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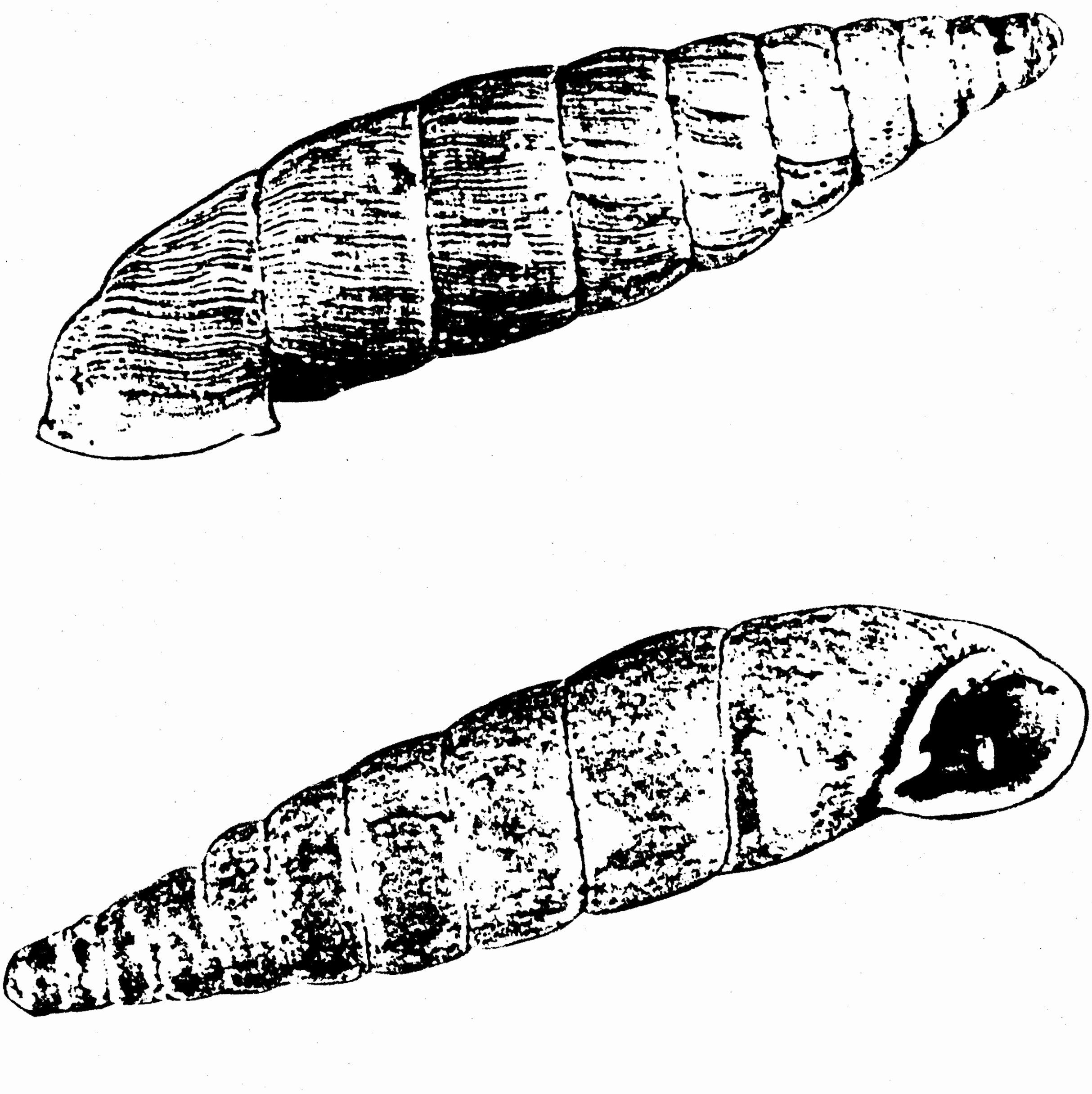
Circaea



Association for Environmental Archaeology

Circaea

Circaea is the Journal (formerly Bulletin) of the Association for Environmental Archaeology (AEA) 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, to whom copy should be sent (c/o Department of Geography, University of Bristol, Bristol BS8 1SS).

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—for example, papers which consider in detail methodological problems such as the identification of difficult bioarchaeological remains.

Circaea is edited and assembled by Allan Hall and Harry Kenward at the University of York, England. It is distributed free to members of the AEA and available to institutions and non-members at £9.00 per annum. Back-numbers: vols. **1** and **2** and vol. **3**(1)—£2 per part; vol. **3**(2) onwards—£3 per part.

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Front cover: Archaeological specimens of the snail Clausilia bidentata *(Ström), favoured by shady conditions and of fairly frequent occurrence in archaeological assemblages. Photograph supplied by Terry O'Connor.*

Editorial

This and the next issue of *Circaea* are being published together, in an attempt to 'catch up'. As always, we apologise to authors who have had a long wait to see their articles in print; we trust that a steady flow of copy will mean that we can produce **9**(2) before too long.

Book Reviews

Milles, A., Williams, D. and Gardner, N. (editors) (1989). The Beginnings of Agriculture. *British Archaeological Reports, International Series* **496**. *Symposia of the Association for Environmental Archaeology* **8**. 267 pp. ISBN 0 86054 636 5. £17.00.

This volume forms the proceedings of the annual conference of the Association for Environmental Archaeology held in Cardiff in September 1987. Out of the original papers a reduced number were submitted for publication; as a result the volume has a decidedly European flavour, no bad thing given the Near Eastern focus of most volumes on early agriculture. What is presented falls into three main groups: theoretical considerations concerning the adoption and spread of agriculture, reviews of the practical considerations of inferring agricultural strategies from assemblages of organic remains, and case studies synthesising the available environmental evidence (inevitably based on bones and plant remains) in terms of the economic strategies adopted on a site or regional basis.

The first three papers, grouped under the title 'theoretical approaches to the beginning, spread and organisation of agriculture' proved to be fairly tough going for someone not thoroughly versed on previous approaches to the beginnings of agriculture. Ken Thomas's paper on hierarchical approaches to the evolution of complex agricultural systems certainly didn't mix with the late night cocoa, introducing terms like 'holon', 'cybernetic theory' and 'agro-ecosystems' into a discussion on the applications of systems to the elucidation of economic strategies. Although thought-provoking, it would have been useful to see a little more reference to practical applications of these complex theories to excavated material, although Thomas himself admits (p. 67) 'in practice it will prove to be very difficult to demonstrate the existence of process-functional hierarchies using archaeological data'. Some of the diagrams (e.g. figure 4) did nothing to aid this reader's understanding of the concepts involved.

Royston Clarke's paper on the integration of social and ecological approaches to early agriculture and Paul Halstead's application of a primarily ecological approach combined with a sociological model were more easily digested. Clarke concentrates on the development of risk-management strategies and consequent development of social organisation through the Mesolithic and Neolithic, using a number of bone assemblages from Italian sites. He argues that the diverse environment in northern Italy encouraged the continuation of hunting within the subsistence system during the Neolithic, as a risk-minimising strategy against the chances of agricultural failure. At the same time, populations in more uniform environments, where a subsistence strategy based on hunting and gathering was less reliable and so higher risk, adopted agriculture earlier and more exclusively. Consequently, more complex social structures evolved in these ecologically homogeneous areas, invoked by the need to develop strategies to buffer against the risk of crop or livestock failure.

Halstead examines the development of agriculture in south-east and central Europe, looking at settlement distributions and environmental evidence to suggest the strategies adopted for subsistence on a short-term (annual) and long-term basis. On the annual scale, his approach mainly derives from a study of the archaeologically recovered remains teamed with environmental determinism. On the inter-annual scale risk-buffering mechanisms are stressed, and settlement patterns seen as a consequence of the need (or lack of need) for co-operation on a local or regional scale, depending on the scale of risks involved. In a diverse environment, it is argued, risks are usually local, so risk-buffering involves local co-operation and village settlement. In more uniform environments risks are more regional (e.g. drought) so longer distance contacts are required to reduce the risks of starvation. These contributions go some considerable way towards the integration of environmental archaeology with archaeological theory;

perhaps future sessions of the Theoretical Archaeology Group will take note.

Of more specialist interest, Caroline Grigson reviews the criteria for, and problems of, differentiating domestic from wild animals. She reviews previously published studies of early domestication of cattle from the Middle and Near East, and concludes that standards of recording and publication have been insufficient to enable a comprehensive study of the origins of domestication. Barbara Noddle concentrates on the domestication of cattle and sheep in northern Europe and Britain. The mind boggles at the concepts of frustrated male aurochs being driven into bogs, and at the population of aurochs being so large that they were 'forced to graze in dangerous situations'. Both of these papers provide extremely useful sources of information (in the latter case some of it previously unpublished) for the study of the development of cattle and both contain extensive bibliographies.

On the plant side, Kevin Edwards gives a thorough review of the methodological problems with reconstructing early agricultural practices from pollen records, and suggests some ways in which things might be improved. Standards of recording (to enable verification of identifications) are again stressed as requiring improvement, and other evidence of agricultural practices, for example by the study of weed floras, charcoal and soil micromorphology, should be sought. Hansjörg Küster summarises the pollen evidence for the Neolithic in south central Europe, largely recognising the problems outlined by Edwards; perhaps the most useful aspect of his article is the extensive bibliography, including many non-British references. Frank Chambers examines the evidence for the early exploitation of rye in north-west Europe, stressing its value as a crop on poor soils in marginal areas, its problems as a free-threshing cereal and a carrier of ergot, its versatility, and literary tradition which suggests it was largely considered a weed. Records of rye from archaeological sites indicate that it was present in pre-Roman times, but whether as a weed or a crop is unclear. The utilisation of wild foods in Neolithic Britain is discussed by Lisa Moffet, Mark Robinson and Vanessa Straker. In contrast to central Europe, wild foods such as nuts and berries seem to have played an important role in Britain during the Neolithic, and charred cereal remains are poorly represented. Whether this is a true reflection of the later adoption of cereal cultivation on a large scale in Britain, as the authors suggest, or a product of retrieval methods or site type, as Legge suggests in an earlier chapter, remains to be tested.

David Robinson and Peter Rasmussen's detailed report on the primarily botanical research undertaken on waterlogged deposits from a Neolithic lake village at Weier, north-west Switzerland, demonstrates what can be achieved by a co-ordinated environmental and archaeological approach which incorporates a sensible sampling strategy. Apart from the obvious importance of a site which produced the earliest western European record of repeatedly cultivated and manured arable fields, the study is exceptional in the rigour with which the deposits were analysed. The material discussed in this paper includes hillwash from fields as well as samples taken from a building interpreted as a byre. Approaches discussed include experimental investigations into the extent to which cattle, sheep and goats digest different sorts of fodder, as well as the more traditional methods of analysing plant macrofossils. The results indicate that a wide range of plants were utilised to provide leaf fodder, which must have been used to overwinter animals.

