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C I R C A E A

CIRCAEA is the Bulletin of the Association for Environmental Archaeology, and - as from Volume 4 - it is published twice a year. It contains short articles and reviews as well as more substantial papers and notices of forthcoming publications.

The Newsletter of the Association, produced four times a year carries news about conferences and the business of the Association. It is edited by l/Vanessa Straker and Bruce Levitan, to whom copy should be sent c/o B. M. Levitan, University Museum, Parks Road, Oxford, OX1 3PU.

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EDITORIAL

Yes, Circaea is late, again - just short of a year late, in fact! As ever, there are several reasons for this, not least the shortage of suitable copy at the appropriate time. Another good one is that the EAU has lost its Manpower Services Commission 'Community Programme' Scheme whereby we occasionally were able to secure the expertise of typists far faster and more accurate than ourselves.

However, we hope that this fatter-than-usual issue will, to some extent, compensate for late arrival. We should also like to advise potential contributors that we have abandoned 'end-dates' for submission of papers and articles - we are happy to receive and deal with them at any time throughout the year: see the last paragraph of the inside back cover.

Even now, issue 2 of this volume is being prepared (though there's still room for more copy), and will be published as soon as possible. Perhaps we could reiterate that papers will usually progress much faster if authors observe the Notes for Contributors on page 79 of this issue. Please remember that the Editors have full-time jobs and do not have secretarial assistance for retyping or redrafting figures.

Frau Friedel Feindt, an AEA member at the Institut für Allgemeine Botanik, University of Hamburg, Federal Republic of Germany, has written to us in response to a piece by one of us on 'spices' in Circaea 5(1) (p. 19). She remarks that she first came across Nigella sativa (Roman coriander) on flatbread in Turkey in 1970 and followed this up by obtaining seed from her neighbouring Institut (für Angewandte Botanik) in Hamburg. Linsensbrot ('lentil bread' - which may or may not exist! - perhaps breads made of besan could be called lentil-breads?) should, of course, have read Leinsamenbrot ('flax-seed or linseed bread'). We are most grateful to Frau Feindt for these comments.

Frau Feindt also asks for the origin of the word 'serendipitous' used in the same article. As such, it cannot be found in the Compact Edition (1979) of the complete Oxford English Dictionary, but appears to have been formed by the author from serendipity; 'from Serendip, a former name for Ceylon ... coined by Horace Walpole, who ... formed it upon the title of the fairy-tale The Three Princes of Serendip, the heroes of which were always making discoveries by accidents and sagacity, of things they were not in quest of'. Serendipity is thus 'the faculty of making happy and unexpected discoveries by accident'.

MISCELLANY

Miscellany in this issue is just that! It starts with a series of book reviews and notices and includes some short articles and a conference report for those who weren't able to go to Denmark last autumn. This section concludes with somewhat more respectable 'mystery objects' than the last specimen of the genre.

Front cover: Detail of a scale of a thin-lipped grey mullet (Liza ramada Risso) from late 14th century Tarquinia, Italy. Original photograph: Andrew Leak.

Nitecki, Mathew H. and Nitecki, Doris V. (editors) (1987). The Evolution of Human Hunting. Plenum Press: New York. ISBN 0 306 42821. 464pp. \$U.S. 75.00 (hard cover).

Titles can be misleading, especially in the case of edited volumes. This book is the outcome of a symposium on the Evolution of Human Hunting held at the Field Museum of Natural History in Chicago, USA, in May 1986. What it offers is more of a series of views on aspects of the evidence for meat procurement by hominids over the last two million or so years than a step-by-step discourse on the development of hunting itself. One of the chapters, by Morlan, on the archaeology of Beringia, does not even do that: it offers precisely what its title says it does, with a few asides on colonisation and possible mammoth butchery, although it is a useful summary of the literature on this interesting region. Behrensmeyer gives an adequate, if somewhat pessimistic review of some of the problems of inferring hunting from the fossil record and, although she mentions some later sites, the emphasis is on the African Plio-Pleistocene. The only chapter that really offers a longer-term view is by Trinkhaus, who concludes that there is little evidence for the impact of predatory behaviour on the course of our evolution; early hominids were not, in his words, acting out Ardreyesque versions of 'Rambo meets the megafauna'¹ (p. 107). Of course that conclusion is heavily dependent on previously published interpretations of human meat procurement activities offered by people such as Klein and Binford.

Both of the latter authors contribute chapters. Klein argues that Lower and Middle Pleistocene sites, usually open-air localities, offer little clear evidence of animal exploitation in comparison with Upper Pleistocene cave deposits. He questions the extent of human involvement in the accumulation of animal bones at the Spanish sites of Torralba and Ambrona, and stresses the comparatively high quality of the data from southern African cave assemblages analysed by himself, brushing aside Binford's recent criticisms of his interpretations of the Klasies River Mouth material. In the following chapter, Binford continues his inexorable efforts to reinterpret every well-known bone assemblage with a fairly standard hatchet job on the unfortunate Leslie Freeman (a former student of Binford's at Chicago) and his interpretation of Torralba as a site of human game-driving and elephant butchery. As one seems to find increasingly with Binford's offerings, his criticisms hit the mark and afford little scope for reply, but his own treatment of the data raises questions. He produces a new multivariate analysis of Freeman's published data and finds significant relationships between tools and species other than elephants, particularly equids. Like Klein, he also seriously questions the overall role of humans in accumulating the carcasses. But on p. 31 of Klein's chapter, we read that in Freeman's publication 'many bones had been incorrectly identified', and that 'it is doubtful that much culturally significant patterning could have survived the small-scale but cumulative transport of particles and often also of bones and artifacts across most of the occupation surfaces' (emphasis added). I make two points. First, Binford has stressed that we must interpret the dynamics of the past from the static archaeological record, but that record may well include the activities (and oversights) of the archaeologist, and reinterpretations based entirely on published information risk that problem. Second, what were the editors of the volume doing at this point?

Klein's theme, of the increased clarity of the Upper Pleistocene picture, is taken up by Straus in his chapter on the evidence for hunting in western Europe during the later part of that period. Geographic terminology is a little idiosyncratic here: his figure 1 shows a map that includes the area now occupied by the countries of the European Economic Community, but his evidence for hunting in western Europe is drawn from three bits of West Germany, a few patches of France, three areas of Spain and one locality in Portugal. Obviously, the evidence itself is clumped, but you surely cannot get a clear overall picture by only looking at the good bits.

Two interesting chapters, one by Frison, the other by Todd, discuss hunting by Palaeoindian communities in North America, and should be read together. Frison integrates his discussion of the archaeological evidence with details of species-specific behaviour, topography, ethnographic accounts and surviving traces of fences and catchpens, to give a graphic account of procurement tactics and meat handling activities. However, Todd then questions a number of assumptions inherent in such integrated approaches, arguing that things in the remoter stages of American prehistory may have been both different from and more variable than those of the immediate past. He draws particular attention to the palimpsest nature of many of the sites, and to the evidence of disturbance by non-human agents.

In the remaining chapter, Fisher considers whether Palaeoindian peoples of the Great Lakes area may have hunted or scavenged mastodonts (*Mammot americanum* (Kerr)), large members of a proboscidean family quite separate from that to which the elephants (including the better-known mammoths) belong. He presents an interesting discussion of the inferential problems involved, and brings data on sex, age structure and season of death to bear on the problem. The subject of the question is not as peripheral as it may appear since, if the people involved could hunt mastodonts, then we have some measure of their abilities, but the samples are small, and the presentation is overlong for its content. This fault is worsened almost beyond belief by an appendix on Bayesian inference applied to such a problem: the chapter itself runs to 112 pages, including references; the appendix alone accounts for 54 of them, and this is a book totalling 464 pages. Most of us have probably suffered the common complaint from journal editors that the manuscript is 'too long'¹. It is thus a little hard to rejoice in the sight of a book costing \$75.00 U.S. with such a massive waste of paper. In the preface we are told that chapters were reviewed: what were the criteria?

In sum: some interesting bits and pieces, and well worth a look at if you see it, but really overpriced.

Alan Turner

U. Körber-Grohne (1987). Nutzpflanzen in Deutschland; Kulturgeschichte und Biologie. Stuttgart: Konrad Theiss Verlag. ISBN 3-8062-0481-0. 490 pp., 95 figures, 132 pi. Price £29.50 (available post free from Oxbow Books, 10 St Cross Road, Oxford OX1 3TU).

Professor Udelgard Körber-Grohne has already produced several fine archaeobotanical books reporting material which she has studied - such as that from the Iron Age Wurt at the Feddersen Wierde, the Roman well at Welzheim and the Iron Age chieftain's burial at Hochdorf (reviewed in Circaea 4(2)). In addition to these, she has published extensively in journals. She has changed her tactics somewhat in the present book: although archaeobotanists will doubtless find it very useful, they should remember that this has not been written especially for them, this time - it is for a wide readership including biology students, natural historians and gardeners, although there will doubtless be some of us who also fall into some or all of these categories.

The book covers the range of useful plants that are now or were formerly grown in central Europe (and mostly also in Great Britain). Many are foods, such as cereal grains, pulses, vegetables and salad plants. Some imported plants such as chickpea are there, along with dyeplants, fibre plants and oilplants. The crops introduced from the Americas (for example maize, runner beans, tomatoes and potatoes) are also included. However,

fruit, herbs and most medicinal plants are omitted, sometimes with a sharp dividing line, so that leeks and onions are in, but garlic is out.

It is very important for a subject such as archaeobotany to be supported by good books which from time to time summarise developments from the mass of scattered periodical literature. The publication of Godwin's (1956; 1975) History of the British Flora provided such a landmark for Quaternary studies in Britain with each edition. There have been books covering the development of cultivated crops, Geschichte unserer Kulturpflanzen (Bertsch and Bertsch 1947) being an early summing-up of the results then available, but much has happened in the last forty years. Evolution of crop plants edited by Simmonds (1976), provided a more modern summary of the botany in an academic textbook, but certainly not the archaeobotany! Nutzpflanzen seems an excellent summing-up of archaeobotany in Europe to date. It should also usefully spread the knowledge of our subject and the accessibility of its results by such a clear and appealing presentation.

The treatment of each of the crops is a thorough account, but certainly not a catalogue of every single find. The discussion simply picks out relevant examples, an approach that does much to make the book readable. Of course the subject is making progress all the time, and the half-predicted find of the seeds of leek, for example, has now happened. Professor Körber-Grohne has also been selective in her use of documentary records of the plants, although there is a number of Huge German Books which have had to be quoted fairly often because, in characteristic fashion, their authors have left no stone unturned in an effort to be fully comprehensive - an example is the series by Becker-Dillingen on cultivated plants. The language she has used is straightforward, which naturally makes for readability; for those of us who find German difficult, it can be said that this is easy German compared with some.

The German view of some familiar crops is interesting: Professor Körber-Grohne herself writes that parsnips are only just now being grown in Germany, while of course they have long been popular in Britain. Celery to an Anglo-Saxon usually means the leaf-stems of the plant, but in Germany it is either the swollen root-base, celeriac to us, or the leaves. 'Rettich'¹, the giant German radish, is not eaten here - for, after all, it is not sold in Sainsbury's, while Jerusalem artichokes (Helianthus tuberosus) seem unknown in Germany. The accounts of the histories of the various crops are very valuable, the more so because the examples given show that Professor Körber-Grohne has grown most of them in her own garden and so speaks from extensive personal experience.

I wonder how long the book took to prepare; the references generally go up to 1984 with a few 1985 ones where there were important new results (on dyestuffs, for instance), which were fortunately published promptly. All too often important archaeobotanical finds are made and generally known about, but actually published at a very leisurely pace if at all. Unpublished information has here been pursued where necessary, as in the case of Carthamus tinctorius (safflower).

The library searches have been most painstaking, both for the written word and, more importantly, for illustrations, which range from Egyptian wall paintings and classical coins through medieval woodcuts to paintings. Some of the botanical illustrations (especially the beautiful watercolours of Georg Oelinger published in 1553) are reproduced in colour, which adds greatly to the appeal of the book - indeed, it is probably worth buying for these alone. Recent plants are illustrated in excellent line drawings by the authoress herself - botanists somehow often seem to manage to do livelier drawings than professional artists. Only the maps were not drawn by her but they are good, with

suitably-sized lettering that is not interrupted by the lines of coasts and rivers. In addition, there are copious photographs (both half-tone and colour) of present-day plants and archaeological remains which were almost all taken by the authoress herself. I know from bitter experience how hard it can be to get a really good half-tone photo of a plant in the field, or a really crisp photo of a small fossil fragment, and to make the best possible print from it. These 132 plates are mostly very good, and must represent a huge outlay of time and effort, many seeming to be new ones done especially for the book.

There was an extra cost, too, for I gather that the Professor lost a Leicaflex camera during her travels! She journeyed to see wild ancestors of cultivated plants, to Italy for wild leeks, for instance, and to Israel for some of the cereals, while less exotic examples include the chicory growing beside a main road next to a traffic light in Tübingen. The standard of illustration makes the book the more informative, as one can get a real feel for the plants described that would not have been conveyed by mere words, and the pictures also make the book very attractive.

The publisher, Konrad Theiss is evidently keen on archaeology, producing many books as well as as the Current Archaeology-like journal Archäologie in Deutschland, all modestly priced by our standards. I like the thorough approach, so that Çatal Hüyük and Starčevo are correctly accented - can Circaea manage this? [We hope so - Eds!] I cannot believe that book production costs are any cheaper in Germany than they are here - the cost of living there is higher. Theiss Verlag shows that the slipping production standards and steeply rising prices of books from British and American publishers are, in my opinion at least, the result of the greed and inefficiency of those who supply the largely captive academic book market in the English language - they know the universities will buy, and do not care about the private buyer. How, otherwise, could our new British flora, a book not very much larger than that under review, and with only a few line drawings, cost more than twice as much and have such a catalogue of mistakes?

Nutzpflanzen in Deutschland is an excellent book in many ways, and it ought to appeal to many people since it brings together archaeobotany, crop science and gardening history in such a readable way, but sadly German is not much taught in Britain (I myself learnt not one word at school) and this will limit its appeal here and in other, similarly neglectful, countries. Another German classic work is to be published in an English edition (Ellenberg's work on vegetation of central Europe), but what (high) price will the English publisher charge? Professor Körber-Grohne's book is very firmly based on Central Europe, but an English edition might also be worthwhile not only for botanists (inasmuch as they still exist), but also for this nation of gardeners. It is by far the best Allium - Zea to appear so far.

References Bertsch, K. and Bertsch, F. (1947). Geschichte unserer Kulturpflanzen. Stuttgart,

Godwin, H. (1956; 1975). History of the British Flora. (1st and 2nd edns.) Cambridge: University Press.

Simmonds, N. III. (ed.) (1976). Evolution of crop plants. London & New York: Longman.

W. Groenman-van Waateringe and L.H. van Wijngaarden-Bakker (editors) (1987). Farm Life in a Carolingian Village. A model based on botanical and zoological data from an excavated site. Studies in Prae- en Protohistorie 1). Assen/Maastricht, The Netherlands & Wolfboro, U.S.A.: van Gorcum. viii+129pp., 23 tables, 22 figures, 17 plates; 37.50 HF1. (paperback). ISBN 90-232-23217.

I must declare my general feelings about this book at the start of this review lest the criticisms that follow lead the reader to believe I did not like it. On the contrary, I like this book very much: it is just the kind of thing that I wish was coming out of environmental archaeology in the U.K. With the exception of the York Archaeological Trust fascicules and one or two other notable publications, we seldom see anything like this being published. This book is a multi-disciplinary environmental archaeological study of a medieval village in central Netherlands. The work emanates from the Albert Egges van Giffen Instituut voor Prae- en Protohistorie (IPP) of the University of Amsterdam and is the first of a series this institute intends to publish.

The book is in English, the text having been translated from the Dutch in part by the authors and in part by (?)professional translators. There is no reason given for choosing to publish in English, but one may assume that the U.K. and American markets were in mind, especially as the publisher has an American branch. Whilst the standard of the English is generally very good, there are some oddities and a very few mis-spellings (the worst of which appear in Table 3.5 where 'Length¹, which is used twelve times, is spelt 'Lenth' twice and 'Lenght¹ once - more a case of poor editing than mis-spelling?). It must be said, however, that having chosen to publish what is intended to be an academic book of high standard, the chosen language should be impeccable. One wonders why the editors did not ask some of their English friends and colleagues in environmental archaeology to check the text through. These quibbles aside, English readers are lucky to have this book so accessibly presented.

The study is based on the excavations of a village in the Veluwe by the IPP (1965-66; 1971-197A; 1977-1980). Evidence of activity from the Neolithic to the medieval periods was recovered, and this book is concerned with the 8th to 10th century settlement of Kootwijk 2 (A.D. 750-1000). There is a preface, and seven chapters covering botanical (pollen and plant macrofossil) and zoological (vertebrate) remains, and chemical (phosphate) analysis. Some of the analyses were completed many years ago and as a result some of the methods employed are (as admitted by the authors) out of date. The bone analysis and the experimental archaeozoology were completed in 1979, the phosphate analysis in 1980.

In the preface, H. A. Heidinga, the director of the excavations, brings out the valid and potent criticism that the different specialisms within archaeology have their own jargon, and this may sometimes serve to obscure rather than illuminate (p. vii). Although there is a defence for dealing with the minutiae of the analysis in specialised terminology, the 'lay¹ reader will tend to skip such sections, and may thus fail to appreciate some of the weaknesses of the analyses or the evidence; they may thereby fall into the trap of using the analysts' general conclusions too uncritically, thus leading to the kind of faux pas so aptly described by J.-P. Pals in his introduction to Chapter 7 (p. 118). Heidinga goes on to point out that one (perhaps the best) way of overcoming such 'hitches in communication between "culturalists" and ecologists' is the inter-disciplinary approach, such as adopted for the Kootwijk project. This is indeed a truism, but it requires restating because this approach is still the exception rather than the rule.

The introduction describes the archaeological background to the site, highlighting the period and the features upon which the environmental analyses are focussed. The 10th century saw a turning point in agricultural economies in the region: cultivation of summer

and winter cereals which had been restricted to dry, loamy sands before this time, afterwards spread to low wet regions such as the Veluwe. At this time the development of sod-manuring took place on the better soils (creating the plaggen soils). These changes were apparently partly triggered by the dry period of hot summers and cold winters experienced at this time which encouraged the move to the moister soils. In the Veluwe this change occurred at a time of drastic alteration of the landscape into desert, so that by the 11th century sand drifting had become a major threat (by the 19th century 20% of the area was rendered infertile). The major contributor to this deterioration appears to have been the iron industry for which deforestation occurred in order to obtain charcoal. The Kootwijk settlement, therefore, spans the period of the early and radical changes described above.

The introduction ends with a two-page reconstruction of what life in the village may have been like ('A day in the life of ...'). It seems a pity this was not further enhanced by a reconstruction drawing, but the text alone serves to give a vivid, if somewhat simplified and perhaps naive, picture of the settlement.

The chapter on pollen analysis is by B. van Geel and 111. Groenman-van Waateringe. In common with the other analyses, the methods and samples are described in great detail. This is, perhaps, a major weakness in the book, because some of this detail seems unnecessary. In this chapter, for instance, there are three pages of sample descriptions of which the following is a typical (short!) example (from p. 14); 'Al2 = P 1974-53-55, cutting LIV, E section. 55 Ao or Al layer, 53-54 ploughed yellow-brown drift sand.¹ Similarly, in Pals' paper on the macroscopic plant remains (Chapter 4) there is a seven-and-a-half -page inventory of the plant remains (pp. 80 ff.). This kind of detail is not required and is surely archival material. If deemed absolutely necessary for publication, then this kind of information would ideally be suited for microfiche. Not only does it unnecessarily increase the length (and cost) of the publication, but it actually detracts from the interest of the rest of the analysis. The conclusions reached by the authors are that the area surrounding the settlement was almost completely lacking in woodland, with the vegetation surrounding the cultivated fields comprising grassy heather. The pollen also picked up many of the weed species seen in the macroscopic remains, these being mainly characteristic of winter cereal fields.

The vertebrate remains, reported on by G.F. IJzereef, comprise only 1356 fragments plus a partial horse skeleton. Four hundred and sixty of the fragments are unidentified, so the assemblage is 896 identified bones (given as 996 in the text) which represent a 250-year period (3.6 bones per year!). Whilst most bone analysts take it for granted that the typical bone assemblage is but a tiny fraction of the original population of animals represented, many are agreed that samples as small as this are of very little value for interpretations about site economy. The small sample is the result of the poor preservation conditions within the sandy soil. Apart from the horse skeleton and a special deposit of pig mandibles, therefore, there is little point in taking analysis of the bones any further than a bone count table (table 3.1). The conclusions drawn (pp. 48-9) are reasonable precisely because they are unexceptional. However the analysis should have dealt only with the two special deposits; the sample is too small for anything more. The two special deposits are described and tables of measurements and age determinations (for pig) are provided. No attempt is made to offer any explanation for the unusual horse burial (in which the hind limbs were broken, possibly to facilitate the burial) other than

calling it an 'emergency burial' whatever that means. Horses would presumably have been expensive and high status animals, so surely this burial was of some significance. The pig mandible deposit is taken up in a later chapter, the present one being content to deal mainly with description. The conclusion, based on this deposit, that there was 'an emphasis on pig breeding in the local rural economy and consequently on pork in the diet' (p. 49) is surely wrong-headed - were several such deposits discovered it might have been more reasonable, but here we are merely seeing a cache from a single event which should not be used to make general statements about the economy.

The longest chapter in the book (43 pages, including the plant inventory mentioned above) is that by J.-P. Pals on the macroscopic plant remains. This reflects the importance of this category of evidence in terms of details about the economy and environment of this site. Both charred and waterlogged remains were recovered, and Pals compares these both in terms of the range of information they provide and the types of feature in which they occurred, noting the important point that the different sources have different implications. He points out that carbonised material will highlight weeds that were present in the fields, whereas the waterlogged remains (from wells) will mainly reflect ruderal situations (p. 75). The comparison shows nineteen species that occur in waterlogged samples only and seventeen only as carbonised remains; a further 30 species are represented in both types of material. Thus the field weeds are characterised by (1) plants of poor, dry sandy soils; (2) plants of loamy soils. There are also nitrophilous plants present. He concludes that manuring was carried out, with most arable cultivation on the sandy soils, but some loamy soils being utilised.

On the basis of the evidence of weeds, Pals refutes the original suggestion that a three-field rotation system was practised: the perennials of phytosociological class Artemisetea are scarce, but would be expected in such a rotation system. He postulates that the fields near to the settlement were intensively cultivated and an infield-outfield cultivation method was employed.

The cultivated species include a wide range of species with rye, oats and barley prominent, plus a range of fruits, and species such as horse bean and flax. Various damp grassland species are present, and Pals takes this to represent hay gathering from stream valleys 6 km or so distant. Progressive drying-out of the pool area of the site is indicated by the 'eutrophication¹ of the plant communities through time. The chapter also includes a useful description of the region's soils, present-day vegetation, forest history and ecotopes based upon these.

