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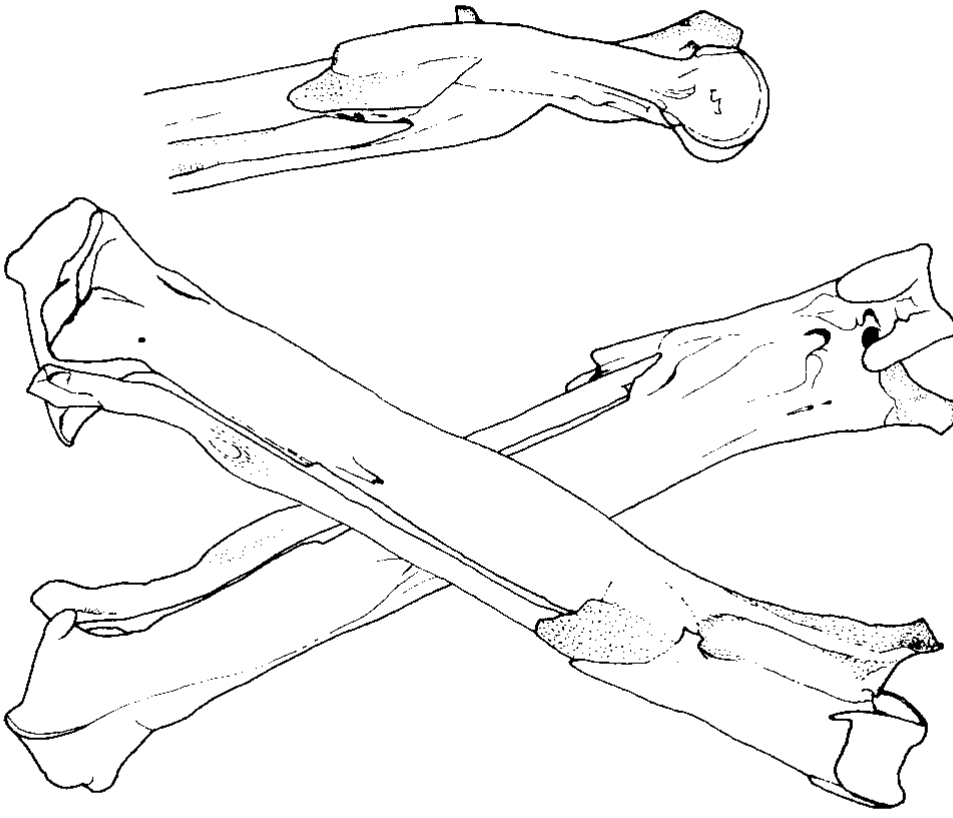

This Issue: Sloan on Scottish shell middens, Gennard on flax pollen, Levitan doing bones, Hall and Francis on **Lycopodium** tablets, Evans and Moore on **Calluna** pollen and Kenward et al. scanning for insects

The Bulletin of the Association for Environmental Archaeology

CIRCAEA

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 Vanessa Straker and Bruce Levitan but, for the present, copy for the Newsletter should be sent to the Editors of Circaea at the address at the foot of this page.

Editorial policy for Circaea is to include material of a controversial nature where important issues are involved. Although a high standard will be required in scientific contributions, the Editors will be happy to consider material the importance or relevance of which might not be apparent to the editors of scientific and archaeological journals, such as papers which consider in detail methodological problems like the identification of difficult bioarchaeological remains.

Circaea is edited and assembled by Allan Hall, Harry Kenward and Terry O'Connor, at the University of York. **Circaea is distributed free to members of the AEA and available to institutions and non-members at £9.00 per annum.** Back-numbers and a limited supply of articles can be purchased at the following rates: back-numbers (vols. 1 and 2, and vol. 3, no. 1) - £2 per part; (vol. 3 no. 2 onwards) - £3 per part; articles - 5p per side, plus postage.

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CIRCAEA VOLUME 3 NUMBER 3 WINTER 1985 (PAGES 133 TO 180)

Contents

Papers

AEA circaea

Editorial

By this time, you will have received the first edition of the revived AEA Newsletter, containing an explanation for some changes in Circaea which will take effect with the next volume; we shall henceforward be publishing two issues a year, but with much the same quantity of material as in the three issues produced annually to date.

This issue contains six short papers on a variety of topics, two book reviews and a lengthy review of a recent conference on the excavation of cemeteries. To some readers this last piece may appear unduly archaeological, but we feel that its inclusion is entirely justified if only on the grounds that it meets the criticism by some members that environmental archaeology comprises too much environment and not enough archaeology!

Sadly, we also include an obituary for Maureen Girling; this is particularly poignant for one of the editors, who was a colleague of Maureen's at Birmingham whilst they were both research students. A fuller account of her life and work should appear in the Symposium volume for the 1986 meeting to be held in Norwich in September.

Dr Maureen Girling (1950-1985)

It was with great regret that we learned of the death just before Christmas 1985 of Dr Maureen Girling. She died of pneumonia at her home in London and will be greatly missed by her friends and colleagues.

After graduating in Geography at the University of Reading, Maureen carried out research into Pleistocene insect faunas under the supervision of Dr Russell Coope at the University of Birmingham. She subsequently joined the Ancient Monuments Laboratory, where she was a member of the Environmental Studies Section for ten years.

Maureen was one of only a handful of environmental archaeologists specialising in the study of insect remains from excavations. She made major contributions to palaeoecological studies, particularly in the Somerset Levels and the Lincolnshire Fens, and added significantly to our knowledge of living conditions in urban communities in Britain in the past. Her impressive publication record demonstrates her commitment to archaeoentomology and the importance of this area of study. In a field which is so desperately short of specialists her death will be felt particularly severely.

Helen C. M. Keeley
Ancient Monuments Laboratory

Cover: Badly healed fracture in a domestic fowl tibiotarsus from twelfth century York (Drawing: Terry O'Connor).

ESF Handbooks for Archaeologists. No. 2 Dendrochronological Dating

This is the second of the European Science Foundation's Handbooks for Archaeologists, the first being on Thermoluminescence Dating. Their aim is to present, in a comprehensive and simple way, developments in the natural sciences that are relevant to archaeology. The Handbook on Dendrochronological Dating therefore sets out to present the practical aspects of tree-ring dating to enable the archaeologist to take samples; to know when and how to contact the dendrochronologist; and to understand what sort of results to expect, and how to interpret them. In short, the book aims to show the archaeologist when and how to use dendrochronology so as to extract the maximum amount of information from suitable wood samples.

The book examines very briefly the relationship between dendrochronology and other dating methods, and the history and development of dendrochronology. The biological background to tree-rings, and the procedures which lead up to the production of tree-ring dates, are also passed over quickly, but more space is given to an account of when and how to sample. The reliability of tree-ring dates is discussed in some detail in a section which also deals with their interpretation and accuracy. The book continually stresses the importance of multiple sampling, and of consultation betwen archaeologist and dendrochronologist at all stages of the excavation. These points are illustrated by several case studies from various sites in north-west Europe. The book also provide a summary of European tree-ring chronologies (albiet somewhat out-of-date), plus addresses of the major European tree-ring laboratories.

I would not recommend it as a text book: it is often too brief, and there are one or two misleading statements about the technicalities of dendrochronology (I suspect arising from lack of consultation between the three dendrochronologists involved in the book's production). But as a practical guide to archaeologists who are excavating wood and timber, it will be very useful, especially as it summarises all the major dos and don'ts of dendrochronology at the end of the book. The final plus point of the Handbook is that it is available free from the ESF in Strasbourg! (European Science Foundation, 1 quai Lezay-Marnésia, F-67000 Strasbourg).

Jennifer Hillam

The Editors would like to thank Jean Johnson, employed through a Manpower Services Commission Community Programme scheme at the Environmental Archaeology Unit, University of York, for her work in inputting the bulk of this issue of Circaea into the word-processor.

G. W. Dimbleby 1985 The palynology of archaeological sites. London, Academic Press, 176 pp.+ figs. £34.50 (available post free ex stock from: Oxbow Books, 10 St Cross Road, Oxford OX1 3TU).

This book is part of the series 'Studies in archaeological science' in which books on a variety of topics have appeared sporadically over the last 12 years. The series has been varied in quality with some books like John Evans' one on snails becoming the standard work on the subject, while others seem to cover their title topic very much less well. There is a great need for authoritative books on aspects of archaeological science, both for specialists and for students who may not be able to get a good idea of a subject when the relevant literature is scattered through periodicals. Circumstances have until now prevented Professor Dimbleby summarising his specialist field, but the publication of this book would appear to fulfill a long-standing need.

Before you rush out and order a copy, please note what you are getting for your money at 20p per page, which is expensive even by the standards of Academic Press whose other books seem to cost between 8 and 14p per page. There is no paperback edition, so this book is immediately out of the reach of the most important market - under- and postgraduates, and it will be limited to institutional and specialist sales only, which seems a great pity. This reviewer had to await the arrival of the library copy.

But what of the book itself? The book deals mainly with soil pollen analysis related to archaeological sites, discussing first the theory and then the applications, well illustrated with examples which are mainly drawn from Prof. Dimbleby's own results, some hitherto unpublished, and illustrated with his pollen diagrams. Although I admit to specialist interest, this is a readable book, which is no mean achievement considering the complexities of the subject. No glossary is given, nor is one needed, for technical terms are not in evidence, although I did note 'coeval'. On a non-technical note, I was pleased to see 'nicely' used in its original sense meaning 'precisely'. I like the forthright way in which Prof. Dimbleby says how far he believes other people's published conclusions - my own included - and his statement of belief that palynology needs first-hand ecological know-how.

Prof. Dimbleby also reviews the work of others, for example the Dutch and Belgian soil pollen analysts, the Swiss lake-village researchers, the French cave sediment studiers, and also some of the work done in the United States. The topic of special interest to me - the investigation of pollen from waterlogged archaeological deposits in association with the study of seeds, beetles, etc. - is also dealt with and I feel that Prof. Dimbleby agress with this kind of work more now than he did ten years ago, when he wrote that difficulties of interpretation made studies of such material fruitless (Dimbleby 1976). On another point relevant to my own work, I do not think he is quite at home with the discussion of the early neolithic lake villages (p. 139). He omits the point made in the original publication that the high values of some tree pollen types found in the occupation layers are the result of branches being brought to the site for leaf hay for feeding the stock.

On a general note, I can find little fault with this book, but I shall nevertheless make some comments. Illustrations, I believe, can make or mar a book, and the pollen diagrams in this volume are very

helpful. The photographs of soil profiles are a little less so, but perhaps some labelling would have helped those who, like myself, know rather less soil science than they should. It is surprising that the excellent figure 1 from Dimbleby (1976) showing sampling localities in round barrows should not have been included; others have seen fit to use it.