The most contentious paper presented at the conference was apparently that by Roy Entwistle and Annie Grant, who dared to challenge the existing views on the importance of cereal cultivation and animal husbandry in the British Neolithic and Bronze Age. Their approach is one of confrontation: based on the lack of an extensive database, they argue, we should not close our minds to alternative ways of viewing early economies. They conclude that there is no good evidence to support the interpretation of a cereal-based Neolithic economy, or for dairy-based cattle husbandry. This view is extensively debated and rejected by Legge, in his reply to their paper which is substantially longer than the original contribution. Clearly the former authors have achieved their aim if it was to stimulate debate.

Legge's paper, like many of the others provides an extremely comprehensive bibliography. Indeed, apart from some excellent papers, this volume is worth consulting for the references alone. Although many papers which appeared in the conference were unfortunately not published

(Susan Limbrey's paper on soils has been an example cited of a useful, but as-yet unpublished contribution) the volume has still maintained a balanced approach to the wide topic of early agriculture. It should be relevant to archaeologists of all persuasions, not just so-called environmentalists. On a more technical level, the standard of presentation is unusually professional for a BAR volume; even the illustrations are legible and the photographs understandable. Clearly a great deal of editorial time has been devoted, and the result means that, in contrast to many recent BARs, the volume is, in this reviewer's opinion at least, worth its price.

Reviewer: **Becky Nicholson**
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Conference Report

British Academy—Royal Society Discussion Meeting on *New Developments in Archaeological Science*, at the Royal Society, London, 13th–14th February 1991

This conference was the seventh in a series of joint meetings with the British Academy on archaeological science held at the Royal Society since 1969. A wide variety of techniques was surveyed, with the exclusion of dating which was covered by posters. Dating will also be discussed in the next joint symposium, on *The origin of modern* Homo sapiens *and the impact of science-based dating* in February 1992. Despite heavy snowfalls, over 200 people attended, and the combination of good time control and a professional projectionist ensured refreshingly smooth running. There was a surprising lack of younger speakers, and of representatives from centres such as London, Sheffield, and Southampton.

Some talks focused on the impact of new analytical methods (e.g. in biochemistry) and others on new interpretations that can now be made as substantial bodies of data become available (e.g. in dendrochronology). Most speakers resisted the temptation to become bogged down in methodological detail, and concentrated on illustrating results. New techniques of presentation are also starting to reach the archaeological world, with many clear, specially-prepared multi-colour graphics in use. The days of the fuzzy, grey graph (or worse, large tables of data in tiny print) may be numbered.

The symposium began with an excellent demonstration by Dr Mike Baillie (Belfast) of how to present elegant ideas elegantly. He likened the long (7000 years+) tree-ring chronologies from Belfast and Germany that are now in routine use for dating to a 'tree-ring kit without a set of instructions', and then drew on a wide range of historical, archaeological and palynological data to try and discover just what ring patterns and overall patterns of bog-oak growth and death might mean in terms of environmental change. The studies of the Neolithic 'colonisation' of Britain—distinct changes seem to be happening at about 4000 bc—and on the effects of volcanic eruptions are very exciting, as is the concept of looking at prehistoric change over periods of a few calendar years rather than in hundreds of radiocarbon years.

Continuing the theme of *Prehistoric human environments*, Professor B. Berglund (Lund, Sweden) described a ten-year project, with 25 staff in six university departments, studying all aspects of the landscape of southern Sweden over the last 6000 years. As we admired the resulting sequence of detailed land-use maps and reconstruction drawings, it became obvious that this is the kind of approach that we should all the taking. While the generous support of the Swedish National Bank certainly helped this project, the reasons for its success (and the failure of so many other 'interdisciplinary' projects) must also relate to efficient organisation and the location of all the team members in one small city.

Dr M.-A. Courty (CNRS, France) ended the morning with a convincing demonstration of how soil thin-sections can tell us about the formation of archaeological deposits. Judging by a gorgeous colour section of a coprolite filled with grass-phytoliths, there is even more potential in this work if allied with analysis of bulk samples.

After lunch the theme was artefact studies, with three talks on characterising metal and stone, where the novelty lay less in the techniques used than in their careful application to archaeological questions. Dr N. H. Gale (Oxford) presented a close look at Bronze Age trade in the Aegean, where the sources of metal objects have been determined using mass spectrometry analysis of isotope ratios. A key element in his work has been detailed sampling of ores in the field. Dr Paul Craddock (British Museum) described an interdisciplinary approach to early mining and smelting in Europe, stressing the importance of experimental and ethnographic work. This detailed and diverse approach allowed a strong argument for independent innovation of techniques throughout Europe. This is, of course, in sharp contrast to the long-established concept of transfer of metallurgy technology from the Near East to Europe. A similarly wide-ranging approach to an old idea was taken by Dr O. Williams-Thorpe (Open University) to the origin of the Stonehenge bluestones. The heroic transport on rafts of these stones from Wales to the Salisbury plain has been a tenet of British archaeology for so long that, as the lengthy discussion afterwards made clear, the well-buttressed argument that these stones are just glacial erratics will take some time to sink in.

There were two technical talks in this session, with Professor M. S. Tite (Oxford) on the role of the scanning electron microscope in studying the microstructure of ceramics, and Clive Orton (Institute of Archaeology, London) on the statistics of counting potsherds.

On Thursday morning we returned to bioarchaeology, with Dr R. P. Evershed (Liverpool) on the use of gas chromatography to separate the components of organic residues on potsherds, and mass spectrometry to identify the molecules involved. Although this kind of work has been going on for some years, previously results have been limited to a handful of potsherds per site. The Liverpool project, as well as looking in detail at important aspects of biochemistry such as post-deposition degradation, is looking at large numbers of early medieval potsherds. Professor Martin Jones (Cambridge) then surveyed the wide range of techniques now used in looking at human diet and exploitation of vegetation. Instead of looking at just a few components in great detail, it is becoming possible to integrate these sources of information, to look at food-webs as whole systems.

Two lectures made up the session on site survey techniques. Dr I. Shennan (Durham) took the broader perspective of remote-sensing of landscapes. Multi-spectral waveband scanners on the French 'Spot' satellite and on aeroplane surveys are picking up very subtle changes in vegetation and, therefore, in underlying features. The raw data are often available cheaply, and the computers that allow them to be handled easily now cost £5000 or so, compared with sums of twenty times that amount five years ago. As Dr Shennan's work in the East Anglian fens shows, this is technology that is now 'up and running'. Mr A. Aspinall (Bradford) looked at geophysical techniques better suited to relatively small areas such as archaeological sites. Techniques such as radar are giving very pretty vertical sections, but a great deal more fieldwork is needed to decide what these actually mean stratigraphically.

The final session concerned the analysis of bits of human body. Professor N. J. van der Merwe (Harvard) described some very nice case studies using carbon isotopes to investigate early primate diet in Africa, and the spread of maize in North America. In regions where C4 plants grow or are grown, this is clearly a useful technique, but the potential of isotopes of other elements, which might be of use in other areas, is still unclear. Dr P. E. Hare (Carnegie Institution) discussed the use of amino acids from ancient bone in dating and diet studies. To end the conference papers, Dr R. E. M. Hedges (Oxford) looked at the very new field of studying ancient DNA. Efforts at present concentrate on extracting sufficient material for sequencing; any assessment of this work as applied to archaeology will have to wait on these.

In his closing remarks Professor Colin Renfrew (Cambridge) made a couple of important points that attracted disappointingly little discussion from the floor. He drew attention to the closer integration between scientists and archaeologists, and contrasted the major developments in archaeological science over the last 30 years with the almost total lack of change in excavation techniques over the same time period. The talks at this conference certainly made clear that working in teams has led to genuine integration on specific projects. All the projects described featured a clear statement of archaeological aims deriving from close collaboration with excavators. While it is true that a lot of new work is driven by the availability of new technology, this is not in itself a bad thing. If a new, more powerful technique is applied, there is a good chance it will turn up something previously unsuspected, with attendant important implications for

Helbinterpretation. A major theme of this conference was the astonishingly good preservation of organic materials from the past, for example of DNA in charred seeds or lipids in potsherd walls.

A point which was not raised is the risk that the current readiness to support the development of new techniques may divert funds from applying existing techniques to archaeological endeavours. To achieve the type of excellent synthesis presented by Prof. Berglund, dedicated and often tedious analysis of basic data is essential. One can also compare the paucity of large-scale seed and bone reports from British excavations to the excellent work coming from other European countries.

The contrast between the high quality of work going on in the laboratory and the usually casual nature of excavations is dismaying, and this seems to be a major weak point in overall strategies. It's also dismaying that techniques developed twenty or more years ago, such as flotation and radiocarbon dating, are still not fully exploited. This has little to do with money, but involves questions of organisation and communications that fell outside the scope of this highly stimulating conference.

Reviewers: **Mark Nesbitt and Delwen Samuel**
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Short contributions

Percival and Helbæk's archive of plant remains

Fellow archaeobotanists may be interested to know of an archive of plant remains held in the herbarium at Reading University. Most of it originates from excavations of the 1920s and 1930s from sites all over the world, including many of the classic British sites published in Helbæk's *Early Crops in Southern England* (1953, Proceedings of the Prehistoric Society 18, 194–233) such as Meare, Fifield Bavant, Hembury, Itford Hill and Maiden Castle. The plant macrofossils were sent to Professor John Percival at Reading for identification, and amended identifications were added by Helbæk in November 1957. There is also a collection of Helbæk's own material which comes mainly from Scandinavia and southern England.

The full list of the carbonised and desiccated plant remains held at Reading (copied from Percival's notebook) is given below. Visits to the herbarium to examine the material should be arranged through Dr Stephen Jury, Plant Science Laboratories, University of Reading, Whiteknights, Reading, RG6 2AS (telephone 0734 875123).

Wendy J. Carruthers
Room 532, Fortress House, 23 Savile Row, London W1X 1AB

Ancient Cereals

A list of desiccated and carbonised archaeological plant remains held at the Reading University herbarium, Plant Science Laboratories, Whiteknights, Reading, as recorded in Professor J. Percival's notebook. Amended identifications marked as * were added by H. Helbæk in November 1957. The 'P' numbers have been added more recently to assist in locating the material. [ ] notes are added by WJC.

