943; Taute 1968).

Although attribution to a western province of the Ahrensburgian (Barton 1989) is currently the most satisfactory hypothesis, it may legitimately be asked whether the industry with bruised pieces from Belloy belongs to an activity facies of a known cultural tradition or to some north-west European group that has not yet been individually defined.

The occupation associated with the *Federmesser* tradition (White Patinated Series)

When excavations were resumed at Belloy, this occupation was poorly represented and badly defined but, during the campaigns of 1988 and 1989, much more material came to light. The recognition of a second occupation during the Late Upper Palaeolithic calls for a reappraisal of certain preliminary observations appearing in earlier publications (Fagnart 1984, 1988). In particular, it should be stressed that *Federmesser* are never associated with the working floors with bruised pieces, but belong to an original and quite distinct assemblage.

Spatial organisation

The material of the White Patinated Series has not yet been subjected to a detailed spatial analysis. Judging from observations made during the excavations, however, it would appear that the material has a homogeneous distribution with rare points of concentration. In particular, the backed points *(Federmesser)* could be preferentially localised with respect to the rest of the assemblage

General typological characteristics

The industry comprises several hundred artefacts, of which 63 are recognisable as tools. The retouched tool assemblage consists of three main classes of tool: burins (22.22%), end-scrapers (20.63%) and backed points or *Federmesser* (31.75%). The remainder are truncated blades (12.70%) and a series of types (backed blade, notch, side scraper, backed bladelet) only represented by a few examples.

The principal characteristics lie in the presence of numerous curved back points *(Federmesser)* associated with a series of generally short end-scrapers on flakes. Amongst the burins, those on truncations are more common than dihedral forms.

General technological characteristics
Blades were produced from prismatic cores with two opposed platforms. Refitting, currently being carried out by A. Boucher, will allow a better understanding of the techniques used as well as of the efficiency of raw material use.

Cores were finally discarded when they were markedly smaller than is the case for the Blue Patinated Series. This can be explained in the first place by the fact that the nodules used were not very large. The back of the cores is generally cortical.

Flaking was aimed at the production of slightly thickened blades, never exceeding 13 cm in length. Blades having a length/breadth ratio greater than 4 are exceptional. The butts of artefacts are in most cases plain but are sometimes faceted. The point of impact, which is often well developed, indicates the use generally of hard hammer technique. Butts faceted *en éperon* are totally absent.

Descriptive study of the lithic assemblage

End-scrapers (Fig 20.5, Nos 24–8)
The number of end-scrapers is more or less the same as that of burins. These are generally short end-scrapers on blades (five examples) or on flakes (eight examples). The mean scraper length is 50 mm (with a standard deviation of 11 mm). The largest scraper of the assemblage, made on a blade, measures 75 mm. Half the scrapers carry more or less extensive areas of cortex. In contrast to the Blue Patinated Series, none of the supports have curved profiles. The retouch is limited to the distal extremity and never extends to the lateral edges of the pieces. The scraper edge, which is always convex, is produced by short semi-abrupt or abrupt retouch scars, rarely tending towards lamellar forms. Two scrapers on thick flakes have somewhat carinated scraper edges.

Burins (Fig 20.5, Nos 20–3)
Burins on truncations (nine examples) are more common than dihedral burins (four examples) or burins on breaks (one example). The burins are made on short blades, with a single example on a bladelet. A few burins have a length/breadth ratio greater than 3 but none exceeds 4. The mean burin length is 69 mm (with a standard deviation of 25 mm). The largest burin of the assemblage measures 103 mm.

The dihedral burins are straight (three examples) or asymmetric (one example). One carries a heavily worn bit; use has completely destroyed the angle between the two facets.

The burins on retouched truncations are mostly on oblique or slightly concave truncations. One example is a Lacan burin in the technological sense. There are two multiple burins on truncations.

The edges of the supports are generally unmodified. A single example has backing which passes smoothly into an oblique truncation. About a third of the group carry more or less extensive areas of cortex.

Federmesser (Fig 20.5, Nos 1–12)
Backed points constitute the characteristic and diagnostic element of the White Patinated Series at Belloy. These pieces are common but often fragmentary: nine complete, six almost complete, two proximal fragments, two mesial fragments, five pointed extremities and one indeterminate fragment.

Given this fragmentation, one can calculate using the complete (and almost complete) pieces and the separate tips that a minimum of 20 backed points have been collected from the site, a number which represents 31.75% of the whole tool assemblage.

These are regularly curve-backed points, or more rarely points with rectilinear backs, produced on small blades. The curved character of the backed edge is the common element in the whole assemblage. A single rather small piece (Fig 20.5, no 12) has an angle-back ('Creswell point'); another shows a tendency towards shouldering (Fig 20.5, no 10). Certain pieces are elongated, with a length/breadth ratio between 5 and 7, whilst others are very much more squat (Fig 20.5, no 11). A single point is the norm, with only one double pointed example (Fig 20.5, no 6).

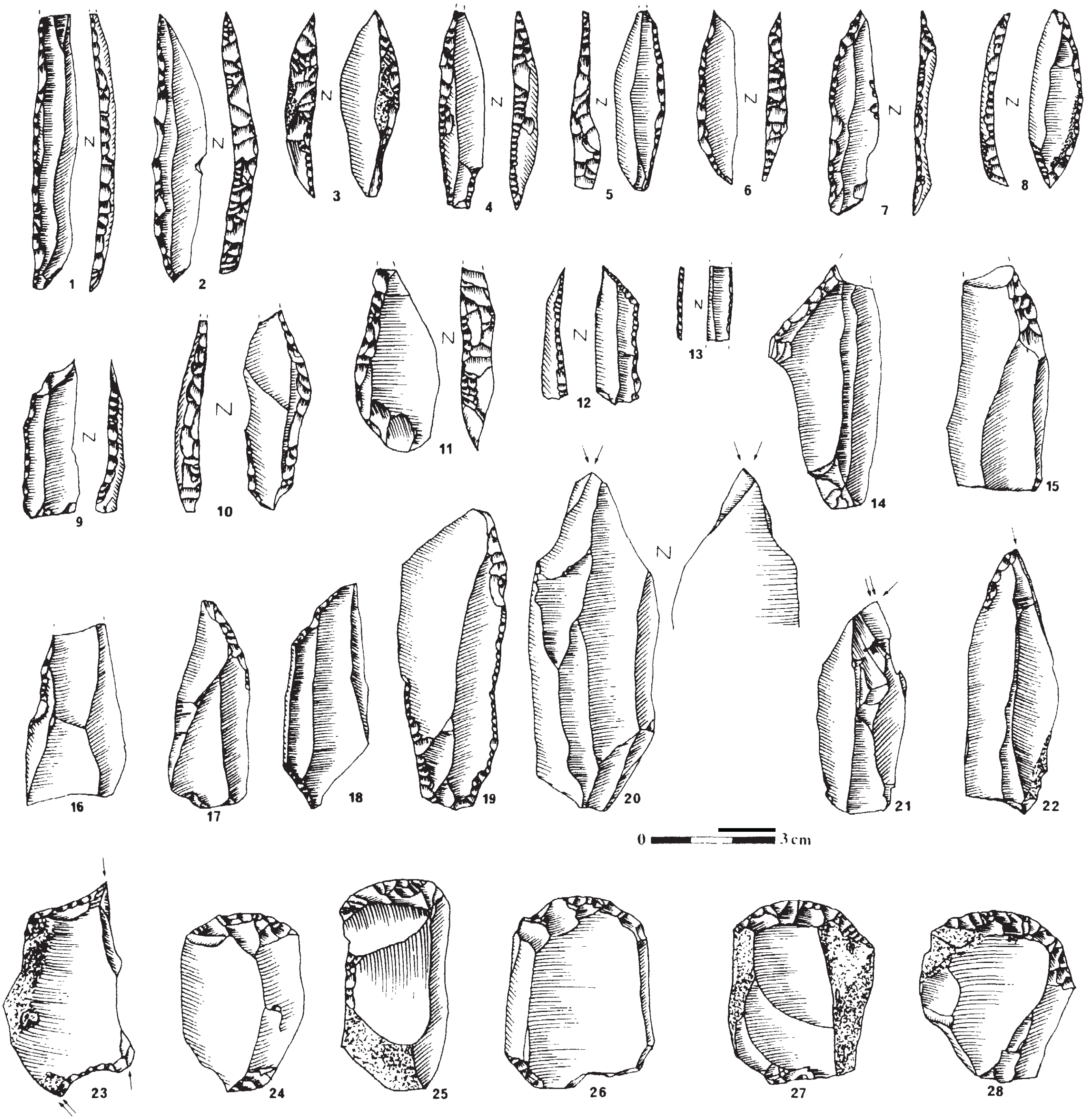

Figure 20.5 Belloy-sur-Somme. Flint industry (White Patinated Series): 1–11) points with curved or sub-rectilinear backing; 12) angle-backed point; 13) backed bladelet; 14–17) truncated blades; 18) bitruncated blade; 19) retouched backed knife; 20–23) burins; 24–28) end-scrapers

The mean backed point length is 50 mm (with a standard deviation of 9 mm). The largest complete point measures 71 mm, the smallest 38 mm. The thickness of the supports varies between 3 and 8 mm (mean 5 mm, standard deviation 1 mm).

In three quarters of the examples, the bases comprise the proximal part of the blade support, sometimes with the bulb still in place (distal points). A few bases (four examples) have been modified by a small oblique truncation converging upon the backing (Fig 20.5, no 8): the 'penknife points' of Campbell (1977).

The lateralisation could be determined in 23 cases, and is to the left in 12 examples and to the right in 11 examples.

Retouch may be direct (11 cases) but generally becomes bidirectional (12 cases) towards the extremity of the point. The same is true when the support is thick or when the backing is particularly invasive. Only three examples carry traces of cortex.

The technological and stylistic characteristics of the curved back points of the White Patinated Series place them very much nearer to the projectile points of the *Federmesser* group (Schwabedissen 1954; Bohmers 1960) than to the projectile points of the classic Azilian of the southwest of France where double pointed types are always much more numerous,

Truncated blades (Fig 20.5, Nos 14–18)
These are a series of blades carrying a truncation which is usually very oblique (six cases) but more rarely concave (one case) or transverse (one case). Four examples with very oblique truncations have broken extremities but it is difficult to determine the nature of the fracture (whether in manufacture or use of the tools).

One bitruncated piece on a thin blade has two opposed oblique truncations, oriented in opposite directions (Fig 20.5, no 18). This piece is very similar to that illustrated by Commont (1913, fig 112) from his lower level.

Backed knives
Three examples on blades have been recovered. The back is produced by abrupt retouch, whilst the opposite edge carries macroscopic use wear. One example shows modification of the base which probably has some connection with hafting (Fig 20.5, No 19).

Backed bladelet (Fig 20.5, No 13)
There is a single fragment of a narrow backed bladelet. Its width is 6 mm.

Piercer
A single rather atypical piercer was recovered during the recent excavations.

Notches
These notched blades are atypical. The notches are shallow and made by semi-abrupt non-scalar retouch.

Side-scraper
A very large convergent convex side-scraper with scalar retouch has been recovered. Its size (234 mm) is unusual.

Retouched or utilised flakes and blades
A group of blades (nine) and flakes (five) carry retouch (sometimes continuous) on at least one edge. This retouch is often only marginal and abrupt or, very much more rarely of a lower angle. Two thin blades carry very fine wear traces on both edges.

Fauna

The 1989 season produced a relatively abundant fauna dominated, judging from preliminary observations, by aurochs and red deer. The remains seem to be associated, at least spatially, with a sector where the Federmesser industry is itself abundant, although this archaeological relationship remains to be demonstrated.

One must be prudent in interpreting this bone assemblage, which might yet prove to belong to a more recent occupation of the site. A few typically Mesolithic stone artefacts were recovered during the stripping of the site. Radiocarbon dating should settle this question.

Affiliations of the industry of the White Patinated Series

Typological and technological characteristics allow the attribution of the White Patinated Series from Belloy to the Late Upper Palaeolithic groups producing *Federmesser* and, in particular, to the Tjongerian as it is defined by Schwabedissen (1954), Bohmers (1960), van Noten (1967) and Rozoy (1978).

This industry is characterised by relatively simple technological procedures designed for the production by hard hammer of short, rather thick blades.

The presence of numerous *Federmesser,* of generally short end-scrapers normally lacking in lateral retouch, and of a moderate number of burins often dominated by examples on retouched truncations, constitute the essential characteristics of the *Federmesser* industries of northern France. In fact, these assemblages show considerable compositional and typological variability (Fagnart 1988; 1989). At Amiens-Etouvie and at Dreuil-lès-Amiens, in the Somme valley, burins are more common than end-scrapers, whilst the opposite is true at Attilly, near Vermand, in the Aisne. At all of these sites burins on truncations outnumber or equal dihedral burins.

Federmesser industries of the Late Upper Palaeolithic therefore show a technological and typological break with the Upper Palaeolithic industries (Final Magdalenian, Creswellian, Hamburgian) which preceded them.

Federmesser groups which are well dated by geochronological methods are still rare. The majority of dates fall in the Allerød, around 11,000 BP. Dates later than 10,000 BP are considered in most cases to be too young (Gob 1988). New excavations, such as those at Niederbieber in the Rhineland (Bosinski *et al* 1982; Winter 1987), at Meer (van Noten 1978) and at Rekem (Lauwers 1988) in Belgium, as well as useful syntheses (Thevenin 1982; Arts 1988; Bolus *et al* 1988; Bosinski 1987, 1988; Burdukiewicz 1987; Deeben 1988; Schild 1988; 1989), allow an appreciation based upon new data of the structuring of the curved back point techno-complex on the scale of northern Europe.

Summary and general conclusions

New research at the Late Upper Palaeolithic site of Belloy-sur-Somme has brought to light, over an area of 1100 m^2, two occupations that are well differentiated from both technological and spatial points of view.

These two occupations lie at the same stratigraphic level, in the upper part of the recent loess. Nevertheless, criteria exist which will allow a chronological distinction to be made. The White Patinated Series is characterised by a much more advanced degree of alteration than the Blue Patinated Series. Certain artefacts from the White Patinated Series, reworked at a later date, show a double patina and the surfaces then exposed are characteristic of the Blue Patinated Series. This therefore provides a supplementary argument of relative chronology.

The more recent occupation (Blue Patinated Series) is characterised by a complex of lithic working floors. As the on-going refitting programme seems to indicate, a number of selected supports have been taken away beyond the excavated area for later use. The absence of hearths and the rarity of fauna and of tools other than bruised pieces indicate that daily tasks linked in particular with the acquisition and consumption of food were not carried out on the spot. The Blue Patinated Series, which perhaps belongs to the Ahrensburgian tradition, thus represents technical activities associated with the working of flint in proximity to a rich source of raw material. Radiocarbon dating places this occupation of the site at about 10,000 BP, at the boundary between the Late Glacial and the Holocene.

The older occupation (White Patinated Series) belongs to the tradition of groups using *Federmesser* and, in particular, to the Tjongerian. No date is yet available for this assemblage. It would seem that the conditions were different for access to raw material sources, close though these were to the site (vegetation cover masking certain outcrops?). The goal of the occupation is not in this case oriented towards the production of blanks for later use elsewhere but towards the transformation of blanks into a variety of tools (end-scrapers, burins, backed points) in the immediate locality. These tools point in an indirect manner to the daily activities of a group of Tjongerian hunters (small camp or hunting stand).

Acknowledgements

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21 The early Postglacial occupation of the southern part of the North Sea Basin

André Gob

Abstract

The development of Pre-Boreal industries on the southern edge of the North Sea Basin can be understood in terms of either 'long' or 'short' chronologies according to various authors. This paper proposes a shorter chronology with the true Early Mesolithic (Beuronian) developing via an 'Epi-Ahrensburgian' out of the true Ahrensburgian with tanged points. A cultural break is envisaged between the tanged point industries and those of Federmesser type.

Introduction

The Late Glacial and Pre-Boreal industries of the southern edge of the North Sea Basin have been considered from several points of view. The three principal ones can be summarised as follows:

1) The 'Palaeolithicist': van Noten *et al* 1978; Campbell 1977. Late Palaeolithic and especially Federmesser industries (Creswellian, Tjongerian) are seen to be part of an extended chronology, starting in the Allerød stage and continuing down to the Pre-Boreal or early Boreal. These authors do not discuss the true Mesolithic industries.

2) The 'Regionalist': Rozoy 1978. In contrast to the former view, Rozoy uses a short chronology and rejects the late dates for the Tjongerian. He presents evolutionary sequences for several regional areas, extending from industries of Allerød age to those of the Mesolithic. In the Rhine-Meuse Basin, the sequence consists of the Tjongerian-Ahrensburgian-Limburgian (a local Mesolithic facies). In the Paris Basin, a similar though less well-established sequence leads to the formation of the Tardenoisian.

3) The 'Mesolithicist': Gob 1988. While analysing the Ahrensburgian industry of the Fonds-de-Forêt Cave, I suggested a general scheme for the Late Glacial/early Postglacial occupation in Belgium and related areas, stressing the following points: a short chronology, like Rozoy; a cultural break between the Federmesser and tanged-point industries; continuity from the Ahrensburgian, through an 'Epi-Ahrenburgian', to the early true Mesolithic industries (Beuronian). In this paper, I shall present arguments in support of this point of view.

Chronology

This question was discussed at length in Gob (1988) and will only be summarised here (Fig 21.1):

1) *Tjongerian:* Despite numerous difficulties with radiocarbon dating, it seems that Tjongerian occupations belong mainly within the Allerød stage in our region, although later Federmesser groups probably existed elsewhere, eg in the Jura, south Germany and Switzerland (Taute 1978; Thévenin 1981). Nico Arts (1988, 300–1) mentions unpublished information about Wouters' and Bohmers' excavations which leads to the same conclusion. The controversy over the age of the Meer settlement shows clearly the difficulties in interpreting data from coversand areas. New excavations at Meer have revealed the presence of a true Mesolithic concentration which explains the presence of microliths in the classical Tjongerian assemblage of Meer II as well as the presence of Holocene charcoal.

2) Typical Ahrensburgian (sensu stricto) appears to be restricted to the Dryas III period, or else only just extends beyond this chronozone into the end of the Allerød (Geldrop I: Arts 1988,301) and the beginning of the Pre-Boreal (Fonds-de-Forêt: Gob 1988).

3) Epi-Ahrensburgian clearly occurs in the first three-quarters of the 10th millennium BP (see Fig 21.1).

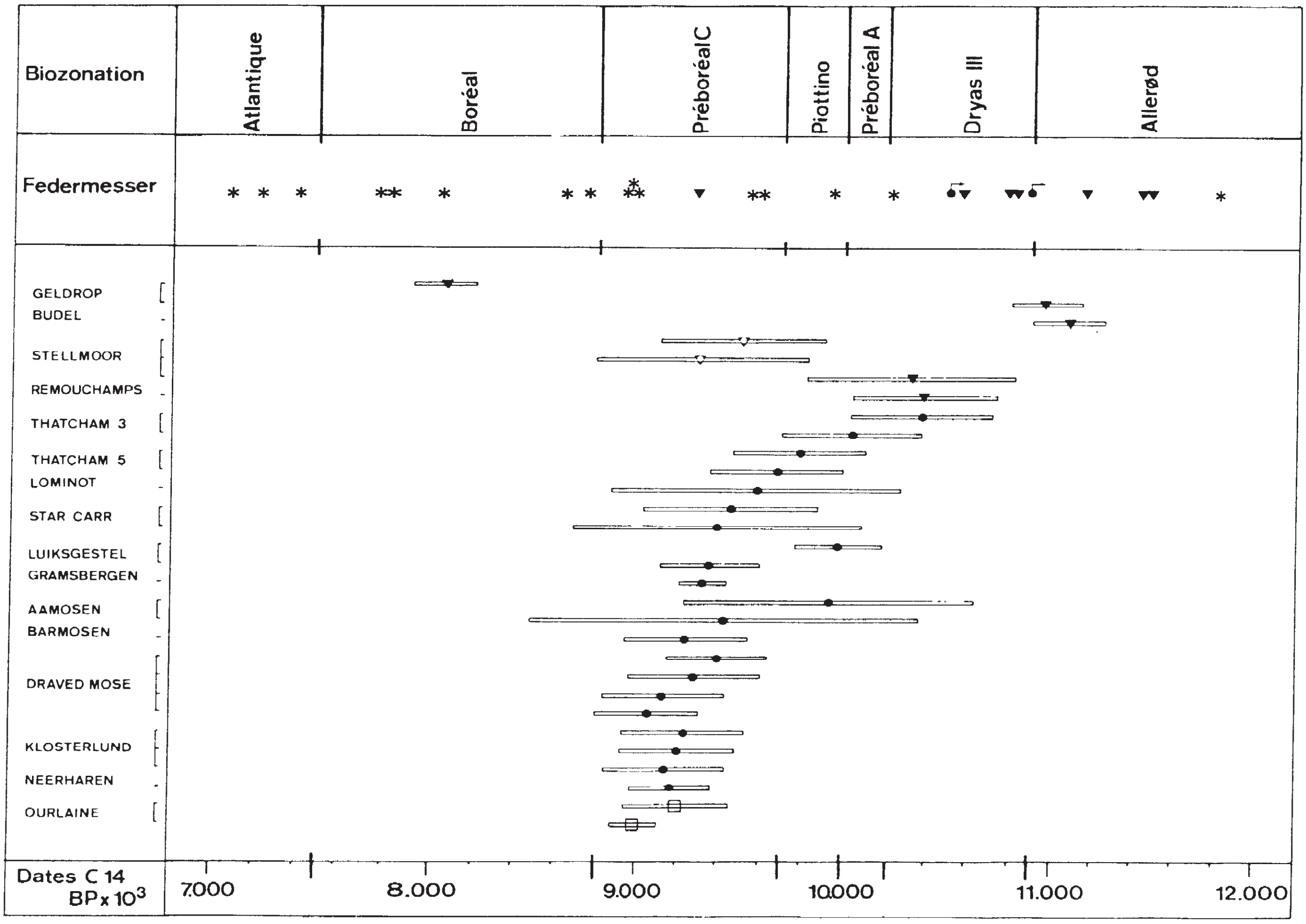


Figure 21.1 Radiocarbon dates for the Federmesser, the Ahrensburgian and the Epi-Ahrensburgian. In the Federmesser group, the asterisks indicate the lack of any litho- or biostratigraphical data; triangles refer to sites which do have this information, and especially the presence of the Usselo soil; dots with arrow denote a terminus ante quem *for such sites. In the rest of the diagram, triangle represent Ahrensburgian* (sensu stricto)*; dots represent Epi-Ahrensburgian and related industries; squares denote Beuronian settlements*

4) *True Mesolithic* industries (Beuronian A) appear, in our region, in the last two centuries of that millennium. However, Beuronian A seems to be earlier in southern Germany and the Jura (Taute 1978; Gob 1990, 39).