The phosphate analysis by H. Kamermans leaves the reader feeling that this was a lot of work for little payoff. The results from samples taken within the settlement and from the fields were compared with control samples from undisturbed podsols. Generally speaking there was no significant difference between the archaeological samples and the controls. This is partly because there were no house floors preserved and partly due to the fact that a characteristic of podsols is the leaching out of bases. Since both these facts were known before the analysis took place, one wonders why such work was carried out. One item of interest, however, does emerge: phosphate levels were higher than average on the western sides of some of the houses. This may be a result of cleaning activities (the wall areas retaining greater amounts of phosphate) or a factor of the building structure (wattle and daub walls?). The author also suggests that manuring was not practised, although he admits that these deductions could not be substantiated statistically. The most telling sentence is the last: 'A pedological study undertaken at an early stage would have clarified the migratory tendency of phosphates in these soils and would have confirmed the limited value of phosphate analysis ... under these circumstances' (p. 105).

The chapter on experimental archaeozoology by L. H. van Uijngaarden-Bakker is a useful piece of work, both in the summary of experimentation in this field (pp. 107-8) and the actual experiment in question. The problem was the interpretation of the butchery marks observed on the cache of pig mandibles mentioned above. These all had part of the ventral margin of the horizontal ramus removed. Two sows' heads were butchered by a

professional butcher. The first was treated for removal of the tongue and masseter muscles, and the mandibles were then separated from the skull. After this the ventral margins were chopped into, revealing a rich source of marrow. The last process was difficult with the mandibles separate from the skull, so the second skull was treated with the mandibles left attached until after opening the marrow cavity: a much easier job. Whilst the reason for the butchery seems obvious, this is a useful experiment because it does show the sequence of events that probably occurred. The discussion of the deposit is also interesting. The similarity of the butchery, the fact that the finds were in a single group, and the small age spread (27 ± 3 months) indicate that this was the work of a single person, and it is postulated he was a travelling butcher who had visited the site around the month of November. The mandibles represent twenty pigs, and if this was the number of farms (not unreasonable from the archaeological evidence), then the ratio of one pig per farm hardly represents the emphasis on pigs postulated by IJzereef.

The final chapter is an interpretation of the economy of the settlement by J.-P. Pals. He divides his discussion into sections on agriculture, stock-raising and manuring before bringing these together for his model of the economy. This reader was somewhat confused by the fact that a detailed series of calorific (and related) calculations were made, but the results were not very fully or critically employed. Furthermore, the wide error margins (admitted by the author) would be wider still when the evidence is combined. Having said this, the picture he presents - of a settlement well able to support itself - seems entirely reasonable.

In conclusion, the main drawbacks of this book are: (1) too great an attention to detail in some cases; (2) too uncritical an approach to, and acceptance of, some methods of analysis. Its strengths are that it is clear and intelligently presented. It provides more than enough data for other environmental archaeologists to use, but is written so that it should be accessible to 'non-environmentalists'. One rather doubts whether all the categories of reader listed on the back of the book would benefit from it, but to this reader, its main facilities are that it shows how environmental studies may combine with and enlarge upon other strands of environmental evidence, and (it is to be hoped) in a way that will convince non-environmental archaeologists that this kind of integration is the right approach.

Bruce Levitan

K.-E. Behre (ed.) (1986). Anthropogenic indicators in pollen diagrams. Rotterdam, etc.: Balkema. 232pp., 4 pis with other photographs and figures in the text. £19 to AEA members (see Newsletter No. 19, January 1988). ISBN 90 6191 673 9.

The background to this volume was a conference held at Wilhelmshaven in 1985 on signs of human activities in pollen diagrams, and the papers that were presented are published here. The people invited there were part of an INQUA working group that was established in 1982, and I believe the seventeen who gave papers were all who attended; it was not an open invitation conference. Even though the organisation of a conference may necessarily limit numbers, it seems a pity that a few more could not have participated; I can think of

palynologists in most countries of northern Europe who could probably have made valuable contributions or at least benefited from the discussions. Still, we can be grateful that the results have been published so quickly and at a reasonable price.

Twelve of the papers are in English and cover Dutch, British Scandinavian and East European results, while the rest, covering the two Germanies are in German. Switzerland and Austria are not represented here (in view of the high Swiss and Austrian 'productivity', this must be a result of 'low pollen transfer'). There are twenty-two pollen diagrams inside the back cover as well as some more printed with the text, perhaps not surprisingly, although I fear that the loose ones in the pocket may get 'lost' from library copies. My overall impression is that many of the papers were longer than they need have been (at least for this reviewer), at around 20 pages; the writers would probably disagree. The strict limit imposed by van Zeist and Casparie in Plants and Ancient Man (hereafter referred to as PAM) made for generally shorter papers, but I know myself the difficulty of trying to write a compact article.

The volume is arranged geographically. Starting with Scandinavia, the areas where there is evidence for indicators of human activity include northern Norway, where the small flora allows good indication to be had from barley, Spergula, Rumex acetosa and Ranunculus acris types, for instance, and Juniperus. Kaland discusses whether the coastal heaths of Norway were the result of man or climate, a bald statement covering an excellent paper. Berglund et al.'s results from south Sweden are on the interpretation of pollen diagrams with the aid of modern spectra from particular stands of vegetation, clearly concluded. Finnish results, in a well-written paper by Vuorela on the evidence for forest clearance, should have some relevance to studies on the earliest clearance here, and Vasari discusses evidence of flooding for haymaking, which was the practice in Finland. Trees in Denmark are discussed by Aaby in a detailed paper which shows what can happen when research resources are concentrated on a subject area.

The German papers have been thoughtfully provided with extra-long English summaries done to a high standard of technical writing. Behre and Kucan report on a particular settlement area in north Germany between the rivers Ems and Ueser in great detail, comparing the evidence for settlement at varying distance from the pollen sites, both kettleholes and mires. Beug has carried out a similar study of an area near Göttingen, but he concentrates on the Early Neolithic. Perhaps not surprisingly, for one who has done such detailed work on cereal pollen identification, much of his effort was directed to cereal pollens as indicators of settlement. Pott presents results of investigations into human activities in the area between the Ruhr and the Rhine, where woodland was managed along with cultivated fields in a distinctive way. Willerding compares the results from macrofossils with those from pollen analyses.

It was particularly valuable to have contributions from East Europeans because it is difficult for them to travel to the west. Lange has studied pollen in settlement ditches in East Germany; Rybníček and Rybníčková summarise results from medieval sites in Czechoslovakia, and Wasilikowa compares macrofossil and pollen results from Poland.

Geographically somewhat on the fringes of 'Central Europe', Groenman-van Waateringe has studied the evidence for grazing land in pollen from modern assemblages and from buried soil surfaces, and Janssen present some of his results from the Vosges mountains in France. Our islands come last (I would have thought we were nearer to Scandinavia, geographically at least), with Peter Moore and associates writing about man-made changes to water regimes, ideas which seem to be gaining general acceptance, if one can judge from

the fact that they are widely quoted; I suspect macrofossil studies might solve some of the problems of being unable to differentiate species within the indicator pollen taxa Potentilla and Melampyrum.

There is an enormous amount of thought and detail in the papers, which makes it quite a daunting task to get to grips with it all. They vary quite a lot in how much they discuss anthropogenic indicators in the strictest sense, i.e. the question of how to detect them in the periods and regions in question. Some papers seem rather more regional studies with human influence as a sideline. The standard is generally high and some very good, formal English (which many of us would have to try hard to emulate) has appeared from non-native speakers. Seven of those whose papers appear here also gave papers at the cultural landscape conference in Norway a year later, and a certain overlap of subject is evident from some of the summaries from the latter, but maybe the final publication of Cultural Landscape (due out some time this year) will deal with rather different aspects of the results in each publication.

Often one can at least get an idea of the source of some of the pollen types from macrofossils, and in small sites plenty more, yet, surprisingly, few papers acknowledged this as a source of information. Of course beetles are another source of evidence about man-made change (the only one, according to some!) but that opinion naturally reflects my own personal interests. To carry on the comparison between pollen and macrofossils, it has seemed to me that palynology as a subject is unfortunate in lacking regular meetings that there are for those who work on plant macrofossils (both in Britain and, internationally, at the IUGP. Such meetings and discussions there are of immense benefit.

Editing, I gather, is a matter for national custom. While, here in Britain, an editor would often send out scripts for referees' comments on all aspects of a paper, and perhaps be able to make some improvements themselves, the conventions overseas are different, and these papers seem to be as the authors typed them. The English terminology used varies from country to country, with terms which are not in general use here such as 'apophytes' used for weeds, and even the extraordinary 'ergasiophyte' for a crop, presumably. Maybe such terminology needed some unification, or even explanation, as such words can be in few dictionaries. At least we were spared the extremes of palynologists' jargon, 'pollenese', and I happily found no 'spatial and temporal inferences' anywhere.

On a technical note, the arrangements for providing camera-ready script as with PAM seem to have been generally successful. Behre's and most of the other contributions were originally typed in something very like Courier 10, perhaps on advice from Balkema, and after reduction they were still clear. However, Beug and Turner both used less readable typefaces, which were uncomfortable to read when reduced in the publication. Kaland used dot-matrix printing for the text and likewise Berglund's Apple Macintosh computer graphics were not a complete success, as fuzzy writing is tiring to read at this size (sorry AEA newsletter). When is desktop publishing with computer and laser printer going to appear on the archaeobotanical scene and give type that looks printed? The A4-sized pollen diagrams were a great improvement on the usual enormous fold-outs, and were mostly readable. As with PAM, the book is well bound and good value. Photographs are mostly included in the text now, although some were a bit small and muddy.

In conclusion, there is much useful information here, and it is well presented. This is obviously near to the state of the art - or is it a science - of palynology. But buy a copy soon; PAW has already been remaindered!

James Greig

E. Roselló Izquierdo (1988). Contribución al Atlas Osteológico cte los Teleósteos Ibéricos 1. Dentario y Articular. Madrid: Ediciones de la Universidad Autónoma de Madrid (Colección de Estudios 16). 308pp, 196 figs. ISBN 84-747-71447. 2,900 ptas (about £15 or \$30 US).

This is a book notice, rather than a review, because the text of this book is in Spanish, which I do not read. In common with many treatises on bone studies, however, sense can be made of the text even if one does not read the language, and the present book is no exception, especially as it is profusely illustrated with finely executed line drawings (the 196 figures often include two or more such drawings, and there is hardly a page without an illustration).

The author carried out the work upon which this book is based for her thesis. The book is partly bone atlas, partly analytical morphology of dentaries and articulars of fish. It is divided into six sections, the first and last being an introduction and conclusion respectively.

Section II is a description of the material and methods. No fewer than 96 species of fish have been covered, from 40 families and 15 orders. Some 144 specimens were examined, which means that most species were represented by a single specimen (there is a list of species and number of specimens examined). The more common species have had two or more specimens considered (e.g. trout (3), hake (2), scad (8)), but other important species such as cod, eel, and flounder have had only one specimen examined. There are also some omissions that are serious for the British analyst, though possibly not for the Spanish - e.g. ling (though even Spanish ling is not considered), herring and haddock.

The body of the book is contained in Sections III (dentaries) and IV (articulars): the atlas/morphological comparanda. This occupies 184 pages, with 192 figures. There is a useful introductory piece for each section, mapping the location of the elements, giving a detailed labelling (in Spanish), and a very good diagrammatic illustration of the main forms encountered (e.g. showing five basic teeth patterns: incisiform, caniniform, molariform, cardiform and coniform). Points of measurement are also shown, followed by a list of the species with their measurements and typical size categories. The line drawings in the atlas section are superb, and most figures show the lateral and medial surfaces of the bones. There are 86 pages (95 figures) devoted to dentaries and 69 pages (89 figures) for articulars. Each species is described, and the main characteristics of identification/difference from other species are given.

Section V is a quantitative analysis of the identification characters described in Sections III and IV. There are 39 tables of comparative listings and six statistical plots of the amount of separation encountered in different factors. The characteristics and species combinations used for each of three factors are listed, and plots of factors I/II, II/III and I/III are given. This section is the most problematic for non-Spanish readers, as the description and analysis of the statistics are central to an understanding of the plots, but a sense of the results can nevertheless be gained, with the more obvious species similarities being listed for each plot.

At the price of 2,900 ptas (which may include postage) quoted above, this book is very good value. Enquiries about it should be addressed to Libreria de la Universidad AutoVioma de Madrid, Cantoblanco, E 28049 Madrid, Espana, Telex: RCUA E, from whom it can be obtained.

Bruce Levitan

A note on the skeleton of a dwarf steer

Although we know very well that cattle of the Iron Age and medieval periods in particular were very small, it is difficult to envisage them, even with the aid of the famous sculpture of the Iron Age ploughman and his beasts housed at Newcastle-upon-Tyne Museum. The large Friesian dairy cows to be seen in every other pasture form a rather easier mental image. To see live, and afterwards to examine the skeleton of, a dwarf Dexter steer was therefore a salutary experience. Unfortunately I do not have the actual dimensions of the live animal or its weight, but the dressed carcass weighed 109kg (240lb). The animal was a pedigree Dexter, destined for sale as a breeding bull. However, at the end of his first year of life his owner decided he was not growing properly and had him castrated. Thereafter he grew hardly at all, and was eventually slaughtered at three years old, thus having the sort of life history which an historical animal might have had.

The animal was probably a pituitary dwarf, and therefore not entirely normal. The flesh was pale, reminiscent of veal, but inordinately tough. There was very little body fat. Bone maturation was late and the metapodials and distal tibia had unfused epiphyses, but it was not likely that much further increase in length was going to take place. Bone measurements were as given below. Compared with archaeological specimens, the bones gave an impression of shortness. Apart from the metacarpals, which had taken their size and shape before the animal was castrated, the bones seemed to have a more slender form than those of other modern breeds.

'Ugly one too¹, the name of this animal, had a little brother. He is now 20 months old and has a withers height of 0.74 m (29 in). He was left entire and reached puberty at 18 months. I am not likely to get his bones, though he will be of some value in a childrens' zoo or similar establishment.

Bone measurements (in mm; abbreviations follow von den Driesch, A. (1976) guide to the measurement of animal bones from archaeological sites).

Humerus	GL 220; Bp 83; Bd		GL 35; Bp 25; Bd 22;
Radius	GL 213; Bp 76; Bd	SD 36;	GL 35; Bp 26; Bd 22;
Netacarpals	GL 150; Bp 55; Bd	SD 30;	GL 36; Bp 27; Bd 24;
	GL 149; Bp 54; Bd		GL 36; Bp 26; Bd 22;
1st Phalanges	GLpe Bp 28; Bd		GL 36; Bp 28; Bd 23;
	GLpe Bp 28; Bd		GL 37; Bp 27; Bd 25;
	GLpe Bp 27; Bd	Femur	GL Bp 83; Bd 82; SD 34;
	GLpe Bp 27; Bd	Tibia	GL Bp 85; Bd 59;
	GLpe Bp 27; Bd	Metatarsals	GL Bp 47; Bd 47; SD 25;
	GLpe Bp 27; Bd		GL Bp 46; Bd 48; SD 25;
	GLpe Bp 26; Bd	Scapula	HS GLP 52; 5LC 48;
	GLpe Bp 26; Bd	Pelvis	LA 60;
2nd	GL 35; Bp 27; Bd	Calcaneum	GL
	GL 35; Bp 25; Bd	Astragalus	GL1 GLm 55; Bd 40;

Deer and sheep are words that cover all ages and sexes of groups of animals comprising several different genera. Domestic animals may be known collectively under the term used for the entire male, such as horses and dogs. Pigs are pigs and cats are cats, but what are cattle? I am no etymologist, but it is well known that this word was widely used in the Middle Ages to have a meaning wider than it does today, implying any of the domestic ungulates: 'all cattle¹ is a term which occurs several times in the Bible. Different species received their own adjective, bovine cattle being referred to as neat or black. But the term was always plural, and if there were a singular word it appears to have been 'beast'.

There is a problem as to how to refer to the animal in bone reports. Before the Second World War the word used was usually oxen, the exact definition of which by the Smithfield Club is a castrate male over four years old, so the archaeological usage is permissible, perhaps, if the livestock were thought to be dominated by plough beasts. Nowadays the word is cow; that is, a female which has borne a calf. This I find irritating, as do several of my colleagues. It implies to me that the user lacks historical insight and imagines that the black and white dairy cattle of the 20th century filled the pastures listed in Domesday Book. There really is no excuse for a table headed

The veterinary profession has had the same problem, and the word 'bovine¹ came to be used as a noun. The editors of journals soon put a stop to this (And quite rightly! -Eds.), and it was substituted by the pedantic 'bovine animal¹. However, this includes yak and bison as well as Bos taurus. There was even an occasional resort to 'bovid', but this was even worse, as it includes a multiplicity of antelopes.

Would resort to Latin names solve the problem? Bos taurus, Ovis aries, and so on would be correct and would cross language barriers, but it does get rather tedious and pedantic. Can anything be done with the word "taurus"? "Taurids" is a bit close to turds -"taurines" perhaps? But this seems to be getting amongst the signs of the zodiac in trendy horoscopes. So cattle persist in being a collective herd. But no cows please, we are historians of a sort.

Barbara Noddle

[As an editorial afterthought, having been brought up in an area where domesticated caprines of the genus Ovis were categorised as wethers or sheep (i.e. sheep were nearly all ewes), I was utterly bewildered when first discussing sheep with an Orcadian to be told 'No, there's no yowes in the flock - they're all sheep'. Work that one out!

Would Latin names really be the answer? The use of full binomials such as Bos taurus is really to be discouraged for domestic animals which are domesticated forms of one or more wild species with which the domesticated forms are strictly speaking conspecific. If domestic sheep are interfertile with wild species of sheep, why are they Ovis aries and not O. ammon? In any case, how often are our identifications of bone fragments really accurate enough to say that specimens are, for example, to be attributed to Bos taurus or B. grunniens rather than the more honest Bos sp(p)? This one could run and run....

T. P. O'Connor]

Although the AEA was founded in Britain nine years ago, it was never intended that it should be a specifically British institution. In the event, it has acquired a membership living around the North and Baltic Seas, whose interests centre on the past environments of northern Europe. It was therefore fitting that a conference should be held outside the British Isles, and the ninth such event was held at Roskilde, in Denmark. It must be said at the outset that the conference was a great academic and social success, organised by David Robinson of the Danish National Museum in Copenhagen. He does know how many hours he put into it, the Museum allowing such time, but did not choose to tell me. David was ably assisted by Ida Boldson and Anette Johnson.

The actual conference headquarters was the Roskilde Youth Hostel, as Danish prices did not permit the choice of more opulent surroundings. However, this does possess a conference room, and the catering was of a very high standard. The first evening's events took place here, and comprised a welcome from the Director of the National Museum, an historical talk by Don Brothwell, and an introduction to the Lejre Archaeological and Historical Research Centre by its new director Bo Madsen. This was followed by a velkomstfest, a Danish word that does not require translation.

Most of the academic content of the conference was delivered next day at Roskilde University Centre in the form of sixteen talks - a bit of a marathon - but all of them interesting and well-presented. The following is a personal selection of the highlights. Foremost academically was the low-key presentation of the first incontrovertible evidence for slash-and-burn agriculture in Scandinavia, based on the recognition of heat-altered pollen grains by Svend Andersen. James Greig demonstrated a new way to defeat weeds: he tried to grow them with standard greenhouse techniques and failed. Andrew Jones opened the proceedings in his own inimitable way - perhaps he should consider changing his nick-name from Bone to Coprolite. Sue Stallibrass followed this by some pictures of an obliging mongrel called Sappho, who demonstrated how bones acquire their gnawing marks. Bruce Levitan described a cave site in the Mendips which can only be excavated by archaeoathletes. Ruth Morgan described a timber neolithic mortuary chamber, which had survived well enough to be reconstructed and dendro-dated, from the splendidly named site of Foulmire Fen in Cambridgeshire. Camilla Dickson talked about varieties of reconstructed Roman porridge, some of which were tastier than others. Su Grierson showed us how she actually carries out the dyeing of wool with plant materials. Keith Crabtree, in bringing us up to date on the British Association Experimental Earthworks, managed to imply that Professor Dimbleby had been left standing in one of the ditches for two years, and produced a photograph of him reminiscent of Lot's wife. He also suggested a whole new environmental topic in studying the Fish Villa at Romanbourne. Bill Boyd, an exiled Scot, introduced us to the problems of environmental archaeology in Australia. Robert Janaway brought the proceedings to a close with a description of some heroic experiments designed to show how the presence of metals on bodies enhances the preservation of fabrics. He placed dead rats in shrouds and made suitable coffins for some of them, and after nine months had some very interesting results. He intends to carry out some even more heroic work with pigs. Added to all this were numerous poster presentations which we endeavoured to study whilst consuming tea and coffee, and an excellent lunch.

That evening, following yet another excellent Danish meal, a somewhat languid gathering held its A.G.M. It was agreed that out-of-Britain conferences were a good thing, but the 10th will be held in London next year.

Day Two was spent mostly at the Lejre Archaeological and Historical Research Centre. Here we were privileged (and I mean it) to hear a lecture from Dr J. Troels-Smith retelling the seminal series of experiments demonstrating the possibilities of neolithic deforestation. Another lecture of fundamental importance came from Peter Rasmussen, He has been examining small ruminant faeces, probably of goat, preserved at the prolific Swiss neolithic site of Egolzwil, and has found clear evidence that in the late winter and spring these animals received fodder in the form of hazel and alder twigs, carrying pollen-covered catkins. Some of us spent the rest of the day at Lejre, whilst most went to the famous Viking Ship Museum at Roskilde. A planned sailing expedition there had to be cancelled, as Danish inclement weather has little to learn from its British counterpart.

Lejre is the first centre of its kind, and all subsequent establishments of a similar nature must pay it due acknowledgement. It is set in 20 hectares of enchanting secret landscape, with a pool or bog at the bottom of every hillock. The reconstructed Iron Age village was a little premature, and is no longer considered to be quite correct. Other much later buildings have simply been rebuilt or were always at their present location. Agricultural experimentation seems somewhat in abeyance as the Centre struggles with the familiar financial problem of generating 60\$ of its own income, but there is plenty of pottery manufacture and flint-knapping. There is an area for schoolchildren where they can light their own fires and go boating on log canoes. Some AEA members indulged themselves with this pastime when the children had gone. Dr Madsen seems the person most likely to succeed in restoring the establishment to its former glory. That evening an item cryptically programmed as 'entertainment'¹ turned out to be two traditional musicians whose excellence got members dancing - in the circumstances, the dance might be called a Danish conga.

Day Three consisted entirely of visits. In the morning we went to the Frilandsmuseet, another Danish first. As early as 1902 they were preserving old farmsteads on this site as well as rebuilding specimens from other areas. Whole farmyards are preserved, and have a wonderful air of belonging to the place. There was far too much for the few hours available. Some sampled Faroese fishing huts, and others attended another session on vegetable dyeing techniques. Sheila Hamilton-Dyer and I discovered a common fascination with cowsheds which we were able to indulge. And it didn't rain all the time.