EGYPT

P18	Emmer 28/2900 Badarian, Mostagadda, M. Egypt. From Guy Brunton, 1928.
P19	Barley 2800, ditto.
P14	Emmer?? Predynastic Al Badari, M. Egypt. From Guy Brunton, 1924.
P17	Emmer chaff & spikelets Predynastic Mostagadda, M.Egypt. From Guy Brunton, 1928.
P16	Emmer chaff & spikelets No.1215 Badarian, Mostagadda, M. Egypt. From Guy Brunton, 1928.
P15	Possibly emmer with dorsal hump and broad apex. Badarian, Mostagadda, M. Egypt. From Guy Brunton, 1927 (winter).
P112	Wheat from Fayum in various gravels. From Miss Catn-Thompson 1925–6.
P113	Wheat grains from K pits 33 & 44, Fayum. From Miss Catn-Thompson, 1926. See Times April 6 & August 11 1926.
P115	Emmer & a little barley Fayum, pit K. 13. Miss Catn-Thompson, 1925–6.
P117	Straw & barley grains chiefly pit 14, Fayum. Miss Catn-Thompson, 1925–6.
P114	Barley grains from pits 33 & 44, Fayum. Miss Catn-Thompson, 1926. See Times April 6 & August 11, 1926.
P111	Barley in various gravels, Fayum. Miss Catn-Thompson, 1925–6.

P116 Barley with a little emmer Pit 34, Fayum. Miss Catn-Thompson, 1925–6.

P118 Straw lining the storage pits, Fayum. Miss Catn-Thompson, 1926.

P8 Emmer grains from underground gallery Magazine, N side of Step Pyramid, Sakkara. (Cairo Museum).

P10 Emmer spikelets from store room of large tomb of the 3rd Dynasty, just inside enclosure wall of the Step Pyramid at Sakkara (also a little barley) [remains missing from box].

P13 Neolithic wheat 2400–2000 BC. Oudoun on No. XVII, M. D. Puydt.

P6 Emmer, *T. dicoccum* (thrashed) Middle Empire 1800–2000BC. From Aboukir, nr. Sakkara.

P12 Emmer grains from Quinah in 1888. Probably 18th Dynasty.

P9 Emmer taken from box in Egyptian tomb of XVIIIth Dynasty. Sir E. Wallis Budge (British Museum).

P11 Emmer spikelets with grain from the tomb of Tutankhamun. Howard Carter sent to Kew for identification & sent to me by Dr Boodle (Jodrell Lab, Kew) [box missing].

INDIA

P45 I Wheat (*T. sphaerococcum*?) From Mohenjo-Dara, India. L area. 1923–7.

P46 II Wheat ditto, SD area. 1927–8.

P47 III Barley (*Hordeum vulgare*) H.R. 1616.
* Six-row hulled barley, probably *H.tetrastichum*. H.H.

TURKEY

P70, P71, P72
Barley grains from Mersin in Cilicia, Turkey. March 1947. From Prof V. G. Childe. 'In Neolithic layers well into the 4th millenium, probably earlier than the Mesopotamium Tell Half Stage', all *H. distichum var. nudum*.

MESOPOTAMIA

P21 Wheat grains? a form of emmer found in a vase in an old Sumerian house 'Jemdet Nasar', Mesopotamia. 17m NE of Kish. 3500BC. Prof. S. Langdon.
* *T. dicoccum* H.H.

P22 Emmer grain from grain room T.T.5 Tal Arpachiyah, nr. Nineveh, Iraq. M. E. L. Mallowen, 1933. (British Museum excavation).
* *T. dicoccum*, one grain *T. monococcum* L = 5.49, B = 2.38, T = 2.56mm. Some 15 grains of hulled barley transferred to P23. H.H.

P23 Barley from grain room T.T.5 Tal Arpachiyah nr. Nineveh. M. E. L. Mallowen, 1933.

P20 Barley chiefly from T.T. well at Tal Arpachiyah nr. Nineveh. M. E. L. Mallowen, 1933.
* A dozen unspecified hulled barley grains, one *T. dicoccum*, one *T.*__ (?) badly puffed. H.H.

N. SYRIA

P89 Barley, 2-rowed No.1 7. Site H.H. *c.*1500BC. B.M. excavations, 1939, T. Brak, N. Syria. M. E. L. Mallowen.

P86 Barley No. 18. Mefesh. An ancient prehistoric site in the Balitsh Valley, Central Syria. Found in a burnt house settlement. Date before 3500BC. B.M. excavation, 1939. M. E. L. Mallowen.

[All of the following] British Museum excavations at T. Brak, N. Syria by M. E. L. Mallowen, all 1939 except no. 14 [P85]

P81 No. 1 Barley J.N.P. 2400BC??

P77 2 Barley, ditto.
* 1 seed *Prosopis Stephaniana*, hulled barley, a few *T. dicoccum*. H.H.

P73 3 Barley & a few wheat (*T. dicoccum*) grains J.N.P. 2400BC??
* 2-row hulled barley, 6 grains of *T. dicoccum*. H.H.

P80 4 Barley & a few wheat grains J.N.P. 2400BC??

P76 5, ditto, 2500BC accurately dated by a Sargonid Tablet.
* 1 frag. grain of *Avena* sp., 7 grains *Aegilops* sp. var., a dozen hulled barley, a dozen *T. dicoccum*. H.H.

P74 6 Barley & a few wheat grains Naram Sin's Palace, Room 13, Subjected to fire action, 2400BC.
* 2/3 hulled barley, 1/3 *T. dicoccum*, (2 grains *T. compactum*?), 1 seed *Lathyrus sativus* H.H.

P79 7 Barley & 5 or 6 wheat grains Court 2. J.N.P. 2400BC.
* Hulled barley, *T. dicoccum*, 1 seed *Lens esculenta*. H.H.

P78 9 Barley Naram Sin's Palace , Room 10.

P75 10 Barley Grain from shaft no. 2. J.N.P. In the filling. Date probably but not certainly 3000–200BC.

P75 [duplicate] *Hordeum vulgare* 3000–3200BC. Barley from excavations in Syria. B. M. Mallory 1936.

P83 11 Barley & 5 wheat grains J.N.P. No. 11 above shaft no. 1, *c.*3000BC. Scorched by fire.

P82 12 Barley & 3 or 4 wheat grains F.S. A.2(?) *c.*2400BC.

P84 13 Barley No. 13 F.S. Level A.2.

P85 14 Barley '1937 dig' CRH. Probably 2400–2900BC.

P88 15 Barley & a few wheat grains Site E.R. *c.*2400BC (some emmer).

P87 16 Barley scorched by fire. H.H. Mix *c.*1350–1500BC.

PALESTINE

P24 Wheat grains Gezer granary *c.*1000BC. From Prof. Macalister, Dublin 1920.
* *T. compactum*, one grain *T. dicoccum*. H.H.

P110 Barley & wheat Jericho excavations. Late Bronze Age *c.*1450BC?

SWITZERLAND

P35 Wheat from Robenhausen. From Dr Heer (Kew).

P37 Wheat, ditto.

P38 Wheat Swiss Lake Dwelling.

P39 *T. vulgare antiquorum* Robenhausen.

P36 Wheat Robenhausen Lake Dwelling.

BRITISH ISLES
DEVON

P34 Wheat Neolithic from Hembury Fort. Pit 15 CXI 1932. Miss Liddell.

P33 Wheat Neolithic. Hembury. CXE Pit Q, 1932. From Miss Liddell.

P32 Wheat Neolithic. Hembury, 1932. Cutting XE, Pit 16. Miss Liddell.

SOMERSET

P43 Barley Meare Lake Village. From Taunton Museum. St John Grey.

P95 Wheat I, ditto.

P96 Wheat II, ditto

P44 *Avena brevis* Meare Lake Village. 'some *Bromus secalinus* caryopses'
* *Bromus secalinus* or *mollis*, 2 *T. dicoccum*, no *Avena*! H.H.

P40 *V. faba celtica* Meare Lake Village.

P41 Barley & beans Worlebury Hill, Weston-super-Mare. Iron Age, La Tène II & III. 'Evidently carbonised by fire action'.

P42 Wheat Little Solisbury, Bath.

DORSET

P67, P68, P107 Barley grains from Winklebury, associated with British Pottery from bottom of pit 3. From General Pitt-Rivers.

P106 Wheat grains (chaff) with small celtic bean (*V. faba*) from Marnhull. Iron Age with Black Belgian ware. From M. C. E. Bean. March 2, 1937.

P98 Wheat & barley Romano-British village, Woodcote, Dorset. Pit 4. Gen. Pitt-Rivers.

P104 Wheat I, 2-grained spikelets. Iwerne. General Pitt-Rivers.

P105 Wheat II Evidently subjected to fire. Iwerne. General Pitt-Rivers.

P99, 100 Wheat Corfe Mullen, from Miss L. Blamey, November 27 1928. Wheat A from 2-grained spikelets.

P102 Wheat Maiden Castle, pit 83 (84). MSL. From Dr Wheeler, November 1936.

P101 Wheat Maiden Castle, pit 75 p11, MSL. From Dr Wheeler, 1936.

P103 Wheat & 7 grains of barley Iron Age. Maiden Castle. Pit 30, grain sample 2. Dr Wheeler.

P69 Bread Maiden Castle. From Dr Wheeler, 1934.

OXFORDSHIRE

P66 Wheat from Charlbury, D.S.E. Quadrant 4, 1.3.39. Iron Age A site. The grains are similar to those from pit 75, Maiden Castle, sent by Dr Wheeler but have been carbonised by fire action. Sent by Miss Margaret Whitley, May 8 1940.

GLOUCESTERSHIRE

P3 Wheat (*T. vulgare*) Iron Age camp, Bredon Hill, Gloucester. E.60, Floor III, Post Hole 1.Q.1937. In association with infant burial in the post hole. Miss Thelma C. Hencken.

BEDFORDSHIRE

P4 Barley (2-rowed), 1 wheat grain & *Bromus secalinus* caryopses Tottenhoe Castle, Bedford. Curator Luton Museum.

P2 Wheat Early Iron Age. 5th-2nd century BC. Tottenhoe Castle, Bedford. C. F. Hawkes. January 25 1937.

?P2 *T. vulgare* Early Iron Age wheat from Tottenhoe, 500-200BC, C. F. Hawkes, January 1937.

NORTHAMPTONSHIRE

P1 Wheat Danes Camp, Hunsbury. Pre-Roman 'late celtic' *c.*50BC–50AD. T. G. George (from Kew to me). The grains have been subjected to fire action.

LANCASHIRE

P25 Barley Ribchester.

KENT

P27 Wheat from a pit at Little Chart, Kent. Roman tile above the pit so Roman or earlier. 24.6.1934. Mr Cole, Maidstone Museum.

P30 Wheat Richborough Castrum 1887. From Maidstone Museum.

BERKSHIRE

P26 Wheat (*T. vulgare*) from small vessel in gravel pit at Theale, nr. Reading. *c.*1896. Reading Museum. Late Bronze Age or Early Iron Age.

BUCKINGHAMSHIRE

P97 Wheat Romano-British, AD50–350. Hambledon Valley, Bucks. *Archaeologia* 1921.

MIDDLESEX

P29 Barley from foundation of a Roman building, Threadneedle Street, London 1841.

?P29 *Hordeum vulgare* Charred barley from Roman pavement under French Protestant Church, Threadneedle Street.

P28 Wheat St Dione's Back church (London). 16 foot below Lime Street under site of S aisle of the ancient church (now gone).