The references go up to 1983 and cover British and overseas work without being completely comprehensive, so that work on coprolites such that of Norbert Paap, and some work on honey remains occur to me as omissions because I find those topics interesting, but I cannot find any glaring gaps in subject coverage. However, I wonder why Havinga is mentioned as the only Dutch soil pollen analyst (p. 1) and only one of van Zeist's many soil pollen publications is listed. Another point I would like to make is that when quoting environmental reports which are sub-sections of archaeological publications, the name of the pollen analyst (often Dimbleby himself) easily becomes lost, and I personally prefer to see them quoted thus (for example): 'Scaife, in Ayers and Murphy (1983)'.

Professor Dimbleby makes a clear statement in his book of the great value of pollen analysis of suitable material from archaeological sites, and of some directions for research, such as the investigation of bat droppings in connection with cave sediments. It is very much to be hoped that others will continue with the kinds of work that he has pioneered, and perhaps this book will provide inspiration. The ridiculous price of the book will unfortunately restrict its circulation.

Now for those bats' droppings!

Reference

G. W. Dimbleby (1976). A review of pollen analysis of archaeological deposits. Pp. 347-54 in D. A. Davidson and M. L. Shackley, Geoarchaeology. Earth science and the past. London: Duckworth.

James Greig

Conference Review

'Bringing the Dead to Life', a conference concerning the excavation of burial grounds, was held at the University of York from September 27-9th, 1985, under the combined auspices of the University of Leeds Continuing Education Programme and the York Archaeological Trust (YAT).

Peter Addyman, the Director of YAT, opened the conference with a general slide tour of the most recent excavations undertaken by YAT. Dr Addyman set the tone for the rest of the conference which, more than any other aspect, stressed the wide ranging scope and intensity of modern archaeological excavations in Britain. York's participation in these developments was the theme of Dr Addyman's presentation, demonstrating how, through careful and well-planned excavation, archaeologists are revealing and adding to the general knowledge of urban developments from the earliest Romano-British foundations and how these early developments affect the topography and maintenance of the modern city. Perhaps one of the most significant details which emerged from Dr Addyman's most interesting lecture was the degree to which YAT and the civic authorities can complement each other's efforts. The most recent excavation on the city walls not only revealed the construction sequence beginning in the Roman period and progressing throughout the Anglian, Anglo-Scandinavian and medieval periods, but also aided the city engineer to determine what sort of maintenance the present walls might need in the future to retain their splendour that so distinguishes the modern city.

The second day of the conference opened with a very intriguing lecture presented by Patrick Ottaway of the Trust concerning his previous work in the city of Winchester and, specifically, on the Romano-British burial ground excavated there in the 1970s. Mr Ottaway discussed the various burial practices portrayed in the orientation and accompanying burial goods of the deceased, dating from the 3rd and 4th centuries AD. The house goddess, Epona, seems to have been held in special esteem amongst this population as the statuettes in the likeness of this deity and numerous house burials would seem to suggest. In the question and answer period following Mr Ottaway's lecture, the question of regional variants was discussed, with Mr Ottaway portraying the inhabitants of Romano-British Winchester as somewhat conservative in their approach to burial practice when compared with developments elsewhere in the country at a similar date. Mr Ottaway stressed that archaeologists should expect a wide range of regional variants among Romano-British burial practices, reflecting in part the regional nature of the earlier Celtic belief systems.

Kenneth Penn, assistant director of the Spong Hill burial ground excavations, followed with a talk concerning this much-discussed and controversial Anglo-Saxon cremation burial ground. Mr Penn, in an all-too-short 50 minute slide lecture, presented some of the various styles and motifs found in the cremation urns themselves and made some provisional suggestions about what sorts of cultural trends they might reflect. One of the most interesting of these cultural trends discussed was that associated with the use of male and female symbols and what their significance might be in interpreting the placement and contents

of the urns. Questions concerning the ways in which these urns were produced and the symbols applied followed, in which it was revealed that some of the urns may have been wasters originally intended for utilitarian purposes.

Andrew Boddington, of the University of Durham, followed Mr Penn's lecture with a presentation on the excavations at Raunds. The excavations of this chronologically later site (10-12th centuries) involve not only the cemetery surrounding an early parish church, but also the wider understanding of the community as a whole and the relationship between proprietary parish church and manor. Future excavations at the site will delve into the shift of the parish association with a postulated second manor in the area. The eventual goal of such excavations will be to attempt a total understanding of the parish through time and how its various elements interacted and influenced one another.

On Saturday evening, those attending were treated to a lecture by Mick Jones of the Trust for Lincolnshire Archaeology. This talk, somewhat akin to Dr Addyman's the previous night, focussed on most recent developments in the archaeology of Lincoln. Mr Jones spoke at length about two of the most illuminating discoveries made in Lincoln in the last few years through the excavations of two parish churches: St Mark's, an extramural church, and St Paul-in-the-Baile, a parish church situated near the centre of the modern city. Both churches probably had very early beginnings, being founded in an extra-mural cemetery in the post-Roman period. St Paul-in-the-Baile, located in an area with an extremely long settlement sequence, was originally a basilica-type Roman construction dating perhaps to the 4th century. A later church on the same site may be the church of the missionary Paulinus, who accompanied the mission of Augustine in the early 7th century from Rome, and who rebuilt the church or reconsecrated the site of the earlier church. Its position in the courtyard of the Roman forum complex suggests that such reconsecrations may indeed have been made and just how they were expressed in the cities once dominated by Rome.

This pattern may yet find parallels in York, where similar circumstances may have dictated a similar sort of consecration in the area of the Roman forress, the possible site of the timber church of King Edwin of Northumbria. This sort of consecration or reconsecration would seem to be suggested by both the writings of Pope Gregory I and by the earlier exegetical writings of Augustine of Hippo when he discusses the use of originally pagan items for the celebration of the Eucharist and othe Christian mysteries in his On Christian Doctrine. Mr Jones' ample description of these two excavations left the audience with many new insights into early christianity. After Mr Jones' talk, Philip Rahtz, Professor of Archaeology at the University of York, surprised the assembled group with a 15 minute video of the recent excavations at Sutton Hoo, where Martin Carver has uncovered the remains of a two-phase inhumation cemetery, which appears to be dated either to the period of Mound 1, the famous ship burial attributed to King Redwald of East Anglia, or to a period as late as the 9th century.

On the following and last morning of the conference Philip Rahtz maintained the tenor set by Peter Addyman and broadened the scope of the conference with his discussion of the excavations at Wharram Percy parish church. The lecture concerned the excavation of a position of the medieval cemetery and grave-markers of the 18-20th century cemetery. In his discussion of these grave-markers, Professor Rahtz made analogies

to the many un-named medieval individuals buried in the preceding centuries. The discussion afterwards emphasised the great potential of such extant cemeteries in explaining and interpreting earlier burial patterns and rituals.

The two following lecturers, Nicholas Pearson of YAT and Professor Mark Williamson of the Department of Biology at the University of York, spoke about the excavation and post-excavation work being done on the Jewish cemetery, Jewbury, in the city of York. Mr Pearson's lecture centred on the development of the excavation strategy, which involved the digging of trenches in only those areas that would have been disturbed by the modern developments on the site and only to answer specific questions about orientation and the extent of the cemetery. In the development of this excavation strategy, Mr Pearson stressed the importance of good relations between archaeologists and contractors in an effort to recover as much information as possible before development. Mr Pearson made several allusions to the problems encountered in excavating this Jewish row cemetery, not the least of which involved the living Jewish community, but left the discussion of the post-excavation work to Professor Williamson.

Though Professor Williamson is not an archaeologist, his contribution to the conference was both informed and very thought-provoking. His treatment of the archaeological population as a biological population added much to his study and, it is to be hoped, this will be the norm in similar future studies. Basically, his approach allowed a total study of both metrical indices (measurements of bones) and non-metrical traits, leading perhaps to answers to questions of relatedness and demographic characteristics such as the determination of age at death, stature estimates, and pathological abnormalities. His conclusions based on these collected data showed that the cemetery was most likely a Jewish cemetery, a fact contested by many, despite well-documented sources pointing to its location at this site. In addition to these physical anthropological studies, Professor Williamson engaged the assistance of living members of the Jewish community for assistance in describing burial practice. The cemetery generally seemed to fit modern Jewish practice with certain discrepancies not yet explained. The discussion after Professor Williamson's very enlightening lecture focused on his use of historical, archaeological, and physical anthropological studies and their agreement. His approach, somewhat akin to work previously carried out on York's medieval cemeteries (see Dawes and Magilton's (1980) work on St Helen's-on-the-Walls), should in the future be the norm followed in cemetery studies.

The final lecture of the conference was delivered by Dr Keith Manchester of the University of Bradford, who spoke on the archaeological occurrence of leprosy and tuberculosis. Dr Manchester's archaeological case-studies lend themselves well to his major research interests in histology and clinical medicine. Throughout his lecture, Dr Manchester made allusions to the complementary nature of physical anthropology and clinical medicine. Each has a major contribution to make to the others. Dr Manchester also made quite extensive use of historical pictorial accounts of such common archaeological occurrences such as trephination of the cranium and explained their significance in studies of early clinical practices.

The conference closed, having shed some very bright light on the archaeological investigation of death and its many facets and the many disciplines involved in its study. The participation of non-

archaeological experts and non-archaeologists was indeed both reassuring and stimulating. The speakers helped make more accessible that to which few have access from the literature and, in addition, presented it in an inspiring and fulfilling manner.

Reference

Dawes, J. D. and Magilton, J. R. (1980). The cemetery of St Helen-on-the-Walls, Aldwark. The Archaeology of York **12**, 1-120+pls. London.

Christopher Knüsel
Whitewater, Wisconsin, U.S.A.

Circaea volume 3 number 3, Winter 1985, pages 143-150

A summary of some recent shell midden analyses

Derek Sloan *

One of the major problems for specialists working in archaeology is that there is often a large time lag between the writing of a specialist report and the publication of the archaeological work of which it forms part. With this in mind, this paper sets out to summarise some recent shell midden work in order that other workers in the field are at least aware of it.

This work has all been carried out in Scotland (see location map, Fig. 76), and covers a broad range of chronological periods. The comparison of foraging patterns from different areas and different periods is of particular interest; rather than discuss the material chronologically, I will consider two groups of sites which may usefully be compared.

1. Faunas dominated by gastropods

a) Oronsay (Sloan 1976)

This work involved an analysis of material recovered from a trial excavation of the Priory Midden, one of several mesolithic midden sites on this small island (Mellars 1978). Although only a very small excavation, and therefore subject to a strong possibility of sampling errors in the single column analysed, several interesting results emerged.