The afternoon was mesolithic. The Vedbaek area has proved so prolific in sites of this period that a museum (Gammel Holtgard) has been set up purely to serve them. The Danes are very museum-conscious, and have more of them per head of population than anywhere else in the world - and this one is a beauty. It was demonstrated to us by Professor Eric Brinch Petersen, who is rightly proud of it. Besides an exemplary display of the finds themselves, there is a series of reconstruction panoramas (referred to as the fiction!) as vivid as those of the Jorvik Viking Centre. We were finally extracted from this splendour to visit the sites of some of the excavations.

That was the end of the conference proper. Sixty-seven persons dispersed to their home bases, and eighteen remained to go on an archaeological tour of Jutland. The conference participants comprised 31 with Danish addresses, eight from other Scandinavian countries, eight Dutch, sixteen U.K., six Swiss, one German, and one Scot from Australia. English, bless everyone, was spoken throughout.

The excursion was superbly planned and hitchless, David (again) doing us proud. We saw the cream of Danish archaeological treasures and a representative selection of sites, each with its own academic specialist to present it. I don't know whether the bus driver had been specially selected, but certainly he joined in the proceedings and was able to contribute information of his own, on farmhouse architecture, for example. We also investigated some of the delights of Danish cuisine in the form of magnificent lunches in delightful settings (most old Danish watermills seem to have been turned into excellent restaurants).

On Day One of the excursion, Or Else Roesdahl showed us the Viking stronghold at Fyrkat, with a magnificent reconstruction of a Viking longhouse strongly reminiscent of an upturned boat. One almost expected the sparrow that the Venerable Bede used as an analogy for the mysteries and transience of life to fly in through the door at one end and out at the other. For the archaeozoologists there was a resident flock of Icelandic sheep to admire. In the afternoon we came into the presence of a mysterious and possibly ritual death at Silkeborg Museum, where Tollund nan exudes his curious atmosphere of peace, the star exhibit in this interesting museum, and presented to us by its head Dr Christian Fischer.

On Day Two we enjoyed another museum, this time an educational one associated with the University of Arhus Archaeological Research Institute at Moesgard (and some of us enjoyed the playground designed for school parties). There was another Iron Age house reconstruction, and we were also shown some of the incredibly rich finds from the site of Illerup Adal, where a Roman army and all their equipment were sacrificially drowned. Dr Jorgen Likjer opened box after box of gilded shield bosses and the like. 'We have¹, he said, 'more Roman swords than they have in the whole of Italy¹. In the afternoon, Dr Kjeld Christensen presented the important ecclesiastical site of Jelling. Gorm the Old and his wife were buried under the appropriate heathen burial mounds, but it has been suggested that his late conversion to Christianity resulted in his reburial in Jelling church. At any rate, when the mound was opened in the 19th century it was found to be Gormless, and there is the splendid Jelling stone, a massive lump of granite carved with a happy mixture of Viking and Christian iconography. Recent dendrochronological work provides a date which supports the story. We also visited the site of an extraordinary Viking-Age bridge crossing a swamp (complete with part reconstruction).

Day Three was spent in the Esbjerg area where an enormous amount of development is taking place, necessitating vast amounts of rescue excavation. 'We have found 20 new Iron Age sites this year', reported Palle Sieman, who is doing his best to cope with all of this activity. The individual sites are impressive more for their quantity than their quality, as the agriculturally poor sandy soil is also ungenerous archaeologically, but the marine resources of this coastal environment helped to support an apparently high population. Medieval sites have also been found in their dozens. After that we were on our way back to Copenhagen, via the splendid old town of Odense, celebrating its millennium this year. We arrived just too late for the Hans Andersen Museum, but I was able to enjoy a private viewing of the new Nielsen Museum. Nielsen's main business in life was music, but his wife was an eminent animal sculptor, so the whole was appropriate for a musically-inclined archaeozoologist.

Besides the official programme, most of us had the opportunity to visit the Danish National Museum for at least half an hour. The prehistoric gallery is magnificent. Not only are there such world-famous treasures such as the Gundestrup cauldron, but there are

serried ranks of lurs (lura?) and some very beautiful Roman glass. The less well-known medieval galleries are also full of interest (e.g. Greenland excavations) and splendour (church furnishings).

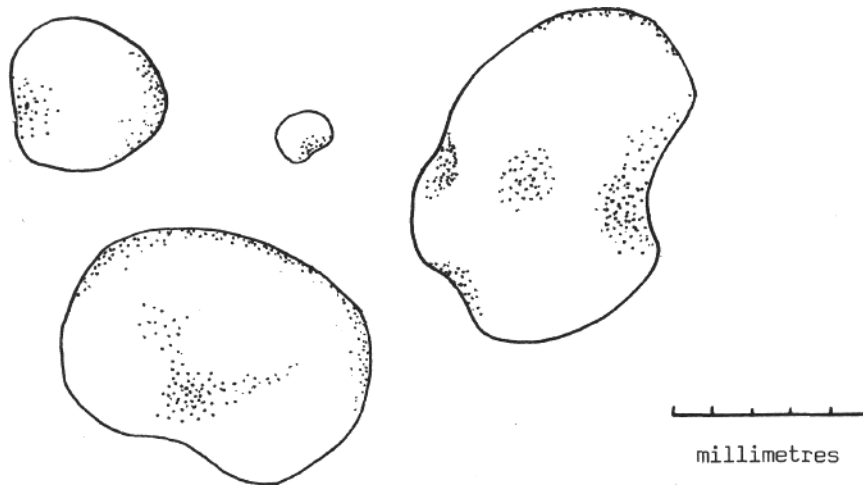
All in all it was a marvellous week. Though flat, Denmark is a country of pleasant scenery and traditional housing in rural areas. The roads are delightfully empty, but take your mackintosh, particularly if you intend to make the journey from Hamburg by bicycle, as did the intrepid James Greig. It is rumoured that his bright purple trousers generate a special form of energy, but then he does eat a lot.

Barbara Noddle

Mystery object number 2 - animal, mineral or vegetable?

Can anyone please suggest what these (see figure) mineralised objects are? I am sure anyone who has sorted sieving residues containing calcium phosphate-replaced plant remains will have seen them. They seem to occur exclusively in 'mineralised'¹ contexts, both in material of faecal origin from latrines and in non-faecal midden deposits.

The objects are quite variable in shape, but have a generally characteristic form and surface properties that make them instantly recognisable. They can be solid or hollow, and are usually pale brown to orange in colour, like the mineralised plant remains with which they occur. I have found them ranging in size from 1 to 10 mm in a single sample. They have been recorded from samples dated from the Late Bronze Age through to the medieval period.



Mystery mineralised objects

So far, the suggestion of tapeworm cysts has been discounted by the London School of Hygiene and Tropical Medicine. Since we still know relatively little about the mechanisms of preservation by mineralisation, I thought it might be helpful to find out what these objects are, since they always seem to be present in deposits with mineralised preservation. Any suggestions will be welcomed - plentiful specimens can be supplied on request.

Wendy Carruthers, Sawmills House, Castellau, Llantrisant, Mid Glamorgan CF7
8LP

Carbonised neolithic plant remains from The Stumble, an intertidal site in the Blackwater Estuary, Essex, England

Peter Murphy

During the first season's excavation of neolithic deposits at The Stumble, Essex, abundant carbonised remains of cereals (Triticum dicoccum, T. monococcum, Hordeum sp. var. nudum) were retrieved, but carbonised remains of rosaceous fruits, Corylus nutshells, and unidentified roots, tubers and rhizomes were also common, indicating a substantial reliance on wild plant foodstuffs. The presence of immature Tilia fruits may be related to the collection of leaf fodder. Sample composition suggests that the assemblages mainly represent accidental charring of semi-clean crop products, though one sample produced crop-cleaning waste. The results from this site provide, for the first time in Eastern England, a firm basis for discussion of a neolithic plant economy.

Introduction

During the early years of this century, the work of S. Hazzledine Warren, F. W. Reader and other investigators established that along parts of the Essex coast a submerged land surface and associated archaeological sites are exposed between tides (Reader 1911; Warren et al. 1936). In response to destruction by marine erosion, sea-wall improvement and other local threats, a systematic survey of the open coast and estuaries of Essex was begun in 1982, with the aim of locating and recording sites on this submerged land surface, and also prehistoric, Roman, medieval and later sites stratified within the overlying Holocene sediment prism (Wilkinson and Murphy 1986; Wilkinson 1987).

In the course of this survey, a group of early to middle neolithic settlements was found within the intertidal zone of the estuary of the River Blackwater. These settlements were originally dry-land sites when occupied and it is estimated that most were approximately 1 km from their contemporary coastline. There is thus no preservation of organic material by waterlogging, although the sites today are some 3 m below Mean High Water. However, they are of unusual significance because the overlying sediments deposited since the area was submerged by rising relative sea-level from c. 2000 B.C. have protected them from disturbance and erosion: the neolithic palaeosol survives essentially intact and shallow features are extant. Only now, as the sedimentary cover is stripped away, are they first exposed and then destroyed by marine erosion. In marked contrast, contemporaneous settlements on the adjacent gravel terraces of the Blackwater have been severely truncated by ploughing, so that only the bases of pits survive.

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Since 1986, one settlement, Blackwater Site 28, on a mudflat known as 'The Stumble', north of Osea Island (National Grid Reference TL 9014 0725), has been surveyed and selectively excavated (Wilkinson and Murphy 1987; Fig. 1). The palaeosol and dug features have been sampled for the retrieval of carbonised plant material, burnt bone and teeth (bone usually survives poorly), over three seasons between 1986 and 1988. In this preliminary paper, results from the 1986 season, when an area of 10 x 5 m was excavated (Site 28A), are presented. Already this one area has produced far more botanical material than any other neolithic site in Eastern England, and for the first time in this area there is a sound basis for discussing in some detail a plant economy for this period. It is intended that the results from all three seasons will, eventually, be published fully with the excavation report in the journal East Anglian Archaeology.

Methods

Sampling and processing of deposits from intertidal sites present a number of unusual problems, and it is thus useful to describe the methods used in some detail.

Samples were collected on a 1 x 1 m grid from the palaeosol during the second and third trowelling passes (samples 1-50 and 51-100 respectively), and from excavated features. Sample size was limited by practical considerations, in particular the weight of soil which could be transported from the site (initially on foot over extensive mud-flats, and subsequently by boat). Samples of 3-6 kg (dry weight) were taken from the palaeosol, and samples of varying weights from the fills of excavated features, depending on the size of the feature. On-site processing was not possible because the clay loam matrix of the deposits would not disaggregate readily.

On the basis of trial processing (Wilkinson and Murphy 1987, 71-3), the following methods were adopted:

(i) the samples, consisting of waterlogged clay loam, were stored in an unheated outbuilding with the bags open, allowing very slow drying;

(ii) after weighing, the dry samples were immersed in fresh water over a 0.5 mm mesh and wet-sieved when they had disaggregated (usually in a few minutes);

(iii) the material retained on the mesh (sand, shells of modern burrowing estuarine molluscs and plant detritus, with carbonised plant remains, bone and artefacts) was transported to the laboratory without drying;

(iv) after wet-sieving and washing with fresh water on a 6 mm mesh (to remove large shells, as well as artefacts, bone and large charcoal fragments), carbonised plant material was separated by flotation/washover with a 0.5 mm collecting mesh. The non-floating residues were wet-sieved on a 0.5 mm mesh. The 'flots' and residues were washed thoroughly to remove as much salt as possible;

(v) the residues were re-floated, because they still contained some charred material;

(vi) the dried 'flot' fractions, which consisted of mats of modern plant detritus with carbonised plant material, were gently broken down manually, before sorting under a binocular microscope at low magnification. After drying, some of the material had surface deposits of salt crystals, despite several stages of immersion in fresh water. It is possible that efflorescence of salt will cause fragmentation in the long term, but re-wetting the dried flots for a further washing would also be destructive;

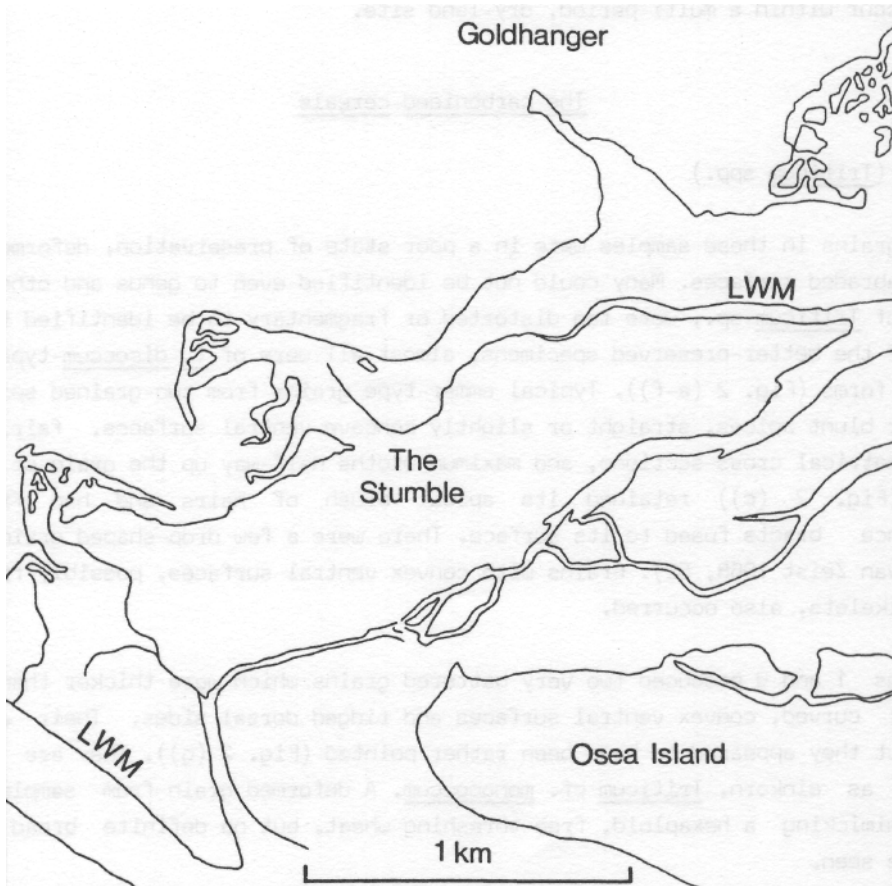
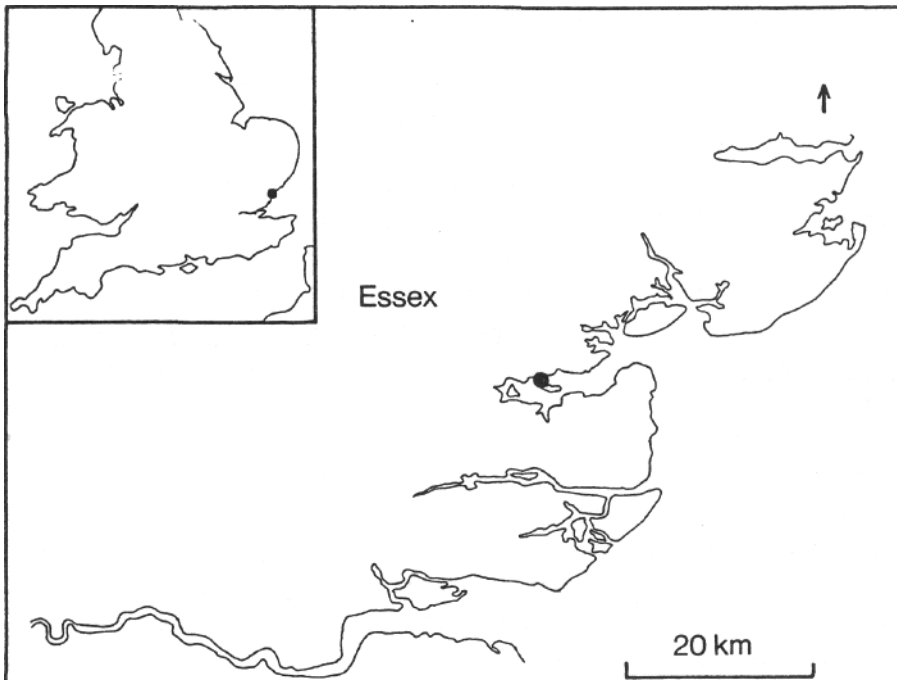


Figure 1. Location of The Stumble. The modern Low Water Hark (LWM) approximates to the early neolithic High Water Mark.

(vii) finally, the residues were sorted for bone and small artefacts, without magnification. The weights of burnt bone fragments, charcoal and hazel nut shell fragments in the samples were also recorded.

Contamination

It was clear, during sorting, that the samples contained a mixture of carbonised plant macrofossils, burnt bone fragments and small artefacts, with intrusive biological material. The latter included foraminiferans, hydrozoans, mollusc shells, crustacean and insect remains, small fish bones and plant detritus (roots, stems, leaf fragments and seeds - mostly of halophytes such as Suaeda maritima, Plantago maritima, Triglochin maritima, Aster tripolium and Ruppia sp.). This intrusive material is likely to have been introduced into the neolithic deposits by the activities of burrowing organisms in two phases: firstly when the site was submerged in the early 2nd millenium B.C., and again, recently, since sedimentary cover was largely removed by erosion. There is no practicable way of separating macrofossils belonging to these two phases of estuarine conditions but none of them is of any relevance to the neolithic site and they can therefore be ignored. Obviously there is scarcely any possibility that any carbonised plant material or mammal bone has been introduced since the site was submerged by rising sea-level. One of the many advantages that this site has over dry-land sites is that the possibility of such contamination can be ignored - something that is not the case where neolithic settlement features occur within a multi-period, dry-land site.

The carbonised cereals

(i) Wheats (Triticum spp.)

Most grains in these samples were in a poor state of preservation, deformed, and with porous or abraded surfaces. Many could not be identified even to genus and others, though certainly of Triticum sp., were too distorted or fragmentary to be identified to species. However, of the better-preserved specimens, almost all were of T_._ dicocum-type. There was a range of forms (Fig. 2 (a-f)). Typical emmer-type grains from two-grained spikelets had rounded or blunt apices, straight or slightly concave ventral surfaces, fairly rounded, often asymmetrical cross-sections, and maximum widths half-way up the grain or above. One specimen (Fig. 2 (c)) retained its apical brush of hairs and had fragments of inflorescence bracts fused to its surface. There were a few drop-shaped grains (Fig. 2 (b); cf. van Zeist 1968, 52). Grains with convex ventral surfaces, possibly from single-grained spikelets, also occurred.

Samples 1 and 9 produced two very battered grains which were thicker than broad and had rather curved, convex ventral surfaces and ridged dorsal sides. Their apices were damaged, but they appeared to have been rather pointed (Fig. 2 (g)). They are tentatively identified as einkorn, Triticum cf. monococcum. A deformed grain from sample 4 showed features mimicking a hexaploid, free-threshing wheat, but no definite bread wheat-type grains were seen.

The wheat spikelet fragments consisted of spikelet forks, glume bases, detached rachis internodes and 'spikelet bases'. This last term refers to forks that had lost all or almost all trace of their internodes and the outer surfaces of their glume bases: the most fragmented examples were barely recognisable as cereal chaff and none of these 'spikelet bases' could be specifically determined with any confidence. The relatively small proportion of better-preserved wheat chaff has been identified with reference to

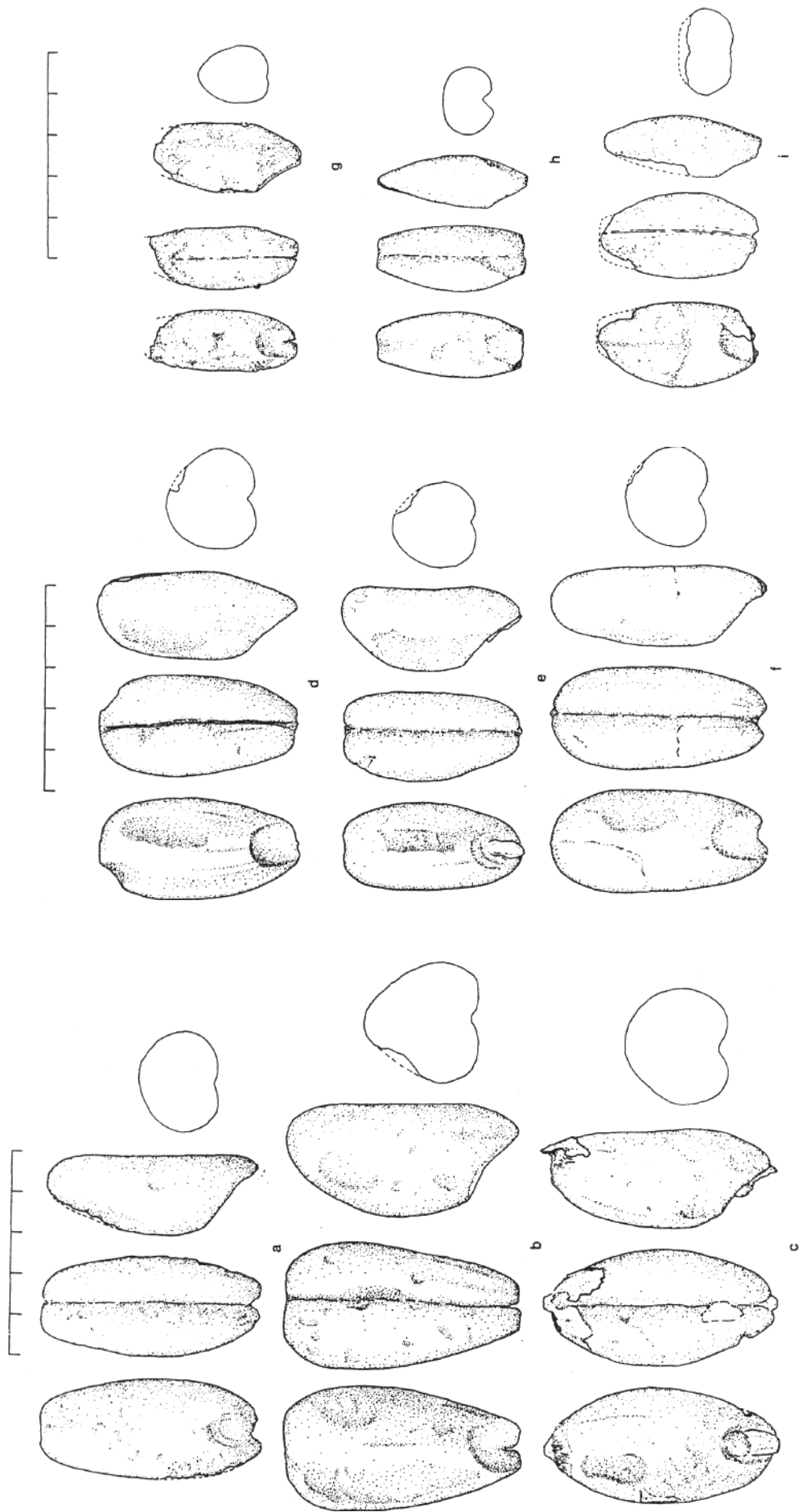


Figure 2. Cereal grains from Site 28A: (a-f) Triticum dicoccum-type (from samples 81, 25, 59, context 138, and samples 60 and 78 respectively); (g) J.- cf. monococcum (sample 9); (h-i) Hordeum sp. war. nudum (samples 72 and 21 respectively). Scale 1 mm.

unpublished criteria devised by Dr G. C. Hillman and to Jacomet's (1987) guide. The morphological criteria used in identification were as follows: presence/absence of nerves on the outer surface of rachis internodes (to detect any hexaploid wheats present); angle between glume faces on spikelet (viewed from above); angle between glumes on spikelet (viewed from front); prominence of primary and secondary keels and degree of tertiary nerve development on outer glume faces; angles between glume faces on either side of primary and secondary keels; distance between top of rachis internode scar and base of glume insertion; and relative width of rachis internode scar. The degree of precision in identification (e.g. Triticum sp., J._ cf. dicoccum, J._ dicoccum) is related mainly to the numbers of these features surviving on each specimen.