YORKSHIRE

P31 Wheat Roman excavation at Malton, Yorks. T. Sheppard.

GLAMORGAN

P108 Wheat & *Bromus secalinus* Middle Bronze Age barrow (*c.*1400BC) from Bridgend. August 1937. Sir Cyril Fox.

JERSEY

P109 Small celtic bean, barley & 1 or 2 wheat grains from Le Pinacle, Jersey. Chalcolithic or very late Neolithic period. Prof. J. Burdo.

IRELAND

P5 Wheat Bronze Age cairn, Baltinglass, County Wicklow. 1935. Dr O'Connor, Nat. Hist. Museum Dublin.

HERTFORDSHIRE

P65 Wheat from burnt debris on floor of cellar. Park Street Roman villa, nr. St Albans. October 1943–March 1944, *c.*367AD.

SCOTLAND

P62 Barley from Cublin Sands, Morayshire. Dr Callender, Edinburgh Museum.

P58 Wheat & barley, ditto.

P59 ditto (barley ?naked)
* Emmer, *T. dicoccum*, naked barley, hulled barley. H.H.

P63 Oats Maudslie Law, Lanark. FR 218, Edinburgh Museum.

P60 Wheat Nr. Roman wall at Castlecary. From John Mirk, Renfrew (Paisley Museum).

P64 Chiefly barley & wheat Forts on Laws Hills, Monifieth, Angus. GN.48, Edinburgh Museum.

P61 Wheat & barley from Roman Fort at Lyne. Edinburgh Museum.

P57 Barley Forts on Laws Hills, Monifieth, Angus. GN 49, Edinburgh Museum.

P56 Barley chiefly Roman Fort, Birrens, Dumfries. Edinburgh Museum.

P55 Barley & wheat Roman Fort nr. Falkirk. F.R. 217. Edinburgh Museum.

P54 Wheat & barley From Roman Station [?] nr. Forth, Clyde Canal. F.R. 215, Edinburgh Museum.

P53 Roman wheat F.R. 216 Edinburgh Museum.

P52 Barley & wheat Roman Fort at Castlecary. FZ 132, Edinburgh Museum.

P48 Barley, ditto, FZ 1331, Dr Callender.

P51 Barley & wheat, ditto, FZ B4, Edinburgh Museum.

P50 Wheat & barley, ditto, FZ 135.

P49 Wheat & barley, ditto, FZ 136.

P92 One wheat grain from the broch of Burrian, North Ronaldshay, Shetland. GB 317, Edinburgh Museum.

P91 Barley from the broch of Burrian, North Ronaldshay, Shetland. GB 318, Edinburgh Museum.

P94 Wheat, chess or *Bromus secalinus*. Rye-like brome grass, common cereal crop weed. From Nybster Broch, Caithness. GA 686, Edinburgh Museum.

P93 Barley From the Broch of Lingrow, Scapa, Orkney. GE 28, Edinburgh Museum.

P90 Barley From the Road Broch, Keins, Caithness. Edinburgh Museum.

[Also present—H numbers, presumably Helbæk's collection]

H1 Saggarah, Egypt: Steppyramid. Ichetti tomb, 6th Dynasty. Excavated J. P. Laver, 1950. *H. tetrastichum, Lolium temulentum* (one grain). 1958, not published, *c.*2350BC.

?H1 *Hordeum tetrastichum* from tomb of Queen Icheti, Egypt *c.*2350BC.

H3 Nimrud, Iraq, exc. M. E. L. Mallowan. 1953, date 7th C BC, Assyrian. *Lens esculenta*, 1958, not published.

H4 As above, *Panicum mileaceum* 1958 not published.

H5 Nimrud, Iraq, exc. M. E. L. Mallowan 1955, date: Hellenistic. *Hordeum distich. nutans* (with v. stray *H. tetrast.* grains in between) 1958 not published.

H6 Lachish, Palestine exc. Olga Tuffnell, 1932–38, date 900–600BC. *Olea europaea* publ: Helbæk 1958 p. 309. O. Tuffnell 1958. Lachish IV. London.

H7 Lobsiegersee, Swit. Exc. H. G. Bandi, by assist., date E. Cortaillot, Neol. *Pisum arvense* s.l. 1958 not publ.

H8? Vallhagar Gotland Sweden, exc. M. Steenberger 1947–48, date C4th AD, Spikelet forks *T. spelta* & *dicoccum*, publ. Helbæk 1955 'The Botany of the V IA Fi. in Vallhagar, Stockholm'.

H9 Melsted Bornholm Denmark, exc. C. J. Becker 1951. Mesolithic (Boreal)
Corylus avellana pub. C. J. Becker 1951. Maglemosekultur paa Bornholm Aarbøger, Copenhagen.

H10 Dalshøj Bornholm Denmark, exc. Ole Klindt-Jensen 1950, date C1st AD, *Hordeum tetrastichum*, mainly *T. dicoccum*, *Avena fatua*. Pub. Helbaek 1957, 'Bornholm Plant Economy' etc.

H11 Sandegaard, Bornholm, Denmk. Exc. C. J. Becker 1950. 2nd mill.BC (EBA), *Pyrus malus* Helbæk 1952 *Acta Arch*. Copenhagen, p. 107ff 'Preserved Apples and Panicum'.

H12 [As above] *Pyrus malus*.

H13 Solbjerg. Mors Denmk., exc. G. Hatt 1928, date C3rd–1st BC, EIA. *Hordeum tetrastichum* naked & hulled, pub. (wrong ident.) K. Jessen 1929 in G. Hatt 1929 Aarbøger Copenhagen (Solbjerg & Fredsø).

H14 Østbirk, Jutland, Denmk., exc. accidentally 1952, date 1000–500BC LBA. Mixed *Triticum* (*monococcum, dicoccum, spelta, compact.*) Pub. Helbæk 1952, *Acta Arch.* **98**.

H15 Birkennes, Jutland Denmk., exc. Th. Tomsen 1919–11. 1000–500BC LBA. Mixed *Triticum* (*dicoccum, mono., spelta, comp.*), pub. Helbæk *Acta Arch.* **98**.

H16 Birkenaes, Jutland Denmk., exc. Th. Tomsen 1910–11, 1000–500BC LBA. *Hordeum tetrastichum* hulled & naked, not published.

H17 Østerbølle Jutland Denmk., exc. Gudmund Hatt 1937, C1st AD. *Camelina sativa* etc (*Linum*) pub. Helbæk 1938 *Aarb. f. Nord. Oldkyndighed*, Copenhagen.

H18 [as above] *Linum usitatissimum*.

H19 Itford Hill, Sussex, exc. Holleyman & Burstow 1949, 1000–750BC. *Hordeum tet. H. hex*. Pub. Helbæk 1952 & 1957 'Early Crops..' *PPS*

H20 Verulamium, St Albans, England. Exc. Mortimer Wheeler & M. Alwyn Cotton 1949. Roman. Mix of *Secale cereale, T. spelta* & *T. compact.*, pub. Helbæk 1952 *PPS*. 1953 Report on Cereals in Cotton & Wheeler, 'Verulamium' 1949. *St Albans Archit. & Arch. Soc. Trans.*

H21 Meare, Somerset. Exc.: ask Reading Museum! EIA. *Vicia faba* var. *minor*. Percival 1934. 'Wheat in Great Britain'. Helbæk 1953 'Early Crops..'

H22 Oxbøl Jutland Denmk. Exc. G. Hatt 1937, C6th AD. Hulled *Hordeum tetrastichum*. Site & grain publ. Hatt & Helbæk, *Acta Arch.* 1959 Copenhagen.

H23 Fjand Jutland. Village C1st AD, exc. G. Hatt 1938–40. Hulled *Hordeum tetrastichum*, grain not published. 1958. Site: G. Hatt, Nørre Fjand *Arkaeol. Kunsth. Skr. Dan. Vid. Selsk.* **2** no.2 (1957).

H24 [as above] *Avena sativa*.

H25 [as above] *Chenopodium album*.

H26 Fifield Bavant, Wiltshire. *Hordeum tetrastichum* hulled grain published, Helbæk 1952 *PPS* **18**.

H33 Helbæk, mostly spelt, M.C. P12 21–23 II. [Maiden Castle]

H39 Maiden Castle. Pit 21–23, *Hordeum tet.* hulled, publ. Helbæk 1952 p. 17.

H51 Maiden Castle, pit 21–23, *Triticum dicoccum* & *spelta, Inst. Arch. Lond. Publ.* Helbæk 2.9.36. Clay earth.

H57 [as above] Mixed, over marsh.

H58 Helb. *Triticum dicoccum* & *spelta* Malton.

H63 Helb. *Triticum dicoccum*? & *spelta* L. Solisbury.

H68 *T. dicoccum* Castle Cary.

H70 *H. tetrast.* hulled, Castle Cary.

H86 *H.* cf. *tetrast.* Birrlus.

[Miscellaneous boxes lacking numbers or other information]

P7 Emmer spikelets 1937.
- Ancient Egyptian bread from Thebes, Renoniz [?] Museum.
- Robinhausen bread.
- Neolithic grain Pit. Hembury, 1932.
- Barley & wheat, Cublin Sands.
- Charred wheat & beans, Marnhull, Dorset.
- *T. vulgare*, Primitive bread wheat, Marnhull, Dorset, 1st C AD.
- Florets from round barrow above Ditchling village (Sussex) not far from Ditchling Beacon Ex. 1963. Gordon Hillman.
- Wild pea, 1962, *Pisum elatius*, Kücük Köy (Turkey).
- Dorset, Maiden Castle Pit 21–23, *T. dicoccum* & *T. spelta*. Inst. Arch. Lond. Pub. H. Helbæk 2.9.1937.
- *V. faba*, Meare Lake Village, Glastonbury. George Gray, January 1927.
- *Atriplex patula* (*?A.hastata*) Iron Age site at Beckford, Worcs. Janet Roberts.
- Oats *Avena brevis* or *A. strigosa*. Among wheat from Corfe Mullen, Dorset.
- *Bromus secalinus* in wheat from Little Solisbury, Bath.
- ditto, Broch, Caithness, 39.
- ditto, Tottenhoe Castle, 22.
- Darnel, *Lolium temulentum*—impurity in emmer sample from store room of tomb of 3rd Dynasty, Nr. Step Pyramid, Sakkara.
- *Vicia faba* var. *minor* Carb. beans Meare L.V. Pit 319—grain from ashy deposit in E side of pit. From batch

sent to B.M.(N.H.) Bot. Dept. for ID by Bulleid G.C.H.
- Pot with included grain, EIA, Øster Leu, Jutland, Dk. G. Hatt 1936.

[un-numbered tubes]
Old Kilpatrick
Glenluce
Forth & Clyde
Fifield Bavant
Castle Cary
Salisbury
Birrlus—*Cenococcum gramiforme*
Barhapple Rock etc.