(i) In common with the other Oronsay middens, the marine shell assemblage was dominated by limpets (Patella vulgata L), with a constant secondary component of winkles (Littorina littorea L.) and dog whelks (Nucella lapillus L). There were also small and variable amounts of other common littoral species. However, in contrast to other midden sites recently investigated or re-investigated (e.g. Bailey 1975), the marine shell appeared to form the major economic component (Mellars 1978, 378). In other words, this site seems to be a true shell midden, rather than a fish midden.

(ii) Detailed measurements of the limpet shells suggested a slight decrease in size through time as a trend, possibly indicating a steady over-exploitation of the resource; however, the decrease was too small for us to be dogmatic about this conclusion.

(iii) Limpet length distributions were basically unimodal and grouped around a mean of 30.5 - 34.2 mm; there seemed to be a low

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representation of the larger shells (48.0 mm and greater) which are the favoured eating of the modern population of the area (Fowler 1974, 37).

(iv) Analysis of the shape of the limpet shells suggested that they were collected from either very low in the tidal range, or from very sheltered locations. These observations are in accord with Fowler's study of modern and prehistoric limpet populations on Oronsay (op. cit.).

(v) Crabs (mainly Cancer pagurus L.) seem to have formed a fairly important resource, although no satisfactory method has yet been devised for evaluating the contribution of this resource to the overall economy.

This study should shortly be reworked for publication as part of the second volume of the final report on the Oronsay project.

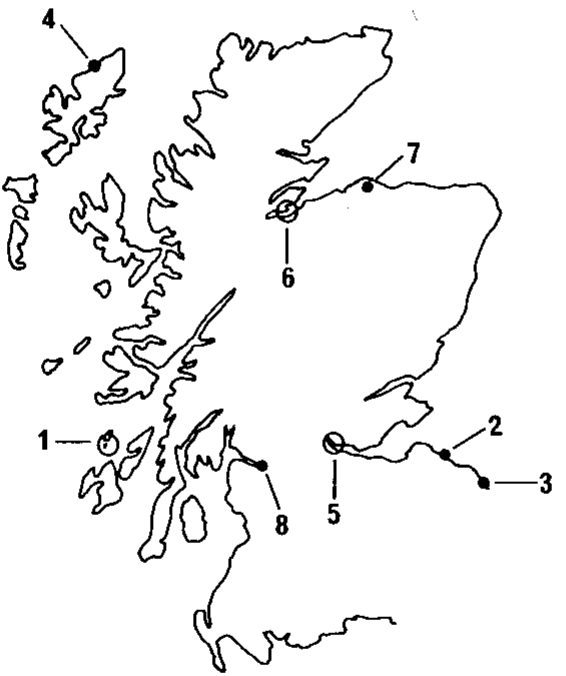

Fig. 76. Location of sites mentioned in the text. 1 - Oronsay 2 - Broxmouth 3 - Eyemouth 4 - Barvas 5 - Forth Valley sites 6 - Inverness sites 7 - Loch Spynie 8 - Glasgow.

b) Broxmouth (Hill 1979)

This almost totally excavated Iron Age hillfort produced a large but fairly limited molluscan assemblage, again dominated by P. vulgata and L. littorea. Detailed analysis of this material led to some extremely interesting conclusions:

(i) In general, shellfish were not a favoured resource, although the proximity of the coast meant that they were always exploited to a minor degree. However, during periods of economic stress, they became an important part of the economy; this was well demonstrated by the way in which the appearance of massive shell middens in the ditch terminals coincided with a great decrease in the amount of animal bone from the site, as well as by the uneven distribution of shellfish through the many phases of the site's occupation. These middens seem to represent a very short depositional period, and it is hoped that the application of oxygen isotope analysis will demonstrate the length of this period.

(ii) This exploitation as a famine resource was so heavy that there was not only a rapid decline in the size of the limpet population, but there was also convincing evidence that the population was depleted to a level from which it was unable to recover; the later phases of the site contain almost entirely L. littorea, an animal which, because of its non-static nature and potential for the renewal of local populations by migration along the coast, is less vulnerable to over-predation than the limpet. Limpets may be unable to re-establish themselves once their food supply (young seaweeds) has been allowed to mature.

(iii) Before this over-predation, limpets of an average length of 36.0 mm were collected.

(iv) The pattern of shell shape in the limpet population was very similar to that observed from Oronsay, with extreme 'low water' or 'sheltered' shapes predominating.

(v) Flat periwinkles (L. littoralis L.) and top shells (Gibbula cineraria L.) were recovered in some number. However, in this instance, these species appear not to be indicative of the collection of seaweeds (e.g. Bell 1981; Evans unpublished), but rather to have been incidentally included during the gathering of common winkles; these species were always found in deposits which contained large quantities of L. littorea.

This most interesting site serves as a demonstration of the value of the close co-operation of excavator and specialist at all stages of the archaeological process. Not only did I have the benefit of working on the excavation, but the excavator (Peter Hill) was extremely concerned to see that the molluscan analysis was integrated with all other aspects of work at the site. Although no criticism of any other excavator is intended, it seems no coincidence that this site should have produced the most interesting and informative results of any of the sites which I have studied. I would urge all potential directors to insist that funds be made available for the purpose of appointing specialists before an excavation starts, and for allowing these specialists at least to visit the site.

Publication of the Broxmouth report will form part of an Edinburgh University monograph on the excavation.

c) Eyemouth Kirk Site

This medieval rubbish dump (rather than true shell midden) again demonstrates the importance of co-operation between excavator (in this case Piers Dixon) and specialist. Although the material was initially unpromising, it was possible to draw interesting conclusions from the site.

(i) An analysis of marine shell, land snails, sediments, and marine flotsam allowed a convincing demonstration that the earlier phases of the site were subject to constant inundation - i.e. that the site was tidal.

(ii) A limited land snail assemblage dominated by Vallonia spp. and Pupilla muscorum L. suggested an original local environment of sand dunes.

(iii) The limpet shell measurements produced a similar pattern to those from the sites mentioned earlier. Observations of the shell morphology of dog whelks suggested that sheltered conditions for the collection of mollusca might be more important than tidal zonation in determining the collection pattern. This point is worthy of further consideration in future studies as the exact significance of the shape of limpet shells from archaeological assemblages is a source of considerable debate among workers in this area.

(iv) Mean limpet length was 30.0 mm, although small concentrations of shells were found with a higher mean of 35.0 mm. It had been hoped that there would be some variation in the shell measurements which would help to demonstrate that the limpets were collected for bait (suggested by historical evidence) rather than for human consumption; no such evidence was found.

(v) Several species (e.g., Dentalium entalis L, Turritella communis Risso, Apporhais pes-pelecani L.) were observed whose inclusion seems to have no elegant explanation, unless they were deposited by otherwise undetected inundations. This is a common problem in marine shell assemblages, and deserving of further study, even though the explanation may be simply whimsy on the part of the collector.

This report is due for publication as part of a monograph on the Eyemouth excavations.

d) Barvas, Lewis

This work on Bronze Age and Norse sites is currently in progress. Preliminary results suggest that the patterns of limpet size and shape will be similar to those from the other sites, but that the assemblage is extremely limited in the range of marine species represented, being almost entirely P. vulgata and L. littorea.

2. Forth Valley shell middens (Sloan 1982a; 1984)

Recent field work by the author has now identified eighteen large shell middens in the central Forth Valley. Similar sites exist at Inverness (Gourlay 1980), on Loch Spynie (Lubbock 1865; Morrison 1873; Sloan forthcoming), and under Glasgow (Sloan 1982b). Two of the Forth

Valley sites have been examined in some detail - one by excavation and one by salvage recording. Work is still in progress, and involves both analytical and methodological aspects.

a) Methodological

These vast and unusual shell middens - comparable in size to the largest of the classic Ertebølle sites - consist almost entirely of oyster (Ostrea edulis L.) shell, with only small amounts of other species, and no evidence for the exploitation of either fish or birds. With this in mind, a strategy was devised to determine the most cost-effective method of sampling and analysis for this type of site. This involved the evaluation of spit and layer sampling, sieve recovery in relation to mesh size, and sub-sampling. The interim conclusions are as follows:

(i) Spit sampling is inadvisable in this type of deposit. The steep angle of tip of some layers means that any controlled sampling must be done in true archaeological layers.

(ii) Of the sieve meshes used (10.0, 7.0, 3.5 and 1.0 mm), a coarse sieve (7.0 or even 10.0 mm) is perfectly adequate to show gross midden composition, although mussel and crab species will be under-represented. The use of a 10.0 mm sieve rather than a 3.5 mm will lead to a saving of sieving and sorting time which is of the order of x5-10, and may be up to x20 in some cases. (This is to some extent an estimation, as only sorting times have been accurately recorded; it is intended to do further field trials on sieving times under controlled conditions.)

(iii) The fragmentation and chemical weathering effects on crab and mussel species is so severe that the true representation of these can only be established at an unrealistic sampling level, i.e. by sorting substantial amounts of material processed through 300 um - 1.0 mm sieves. I would be very interested to hear from anyone who knows of any work on the use of heavy liquid separation techniques for this type of material, as this seems the only practical possibility of sorting large amounts of finely sieved molluscan material; granted the different mineral make-ups of molluscan species, this should be theoretically possible. An unexpected observation was that seriously decayed mussel shell breaks down into a fibrous bundle, not unlike a cigarette filter; this caused some confusion until the source of this substance was established.

(iv) Sub-samples of 1.0 kg of coarsely sieved (3.5-10.0 mm) material, from original samples of 30-40 kg (unsieved weight), are adequate to show the representation of common elements. An approximate technique has been devised for 'weighting' the less common elements. This involves considering the number of whole shells of these species in the sieved but unsorted part of the sample, and their average weight. As the bias in subsampling is caused by an under- or over-representation of whole shells and large fragments (smaller fragments are proportionally represented in subsamples) an adjustment is then possible to take account of the possibly faulty representation of these larger pieces. This may not be statistically elegant, but it seems to be effective.

Even smaller subsamples are useful for more finely sieved material; although the optimum sizes have yet to be calculated; about 5.0 g of 500 µm sieved material seem to be adequate.

(v) To obtain sufficient oysters for metrical analysis, initially large samples are required - possibly as large as 100 kg, depending on the amount of matrix in the deposit. This process may be expedited by the use of a large-meshed sieve (50.0 mm) which will only retain large pieces of oyster and sizeable stones.