Measurements have not been used as a basis for identification, in part because of the poor state of preservation of the material. Rather few of the spikelet forks remained undeformed or retained the outer surface of their glumes, for example. The only dimension fairly consistently determinable was the width of detached glume bases, since these are often well-preserved. Jacomet (1987, 62) gives width ranges for einkorn of 0.45-0.9 mm and for emmer of 0.7-1.1 mm. However, in these samples, there were some very slender bases (less than 0.6 mm), with distinctively emmer-type morphology. Consequently the distribution of glume widths in this case is not likely to give a reliable separation. It is hoped that more, and better-preserved, spikelet fragments will be recovered in future seasons.

Some of the best-preserved material is illustrated in Fin. 3. Spikelet forms of emmer (T. dicoccum) are shown in Fig. 3 (a-d). They show wide angles between the glumes and the internode scars are generally narrow. On many specimens the internode scar was obscured by scraps of tissue remaining from the internode. Fig. 3 (e) illustrates a terminal spikelet fork of emmer. This has no ascending internode scar and the glumes are roughly symmetrical. The specimen shown is illustrated at an oblique angle: the crack in the glume makes it appear rather wide. The fork shown in Fig. 3 (f) is thought to be of einkorn (T. monococcum), from near the base of the ear. The surviving glume ascends almost vertically; it is narrow and has prominent primary and secondary keels, partly broken away, though (as in most cases) the outer glume face is rather abraded and damaged. Some of the spikelet forks (e.g. in sample 9 and from a post-hole fill, context 138) had wide internode scars. The example from sample 9 was simply too poorly-preserved to be identified specifically (the glumes were almost completely broken off), and the specimens from 138, though showing this einkorn-type feature, had emmer-type glumes set at an angle when viewed from above. They are assumed to be extreme forms of emmer.

Almost all the identifiable detached glume bases were of emmer. A typical example is shown in Fig. 3 (g). It has quite a prominent primary keel, the secondary keel is marked mainly by an obtuse angle on the glume face, and the tertiary nerves are visible, though rather faint. The glume faces on either side of the primary keel are at an acute angle. There were a few much more robust emmer glume bases with strongly-developed keels and tertiary nerves (Fig. 3 (h)). In context 138 there were some extremely narrow and badly-distorted glume bases, perhaps from immature ears. The slender glume base illustrated in Fig. 3 (i) shows very faint traces of tertiary nerves, and has the faces of its glumes on either side of the primary keel set at just under 90°.

Intact rachis internodes were very rare. The detached examples from 138 mostly had damaged outer faces, but none of them showed nerves on these abaxial surfaces (Fig. 3

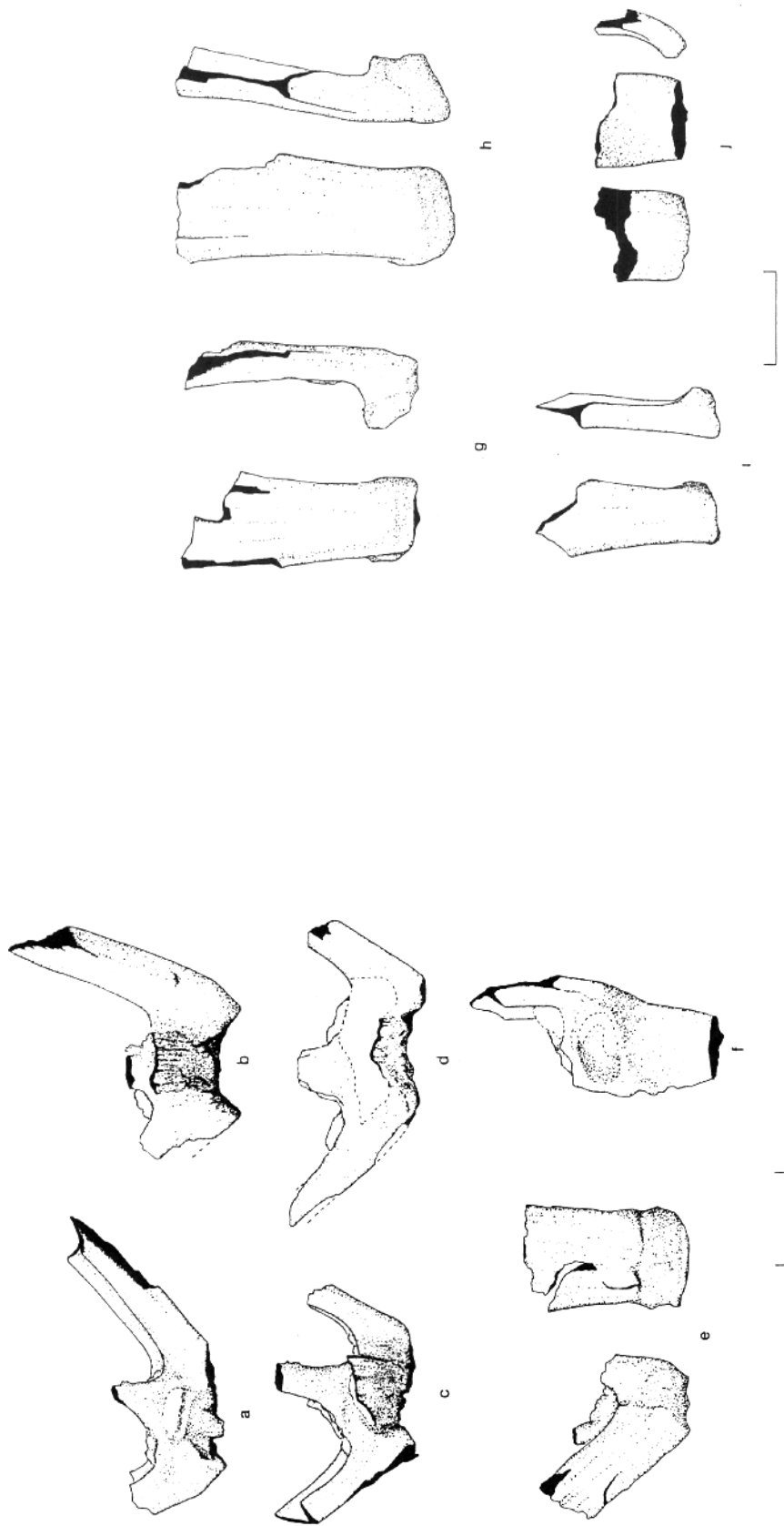


Figure 3. Wheat spikelet and rachis fragments from Site 28A: (a-d) T₁-dicoccum spikelet forks (a-c from sample 60, d from 30); (e) T₁-dicoccum terminal spikelet fork, oblique views (context 138); (f) T₁-cf. monococcum spikelet fork from near base of ear (context 138); (g-h) T₁-dicoccum (g - typical glume base, sample 3; h - robust glume base, sample 60); (i-j) T₁-cf. dicoccum (i - slender glume base from sample 60; j - rachis internode from context 138). Scale 1 mm. Blank areas enclosed by dashed lines were those obscured by sediment encrustations.

In summary, features of the grains and spikelet fragments indicate that emmer (*T. dicoccum*) was the main wheat in these samples. There was a small proportion of einkorn (*T. monococcum*), but the material is thought to be too poorly preserved to give an exact figure. No evidence for the presence of hexaploid wheats was seen.

(ii) Barley (*Hordeum* sp.)

Grains of barley were uncommon and the few specimens present were either underdeveloped or poorly-preserved (Fig. 2 (h-i)). Presumably a B-row form is represented, but all the grains in these samples are, or were, symmetrical (the grain shown in Fig. 2 (i) is deformed). The rounded profiles of these grains and, in some specimens, the presence of a central groove on the dorsal surface and a narrow ridge in the ventral furrow establish the presence of naked barley (var. *nudum*). No barley rachis fragments were seen.

(iii) Grass/cereal culm

Context 138 produced some quite large fragments of charred grass or cereal culm with a few nodes. The fragments were up to 10.5 mm in length and 1.4 mm in diameter, but generally less. There was also a single node from sample 60.

The weed flora

Carbonised fruits and seeds of weeds were uncommon, but in the samples from the palaeosol and most of the features *Lycium/Lathyrus* sp(p). and *Galium aparine* were the two most frequent taxa. The former were represented mainly by badly damaged, separated cotyledons with some whole seeds which, however, did not retain well-preserved intact hila. Nutlets of *Rumex* sp(p). and *Polygonum aviculare*, seeds of Chenopodiaceae and small caryopses of Gramineae occurred in a few samples.

The assemblage from context 138 was different. As noted below, this post-hole seems to have contained a proportion of crop-cleaning waste, including weed seeds. In order of abundance, these were of *Rumex* sp(p)., Gramineae (at least three species), *Chenopodium album*, *Polygonum* cf. *aviculare*, *Polygonum* sp(p)., *Vicia/Lathyrus* sp(p)., *Stellaria graminea* and indeterminate Caryophyllaceae. However, the total weed 'seed' assemblage from this sample only comprised 39 identified specimens.

Nuts, fruits, etc.

Fragments of carbonised hazel-nut shell (*Corylus avellana*) were amongst the commonest macrofossils, though the density of fragments in the soil was very low. No intact nuts were recovered, apart from one almost complete immature nut, 6 mm in length. As mentioned above, weights of fragments in each sample were recorded.

Fragmentary fruitstones of sloe (*Prunus spinosa*) came from 15 samples. Most fragments were very small and were identifiable only from the rough surface of the endocarp; tentative identifications refer to abraded fragments. The most complete example, from sample 50, retained its prominent dorsal ridge. Context 164 produced a fruitstone of hawthorn (*Crataegus monogyna*), 5.0 x 3.7 mm in size. The fruitstone of *Rubus* sp. from sample 90 was in a poor state of preservation: only traces of the endocarp with its coarsely reticulate surface survived on the finely striated internal tissues. A few samples contained small enrolled fragments of tissue thought to be epidermis of apple (*Malus sylvestris*). Two immature fruits of *Tilia* sp. came from samples 52 and 89. Both were sub-spherical with pentagonal symmetry.

Fragments of vegetative plant material occurred frequently in these samples. The specimens were divided into nine main categories and examples of each type were shown to Jonathan Mather (Institute of Archaeology, University of London), to whom I am indebted for many of the comments below.

1. Swollen basal internodes of Gramineae (samples 10, 24, 52, 54, 61, 66, 75, context 164 and unlocated sample f). These pyriform or bulbous swollen basal internodes varied considerably in size (length approx. 3.0-5.4 mm; width 0.9-3.1 mm) and shape, depending partly on their original positions at the stem base, examples of lower internodes being rather rounded, the upper more elongate (cf. Hubbard 1968, 234). Epidermal cells are visible on the outer surfaces of most specimens (Fig. 4(a)) and many of them are fractured longitudinally, showing parenchyma on the fractured surfaces in radial longitudinal section (RLS; Fig. 4 (b-c)). They are similar to swollen basal internodes of the onion couch, Arrhenatherum elatius (L.) Beauv. ex J. & C. Presl. var. bulbosum (Willd.) Spenner.

2. Other Gramineae stem fragments with short internodes (context 164). A fragment from this context, approx. 3 mm in length, comprises one whole and two incomplete internodes. It is longitudinally fractured and in RLS a central area of parenchyma, with fibre and vessel tissue at the periphery is visible. The very short length of the internodes implies an underground or basal stem section. (The presence of aerial grass/cereal stem nodes and fragments in context 138 and sample 60 has been noted above; see also Fig. 4(d).)

3. Monocotyledonous internodes with strong longitudinal ribs (sample 99). The specimen consists of two conjoined short internodes up to approx. 2 mm in width. There are faint traces of epidermal tissue on the ribs. In transverse section (TS), most of the cell structure has been reduced to amorphous carbon, though small lumina (probably of fibre cells) are visible in the 'rib' areas (Fig. 4(e)).

4. Section of dicotyledonous fleshy tap-root (sample 2). The specimen is an incomplete disc, comprising a transverse section across a root, approx. 5 mm in diameter, and about 1.5 mm thick. It is not clear why it has fractured in this way (longitudinal rather than transverse fracturing would probably be expected), though there is the possibility that it was cut before carbonisation. In TS, a radial pattern of linear cavities, very characteristic of degraded xylem parenchyma, can be seen, but the outermost thin band of tissue does not have such cavities and probably consists of degraded phloem and epidermis (Figs. 4(f) and 5(a)). A second fragment (from sample 44) shows similar degraded tissue with radial cavities, but is attenuated to a point at one end (Fig. 5(b)).

5. Central xylem and fibre 'cores' of ?roots (samples 1, 3, 16, 25, 31, 35, 51, 52, 57, 70, 79, 92 and 95). These specimens consist of small 'twig-like' fragments 0.4- 2.0 mm in diameter, irregularly curving, sometimes 'branched', and with numerous small side 'shoots' (Fig. 5(c)). In relation to the main axis, these diverge at all angles, suggesting the material is from roots rather than aerial stems. Their surfaces appear to consist of fibre tissue and they are thought to represent the central vascular and fibrous cores of roots that have lost their periderm, phloem and associated parenchyma. Specimens examined in TS show only solid masses of amorphous carbon. One specimen from 51 partly retains its outer tissues, represented by a sheath of porous and vesicular carbon.

6. Rhizome fragments with prominent circular root scars (samples 8, 10, 30, 34, 39, 40, 45, 62, 84, 85, 91). A typical example is illustrated in Fig. 5(d). Characteristic features are the short internode length, rather irregular longitudinal ribbing on the internode, and conspicuous circular root scars, some of which have hollow centres, whilst others have small central projections. The specimens are very irregular in width and often rather flattened. Traces of epidermal tissue are visible on some specimens.

7. rhizomatous fragments of ill-defined form Small and/or abraded fragments believed to be rhizomatous because of the short internode lengths and apparent root scars.

8. Inflorescence axis (sample 82). Flattened short length of stem with numerous small side shoots diverging at acute angles from stem axis (Fig. 5(e)).

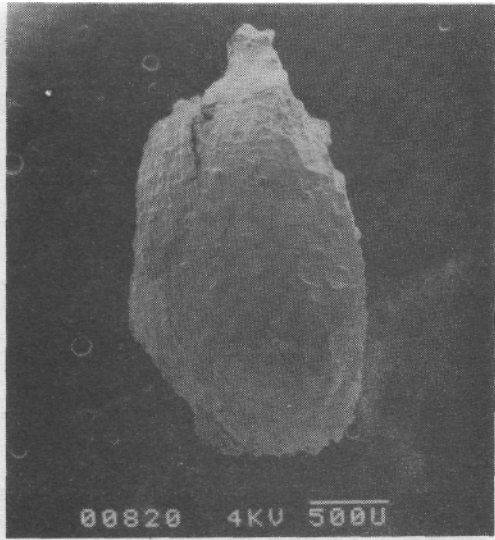
9. Stem/rhizome with whorls of shoot or root bases at nodes (samples 62, 75, 85). These are quite robust lengths of stem, 2.0-2.6 mm in diameter, with short internodes at which there are whorls of small circular scars. There are also large circular scars on the internodes at intervals (Fig. 5(f)).

Some of these categories of vegetative plant material are quite distinctive, whilst others share features and may indeed have come from different parts of the below-ground structures of the same species of plant. With the exception of the onion couch basal internodes, none of the material is closely identifiable at present, though the author would be most grateful for any comments on identification from colleagues.

Spatial distribution of macrofossils

Sampling in a grid pattern across the excavated area has made it possible to draw up plans showing the distribution in the palaeosol of charcoal and burnt bone (as grammes of fragments greater than 2 mm per kilogramme of soil), Corylus nutshell fragments (grammes of fragments greater than 0.5 mm per kilogramme), cereal grains and glume bases (numbers per kilogramme), roots, rhizomes and tubers and fruitstones (presence/absence). These plans show that macrofossils are not uniformly distributed across the site: there are definite concentrations, some of which can be correlated positively with artefact distribution. However, it seems that the 1986 excavation was simply too small (10x5 m) for much sense to be made of these concentrations, let alone distinguishing 'activity areas'. It is hoped that results from the samples from the larger areas excavated in the 1987 and 1988 seasons, when added to those of the 1986 season, will produce interpretable patterns.

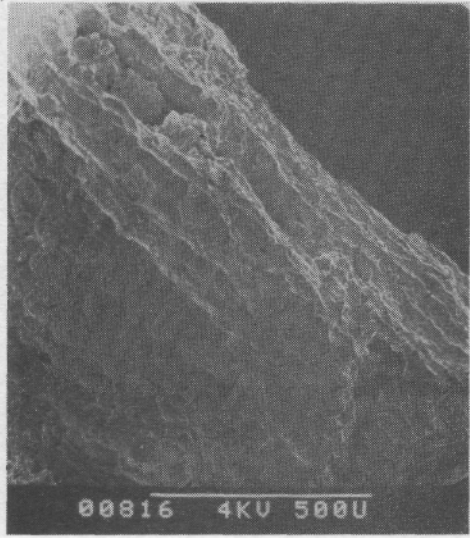
Figure 4 (opposite). Scanning electron micrographs of plant remains from The Stumble: (a) Swollen basal internode of Gramineae, Arrhenatherum elatius var. bulbosus-type. Exterior surface showing epidermal cells (from sample 54).; (b), as (a) - fractured radial longitudinal section (apex at bottom right; from sample 61); (c) detail of specimen illustrated in (b), showing parenchyma cells; (d) grass/cereal aerial culm node (from context 138); (e) monocotyledonous basal internodes with strong longitudinal ribs (from sample 99); (f) dicotyledonous fleshy tap-root in transverse section (from sample 2).



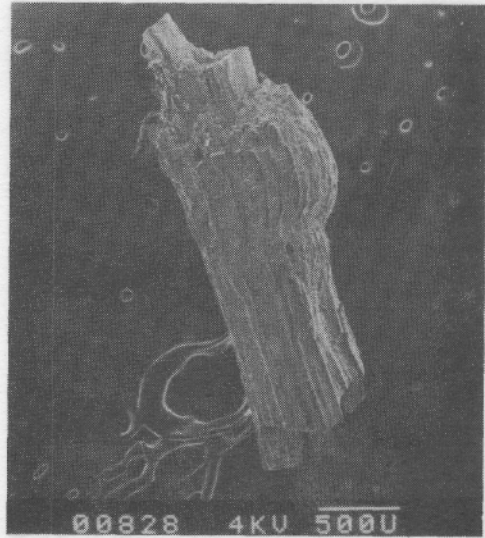
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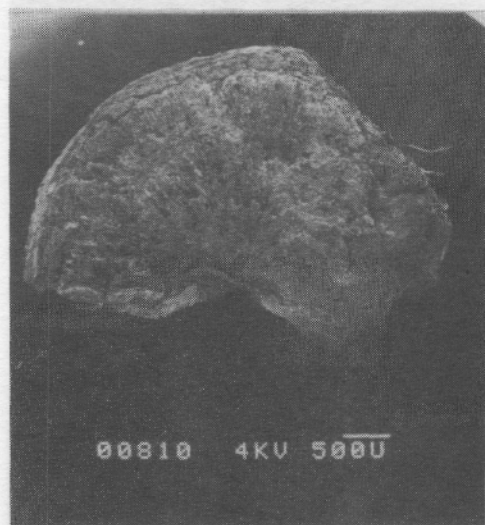
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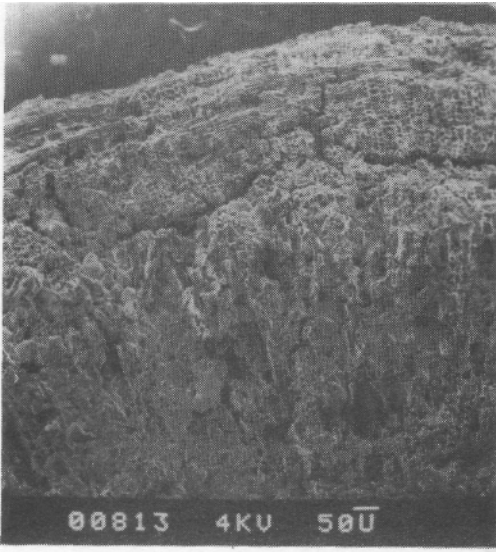
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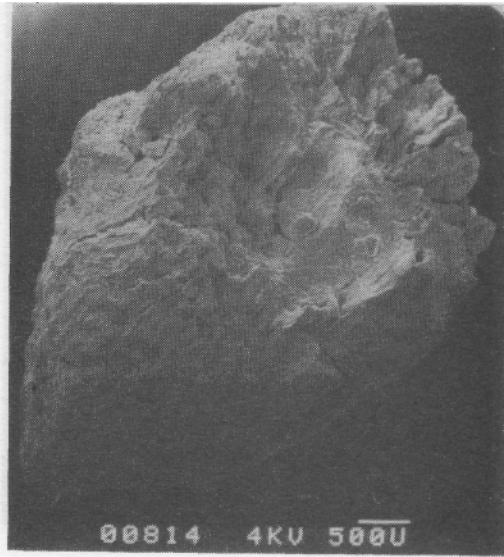
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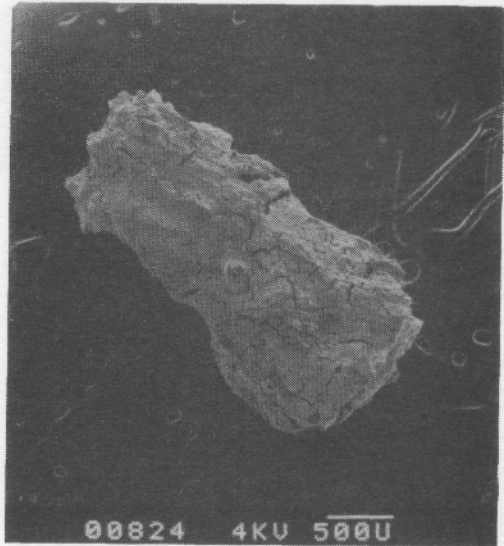
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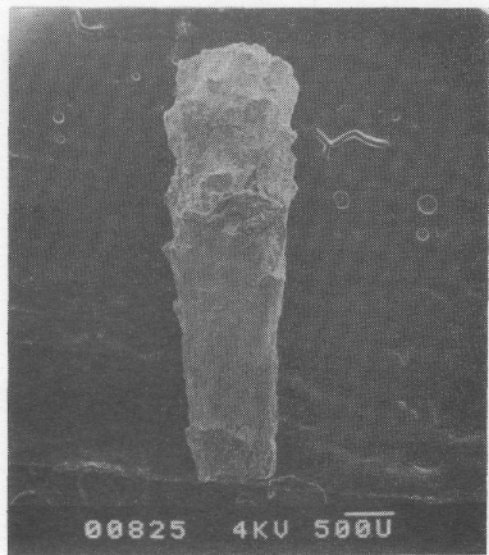
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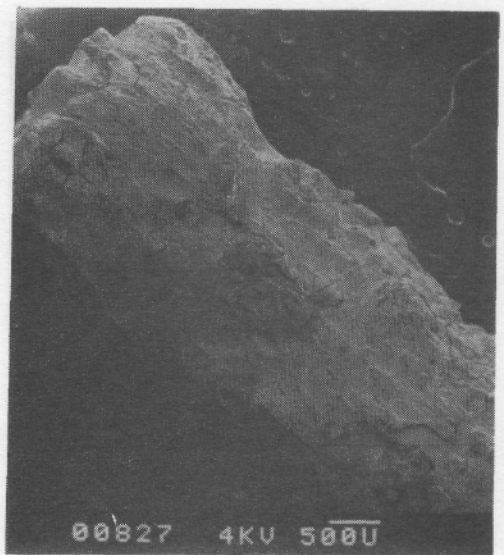
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Discussion

The frequencies of the various plant taxa and elements identified in the samples are summarised in Table 1. Apart from charcoal (and the few bud, catkin and thorn fragments also retrieved), the plant remains fall into four categories: cereals; weed seeds; nuts and fruits; and vegetative material (roots, rhizomes, 'tubers', etc.).