[un-numbered petri-dish displays]
Falmer, Sussex
Fifield Bavant
Great Weldon, Northants
Itford Hill, Sussex
Lamb Lea, East Dean, Sussex
Wickbourne, Sussex
Lullingstone, Kent
Woodcuts, Dorset
Verulamium, Herts
Great Casterton, Rutland
Rotherly, Wilts
Glastonbury Lake Village, Somerset
Meare Lake Village

What shall we call these organic pit fills?
(A stercoraceous miscellany)

I have been engaged in a gentle match of wits with one of the editors of *Circaea* during the last few years over a subject dear to the hearts of many of us who work on urban archaeological sites—namely what (in a respectable scientific journal) to call pit fills which, on the basis of their suite of food remains and intestinal parasite eggs, clearly contain human fæces. It is a subject clothed very modestly in swathes of euphemism and I hope that unravelling some of them here will not offend the reader.

The way in which I shall tackle the problem is to go back through the shifting sands of linguistic evolution and look at the history of some of the words which were or are used in this context, and to consider some others which *might* be. Words to be used in a scientific context such as environmental archaeology should be precise, clear and easily understood (or easily looked up in a dictionary) by non-native speakers of English. I hope I can provide some suitable terms. Etymology is a tricky area for a botanist to tread, and I have been glad of the help of Dr C. C. Dyer of Birmingham University, as well as that of the Editors of *Circaea* and an anonymous referee. I cheerfully admit that any gross blunders will probably be mine.

I have used two main sources of information: *The Oxford English Dictionary* (1978 edition) and *The Middle English Dictionary* (Kurath and Kuhn 1954–), hereafter abbreviated to *OED* and *MED*. The written record prior to the fourteenth century is sparse and most of this medieval documentary evidence is about financial transactions or litigation, so that references to such a personal subject as defecation are naturally somewhat rare, and citations in the *MED* are therefore especially useful.

The story starts with *privy*, which is one of the terms still understood today in its original medieval sense as a private (place) and, by extension, as a place where various bodily functions could be carried out in private. Most of the other words for this are as indirect as modern ones: one such is *easement*, used by Chaucer in *The Reeve's Tale*, among others. An example of its use dated 1513 instructs: '... and se the house of *hesement* be swete and clene' (*OED*). The word was still used in its more general sense (the process of giving relief), too.

Latrine (and the more modern *lavatory*) derives from Latin *lavatrina*, itself from *lavare*, to wash. In its Latin form it was very commonly used in the fourteenth and fifteenth centuries in official documents, and this probably led to its adoption by the English language. The English word *latrine* is recorded only from 1642 (*OED*). With such a pedigree, it seems a not entirely unsuitable word to use in the context with which we are dealing; it is one of many examples of euphemism in which words meaning 'a washing place' are used to describe a place of defecation and/or urination.

Another old word in regular use was *garderobe*. Its use, to signify a privy within a house, is almost exclusively a sense adopted by historians, for example Ernest Sabine (1934), who used the term extensively, but always italicised. Garderobe really means a place for storing clothes (from French *garder* and *robes*), and is still used in this sense in modern French and German (and in modern English *wardrobe*). I caused confusion to one of my continental colleagues by using the term innocently (along with most of the other words of the title, as it turned out) in the article *Garderobes, Sewers, Cesspits and Latrines* (Greig 1982). A search of the *MED* has failed to produce any clear quotations suggesting that garderobes were anything other than clothes stores, and the stercoraceous meaning is probably a nineteenth century euphemism (C. C. Dyer, pers. comm.). Garderobe, then, seems a bad word for us to use for a medieval privy.

The material deposited into privies and easements often went directly into flowing water which would carry it away (as in medieval London—see Sabine 1934), but in towns the shortage of space often made other means of disposal necessary—in pits, for instance—and the preservation of the contexts of some of these has provided archaeobotanists and archaeozoologists with excellent study material. It is also an area of linguistic difficulty which I shall attempt to clarify a little.

The basic process of waste disposal was simple, as shown by a statement from 1387: 'þey wolde make hem a pitte ... whan Þey wold schite, and whanne Þey hadde i-schete Þey would fill Þe pitte agen'. Such pits are commonly called *cesspits* or *cesspools* in archaeological reports. The origin of this term is obscure according to the *OED*. Some have suggested derivation from French *souspirouelle*, as in the context: 'avoir nettoyé toutes les groise et ordures ... et nettoyé le souspirouelle', translating as 'having cleaned all the filth and ordure ... and cleaning the cesspool' (from accounts of works from May 1412, Godefroy 1892). The word seems to appear in the 1583 quotation 'Cesperalle to be made for stopping the filth by the brooke' (*OED*). The original bone of contention which I raised with my York colleague was that the dictionaries do not have the word *cess* for the contents of a cesspit in the way that *cess* had been used in archaeobiological reports. This is made clear if the origin of the word is as given above, and has nothing to do with pits. I therefore considered the word *cess* to be incorrect in this context. I still do. Now I find that *cesspit*, which I had been using myself, is somewhat suspect as a good medieval term, although perhaps this and *cesspool* are permissible, since both are so widely understood (though their derivation remains obscure).

The contents of these pits has been described in medieval documents by the Latin word *putredines*, literally 'rotting matter', which Sabine (1934) has translated as 'filth'. The word 'ordure' seems more commonplace according to my limited searches. It has come from Old French, derived in turn from Latin *horridus*, meaning 'that which makes the hair stand on end'. I have seen a sign in a town in France forbidding the deposition of 'ordure' and assumed it just meant 'rubbish' in French, but the dictionary tells me that it still retains its medieval sense, as illustrated by a quotation from the Wycliff Bible of 1388: 'The Lord smyte the part of the bodi wherby ordures ben voyded... ' (*MED*). In the context of medieval pit fills, it is very descriptive, since it covers a wide range of foul waste products, including those of the human digestive system, as shown by the quotation. Another word used in medieval writing is *drit*, which has since changed its spelling to *dirt*, though it remains *dríta* in Icelandic (Cleasby 1957). Its principal meaning was 'human waste', as in a quotation from 1387: 'Arrius sched out his bowels and his lyf wiÞ Þe *dritt* Þat he schat' (*MED*). Otherwise, it just meant dirt in the modern sense.

The most direct word used for the main component of these pit fills—*shit*—has strong folk, if not literary, use today and is of Germanic origin. As in the case of *drit* (see above), the degree of foulness conveyed by the word *shit* varies with place and time. From the Middle Ages to the sixteenth century in Britain *shit* was used as a generic term for dirt, as well as having its present-day connotations (C. C. Dyer, pers. comm.). This generic meaning exists today in mainland Scandinavian *skitt* (with *sk* pronounced as *sh*), which can also just mean 'dirt'. In English, however, words of French or other non-Germanic origins have been regarded as being more refined or polite than their 'rude Anglo-Saxon' antecedents, so that words such as *shit* and *snot* came to be avoided in polite conversation and writing. The 'dirty' meaning is also retained in the most conservative Scandinavian language, Icelandic, in the word *skitur* (Cleasby 1957).

The word *shit* has been recorded in Anglo-Saxon as the verb *scitan* and the *OED* gives a quote from a leechbook of about AD 1000:

'Wiþ Þon Þe men mete untela melte & gecire on yfele wae & *scittan*'. This is the alternative meaning of the word, now modified to *shits*, i.e. diarrhoea. In 1118, Florence of Worcester recorded that 'Lues animalium quae Anglice *Scitta* vocatur, Latine autem fluxus interaneorem dici potest', which can be loosely translated as 'the flow from the animals which the English call *Scitta* could however be called diarrhoea in Latin'. The modern versions of these words are perhaps more often heard 'on the Clapham omnibus' than seen in print or heard in broadcasts. Maybe in Middle English the distinction between the spoken and the written forms of the language had not developed in this way. Chaucer could use the word and in 1484 Caxton, in his *Fables of Æsop*, could have: 'I dyde *shyte* thre grete toordes' (*MED*). Shakespeare, however, does not seem to have had occasion to use this word, but this may be because the whole subject was by then generally one that was avoided.

The next most direct word has been relegated to dialect by the lexicographers, though widely known (if not understood) for its true meaning in the expression 'cack-handed' or 'cacky-handed' (for left-handed, or just clumsy). The word has a long history, however, and the Saxon word *cac-hús* (Bosworth 1882) should need no explanation. *Cack* has appeared less often in print, but one quotation from 1600 given by the *OED* is: 'Hee hath a face like one that is at *cack*'. On the whole, this word seems a little rarer, or perhaps more local in English than *shit*; it is certainly very much used in certain regions, such as the Black Country of the West Midlands. It is also present in German and Dutch as a noun and a verb (*kacken*) in almost identical form to English. I am given to understand that it is more usual there than the equivalent words for *shit*, and this is confirmed by its presence in modest-sized Dutch and German dictionaries, but not in English dictionaries of equivalent size. Skeat (1882a) traces it back through Latin to Greek.

Of the words that are regarded as acceptable in polite company today, most are strongly euphemistic. *Fæces* is an official, written term now. Originally it came from the Latin *fæx* for 'dregs', and still had that meaning in the medieval period, as can be seen from a quotation from 1460: 'Rotun *fecis* of wiyn', and this usage continued into the eighteenth century, although increasingly the word came to be used for human wastes, from abscesses as well as from the bowels. Another relatively acceptable word in written English, *excrement*, also derives from Latin and originally meant 'that which had been sifted out', later meaning waste matter (including fæces), as is clear from a quotation from 1533: 'Breade haueing moch branne doth fylleth the body with *excrementes*' (*MED*). The present meaning is a comparatively recent use of the word.

I have also used the word *sewage* and, on receiving a caution from York, I checked and was horrified to see that this meaning (as *shit*) is only recorded back to 1834. The word *sewer* originally applied to any drainage channel (C. C. Dyer, pers. comm.); the word *sewage* now means 'flowing contents of a sewer', and that is no good for describing medieval pit fills, I am afraid, so I retract this term.

There are many other words which have been used for our present purpose. The Latin *stercus*, as in the subtitle of this piece, is but one, as shown by some Middle English and Latin equivalents given in the *MED*: 'esyn, or cukkyn, or schytyn: *stercoriso*, merdo, egero'. The Latin *merdo* is alive and well in modern French, but in English another cognate word *to mute* refers specifically to falconry. Similarly, the word *fumet*, which is mainly remembered from Lewis Carroll's poem *The Hunting of the Snark*, was applied to the droppings of animals that were hunted, deer especially; the word *crotty* was also used in this way.

'Coprolite' is more a purely geological term that has been applied to archaeological material, but is more appropriate to hardened and more or less mineralised sediment rather than the softer and unconsolidated pit fill with which we are largely concerned here.