(vi) These middens contain large land-snail faunas, but extraction of snails from a background of crushed oyster shell is incredibly time-consuming. A repeated float/agitate/decant system appears to provide adequate samples, with only unidentifiable fragments and the tiniest juveniles being missed. It must be stressed that this is not ordinary flotation, as usually carried out on-site, which is universally regarded as being insufficient for the retrieval of useable samples of land snails.

(vii) Small stones and pea-grit are a considerable problem in sorting, but an extremely crude gravity separation can save much valuable time.

(viii) Analysis of this type of site produces a vast volume of data, and I would be grateful to hear from anyone who has applied computers to the analysis of shell midden material.

(ix) Although the basic methodology can be devised to fit the known characteristics of the site, the possibility of variation must never be forgotten. Random checks on the material are essential if this type of site-specific methodology is to be employed.

(x) Recent observations of a midden which is located on the modern shoreline, and of natural deposits from the Cromarty peninsula, have suggested that birds may play a considerable part in the deposition of shell midden material. A systematic study is to be carried out, as this could seriously influence certain aspects of shell midden study, e.g. seasonality determinations.

b) Analytical

(i) Preliminary results suggest that the measuring of oyster valves from this type of site may be of value, although stratigraphic problems are making this hard to interpret. This implies a selective process in the original collection of the oysters. More information is needed on the possible effects of local environment on shell shape.

(ii) The less common species of marine mollusc tend to occur in concentrations, presumably indicative of individual meals or parts of meals, fluctuations of taste, etc. (e.g. Meehan 1983, 10-11).

(iii) There are observable activity areas within the middens. Although the sites would at first seem to be unstructured shell heaps, they are in fact very complex structures. This is an important point to remember when considering material derived from small-scale excavations; material cannot be interpreted correctly without an appreciation of the type of context from which it is derived.

(iv) As observed on Oronsay (Mellars 1978), the basic shell deposits can be split into two types, which I prefer to call 'dump midden' and 'occupation midden'. These classifications can be subdivided into various fairly simple categories, e.g. 'M1f': crushed

shell with little or no matrix. These categories can be applied to primary site records on the basis of purely visual observations of the material as it comes out of the ground, and enable a certain amount of interpretation to be undertaken without the analysis of the samples. (The example quoted seems to indicate modification of the deposits by marine action.)

(vi) The samples so far analysed show a consistently 'woodland' land snail fauna, dominated by Carychium tridentatum (Risso), Discus rotundatus (Müller), and Zonitidae. The intriguing question is whether this indicates a true woodland situation, or whether this might not be a reflection of (a) a shady and damp environment provided by the oyster valves; (b) the exploitation of residual food scraps by opportunistic carnivores; or (c) a combination of the above.

As already mentioned, these are only interim results. However, the huge research potential suggested by the number of these sites and their length of occupation (from 4,000-2,000 bc in the case of one of the two dated sites) makes them very important for future work. Not the least important aspect is the huge amount of botanical material in the middens, on which no work has yet been done because no funding has been provided. I would be most pleased to hear from anyone who might be interested in any such future research, or who has any information which might help with the problematic areas mentioned in this brief summary.

Acknowledgment

I would like to thank Dr Ken Thomas for suggesting that I write this brief report, and express my gratitude to Dr John Evans for his generous help with land snail identifications.

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Preliminary investigations into the causes of 'clumping' during standard pre-treatments using *Lycopodium* spore tablets in absolute pollen analysis

Elizabeth Francis and Valerie Hall *

The problem outlined in this paper was encountered during routine pre-treatment of samples for absolute pollen analysis (Faegri and Iversen 1975). Many of the commonly used methods for this type of analysis require the addition of exotic marker grains. A convenient method of adding these is by using *Lycopodium* spore tablets which are specifically produced for the purpose. These were originally produced by Stockmarr (Stockmarr 1971) but the business was taken over in 1980 by Prof. B. Berglund, University of Lund, Sweden.

Recently, a number of workers have experienced 'clumping' of their sediments during pre-treatments and although some laboratories appear to have overcome this problem, others have not. A literature search has not revealed any information on their techniques. The 'clumps' range in size from 50-500 µm and are composed of aggregations of organic material leaving no free pollen in the mounting medium and making identification of the pollen grains difficult and estimates for pollen analysis inaccurate.

When duplicate samples of algal gyttja, woody peats and *Sphagnum* peats were pre-treated for percentage and absolute pollen analysis, clumping occurred only in those pre-treated for absolute pollen analysis. These results indicate that clumping occurs irrespective of the sediment type. As the only other main difference was the presence or absence of *Lycopodium* spore tablets it seems likely that these are the main cause of clumping. This does not seem to have been a problem for workers using the original Stockmarr tablets.

Thomas Persson, University of Lund (pers. comm.) said that the original formulation had been changed due to altered manufacturing techniques and a list of the new chemicals used is provided on an information sheet supplied with the tablets. However, to carry out quantitative investigations, the proportions of the components was needed. An analysis by the Department of Chemistry, Queen's University Belfast, gave the following results:-

Average weight of tablet: 0.9g

83.0%	sodium bicarbonate
2.8%	polyethylene oxide

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9.9% polyvinylpyrrolidone
4.3% water + traces of Lycopodium spores

The molecular weights of the polymers were not determined

Preliminary investigations were performed on standard pre-treatments using the individual components at the concentrations stated. Under these conditions, clumping occurred only with the polyvinylpyrrolidone. We are aware that this is not an exhaustive investigation and that other effects e.g. interactions between the tablet components and the chemicals used during pre-treatments may occur, but we conclude that polyvinylpyrrolidone seems to be the main cause of clumping.

Workers should be made aware that the newly formulated tablets may be causing a problem not encountered when the original tablets were used.

In the Palaeoecology Centre, Queen's University, Belfast, we overcame the problem of clumping by adding 15ml of 10% HCL to 2-5 Lycopodium spore tablets and $1cm^3$ of sediment, followed by two water washes. We found that dissolving the tablets in water alone was inadequate. Once the clumps had formed, techniques such as fine sieving, water and acid washes which had been suggested by other workers did not solve the problem.

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How to do bones: a survey of opinions

Bruce Levitan *

Like all short, catchy titles, that of this paper is an over-statement. It should really be along the lines of: 'How some bone analysts think some of the major problems in bone analysis should be tackled: a survey of opinions held by a sample of 22 bone analysts'! This is not meant to be merely frivolous; the first part of the title refers to the subject of this paper, the second to the level of response. In April 1985 a one-day meeting was held at the Institute of Archaeology, London, to discuss major issues in archaeological bone analysis. Topics covered by the papers given ranged from collection and analysis of bones through to reports and curation. It became apparent that many problems are unresolved, and that opinions about their resolution differed. One result of the meeting was the suggestion that working parties be set up to consider these problems and, it was hoped, to give them a priority rating. To this end, a questionnaire appeared in Circaea 3(1), and this paper gives the results of that survey.

The results given below are discussed in isolation from the size of sample in order to avoid repetition concerning the latter. The discussion, therefore, must be preceded by a comment on the level and kind of resonse. The questionnaire was in two parts. The first part listed sixteen topics, the sixteenth being an open topic. It invited respondents to give each topic a priority rating. The second part of the questionnaire focussed on the topic of bone reports, since this had excited so much discussion at the April meeting. This called upon people to list those topics which should be considered in a bone report. A total of 22 people replied, but not every reply answered both questions; those who answered the first part totalled fourteen, and those who replied to the second numbered seventeen. These levels of response are very small and cannot be considered representative of bone analysts generally (more than 40 attended the April meeting, and the questionnaire must have reached an even larger number of bone analysts). These results, however, are all that is available and are a valuable survey of opinion.

A further problem with the results from the first part of the questionnaire is that most of the respondents chose to give priority ratings at only three levels, giving many topics with equal ratings. Where replies gave a greater number of ratings, these have been transformed into an equivalent of the former. For example, if ratings of 1-15 were given, 1-5 become 1, 6-10 become 2 and 11-15 become 3. Another problem is that some respondents chose not to give any rating at all to some topics. It was felt that rather than make assumptions about

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the intent, blank 'votes' were ignored in the summary of results (Table 5). Most topics received at least ten votes, and the greatest number (14) was for pathology.

The results in Table 5 have been given overall priority values on the following (arbitrary) basis:

1) first priority (***) - topics where more than 60% of replies gave a rating of 1;

2) second priority (**) - topics where 45-60% of replies gave a rating of 1;

3) third priority (*) - topics where less than 45% of replies gave a rating of 1.

Contents of the report and analysis of anatomical elements come out as equal first. In second place are measurements of the major domestic taxa, quantification of species and sex determination. The other topics fall into third place. Additionally, four other topics were suggested under the open topic; two of these, taphonomy and career structure/policy, received three first priority rating votes each. These results are not surprising since they reflect those topics which excited most discussion at the London meeting. The relative lack of interest in measurement and especially in ageing and archive might be interpreted as an indication that these topics are not considered important enough for working parties, but it may also reflect a lack of involvement with those issues. For example, few bone analysts have any involvement with the curation of the bones. Lack of involvement, however, is no excuse for lack of interest, and we should take care not to become blinkered by specialisation.

The results in Table 5 are extremely difficult to interpret since omission does not imply that a topic should <u>not</u> appear in a report. An example is the bibliography; very few respondents listed this as an item for inclusion, presumably because they assumed it would naturally be included. Indeed, some replies made it clear that they were listing the 'missing bits' to which more attention should be paid. In order to illustrate the point more fully, each response has been summarised individually in Table 6. What does emerge is a very full list of topics which should be considered; these have been divided into the sections given in Table 6. Some respondents made a distinction between topics of greater and lesser importance, and others made a division between topics which should appear in the report and those which should be on microfiche. Where such distinctions were made, they have been included in Table 6. The variety of opinion is well illustrated in the case of butchery.

Recalling the comments concerning the level of response, it is difficult to assess how far the results in Tables 5 and 6 can be taken in making decisions about further developments. The concern is there, however, and the next stage is to organise working parties to tackle the problems. The final part of this paper considers this aspect.

In order to work effectively, the number of participants in each working party should be kept fairly small - six is possibly an optimum. In order to ensure that the working parties reflect the general feelings on the subjects, one duty should be to canvass for opinion. It is

Table 5. Summary of priority ratings for topics to be discussed by working parties.