Cereals occurred in the majority of samples (almost 94%), but a high proportion of these remains were too deformed, abraded or fragmentary to be identified more closely. However, it is quite clear that naked barley makes up only a very small proportion of the total assemblage (5.4% frequency, including tentatively identified grains). Wheats predominate: emmer is by far the most frequent and numerically abundant species and einkorn is rare and usually tentatively identified. These samples could be interpreted as indicating that cereal farming was essentially monocultural, based on emmer, with other cereals as contaminants of the emmer crop. However, the 1987 and 1988 samples may prove to contain different proportions of these or other crops. Spikelet fragments were fairly common but not as frequent as cereal grains. Sample composition is summarised in Fig. 6, in which numbers of cereal grains (excluding barley) are plotted against numbers of glume bases (calculated as loose glume bases + (spikelet forks + spikelet bases) x 2) as a scattergram. The cluster of samples containing less than ten grains and five glume bases is omitted for the sake of clarity. In samples composed mainly of two-grained wheat spikelets, a 1:1 grain-to-glume ratio would be expected, but clearly in most samples from the palaeosol there is an excess of grains. Interpreting the samples from this deposit in terms of specific activities is hazardous, for it is very likely that more than one phase or type of activity is represented. However, these samples could be interpreted as a background scatter of material across the site, produced during such domestic activities as spikelet parching and grain roasting. The fragments of inflorescence bracts fused to a grain from sample 59 imply carbonisation in the spikelet. Only one sample (from context 138) seems to contain a proportion of crop cleaning waste: it included culm nodes and fragments, its grain-to-glume ratio is about 1:7.5, and it had a relatively large number of weed seeds. The presence of culm fragments and nodes, albeit in small quantities, does perhaps give some indication that the earlier stages of crop processing were taking place at the site and this does imply production in the vicinity (cf. Hillman 1984, 33).

As has been noted above, the weed flora is very restricted. The two commonest taxa (Vicia/Lathyrus sp(p). and Galium aparine) both comprise climbing or scrambling plants which would have ascended cereal culms. Their seeds/fruits could easily have been accidentally collected during harvesting, particularly if this involved ear collection by plucking or cutting. Furthermore, the large propagules of these plants would have been less easy to remove from the harvested crop than those of smaller-seeded weeds. In

Figure 5 (opposite). Scanning electron micrographs of plant remains from The Stumble: (a) detail of specimen in Fig. 5 (f), showing central area of degraded xylem parenchyma with linear radial cavities and outer band of phloem and epidermis; (b) dicotyledonous fleshy tap-root, tapering at one end (from sample 44); (c) central xylem and fibre 'core' of ?root (from sample 52); (d) rhizomatous fragment with prominent circular root-scars (from sample 8); (e) ?inflorescence axis (from sample 82); (f) rhizomatous fragment with whorls of small root scars and large circular root scars on the internodes (from sample 75).

Table 1. Frequency of taxa and plant elements. (Frequencies based on a total of 112 samples; figures in parenthesis refer to tentative identifications).

	Frequency	%Frequency
1. Cereals		
Triticum dicoccum-type (emmer: grains)	47	42.0
T. dicoccum SchUbl. (emmer: spikelet fragments)	28(+5)	29.5
T. cf. monococcum (einkorn: grains)	(2)	1.8
T. monococcum L. (einkorn: spikelet fragments)	1(+1)	1.8
T. sp(p). (indeterminate uheat(s): grains and	65	58.0
T\ sp(p). (ditto: spikelet fragments)	50	44.6
Hordeum sp(p). var. nudum (naked barley: grains)	4(+2)	5.4
Indeterminate cereal(s) (grains and fragments)	105	93.8
Cereal/grass (culm fragments and nodes)	3	2.7
2. Weed 'seeds'		
Stellaria graminea L. (lesser stitchtuort: seed)	1	0.9
Caryophyllaceae indet. (chickweed family: seed)	1	0.9
Chenopodium album L. (fat-hen: seed)	1	0.9
Chenopodiaceae indet. (fat-hen family: seeds)	2	1.8
Vicia/Lathyrus sp(p). (vetches/tares: seeds and cotyledons)	42(+1)	38.4
Rumex sp(p). (docks: nutlets)	4	3.6
Polygonum auiculare agg. (knotgrass: nutlets)	1(+1)	1.8
Polygonum sp(p). (nutlets)	2	1.8
Galium aparine L. (cleavers: fruits and fragments)	13	11.6
Gramineae (grasses: caryopses)	a	7.1
3. Nuts, fruits, etc.		
Corylus auellana L. (hazel: nutshell fragments)	95	84.8
Prunus spinosa L. (sloe: fruitstone fragments)	10(+5)	13.4
Crataegus monogyna Jacq; (hawthorn: fruitstone)	1	0.9
Rubus sp. (?bramble: fruitstone)	1	0.9
Malus sp. (apple: epidermal fragments)	(4)	3.6
Tilia sp. (lime: immature fruits)	2	1.8
4. Roots, rhizomes, tubers, etc.		
Gramineae (swollen basal internodes - grass stem 'tubers')	9	8.0
Dicotyledon (fleshy tap-root fragments)	2	1.8
Other root/rhizome fragments	29(+9)	33.9

general, semi-cleaned crop products tend to include a high proportion of weed seeds in approximately the same size category as the crop itself (Jones forthcoming). It therefore seems that the composition of the weed seed assemblages in these samples has been influenced mainly by the growth habit of the weed plants and the limitations of crop cleaning by sieving or winnowing. Certainly the results available at present do not provide any useful information on the overall composition of the weed flora, nor is it possible to draw any inferences about cultivation methods.

Fragments of hazel-nut shell (*Corylus avellana*) were extremely common (almost 35% frequency, compared with 94% for cereals). However, the quantities of nutshell recovered were very small, rarely comprising more than about a tenth of a nutshell per sample. It is possible that this species was over-represented in terms of frequency, compared with cereals, since its nutshells are woody and would readily have become carbonised. Once carbonised, even small fragments would be durable and could easily have become dispersed across the site. Nevertheless, the high frequency of nutshell fragments does perhaps imply that hazel-nuts formed a significant component of the diet. There are good grounds for thinking that neolithic communities were capable of managing woodlands to produce specific

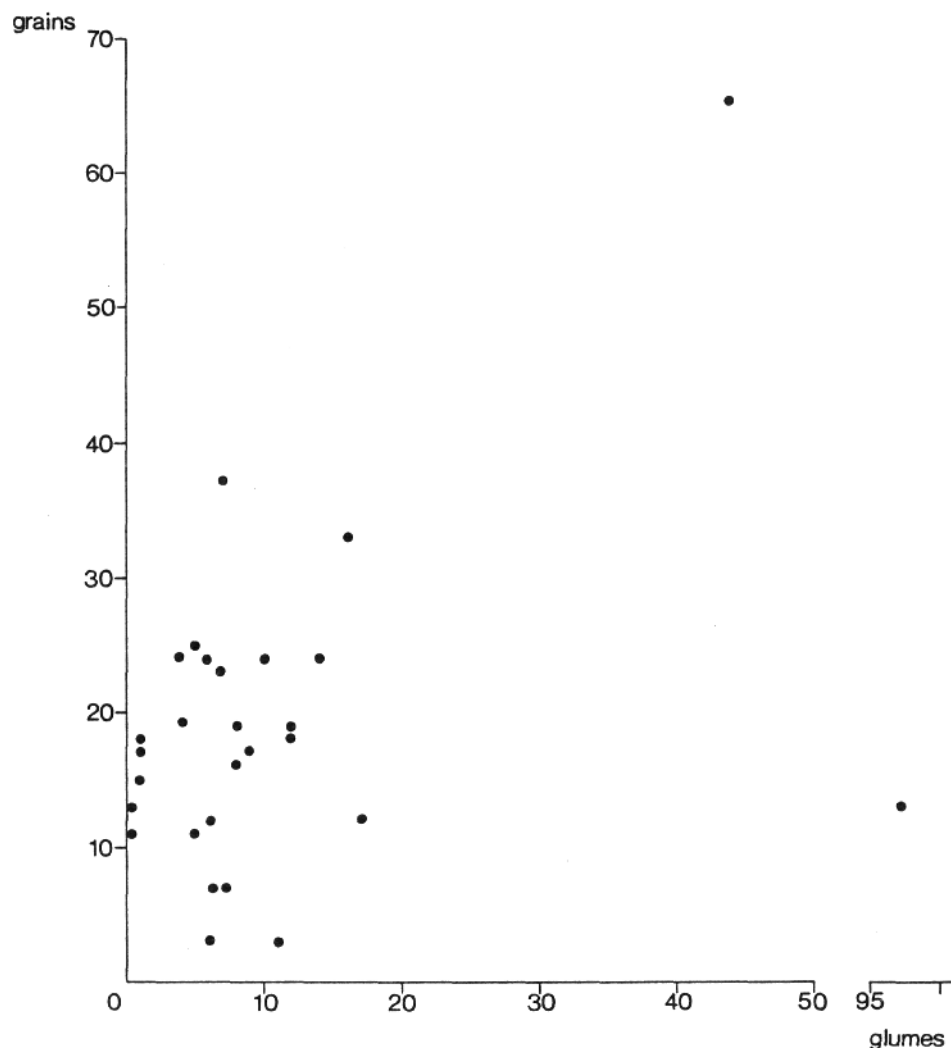


Figure 6. Scattergram summarising numbers of grains and glumes in the samples containing more than ten grains and five glume bases.

products, such as the hazel rods used in the construction of the Somerset Levels trackways (Morgan 1988, and references therein), and it is quite possible that in this case local woods were managed so as to provide suitable conditions for the flowering and nut production of hazel as suggested by Dimbleby (1967, 35 and 146).

Of the rosaceous fruits likely to have been available in nearby woods, Prunus spinosa (sloe) was the most abundant species in these samples. This again may in part be related to the durability of its fruitstones. Fruits of hawthorn (Crataegus monogyna), ?bramble

(Rubus sp.) and Malus sp. (presumably crab-apple, Malus sylvestris), seem also to have been collected. The two immature fruits of lime (Tilia sp.) may indicate that lime branches and twigs were brought to the site in the summer months. These would, of course, have been leaf-covered, and it is possible that we have here some evidence for intentional collection of lime leaves. It has been suggested that the nutritious leaves of this taxon were used in prehistory as animal fodder (cf. Tinsley 1981, 238).

The samples also contained roots, rhizomes and 'tubers'. As Table 1 shows, swollen basal internodes of Gramineae occurred in 8.0% of samples, fragments of dicotyledonous fleshy tap-roots in 1.8% and other root and rhizome fragments in 33.9%. Plant organs of these types contain, in general, a high proportion of fleshy parenchymatous tissue and, hence, of water. It seems probable that such material is more likely to explode or fragment during carbonisation than are cereal grains or nutshells. Consequently such vegetative plant material is, if anything, likely to be seriously under-represented as carbonised macrofossils. The association of this material with undoubted foodplant remains suggests that some, or all, of it was intended for consumption, but close identification has not been possible.

The high density of carbonised plant remains in the deposits at this site is very marked. By contrast, neolithic features on the adjacent gravel terraces of the Blackwater contain very little material. For example, from 17 neolithic pits at the site of Lofts Farm, about 1.5 km north of the estuary, samples totalling approximately 292 litres were collected and processed. Only five of these contexts produced 'seed remains': two indeterminate cereal grains, one indeterminate grass caryopsis, fragments of hazel-nut shell and a scrap of Prunus sp. endocarp (Murphy in prep.). On the evidence available, this seems to be typical of neolithic features in East Anglia. Why, then, do the samples from The Stumble contain so much more material? One possibility is that there was a real economic difference between, say, the Lofts Farm site and The Stumble, cereal production being more important at the latter. However, one would have expected that the mainly light gravel-based soils of the river terraces would have been better-suited to neolithic agriculture than the clay-based soils around The Stumble. Furthermore, this suggestion does not account for the abundance of Corylus nutshells and rhizomatous material at The Stumble. Perhaps a more likely explanation is to be sought in terms of taphonomy. At Lofts Farm, only comparatively large pits were available for sampling, since the site had been truncated by ploughing. The functions of these pits, and the ways in which they were backfilled, are unknown. It appears that few remains of cereals and other foodplants became incorporated into their fills, perhaps because they were backfilled rapidly. The palaeosol, pestholes and other features which survived at The Stumble were obviously contexts that were 'open' for extended periods, providing ample opportunity for the incorporation of plant remains.

Moffett et al. (forthcoming) list and discuss earlier neolithic material from a number of sites in England and Wales. It is notable that virtually all the material has come from pits at truncated settlement sites or from ditches associated with ritual or ceremonial structures and that at almost every one of these sites densities of plant

material in the deposits are very low. The one marked exception (apart from The Stumble) is the site of Hazleton chambered tomb, Gloucestershire, where a buried soil sealed beneath the monument produced abundant cereals and Corylus nutshells. The implication of this for future work seems clear: pits, in general, have produced little material, whereas buried soils seem to be markedly more productive. The nature of the deposits burying the soil is irrelevant: they might be estuarine sediments (as at The Stumble), peats, colluvial deposits, blown sand or artificial earthworks. Whilst more work needs to be done on all types of neolithic deposit, large-scale flotation of buried soils must take a high priority.

In summary, the samples from the 1986 season are thought to provide a picture of a neolithic plant economy based in part on the production of cereals, mainly emmer, and in part on the collection of wild plant foodstuffs, including fruits, nuts, roots, rhizomes and tubers. There are real problems in making any quantitative assessment of the relative importance of cultivated and wild foods, for the different types of foodstuff differ both in terms of cellular structure and in the ways in which they might be prepared for consumption. These factors have probably resulted in differential preservation of the various categories of material, Nevertheless, the very marked contrast between the assemblages from these samples and those from later prehistoric sites in the same area, which are composed almost entirely of cereal remains, does seem to establish a substantial reliance in the neolithic on wild plant foods. This result is quite consistent with the general pattern for British neolithic sites discussed by Moffett et al. (ibid.).

The conclusions made after examining the 1986 samples should, of course, be regarded as provisional; two more seasons' samples await examination. The 1987 samples were taken in part from an area of excavation contiguous with the 1986 area, and it is hoped that these will help to make more sense of the spatial distribution of macrofossils across the sites. Samples were also collected in 1987 and 1988 from areas some distance from the 1986 area, including an apparent midden which contained very large unabraded pottery fragments. It is quite possible that samples containing different crops, crop products or waste material will be found.

Acknowledgements

I am most grateful to all members of the excavation team, and to Sandy Gray in particular, for their arduous work in the collecting, transporting and initial processing of the samples. Jon Mather, Glynis Jones and Mark Robinson kindly advised me on problems of identification. My thanks are also due to Steve Bennett (School of Environmental Sciences, University of East Anglia) for allowing me to make use of a scanning electron microscope and for his help in its operation. The work here described has been supported by grants from the Historic Buildings and Monuments Commission for England (English Heritage).

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**A note on the recovery of Thoracochaeta zosteræ
(Haliday) (Diptera: Sphaeroceridae) from
archaeological deposits**

Robert Belshaw; *

Thoracochaeta (formerly Leptocera) zosteræ (Haliday) is a small fly which may be found today in Britain, and elsewhere in the Holarctic region, breeding within wet decaying seaweed cast up on the shore at the high water mark, often forming large populations. It is only rarely found inland (Pitkin 1988). Given its modern distribution, it is surprising that this was the most commonly encountered, and the most abundant, species recovered from a number of archaeological deposits in London (Belshaw 1987). The contexts in which it was present were waterlogged pit-fills, their dates ranging from Saxon to 18th century. T. zosteræ puparia were recovered from a total of twelve distinct contexts from seven sites.

A puparium of J. zosteræ is shown in Fig. 7, the specimen having been recovered from a 12th century pit-fill in Moorgate, London. Illustrations of the puparium are given by Egglislaw (1961) and Richards (1930).

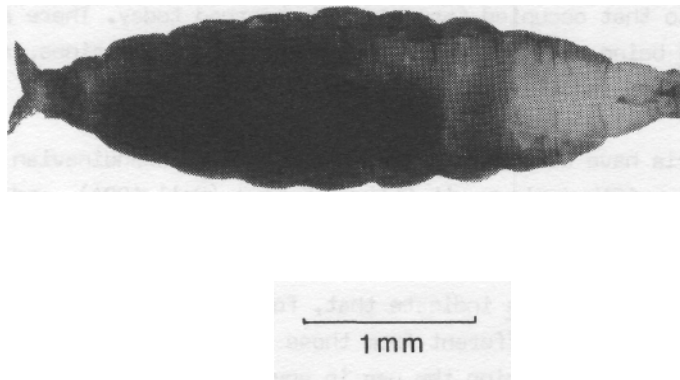


Figure 7. Puparium of Thoracochaeta zosteræ, ventral view.

Other organic remains recovered indicated that many of these deposits were likely to have been cesspit-fills. These included the seeds of fruits likely to have been consumed whole (e.g. fig, *Ficus carica* L.), human gut parasite eggs, small bone fragments with

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evidence of corrosion, possibly caused by digestive processes, and the puparia of fly species which today breed in such environments (e.g. Fannia scalaris (Fabricius) and the sepsid Themira putris (L.)). There was evidence, such as larger bone fragments and the puparia of a number of muscid and sphaerocerid flies, that some deposits also contained more general household and garden refuse.

At the present time, furoid seaweeds are not found as far up the Thames as London (Tittley and Price 1977). Although in the past seaweed was commonly collected and used as fertiliser in areas near to the coast, there appears to be no evidence indicating that it was widely used within towns. It is also significant that no remains of other organisms usually found on the seashore were recovered from the archaeological deposits examined. J. zosteræ larvae may have been present in other refuse later dumped into the pits, but this is perhaps unlikely as it is not today present in refuse, a habitat which is still quite common.

In some deposits the concentration of T. zosteræ puparia was very high. One 250 g sample contained at least 432 individuals, indicating that the larvae were probably

present in the pit during, or prior to, the period of deposit formation. Today the species appears normally to develop in a wet, saline environment. In the laboratory, Egglshaw (1961) found that the larvae preferred wet conditions, especially the early stages, which could completely immerse themselves for brief periods to feed. The larvae are probably filter feeders (Marshall 1982). Although pupation usually occurs in the sand underneath the decaying seaweed, puparia may also be found in the drier upper layers of the wrack. This is where pupation occurs when the species is reared in glass containers.

One possibility is that T. zosteræ was pre-adapted to exploit a new niche created by one of man's waste disposal techniques, the cesspit. This new habitat would also presumably have been of a semi-fluid consistency and with a high concentration of salts derived from the urine present. When this habitat became rarer, the range of the species may have contracted to that occupied formerly and observed today. There are, however, no records of J. zosteræ being recovered from modern cesspits or latrines, and its presence in archaeological deposits remains enigmatic.

T. zosteræ puparia have also been recovered from Anglo-Scandinavian deposits in York (J. Phipps in litt.), a 16th century pit-fill in Exeter (Bell 1984), and an 18th century cave-fill in Nottingham (observed by the author).

These records of T. zosteræ indicate that, for whatever reason, the species was present in environments very different from those in which it occurs today. They are perhaps of interest when considering the use in environmental reconstruction of direct extrapolation from the modern habitats of insects. A similar phenomenon, this time in the Coleoptera, has been remarked upon by Hall et al. (1983, 81). The most abundant ptiliid beetle at the Lloyds Bank site, 6-8 Pavement, York, in deposits believed on various evidence to be Anglo-Scandinavian floors, was the seaweed-inhabiting species Ptenidium punctatum (Gyllenhal).

T. zosteræ puparia have in the past been confused with those of Teichomyza fusca Macquart. Until recently, the reference material of J. zosteræ puparia at the British Museum (Natural History), from the 1954 Temple of Mithras excavation in London, was mislabelled as J. fusca (Pitkin pers. comm.). The puparia of T. fusca are larger and quite distinct. This ephydrid used commonly to be found breeding in cesspits and latrines until such habitats became rare in this country. The reference to it also breeding on the shore

by Smith (1986), taken from Walker (1853), is possibly incorrect, as several other studies do not mention it. Puparia of J. fusca have also been reported from archaeological deposits (Girling 1984; Greig 1982). Oldroyd (1964) also mentions recovering the larval stage from medieval woodwork in London.

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**Limitations of soil pollen analysis - an example from
Mauley Cross, a mesolithic site on the North
York Moors**

Peter Cundill *

Summary

This paper examines the problems of interpretation of pollen analyses of a soil profile which contains mesolithic flint waste flakes at two separate levels. It is argued that, because of the variety of processes that has affected both the pollen and the flints in the profile, very limited conclusions may be drawn from such analyses.