A number of other words seem to have been used either in the farmyard or domestic sense. *Turd* (as in the Caxton quotation, above) comes from the Old English *tord* (=dung), and survives from the Old Norse in the word *tord-yfill* for dung-beetle. Turd seems to be one of the few more-or-less acceptable words for written use today. *Dung*, another Old English word with Norse origins, was mainly used (as now) for the products of farm animals, so it could be written in 1534 that sheep should be folded on the fields so that they would 'pyss and *dung* there' (Skeat 1882b). Its second meaning is for human fæces (*MED*). Amongst the Scandinavians, Norwegians now prefer the work *møk*. The English language has retained all these words, the last in the form *muck*.

In conclusion, many of the words mentioned here have been used (by myself, as well as by others) either wrongly or without due regard for their history. *Latrine* seems a perfectly good, if rather euphemistic, word that has hardly changed its meaning over the years. Likewise, *cesspit* has a fairly clear meaning in English nowadays, though its ancestry and medieval use are rather uncertain. *Rubbish pit* is equally apt, but dare we allow *shit pit* (or *shitpit* or *shit-pit*)?

Words such as *fæces* and *excrement* are perfectly correct and well understood now, although they have only taken on their modern meaning fairly recently. *Turd* appears to be the only English word of clear meaning that is even partly 'respectable' (though the 1944 edition of the *OED* (corrected and revised to 1978) states that it is not now in polite use!). The most apt and ancient word that has been used in England, at least from Saxon times—*shit*—is, unfortunately, widely considered unprintable in full, although such words are now occasionally to be seen in 'quality' newspapers.

The fills of medieval pits contained a mixture of remains—of human turds, perhaps animal dung, and a range of household rubbish, including flooring material and larger bones. It is very difficult to find a word that covers all this accurately. Sabine used *filth*, which is quite descriptive, but *ordure* is what the stuff was actually called in the Middle Ages. Is this, then, what we analyse?

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[Editors' note: James Greig sent us the text on which this piece is based an extremely long time ago and we apologise for the delay in getting it into print. With regard to the spellings *fæces* and *defecation*, we have followed the first spellings in the citations used by *OED*, even though the ligature *æ* seems archaic and the latter spelling has the ring of American English.]

[Editor's aside: mere millimetres beneath the *OED* entry for 'shit' comes another very interesting and useful word: *shive* (to rhyme with English sieve), whose plural means 'the refuse of hemp or flax'. Here is the word we have been looking for to stand for the German *Scheben* in wide currency in Professor Körber-Grohne's reports on the Feddersen Wierde, for example; no doubt *shives* is a survivor in English from a common Germanic ancestor. — **Allan Hall**]

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Small-vertebrate and molluscan analysis from the same site

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Summary

Small-vertebrate and molluscan data from the same two sequences about 55 m apart through Neolithic deposits at Maiden Castle, Dorset, England, are described. The small-vertebrate analysis was done to amplify the molluscan data and extend the spatial range of evidence. The molluscan sequences are matched through their similarities, and the litho-, archaeo- and ^{14}C stratigraphies.

The two small-vertebrate sequences match well, showing that they have at least site if not wider relevance. It is suggested on the basis of their fragmentary nature that the remains are from bird of prey predation and, specifically (in view of the absence of complete bones and skulls and a prey spectrum which suggests a diurnal raptor), from kestrel. They may be interpreted in site and local terms accordingly. From the point of view of the locality, the data probably reflect the selection of prey from areas of terrain such as hedgerows, field edges and river margins rather than randomly from around the roost, and this has to be borne in mind in environmental interpretation. All taxa were present throughout, with the significant exception of newts, which occurred in the lower part of the bank barrow ditch, perhaps reflecting the presence of an on-site permanent pond, and shrews, which occurred at the top of the sequences in a horizon which saw renewed human activity after a period of quiescence.

Interpretation is difficult because of the low numbers. Five kilogramme samples (not 1 kg, as used here) are recommended for future work. Species identifications are the most useful ecological data, so a good reference collection is essential. Identifications to higher taxa such as 'Amphibia' and 'total numbers' can give information of a more general nature and about roost-site activity, and skeletal element proportions can suggest the nature of the predator species.

Introduction

Subfossil Mollusca usually give information about the environment at the sampling spot, but it is seldom possible to extrapolate beyond that to the locality. This is because of the very local significance of the molluscs, and modern work has shown that boundaries between communities can be very sharp (e.g. Boag and Wishart 1982). This is especially true of the later Holocene, from the Neolithic onwards, when most contexts on archaeological sites are from spot or linear features like pits and ditches (Evans 1972). On a wider, regional, scale, broad chronologies of introductions have been detailed for southern and eastern England (Kerney *et al.* 1980), but they relate to long time and biogeography, not environment *per se*, and are therefore largely irrelevant to local issues in environmental archaeology.

One way of obtaining information about a larger area is to take more than one sample column from equivalent chronostratigraphical sequences. Another is to use other types of biological indicator which, although not giving the very local—or on-the-spot—detail that molluscan assemblages do, are of more general, i.e. local or micro-regional, environmental significance. Pollen and insects are unsuitable in the usual preservational context for land molluscs (aerobic calcareous conditions) because they are not generally preserved, while charcoal, since it is mostly of anthropogenic origin on archaeological sites, is subject to the vagaries of human selection (although see Ashbee *et al.* 1979, table 2, and Dimbleby and Evans 1974).

Small vertebrates offer a suitable possibility because they are well preserved, although in smaller quantities than mollusc shells, and they reflect a bigger area than molluscs because they have larger home ranges. In some cases they reflect the site environment, as when they have fallen into pits or ditches and died there. In others, they are derived from raptor pellets, in which case they reflect a wider area than shells, but may give less specific information. Clearly it is necessary to separate these two components.

Methods

The excavation in 1985 and 1986 of the Neolithic site of Maiden Castle, Dorset, England, was a suitable opportunity for comparing the use of small vertebrates and molluscs because both were preserved and multiple sample columns were obtained from the same chronostratigraphical (^{14}C) and archaeological sequences. The site is at about 130 m OD, on a chalk ridge with patches of clay-with-flints and plateau gravel. The South Winterbourne stream is 500 m to the south. The National Grid Reference for the sampling location is SY 670885.

The sample sequences

The situation at Maiden Castle is that the infilled ditches of an Early Neolithic double-ditched causewayed enclosure and of a later, but still Early Neolithic, bank barrow are overlain by a bank of an Early Iron Age hillfort. A ditch precedes the causewayed enclosure and this is referred to as the 'pre-enclosure feature'. The archaeology, lithostratigraphy, chronostratigraphy and molluscan sequences are described by Evans *et al.* (1988). The molluscan record (Evans *et al.* 1988; Evans 1990) indicates that the pre-enclosure feature was constructed in woodland, while the causewayed enclosure was constructed at a woodland edge. After a few centuries, the bank barrow was built in partly cleared land. Human abandonment at the hilltop followed and there was regeneration of woodland. In the later Neolithic, renewed human disturbance involved woodland clearance and cultivation. In the Bronze Age, the site was once again abandoned for human use; impoverished grassland developed on a decalcified soil.

Three sequences were analysed for small vertebrates and molluscs (Figs. 15 and 16):

MC XIII. This goes through the pre-enclosure feature and the overlying infilling of the inner ditch of the causewayed enclosure. The upper part of the sequence is a midden. The deposits are overlain by the bank barrow mound. The snails indicate woodland, and the presence of *Acicula fusca* and *Columella* sp., absent subsequently, suggests that this was primary. Later there was slight clearance, probably for the construction of the causewayed enclosure and bank barrow.

MC III. This is through the inner ditch of the causewayed enclosure, about 55 m away from **MC XIII**. The deposits are not overlain by the bank barrow, so they continue the sequence until the construction of the Iron Age rampart which seals them. The horizon at which the bank barrow was built is indicated archaeologically (by pottery) and by ^{14}C dating, and there is an increase in open-country snails, specifically *Vallonia costata*, at this point. In the upper part of the sequence the site was abandoned and woodland spread in: *Ashfordia granulata* was characteristic. In the Later Neolithic there was renewed human activity, still in woodland, with *Pomatias elegans* characteristic, followed by clearance and ploughing across the ditch in the Beaker period. The Bronze Age environment was grassland on a decalcified soil.

MC IV. This is a sequence through the bank barrow ditch in the same trench as the **MC XIII** sequence, the whole of which corresponds to the **MC II** sequence between 90 and 0 cm. The same lithostratigraphy, archaeology, ^{14}C dates and molluscan sequences are present, but in an expanded form. Particularly distinctive is the dichotomy within the woodland phase, initially with *Ashfordia* and later with *Pomatias*. This dichotomy was recognised from two other sequences on the hilltop spanning the same time range, and although its significance in ecological terms is not clear, it serves to demonstrate the relevance to the site (i.e. hilltop) of the molluscan data.

Extraction and identification

All bones and teeth greater than 0.5 mm were extracted from the 1.0 kg molluscan samples and identified using the reference collections of the Environmental Archaeology Unit, University of York.

Results

Taxa

Most of the identifications were for teeth, although a few long bones, podials, scapulae, innominates, vertebrae, spines, scales and