'Industrial' questions

In the area studied, there is a cultural break between the Tjongerian (and Federmesser) industries and the Ahrensburgian, which can be seen especially in the Belgian cave sites and the Geldrop sites. This break is obvious when we compare tool frequency tables and tool styles: for example, for the Tjongerian, see the Meer industry (van Noten *et al* 1978, 34–52 and Pls 10–26), and for the Ahrensburgian, see Remouchamps (Dewez 1974), Geldrop III 1 and 2 (Rozoy 1978, Pls 11–17) or Vessem (Arts & Deeben 1981).

The continuity between the two industries, claimed by Rozoy (1978, 105 and 126–7) and Schlagmuylder (1985) seems to be purely an artefact of their analysis. Their view of the Ahrensburgian occupying an intermediate position is problematic and is based on the following very general data:

— the lack (in the Tjongerian) or the scarcity (in the Ahrensburgian) of a microlithic component, resulting in an over-representation of 'common tools'. This is obvious since Rozoy had to use an alternative type list for the Late Upper Palaeolithic Tjongerian industry (ie the 92 type-list of Sonneville-Bordes & Perrot 1955)

— the absence of a 'tanged point' category in the type list for the Mesolithic (ie the 132 type-list of Rozoy). This problem arose during study of the Ahrensburgian industry and led Rozoy to place these tanged points at a 'strategic' place, in the middle of the list, giving an apparent 'transitional' character to the Abrensburgian site curve.

— On the Schlagmuylder diagrams, which present statistical factor analyses based on Rozoy's data, the parabolic curve, denoting a continuity effect, seems rather dubious on the left side of the diagram: there are two clusters of points, one for Tjongerian and one for Ahrensburgian sites, but nothing between them.

Another point must be stressed in order to confirm the chronological differentiation of the three cultural entities, despite the radiocarbon results from Meer (and elsewhere: see above and Gob 1988). It is worth recalling that Tjongerian and Mesolithic industries are quite different as regards technological features (debitage); point morphology and typology (backed points *vs* microliths); and the relative frequencies and morphology of common tools such as scrapers and burins. Moreover, where microliths are found together with Federmesser artefacts (at Meer, for instance), there are no signs of hybridisation or influence of the former on the latter. This would undoubtedly be the case, if we accepted the supposed duration of that cultural unit (more than two millennia) and the formidable ecological transformation of the area during that time. How could these constraints have led to the emergence of the Mesolithic assemblages and, at the same time and in the same area, have left unchanged the old, Upper Palaeolithic, Tjongerian tools? In addition, the usewear analysis of the Meer assemblage seems to show the occurrence of classical Palaeolithic open landscape activities (Keeley in van Noten *et al* 1978; Cahen 1984).

So called Epi-Ahrensburgian industries are closely related to the classical tanged-point Ahrensburgian; more specifically, an evolutionary scheme can be drawn between Taute's Callenhardt-Remouchamps Group and the early Pre-Boreal assemblages in the Rhine-Meuse Area. I have previously defined the nature of the Epi-Ahrensburgian (Gob 1988) and the main characteristics of this industry are the inclusion of classical Ahrensburgian common tools, with a trend toward smaller pieces and a reduction in the amount of burins; a scarcity or lack of true tanged points (Fig 21.2); a predominance of Zonhoven points (Fig 21.2); and the presence of atypical geometric microliths derived from tanged points (triangles, small and irregular trapezes (Fig 21.2).

The typical Epi-Abrensburgian sites (see map Fig 21.3) include the following: in Belgium — Zonhoven-Kapelberg (Huyge 1985), Sougne A-WF (Gob 1981, 171–2); and Hodainry (Counasse 1980; Gob 1981, 205–6); in the Netherlands — Geldrop III–2 (Rozoy 1978, 134–8), and Gramsbergen (Stapert 1979) with 48 Zonhoven points as the only microliths; in Germany – Bedburg-Königshaven, near Grevenbroich (see Street, this volume); and in northern England — Pointed Stone 2/3 (Jacobi 1978, 309). Some small assemblages in Northern France may also be associated with the Epi-Ahrensburgian (Bois de Hannappes, Hinout 1988). On a broader scale, the Epi-Ahrensburgian is related to the Thatcham-Star Carr and Klosterlund groups.

The situation in the Paris Basin is not very clear. Some industries with Creswellian (Evreux) or Federmesser (Les Blanchères) affinities are present and Rozoy (1978, 379–86) sees them as direct antecedents of the Tardenoisian. Moreover, the industry of Vénerolles (Hinout 1988) yielded typical penknife points which could hardly be later than Allerød, if we refer to the chronological position of the Tjongerian. However, it seems possible, at least in the northern part of the area, that the evolution of the industries may be similar to that which can be observed further north.

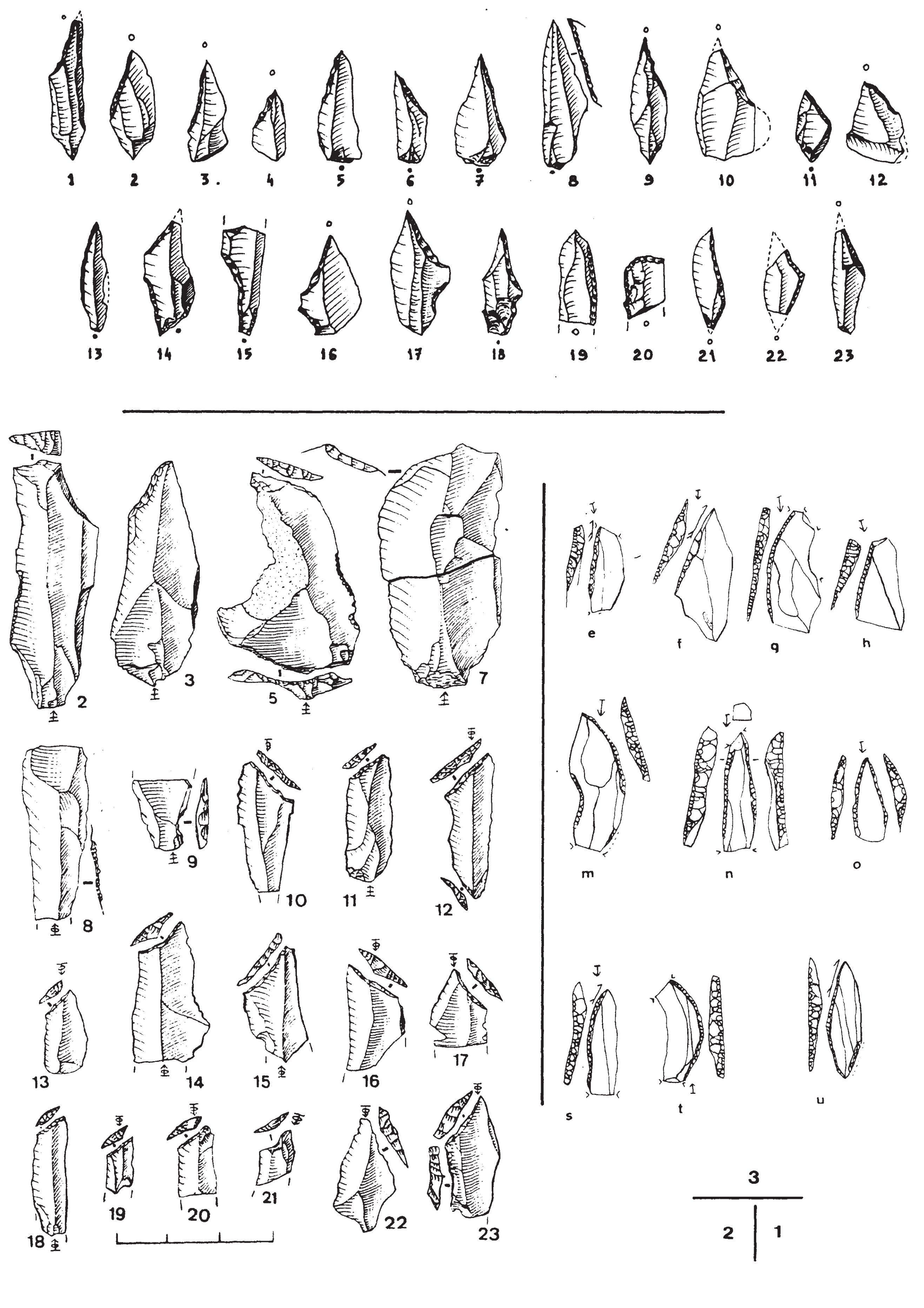
There are very few examples of a contemporary bone or antler industry. A number of barbed points have been found during dredging in several places in Belgium and France, but their cultural attribution remains unclear. They could be of Late Palaeolithic age or later.

Some recent discoveries, apparently quite different from the material described above, should be mentioned here, namely the 'Long Blade' industries with *lames mâchurées* described at Belloy-sur-Somme in northern France (see Fagnart, this volume) and in southern England (see Barton, this volume). These unusual and distinctive industries are well dated to between 10,500 and 9500 BP at Belloy, and a similar age seems likely in England at sites such as Sproughton, associated with a Zonhoven and a rhombic point, and Uxbridge, near London (Lewis, this volume). These industries represent a western (and probably atypical, 'workshop' facies), and are probably counterparts of the classical Ahrensburgian (Barton 1989). It seems clear that the 'Long Blade' industry with *lames mâchurées* at Belloy-sur-Somme is not directly connected with the classical Federmesser industry found some meters away at the same level: the physical aspect (patina) as well as the knapping techniques and, of course, the tool typology, are quite different (see Fagnart, this volume).

Discussion and conclusions

The chronological framework for the industries mentioned in this paper can be summarised as follows (Fig 21.4):

1) The Tjongerian (and the Federmesser) are present during the Allerød.
2) The Ahrensburgian and related assemblages occur in Dryas III times and the first part of the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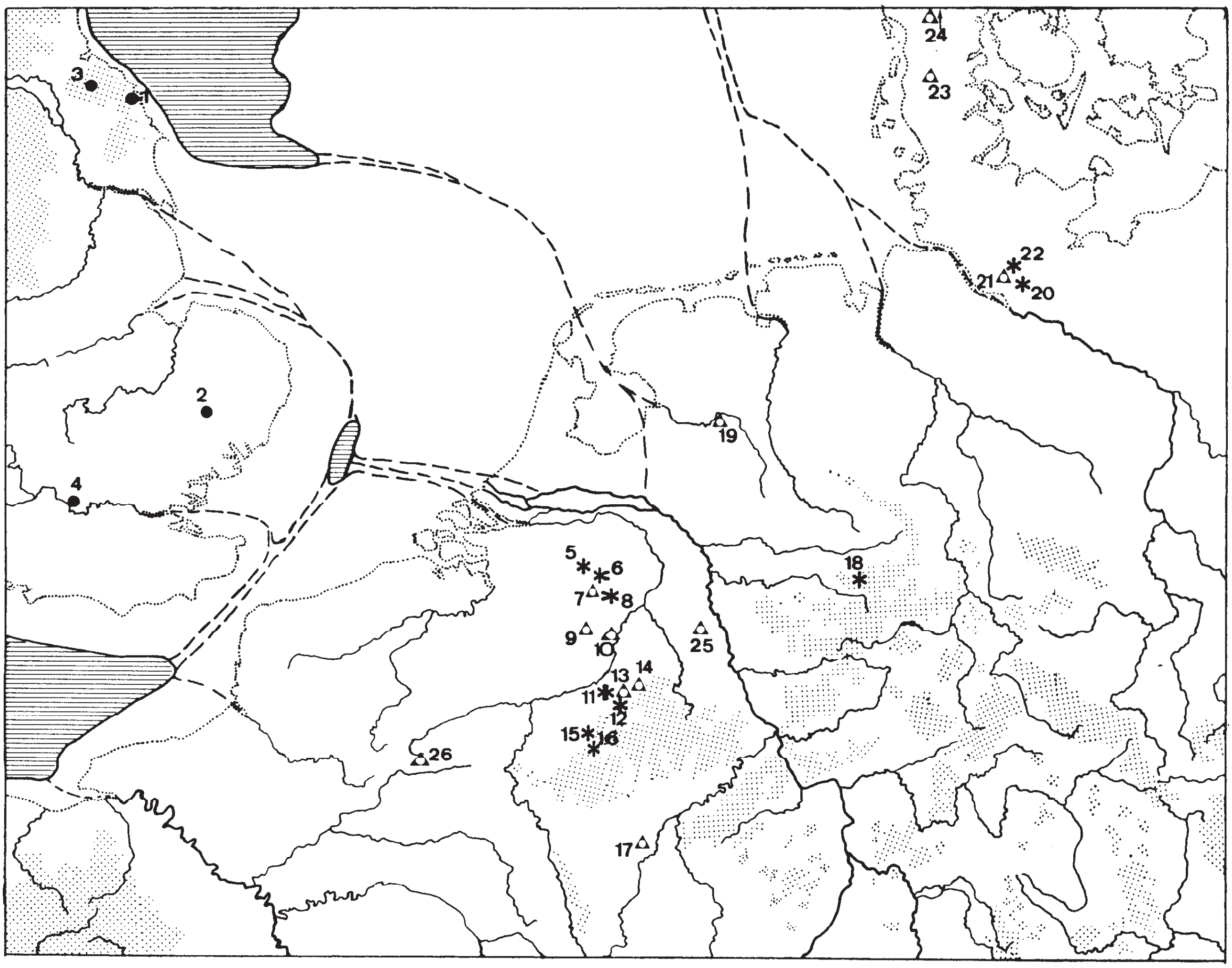

Figure 21.3 Map of north-west Europe with sites quoted in the text and Fig 21.1: 1) Star Carr; 2) High Beech; 3) Pointed Stone; 4) Thatcham; 5) Geldrop; 6) Vessem; 7) Luiksgestel; 8) Budel; 9) Zonhoven; 10) Neerharen; 11) Fonds-de-Forêt; 12) Remouchamps; 13) Sougne A-WF; 14) Hodainry; 15) Grotte du Coléoptère; 16) Grotte de la Préalle; 17) Altwies; 18) Callenhardt; 19) Gramsbergen; 20) Stellmoor; 21, 22) Pinneberg 1b and 2; 23) Draved Mose; 25) Bedburg-Königshoven; 26) Hannappes

Pre-Boreal, probably down to the middle of the 10th millennium BP.

3) A well-developed Mesolithic emerges after 9,500 BP.

Within this scheme there exists some greater variation in the Ahrensburgian complex than that presented by Taute (1958) in his definitive study of the classical tanged-point culture in Germany, Denmark and Netherlands.

We must consider two axes of variation:

1) An east-west gradient moving, roughly, from assemblages with numerous large, typical tanged points to those with small atypical pieces, and where these are outnumbered by Zonhoven points. Moreover, 'Long Blade' industries with *lames mâchurées* are a special facies in the western part of the region: they may be a variant of the Ahrensburgian, but at present this supposition is only based on the contemporaneity of the two, suggested by radiocarbon dates, and the occasional presence of points.
2) A chronological trend toward assemblages with smaller pieces, fewer tanged points and more numerous Zonhoven points. This phenomenon appears over the whole area, from England to Denmark, as if the 'Belgian style' became the rule; it characterises what I have called the Epi-Ahrensburgian stage.

Dramatic ecological changes, of which the disappearance of the reindeer in the area studied and the rise of the sea level created the most stress,

Figure 21.2 (opposite) Lithic industry: 1) Sougné A-WF (after Gob 1981, pl 33); 2) Zonhoven-Kapelberg (Huyge 1985, fig 3); 3) Geldrop III-2 (Rozoy 1978, pl 17)

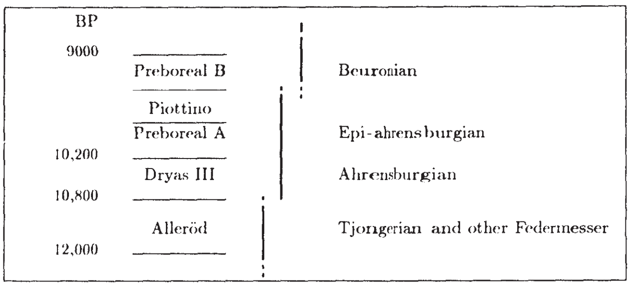

Figure 21.4 Chronological sequence of late Pleistocene and Early Holocene cultures in north-west Europe

caused the rapid break-up of the Ahrensburgian complex, which became dispersed into several local groups with less contact and exchange and growing differentiation between them. These trends were initiated by the gradual formation of the North Sea: the marine transgression led to the displacement of populations west, south and east and resulted in the regional isolation of these groups. This situation subsequently led to the increase in population density locally as well as a differentiation of cultural patterns. Only a small part of the 'tanged point' population, if any, appears to have followed the reindeer northwards, giving rise, ultimately, to the Holocene north Scandinavian tanged groups (Komsa & Fosna groups: see Kozlowski 1975; Kozlowski & Kozlowski 1979).

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22 Technological innovation and continuity at the end of the Pleistocene in Britain

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Abstract

This paper re-examines evidence for the occupation of Britain during the period of the Pleistocene/Holocene transition (*c* 10,000 BP). It is suggested that Holocene assemblages pre-dating 9700 BP are technologically very similar to Late Glacial ones and that it is only from the middle Pre-Boreal chronozone onwards that toolkits representing adaptation to more heavily wooded environments become widely present in Britain. The latter are identifiable with the local Early Mesolithic facies. The implications for the classification of earlier Postglacial assemblages are discussed.

Introduction

Despite the relative wealth of detail concerning the palaeoenvironmental and palaeoclimatic shifts at the end of the last Ice Age (Hammer *et al* 1986; Atkinson *et al* 1987; Dansgaard *et al* 1989) comparatively little attention has been focused on human cultural evidence in north-west Europe in the light of events at the Pleistocene/Holocene boundary. This is a period often characterised as one of extreme environmental instability with the consequent changes influencing the availability and distribution of resources utilised by contemporary hunter-gatherers. To what degree such natural events affected or were responsible for altering human subsistence strategies and how these adaptational changes were reflected in aspects of the toolkits is, of course, still a source of much interest and speculation (Soffer & Gamble 1990). Certainly, Late Pleistocene studies of the southern latitudes caution us that cultural shifts may have been determined less by environmental change than by complex social variables (Lourandos 1987; Allen 1990). The ability to test these and other related models in a north European context is still greatly dependent on the existence of a reliable temporal framework. In this paper I consider the nature and timing of developments in the indigenous British lithic technologies and try to set these, as far as possible, against the background of shifting conditions at the end of the Pleistocene. Using this approach it can be argued that changes in toolkit lag significantly behind the climatic improvement at the beginning of the Holocene and that adaptation to Postglacial wooded environments occurs only gradually.

Interpretation of the database: current problems

Terminology

Clark's view of the Mesolithic as an intermediate cultural stage filling the gap 'between the close of the Pleistocene and the arrival of the Neolithic arts' (Clark 1932, 5) is the definition still most widely favoured by Old World Prehistorians. The deficiencies of this cultural/chronological definition *(sensu stricto)* have, however, been recognised by several authors who point to the time-transgressive nature of change across Europe and the degree of continuity between the Mesolithic and its antecedents (Price 1983; Mellars 1981). In Britain, the usefulness of this definition is devalued by the fact that the earliest Postglacial technologies resemble so closely local Late Glacial ones (Barton 1989). As a consequence it will be suggested that the term 'Mesolithic', in a north-west European sense, be reserved for specific technologies appearing several centuries after the beginning of the Holocene. The evolution of such toolkits seems to be closely linked with the adaptation to more heavily wooded environments (cf Childe 1931).