Introduction

The aim of this paper is to explore the value of soil pollen analysis carried out on material from Mauley Cross, a mesolithic site on the North York Moors in north-eastern England (Fig. 8). Although recently Dimbleby (1985) produced a wide-ranging discussion of the importance of palynology in archaeology, the Mauley Cross study summarises in a single site many of the difficulties of attempting to link pollen analysis with archaeology.

In 1971, Raymond Hayes discovered an area some 250 m north-west of Mauley Cross (National Grid Ref. SE 795945) in which Forestry Commission ploughing had revealed a substantial number of mesolithic flints. He collected the loose flints from the site (about 400 were recovered, amongst which were 12-14 rods and scalene triangles, one arrowhead and two round scrapers: R. Hayes, personal communication) and also took three monoliths of the soil profile at the site, all of which contained flints stratified at a range of depths. The monoliths were interesting because they initially appeared to offer the prospect of linking archaeological and palaeoecological data. Consequently, they were sent to the author for examination and the monolith with the greatest number of microliths exposed in its profile was sampled for pollen analysis, using standard preparation techniques (e.g Moore and Webb 1978). A pollen diagram (Fig. 9) was produced in 1973. The results were not published then, mainly because of the difficulties of interpretation, and it is this aspect which provides the focus for discussion in this paper.

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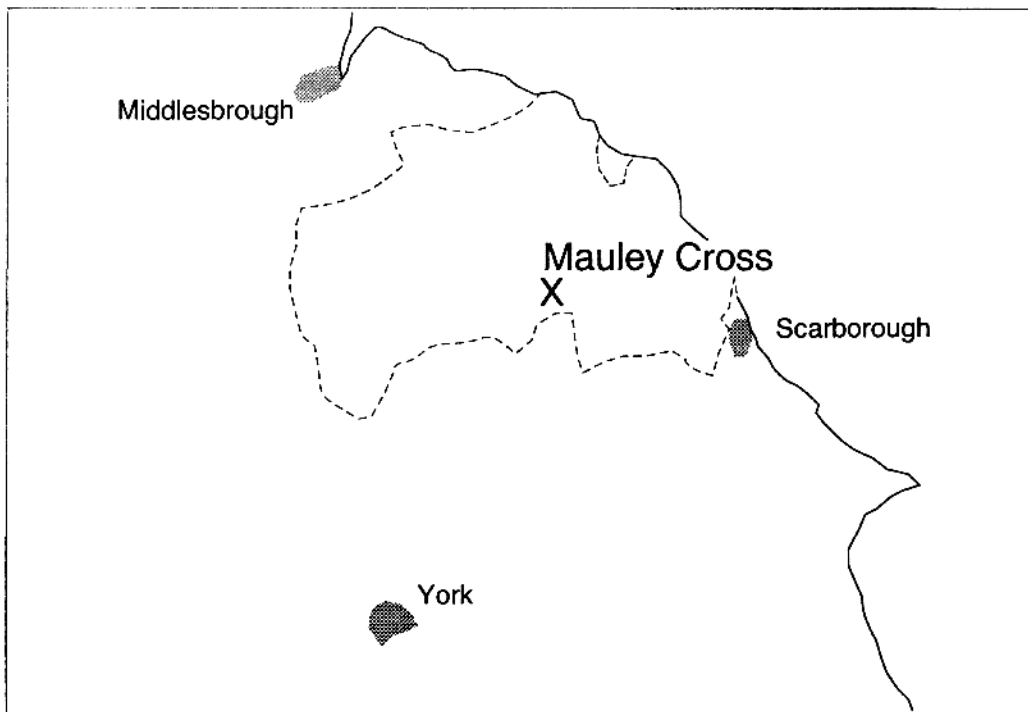


Figure 8. Location of Mauley Cross (the dashed line marks the North York Moors National Park Boundary).

Problems of interpretation

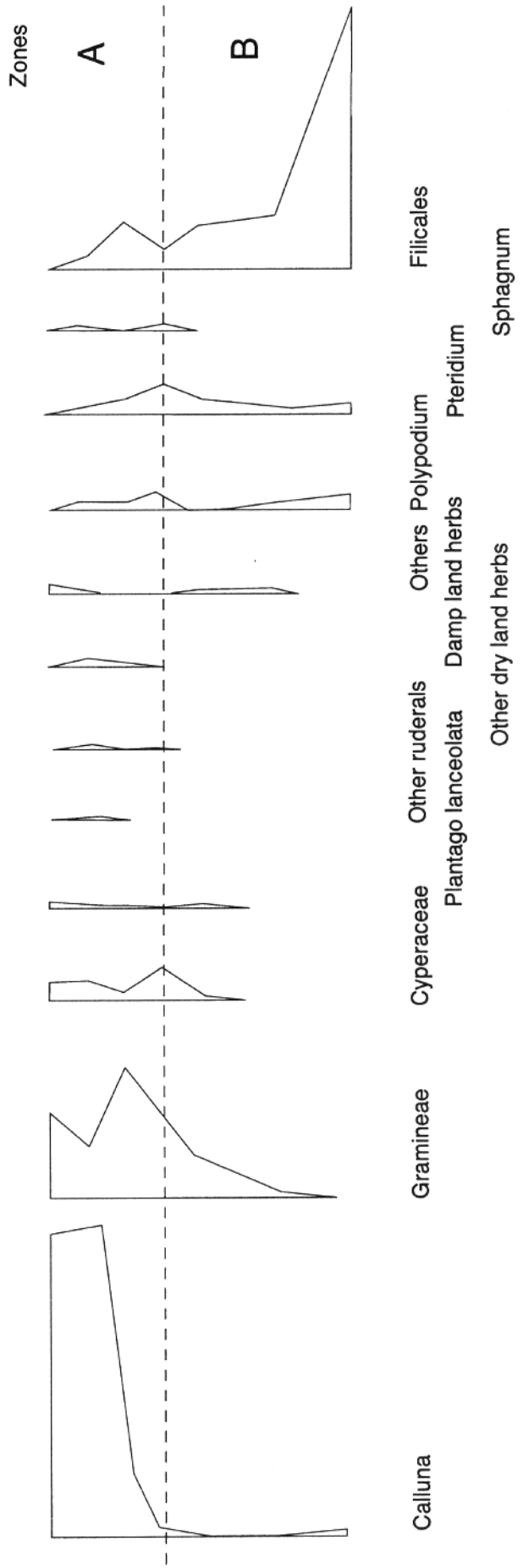
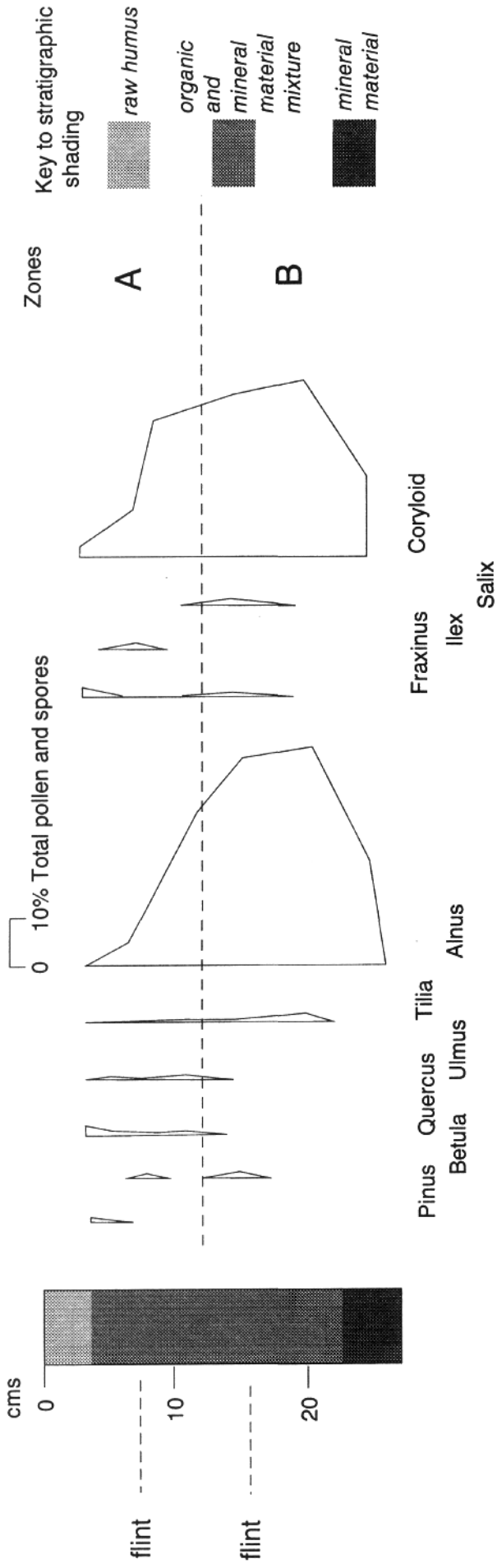
The pollen diagram may be divided into two 'zones':

A - with high Calluna pollen values, probably reflecting the relatively recent (i.e. late Flandrian) dominance of heath in the North York Moors area, although it is impossible to provide a date for the arrival of the heath. Some of the Calluna pollen may have moved down the soil profile.

B - dominated by Alnus and Coryloid (?hazel) pollen, but with an increase in the proportion of fern spores (Filicales) towards the base of the profile. The presence of Alnus and Coryloid pollen indicates that the soils of the area were formerly much less acid. This suggestion is supported by the record of Tilia pollen. 'Zone' B may therefore indicate an early stage of vegetation development in which relatively base-rich soils existed, although this would have resulted in the mixing of the soil and the pollen by the soil fauna that would have been present.

There seems little else of a straightforward nature that may be interpreted from the pollen evidence simply because there are a number of processes which could have influenced

Figure 9 (opposite). Relative pollen diagram from Mauley Cross, showing major pollen types only. Analysis: P. Cundill 1973.



the distribution of pollen in the soil profile. There are, for example, indications of two common soil pollen phenomena in the pollen data:

(i) there seem to be greater concentrations of pollen nearer the surface. The evidence for this may be seen in (a) the higher pollen counts in the upper layers of the soil; (b) the greater number of pollen per traverse of the pollen slides for the upper samples (although other factors, such as the quantity of mounting medium added to the sample, may have influenced the concentration of pollen); and (c) the greater range of taxa in the upper layers (although this is influenced by the reduced pollen counts in the lower soil layers). Table 2 illustrates these points.

(ii) there is evidence in the lower horizons of the profile for greater numbers of those pollen grains and spores that are commonly regarded as more resistant to the processes of degradation (e.g. Tilia, Filicales; see Havinga 1964; 1984), although this may be a misleading impression, because total counts in the lowermost two samples were below the 200 minimum recommended by Dimbleby (1985).

The flint waste flakes were found at various depths in the soil in this monolith: one at 8 cm and the others at between 15 and 17 cm. How they became buried at depth beneath the present surface is a matter for conjecture. If the matrix in which the flints are located had been accumulating gradually, it would be acceptable to interpret the flint horizons as former land surfaces. There may be some evidence to support this suggestion because, according to the pollen per traverse figures (Table 2), there are higher pollen concentrations at the flint levels. Certainly Dimbleby (1985) has frequently found flint horizons associated with buried soils, with the soils having become buried through the accumulation of wind-blown sand. In other cases, where buried soils cannot be demonstrated, Dimbleby has argued that soil fauna such as worms may have moved objects such as flints down the soil profile. While there may be a hint of buried soils at Mauley Cross, the evidence is equivocal and processes based on the presence of soil fauna seem more feasible, especially if such activities took place in the period when there was a forest soil with a higher pH than that in evidence at the present day.

Depth (cm)	Total count of pollen and spores per level	Mean number of pollen and spores per traverse	Number of taxa per level
5	776	20	20
8	519	47	19
10	691	28	17
12	602	18	17
15	356	40	15
20	177	4	10
24	109	1	8

Table 2. Pollen and spore count data from analyses of the soil profile at Mauley Cross. 46

The value of the Mauley Cross analysis

The speculation regarding the displacement of flints within the profile and the inherent difficulties of interpreting soil pollen data mean that no simple and direct connexion between the flint horizons and the pollen record can be inferred. It is recognised that, from a number of points of view, the pollen analysis of the material is less than perfect because nowadays it is routine to carry out pollen concentration counts (using, for example, Lycopodium spore tablets: Stockmarr 1972) and to assess the state of preservation of pollen and spore exines (using, for example, the scheme of Gushing 1976) as well as ensuring that a statistically acceptable count is achieved. These improvements to the technique, together with mineral analysis of the soil material, might have clarified the situation with regard to the presence of buried soils, but even if these steps had been taken, the level of interpretation of the pollen results would only have been enhanced marginally. The difficulties of marrying two distinctly different sets of data - archaeological and botanical - each influenced by different sets of interacting forces, makes for complex and highly speculative interpretations at best. While Dimpleby (1985) argued that valuable results can be obtained from soil pollen analysis, it is apparent that analyses of the kind described here could be summarised as 'high effort for low return'¹ and this point should be borne in mind in any attempt at such analyses.

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Butchery evidence on animal bones

D. Rixson *

Identifying and interpreting butchery evidence on animal bones is an important part of the analysis of bones from archaeological sites. This paper outlines the purposes for which butchery would have been carried out which can prove an aid for interpretation, this being related to one or other of those purposes. There is also some discussion of the type of evidence that may be found and the identification of that evidence. Interpretation must take account of the practical aspect of a range of butchery methods and the feasibility of meat utilisation under various conditions.

Introduction

With the growing emphasis on the study of animal bones from archaeological sites, it is important to observe and assess correctly the evidence of butchery. Signs of butchery are an indication that the bones are the remains of animals used for meat. There is, of course, the possibility that cutting or chopping bones was carried out as part of bone working and it is important to try to distinguish the difference between the evidence for bone working and butchery. Analysis of butchery evidence may indicate the method of utilising carcasses which may add to the understanding of the general social conditions and activities of the place and time. Signs of cutting, chopping etc. on animal bones may be the result of:

- (i) primary butchery - slaughter and dressing i.e. killing skinning or flaying and eviscerating; may also include removal of head and feet;
- (ii) secondary butchery - initial division of carcass into the major cuts or portions, e.g. loins, legs;
- (iii) tertiary butchery - reduction to household or pot- size pieces; (iv) utilisation for fat extraction; (v) bone working.

When assessing the evidence of butchery on animal bones it is obviously of great value if this can be related to one of the above categories, bearing in mind that categories (i) to (iv) will often overlap.

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Evidence of bone-working

Fine sawing of bones is almost certainly evidence of bone working. It is most unlikely that valuable saws would have been wasted on butchery, particularly as it needs a very good sharp saw blade with fine teeth to saw through long bones. Long bones from older animals are especially hard and require much effort to saw through, even with a modern sharp butcher's saw.

Most of the sawn bones I have seen from archaeological excavations have been cattle metapodials, the saw cuts on which must logically be assumed to be the result of bone working. This assumption is based on the following:

- (i) there is no meat around metapodials - i.e. no reason for sawing for butchery utilisation;
- (ii) removal of the feet can be effected quite easily by cutting the ligaments and tendons to separate the carpal/metacarpal joint or the tarsal/metatarsal joint;
- (iii) splitting the bone for the removal of bone marrow can be achieved relatively easily using a chopper.

Indications of butchery

Much of the butchery evidence indicates an extensive use of a chopper for primary and tertiary butchery and splitting bones for bone-marrow extraction. Evidence of chopping on bones may be seen in the proximity of the joint which could indicate the disarticulation of the limb. To conclude that such chopping was for the disarticulation of the limb, consideration must be given to the feasibility of the separation of the joint being effected by such chopping.

To arrive at such conclusions it is useful to estimate the direction of the chopping, bearing in mind the way in which the joint is held together. I have seen quite a number of cattle ulnae which have been chopped through starting at the shaft about 3 cm distal to the articulation with the humerus (Rixson 1971). The direction of the chopping is almost parallel to the long axis of the radius, angled slightly to the centre of the joint (Fig. 10). The effect of this chopping would be to separate the olecranon process, chopping through to the humero-radial-ulnari joint - a major step in disarticulating the joint. This joint is one of the most difficult to separate using a knife. It would therefore be logical for an experienced butcher to use his chopper in the way described above.

Another joint difficult to separate using a knife is the hip joint. It requires the blade of the knife, which must be thin, being manipulated into the acetabular socket to cut the ligament attached to the head of the femur. It would require only one blow of a chopper to cleave through the neck of the femur, providing the butcher's aim was true (Rixson 1978). I have chopped through the neck of a bovine femur with one blow using a 4 Ib (1.8 kg) chopper.

A good deal of the tertiary butchery was probably carried out using a chopper. The evidence for this is in the high degree of fragmentation of cattle bones from excavations. The effect of using a chopper, in many cases, results in the bone breaking rather than shearing with the only evidence of the use of a chopper being at the point of impact. It is sometimes observed that this chopping had been excessive, resulting in cattle bones being reduced to very small fragments. I have seen some cattle bone assemblages where even

the astragali and calcanae had been chopped into three or more fragments. A suggestion has been put forward that the purpose was for making soup (van Mensch 1974).

Fat extraction would also lead to fragmentation of the bones and bone working residue would also be fragmentary.

Some fragmentation could result after the bones were discarded. Ribs, vertebrae and some of the smaller bones may have become increasingly fragmented by scavenging animals although, in many cases, the scavenger would carry the bones off (note 1). Some fragmenting is quite likely to occur when the bones have become more fragile with the loss of collagenous connective tissue. This subsequent breaking of the bones may even have been the result of excavation but this should be distinguishable from the breaks that occurred when the bone was fresh.

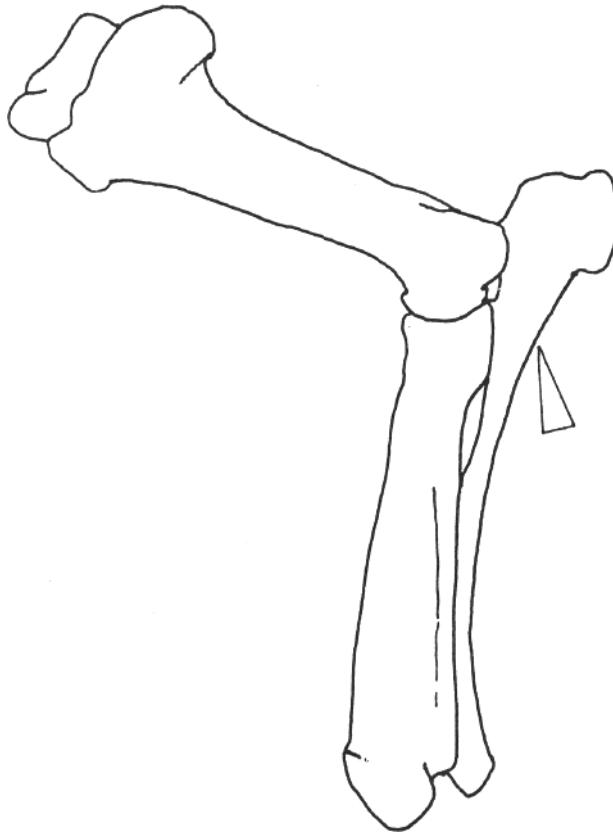


Figure 10. Location and direction of a single chopping blow to disarticulate the elbow.

There are indications that a chopper was often used to remove flesh from a carcass. Evidence for this is where the spinous process of the scapula (Rixson 1978) and the processes of the vertebrae were chopped through, probably to remove the flesh around these processes, leaving only the main body of the bone. Further evidence of a chopper being used to remove flesh is where chopper cuts are found on the shaft of a bone at a very acute angle or where the chopper has flaked pieces of bone from the surface. Chopping of the cancellous bone can be distinguished from a break by the smoothness of the cut surface and by this surface being level and even.

The chopper would often have been used to remove the horns from cattle, much in the same way as today. There is archaeological evidence for this from Roman levels at Billingsgate (Armitage 1974) and from medieval Baynards Castle (Armitage 1977), both in London.

If a carcass was hanging, the horns would need to be chopped from behind (i.e. chopped in a caudal-cranial direction) but if the animal's body was on the ground, they could be chopped quite easily from either direction. Removal of the horns from the head would make it easier to separate the horns from the horn cores by boiling.

Removal of the bone marrow fat from the medullary cavity can be readily facilitated by splitting the long bones with a chopper. To chop a bovine long bone across the shaft is very difficult and sometimes impossible using only a light chopper, but by chopping the bone from the end it can be split sufficiently for the removal of the marrow.

Using the 4 lb chopper referred to previously, I have split femora from adult cattle with five or six blows. The method is to place the bone on a firm surface (a butcher's block, tree trunk - or something equally solid) with one end towards the butcher and chop through the epiphysis in a longitudinal direction to the bone.

Because there is only a thin layer of compact bone covering the epiphysis, the chopper will shear through this and the cancellous bone tissue causing the thick compact bone of the shaft to split more or less longitudinally.

Bone-working residue

It is important for the people recording animal bone to try to recognise the residue from bone working so this can be distinguished from butchery remains. To this end they should familiarise themselves with the type of products and the type of bones normally used and the probable methods used in bone working. It is unfortunate that, on some occasions, the animal bone analysts do not get to see the worked bone from a site as this is passed to some other specialist.

One form of bone debris which I have seen fairly frequently and have concluded to be a type of bone working residue, is the proximal end of a cattle metapodial, sawn with a very fine toothed saw through the shaft at right-angles, about 2-3 cm from the proximal end. There were also a few distal ends of metapodials sawn similarly, about 1-2 cm proximal to the epiphysial line (Rixson 1974). The evidence for sawing was the squareness of the cut and a few fine lines left by the saw on the cut surface. The cut surface on these pieces of bone had not been smoothed after sawing because on most there still remained a small flange on the edge of the bone where the saw-cut ended. I would suggest that these ends of the metapodials are the residue and that the shaft was the part used for bone working. The shaft of a metapodial enables thick straight even pieces of compact bone to be obtained. The shape and size of a metapodial shaft makes it ideal for use as a handle with the hasp of a blade being wedged into the medullary cavity.

A quantity of bone working residue was obtained from a 17th century context at Southwark, London; the main purpose of the bone working seemed to be the manufacture of dice. All the identifiable bone fragments of this residue were cattle metapodials. The method of manufacture of these dice seemed to be to split the shaft of the bone longitudinally to obtain fairly straight sections of bone and then shape these pieces

until they were neatly square in cross section. The piece of bone would then be sawn through at right angles, sawing off dice cubes from the shaped end.

Another type of bone working evidence that I have seen is sheep humeri that have been cut through the shaft squarely at right angles, about a third of the way from the proximal end. The squareness of this cut was effected by chipping a groove around the shaft of the bone until it finally broke along the line of this groove; the operation probably carried out using a chopper. I have also seen some sheep humeri scored neatly around the shaft with a knife. The intention here could have been the same as above. When fresh bone is scored this way and then given a sharp tap it can be broken along the scored line in the same way as cutting glass.

Carcase handling and meat preservation without refrigeration

In assessing evidence of butchery it is important to adjust one's thinking away from the modern methods of meat distribution and butchery practices to the situation in the past with its many problems that modern technology has eliminated.