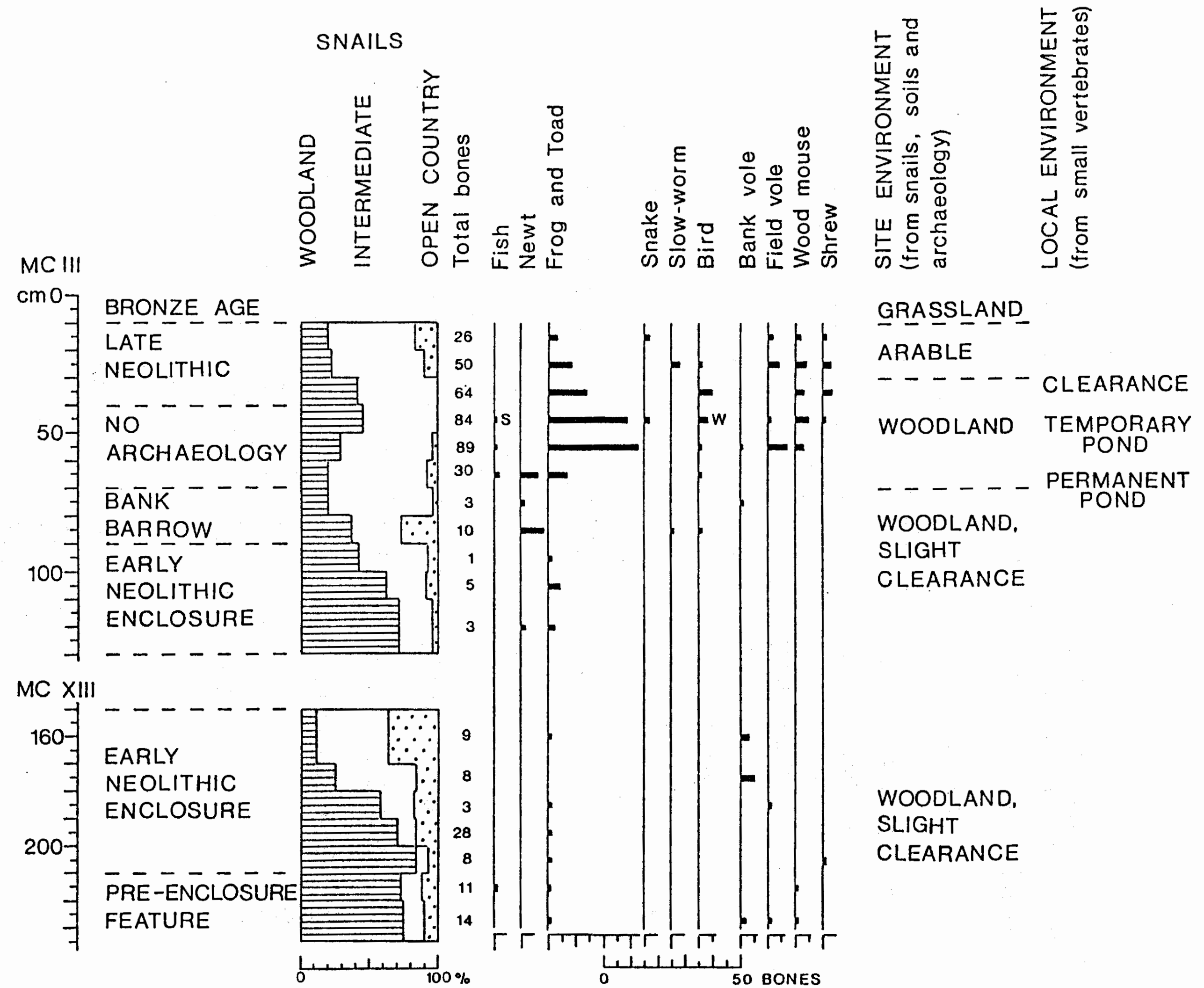

Figure 15. Maiden Castle: combined land-snail and small-vertebrate sequences, ***MC XIII*** *and* ***MC III****. S = stickleback; W = includes one wren. Habitat, archaeological and molluscan sequences from Evans* et al. *(1988).*

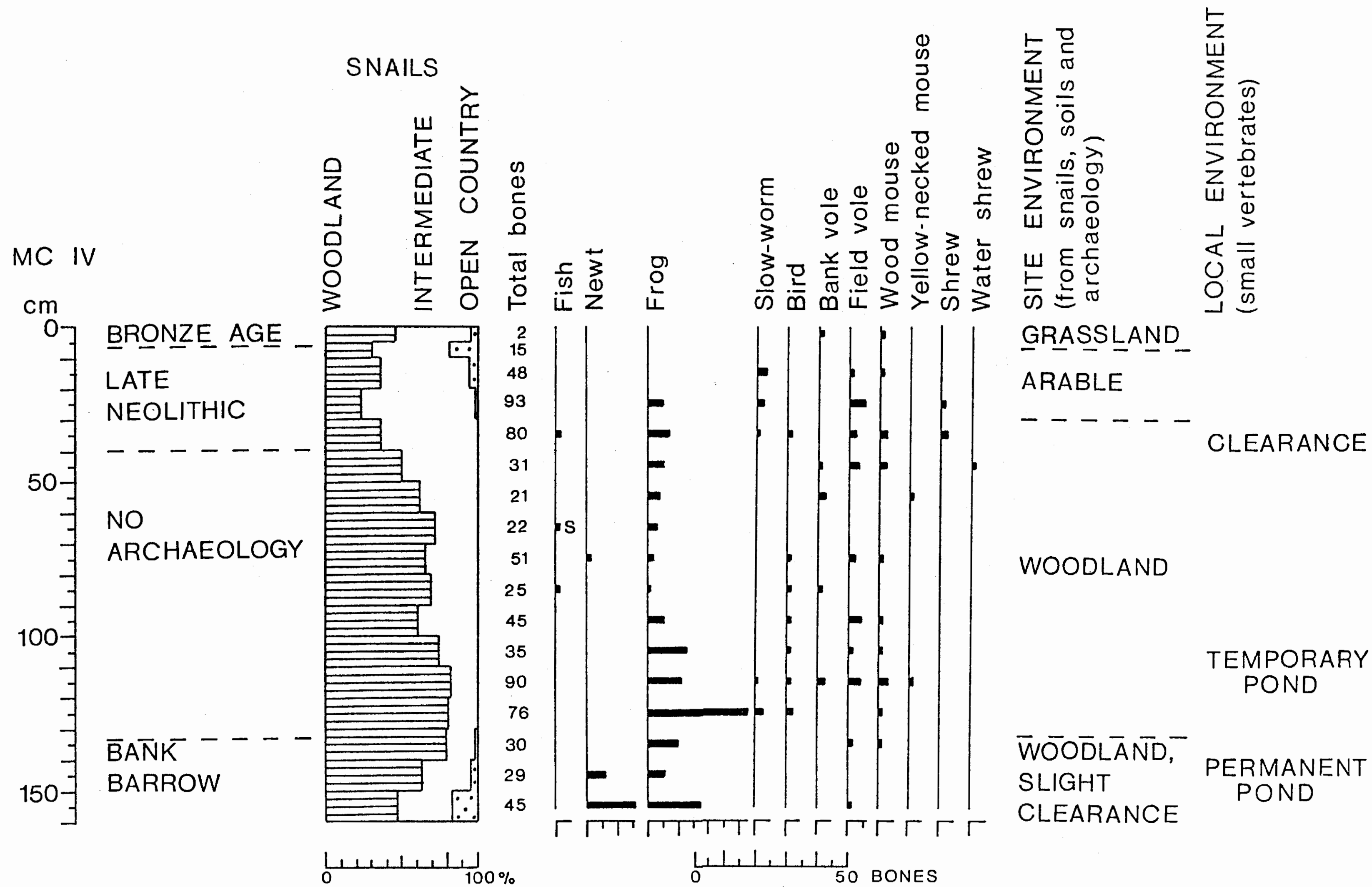

*Figure 16. Maiden Castle: combined land-snail and small vertebrate sequences, **MC IV**. S = stickleback. Habitat, archaeological and molluscan sequences from Evans* et al. *(1988).*

skull fragments were determinable. Much, however, could be identified only to groups such as 'mouse/vole', which is useful only for the information it gives on total numbers of fragments and the composition of the assemblages in terms of skeletal elements (Fig. 17).

The following taxa were identified:

(i) fish, all very small, including stickleback, *Gasterosteus aculeatus* (L.).

(ii) toad, *Bufo* sp.

(iii) frog, *Rana* sp. Some material was identified only to toad/frog but both groups were present in all profiles.

(iv) newt, indet. (Amphibia, Salamandridae).

(v) bird, all very small, of pipit/wagtail size, and one wren, *Troglodytes troglodytes* (L.).

(vi) probably grass snake, cf. *Natrix natrix* (L.), identified from a vertebra (cf. Holman 1985).

(vii) probably adder, cf. *Vipera berus* (L.), identified from a tooth.

(viii) slow-worm, *Anguis fragilis* (L.).

(ix) shrew, probably all common shrew, *Sorex araneus* L.

(x) water shrew, *Neomys fodiens* (Pennant).

(xi) bank vole, *Clethrionomys glareolus* (Schreber).

(xii) field vole, *Microtus agrestis* (L.).

(xiii) mouse, probably wood mouse, *Apodemus sylvaticus* (L.).

(xiv) probably yellow-necked mouse, *Apodemus flavicollis* (Melchior), identified from a distal end of a humerus plus shaft and an upper first molar. In view of the difficulties in identifying this species even with complete mandibles (e.g. Bramwell *et al.* 1990), these identifications must remain tentative.

Taphonomy and origin of the material

All the material was fragmentary, usually only the smallest bones, the phalanges, being complete. Mostly there were single teeth, parts of long bones and skull and mandible fragments, the last two categories with never more than two or three teeth *in situ*. There were no complete skulls and jaws. Most of the long bones were incomplete, often with epiphyses partly destroyed and the shafts with long oblique breaks. These data, together with the general paucity of fragments (Figs. 15 and 16), indicate that the material is not from animals that died in their place of deposition but from predator debris, and specifically from bird of prey pellets. Elsewhere on the site, in Iron Age storage pits, complete skeletons (including those of weasels) were preserved, and these are from animals caught in the pits (information from Miranda Armour-Chelu, who has worked on the Maiden Castle bone), but this is not the origin of the material discussed here. The contexts, too, are wide ditches which, after a small amount of infilling and weathering of the sides, would have allowed easy escape; they would not have functioned as natural pitfall traps.

Most of the material is probably from kestrel, *Falco tinnunculus* Linné, pellets, as suggested by the small size of the prey (absence of larger vertebrates such as squirrels, mustelids, etc.), the prey spectrum (which suggests daytime hunting), the very varied diet (Village 1990) and the very fragmented nature of the material. Owls, for example,. and especially the barn owl, *Tyto alba* (Scop.), produce pellets with relatively complete long bones, and skulls with teeth often in place (Andrews 1990). Diagrams of skeletal element proportions (Fig. 17) do not match those of either barn owl or kestrel as presented by Andrews (1990). His data show more skull fragments and fewer phalanges for kestrel; however, these are from modern pellets and it may be that, in soils, skull fragments become broken down. There is also the point that the Maiden Castle material may be from more than one predator species.

With regard to this last point, the possibility must also be considered that the amphibian bones are from a different source, specifically from animals that lived (even if transiently) and died on the site, especially since they are rarely taken by kestrels today (Village 1990). The topography of the site and the porosity of the chalk would not have allowed the ditches to have held water long enough for amphibians to breed in them, and there are no aquatic mollusc assemblages, but it is possible that they were suitable sites for hibernation. However, the amphibian remains are as fragmentary as the mammalian and other material and, although more abundant in some levels, this abundance is low by comparison with what might be expected from the remains of complete skeletons. Furthermore, although there is a concentration of amphibian remains in the lower part of the **MC IV** sequence, this location is fortuitous, being matched by a similar concentration at the same chronological level in the **MC III** sequence, but much higher up in the ditch. We therefore conclude that the amphibian remains are likewise from raptor pellets, although not discounting the possibility that they may be from a different, perhaps more local, origin than some of the mammalian material. Certainly, it appears that freshwater habitats were being exploited by the raptors, if the fish bones, too, were from pellets.

Examination of the types of corrosion to distinguish different types of raptor (e.g. Mayhew 1977) and to separate the effects of pedological processes from stomach acid corrosion (e.g. Andrews 1990) was not made, in view of the small amount of material, the probability that more than one raptor species was involved, the uncertainties of distinguishing diurnal and nocturnal raptors (Andrews 1990) and the variety of deposits.

The sequences

The main features of the sequences are as follows:

(i) allowing for absences which can be attributed to small sample size, almost all taxa are present throughout. The two exceptions are newts and shrews. Some taxa, such as frogs and toads, are abundant and continuously present; others, such as fish and bird, are in low numbers and sporadic. Field vole and wood mouse are more uniformly present than bank vole.