Radiocarbon chronology

Although a relatively large number of conventional radiocarbon determinations are now available for the Early Mesolithic (Switsur & Jacobi 1975; Jacobi 1978) these have never been subjected to any form of rigorous critical review. Comparison with more stringently selected of AMS (Accelerator Mass Spectrometry) dates on worked bone and antler

Table 22.1 Direct radiocarbon determinations on bone and antler artefacts of Younger Dryas and early Pre-Boreal ages (Oxford AMS)

Lab No	Sample	Findspot	Date (BP)	Ref
OxA-517	barbed point (bone)	Sproughton (Suffolk)	10,910±150	1
OxA-518	barbed point (antler)	Sproughton (Suffolk)	10,700±160	1
OxA-811	cut-marked bone (red deer)	Elder Bush Cave (Staffordshire)	10,600±110	2
OxA-803	worked antler ?axe (reindeer)	Earl's Barton (Northamptonshire)	10,320±150	2
OxA-111	decorated mandible (horse)	Kendrick's Cave (Gwynedd)	10,00±200	3

References: 1 = Gowlett *et al* 1986a; 2 = Gowlett *et al* 1986b; 3 = Gillespie *et al* 1985

objects now offers the beginnings of a more reliable Late Glacial and early Postglacial radiocarbon chronology. Many of the dates, however, derive from isolated contexts, sometimes with no other archaeological association. Quite apart from the inherent difficulty of interpreting single dates, dendrochronological studies now show that past variations in atmospheric carbon (eg around 10,000 BP and 9550 BP) have resulted in plateaux of constant radiocarbon ages lasting over 250 years (Becker & Kromer, this volume).

Environmental framework

Local and regional biostratigraphic sequences provide essential contextual frameworks for studying the nature and timing of the human occupation of Britain during the Late Glacial/Early Postglacial periods. They also provide independent means for correlating and testing the internal consistency of the radiocarbon record. Recent studies of this kind are exemplified by the palaeobotanical investigations in the area of Seamer Carr, North Yorkshire (Cloutman & Smith 1988), although the associated archaeological data have yet to be fully evaluated (Schadla-Hall 1987, and in prep).

A suggested archaeological sequence for the Late Glacial and early Postglacial in Britain

Despite the inherent limitations of the database, it is possible to suggest an outline sequence for the indigenous archaeological record based on various key stratigraphic profiles and the evidence of artefact assemblages from Britain and parts of the adjacent European mainland. For convenience, these data are considered with relevance to local pollen zonation as established for the Late Glacial and early Postglacial (Godwin 1956).

Younger Dryas (Loch Lomond Stadial)

Previously this period of climatic deterioration at the end of the Pleistocene was thought to represent a hiatus in human settlement in Britain or at least one which was only punctuated by visits of an episodic nature (Jacobi 1981). While this picture has not altogether changed, there is now growing evidence to suggest that occupation might have taken place in certain parts of the country over a more prolonged period.

Revised estimates for the Loch Lomond ice readvance indicate a relative short period of major ice growth, which may have reached its maximum extent in Scotland between 10,900 and 10,700 BP (see Tipping, this volume). Thereafter pollen analyses suggest a period of increased aridity with indicators such as *Artemisia* hinting at increasing continentality of climate. Evidence supporting these conclusions is provided by the analysis of beetle faunas (Atkinson *et al* 1987) and occurrences of dated mammalian remains. The latter shows that the suite of animals adapted to cold, arid, open environments (eg reindeer, horse, glutton and steppe pika) continue to thrive in Britain up to about 10,000 BP (Jacobi 1987; Hedges *et al* 1990; Currant, this volume). The fact that a general amelioration of climate may be signalled in the record before the accepted beginning of the Holocene at 10,000 BP (Mitchell *et al* 1973) need not conflict with these data, especially if faunas of this kind were becoming progressively more restricted in their geographic distribution. It is possible also that increased aridity towards the end of the Younger Dryas may have stimulated the local growth of wild grasses and created grazing conditions especially favourable for wild horse and reindeer populations.

Confirmation of a human presence in Britain between 11,000 and 10,000 BP is currently provided by a small series of directly dated bone and antler artefacts and cutmarked bones (Table 22.1). The two earliest artefacts, both uniserial barbed points from Sproughton in Suffolk, are dated to the main phase of the Loch Lomond

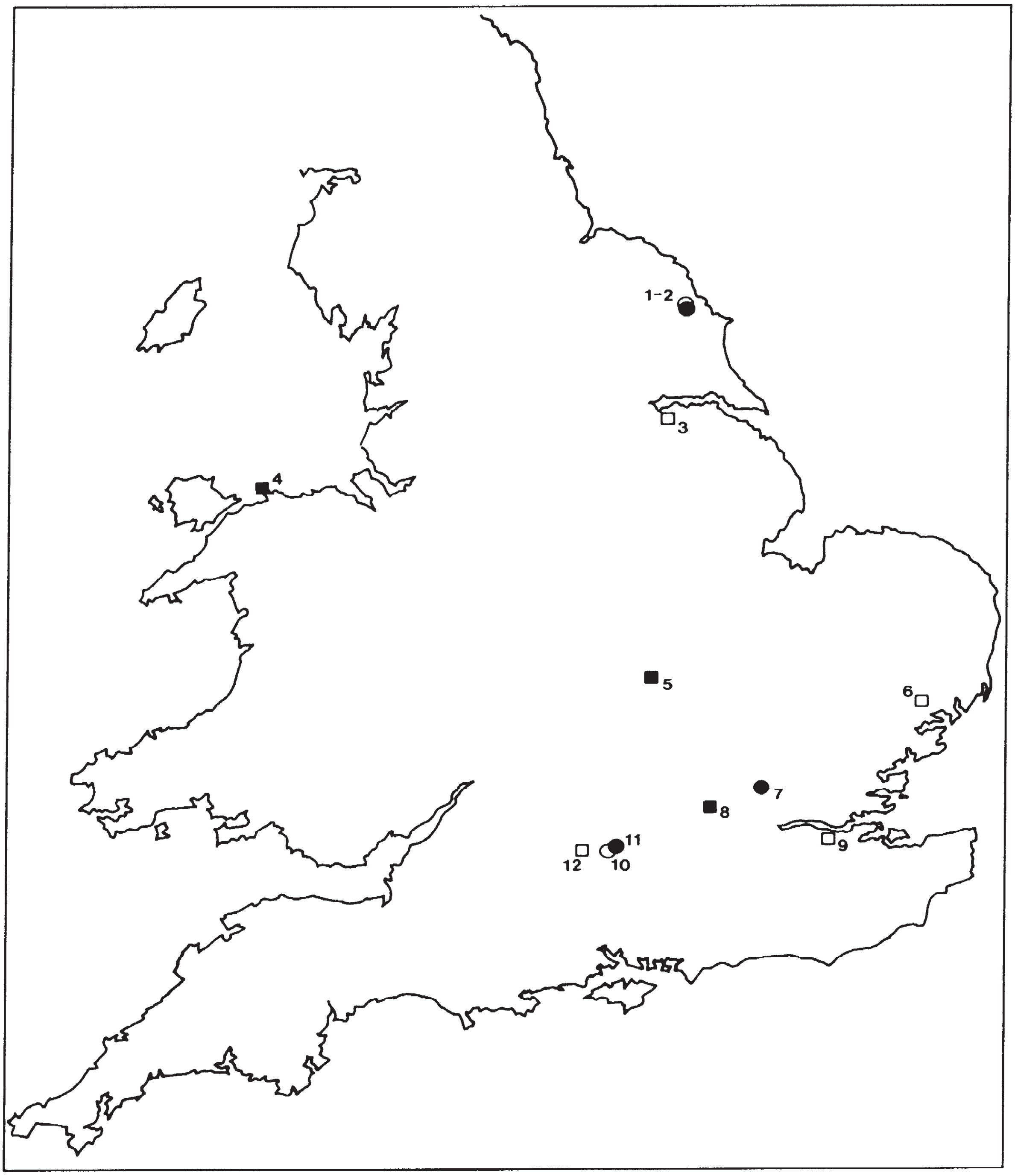

Figure 22.1 Late Glacial and Early Postglacial findspots. Younger Dryas/early Pre-Boreal: (open squares) assemblages attributed to these zones; (solid squares) radiocarbon dated bone and antler artefacts. Mid/late Pre-Boreal: (open circles) assemblages attributed to these sub-zones; (solid circles) radiocarbon dated bone and antler artefacts. Key to findspots: 1, 2) Star Carr, Seamer Carr; 3) Risby Warren; 4) Kendrick's Cave; 5) Earl's Barton; 6) Devil's Wood Pit, Sproughton; 7) Waltham Abbey; 8) Three Ways Wharf, Uxbridge; 9) Springhead (Lower Floor); 10) Thatcham III; 11) Thatcham N; 12) Avington VI

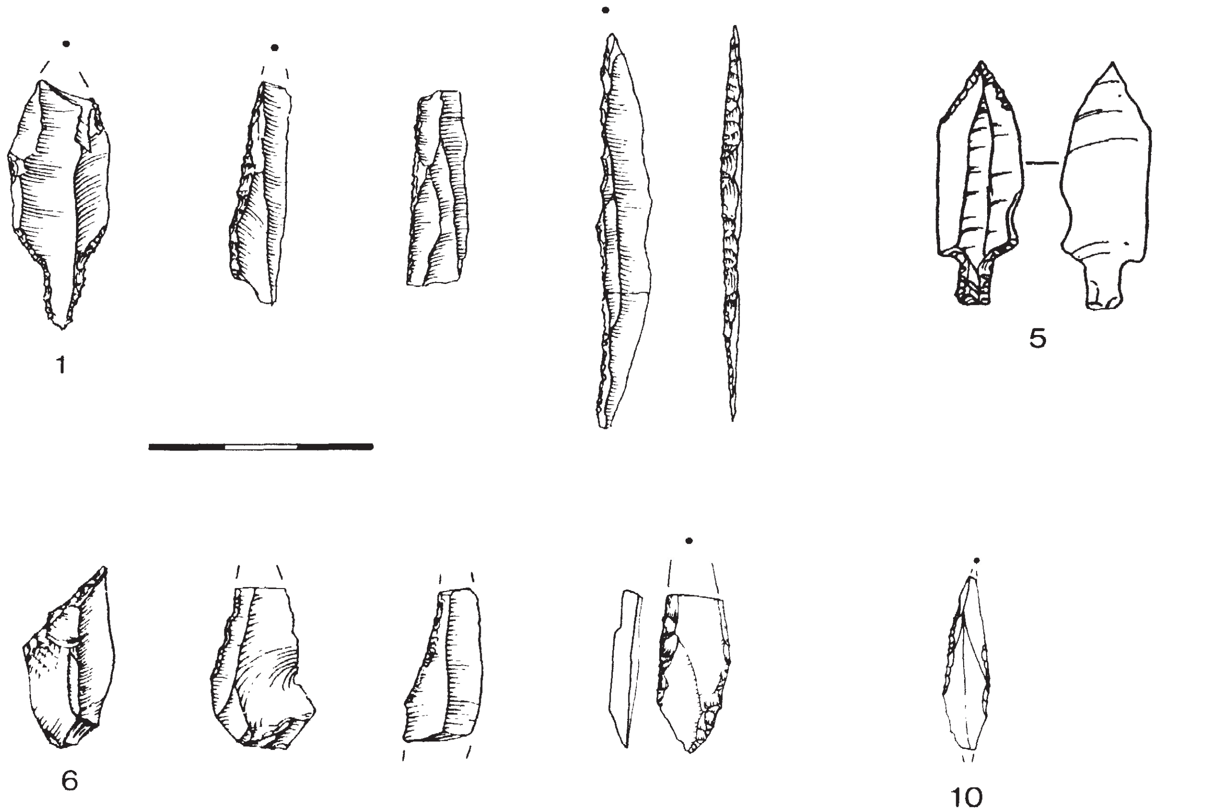

Figure 22.2 Younger Dryas and early Pre-Boreal lithic assemblages. 1) Small tanged point and 2–4) slightly oblique and backed points (Avington VI); 5) small tanged point (Tayfen Road, after West 1971, fig 11); 6) oblique point (Zonhoven point) and 7–9) slightly oblique points (9 with additional retouch) (Sproughton); 10) slightly oblique point with additional retouch (Springhead, Lower Floor). Scale in cm (No 9 is at c 2:1)

Readvance. Although the points were separated vertically by 4 m (Wymer *et al* 1975) they are seen as being effectively the same age (Gowlett *et al* 1986a). Neither of the artefacts, however, can be linked to a lithic technology and as such they probably represent casual hunting losses. Likewise, no lithic associations can be demonstrated for the radiocarbon dated cache of cutmarked red deer bones from Elder Bush Cave, Staffordshire (Bramwell 1964). A dated reindeer antler artefact (cf Lyngby axe) from Earl's Barton, Northamptonshire (Cook & Barton 1986) and a decorated horse mandible from Kendrick's Cave, Gwynedd in Wales (Sieveking 1971; Gillespie *et al* 1985) lend support to the theory that these areas were occupied during the later, drier phase of the stadial.

Despite the absence of directly dated flint assemblages from this period, some hint of the lithic material which could be expected to date from the Younger Dryas is provided by dated collections from north-west Europe. The British evidence comes from individual findspots and other contexts yielding more detailed biostratigraphic information. Examples of the latter are the open-air sites of Avington VI, Berkshire and Risby Warren, South Humberside (Fig 22.1). At the Berkshire site pollen and mollusca recovered from the same level as the *in situ* chipping floor (Barton & Froom 1986) contained mainly disturbed open ground taxa typical of the Younger Dryas (Holyoak 1980). At Risby, two Late Glacial flint assemblages are known from localisations below and above Younger Dryas equivalent coversand (May 1976; Jacobi 1980 and Jacobi, pers comm). Further evidence of contemporary occupation of the same area may be provided by a radiocarbon dated context for a blade end-scraper at Messingham, although on insect faunal grounds the age of the peat deposit concerned seems to be too young (Buckland 1984).

The flint toolkits from Avington VI and Risby Warren (upper assemblage) are distinctive in that they both include diminutive tanged forms typologically identical to north-west European 'Ahrensburgian points' (Fig 22.2; Taute 1968). Further possible examples of such tanged points are known from other British findspots — Doniford Cliff, North Somerset and Tayfen Road, Suffolk (Fig 22.2; West 1971; and Jacobi, pers comm). At Avington VI they are outnumbered by slightly oblique points and backed points (Fig 22.2). Not all

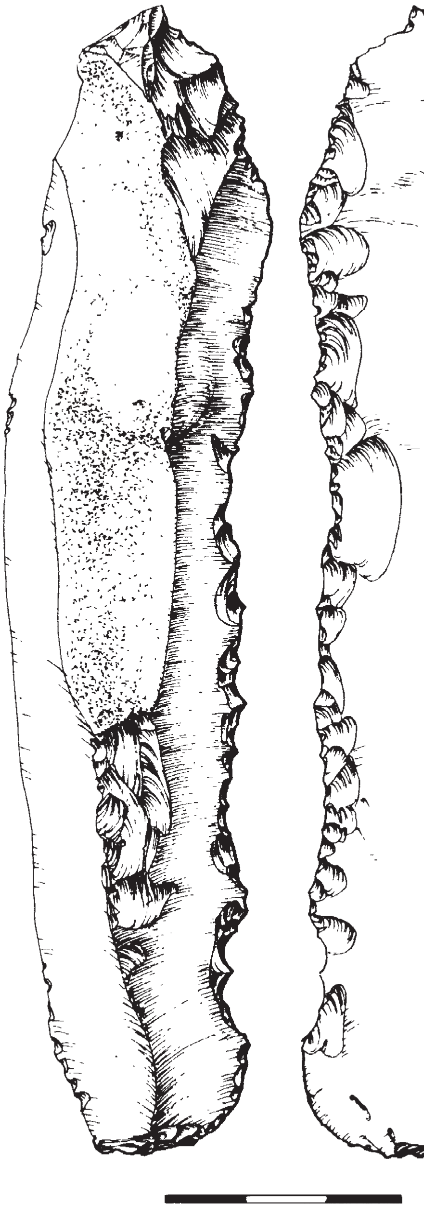

Figure 22.3 An example of a 'bruised blade' (lame mâchurée) *from Riverdale, near Canterbury, Kent (British Museum: Grace Collection). Scale in cm*

of these pieces are strictly microlithic (ie some tools retain their bulbs). This assemblage is also characterised by scrapers on the ends of large blades and blades with 'bruised' edges *(lames mâchurées:* cf Fig 22.3). There is a strong representation of blade blanks in the debitage and a significant proportion (43%) have faceted butts. It could be predicted that British assemblages of similar age would share some if not all of the characteristics outlined above (Table 22.4).

Analogous finds to those in Britain occur in assemblages from north-west Europe. 'Ahrensburgian points' are well-known from the north German site of Stellmoor (Rust 1943) and other findspots in Belgium, Holland, Germany and Poland all belonging to Taute's *Stielspitzen-Gruppen* ('tanged point complex': Taute 1968). These assemblages are all dominantly laminar, and some contain very large blades and blades with 'bruised' margins *(lames mâchurées).* So far the only dated occurrences are at Stellmoor (Fischer & Tauber 1986) and, less reliably, Teltwisch (Otte 1989) where Ahrensburgian levels with bruised blades can be shown to belong to the latest Younger Dryas. A low but recurrent presence of Ahrensburgian points has also been noted in northern French 'epi-palaeolithic' collections (cf Hinout 1989). Sites of presumed equivalent Younger Dryas age, such as Les Blanchères (Rozoy 1978; Schmider 1981), are without a tanged component and show relatively high frequencies of backed points and oblique points, but also backed pieces with straight basal retouch *(Pointes de Malaurie)* which appear to be missing from the British tool inventories of this age.

Early Pre-Boreal

This period represents the earliest warming episode at the beginning of the Holocene epoch. Various contrasting age estimates have been put forward for the onset of Postglacial conditions in Britain (see Housley, this volume). There is also potential conflict in the interpretation of events on the continental mainland where some pollen analysts recognise a Postglacial warming/cooling cycle (cf Friesland/Rammelbeek) prior to the Pre-Boreal (van der Hammen 1951; Casparie & van Zeist 1960; Behre 1967; 1978), though evidence for this event has yet to be formally recognised in Britain.

British earliest Postglacial pollen assemblages are often rich in *Artemisia* and disturbed ground taxa. Recognisable also from many profiles is a subsequent *rise* in *Empetrum* and *Juniperus* (Tipping 1988), the latter becoming a predominant species in Southern Britain soon after 10,000 BP (Scaife 1982). Birch woodland also appears to have become more widespread at around this time (Kerney *et al* 1980) although its early spread may have been geographically restricted to the south and west. Biochronological zonation of the period is helped by dated land molluscan sequences which show a persistence of bare soil species in Kent, south-east England as late as (Q-1508) 9960±170 BP (Kerney 1977).

Indication of a human presence in Britain at this time is restricted to relatively few radiocarbon dated occurrences. Of relevance, if taken at face value, is a dog vertebra *(Canis familiaris)* from Seamer Carr, directly dated to (OxA-1030) 9940±100 BP (Hedges *et al* 1987) but not clearly

Table 22.2 Direct radiocarbon determinations on bone and antler artefacts and human material of mid/late Pre-Boreal and Early Boreal age (Oxford AMS; British Museum and Cambridge conventional method)

Lab No	Sample	Findspot	Date (BP)	Ref
OxA-732	worked antler (red deer)	Thatcham IV (Berkshire)	9760±120	1
OxA-894	burnt antler (elk)	Thatcham IV (Berkshire)	9490±110	1
OxA-1427	barbed point (antler)	Waltham Abbey (Essex)	9790±100	2
OxA-1176	worked antler	Star Carr (N Yorkshire)	9700±160	3
OxA-1154	antler (red deer)	Star Carr (N Yorkshire)	9500±120	3
OxA-500	barbed point (antler)	Earl's Barton (Northants)	9240±160	4
OxA-799	human bone	Aveline's Hole (Somerset)	9100±100	5
BM-471	human bone	Aveline's Hole (Somerset)	9114±110	6
Q-1458	human bone	Aveline's Hole (Somerset)	9090±110	6
OxA-814	human bone (Cheddar Man)	Gough's New Cave (Somerset)	9100±100	5
BM-525	human bone (Cheddar Man)	Gough's New Cave (Somerset)	9080±150	6

References: 1 = Gowlett *et al* 1987; 2 = Hedges *et al* 1989; 3 = Cloutman & Smith 1988; 4 = Gowlett *et al 1986a; 5 = Gowlett et al* 1986b; 6 = Jacobi 1987

linked with any lithic evidence. More helpful is the apparent association of flint artefacts and fragmentary wild horse remains from Three Ways Wharf site at Uxbridge (Lewis, this volume). The central values for the two dates on a single horse specimen (tooth and mandible) fall close to *c* 10,000 BP. If not themselves unequivocal, they provide very strong circumstantial evidence for human activity in Britain at this time.

Other possible candidates of early Pre-Boreal age are the lithic assemblages from Sproughton, Suffolk and Springhead, north Kent (Barton 1989). The Sproughton flint industry comes from the same gravel pit as the two barbed points but from stratigraphically higher in the profile (Wymer 1976). The flint artefacts were discarded on the surface of a buried channel soon after its infilling with sediment (Rose in Wymer 1976, 12). This event is believed to have occurred during the early Pre-Boreal according to radiocarbon dated willow twigs from the upper part of the channel. By implication, this provides a maximum age for the industry of (HAR-259) 9,880±120 BP (Wymer 1976, 10). The Springhead assemblage (Lower Floor) is likely, from its reported context, to be more securely dated within some part of zone **(a)** of the local molluscan biostratigraphy (Jacobi 1988) and thus close to the Pleistocene/Holocene boundary (Kerney 1977).