One of the major problems would have been the absence of refrigeration. Documentary evidence from the past, and evidence from less developed countries today, indicate that most meat would have been consumed on the day of slaughter and certainly not more than one or two days after slaughter.

A statute of the streets of the City of London during the reign of Henry VI forbade butchers to 'sell any flesh that had been killed above three days in the winter and two days in the summer' (Hammett and Nevell 1929). Although hanging meat (especially beef) for seven to 14 days is recommended today to improve flavour and tenderness, this would have been generally impracticable without refrigeration. A point worth noting is that meat is more tender if cooked and eaten before rigor mortis has occurred; this takes about 12-14 hours after death in normal healthy cattle. Added to this is the claim by everybody I have spoken to from Africa and the Far East that, where meat does not undergo refrigeration, this meat has more flavour than refrigerated meat.

An obvious thing to do with meat in the absence of refrigeration is to hang it, allowing a good circulation of air. This would result in some partial drying of the surface, retarding bacterial growth and thereby slowing the process of putrefaction. If meat was left lying on a surface, the part in contact with the surface would more rapidly decompose and even sour (note 2). Because of the need to hang carcasses, it would follow that the easiest way to dispense the meat would be to cut the flesh as required from the hanging carcass. This is a practice still common today in many parts of the world. This method of cutting meat as required from a hanging carcass would also have improved the keeping qualities of the meat. The longer meat is kept intact in large pieces, the slower the rate of bacterial decomposition because the maximum bacterial activity is on the cut surfaces. Therefore, the more delay there was in cutting a carcass into pieces, the longer it would remain palatable. Healthy animals slaughtered in unstressed conditions will have no bacteria in their tissues to cause spoilage ('a high proportion of sterile tissue samples can be obtained from normal healthy animals', International Commission on Microbiological Specifications for Foods, 1980). This means that, in most cases, bacterial decomposition will only occur on the cut surface where it will have become contaminated by bacteria. Bacterial growth requires moisture; therefore the drying of the surface of the muscle will retard bacterial growth. This drying can reach a point where bacterial growth virtually ceases.

I have hung a piece of beef for three days in an average temperature of 25 C. The surfaces became very dark and dry but, after the surfaces were trimmed, the meat underneath was in perfect condition and extremely palatable. There was a considerable loss from evaporation and, of course, the trimming but I am certain that this piece of meat would have been in the same condition after a week.

During the cooler weather of late autumn and winter, poultry and game will keep quite well without refrigeration if it is not eviscerated. These birds will need to be hung to allow air to circulate, in which case they will keep for at least two weeks.

Where carcase meat has a layer of subcutaneous fat, this will largely prevent evaporation of water from this muscle surface and the fat itself is not subject to the type of bacterial spoilage that occurs on muscle but will undergo spoilage by oxidation (causing rancidity) which is much slower than bacterial spoilage of muscle, especially in the fat of cattle and sheep. The soft fat of pork and poultry is oxidised more rapidly.

Drying strips of muscle has long been a method of preserving meat, e.g. biltong, the South African dried beef, charqui of South America, and pemmican produced by the North American Indians (Lawrie 1979). Biltong is still produced as a commercial product; in my opinion, it tastes good.

Drying the meat would often have been achieved by hanging strips of muscle in the sun. An alternative would have been to dry the strips of meat over a fire which is akin to smoking. Smoking meat has the added preserving effect, apart from surface drying, in that the smoke from the sawdust contains bactericidal agents such as formaldehyde and also inhibits fat oxidation (Lawrie 1979).

Salting meat was probably the principal method of preserving meat in the past and it dates back at least to 1000 B.C. (Lawrie 1979). From this need to salt meat to preserve it have evolved many of the cured products of today, e.g. the various types of bacon, hams and 'continental' type sausage. One can quite easily appreciate the development of York hams as a means of preserving pork in the farmhouses of the past. Whilst on a visit to the South of France I purchased some local sausage which I had hanging in a non-refrigerated space for six weeks (June/July) and it was still perfectly good to eat.

Potassium nitrate (KNO₃) is used with salt (sodium chloride, NaCl) in many curing recipes. Nitrate is converted to nitrite by bacterial activity and the nitrite has an additional effect in suppressing bacterial activity to that of the salt.

Variations in methods of_ butchery

Using a chopper to remove the flesh from the hanging carcase would have been most probable. Indeed, the intact carcase would be stable enough to chop through the bones as well as the flesh, chopping in a downwards direction, of course. When most of the flesh was removed from the bones, the remainder - bones with some flesh still attached - could have been chopped into pieces suitable for the stewing or soup pot.

Chopping a carcase down through the centre of the spine into two sides would not have become necessary for beef carcasses until butchery had developed to the stage of cutting the carcase into separate joints, much as is done today. Evidence indicates that chopping cattle carcasses into sides began about the 16th century. This could have been because

butchers had changed their method of butchery to cutting carcasses into more clearly prescribed separate joints.

Coarse meat from older cattle would have been another factor in favour of cutting the meat, as it was required, from a hanging carcass, because there is much less variation in the quality of meat from the different parts of the carcass. This lack of variation of quality would be even more the case if the carcasses from old cattle were plain (i.e. lacking in fat).

Slaughtering animals

Before the advent of railways, the way that most animals moved about the country (including their journey to a place of slaughter), would have been by being driven on the hoof. For some animals, the journey to the ultimate place of slaughter could have been many miles taking several months e.g. driving cattle from Scotland or Wales to London (Bonser 1970).

Before the advent of the captive bolt pistol, the poleaxe was one method used for stunning cattle. In some of the big slaughterhouses established in South America for the meat export, a 4 lb. hammer was used for stunning cattle (Gerrard 1951). The pig mallet was used for stunning pigs. This consisted of a large wooden ball on the end of a long handle, the pig being rendered unconscious by a blow on the head. The purpose of stunning was not only for humane slaughter but also to immobilise the animal so that bleeding was made much easier, especially if the blood was to be collected for food (note 3).

The bleeding of animals would commonly involve cutting into the neck of the animal and severing one or both the jugular veins and carotid arteries. Ritual slaughter (Shehita or Halal) results in the severance of both these blood vessels. The method for bleeding pigs is usually to cut the brachio-cephalic artery at the junction of the carotids.

It has long been the belief in the meat industry that, if the animal was not bled immediately it was killed, the muscles would contain high levels of residual blood that would be conducive to a more rapid rate of decomposition of the tissues. It was also the opinion that the heart needed to continue functioning to pump the blood from the body during bleeding. Research has found that it is the constriction of the blood vessels in the muscles that forces the blood from the muscle tissue and that the method of slaughter has no effect on residual blood in the meat (Warriss and Leach 1978) and that there will be no difference in the amount of residual blood in the muscle in animals that are bled and those that are not bled at slaughter (Warriss 1978). It has also been established that the amount of blood removed from an animal will be the same whether the heart stops pumping prior to severing the blood vessels or continues pumping whilst bleeding occurs (Warriss and Uotten 1981).

Standards of butchery

It is fairly certain that there would not have been a unified standard of butchery in the past. Even today, with a much higher level of organisation, universal means of communications and greater facilities for training, the difference in standards of skill and variations in methods of cutting are considerable. Marked differences in basic

butchery techniques could have been due to the type of person carrying out the butchery. At those times when the butcher's shop, as such, existed in the towns, the butcher would have developed the highest standards of butchery.

For the large household, like a villa, it was probably the task of one of the servants to carry out the butchery requirements for the household. The meat for such establishments may have been obtained as whole carcasses or as live animals. There would also have been butchery carried out by the peasant farmer when he slaughtered one of his own animals; this could have been a somewhat crude form of butchery.

For many periods in the past, the flesh of the animal was a by-product of other uses of the animal such as dairy, wool production or draught. Under such circumstances the supplies would have been inconsistent and the quality generally poor. This would not have been conducive to a high degree of finesse in butchery techniques. Trow-Smith (1957) suggested that, apart from old animals, it was the sheep suffering with sheep pox or sheep scab rendering them unsuitable for wool that went to the butcher.

Simply to remove meat from the carcass and reduce it to pot-size pieces could have given rise to a chop-and-slash approach (not unknown today where hard frozen meat is being cut or meat is destined for a mincing or grinding machine). This approach should not imply a totally indiscriminate method because the butchery would always need to take into account the general structure of the carcass and the joints of the skeleton. Where meat was being chopped from a hanging carcass, it would have been important to keep the skeleton with its ligaments intact until the bulk of meat was removed.

Interpretation of evidence

Interpretation of butchery evidence must be considered carefully, especially in respect of the feasibility or practicability of suggested methods of butchery based on the evidence. I have seen it suggested that chopping through the vertical ramus of the mandible was carried out to remove the tongue. I am sure that the butchers of the past were brighter individuals than to go about the removal of the tongue in the hardest way possible. Simply to cut the tissues on either side of the tongue from under the mandible will enable the tongue to be removed, separating it from the head by cutting through the soft tissues at the root of the tongue and separating the joint between the great cornu and middle cornu of the hyoid bone. This chopping through the vertical ramus of the mandible is often accompanied by chopping through the diastema (Fig. 11). The purpose of this could have been to remove the ox cheek (masseter muscles) with the main part of the mandible, the only significant amount of meat of the head apart from the tongue. Alternatively, this chopping could have been part of the process to chop the head bones (after the removal of the meat) into pieces for boiling for fat extraction, etc.

Distinguishing between cuts in a bone made by a chopper and cuts made by a knife is not always easy. Many light cuts are made by a chopper in bones during butchery, due to a light blow or perhaps when the chopper reaches the bone after cutting through flesh or other bones, having lost much of its force. Cuts made by a knife will be very fine. In many cases where a knife is used to bone out a piece of meat or disarticulate a joint, there will be very little more than knife cuts into the periosteum or the articular cartilages which, of course, will have disappeared from archaeological bones.

The possibility should not be discounted that some of the chopping marks on bone could have been the result of a miss-hit by the butcher or even a less than discriminating application of butchery.

Fragmentation of bones beyond the needs of normal butchery is mostly considered to be the result of fat extraction. The possible alternative is the chopping of bones for soup, broth, etc. (van Mensch 1974). Some of the layers from a site at Southwark (London) yielded a large quantity of cattle bone that was extremely fragmented by chopping. The degree of fragmentation was more extensive than is normally encountered, with the extremities of the bones having been chopped into small pieces and even the calcanea, astragali and central tarsi chopped into three or four pieces. There are many other examples of this process from Roman towns in Britain, Holland and Switzerland.

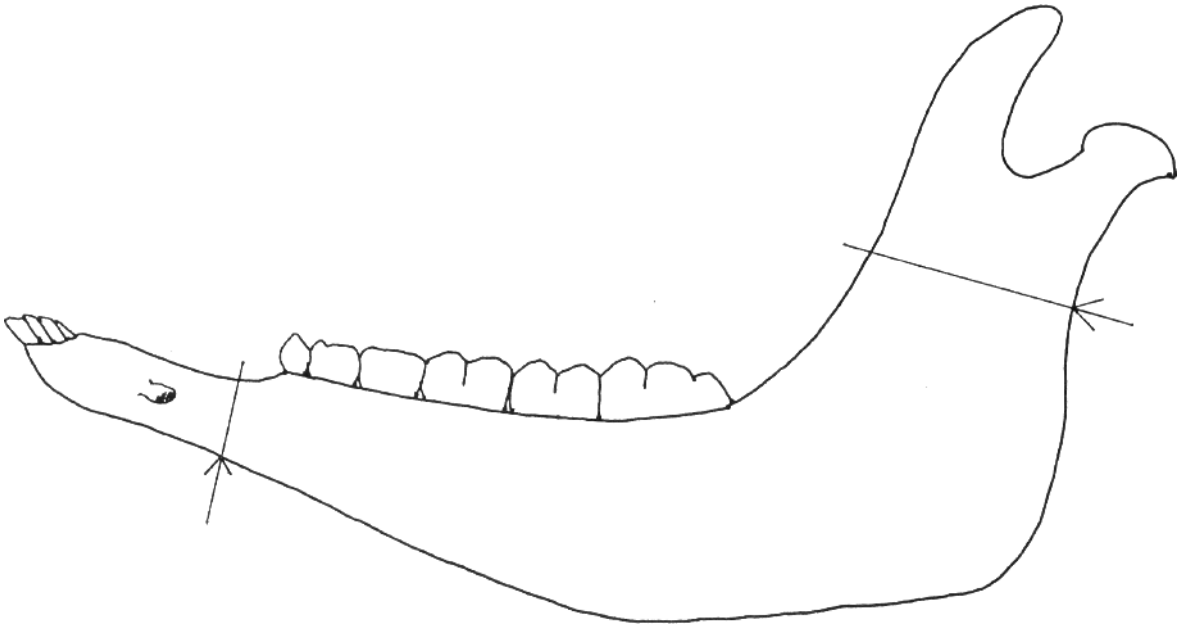


Figure 11. Butchery evidence on a cattle mandible. Chopping across the diastema and the vertical ramus may be the result of the removal of the mandible and of the cheek meat from the skull.

The ends of long bones, tarsals, carpals, ribs, vertebral bodies and sternum would not yield as much fat as the marrow of long bones but would produce a rich broth with a high protein content.

Before a firm conclusion is put forward in a report, the weight of evidence should be significant enough to support such a conclusion. It is always a temptation to try and make too much of a small amount of evidence. The following is taken from a bone report:

'The proportions of the different parts of the skeleton are not such as would result from differential preservation. They are consistent with large-scale organised slaughtering such as one would find at a modern slaughterhouse in that (a) the bones represent almost entirely the inedible or less edible parts of the animal; (b) all the horns seem to have been removed elsewhere and (c) there is a very consistent pattern of breakage of leg bones.'

The animal bones from this site represented a minimum of 12 cattle, two sheep/goats and two pigs. What would be described as a large modern slaughterhouse would have a throughput of 200-500 cattle per week.

In another report the suggestion was made - 'knuckle end of shoulder seems to have been the favourite joint'. This was based on the discrepancy between the proximal and distal ends of the sheep humeri and radii excavated, i.e. 17 distal humerus, 2 proximal humerus, 3 distal radius, 17 proximal radius - a somewhat tenuous conclusion from this evidence.

One should also take into account conflicting evidence, e.g. the number of bones that do not conform to the evidence. I have, for example, seen cattle vertebrae from a Roman British Site which were chopped longitudinally, a fact that could be taken to indicate that the carcasses were split into sides; these were just the bodies of the vertebrae. There was an even larger number of vertebrae chopped at varying angles to the line of the vertebrae. This variable direction of chopping the vertebrae indicated to me the probability that this chopping was the final butchery, reducing what was left of the carcass to pieces suitable for the pot. This would put this type of butchery into the tertiary category rather than secondary butchery which would have been the case if it could have been concluded that the carcasses had been split into sides.

When considering evidence as indicating a slaughter point, it should be borne in mind that the slaughtering process is somewhat obnoxious and causes unpleasant smells. It is most unlikely, therefore, that a slaughter point would be sited close to the better-class living areas. There is also the question of the disposal of the unwanted products of the slaughtering process. The major product that would need disposal is the stomach and intestinal contents, which is about 15% of an animal's weight (e.g. 37.5 kg (82.5 lbs) of the body weight of a 250 kg (550 lbs) bovine). The simplest solution would be disposal close to the point of slaughter: a convenient river, for example. The only use for these contents would be as fertilizer. The stomach and intestines may have been used as food, but this would depend on the eating habits of the people and whether meat was plentiful or in short supply. Usually an abundance of meat results in the less palatable products of the animal being discarded.

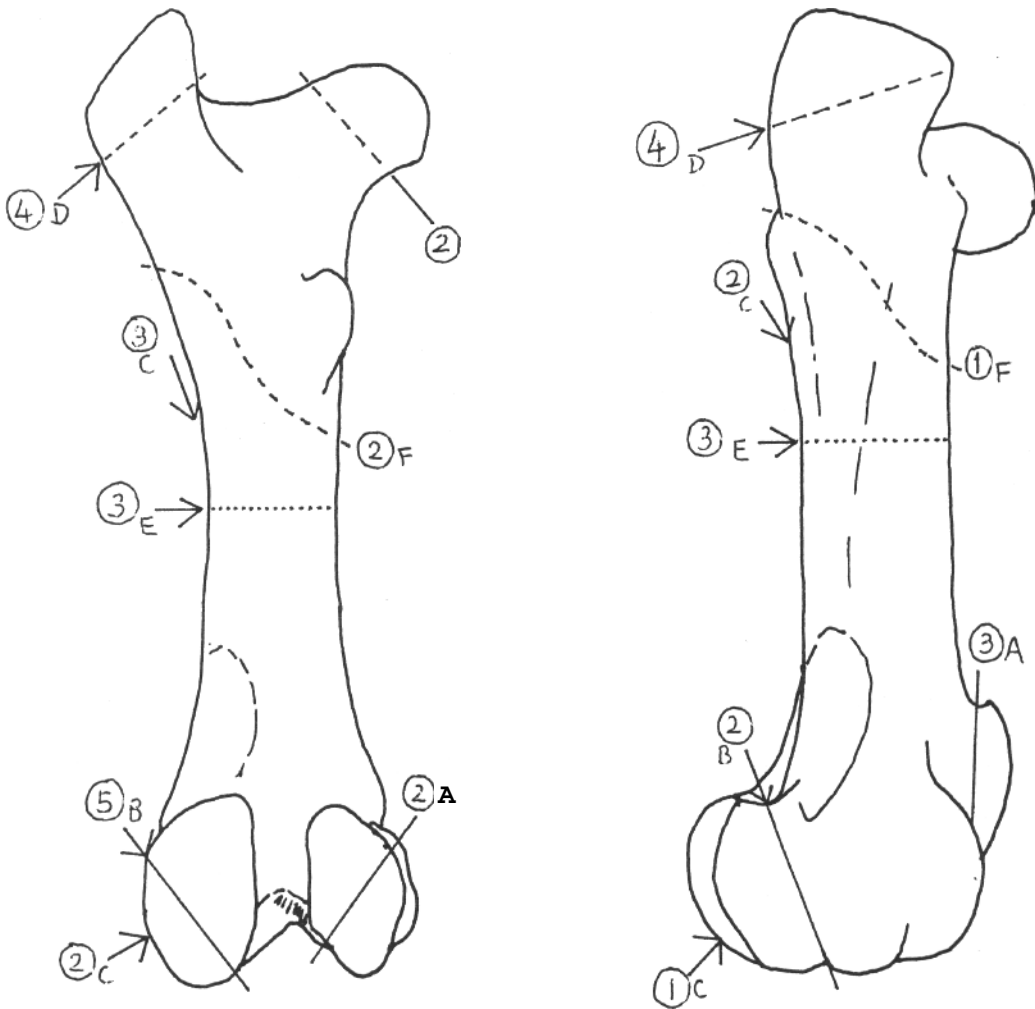
During the 14th century in London it was a practice to cart offals from the St Nicholas Shambles to a jetty on the Thames called 'Butchers Bridge' where Beadles of the Butchers' Company supervised the dumping of these offals into the river (Hammett and Mevell 1929).

Stomachs and intestines may have been used to contain food preparations, e.g. intestines used as sausage casings or stomachs as containers for haggis. Sometimes stomachs and intestines along with other less popular offals would be used to feed carnivorous animals kept for hunting, sport etc. During the reign of Edward III, butchers providing entrails for feeding the king's bears were granted a piece of land near the Fleet Ditch (London) where entrails could be washed (Hammett and Nevell 1929).

The evisceration of animals would have produced large amounts of valuable fat (gut fat - e.g. mesenteric and omental fat). This was probably the chief source of animal fat apart from bones. There are indications that, during many periods in the past, animals would have been on a low plane of nutrition and this would have resulted in very little fat covering the carcass or between the muscles.

Some of the by-products of animal slaughter would have provided the raw material for other industries, e.g. horns, hides and skins, metapodials for bone-working. This could have extended to such items as intestines for catgut, depending on the technology and requirements of the period.

Figure 12. Examples of composite diagrams showing the location (position of line), type (nature of line), extent and frequency (number in circle) of butchery marks observed on cattle femora.



A - sheared through the bone with no indication of the direction of the chopping (shear indicated by continuous line);

B - sheared through the bone with the direction of chopping determined by marks on the bone and indicated by the arrow;

C - chopping marks on the bone resulting in chips on the surface but not having sheared or broken the bone;

D - chopping causing the bone to break. Arrow indicates the direction and point of impact of chopper. Broken line indicates the line along which the bone breaks. Part shear indicated by continuous line followed by broken line;

E - bone sawn through. Sawing indicated by dotted line and direction of saw-cut shown by arrow;

F - break of the bone as a result of butchery or working, but no signs of chopping.

When writing conclusions for a report arising from evidence of butchery or bone working, the words used should be correct. It seems to be common in bone reports to write 'this was due to' or 'the reason for this chopping was', as if reporting fact rather than proposing a hypothesis. As true research workers, bone processors should only use such words as 'possibly the result of'¹ or 'may have been due to', when writing conclusions or suggesting hypotheses. The most positive a conclusion can be proposed is in the words

'this was probably due to'. When setting out hypotheses in a bone report, all reasonable alternative hypotheses should be put forward for the reader to consider.

Recording butchery or bone-working evidence

To describe butchery evidence in words will often result in something complex and not readily understood by the reader. The most effective way is to show the position and direction of cuts, chopping etc. on a diagram of the bone (Fig. 12). By having sets of diagrams of the bones (two views of each bone and right and left limb bones), butchery or bone working evidence can be marked on the diagrams for each bone group of a site. The evidence could then be amalgamated on to one set of diagrams for larger groupings. In this way patterns may emerge giving clearer indications of methods of butchery practiced or, indeed, that no clear pattern exists.

Conclusion

The object of processing and producing reports on archaeological bones is to increase the knowledge of the animal husbandry and utilisation of animal carcasses and their by-products in antiquity. To this end the bone reports can contribute most by the accumulation of data. The ultimate aim should be that the data amassed be as comprehensive as possible in covering all periods over the widest possible geographical area.

For all the data from all the reports to be statistically valid, there must be a commonly accepted method of processing and obtaining data and a universal method of recording and reporting those data. This would enable archaeological researchers to make comparisons between different periods or different types of site. It would also be reasonable to amalgamate certain items of data from a large number of separate reports.

Any method of recording and reporting needs to be:

- (i) uncomplicated - otherwise it will increase the mistakes made by those using it or, if the method is very complex, many workers will not adopt it;
- (ii) capable of recording the required data accurately,
- (iii) relatively easy to read and comprehend.

Data that are readily understood and not misunderstood or ambiguous by all in archaeology, not just the few specialists, will contribute more to furthering archaeological knowledge.

Notes

(1) Concerning which animals will gnaw bones, I found some pig bones in a wood that were extensively gnawed and chisel-like marks indicated that the gnawing had to be done by a

squirrel. Cattle also have been known to chew bones to obtain calcium, and pigs, given the opportunity, would turn a midden over.