Rating	Measurements				Ageing			
	sh/gt	pig	cattle	other	sh/gt	pig	cattle	other
1	5	5	5	4	5	5	5	2
2	4	5	4	5	7	7	7	4
3	1	1	1	0	0	0	0	2
Sum	10	11	10	9	12	12	12	8
Priority	**	**	**	*	*	*	*	*

Quantification	Anatomy	Butchery	Pathology	Sex	Report	Archive	Job	Taphonomy	Rating
7	9	5	6	5	7	1	3	3	1
1	3	4	6	5	2	6	0	0	2
4	1	3	2	1	2	2	0	0	3
12	13	12	14	11	11	9	3	3	Sum
**	***	*	*	**	***	*	?	?	Priority

suggested that the working parties take one year to examine their topic, and that after the year a meeting should be held at which their results and conclusions are discussed. Ideally, summaries will have been pre-circulated to those wishing to attend the meeting. A short space of time should then be given for the working party to make any necessary modifications which arise from the meeting; after this a paper should be published (perhaps in Circaea). Such papers would then provide a kind of generally agreed standard for that topic, though this need not be an absolute standardisation which many would feel to be insidious. Each annual meeting could also decide on the topic for the next working party, and the personnel could be chosen. It is hoped that this would become a regular, annual occurrence which could even be made more frequent should the demand be great enough.

Topic	Respondent:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Summary
INTRODUCTION																			
Archaeological background		+	+	-	-	?	+	-	-	-	-	-	-	+	-	-	-	-	5+ 1?
Provenance		+	+	+	x	-	-	+	-	-	-	-	-	-	+	-	-	-	5+ 1x
Dating		+	+	+	-	+	-	+	-	-	+	-	+	-	+	-	-	-	8+
Recovery techniques		+	+	+	-	+	+	-	-	-	+	-	-	+	+	-	-	-	8+
Archive		+	+	+	-	-	+	-	-	-	+	-	-	-	-	-	-	-	5+
Laboratory methods		?	+	+	+	+	+	+	-	x	+	-	-	+	-	+	-	-	9+ 1x 1?
Reasons for analysis		+	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	3x
Taphonomy and fresh breaks		+	+	+	?	+	+	+	-	-	+	+	-	+	-	-	-	-	9+ 1?
ANALYSIS																			
Quantification		+	+	+	+	+	+	+	+	+	+	+	+	-	-	-	+	-	13+
Anatomical part analysis		+	+	+	+	+	+	+	+	+	-	+	+	-	-	+	-	-	11+
Ageing: teeth		+	+	+	+	+	-	+	+	+	+	+	-	-	-	-	-	-	10+
Ageing: epiphyses		?	+	+	+	+	-	+	?	+	-	+	-	-	-	-	-	-	7+ 2?
Spatial analysis		+	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	2+
Sex determination		+	-	-	+	-	-	-	+	-	+	-	+	-	-	-	+	-	5+
Butchery		?	?	?	+	-	+	?	?	-	-	?	-	-	-	-	-	-	3+ 6?
Fragmentation		+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1+
Worked bones		+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2+
Biometric study		+	+	+	+	+	-	+	+	+	-	+	+	-	-	-	-	+	11+
Pathology		+	+	+	+	x	+	+	+	+	-	+	-	-	-	-	-	-	9+ 1x
Non-metrical traits		+	+	+	+	x	+	-	+	+	-	-	-	-	-	-	-	-	9+ 1x
Tables of untransformed data		+	-	+	x	+	+	-	+	-	-	-	-	+	+	+	-	-	9+ 1x
DISCUSSION																			
Discussion		+	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	3+
Documentary evidence		?	-	+	+	-	+	-	-	-	-	-	-	-	-	-	-	-	3+ 1?
Comparison with other sites		?	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	1+ 1?
BIBLIOGRAPHY		+	+	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-	4+

Key: + - should be included; ? - brief summary/only where relevant; x - included in microfiche or archive only.

Table 6. Summary of voting pattern for preferred content of bone reports.

In order to start the ball rolling, the first working party will comprise Miranda Armour-Chelu, Andrew Jones, Mark Maltby, Barbara Noddle, Terry O'Connor and myself. We have not selected either of the first priority topics in Table 5 because it seemed logical to begin with a consideration of the most fundamental problem; taphonomy. The impact of damage and loss of bone has been shown in the work of Binford (1981), Sebastian Payne (paper given at the 1983 AEA symposium) and Andrew Jones (pers. comm.). We need to decide how to deal with this in looking at the bone sample: is the loss consistent? is it predictable? are different bones/species affected differently? etc. These are the kind of questions we hope to tackle. Anyone who feels they have something to offer on this subject should contact one of us as soon as possible.

The venue of the first meeting will be Bristol, to take place next Summer or Autumn; details will be published at a later date. It is hoped that this initiative will receive enough support to engender the programme of working parties outlined above. Please contribute, please attend the meetings - the effort will surely be worth it.

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Observations on the evidence for flax growth in Ireland provided by pollen analysis

D. E. Gennard *

Summary

Two random samples of the top 1 cm 3 of soil in the centre of a newly harvested flax field, together with samples of the flax stems and bolls (seed capsules), were subjected to pollen extraction techniques. The results indicate that only small numbers of flax pollen remain in the field to reveal growth of the crop.

Therefore the presence of even a single grain of Linum usitatissimum L . (flax) pollen, is sufficient to indicate the probable growth of the crop nearby. This strengthens, in respect of flax pollen, the tentative interpretation of presence usually placed upon single grains in relative pollen diagrams.

Introduction

In the 19th Century, flax and the production of linen were synonymous with the name of Ireland. The demise of the linen industry has reduced the frequency with which the crop is now grown. However, renewed interest, created by EEC grants, has led at least one farmer to plant trial fields of flax in order to compare its financial rewards, as a cash crop, with that obtained by sowing spring barley.

This provided an opportunity to test the idea that we can identify previous flax growth by using pollen analysis (Godwin 1975). In making these observations, no attempt was made to assess the pollen productivity of flax in the field or to determine the quantity of pollen released per plant. Rather an attempt was made to simulate the sort of sampling usual in palaeoecological analysis where, through limitations on time and facilities, the results of sampling at one point have to be accepted as representative of the area. As such, the results should be treated as observations rather than a statistical analysis of the impact of growing flax on the surrounding area.

Materials and methods

The flax field (Grid Ref. J502476) was situated on a hill on the outskirts of Newtownards, a former linen mill-town on the shores of

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Strangford Lough. The field was adjacent to three housing estates and the ruins of Movilla Abbey in the local cemetery. Within the cemetery are yew trees (Taxus baccata L.), and both exotic and indigenous garden plants and trees, including pine (Pinus sylvestris L.), grow in the surrounding gardens. Beyond the immediate conurbation there is open farmland in all directions. Hawthorn (Crataegus monogyna Jacq.) hedges surround both the flax field and the majority of fields in the locality.

Flax seed had been sown at the rate of 122.4 kg per hectare and the growing crop sprayed at the seedling stage to reduce the growth of weeds. In the two previous growing seasons the farmer had grown wheat preceded by barley in this field.

Two $1cm^3$ samples of soil were taken at random from the surface of the centre of the newly harvested field. In addition, ten flax bolls and five flax stems were removed just before the crop harvested. These were analysed to determine whether flax pollen was particularly abundant on plant parts which, through flax processing, could be expected in archaeological deposits. Both the soil samples and the flax plant parts were subjected to absolute pollen recovery techniques.

Results

The results of analysis of the flax bolls and stems are shown in Table 7 and the results of the soil pollen analysis in Table 8.

Flax pollen was present in very small quantity in the soil samples; there were only three flax pollen grains in a total of 1034 grains counted. The remaining pollen reflects open pasture land beyond the housing estates; Gramineae pollen comprises over 50% of the pollen rain. Pollen from the expected crop weeds such as Chenopodiaceae, Plantago lanceolata, Compositae, Urtica and members of the Umbelliferae were 'present' or contributed one or two percent to the sum. The presence of pollen of such water plants such as Potamogeton and Iris pseudacorus was not unexpected and these grains probably originated from plants around the small boggy pool slowly being infilled with yellow flag less than 700m ENE of the flax field.

Most of the rest of the pollen can be accounted for as representative of the garden plants found in the locality. This includes the 2.3% unidentified pollen which was thought to represent the more exotic garden plants not usually found as fossil pollen. The single grain of Carpinus might have originated from the Arboretum at Mount Stewart 4.75 km away. High levels of Alnus pollen (17.7%) must be considered to have been wind-borne from some away distance since no alder trees are present in the surrounding hedgerows or fields, nor are conditions, other than surrounding the boggy pool, suitably damp to enable a copse of alder to establish itself.

In addition to the pollen taxa, a small amount of charcoal (less than 0.5%) was noted in almost all the slides. The charcoal may have been wind-borne since the crop had not been fired to remove stubble for the last two seasons.

Part of flax plant	Number of grains/spores					
	Linum	Gramineae	Cyperaceae	Filicales	Ranunculus	Chenopodiaceae
Bolls	0	13	1	3	1	0
Stems	5	20	0	1	0	1

Table 7. Number of pollen grains and spores recorded adhering to the flax bolls and stems.

Conclusions

The recoverable pollen from the soil samples suggested flax produces little pollen. In part, this is because modern cultivated flax is self-fertilising and fertilisation occurs prior to the opening of the flower (J.S.Faulkner pers. comm.). In addition the plant retains a degree of entomophily. Little pollen is therefore available to be retained in the soil to provide evidence of former flax production.

Despite the apparent possibility of retention of pollen by the plant, little evidence remained adhered to either the stem or within the bolls of the flax plant. (The results indicated that only five Linum pollen grains were recovered from flax stems and none from the bolls.) The observations from this study suggest that there is little pollen disseminated by flax to provide evidence of former cultivation even if the site of archaeological investigation is also the site of former flax growth. Therefore recovery of even a single flax grain (provided it is not a possible contaminant) must be considered to indicate the probable previous growth of a flax crop nearby.

Acknowledgements

I wish to thank Mr S. Drysdale of Newtownards for allowing me to take samples from his land. The technical assistance of Mr P. McCann is gratefully acknowledged.

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Table 8. Results of the analysis of two soil samples from a flax field. All Gramineae larger than 40 um were classified as Cerealia type pollen. They made up 27.5% of total Gramineae. + - pollen present.