Both of these lithic assemblages together with that from Uxbridge (scatter A) share some similarities with local 'Early Mesolithic' facies, but there are also a number of significant differences which, if interpreted correctly, could signal a genuinely earlier stage in the development of Postglacial flint technologies. Characteristic of the small retouched equipment are broad oblique points, sometimes with additional chipped modification (Fig 22.2). The fact that not all of the tools are retouched proximally is reflected by the scarcity or total absence of microburins at these sites. A recurrent feature of the utilised debitage are large blades with heavily crushed or 'bruised' edges which also appear in the assemblages of Younger Dryas type (see above). Apparently absent from these early Pre-Boreal toolkits are a number of artefact types including broad microlithic isosceles triangles, drill-bits (steep bilaterally retouched bladelets), microdenticulates and adzes or axes, as well as the characteristic debitage from their manufacture and resharpening. As will be argued below, these only become progressively more common from the middle of the Pre-Boreal.

Typological comparisons for the British assemblages may be found amongst north German sites originally classified as Ahrensburgian by Taute (1968) but dominated by oblique points (Zonhoven points) and without the characteristic tanged forms or triangles. These include the collections from Immenbeck III, Gifhorn, Eitzmuhlen, and Minstedt (data from Taute 1968). If these do represent contemporary facies of the Ahrensburgian, as Taute believed, they may just pre-date the British examples. Significantly, the Lower Saxony sites also contain large well-made blades, utilised or 'bruised' blades and lack the diversity of tool forms typically associated with the Duvensee group of Early Mesolithic assemblages.

Overlapping chronologically with these findspots is material from several sites in northern France from the Somme valley and its tributaries (Fagnart 1988). Dates for the best-known locality, Belloy-sur-Somme, suggest occupation at close to about 10,000 radiocarbon years BP (Gowlett *et al* 1986b).

Table 22.3 Early series of conventional radiocarbon determinations from Thatcham III and V and Star Carr (Cambridge and Chicago)

Lab No	Sample	Findspot	Date (BP)	Ref
Q-658	C (bulked)	Thatcham III (Berkshire)	10,030±170	1
Q-659	C ('hearth')	Thatcham III	10,365±170	1
Q-652a	W pine	Thatcham V (Berkshire)	9480±160	1
Q-652b	W (repeat)	Thatcham V	9500±160	1
Q-650	W sp? (bulked)	Thatcham V	9670±160	1
Q-677	W sp? (bulked)	Thatcham V	9780±200	1
Q-651	W birch & pine	Thatcham V	9840±160	1
Q-14	C	Star Carr (N Yorkshire)	9557±210	2
C-353	C	Star Carr	9488±350	2

Sample key: C = charcoal; W = wood.
References: 1 = Churchhill 1962; 2 = Clark 1954

The excavated artefact inventory from this site is structurally very similar to the British assemblages with oblique points and large well- made blades, including many with 'bruised' margins (Fagnart, this volume).

Mid/late Pre-Boreal and early Boreal

The first unequivocal records of flint toolkits combining microlithic forms (oblique points and broad triangles) with transversely-sharpened core axes and adzes can be argued to date no earlier than the middle of the Pre-Boreal. Their first occurrence in Britain coincides with a time of developing birch and pine woodland and may just precede the steep rise in the growth of hazel *(Corylus)* usually considered to mark the beginning of the Boreal (Walker & Godwin 1954). In north Britain, within areas of established birch woodland, the expansion of hazel may have occurred as early as 9600 BP (Cloutman & Smith 1988). Elsewhere in the south of the country this event is not securely dated, but the earliest rise in the Postglacial hazel pollen curve can be shown to have taken place against a background of developed pine woodland (Scaife 1987).

Amongst the few sites which can be confidently ascribed to the Pre-Boreal are the lake-edge occupations at Star Carr and Seamer Carr in the Vale of Pickering, North Yorkshire. Recent palaeoenvironmental work by Cloutman (Cloutman 1988) next to the *locus classicus* has demonstrated that the main occupation at Star Carr correlates with the 'wood layer and underlying charcoal layer' *(ibid,* 45), the base of which would appear to have formed no earlier than (CAR-1020) 9720±80 BP These deposits contain flint, bone and antler artefacts associated with the occupation of the adjacent landsurface. A direct AMS date on a worked red deer antler from the deposit immediately above the wood layer (Table 22.2) also shows close agreement with conventional radiocarbon dates reported for wood fragments from the original excavations by Grahame Clark (1954 and Table 22.3). Overlapping the results from Star Carr are a series of radiocarbon determinations for sites K and C at Seamer Carr which range in age from *c* 9600–9100 BP (Schadla-Hall, pers comm). Both sites have produced lithic assemblages which include microlithic oblique points, broad isosceles triangles and axe re-sharpening flakes (David, pers comm). These locations at the eastern end of 'Lake Pickering' thus provide some of the earliest evidence for the new toolkits in the mid Pre-Boreal period.

Similar hints are to be found amongst data from the southern English locations at Thatcham in the Kennet Valley, Berkshire (Wymer 1962). Here, palaeoenvironmental work by Churchill (1962) showed that human occupation of a low gravel terrace was reflected by changes in sediment colour within adjacent limnic deposits. Radiocarbon determinations on stratified pine and birchwood samples from within these deposits at Thatcham V (Table 22.3) show an important sediment boundary at around 9700 BP. Independent confirmation of the relative age of the sediments is provided by pollen data from the same profile. The significant increase in flint artefacts above this mid/late Pre-Boreal level suggest that commencement of occupation of the nearby landsurface (Thatcham III) had begun not long before 9700 BP. This interpretation is also supported by the direct date on a worked red deer antler beam from the nearby location of Thatcham IV (Table 22.2).

The lithic assemblage from Thatcham III contains oblique points, microlithic triangles, drill-bits, microdenticulates and transversely-

Table 22.4 Proposed archaeological sequence for the British Late Glacial and early Postglacial

Chronozone	Assemblages: Lithic toolkit	Assemblages: Lithic debitage	Assemblages: Bone & antler	Sites
Boreal				
c 9400 BP				
mid/late	oblique points (microlithic) triangles drill-bits m'denticulates adzes/axes end-scrapers burins	blade/lets butts plain many microburins		Star Carr Seamer Carr (Site K) Thatcham III *Waltham Abbey *Thatcham IV
Pre-Boreal early	oblique points backed points (microlithic/non- microlithic) bruised blades' end-scrapers burins	blade/lets butts plain & faceted microburins	uniserial barbed points	Sproughton Springhead (Lower Floor) Uxbridge (Scatter A)
c 10,000 BP				
Younger Dryas	oblique points backed points (microlithic/non- microlithic) tanged points bruised blades' end-scrapers burins	blade/lets butts plain & faceted few microburins		*Kendrick's Cave Avington VI *Earl's Barton

*Dated bone and antler objects (see text)

sharpened axes. The two existing radiocarbon dates from amongst the flint scatters of the terrace (Table 22.3) do not compare well with the dated sequence from the adjacent limnic sediments and appear 'too old'. Reasons for this discrepancy may be due to bulk sampling which has incorporated organic materials of different ages. Certainly the reported presence of hazel nut shells amongst the material used to make up Q-658 would seem to support this interpretation. However, if the dates are unaffected in this way they could be attributed to repeated occupation events with loss of the earlier component within the larger population of later artefacts.

Lithic artefacts of strikingly similar types to those in the Star Carr/Seamer Carr assemblages can be documented in the north-west European record from about 9700 BP onwards. Some of the earliest finds occur at the sites of Friesack, Bedburg-Königshoven, Duvensee 8 (Germany), Klosterlund (Denmark) and Henninge Boställe (Sweden). At Friesack the first of the artefactual levels can be dated to (Bln-3036) 9680±70 BP and these are stratified beneath a thick succession of deposits of Boreal to early Atlantic age which have produced an ordered sequence of over 26 radiocarbon determinations (Gramsch & Kloss 1989). Reliable mid/late Pre-Boreal dates are also known from birch bark matting (Kl-1818: 9640±100 BP) at Duvensee habitation 8 (Bokelmann *et al* 1981) and from a comprehensively dated series of archaeological deposits at Bedburg-Königshoven (Street, this volume).

Discussion and conclusions

Given the nature and rapidity of climatic improvement at the end of the Pleistocene it is perhaps remarkable that events of such magnitude were reflected in so few obvious changes in the material equipment of contemporary hunter-gatherers. Clark and Thompson (1954) and Clark (1980) have already pointed to the degree of cultural continuity between the Upper Palaeolithic and Mesolithic. They cite as examples the continued use of the groove and splinter technique for extracting bone and antler blanks and the retention of backed bladelets and burins in the lithic toolkit. Such observations serve to underline the fact that the same basic equipment forms part of a much longer European leptolithic tradition stretching back over 30,000 years and spanning other major climatic fluctuations.

Among the most significant technological innovations during the Late Pleistocene in north-west Europe was probably the (?re-)introduction of the bow and arrow. The first certain evidence of this kind comes in the form of pinewood arrowshafts and possible bow staves recovered from the Latest Glacial levels at Stellmoor in north Germany (Rust 1943; Fischer & Tauber 1986). Lithic finds from this site and others indicate that small tanged flint, projectiles and oblique points, formed an essential part of the bow hunting technology. The occurrence of identical tool types across much of north-west Europe, sometimes accompanied by arrowshaft smoothing stones (Taute 1968), provides circumstantial indications of the widespread adoption of archery equipment, at this time. The subsistence economies of this period appear to have been based largely on hunting of reindeer herds of the open plains rather than game occupying woodland environments.

In Britain, a continuity in technological tradition is emphasised by a lack of essential differences between Younger Dryas and early Pre-Boreal lithic assemblages, although there is a little comparative information on the organic components. The lithic projectile equipment shows the presence of oblique points and, very rarely, tanged pieces. This may be due to factors of chronology, with tanged points being gradually replaced by oblique points (Gob, this volume), or simply to a stylistic preference for oblique weaponheads in the western and southern fringes of the north European area (Barton 1989). Apart from the projectiles and possibly some end-scrapers, there are no other elements of potentially haftable equipment. Amongst the other consistently recurring artefacts are very large 'bruised' blades *(lames mâchurées)* which, according to the interpretation of edge-wear patterns (Barton 1986), may have had a hunting-related function (eg butchery knives, tools for the repair of bone and antler equipment). Characteristically, these assemblages lack axes/adzes, drill-bits and microdenticulates, as well as the range of microlith types which become progressively more common from the mid Pre-Boreal onwards.

A review of the available dating evidence for Britain and north-west Europe suggests that after about 9700 BP chipped stone assemblages of a slightly different aspect become very much more abundant in the archaeological record. In Britain, such assemblages are typified by the appearance of supplementary microlith forms (notably broad triangles) and a range of other composite flint equipment including transversely-sharpened core axes/adzes designed for use in wooden or antler handles. In practical terms the axes/adzes are unlikely simply to be the functional equivalents of the 'bruised' long blades. For one thing, the re-sharpening flakes and tranchet edges of the adzes seldom if ever display the same severe degree of damage present on the blade margins. Furthermore, rare examples of flakes with bruised edges do occur in collections containing axes/adzes. Apart from typological and morphological indicators, further divergence is recognisable in the increased use of the microburin technique and differences in the core reduction and blank manufacturing methods (Barton 1989). The variation observed in the lithic assemblages of these periods, therefore, is greater than would otherwise be expected for technologically related but functionally divergent toolkits (cf Clark 1932). In consequence there would appear to be strong circumstantial evidence for the presence of at, least two lithic technologies in Britain, narrowly separated in time but overlapping in their geographical distribution.

Although there are insufficient data yet available for determining exact causes of technological changes in the mid/late Pre-Boreal toolkits it is interesting to note the first appearance of axes/adzes as potential items of woodworking equipment at this time. It is no coincidence that the expansion of closed forest and the rise in hazel can also be documented from just this part of the chronozone, as can the occurrence of woodland indicators amongst the hunted faunas (Clark 1954; Wymer 1962). Given this combination of factors it is reasonable to infer that significant changes in human subsistence patterns were made necessary by the spread of denser woodland. Currently available evidence suggests that both vegetational and technological developments took place broadly synchronously in Britain and north-west Europe several hundred years after the beginning of the Postglacial amelioration. The appearance of new elements in the toolkit marks a significant departure from the continuity exhibited between the Late Pleistocene and the very earliest Holocene technologies.

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23 A Late Glacial and early Postglacial site at Three Ways Wharf, Uxbridge, England: Interim report

John Lewis

Abstract

A series of excavations between 1986 and 1988 on a site in the bottom of the Colne Valley (Middlesex), revealed major *in situ* lithic and faunal scatters. It is inferred that both represent the remains of hunting and gathering activity. Scatter 'A' contained flintwork and associated reindeer and horse skeletal material dated to *c* 10,000 BP. In contrast, scatter 'C' produced typically Early Mesolithic flintwork and an associated fauna of red deer. The site at Three Ways Wharf therefore provides a rare opportunity to study the archaeological and environmental transition between the late Devensian and early Flandrian in Britain.

Introduction

Uxbridge is situated at the north-western periphery of Greater London, adjacent to the River Colne, a major tributary of the Thames. The Lower Colne Valley is aligned north-south and is cut through older Thames terrace sediments resting on Lower Tertiary deposits, and, above Denham, on Chalk bedrock (Gibbard 1985, 82). Three Ways Wharf occupies a low-lying site at the north-western edge of Uxbridge in the valley-bottom, 75 m from the present course of the river (Fig 23.1).

The excavation at Three Ways Wharf, Uxbridge, carried out by the Museum of London's Department of Greater London Archaeology, attempted to locate any surviving prehistoric deposits in the valley bottom, following up earlier fieldwork by A D Lacaille and others (Lacaille 1961; 1963) which had established the presence of a number of Mesolithic sites in the area.

Accordingly, trial excavations were carried out in 1986, with further full scale excavations undertaken in 1987–88. These revealed an undisturbed sequence of sediments containing *in situ* flint artefacts and associated fauna which offered the first opportunity in Britain for dating and characterising the transition between the late Devensian and early Flandrian, a period hitherto poorly understood in this country.

This article is intended to expand on an initial statement of the results obtained from the earliest deposits on the site (Lewis 1989). Later material, which includes a series of later prehistoric, medieval and post-medieval features will be considered elsewhere. It must be stressed that the great majority of post-excavation analysis is still to be carried out, the results of which will necessarily modify the views expressed here.

Stratigraphy

The basal deposits are of fluvial origin and consist of Colney Street Gravels (Gibbard 1985, 81–5) overlain by argillaceous sediments deposited by gentle overbank flooding (Figs 23.2 and 23.3). At the top of this sequence is a grey clay horizon which contained the *in situ* flint artefact and faunal assemblages. Overlying and sealing this horizon was a black clay containing large amounts of charcoal and organic material. The whole sequence appeared undisturbed with no major temporal or spatial unconformities (Collcutt nd). Stratified above the black clay was a locally reworked calcareous tufa and a layer of grey/brown clay, which produced finds of a possible Late Neolithic/Early Bronze Age date. The rest of the sequence was composed of medieval and post-medieval deposits.

Excavation methodology

The multi-disciplinary project was aimed at studying the archaeology within a detailed palaeoenvironmental and palaeotopographical framework.

An area *c* 34 m x 24 m was mechanically stripped to a depth of *c* 1.80 m (ie just above the black clay deposit identified in the trial work). Three test trenches were also cut to assess the nature of the deposits north of the backfilled canal dock. Manual excavation then commenced, initially in the area of

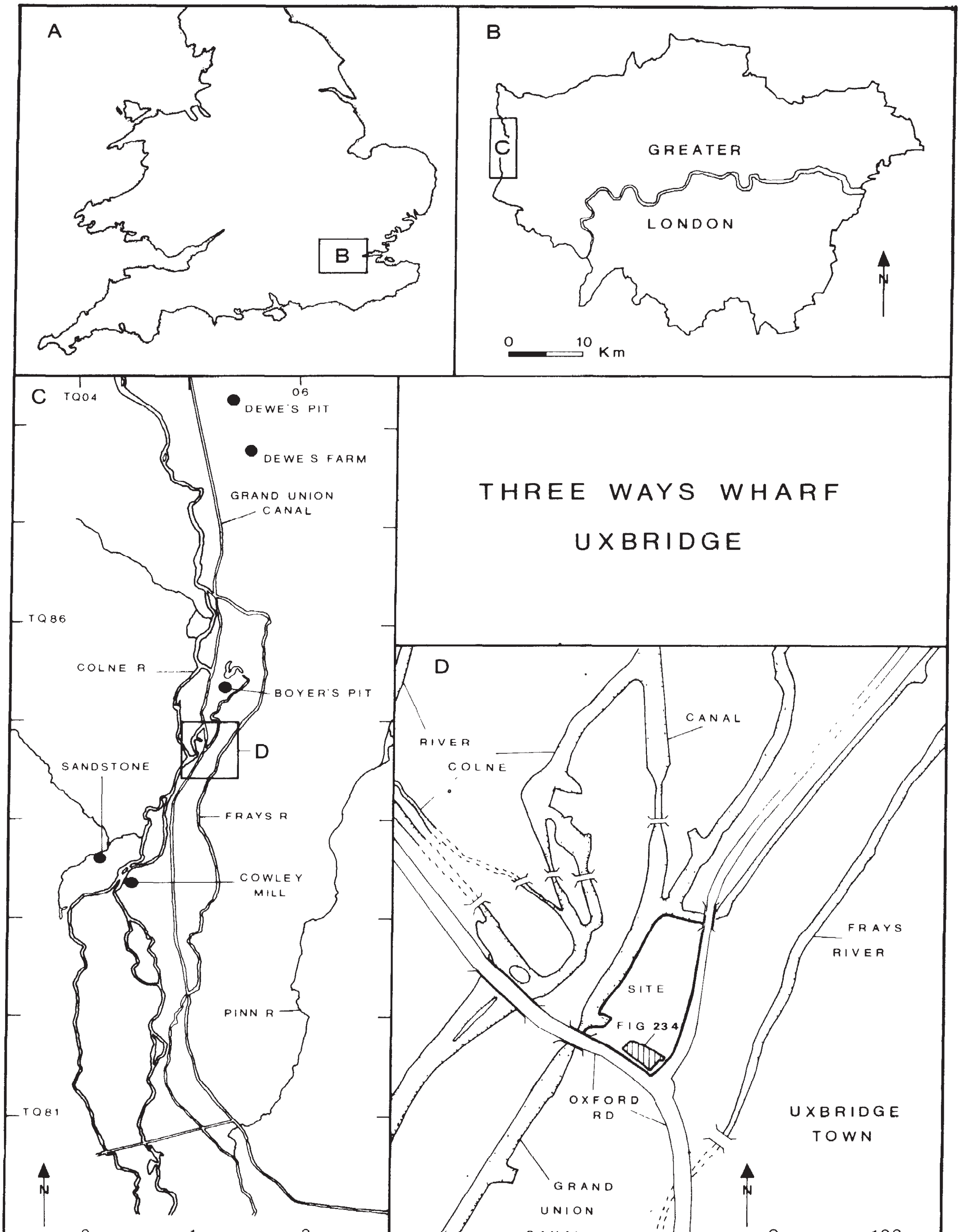

Figure 23.1 Location map of the Three Ways Wharf site, Uxbridge, and other Mesolithic sites in the Colne Valley