(2) Souring of meat can occur if there is not a free air flow over the surface of the meat while the temperature is still high after slaughter.

(3) Blood from slaughtered animals is highly nutritious and is used in the manufacture of products such as black pudding. The Scottish drovers were reputed to have mixed blood with the oatmeal and onions they carried as their main victuals; this blood coming from animals in their herd (Bonser 1970). The practice is still employed by the Masai herdsmen of Kenya.

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**A comparison of grass foliage, moss polsters and soil
surfaces as pollen traps in modern pollen
studies**

Valerie Hall *

Summary

Modern pollen studies are usually performed using moss polsters or artificial pollen traps. As neither of these methods were suitable at the site under investigation, grass foliage was chosen as the trapping surface. A comparison was made with soil surfaces and moss polsters to evaluate the suitability of grass foliage for modern pollen studies.

Introduction

In the interpretation of fossil pollen assemblages, much use has been made of information derived from the study of modern pollen rain produced by various types of vegetation. Those studies carried out by Andersen (1970) on forests, and by Vuorela (1973) on the extent to which agriculture is reflected in pollen rain, have done much to increase the understanding of the many processes affecting the production and transport of pollen under these conditions.

Little work has been done on the identification of pollen spectra associated with local variations in agriculture, however, especially with regard to the recent past. The information derived from modern pollen studies in an agricultural context should be useful in the identification and interpretation of fossil pollen assemblages (Hall 1989).

A modern pollen study of a farm typical of those common in late eighteenth and early nineteenth century Ireland was therefore performed at the Ulster Folk and Transport Museum, Cultra, Co. Down. The farm was established approximately ten years ago, and is being managed according to the practices of the early nineteenth century. The fields are enclosed by walls and by hedges of hawthorn and blackthorn, and rye, wheat, potatoes and flax are all grown.

Farming practices in late eighteenth and early nineteenth century Ireland

During the eighteenth century a number of changes took place in farming practices throughout Great Britain. During the closing years of that century in Ireland, changes in arable cultivation, such as the application of lime, typified the new, 'improved'¹ system of agriculture.

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Enclosure by ditch and bank became increasingly common. The bank was usually planted with hedges composed, primarily, of hawthorn (*Crataegus*) with blackthorn (*Prunus spinosa*) to a lesser extent. Documentary evidence from the period states that crops such as oats, barley, rye, flax and potatoes were grown in the newly-created enclosed fields. Many of the farms also included land used for grazing.

There is little documentary evidence about the inception or rate of spread of enclosure, and the agricultural changes which accompanied it, anywhere in Ireland. Palaeobotanical studies of deposits from this period may therefore be the only method of identifying and tracing some aspects of the development of the enclosed agricultural landscape.

The choice of sampling method

Traditionally, modern pollen studies have made use either of artificial pollen traps (e.g. Lewis and Ogden 1965; Tauber 1974; Cundill 1986) or of moss polsters (e.g. Carroll 1943; Jonassen 1950; King and Knapp 1963; Andersen 1970; Vuorela 1973; Caseldine 1981).

In this study, neither of the traditional methods could be applied. Regular cultivation of the fields under study meant that small moss polsters were present only sparsely, on the walls separating the fields and never beneath the crops. The placement of artificial pollen traps would have been difficult, as they would have been disturbed by mechanised cultivation or by grazing animals. The paths which run through the museum are in regular use by the public and this increased the likelihood of disturbance (interference with traps can be a significant problem, according to Vuorela (1973)). It was for these reasons that it was decided to attempt the study using green grass foliage as the trapping surface. Grasses grew throughout the study area, both as a component of the weed understorey of the crops and as the major constituent of the flora of the grazed areas.

Grass leaves are not an ideal impaction and preservation surface for pollen grains. Unlike many mosses, they are not constantly damp and do not provide a pH which facilitates preservation. Repeated wetting and drying of the trapped pollen on grass foliage may therefore result in some degree of chemical or physical damage. On the other hand, grass foliage has the advantage of being relatively uniform in surface texture and thus might be thought to vary little in its ability to act as a trap.

To evaluate the usefulness of grass foliage as a pollen trap, a comparison was made with moss polsters from the field walls and exposed soil surfaces.

Sampling and sample pre-treatment

Some 60 samples of green grass foliage were obtained during the autumn of 1985. They were taken mostly at 5 metre intervals along three transects passing through the major arable, pastoral and enclosure features on the site. The sampling intervals were shorter where there were distinct vegetational changes, for example at a crop/hedge boundary.

The soil surfaces of the fields used for pasture were the only ones to have been exposed and undisturbed for long enough for them to have captured the pollen spectrum produced over a full yearly cycle, the soils beneath the crops having been disturbed during preparation for sowing and harvesting. About 20 surface soil samples were taken from the same points on the transects in the grazed fields in early spring 1986.

There were only five places on the site where mosses grew and, with the exception of one, and none was closer than 15 m to a transect. The mosses were of different height and growth forms and thus may not provide directly comparable trapping surfaces (Boyd 1986). All five samples taken were from mosses growing on or near the base of walls.

As the samples were small, it was not thought practicable to remove the green parts from the mosses in order to provide the surface most comparable with that of the grass leaves. Moreover, the use of the whole moss plant may provide a composite pollen spectrum for a number of years (Bradshaw 1981). This has the disadvantage of masking annual variations in the pollen rain and reduces the degree to which a valid comparison can be made with the pollen rain of only one season in the spectrum trapped by grass foliage.

The samples were stored until required in a refrigerator at 4° C. Standard pre-treatment (Faegri and Iversen 1975) was performed using potassium hydroxide, sieving through 250 and 10 micron polyester meshes, and acetolysis. After washing twice in distilled water, the samples were dehydrated in alcohol, stained with safranin and mounted in silicone fluid.

A pollen sum of 500 grains was used for the moss and grass samples. Where possible, the same sum was used for the soil samples, but in some cases sums of 100 grains were all that could be reasonably counted.

Results

(i) Grass samples

Results from the grass samples clearly demonstrated that much of the pollen trapped on them was of very local origin and, in all cases, grass pollen was present at varying concentrations. In these samples, the state of preservation was variable.

As might be expected, the concentrations of all pollen-types was highest in the vicinity of the plant producing it. Between 9 and 22% cereal pollen was present in samples beneath the crop, but consistently low values of 1-2% were recorded at distances of more than 1.5 m from the edge of the crop.

Linum pollen was present at levels of 45% beneath the crop, but was rarely detected other than as single grains outside the area where the flax was growing.

At no point in this, and a previous study by the author, was potato pollen detected in any sample.

The pollen of taxa growing in the hedge was present in samples close to the hedge and to a belt of trees surrounding the site. These were single grain occurrences in some instances.

Pollen from the perennial and (many) annual weed taxa was present at varying levels throughout the site. Tree taxa were represented by very low pollen levels in the grass foliage traps. Many of the herbaceous species present on the site also made contributions to the pollen sum.

(ii) Moss polsters

The moss polsters contained fewer pollen taxa than the grass foliage, but the state

of preservation was good. The values of 3% cereal pollen were similar to those from grass samples taken beyond the area of the crop. Values for perennial weeds were higher than the average of 5% for this category in the grass traps. Levels for other taxa varied to some extent from those recorded in the grass foliage samples.

(iii) Soil samples

The soil surface samples contained the least number of taxa, in general, but on the other hand the highest values for tree pollen taxa occurred in these samples. Although the values for tree pollen were high, the state of preservation was, as throughout these samples, poor. This was especially true for Alnus, where the grains were badly corroded.

The results obtained from these analyses are summarised in Table 3, where the figures are expressed as mean percentages of the total pollen sums (including standard deviations).

Table 3. Mean percentages (with standard deviations) for three categories of pollen from mosses, grass foliage and soil surfaces

	%tree pollen	%grass pollen	%herb and cereal pollen
samples from mosses (n=5)	11.0+3.7	60.0+5.5	26.0+7.2
samples from grasses (n = 56)	4.5+3.8	70.0+14.8	23.0+25.8
samples from soils (n = 17)	14.0+5.9	70.0+11.1	10.0+13.8

Discussion

A comparison of this type can only be made at a general level. The moss and soil samples came from areas that were used primarily for grazing, and therefore neither contained the range of taxa trapped by the grass sample, which had been collected from many different parts of the site. Moreover, the environment reflected in the moss and soil samples was more uniform than that in the grass samples. Nevertheless it is believed that grass and soil samples containing at least part of one year's pollen rain can still be fairly compared with the small number of moss samples containing the pollen rain of several seasons.

The poor state of the pollen trapped on the soil surface samples and, to a lesser extent, on the grass foliage (compared with that on the mosses) demonstrates that the pollen trapping surface is a factor in determining the final state of pollen preservation.

There was an element of difference between the percentage of tree pollen in the assemblage trapped by the grasses and those trapped by the mosses and soils. During the winter and early spring, the only areas on the site that had green grass foliage present on them were the fields used for grazing, and their surrounding banks. Samples from these areas were the only ones likely to have trapped the pollen rain produced at this period of the year. Such material would have comprised only a small proportion of the grasses sampled throughout the site during the autumn, by contrast.

The low percentages of pollen produced during the winter and spring are more likely to reflect this shortcoming in the sampling strategy rather some inherent inability of grass foliage (present during winter and early spring) to trap pollen grains. For this reason, it is probable that tree pollen, and possibly all pollen produced during winter and early spring, may be poorly represented in the pollen spectrum from the grass traps.

Grasses produce copious amounts of pollen and this was present at high values throughout the site in the various sample types. Some degree of over-representation of grass pollen might therefore be expected in the grass foliage traps. The similar values for percentage grass pollen for all three types may reflect the extremely local nature of all the trapped pollen, as both the mosses and the soils were surrounded by large expanses of flowering grasses.

Herb and cereal pollen

A study of modern pollen rain associated with agriculture in Ireland has been performed by O'Connell (1986), who used soil surface samples and Sphagnum polsters. In general, his results for cereal pollen percentages from analyses of these samples are similar to those obtained in the present study.

The similarities between the figures for percentages of herb and cereal pollen from the grass and moss samples (Table 3) are notable, even though the number of moss samples was small. A wider range of taxa was trapped by the grass foliage, but this is probably a function of the greater number of sites from which grasses were taken. All the taxa typical of the system of agriculture were detected in the grass traps: Cerealia, Linum, taegus, Prunus spinosa and perennial and annual weed taxa. Corylus and Alnus, which flower in late winter/early spring, were also present, but in very small amounts.

The slightly higher values for herb and cereal pollen in the moss samples was mostly a result of values of over 50/K Plantago pollen in one sample taken from a wall, with a number of Plantago plants growing nearby. Variations in data are almost inevitable when averages from a small number of samples are all that are available.

Conclusions

As most of the grass foliage sampled was produced during the late spring and summer, there was an increased chance of sampling pollen produced during this period. The same might be said of the soils, which trapped pollen produced by winter- and spring-flowering trees. As the composite pollen spectra from mosses and, to a lesser extent, from the soil

surface samples, mask the annual variation in pollen rain, it is necessary to take a number of grass samples from all vegetation types on the site to provide data as a basis for comparisons of this kind.

Although grass foliage sampled during the autumn contained only a small proportion of material that was present during the early part of the year, the pollen spectrum typical of the system could be identified from the results obtained,

A bias in favour of summer-produced pollen is built into this sampling method where samples are taken during or soon after this part of the year. This is not necessarily a disadvantage when trying to evaluate pollen productivity and dispersal from agricultural systems, however, since these are intrinsically spring and summer phenomena.

With adaptation, especially with regard to the time at which sampling takes place, the method might be used to carry out modern pollen studies of other systems of land-use, where aspects of local variation in a pollen spectrum may be identified in a fossil pollen assemblage.

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**National wheat-growing experiment: interim report
1987/8**

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Summary

ⁿ wheat-growing experiment was set up in Britain during 1987. On 22 plots across the country, three wheat species are being grown experimentally, in order to improve our knowledge of their growth requirements and yield potential. The three species involved are Triticum dicoccon (emmer), T. spelta (spelt) and T. aestivo-compactum (bread/club wheat), which are the important wheat species of the prehistoric and early historic periods in Britain. Soil and weather conditions are being monitored for each plot. The experiment will run initially for three years, after which the results will be assessed. The experiment is seen as the first step of a much larger research project. The first interim results are presented in this report.

Introduction

The analysis of charred plant remains from prehistoric sites in Britain has indicated that, during the first millennium B.C., a number of changes took place in the range of crop plants being grown. The change from emmer to spelt wheat is seen as a particularly important development. Of equal importance is the change from glume wheats (emmer and spelt) to a free-threshing type (bread/club wheat) in the first half of the first millennium A.D. While these changes are recorded across the country, differences in the timing have been found for the various regions of Britain.

The reasons behind these changes are poorly understood. The only explanation put forward so far is that by Jones (1981), who argues that these developments are a direct result of an intensification of agriculture, brought about by population pressure and the need to increase yields and expand onto previously marginal land. Spelt is thought to be tolerant of heavier soils than emmer wheat, to be hardier, and to be more resistant to wind damage, diseases and pests (Jones 1981).

During the first millennium B.C., changes occurred in the climatic regime over Britain, with a gradual increase in the amount of annual rainfall and a decrease in overall temperatures. The consequences of this climatic deterioration have often been used by geographers and archaeologists to divide the country into a Highland and a Lowland Zone (Evans 1975) and to explain differences in settlement patterns and farming practices.

Very little is known about the climatic and soil requirements of the prehistoric wheat species. There are no historical records about their production in Britain (emmer and spelt not having been grown since the early Anglo-Saxon period). Most of our information about the growth and yield characteristics of emmer and spelt wheat comes from

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Percival (1921), although valuable knowledge about these crops is now becoming available from the research carried out at Butser Ancient Farm, Hampshire (Reynolds 1987).

The wheat-growing experiment has been set up in order to improve our knowledge of the growth and yield potentials of these wheat species in different parts of Britain. The purpose of the experiment is to try to establish what the possible yield differences are between emmer, spelt and bread wheat in the different ecological zones of the country. The experiment will run for a total of three years in the first instance, after which the results will be assessed. The experiment is seen as the first stage of a much larger research project. It is hoped that the results of the experiment will identify the most important variables influencing crop yields and the regions of Britain in which further, larger-scale experiments need to be set up.

Methods

A total of 22 plots has been established across Great Britain (with the exception of central and northern Scotland). There are ten plots situated in the Lowland Zone and 12 in the Highland Zone (see Fig. 13). The location of the plots was determined by the availability of volunteers to look after them; the total number of plots (22) was determined by the amount of seed-corn available. The seed for all three species was provided by Terry Miller of the Agriculture and Food Research Council's Institute of Plant Science Research, Cambridge Laboratory (formerly the Plant Breeding Institute). The seed for each species came from a single harvest. The three species grown are *Triticum dicoccum*, *J. spelta* and *T. aestivo-compactum*. All were autumn-sown examples. Their AFRC/IPSR accession numbers are: emmer - 1070024; spelt - 1220017; and bread/club wheat - 3260 (VH77267). The spelt is awned and with grey glumes. The bread wheat has short, compact ears (most prehistoric and early historic bread wheat grains found in Britain are short, rounded and plump), and with short awns. The emmer and spelt are similar to those grown at Butser Ancient Farm.

On each plot, the three species are being grown in one-metre-square subplots. The seed is randomly allocated to each plot and the allocation of each species to the subplots is also randomly determined in the first instance. Their location on the subplots will rotate each year, in order that each species will have been grown once on each subplot.

Emmer and spelt are being sown as spikelets (50 per square-metre subplot), while bread/club wheat is sown as naked grains (100 per subplot). The spikelets of emmer and spelt are just covered with soil when sown; the grains of bread/club wheat are sown about 2-3 cm deep. The young seedlings are protected from birds by netting. Later, the netting is raised to give support to the tillers and to prevent lodging of the crop. The date of sowing was 15 October 1987. Some weeding was carried out during the growth of the crop.

In order to get the experiment started as soon as possible, certain compromises were necessary. The experiment is being run with the help of volunteers who have provided part of their garden or allotment to grow the three crops; consequently, for lack of space, it has not been possible to grow more than one crop of each species. If the experiment is continued after the initial three years, the most important alterations will probably be an increase in the number of examples of each species grown, including both autumn- and spring-sown specimens, in addition to an increase in plot size.

For each of the plots, four categories of data are being recorded; they are listed in Table A.

Results

At the end of the first year it has become clear that running an experiment like this is much more difficult than had been envisaged. Several unexpected problems arose. Many volunteers found themselves unable to visit their plots regularly enough to make accurate records of the date of germination, ear emergence and flowering; damage by birds and/or mice was much more extensive than had been anticipated. One plot (no. 3) was destroyed by rabbits and/or deer in early spring and had to be abandoned for the rest of the year. On



Figure 13. Map showing distribution of plots in wheat-growing experiment. The line from the mouth of the R. Exe to the mouth of the R. Tees defines the traditional division of Britain into Highland (north and west) and Lowland (south and east) Zones. Plot numbers: 1 Glasgow; 2 - Jardinefield; 3 - Doddington; 4 - liJhitchester; 5 - Durham; 6 - Oakenshaw; 7 Dalton; 8 - Lancaster; 9 - Liverpool (New Brighton); 10 - Lampeter; 11 - Castellau; 12 - Truro; 13 - York; 14 - Sheffield; 15 - Birmingham; 16 - Oxford; 17 - Bristol; 18 Romsey; 19 - Norwich; 20 - West Stow; 21 - Sleaford; 22 - Bicker.

Table 4. Data recorded for the wheat-growing experiment.

Growth Data	Plot Data
1. Date of sowing	1. Altitude
2. Date of germination	2. Orientation and aspect
3. Date of ear emergence	3. Underlying sediments
4. Date of flowering	
5. Date of harvest	Soil Data
6. Mean height of tillers	1. Particle size
7. Total number of ears	2. Organic matter content
8. Number of grains from 25 ears	3. Calcium carbonate content
9. Weight of grains from 25 ears	4. Magnesium content
WeatherData	5. Phosphate content
1. Monthly air temperatures	6. pH
2. Monthly soil temperatures (at 3D cm)	
3. Monthly rainfall figures	

six plots (nos. 5, 7, 13, 16, 20 and 21) birds and/or mice ate the entire crop just before harvest time, while on two plots (nos. 15 and 22) few seeds/spikelets germinated, possibly because of slug damage or because the seeds or young sprouts were eaten by birds. One volunteer withdrew from the experiment at the end of the first year. Consequently, as much as 40-50% of the data are missing, which makes it impossible to give any reliable statistical interpretation of the results from this year.

For this reason, the only results given are a list of plots in order of yield for each of the three species (Table 5). It must be stressed, however, that the order of the plots may not be representative at all, and may largely be the product of the great volume of missing data. From the present results, it would appear that no one region of Britain can claim to produce the highest yields, suggesting that the location of the plots (aspect and wind protection) and local soil conditions play a very important role. It has not yet been possible to compare the yield results with the results of analysis of the soil samples from the plots.

On all plots, the total number of ears of emmer wheat was much greater than for spelt, although in all cases but one (no. 17) the spelt grain yields were higher than those of emmer. This is a function of the different number and weight of grains in a single ear. In emmer, the mean number of grains per ear was 25.8 (standard deviation 5.5, $n = 4$), compared with 39.9 (SD 4.7, $n = 13$) for spelt. The figures for bread wheat are difficult to interpret because of erratic germination (see below). The mean number of grains per ear was 45.2 (SD 10.9, $n = 13$), but the yields of this species were not consistently higher or lower than those of either of the glume wheats.

A number of observations have been made during the course of this first year of the experiment:

(i) Germination usually took place within 2-3 weeks of sowing, but on a few plots (nos. 1, 4, 6 and 14) it took 4 weeks.

(ii) While there was little difference between the three species in the time of earliest germination, there were differences in the rate. Bread wheat had a very poor

germination rate on all plots, with often less than 50% of the seeds germinating at all. It is possible that, as they were sown as naked grains, they were more susceptible to slug damage or to waterlogging than emmer or spelt which were sown as spikelets. (October 1987 was an extremely wet month and the soil on most plots was waterlogged, or at least wet.)

(iii) On some plots (e.g. nos. 15 and 22), emmer and spelt wheat germinated very badly, even though on the other plots the germination rate was often 90-95%, suggesting that the bad germination rate could not have been caused by bad seed.

(iv) The time-lapse between the date of sowing and the date of ear emergence was ca. 32-33 weeks on plots in the south of England, 34-35 in Wales, and about 36 weeks on the northern plots. This probably reflects the slower rate of soil warming and consequently of delay in the start of the growing season. Flowering usually took place within about one week of ear emergence, but this date was not often accurately recorded.

(v) The time lapse between the date of sowing and the date of harvest varied from 41-44 weeks in the south and west to 47 in the north and 48 in Sheffield (plot no. 14). Insufficient information is available at the moment to comment on any differences between species.

(vi) On several of the northern plots bread wheat was affected by a fungal disease (Septoria) in early spring, when the weather was mild but wet. The very warm and dry spell that followed prevented the disease from spreading onto the top leaves and ears. It was interesting to note that the emmer and spelt plants growing next to the diseased bread wheat did not become affected. On two southern plots (nos. 18 and 19), aphids were a serious pest, although it is difficult to assess to what extent this affected yields. On plot no. 18 the aphids were largely restricted to bread wheat, while on plot no. 19 all three species were attacked. On plot no. 10, emmer and spelt were affected by a black mould, and on plot no. 14 spelt and bread wheat were affected by rust.

<u>Triticum dicoccum</u>	<u>Triticum spelta</u>	<u>Triticum aestivo-compactum</u>
Whitchester	Whitchester	Norwich
Truro	Glasgow	Whitchester
Bristol	Truro	Jardinefield
Sheffield	Romsey	Glasgow
Romsey	Castellau	Bristol
Castellau	Norwich	Birmingham
Glasgow	Sheffield	Oakenshaw
Norwich	Jardinefield	Castellau
Jardinefield	Bristol	Lampeter
Oakenshaw	Bicker	Sheffield
Dalton	Oakenshaw	Truro
Lampeter	Lampeter	Romsey
Birmingham	Liverpool	Liverpool
Liverpool		

Table 5. Some results of the wheat-growing experiment, 1987/8. Plots are listed in descending order of crop yield (plot numbers are given in the caption to Fig. 10).

(vii) At the time of harvest it was noted that the ears of bread wheat took much longer to dry than those of emmer or spelt. The tendency of the ears of the glume wheats to bend over, and the presence of tightly-fitting glumes caused the rain water to run off the ears, while the ears of bread wheat remain upright and this, together with the open glume structure, means that the ears fill with water and remain wet. This resulted in some cases in germination of the grain (plot no. 11).

During the next two years it will be necessary to cover the entire plots down to the ground to prevent the damage done this season. Mouse traps may be necessary. Obviously, prehistoric farmers will have suffered similar damage to their crops. In our case, however, the one-square-metre subplots are the only areas we have: we cannot afford to lose the entire crop.

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