Species	Percentage total pollen excluding spores
Betula	1.1
Pinus	+
Quercus	+
Alnus	17.7
Corylus	7.2
Fraxinus	+
Carpinus	+
Taxus	0.4
Ilex	+
Gramineae	50.8
Cyperaceae	3.8
Chenopodiaceae	1.1
Linum usitatissimum	**0.3**
Plantago lanceolata	0.3
Plantago coronopus	0.3
Polygonum bistorta type	+
Compositae Tubuliflorae	2.1
Liguliflorae	1.6
Cruciferae	+
Urtica	0.2
Umbelliferae	0.6
Stachys	+
Viscum	+
Solanum nigrum	+
Hypericum perforatum	+
Ericaceae	0.8
Iris pseudacorus	+
Allium	0.6
Potamogeton	0.3
Pteridium	1.8
Filicales	13.7
Polypodium	0.6
Unidentified grains	2.3
Damaged and indeterminate grains	2.3
Broken grains	3.2
Crumpled grains	2.2

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Rapid scanning of urban archaeological deposits for insect remains

Harry Kenward, Craig Engleman,

Alan Robertson and Frances Large *

Abstract

Full analysis of archaeological samples for insect remains is very time-consuming, and impracticable for large groups of samples given current funding. Selection of small subsets from within such large groups does not present an acceptable solution, so a cheaper method of recording information from large numbers of samples is essential. The evolutionary history of methods for rapid processing and recording used in the Environmental Archaeological Unit (EAU) is outlined, and their usefulness discussed. The current methodology is summarised, with comments on efficiency of extraction and the amount of information of archaeological value obtained. Prospects for further development are considered briefly. Methodologies are summarised in Table 9.

Background: the problem

Until recently, most work on urban archaeological insect remains in Britain has employed small numbers of samples, typically no more than ten from a site. Although the standard of entomological work was high, there was no attempt made (or funding provided) to deal systematically with a wide range of material from a large archaeological site. All samples were processed using sieving and paraffin flotation methods essentially like those described by Kenward et al. (1980), and all the remains recovered were identified to the lowest practicable taxonomic level (Table 9).

In the early 1970s some urban sites began to be sampled extensively for insect remains, one of the earliest examples being Lloyd's Bank, 6-8 Pavement, York (Buckland et al. 1974; Hall et al. 1983). Around 60 samples were collected from this site, and an attempt was made to record insects from all of them at the level of accuracy then considered adequate. On the scale of work undertaken at that time, this was a very large project. Later sites produced much bigger groups of samples for biological analysis - in the case of several of the sites at York, hundreds, and at 16-22 Coppergate, over 3000. Full examination of all of these, or even just those where a clear archaeological question was presented, would have taken tens of man-years. On the basis of earlier

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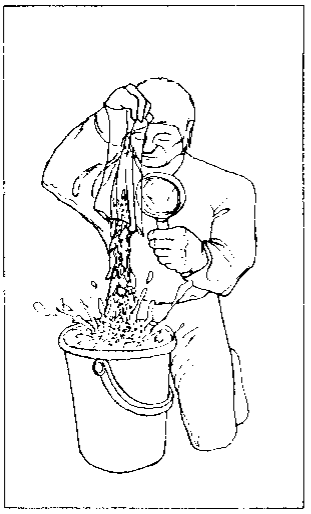
experience it was clear that even a limited programme of work on a selection of (possibly) representative samples would have involved many years of work.



A smaller-scale study of 'representative' samples chosen at random or by archaeological criteria would have been feasible, but certainly would not have been effective, since urban archaeological deposits like those at sites in York are extremely diverse. To use Coppergate as an example, there are many phases (from Roman to medieval), four parallel tenements, a long topographical succession from front to back of the site, and many different kinds of contexts. There is great variation within any category of deposit, so that many samples are needed to achieve any kind of representativity. Indeed, at this site even the full range of material collected is barely adequate to represent most context types, and there are still a few gaps!

This argument may be extended to urge even more intensive sampling, to cover the widest possible range of feature types and dates, and to avoid the frustration of discovering that contexts crucial to archaeological interpretation have been left unsampled. Selecting samples on site is difficult and often unsatisfactory, and the best solution is to collect extensively, from apparently promising and unpromising deposits alike, and to select before and during processing. This is surely more sensible than over economising during excavation, only to repent at leisure later.

Attempts at rationalisation:

'pilot samples'

In the late 1970s the volume of entomological work required of the EAU had grown to a point where it was essential to find some method of reducing the number of insect samples processed to completion, without excessive loss of information. The approach taken was to paraffin-float an initial 1 kg subsample from each sample, after rejection of any which were 'obviously useless' - for example those which the records suggested were unstratified or contaminated. After this subsample was floated and (usually) sorted, one of three courses of action would be taken: (a) the insects would be counted for interpretation, if apparently sufficient in number (a rare event); or (b) more 1 kg subsamples would be processed,

until enough insects were recorded for interpretation to be thought possible according to the criteria adopted at the time; or (c) the sample might be abandoned as giving too small an assemblage for useful work.

This approach was helpful in the case of modest groups of samples (50-100), but not entirely satisfactory. If properly sampled, many sites produce too many samples for a 1 kg subsample from each to be examined in detail. Time was lost in carrying out replicate processing when a single, larger, subsample could have provided enough material. The time spent processing the initial subsample in full was often effectively wasted, in that little information was obtained other than that the sample had only a low concentration of insects. (An advantage was that several replicates from a sample gave information about variation within contexts; at that time, intra-context variation was emerging as a serious consideration in urban archaeological work.)

This system was eventually formalised, with the first 1 kg subsample being regarded as the 'pilot' sample; subsequent processing was then undertaken of a further subsample of sufficient size to provide an insect assemblage large enough for detailed interpretation (using developments of methods described by Kenward 1978) when combined with the pilot sample (Table 9).

Concentration of insect remains, and even their species composition, may vary considerably, so that the first sample may not be representative, and the prediction of the amount of sample required may be quite wrong; this is complicated by the effect of calculating minimum number of individuals (MNI), for doubling sample size may only marginally increase MNI. This problem has yet to be overcome, but 3 kg has been the sample size typically found adequate for detailed study. One possible solution to

the problem of sample heterogeneity is to mix the material in the bag - at risk of damage to fossils. Information about variation will obviously be lost, but as it cannot be collected within the time constraints of most projects, this is hardly a consideration.

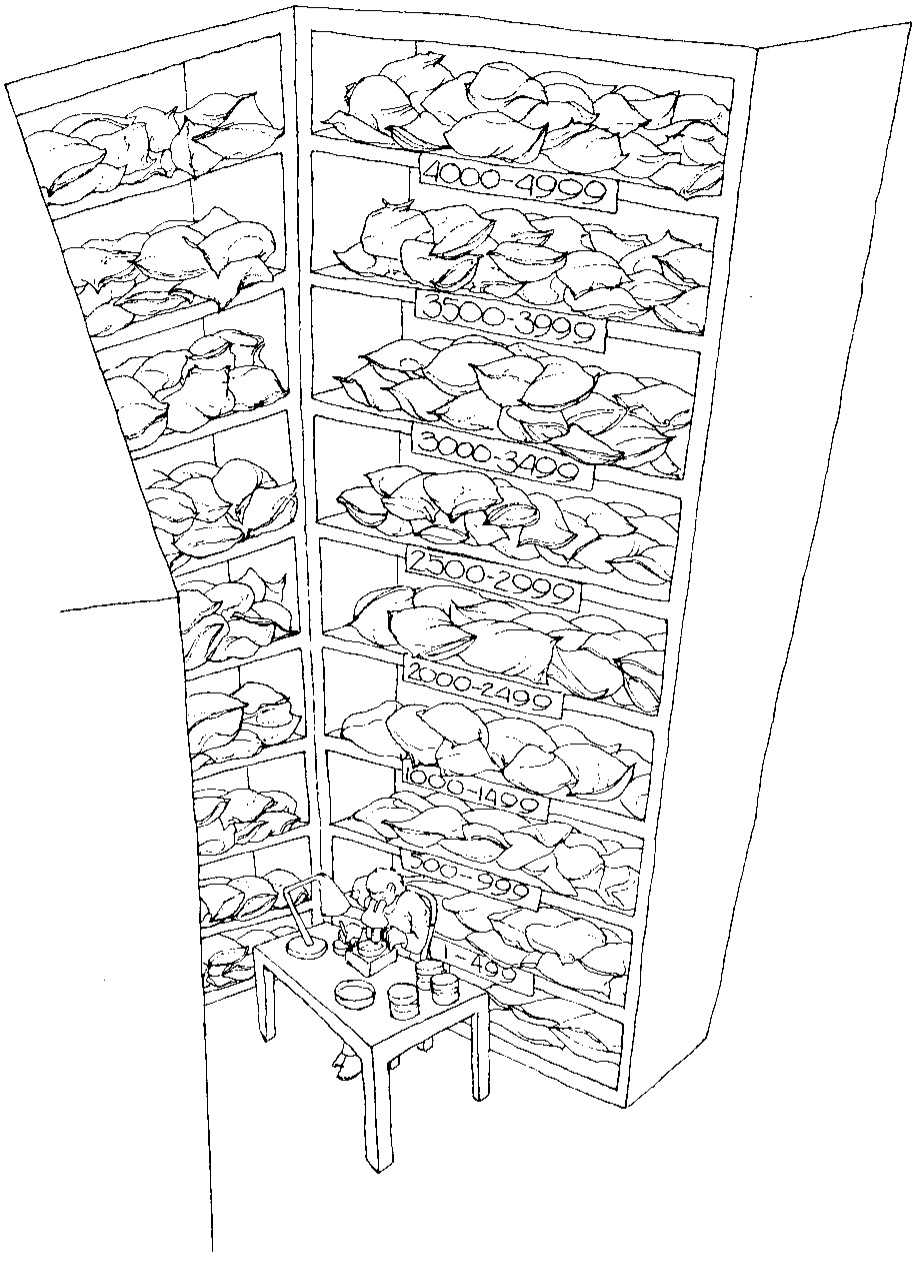
Crisis at Coppergate: 'test samples'

The 'pilot' system functioned well for sample groups of modest size (or for small groups from larger ones, e.g. Hall et al. 1980 and Kenward et al. forthcoming) and in an environment where cost-effectiveness was not always the primary consideration (i.e. under a regime based on 'research' rather than 'service'). The 16-22 Coppergate site produced a huge number of worthwhile samples (indeed, for reasons outlined above, almost all those collected deserved examination). However, the changing economic climate of the 1980s has meant that cost-reduction is always at the forefront in policy decisions. The pilot system simply could not cope with the scale of the Coppergate site within a realistic budget or time-scale. It was felt that the number of samples examined could not be more than marginally reduced without endangering the credibility of the project, since there was good reason to believe that a large proportion of the samples were needed to provide a usefully representative view of the insect assemblages from the site. An attempt was made to cut down numbers of samples more drastically for some context groups and the result was most unsatisfactory (indeed, demoralising); it was clear that too few samples could be examined for reliable archaeological conclusions to be drawn according to our criteria, and that no form of analysis above sample assemblage level could have any meaning. Drastic measures were clearly necessary.