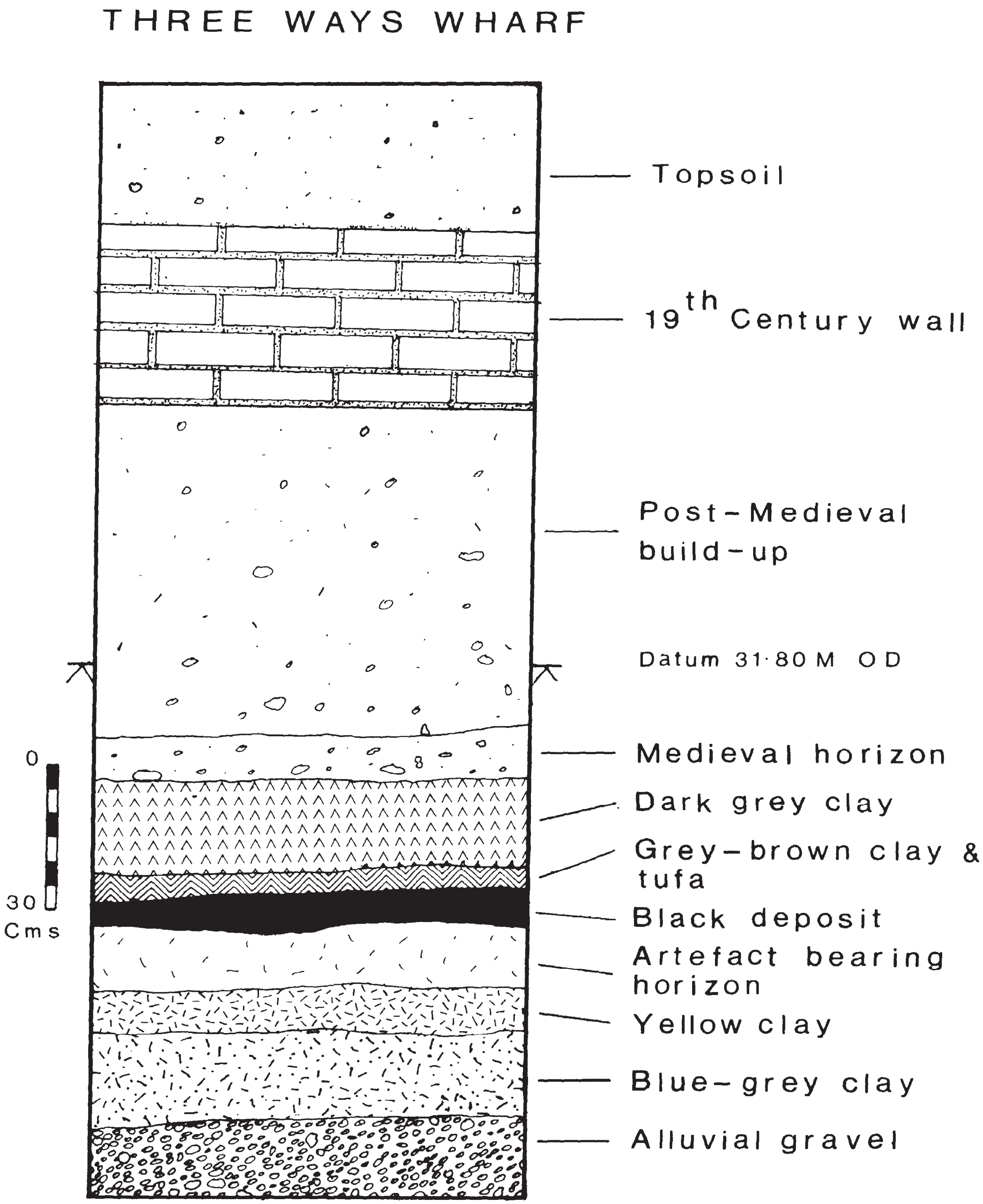

Figure 23.2 Section through stratigraphy

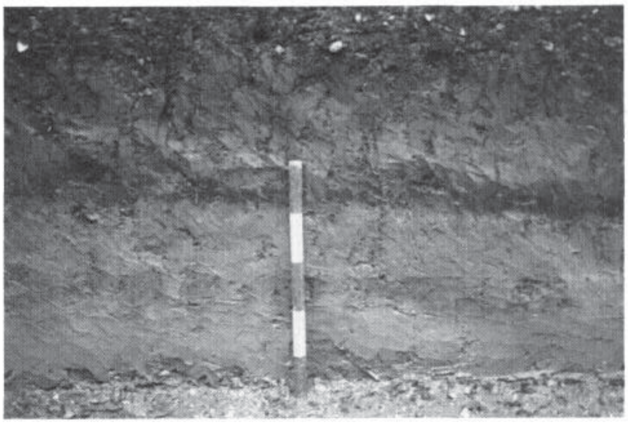

Figure 23.3 Basal sediments, illustrating artefact bearing horizon and the overlying black clay (see Fig 23.2)

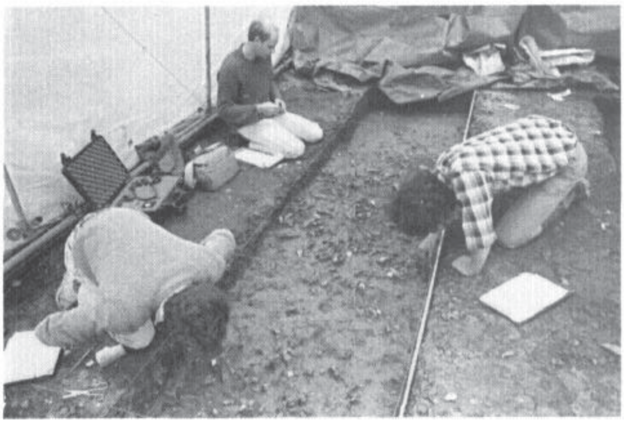

Figure 23.5 Scatter 'C' under excavation

the flint and fauna1 scatter ('A'), which had been detected during the trial work. To map the topography of the sediments and to detect further flint scatters, the site was sampled using 1 m² test pits located at 4 m intervals. This resulted in the discovery of scatters 'B' and 'C' (Fig 23.4).

Recording was based on 0.25 m squares. Sediment was removed in 20–50 mm spits, with the spot heights of each spit being recorded. All flints >10 mm and bone >50 mm were three-dimensionally recorded (Fig 23.5). Finds under these sizes were merely assigned to their respective 0.25 m square and spit. The orientation of all flint and bone from scatters 'A' and 'B' was recorded; these data were selectively recorded in scatter 'C'.

The excavated sediment (in excess of 30 tonnes) was sieved on site or as part of the post-excavation sieving programme. This had two aspects; recovery of microdebitage and microfauna. The latter involved sieving the sediment from selected squares at a mesh size of 0.85 mm. For micro-debitage, all artefact bearing sediment from

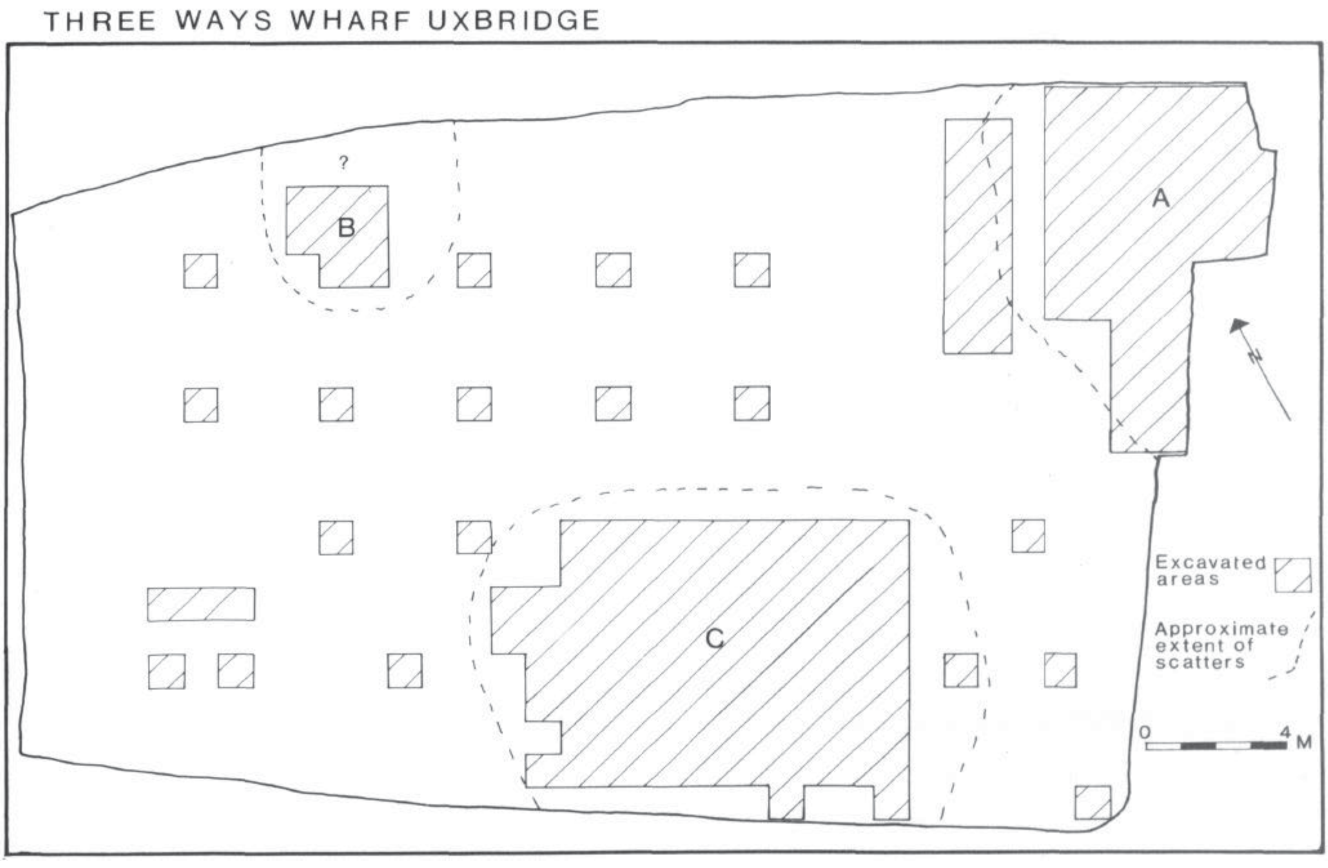

Figure 23.4 Three Ways Wharf: site plan

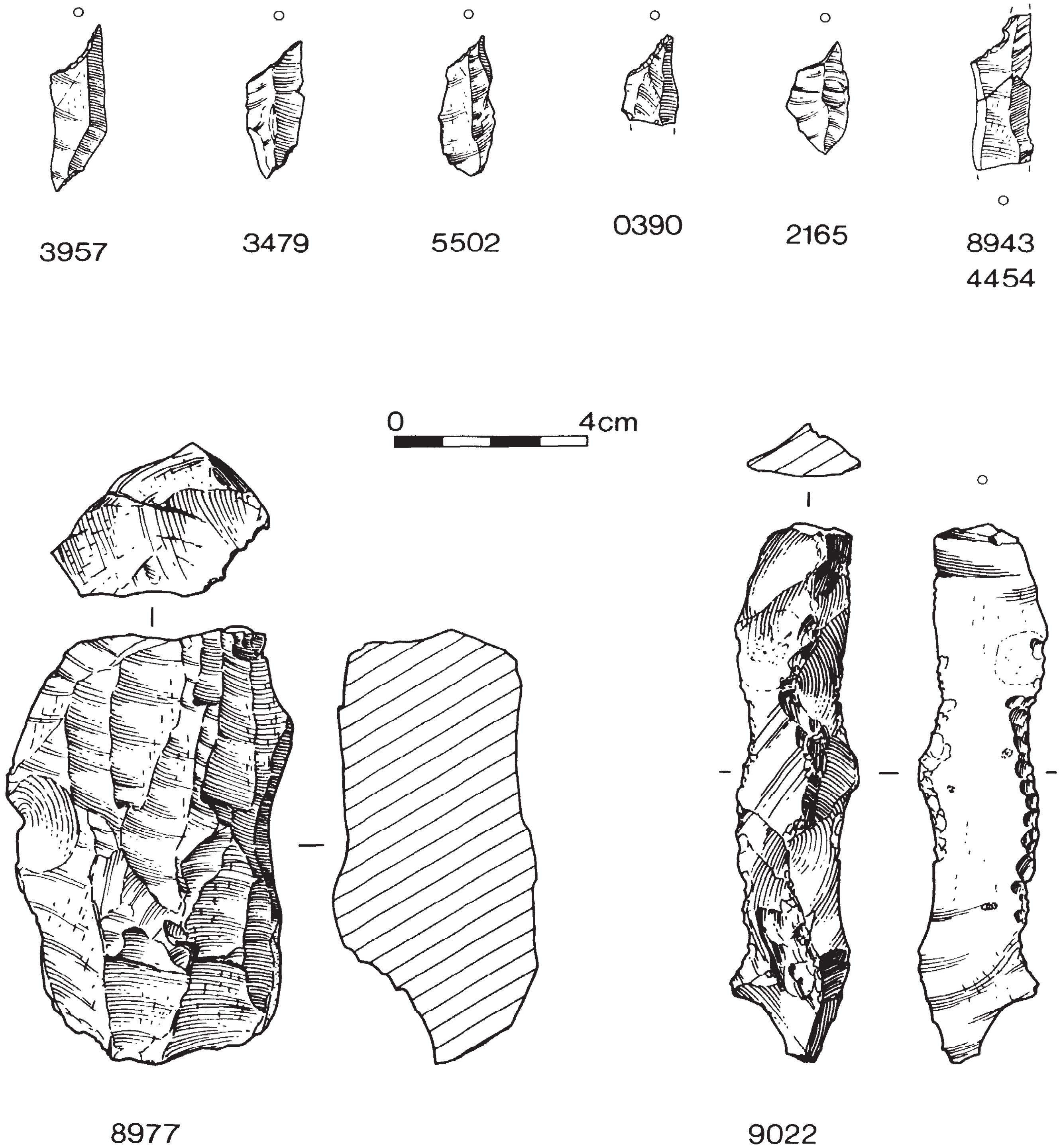

Figure 23.6 Selection of flintwork from scatter 'A': 3957, 3479, 5502, 0390, 2165, 8943/4454 = microliths; 8977 = opposed platform blade core; 9022 = lame mâchurée. *Scale in cm*

Figure 23.7 Faceted opposed platform blade core and refitting debitage. Length of core is c 175 mm

the flint scatters was sieved at mesh sizes of 3 mm and 1.5 mm. Debitage >3 mm will provide an understanding of the taphonomy of the site while residues >1.5 mm will be selectively sampled to augment the microdebitage and microfaunal data.

Results

It is possible to interpret the sediments as permanently damp surfaces temporarily stabilised by sedge cover. Human occupation would have occurred on these surfaces prior to their being

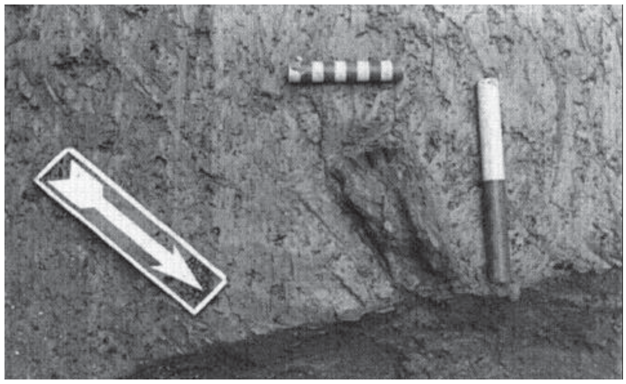

Figure 23.8 Horse mandible, scatter 'A'

buried by sediment from more overbank flooding. On the basis of pollen analysis, the black layer sealing the artefact-bearing grey clay may date from *c* 8500 BP to *c* 8000 BP and has been interpreted as a sedge swamp (Wiltshire, nd). The very large quantities of charcoal present in the black layer were probably derived from *in situ* burning and from inwashed soils made unstable by the burning of the surface vegetation (Macphail & Wiltshire, pers comm). Beneath the black layer, three distinct flint and faunal scatters were defined: 'A', 'B', and 'C', (Fig 23.4), with scatters 'A' and 'C' producing significant quantities of material. These scatters seem to represent at least two distinct phases of occupation: scatter 'A' dating to the end of Dryas III, and scatter 'C' to the early Postglacial. Scatter 'B' is at present undated.

Scatter 'A' (Late Glacial)

Scatter 'A' was located at the eastern edge of the site and appeared to continue beneath the adjacent road (Fig 23.4), thus making an estimate of its full extent difficult. A total area of 64 m^2 was excavated, producing *c* 700 flint artefacts and *c* 100 fragments

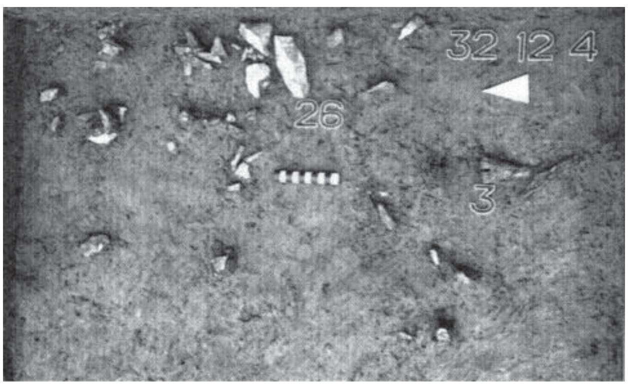

Figure 23.9 Lithic and faunal material in part of scatter 'A'

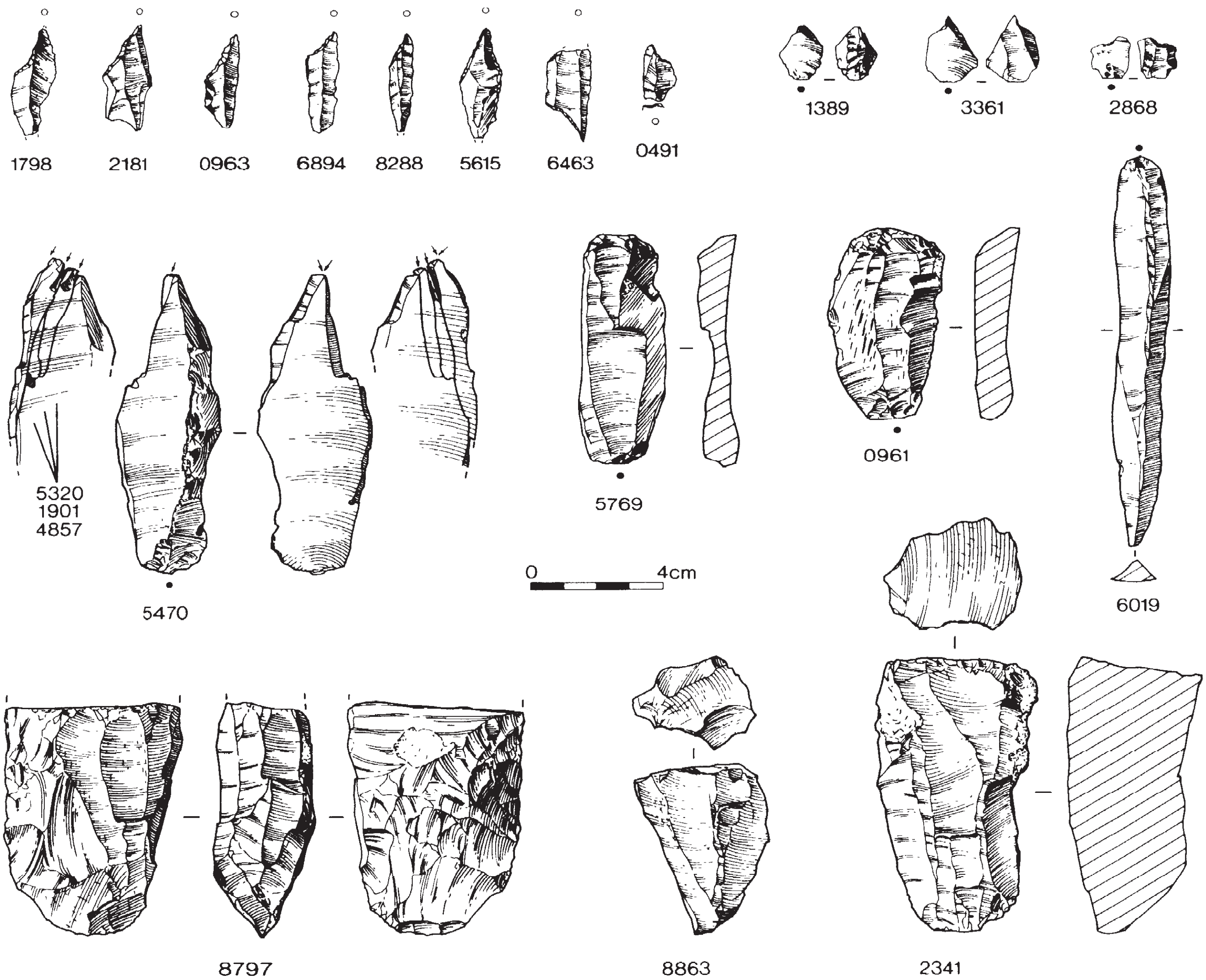

Figure 23.10 Selection of flintwork from scatter 'C': 1798, 2181, 0963, 6894, 8288, 5615, 6463, 0491 = microliths; 1389, 3361, 2868 = microburins; 5470 = dihedral burin with refitting spalls (5320, 1901, 4857); 5769, 0961 = end-scrapers; 6019 = blade; 8797 = tranchet axe fragment, reused as core; 8863 = pyramidal core; 2341 = opposed platform core. Scale in cm

fragments of bone. The flint assemblage includes opposed platform blade cores, obliquely backed points and a heavily edge-damaged crested blade *(lame mâchurée)* (Fig 23.6). The rest of the assemblage is composed of knapping waste and unretouched flakes and blades, a number of which display faceted butts. Figure 23.7 illustrates debitage refitting back to an opposed platform blade core.

The retouched tool element represents *c* 1% of the assemblage and is composed of six obliquely backed points, at least four of which were produced from opposed platform cores. All six have been truncated at their proximal end, while two have additional retouch at the distal end producing a rather distinctive shape (Fig 23.6). No microburins have yet been identified in the assemblage.

The fauna so far identified consists of a horse mandible (Fig 23.8) and fragments of reindeer bones. A few pig teeth were also present.

Although the overall density of lithic and faunal material within scatter 'A' is fairly low (Fig 23.9), two areas of higher flint concentration were evident, and refitting has shown that these represent discrete knapping areas. Post-depositional lateral movement is of a very small order. The refitting flints are distributed vertically through approximately 150 mm of sediment, indicating that the scatter represents one phase of activity rather than successive occupation horizons.

Scatter 'B' (Undated)

The low density of flintwork recovered suggests that the excavated area lies at the edge of a more substantial scatter to the north. If so, construction of a now backfilled canal dock in the 1790s will have destroyed the archaeological deposits. In addition, the excavated area of 8 m^2 had been disturbed by medieval features. The 24 pieces of flintwork from scatter 'B' are undiagnostic, apart from a small opposed platform blade core.

Scatter 'C' (Early Postglacial)

Scatter 'C' covered an area of *c* 130 m^2, of which 90 m^2 was excavated. In total *c* 7000 flints and *c* 2000 bone fragments were recovered. Preliminary results from the sieving programme suggest that these totals may be doubled when all the sieved residues have been sorted.