The solution adopted grew out of the 'pilot' system. In order to examine as many samples as possible to allow rapid assessment, a simpler and swifter method was needed. It had long been realised that during the series of treatments involved in full paraffin flotation (Kenward et al. 1980) most insect fragments, or at least a reasonably representative sample, were usually recovered by the first treatment with paraffin. (However, full treatment as described by Kenward et al. is necessary to provide a basis for detailed counts.) This fact was exploited to develop the 'test' treatment, a modification of the standard treatment in which disaggregation is carried out rapidly, regardless of the danger of damaging fossils, and in which only one paraffin application and (typically) three 'floats' are applied. One kilogramme 'test' samples are used (Table 9).

In the early stages the only use to which the resultant flot was put was a rapid glance to provide a basis for an assessment of the general nature of the assemblage and further action required. The test survey of a group of samples (for example floors of a structure) would be followed by a small number of detailed analyses, perhaps less than one in ten. The result of the 'test' examination was included in archive reports as a series of subjective notes.

This system was very rapid and, in terms of its initial aims, successful. A large number of samples (over 20 per technician-week) could be processed by essentially unskilled workers. This afforded the opportunity to examine a large proportion of the sampled contexts, which in turn allowed for better-informed choice of those samples most likely to give crucial archaeological information. Samples which would have



been rejected before processing, on the basis of their lithology or purely by guesswork, could be included in the analysis, sometimes with surprising results. The examination of a larger number of samples also increased the probability of recording infrequent species of entomological or climatic importance.

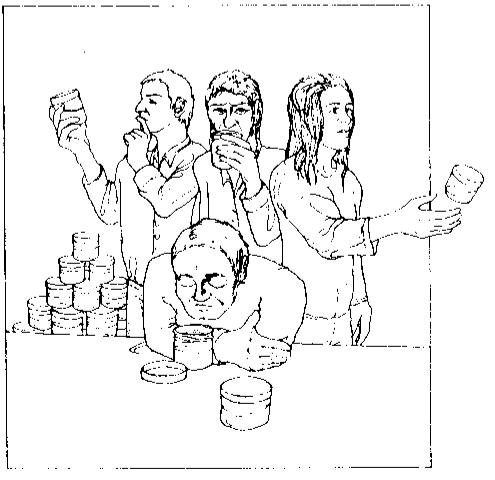
One practical problem which may be encountered in a confined working environment is confusion and cross-contamination within large batches of test samples processed simultaneously by several technicians. In addition, the logistical problems of finding, transporting, storing, recording, and subsampling up to 100 samples per week can be surprisingly thorny. These problems can be adequately overcome by meticulous planning and a systematic approach.

The adoption of this system did lead to the suggestion that the samples examined in detail were a biased 'sample of samples'. This is of course true if a strict random sample of contexts from the site is required, but the project aim is primarily to obtain information about specific archaeological contexts, and not a theoretical exercise which would have been statistically elegant but practically uninformative. In addition, under the previous system, so few samples would have been examined that the 'sample of samples' would have been quite inadequate and inevitably biased in other ways.

The next step: semi-quantitative 'scan' recording

The test system did adequately what it was designed to do, and revolutionised work on insect remains at the EAU. However, the members of the team quickly began to feel dissatisfied with the limited results obtained from the test samples, and felt that a greater amount of information could be retrieved within the same general framework. Therefore, working on the basis that recovery was at least reasonably representative, the insect remains in the test floats were recorded 'semi-quantitatively'. This was initially done (by HK) very subjectively, and extremely rapidly; many of the samples could be recorded in a few minutes. The flot was examined in small amounts in a 9 cm-diameter petri dish. The dish was scanned systematically and the abundance of the insects estimated on a semi-quantitative scale: 1, 2, 3, 'several' (about 4 to 9), 'many' (more than 10). At first, this information was used to provide a more reliable basis for a subjective approximate interpretation of the remains.

This initial method was rapidly developed further. When the rest of the team began to record the insects in test samples, their lack of entomological experience meant that the subjective recording used by HK was not at all satisfactory. At the same time, HK had decided to build a data-base of the 'scan' records, and often wished that recording had been more complete. These factors led to the realisation that there must be a 'middle way'.



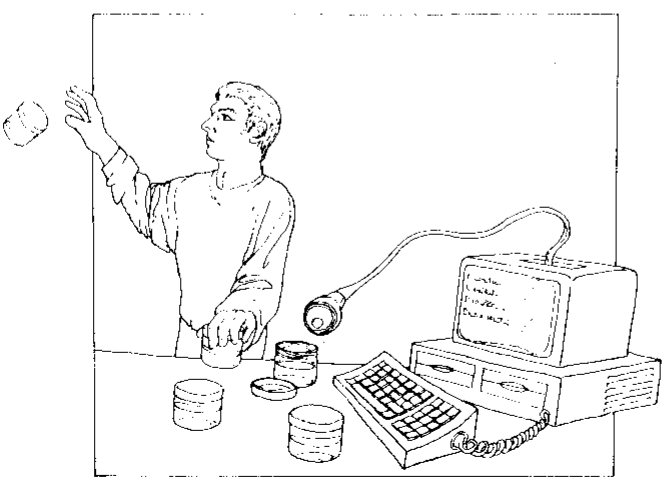
As a first step towards this we now record the sclerites(skeletal components) as they are scanned, so that a minimum number of individuals (MNI) can be

determined. This is generally done until three individuals (MNI) have been counted for any species, whereafter the estimate of 'several' or 'many' can be made subjectively. The precise methodology varies between team members, but not so as to bias results. Any specimens which appear to be of special interest are laid on damp filter paper, or even mounted on card slides in the usual manner either for more precise identification or to serve as vouchers. Doubtless with experience it will be found that very few specimens need be removed from alcohol for the level of identification considered appropriate for this scanning process.

Semi-quantitative ('scan', Table 9) recording takes considerably longer than the rough scanning initially conceived for test samples. It is, however, still very quick: with experience, usually a few minutes to about an hour per sample, depending on the nature of the material. It is obviously practicable to examine very large numbers of samples in this manner. The species lists are entered to computer storage in a highly abbreviated form and decoded and re-formatted for incorporation into a database on the University of York DEC-system 10 mainframe computer using PASCAL programs written by HK. Other programs allow output of main statistics for each test sample.

Current developments and future prospects

The recording technique currently employed seems quite satisfactory and it would generally take very little more time to count all of the remains (making identifications at the level used in rapid scanning), opening the prospect of using the data for fully quantitative analyses. If the level of identification remains high, as at present, it is practicable to scan hundreds of test samples from an urban site while remaining within reasonable project limits (overall time/sample for processing, recording, and data entry will usually average about half a day, and this can doubtless be improved on with experience). However, considerations of this kind only serve to emphasise the fact that recovery using test methodology may be incomplete. If time is to be spent recording scan samples in detail, we would like to be sure that recovery is complete and consistent. Doubts are caused by the great differences in concentration of fossils sometimes observed between test subsamples and subsequent fully processed ones. It is suspected that test recovery may very occasionally be poor; it certainly appears to be a little unpredictable.



Long experience of examining paraffin flots has shown that the proportion of fossils

Table 9.

System	Method	Quantification	Level of Identification	Practicable scale	Average time per sample	Proportion of samples analysed
Detailed analysis of whole of all samples	All, or most, of all samples analysed in detail (often 4 to 10 kg)	Fully quantitative	To lowest possible level	Tens of samples	About one week	All of a small group
'Pilot': initial form	1 kg initial subsamples of all samples processed fully; further 1 kg subsamples processed until enough remains available for analysis; abandoned if too few fossils	Fully quantitative or not recorded	To lowest practicable level or none	Tens of samples	About one week if rich; about half a day if abandoned	Most of a small group; only rich samples recorded
'Pilot': final form	1 kg initial subsamples of all or a selection of samples processed fully; abandoned if concentration low; some selection for most useful samples; sufficient material to give analysable assemblage processed in second subsample	Fully quantitative or not recorded	To lowest practicable level or none	Several tens of samples if large proportion abandoned	About one week if rich; about half a day if abandoned	A selection of a moderately large group; only rich samples recorded
'Test'	1 kg initial subsamples crudely processed from all or most samples; rapid examination of flot; selection analysed in detail, usually from 3 kg subsamples	Detail: fully quantitative. Test: short subjective description	Detail: to lowest practicable level. Test: only abundant taxa and general character noted	Hundreds of samples	Detail: about one week. Test: about 2 hours	All can be examined; selection recorded in detail
'Scan'	1 kg initial subsamples crudely processed from all or most samples; all recorded; selection analysed in detail, usually from 3 kg subsamples	Scans: semi-quantitative. Detail: fully quantitative	Scans: no lower than needed for broad ecological information. Detail: to lowest practicable level	Hundreds of samples	Scans: 2 to 4 hours. Detail: about one week	All can be examined and recorded semi-quantitatively; some recorded in detail

recovered in the first paraffining varies, and occasionally a large proportion are only recovered in subsequent paraffin stages (we do not yet fully understand this phenomenon, though the volume of residue left after initial sieving to 300 microns (Kenward et al. 1980) is certainly one factor). If recovery in test processing can be made complete, or at least consistent at a high percentage (over 95%), the choice of recording method can be deferred until after flotation. Recording could be (a) a rough semi-quantitative scan, (b) a quantitative scan at a low level of identification, or (c) a detailed record, as complete and accurate as possible, with assessment of 'types' for detailed statistics and requiring mounting of critical material and a much greater expenditure of time.

If test recovery and scan recording can be made reasonably complete and accurate, this could become the standard technique, allowing an enormous increase in the number of samples and sites examined. It provides a valuable database, suitable for many kinds of analysis and for context assessment, providing useful archaeological information cheaply. Detailed analyses remain essential for investigation of particular problems and to provide precisely described 'standard' assemblages for comparison during analysis of the scan database. In this way we obtain vastly more information and a way of linking semi-quantitative scans into a more objective scheme. It is practicable to study large sample groups fully, and small ones hardly cause a ripple in the system. In future, scans could be carried out as digging proceeded, with processing supervised by a site-based environmental technician, the results being of value in determining the priorities for further excavation and sampling.

Currently, the team's thoughts are focussed on ways of increasing confidence in the extraction techniques. There are three aspects: (a) homogenising bagfulls of sample before subsampling; (b) draining out water more completely before paraffining; and (c) mixing paraffin more completely with the sample material before floating. The next priority is to explore ways of making recovery complete without spending too much time on it. A 'paraffining machine' looks good on paper, but can we make it work?

Acknowledgements

The authors are grateful to the many people who have worked on the insect remains in the EAU, including Pat Veilleux, Marion Berry, Lesley Morgan, Jo Higson, Linda Scott, Anne Sutherland, Andrew Ruddock, and especially Simon Pearsall. In addition, the authors would like to thank Terry O'Connor and Allan Hall for their helpful comments on an early draft of this paper. Alan Robertson gratified his co-authors by illuminating the text. The EAU is primarily supported by the Historic Buildings and Monuments Commission for England (both directly and through project funding), and by the Manpower Services Commission.