The retouched tool element of scatter 'C' is composed of obliquely backed points (manufactured using microburin technique), end-scrapers, burins and a fragment of a tranchet axe.

Unretouched utilised blades, as well as pyramidal and opposed platform cores rejuvenated by removing core-tablets are also present in the assemblage (Fig 23.10). Typologically, the flintwork appears to be Early Mesolithic in character. The fauna is dominated by red deer bones, some showing evidence of charring. At present, there is *no* evidence of horse or reindeer. Flint and faunal densities in scatter 'C' were very high (Fig 23.11), and individual knapping areas can be identified; data from micro-debitage sorting suggest the presence of at least two microlith production areas.

It would appear that the flint and faunal material has undergone even less lateral movement than that in scatter 'A', whilst the degree of vertical movement is comparable. Preliminary refitting suggests that the scatter represents a single phase of activity, but further work may prove otherwise.

Discussion

The occurrence of mammal bone and flint artefacts in discrete scatters and the presence of both burnt flint and bone among the finds allows the inference that assemblages 'A' and 'C' are products of hunting and food processing. Refitting data, and trends in the microdebitage distribution, suggest that the scatters have undergone a small amount of post-depositional lateral and vertical movement. Macphail (pers comm) has suggested bioturbation as a possible mechanism for this phenomenon.

The contrast between the faunal assemblages from areas 'A' and 'C' suggests a chronological difference between the two scatters, a contrast supported by physical dating methods. Two radiocarbon accelerator dates have been obtained from scatter 'A':

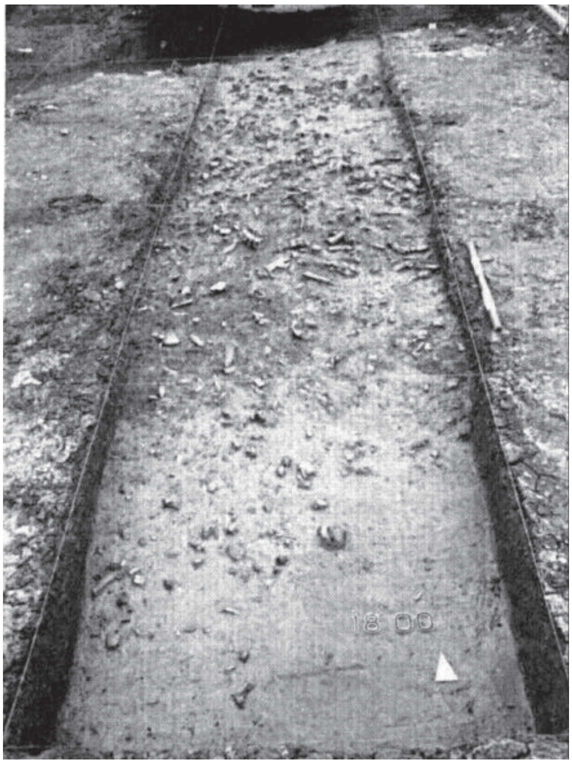

Figure 23.11 Lithic and faunal material in part of scatter 'C'

OxA 1778	horse molar	10,270±100 BP
OxA 1902	horse mandible	10,010±120 BP

These dates would place scatter 'A' at the end of Dryas III, during a warming climatic phase which started around 10,500 BP (Atkinson *et al* 1987).

In contrast, a thermoluminescence date of (OxTL-772f1) 8000±800 BP has been obtained from a piece of burnt flint from scatter 'C'. Combined with the typically Early Mesolithic flint assemblage and red deer fauna, this date would suggest that the occupation represented by scatter 'C' dates to the early Postglacial.

Further work

It is intended that future post-excavation analysis will include the computerisation of the spatial location data. This will allow the archaeological sediments to be mapped three-dimensionally and will provide a framework in which to place the point data for the environmental and lithic assemblages. The post-depositional taphonomic processes may then be studied by combining analysis of the environmental materials with lithic typing, refitting, and microdebitage analysis. These techniques have already been shown to be essential in interpreting the site. After taphonomic processes have been determined to an acceptable level, analysis of the flint and faunal assemblages together with microwear and bone cutmark techniques will allow patterns of spatial and temporal activity to be mapped.

Analysis of the soil micromorphology combined with the microfauna retrieved from the sieving programme should allow a very detailed study of the environment during the Late Glacial/early Postglacial transition, while further radiocarbon and TL dates from scatters 'A' and 'C' will allow these studies to be set within a tightly defined chronological framework.

The site at Three Ways Wharf in its wider perspective

In a local context, the site at Three Ways Wharf can be seen as part of a Mesolithic landscape of sites within the Colne valley (Fig 23.1c). Further analysis, combined with the location and excavation of more sites, may allow us to study Early Mesolithic economic and settlement patterns in the valley. At Three Ways Wharf, the black organic and charcoal rich layer sealing the artefact bearing horizon is of considerable interest, in that it appears to represent successive phases of burning within the Colne valley generally, and specifically of the sedge swamp which had developed on the site. Wiltshire (nd) has suggested that this represents human use of fire for environmental management during pollen zone VI (*c* 8500–8000 BP). Although difficult to prove archaeologically, recent pollen studies in southern Scandinavia (Welinder 1989) have produced evidence that might support such a hypothesis.

Recent excavations by the Department of Greater London Archaeology at Cowley Mill Road, Uxbridge (Fig 23.1c), have revealed small, apparently Mesolithic flint scatters (I Stewart, pers comm). These were also sealed beneath a black clay similar to that found at Three Ways Wharf and at the nearby site of Sandstone (Lacaille 1963).

The archaeology of the Latest Glacial (Dryas III) in Britain is poorly understood. Barton (1989) has drawn attention to sites which have produced flint assemblages dating to the Dryas III/Pre-Boreal transition and which are sufficiently distinct typologically and technologically to form the so called 'Long Blade' industry. The majority of these sites (Barton *ibid)* are found in river valleys where a plentiful supply of good quality flint is available nearby. It is possible to see scatter 'A' from Three Ways Wharf as part of this 'Long Blade' industry on the grounds of typological, faunal, and physical dating evidence.

However, the most striking feature of the assemblages from 'Long Blade' sites such as Avington VI, Berkshire, (Barton & Froom 1986), Sproughton, Suffolk, (Wymer 1976), Gatehampton, Oxfordshire, (T. Allen, pers comm) and the Somme valley sites in France (Fagnart 1988, and this volume) is the very large size of the blades, with many over 150 mm in length. At Uxbridge, the use of river gravel nodules as raw material may have determined the smaller size of the flintwork. The rolled flint nodules were certainly inferior to the raw materials utilised at the above sites. At present, analysis of the Uxbridge flint assemblage is not at a stage where detailed typological and technological comparisons can be made.

Some of the British 'Long Blade' sites such as Avington VI, Springhead, Kent (Burchell 1938), and Sproughton, have been tentatively dated to the Dryas III on the basis of environmental and stratigraphic evidence (Barton 1989). The nearest radiocarbon dated site is Belloy-sur-Somme, France, which has produced a range of dates from horse material centring on 10,000 BP (Fagnart 1988). If the flint artefacts and fauna from scatter 'A' are in true association, we may have for the first time in Britain a securely radiocarbon dated 'Long Blade' assemblage. It is hoped that the data from scatter 'A' may also contribute to our understanding of economic strategies between 11,000 and 10,000 BP, a British research priority recently highlighted by Jacobi (1988,441).

Mesolithic flint scatters are not uncommon, but the association within scatter 'C' of flints, animal bone and other environmental evidence is much rarer. The early Postglacial sites at Thatcham and Star Carr (Wymer 1962; Clark 1954) are the most important comparable sites. On the basis of a recent faunal analysis, Legge and Rowley-Conwy (1988) have reinterpreted Star Carr as a summer hunting camp rather than the winter base camp proposed in earlier work (Clark 1972). The analysis of the Three Ways Wharf faunal collection along similar lines will permit a direct comparison with this study and provide a test for the hypothesis. The material from scatter 'C' provides a rare opportunity to study functional behaviour in an Early Mesolithic hunter-gatherer group.

In conclusion, the Three Ways Wharf site offers an unrivalled opportunity to study the archaeology and environment of the Late Glacial and early Postglacial both in the context of the Colne valley and for Britain as a whole.

Acknowledgements

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24 Bedburg-Königshoven: A Pre-Boreal Mesolithic site in the Lower Rhineland, Germany

Martin Street

Abstract

The site of Bedburg-Königshoven provides new information on the earliest Postglacial settlement in the Lower Rhineland and on environmental conditions during this period. The large mammal fauna from the site shows that the transition from the open landscape of Dryas III to Postglacial conditions was well advanced. The lithic assemblage can in some ways be compared with Final Palaeolithic *(Spätpaläolithikum)* material, but closest parallels are to be found in the northern European Early Mesolithic tradition. For instance, the types of bone tool recovered, especially a 'lissoir', and also frontlets of red deer antler have affinities not with the Tanged Point technocomplex, but with the northern European Mesolithic. The choice of site location is also typical of early Holocene sites such as Star Carr and Hohen Viecheln.

Site topography and stratigraphy

The site of Bedburg-Königshoven lay approximately 20 km to the south-east of Monchengladbach in the valley of the River Erft (Fig 24.1). Here, in the centre of the opencast lignite mine of Garzweiler, a small area left intact by quarrying was found to contain some 500 square metres of early Holocene sediments within a silted-up channel of the Erft. The site had been cut through on two sides by converging quarry faces and was truncated vertically in its northern part. Despite the scale of destruction, old maps and the surviving stratigraphy, together with previous studies of the geography and geology of the region (Averdieck & Döbling 1959; Beckel 1958), allow an accurate reconstruction of the original situation.

It can be established that the site was located within the northern end of a former meander of the River Erft (Fig 24.2). Preserved were only the limnic sediments formed during silting-up of this body of water and overlying peat layers. Terrestrial sediments adjacent to the site, which would have contained the main settlement area, had already been destroyed.

The stratigraphy of the site shows that the land within the curve of the meander has been dominated by wetland conditions since the Late Glacial (Fig 24.3). The base of the recorded section was formed by Upper Pleistocene fluviatile sands and gravels, which at this point are cut into underlying Tertiary lignite deposits. The gravels are covered by waterlaid silts, which show a steady increase in organic content towards the top of the sequence where they are replaced by a gyttja (Ikinger 1989). This latter material, which contains the archaeological horizon, is highly calcareous. Overlying the archaeological horizon is a series of peat deposits. At the base is a reed peat, followed by a well humified wood peat of terrestrial origin (carr). Within the carr-peat deposit occur carbonate bands of sub-aquatic origin (tufa), which point to repeated flooding of the area. The peat deposits had in many places been removed by peat cutting, probably in the medieval period.

The sections were investigated palynologically at the University of Gottingen (Behling 1988), providing information for both the chronological position and the ecological setting of the occupation of the site. A series of twelve samples of wood and peat, taken through the preserved stratigraphic sequence, was submitted to the Radiocarbon Laboratory of the University of Cologne for conventional radiocarbon dating. Nine results have already been obtained, providing a coherent series extending from the base of the fluviatile silts to the top of the carr-peat (Fig 24.4).

The base of the sequence contains little and poorly preserved pollen. An additional problem is provided by the presence of quantities of Tertiary pollen *(Pinus)* and spores derived from the underlying lignite beds. A sample of wood from the base of the silts gave a date of 10,270±90 BP (Fig 24.3.1).

Higher in the sequence it is possible to identify typically Late Glacial species such as *Salix, Juniperus* and *Artemisia.* These dominate the pollen spectrum as high as a thin band of dark organic material dated by radiocarbon to 10,010±85 and 10,070±95 BP (Fig 24.3,2). The mineral

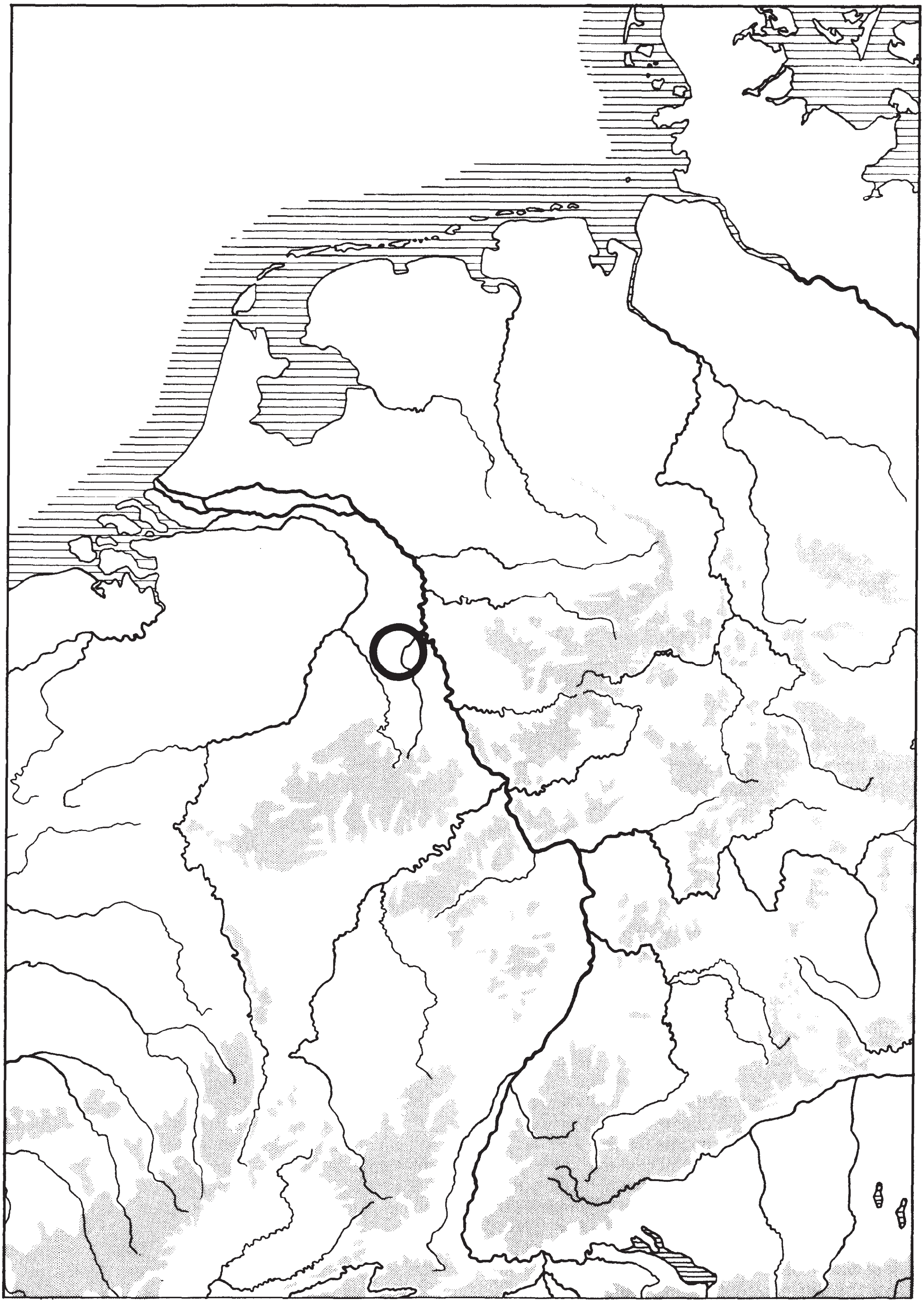

Figure 24.1 The site of Bedburg-Königshven in the Erft Valley, Lower Rhineland, Germany

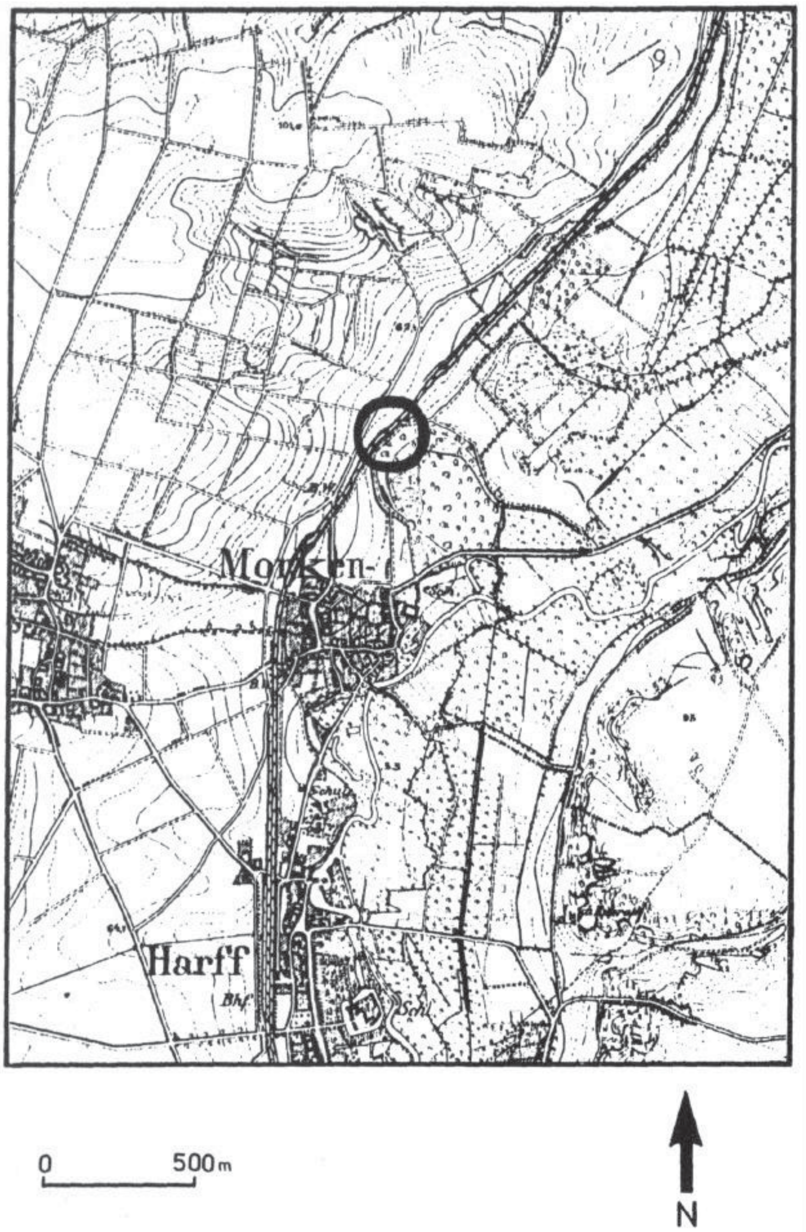

Figure 24.2 Site location within the northern part of a meander of the Erft river, still visible in recent times as an area of wetland

sediments below this organic band represent aggradation during the second half of Dryas III. The younger of the two Lower Terraces of the Rhine was certainly forming in the Lower Rhine Basin within Dryas III, since this terrace contains reworked Laacher See pumice of late Allerød date (Brunnacker 1978); a similar cycle of downcutting and aggradation is also probable for the Erft valley.

In the layers immediately below the dark band the sediment is extremely calcareous, with a high organic content. It contains pollen of waterweeds *(Miriophyllum)* and waterlilies *(Nuphar, Nymphaea)*. This part of the section clearly represents the deposition of material in still water, and falls towards the end of a first cycle of silting.

The thin organic band was identified as a reed peat of late Dryas III age. The pollen spectrum reflects this in high values for bullrush *(Typha)*. Reed *(Phragmites)* is certainly very often lost among the generally high values for *Gramineae*. The presence of these species and the accumulation of peat deposits shows that at the end of Dryas III silting was already far enough advanced for the development of shallow-water plant communities. This relatively short phase, (during which fairly warm water temperatures must have existed for bullrush to thrive), is followed by the development of sub-aquatic gyttja deposits. This is interpreted as a response to rising water levels at the beginning of the Holocene. The upper half of the

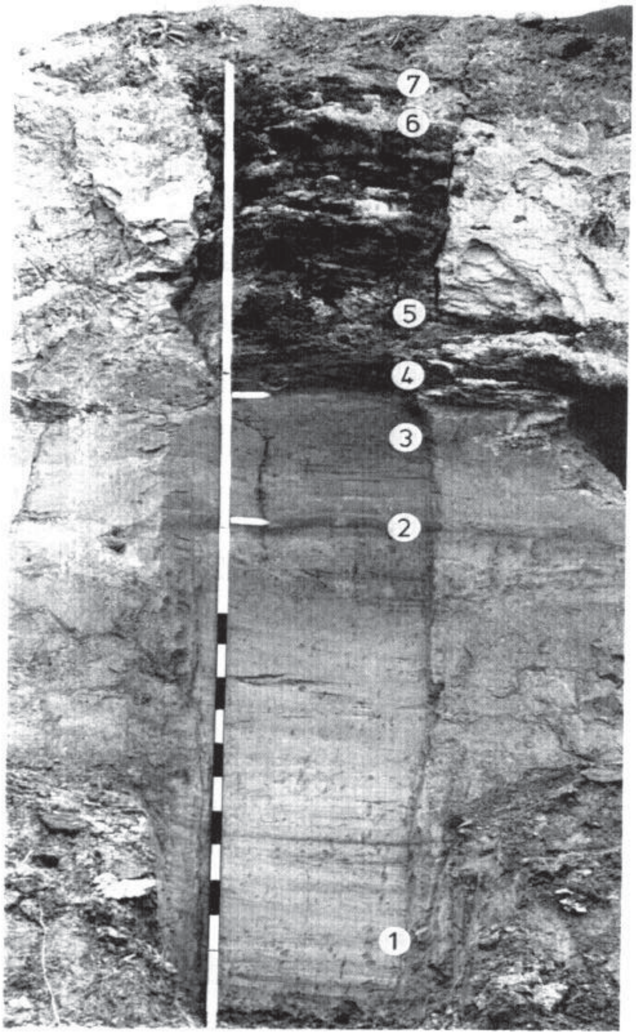

Figure 24.3 Section through the site, showing the series of fluviatile and limnic sediments. The archaeological horizon was situated between the white arrows; the numbers refer to the position of radiocarbon samples mentioned in the text

gyttja deposit contains by far the greatest part of the archaeological material. Two samples of wood from this, the layer containing the archaeological material, gave dates of 9780±100 and 9600±100 BP (Fig 24.3, 3). The silting process continued until the aquatic elements were once again replaced by reed swamp (demonstrated by high values for *Typha).* This species then becomes more common in the reed peat, which seals the gyttja and is dated to 9690±85 BP (Fig 24.3 and Table 24.1). The sequence so far precedes the rise of hazel *(Corylus)* pollen which signals the beginning of the Boreal (= Zone V). The archaeological material is thus sealed by a deposit of late Pre-Boreal date, and must itself be of middle or early Pre-Boreal age.

By contrast with the closely spaced dates for the Dryas III and Pre-Boreal limnic sediments the Boreal carr-peat provided three dates of 9310±80, 9060±85 and 8010±75 BP (Fig 24.3–5 and Table 24.1), indicating a much longer timespan for the accumulation of the terrestrial deposits.

Lithic assemblage

The artefacts recovered in Bedburg are, with few exceptions, manufactured from flint. A range of materials can be recognised, suggesting that more than ten different nodules of flint were worked at the site. Other raw materials were also used, among which are a fine grained quartzite and two varieties of *Kieselschiefer* (metamorphosed slate or lydite). For a total assemblage of less than 200 artefacts the overall estimated number of some fifteen raw material units is relatively high.

It is obvious that by far the greatest proportion of the original assemblage was not recovered. Distribution plans of Mesolithic sites in comparable waterside situations show that the concentration of lithic material on such a site is not the same as that of the preserved bone. The former is logically concentrated on the drier land which was the actual settlement area, while the bones survive in the limnic sediments adjacent to this (eg Henriksen 1976, 36 ff). It is very likely that at Bedburg too the major part of the lithic assemblage was situated on the raised ground to the north of the surviving section of the site and was not therefore present in the area investigated.

Most of the flint used derives from Pleistocene gravels of the River Meuse, and often has the rolled cortex typical of gravel flint. Flint-bearing gravels occur for the most part to the west of the River Rur, some 25 km to the south-west, although flint can also be found sporadically in gravels closer to the site (cf Heinen 1990). A few pieces however have a chalk cortex which is so fresh that it suggests a primary source within the Cretaceous formations west of Aachen, 50 km to the south-west of the site. Other artefacts with a translucent glassy appearance are made of 'Baltic' flint derived from moraine deposits of the Saale glaciation found in the Ruhr region 30 km to the north-east, and near Krefeld the same distance to the north.

Only rarely represented (four artefacts) is Tertiary *Maasei* flint. This material is found locally in the form of heavily rolled pebbles (Fig 24.4.15) with a typical bluish-black mottled cortex, and occurs primarily in beach deposits of Miocene age. This raw material is the one most commonly used in the previously described Mesolithic assemblages of the immediate region (Arora 1979). Its rarity at Bedburg is probably due in part to the normally small size of the *Maasei*-pebbles, which would not allow the manufacture of the larger blades present at the site.

In summary, the majority of the recovered lithic material could be obtained within a radius of some

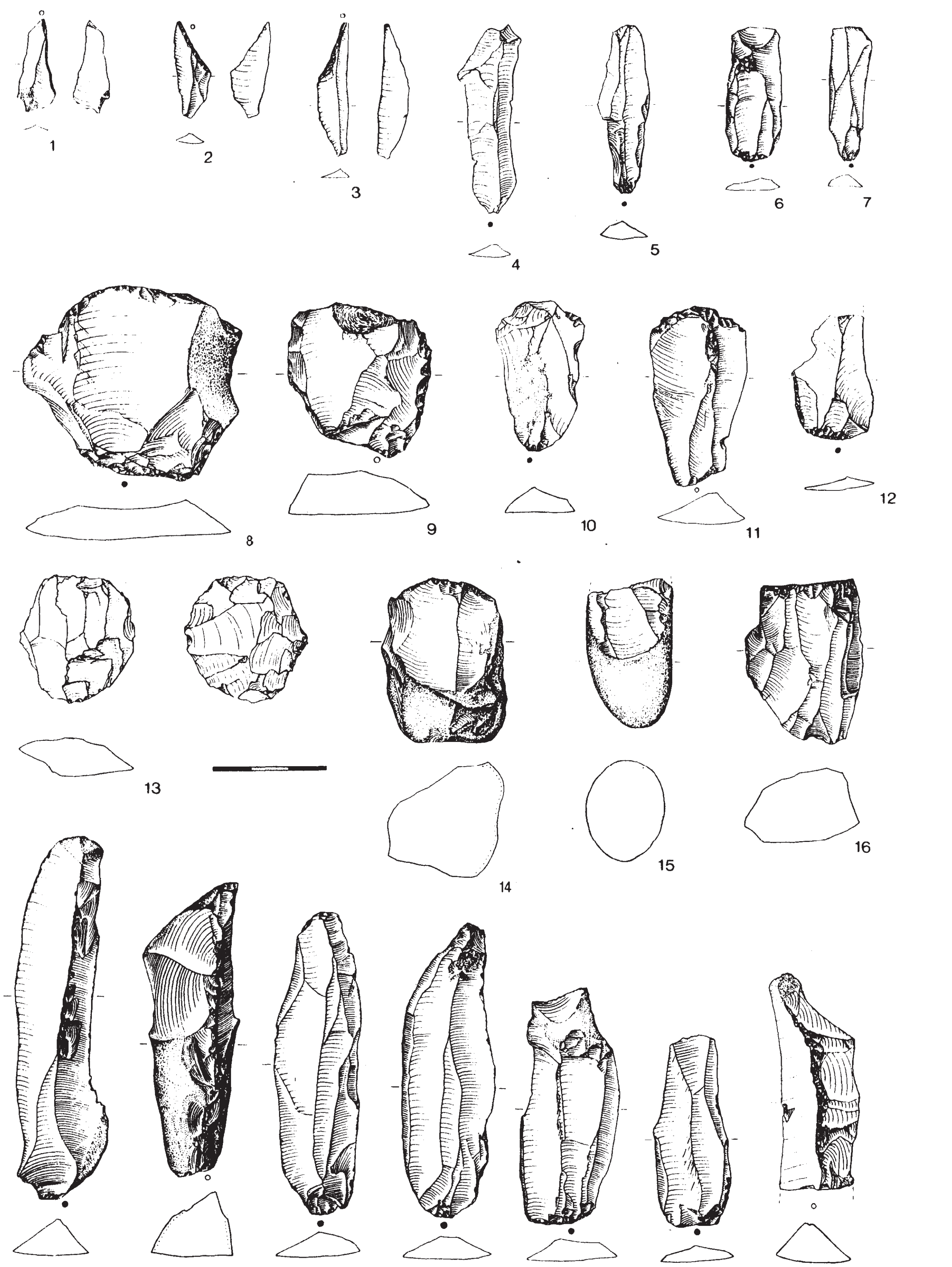

Figure 24.4 Lithic artefacts from Bedburg-Königshoven: 1–3) microlithic points; 4–7.) bladelets; 8–11) scrapers; 12) laterally retouched blade; 13) disc core; 14–16) bladelet cores; 17, 18, 23) crested blades; 19–22) blades. Raw material: 1–4, 7–9, 11, 14, 16, 18, 20, 21) Meuse gravel flint; 5, 6, 10, 17, 19, 23) 'Baltic' moraine flint; 12, 13, 22) 'Kieselschiefer' (Lydite); 15) 'Maasei' Tertiary beach pebble flint. Scale in cm. Drawings by G Rutkowski and P Schiller

Table 24.1 Radiocarbon dates on wood and peat from Bedburg-Königshoven carried out by the University of Cologne Radiocarbon Laboratory

Lab No	C14 Age BP	Material
KN4006	8010±75	peat
KN4005	9060±85	wood (birch)
KN4003	9310±80	wood
KN4001	9690±85	reed peat
KN3999	9780±100	wood
KN3998	9600±100	wood
KN3997	10,010±85	wood
KN3996	10,070±95	wood
KN3995	10,270±90	wood

30 km around the site. Probably a smaller amount of material was brought in from distances of over 50 km. There is a distinct bias towards better quality, but not immediately locally occurring material.

Primary manufacture of artefacts at the site is documented by the large proportion of cortex flakes and cores (Fig 24.4.13–16). Excluding bladelets and splinters less than 1 cm, all categories of artefacts are represented to more than 50% by pieces with cortex. This high proportion remains the same whether calculated by number of pieces or by weight. The cores can have one or more flake removal surfaces, and in a few cases have been subject to a systematic opposed platform reduction. They are mainly bladelet cores, which leaves the question of on-site production of the larger blades found at the site open. There is a definite bias towards the production of lamellar forms. In the case of Meuse gravel flint these make up almost half of the total of flakes and blades, while in the case of 'Baltic' flint they dominate the small assemblage totally. Alongside bladelets (Fig 24.4.4–7) there also occur larger regular blades (Fig 24.4.17–23). Several of the blades are crested and demonstrate core preparation.

The presence of relatively long blades in the assemblage is striking, nevertheless these forms are not dominant within the lamellar debitage. Many of the blades and bladelets are broken, but 29 intact pieces could be measured in order to establish their mean length. The majority of the blades are between 40–60 mm in length, with only isolated specimens above this.

Only a small number of the retouched pieces can be typologically defined. There are, in all, three oblique microlithic points and four scrapers. A few other pieces carry retouch which is certainly more than use wear and represents deliberate intent. Burins are not present.

The microlithic points are made on narrow bladelets of Meuse gravel flint, and are retouched at an acute angle (Fig 24.4.1–3). In this they resemble less Ahrensburgian-type Zonhoven points, which are usually made on wider bladelets by a more oblique retouch, than the simple microlithic points typical of early Mesolithic groups (Taute 1968). The pieces were found in different parts of the site, up to 16 m apart, and are unlikely to have been hafted together.

The scrapers are varied in form, and include a large, convex flake scraper (Fig 24.4.8), two short end scrapers (Fig 24.4.10 and 11) and a straight-edged side scraper (Fig 24.4.9). This last piece is the only artefact in the assemblage to show traces of contact with fire; it has several 'potlid fractures' and shows changes in colour.

The lithic assemblage can in many ways be compared with Final Palaeolithic material *(Spätpaläolithikum)*. The presence of good blade technology, together with the morphology of the scrapers and simple oblique points find parallels in assemblages of the Tanged Point technocomplex. Of especial importance in this context are those complexes assigned to this group in which tanged points themselves are absent, such as Gramsbergen and Swalmen (Stapert 1979), or Höfer (Veil 1987).

Such an important component of large lamellar debitage is so far unknown from early Postglacial sites in the Lower Rhineland; the raw material spectrum is also different from that of Mesolithic sites previously described from the area, and consists mainly of flint obtained from exposures some 30 km away. The context and dating of the site however leave no doubt that the material should be designated Mesolithic.

The closest technological parallels with Bedburg are to be found in the northern European Early Mesolithic tradition. Here can be found a very similar lithic assemblage to that excavated at Bedburg. The bone tools and also the frontlets of red deer antler (see below) have affinities not with the Tanged Point technocomplex, but with the northern European Early Mesolithic. The absence of this facies of the Mesolithic in the Rhineland may in part be due to the normally inaccessible location of sites. The common choice of low wetland situations will mean that many sites will be below the water table or buried under several metres of colluvium. It is however likely that other types of upland location were also settled. One possible explanation for this absence is that lithic assemblages from exposed surface sites which possess a pronounced blade component would, in the absence of stratigraphical context and associated fauna, tend to be interpreted automatically as Final Palaeolithic.

Worked bone and tooth

Two bone tools were found, which can be paralleled by material from early Holocene contexts. The first of these pieces is a point, which is made from the compact shaft of a long bone, probably a

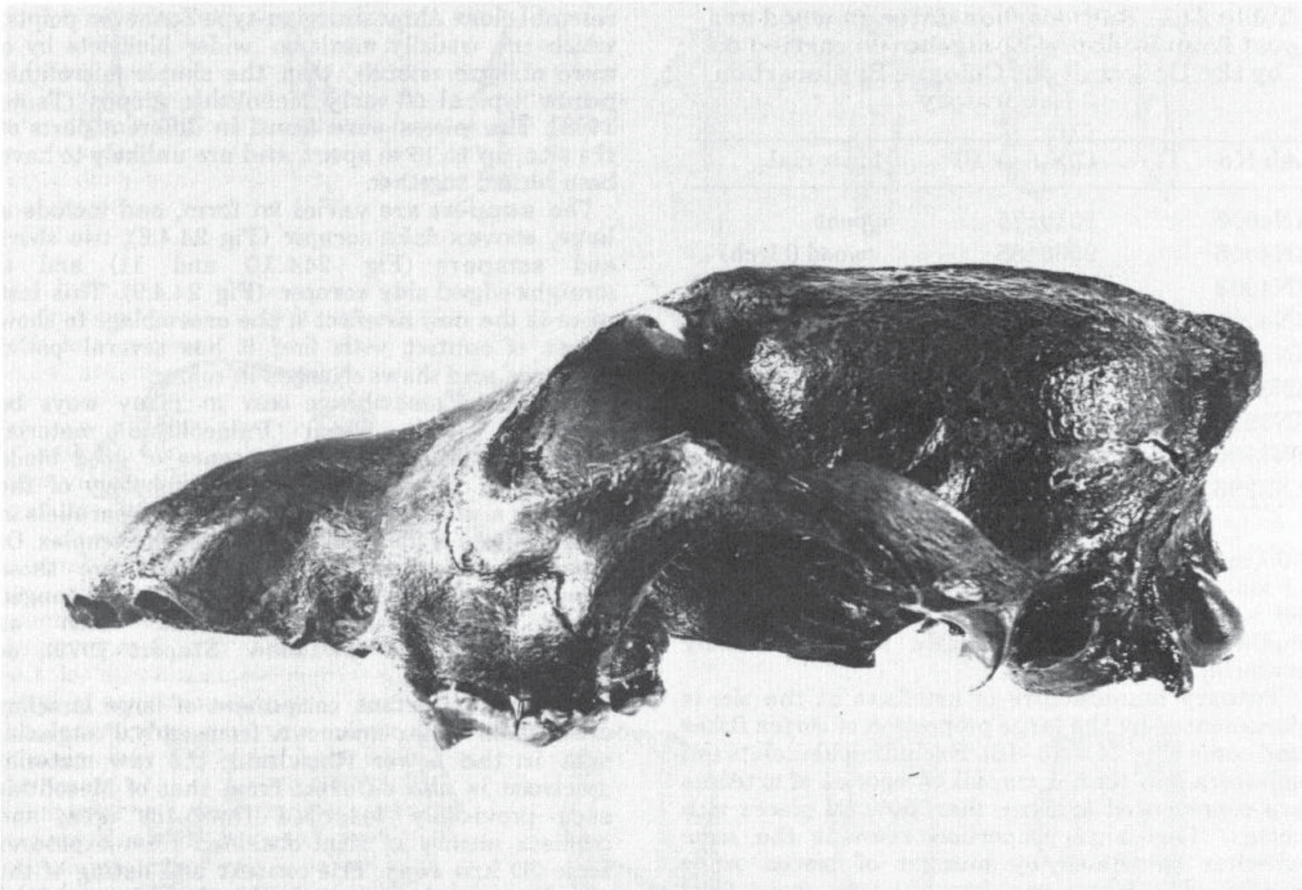

Figure 24.5 Skull of a small dog (Canis familiaris); in size and morphology the specimen compared most closely with semi-feral pariah-dogs from Africa and south Asia (Photo: RGZM)

metapodial. Similar types, and split and cut metapodials allowing the recognition of details of manufacture have been described from Hohen Viecheln (Schuldt 1961). The Bedburg point has been made by cutting and scraping of the bone substance, the traces of which are still clearly visible, giving a sub-cylindrical cross-section. The concave surface of the marrow cavity is still visible.

The second bone tool found is of a type also known from early Holocene sites in northern Europe. These tools have been variously described as 'chisels', burnishers and simply 'spatulate tools', but their actual function is, as the vague nomenclature suggests, unknown. The Bedburg specimen is 223 mm long, and is made on the radius of an immature red deer. The base of the tool is formed by the unfused distal diaphysis.

The use of teeth of various animals for decoration (whether perforated or not) is not uncommonly documented from Mesolithic sites. In Bedburg, in addition to one red deer canine tooth perforated as a pendant, two further teeth of red deer and one of pig show traces of cutting and grooving, showing that they were carefully extracted from the jaw, possibly prior to further modification. The low representation of permanent incisors of aurochs relative to teeth of the deciduous dentition might be an indication that the adult rostra1 teeth of this species tiere also removed from the mandibles for this purpose.

Faunal remains

The greater part of the fauna1 material recovered from the site consists of fragments of bone of large mammals. Less common are the remains of small mammals, birds and fishes. The large mammal remains certainly represent man's hunting activities; to what extent the remains of birds and fishes are associated with human occupation is unclear.

Not only bones, but also scales of fish were recovered. Certainly identified are pike, represented by several bones of the skull; and perch, which is evidenced by numerous scales. Also present are pharyngeal teeth of cyprinid fish (Krey, in prep).

Several species of bird are present (Table 24.2). Most of the material could be identified as various types of waterfowl, although other species are represented. There are indications that some of the

Table 24.2 Species of large mammals and birds identified at Bedburg-Königshoven

	coot	*Fulica atra*
	mallard	*Anas platyrhynchos*
	tufted duck	*Aythya fuligula*
	white stork	*Ciconia ciconia*
	partridge	*Perdix perdix*
	crested lark	*Galerida cristata*
Rodentia	beaver	*Castor fiber*
Carnivora	badger	*Meles meles*
	dog	*Canis familiaris*
Perissodactyla	horse	*Equus sp*
Artiodactyla	red deer	*Cervus elaphus*
	roe deer	*Capreolus capreolus*
	aurochs	*Bos primigenius*
	wild pig	*Sus scrofa*

bones, including those of the stork, should be regarded as part of the archaeological assemblage; others however represent waterfowl which died naturally and have no direct connection with the human occupation of the site.

The large mammal fauna (Table 24.2) is clearly comparable to others of Pre-Boreal date from northern Europe, such as Star Carr (Clark 1954) or Thatcham (Wymer 1962). It is noticeable that the elk is not represented at Bedburg, although this species is normally present on early Holocene sites. In view of the small absolute size of the Bedburg faunal complex in terms of demonstrated individuals this absence should not be over-emphasised.

Domestic dog *(Canis familiaris* L) is represented by an almost complete skull, isolated teeth and postcranial bone. The skull is extremely well-preserved (Fig 24.5). Tooth development is complete and the bones of the skull are fused, showing that the animal was adult. The right molars had been lost during the animal's lifetime possibly due to periodontitis (Hillson 1986) and the alveolae are filled in by bone tissue.

Several features which are diagnostic for distinguishing wolf and domestic dog (Benecke 1987) are clearly present in the Bedburg specimen (Street 1989). It was compared with a large number of recent dog skulls, including a wide variety of races and dingoes, in the collections of the Senckenberg Museum, Frankfurt. The best correspondence in both size and morphology was with skulls of pariah-dogs from southern Asia (Sunda) and Africa (Chad).

Traces of gnawing by scavenging animals can be recognised on the recovered faunal material. The gnawed bones are otherwise as unweathered as non-chewed specimens, which suggests that scavenging was probably synchronous with the settlement activities, and that these bones were not exposed on the surface longer than ungnawed specimens. The most likely explanation, supported by the size of tooth mark on the bones, is that the bones were gnawed by dogs.

Ravaging of a faunal assemblage by scavengers can be a major factor affecting the survival of bones. In order to evaluate the importance of this influence in Bedburg all bone fragments were examined for traces of destruction by carnivores. Of 354 examined bones of aurochs, 116 show some form of gnawing, an overall proportion of 32.8%. This is quite a high percentage, and certainly well above that observed on the Star Carr assemblage (Legge & Rowley-Conwy 1988). It should be observed however, that in many cases the damage caused by gnawing was not severe, and in no case did it prevent the identification of a specimen. Perhaps unexpectedly, despite the demonstrated presence of carnivore gnawing on much of the assemblage, the frequencies of occurrence of bone elements are not those of an assemblage ravaged by scavengers (Brain 1967), in fact certain elements which should have a low survival potential, such as the proximal femur and proximal humerus, are relatively common. It would appear that, at least in the case of *Bos primigenius,* the bone assemblage which became incorporated into the excavated deposit should not be regarded as showing heavy modification by scavenging animals, but can be accepted as still primarily reflecting human activity. This is no doubt due to the fact that the material was removed from the influence of scavenging animals (and weathering) before these could dominate the character of the assemblage.