Table 9 (opposite). Summary of approaches to sampling and recording insect remains from urban archaeological deposits used in the EAU, 1975-85.

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Surface pollen studies of Calluna vulgaris (L.) Hull and their relevance to the interpretation of bog and moorland pollen diagrams

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Introduction

Pollen diagrams derived from raised bog peats, blanket peats and moorland humus layers often show elevated levels of Ericales (sensu lato) or Calluna vulgaris pollen in their upper layers (e.g. Wiltshire and Moore 1983), and these are normally interpreted as indicative of the spread of heather with the nutrient depletion of soils, clearance of woodland, moor burning or grazing of the area in question. The actual levels of Calluna recorded are variable from site to site and may display a considerable variation within a given pollen profile (e.g. Moore, Merryfield and Price 1984). Such Calluna pollen is normally interpreted as being of very local origin, mainly on the basis of the plant's being largely insect-pollinated: its tubular flowers are visited not only by bees and wasps but also by long-beaked flies, such as Rhingia (Proctor and Yeo 1973) and various Lepidoptera and thrips (Hagerup 1950). On the other hand, pollen grains of Calluna are occasionally recorded in surface samples and pollen traps far from any heather plants, as in the samples of Hyde (1950) in Cardiff and at a variety of sites (overall 0.46% of pollen in eight city sites) and those of Evans and Moore at Butser Hill on the South Downs of Sussex (unpublished data). This long-distance transport may indicate a contribution of wind pollination to the reproductive strategy of Calluna, but the generally low pollen productivity of the plant (about 2,000 tetrads per anther, compared with 30,000 in the anemophilous Rumex acetosa L., according to Erdtman 1969) suggests that entomophily is the normal mode of pollen transfer.

An increasing interest in the origin of blanket mires and moorlands and the details of vegetation development and short-term land use changes on such sites has stimulated an awareness of our need for more information concerning the representation of Calluna pollen under different heather canopies. Surface pollen studies on heathland and moorland sites (such as those of Tinsley and Smith 1974) have concentrated upon tree pollen rather than that of the dwarf shrubs and have not provided sufficient information about Calluna density or cover to permit the interpretation of variations in Calluna pollen proportions. This study aims to provide such information by

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investigating Calluna pollen dispersal at an appropriately small scale. It is designed to provide the type of information for Calluna that the studies of Andersen (1970) and Bradshaw (1981) have achieved for many tree species.

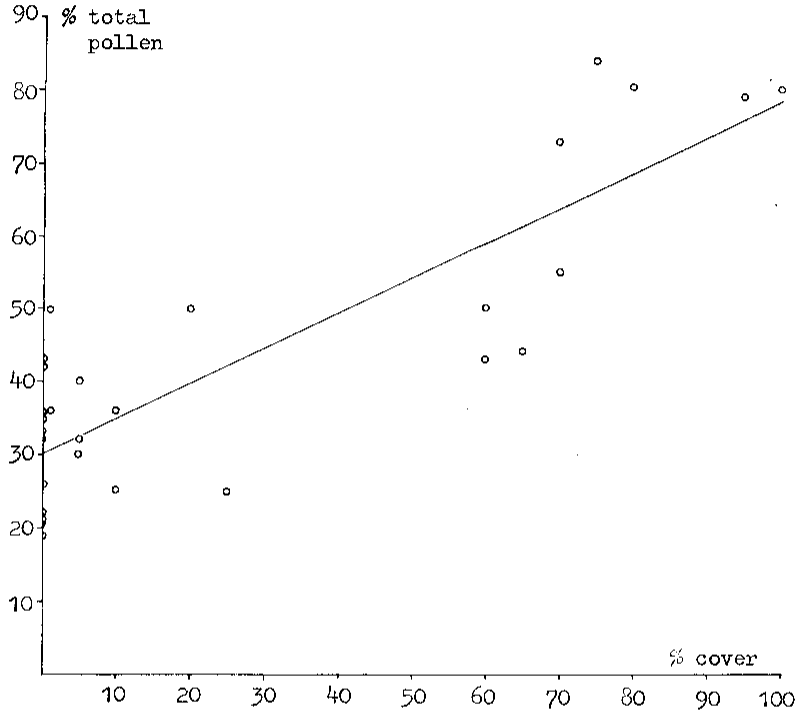

Fig. 77. Relationships between Calluna pollen in a surface sample (% total pollen) and the percentage cover of Calluna within 1 m radius.

Methods

Field sampling was carried out at a site near Shirlaw Pike in Northumberland, about 10 km from Alnwick. The area is grazed by sheep and consists of rough grass/heather moorland, forming a mosaic of dwarf shrubs (Calluna vulgaris, Empetrum nigrum L.) with grass patches (Molinia caerulea (L.) Moench, Nardus stricta L., Festuca ovina L. Agrostis canina L.) containing such herbs as Galium saxatile L. and Potentilla erecta (L.) Räusch. A 60 m transect was established down a shallow slope and was selected to cover patches of Calluna and grass. Samples of surface bryophytes and litter were collected at 2 m intervals. A circle, 1 m in radius, was measured around each sample point and percentage cover estimates were made subjectively of the major species.

The choice of a 1 m radius circle was determined by the limitations of percentage cover estimations. A circle with a diameter of greater than 2 m presents considerable difficulties when trying to determine the cover of dwarf shrub and herbaceous species.

Samples were returned to the laboratory in polythene bags and were acetolysed and mounted in glycerol jelly. At least 400 pollen grains were counted in each sample, including at least 100 Ericales tetrads. This latter precaution was undertaken to ensure an adequate differentiation between Calluna and Empetrum tetrads.

Pollen values are expressed on a percentage total pollen basis. In fact, Calluna and Gramineae were the major components of the pollen rain, with the arboreal pollen forming a fairly constant background, never exceeding 10% of the total.

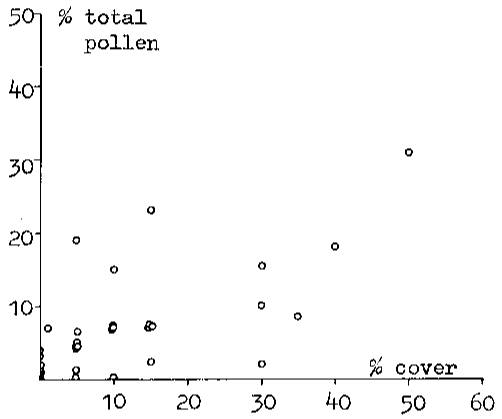

Fig. 78. Relationships between Empetrum pollen and the percentage cover of Empetrum in the vegetation.

Results

Fig. 77 shows the relationship between Calluna pollen (% total pollen) and the surface cover of Calluna within 1 m radius. A linear regression line has been computed for the data (with acknowledgements to S. Moseley) in which

$$y = a + bx$$

where **a** = 30.2 and **b** = 0.48.

A variety of curvilinear regressions provided only marginal improvements in the goodness of fit. In general, linear models are preferred for this type of study (see Prentice 1982), though a variety of approaches has been tried. Webb et al. (1981) have reviewed the subject of estimating plant abundances from pollen percentages. Their work, and indeed most published material on the subject, is concerned with trees and with much larger areal samples (20 - 30 m radius). We believe that a smaller sample size is appropriate for dwarf shrubs, though the general principles relating pollen percentages to abundance

values still apply.

The high value for the constant **a** (the intercept of the line with the y axis) is a consequence of the general abundance of Calluna in the area. Bushes were invariably present within a few metres of the sample site even when no Calluna was found in the 1 m radius circular plot.

Results for Empetrum show no clear relationship (Fig. 78), but the general level of pollen deposition is lower than that of Calluna at equivalent canopy cover. The Gramineae pollen was related to general grass cover in a linear fashion (Fig. 79), but the slope of the curve and the overall pollen output are lower than in the case of Calluna: **a** = 13.2 and **b** = 0.24.

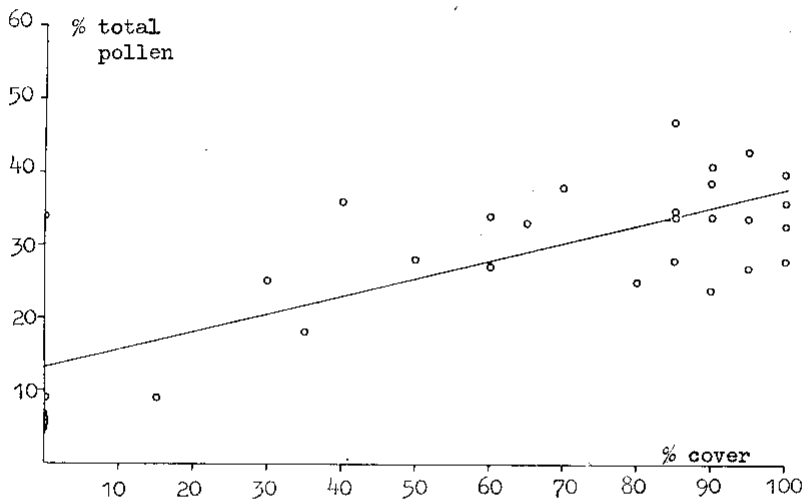

Fig. 79. Relationship between Gramineae pollen and the percentage cover of combined Gramineae species in the surface vegetation.

Discussion

The relative representation of the three pollen types considered here is somewhat surprising. Calluna vulgaris is considered to be generally insect-pollinated but with a facility for wind pollination available as a backup (Proctor and Yeo 1973), yet its local pollen representation in surface samples exceeds that of the grasses which are totally wind dependent. Empetrum is also reckoned to be wind-pollinated (Clapham, Tutin and Warburg 1962) yet its pollen representation is low and apparently unrelated to local Empetrum canopy.

The evidence presented could be taken to indicate a higher degree of reliance on wind pollination by Calluna than might be expected, which

could be due to the tendency described by Hagerup (1951) for Calluna pollination to become increasingly dependent on wind in locations where insect vectors are scarce. It is also possible that grazing pressures may have reduced flowering on the part of the grasses, which would inflate the proportion of Calluna in the pollen assemblage.

The good relationship between Calluna pollen proportions and canopy cover, however, should encourage palaeoecologists working on peat profiles in which Calluna growth is local in nature, to interpret more closely the changing proportions of Calluna with depth. It should be possible to separate short-term changes in patchy Calluna growth from longer term or more general trends in Calluna abundance. It then becomes necessary to interpret such trends in terms of hydrological or land-use changes.

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