Grønnow (1987) describes ethnographically documented examples of the cleaning up of a butchering site. Of especial interest is the disposal of waste material into an adjacent body of water. This would seem to be the most plausible explanation for the nature and distribution of the bone assemblage in Bedburg. A tendency to dispose preferentially of the larger elements (especially bones of *Bos primigenius)* will have contributed to the accumulation of an assemblage dominated by this species. It is also probable that the less robust bones of the smaller species at the site would have suffered much greater destruction by dogs, thus also contributing to their less common occurrence.

The dominant species at the site is the aurochs *(Bos primigenius);* bones of this animal were the most common category of material recovered. Almost all elements of the skeleton of this species could be identified, indicating intensive butchering of the aurochs at this site (Fig 24.6.b). Only elements of the axial skeleton and the proximal

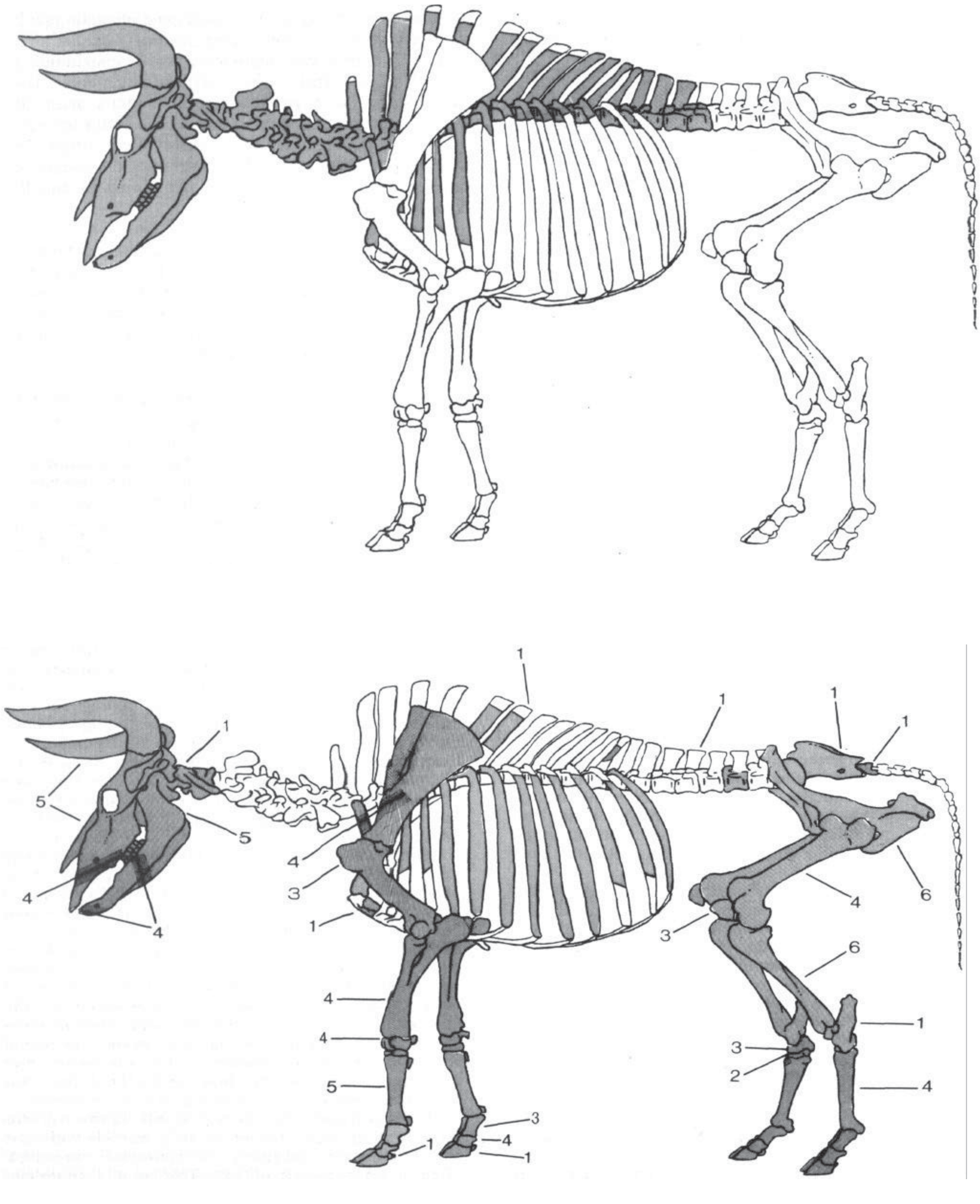

Figure 24.6 (Top) Potsdam-Schlaatz: the shaded elements of the skeleton were recovered from a Late Glacial aurochs kill-site (after Gustavs 1987); (bottom) Bedburg-Königshoven: the shaded elements of the skeleton were recovered from the *gyttja deposit. The numbers represent the NMI given by the duplication of each element of the skeleton*

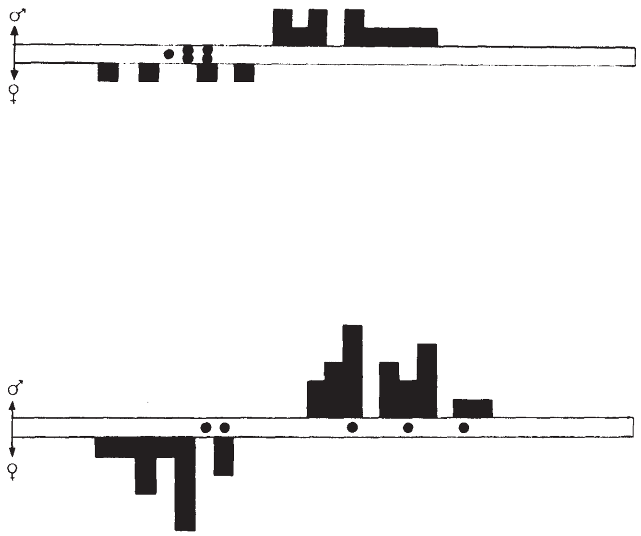

Figure 24.7 Sexual dimorphism of aurochs (Bos primigenius *Boj) Bedburg specimens compared with the material of known sex described by Degerbøl & Fredskild (1970). (Top) greatest depth of the femur head. The Bedburg specimens are clearly identified as females; (Bottom) distal breadth of the metatarsus. Both males and females are represented*

ends of ribs are under-represented. It was possible to establish with some certainty the number of individuals represented, and in the case of a limited number of fragments to identify the age of the butchered animals.

The aurochs is a species showing pronounced sexual dimorphism, reflected in the relative size of many bones,-and often measurable even on quite fragmentary material. A large number of complete aurochs skeletons of known sex and age (Degerbøl & Fredskild 1970) served as reference material for the Bedburg assemblage. This allows a further confirmation of the composition of the hunted assemblage.

Measurement of the length of the acetabulum demonstrates two groups of individuals which can very probably be interpreted as males and females. Three cows can be evidenced by duplication of the left acetabulum. A left and a right male acetabulum could however be from one individual. The over-representation of females by the acetabulum is repeated in the case of the-proximal femur (Fig 24.7.a). It was possible to measure the greatest depth of the caput femoris on five specimens while a further specimen, although gnawed and no longer measurable, was no larger. Comparison with material of known sex clearly identifies all specimens as female. Whether the over-representation of the female pelvis and proximal femur implies that male elements were not present in equal numbers at the site, or were otherwise disposed of cannot be finally decided. Possibly in the case of the much larger bulls a different butchering strategy was adopted, involving the disposal of more bones at the actual kill site.

The breadth of a number of both proximal and distal metatarsal fragments could be measured. The distal fragments can be clearly correlated with male and female individuals (Fig 24.7.b). It is possible to identify two female and three male elements. The morphology of the pieces suggests that a male right and left element could be from the same individual. This would imply only two males and two females.

These few examples demonstrate on a range of elements of the skeleton that both male and female individuals of *Bos primigenius* are represented at Bedburg. Only in the case of relatively few of the measurable specimens is it unclear if they are male or female elements. Immature animals and calves are also present.

The duplication of bone elements together with the consideration of immediately apparent size discrepancies (immature animals) reveals the presence of at least seven individuals. It is however desirable to incorporate the largest number of criteria in the calculation of the Minimum Number of Individuals (MNI). It was therefore attempted to elaborate the MNI given by the duplication of bone elements using information provided by the age and sex of the animals.

To account for all evidenced males, females and calves a MNI of 11 is necessary (Fig 24.6b). It is believed that this figure, based on the analysis of all available data, could reflect the approximate number of individuals originally present at the site. Even so, this does not necessarily imply that all body parts of all evidenced individuals were present at the site.

By analogy with calculations recently proposed by Legge and Rowley-Conwy (1988) for Star Carr; the quantity of meat evidenced by the MNI of large mammals at Bedburg would be sufficient to support a stay of some 80 days by a group of eight adults and 12 children. Alternatively it could represent a total of 200 days spent at the site by a smaller hunting group of six adults, if these only consumed a portion of the meat there and transported the rest to a residential site.

The presence of several bones in articulation shows that at least a part of the assemblage was incorporated into the gyttja layer before soft tissues decayed and the excellent preservation of the fauna1 material has optimally conserved original bone surfaces. These reveal cut marks, resulting from jointing and filleting the carcasses, and fracture marks due to breakage of the bone for marrow extraction.

All fragments of bone were examined for cutmarks; in the case of those bones identified as *Bos primigenius* cutmarks are present on some 50% of the fragments (Fig 24.8). The total of examined pieces includes teeth and very small corroded fragments, which indicates that the original proportion of pieces with cutmarks was appreciably

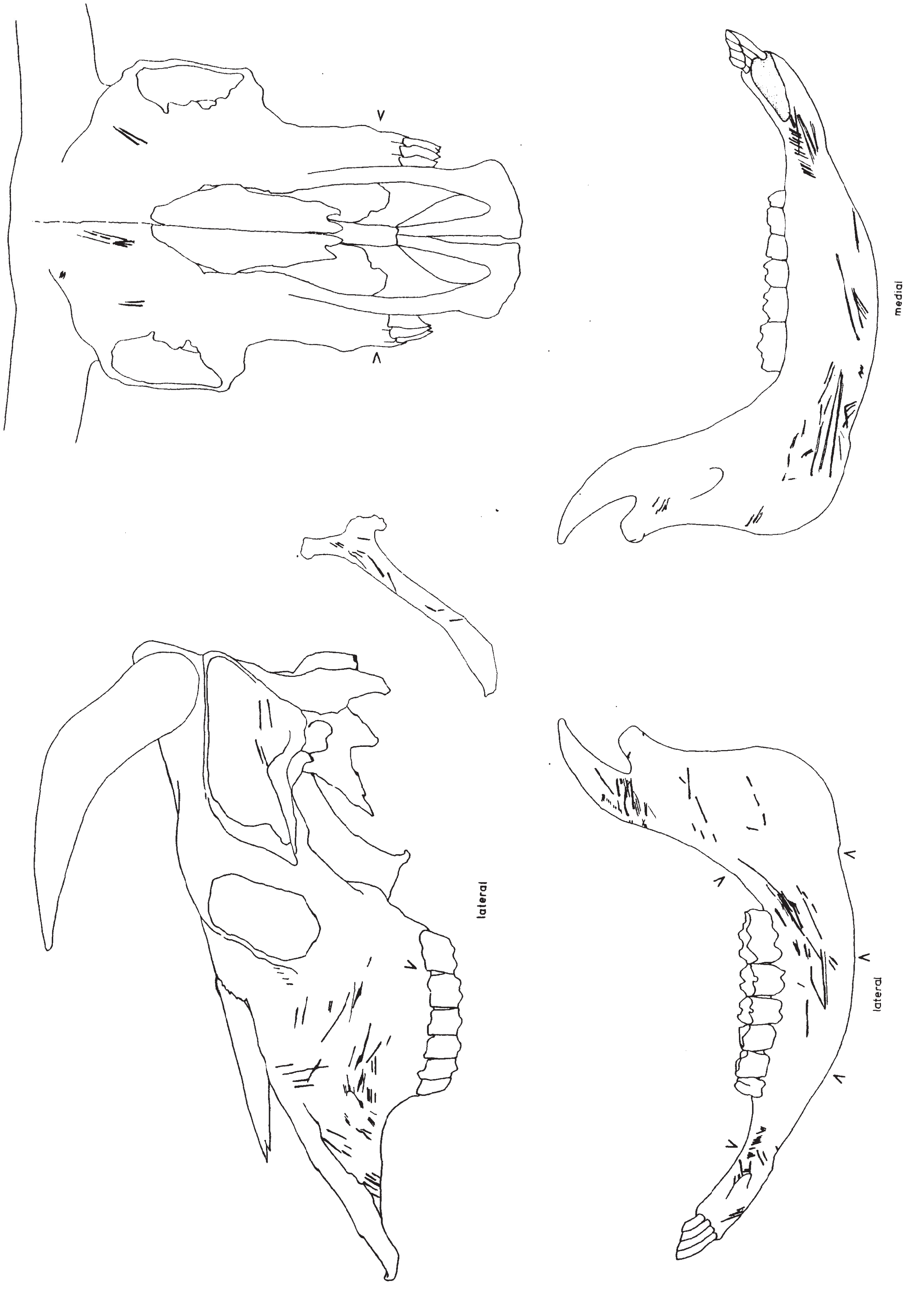

Figure 24.8 *Placement of cutmarks (/) and fracture marks (<) on the skulls, mandibles and hyoid bone of aurochs*

higher. It is possible to recognise cut marks on and around joints due to dismembering the carcass, which in the case of the larger animals such as aurochs would at least in part be performed at the kill site to enable transport. Others on the shafts of bones and on the scapulae, vertebrae and ribs are due to filleting meat from these parts. A small number of bones have cutmarks which can probably be attributed to skinning the carcass, while in the case of metapodials cutmarks on the shaft may be due to cleaning the bone of tissue and periosteum prior to marrow fracturing. Cutmarks on the metapodials and the phalanges may relate to sinew processing (Parkin *et al* 1986). In all these cases, the use of standardised procedures suggests very systematic butchering practices. The recovered bones are highly fragmented. Almost all limb bones, including the first phalanx, and all mandibles, are cracked open for the extraction of marrow.

Season of occupation and interpretation of the faunal assemblage

Certain bones and teeth could be aged accurately enough to provide indications of the season of death of the specimen. Assuming calving in spring, at least four individuals of aurochs were killed in summer. Worn milk teeth of roe deer are also evidence for a human presence at this time (data from Legge & Rowley-Conwy 1988). The presence on the site of a roe deer skull with attached antler does not contradict this. Unshed red deer antler was probably used (in the form of frontlets) for a purpose unrelated to subsistence activities and cannot be used as an indication of the season of occupation of the site. A further indication of summer occupation is provided by the bones of the white stork *(Ciconia ciconia).* This species is at the present day a summer visitor to northern Europe and its association with settlement waste supports the evidence of the large mammal fauna.

The interpretation of the type of site represented at Bedburg remains to be discussed. The fact that so many elements of the skeleton reached the site speaks in favour of a kill-site in the immediate area, since otherwise certain parts of the carcass found at Bedburg would have been processed and discarded at the kill-site itself.

An example of an aurochs kill-site of Late Glacial age is known from Schlaatz near Potsdam (Gustavs 1987). Here, a butchered aurochs was found in primary context, associated with a small number of flint blades. The skull and axial skeleton were found in anatomical association, all the limb bones and parts of the rib cage were missing (Fig 24.6a). Schlaatz represents the actual site of a kill, and of the primary dismemberment of the carcass, which has undergone at most slight redeposition while the bones were still in anatomical connection. This is obviously a different situation to that at Bedburg, where were found not only skulls and rarely elements of the axial skeleton, but also all of the elements which were missing in Schlaatz (Fig 24.6b). The proximal ends of ribs and the vertebrae which are under-represented at Bedburg are precisely the elements found at Schlaatz. An interpretation of Bedburg as a kill-site can almost certainly be ruled out.

The discrepancy in this pattern, namely that the skull is found at both types of site, is possibly to be explained in terms of the distance between the kill-site and the final destination of the material. The presence at Bedburg of crania, mandibles and one atlas suggests that the kill-site was close enough to make the removal of the dismembered heads a feasible proposition. Taking into account the brain, meat, tongue, marrow and perhaps the horns, these were by no means waste. Nevertheless it is interesting that the skulls recovered at Bedburg are all of smaller female or subadult individuals.

The heterogeneous character of the faunal assemblage, the evidence for repeated episodes of lithic tool production, and possibly also the presence of bone tools and the antler frontlets suggest that the site has the nature of a central residential camp. In view of the presence at the Bedburg site of so much of the carcass, it is suggested that the animals were hunted and killed probably some several hundred metres further out into the valley bottom marshland, and after primary dismemberment were transported only as far as the nearest dry land for further processing. It should therefore also be considered whether the Bedburg site is of a specialised character and represents neither a permanent residential camp nor a kill-site but a temporary hunting and processing camp, as has recently been suggested in the case of Star Carr (Legge & Rowley-Conwy 1988).

While it is probable that the location of the site, on the edge of a favourable hunting ground at the narrowest part of the valley, would have been suitable for the establishment of such a camp, the advantages presented by the situation would no doubt have been equally as attractive in the choice of a settlement site of a more permanent nature. The question whether the location was used over an extended period of time by an entire group as a residence camp, or perhaps sporadically by a smaller group as a hunting camp, is, in view of the absence of much of the assemblage and all settlement features, perhaps impossible to answer. Nevertheless, the representation at Bedburg of practically all elements of the carcass is not suggestive of a site with a specialist butchering function. Rather it indicates that the animals were hunted at no great distance, and all body parts brought back to the site and further, that all subsequent aspects of processing and consumption took place at this same location. This might be suggestive of more opportunistic hunting methods

Figure 24.9 Antler frontlet with trimmed calotte and artificial perforation of the parietal bone

(foraging?) rather than mass killing by, for instance, drives. The close association of very varied elements (bones of different species, butchered dog, bone tools, antler frontlets and a range of lithic raw materials), also speaks against the assemblage being the result of accumulation of several short-term episodes. The evidence is believed to fit better to an interpretation as a residential site.

Antler frontlets

The original reason for the excavation was the discovery of an antler frontlet. During the course of the investigation a second example was found. Both frontlets are made from the skulls and antlers of adult red deer. The antlers are fully developed and complete; the first example has 14 tines and the second piece 12 (Fig 24.9).

The similarities of the Bedburg specimens with those from Star Carr (Clark 1954), Berlin-Biesdorf (Reinbacher 1956) and Hohen Viecheln (Schuldt 1961) are self evident. There are however obvious differences between them. The Star Carr and Berlin specimens are to a large extent worked down by groove and splinter technique, while the frontlets from Hohen Viecheln are almost entirely lacking their antlers. The Bedburg frontlets by contrast have complete and unmodified antlers. In the case of the Star Carr frontlets Clark (1954) interpreted their condition as being due to trimming of the antlers in order to reduce weight, and recognised a selection for skulls with smaller antlers compared with those pieces used for the production of blanks for tools. In view of the fact that the Bedburg frontlets were left with their antlers intact it is perhaps justified to ask whether the reduction of antler at Star Carr was in fact primarily for the purpose of lightening the frontlets, or whether the obtention of raw material was the first priority, the most suitable (lightest) waste products being then selected for modification into frontlets.

The function of such pieces has been the subject of discussion since the discovery of the Star Carr examples. It is generally accepted that they were worn as headgear (Clark 1954). This is sometimes attributed to the use of such headpieces as camouflage during the hunt, and examples of this are known ethnographically (Halls 1984). A second interpretation for the function of the frontlets was already suggested by Clark (1954) in the case of Star Carr. This is the use of such headwear during the performance of shamanistic *(sensu lato)* rituals.

Summary and discussion

The site of Bedburg-Königshoven provides new information on the earliest Mesolithic in the Lower Rhineland and for environmental conditions in the early Holocene. The site can be assigned by pollen analysis to the Pre-Boreal; this is confirmed by a consistent series of radiocarbon dates.

The large mammal fauna shows that the transition from the open landscape of Dryas III to postglacial forested conditions was well advanced. The presence of horse indicates that forest cover was by no means closed, but species typical of glacial conditions such as reindeer are no longer represented and the species indicative of a forested environment such as roe deer, red deer and aurochs are already dominant. The evidence of the large fauna is supported by the presence of two species of bird which require open conditions, the white stork and the crested lark.

The site was located at the foot of gently sloping land bordering on marshland. It was at the narrowest point of the Erft valley, sheltered from the north by a ridge of higher ground. There was probably a source of fresh water at hand in a small valley draining from the west of the site. The advantages of the situation for the exploitation of a range of resources are readily apparent. Possibly the site was located deliberately at a point logistically important for hunting expeditions returning from the marshy valley floor.

Large mammals were intensively butchered at the site: the parts of the skeleton represented suggest that the animals were hunted close to the site, but that the site itself is not the kill site. Butchering was carried out according to a recognisably standardised system. Bones of birds and remains of pike and perch indicate the availability of other resources at the site, even if their exploitation is not in all cases certain. A number of bones and teeth of young aurochs and roe deer, and bones of a migrant bird, indicate the season of occupation of the site as late spring and/or summer.

In addition to faunal remains related to subsistence activities were found two exceptionally complete antler frontlets similar to previously recovered specimens from Star Carr, Hohen Viecheln and Berlin-Biesdorf.

The suggested interpretation of the excavated site is that it is the offshore disposal area for butchering waste from a summer residential camp. This was probably occupied on only one occasion for a period of, in the case of a group of 20 adults and children, at least two to three months.

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