(ii) the earliest deposits (**MC XIII**) are characterised by bank voles, contrasting them with later levels.

(iii) newts are characteristic of the bank barrow horizon.

(iv) frogs and toads are abundant in the woodland horizon between the Early and Late Neolithic.

(v) shrews, including water shrew, are present mainly in the Late Neolithic horizon.

(vi) the **MC IV** sequence is broadly similar to the equivalent part of the **MC III** sequence 55 m away.

Discussion

Size of area represented by the material

Various indications suggest that the small-vertebrate sequences reflect the local rather than solely the sampling spot environment, and in this respect they differ from the molluscan data:

(i) The home ranges of the small vertebrates are large, especially when compared with those of land mollusca.

(ii) As argued above, in the specific case of Maiden Castle, the material is probably of bird of prey pellet origin, and this implies a greater sphere of reference with regard to environmental interpretation than would be the case if the bones had derived only from animals whose home ranges had encompassed the sampling spots. For kestrels, the home range varies from about one to about ten square kilometres (Village 1990).

(iii) There are two similar sequences which match chronologically from the bank barrow level upwards, 55 mm apart, illustrating that the individual sequences are of more than sample spot significance. This is deemed to be the most important result of the investigation.

In addition, the remains are giving information about roosting/nesting sites (or, at the very least, pellet-regurgitation sites), usually well above ground on posts, in trees or in buildings. Thus the increase in abundance of remains in the period of human abandonment between the Early and Late Neolithic is probably a reflection of the increasingly wooded nature of the site at this time.

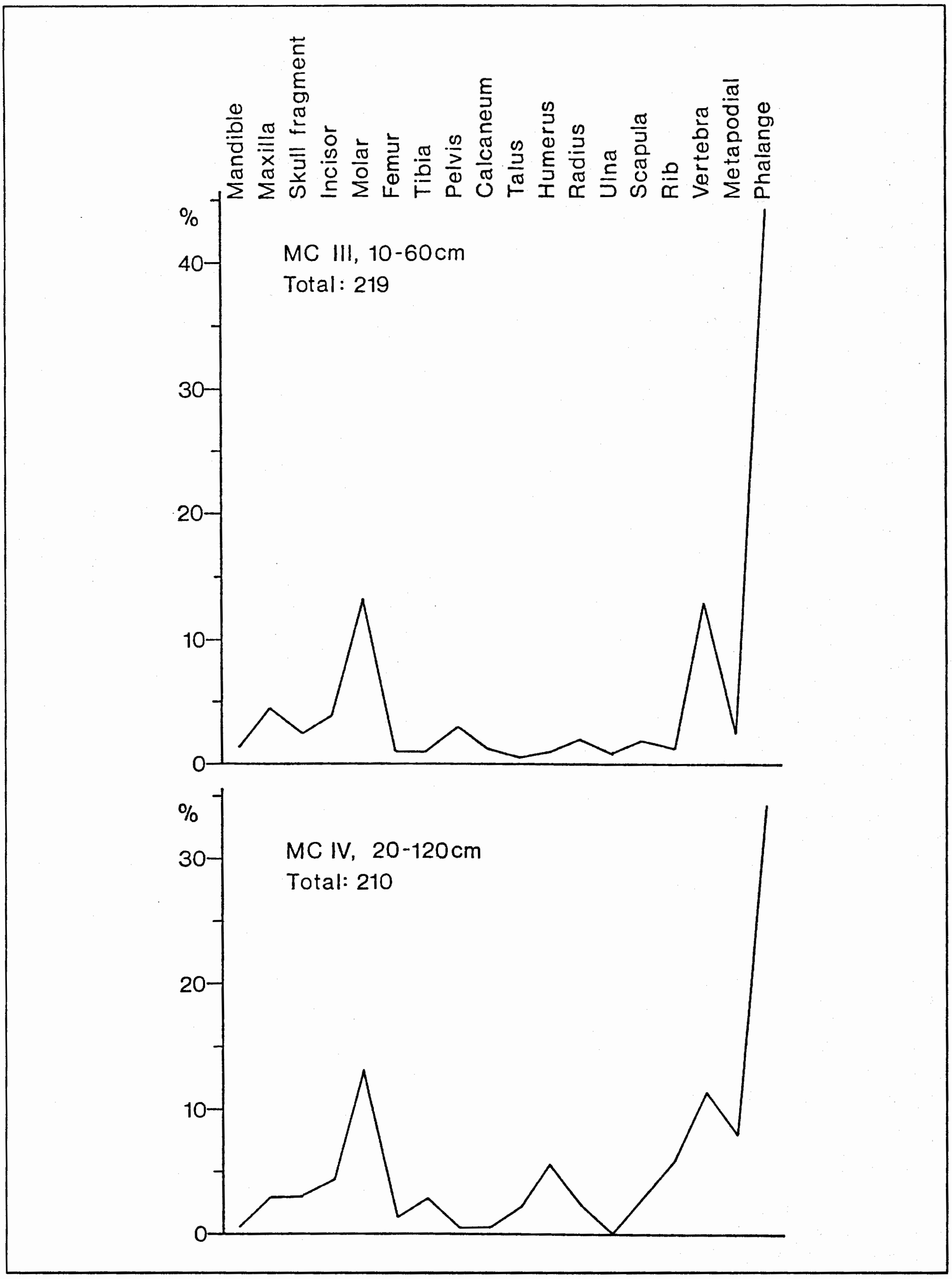

Figure 17. Maiden Castle. Skeletal element proportions of small vertebrates as percentages of fragments whose skeletal element was identified (not of total fragments).

General environmental interpretation

Because the material probably derives from bird of prey pellets it does not reflect a uniform area, for particular raptors select particular parts of the landscape for their hunting and have particular prey preferences. The kestrel, for example, argued as being the main species responsible for the accumulations at Maiden Castle, hunts scrubby hillsides and woodland edge, as well as grassland, and has a very varied diet, although concentrating on field vole, *Microtus agrestis* (Masman *et al.* 1988; Village 1990); barn owls, on the other hand, select long strips of open land along field edges, streams or woodland/arable interfaces, and also prey very heavily on field voles (Shawyer 1987). These aspects of raptor behaviour need to be borne in mind when considering the results.

The assemblage is a mixed terrestrial and amphibious one, with a few aerial and aquatic representatives. The terrestrial taxa reflect a heterogeneity of local habitats—open (field vole), scrub (bank vole, shrew) and woodland (mice)—although species should not be assigned too rigidly to habitats. The amphibious species may have been living on the hilltop in artificial ponds and/or taking advantage of the Neolithic ditches for shelter and hibernation, while breeding by the South Winterbourne stream, 500 m away. Whatever the case, they were part of the raptor spectrum, not living and dying in the Neolithic ditches in their place of burial. The aquatics (fish and, to a lesser extent, water shrew) at least are clearly from further afield.

The temporal sequence

Little can be said about the pre-enclosure and Early Neolithic enclosure levels because numbers of bones are low, but the abundance of bank vole in **MC XIII** against the paucity of field vole (and in contrast to the situation in the later part of the bank barrow ditch fill) is perhaps significant and indicative of good scrubby ground cover in and around woodlands.

The distinctive feature of the bank barrow horizon, the abundance of newts, suggests the presence of a pond on the hilltop, although there is the alternative possibility that these and other amphibians were breeding in water bodies further afield. If a pond had been present on the hilltop in the Neolithic period it would certainly have had to have been an artificial, clay-lined one. A pond would have been a not unlikely feature of the site in view of the predominantly cattle-raising economy of the Early Neolithic, and especially the importance of causewayed enclosures in this.

Allowing the pond hypothesis, the later absence of newts in the earlier part of the secondary woodland stage when the hilltop was abandoned suggests that the pond became infilled. This was a period of considerable diversity in the small-vertebrate assemblages, indicating an undisturbed environment for raptor roosting and nesting, and supporting the archaeological and molluscan evidence for human abandonment and woodland regeneration on the hilltop.

In the upper, Later Neolithic, parts of the sequences, toads and frogs decline, suggesting water was further away. Shrews are characteristic at this time, although the ecological significance of this is unknown. Their appearance with the land snail *Pomatias elegans* may be commented on, with the implication of a possible predator-prey relationship. Terry O'Connor has suggested a relationship with human activity and, as this was a period of renewed human activity, first in woodland, and later in a cleared and cultivated landscape, the shrews may in some way be reflecting this.

Wider implications of the results

The small-vertebrate data do not reflect the detailed story shown by the molluscs for the site (Evans *et al.* 1988). Instead, they indicate a heterogeneous landscape around Maiden Castle from the very beginning of the sequence, that is prior to the construction of the causewayed enclosure, and this is backed up by other evidence. For example, surface flint scatters, studied by Peter Woodward, show localised areas of activity at the eastern end of the hilltop and on the valley sides in the Early Neolithic, probably prior to the causewayed enclosure. So there was probably some clearance of woodland in the locality. The enclosure itself was probably sited on the edge of this activity, at the woodland edge, and there is molluscan evidence that the eastern end of the enclosure was in more open country than the western end, where the sample series described in this paper came from. Indeed, evidence generally from causewayed enclosures in southern England suggests them to have been sited on the edge of territories, in woodland clearings (Evans *et al.* 1988).

Wood charcoal, studied by Rowena Gale, amplifies the picture further. Oak and other woodland trees were exploited in the Early Neolithic and continued in use into the bank barrow horizon and secondary woodland stage. By the time of the Late Neolithic clearance, however, shrubs of wet and acidic soils were being utilised, indicating that people needed to exploit areas further afield than previously for timber and reflecting progressive clearance of the area and the need to go further afield than previously for timber.

All this suggests that the Later Neolithic woodland in the ditches at Maiden Castle, and perhaps too as recorded at other sites in southern and eastern England (Evans 1990), was specific to these sites. This is not to say that abandonment or relaxation of use of the land was not a general feature of then landscape at this time, only that such practice was being registered more fully in the ditches of monuments than elsewhere.

Conclusions

Small vertebrates, when derived from raptor pellets, give information additional to that from molluscs at the local and small-regional scales. The most important observation to emerge from the work at Maiden Castle is that two later sequences, from points 55 m apart, are similar. But bigger samples, at least 5 kg, are needed to provide more precise data. The sort of information about subtle environmental changes in vegetation cover that are revealed in modern studies of raptor pellet debris can only be obtained with much larger data bodies than used in this paper (e.g. Yalden and Morris 1990). Reference material is crucial because information at other than the species level is only useful for indicating general trends in input and possibly raptor species.

Acknowledgements

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The effect of recovery techniques on faunal data at Klithi, North West Greece

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Summary

The palaeolithic rock shelter of Klithi, North Greece, has been undergoing investigation by archaeologists and geologists since 1983. During this period excavation strategies and in particular recovery techniques have been occasionally revised as the condition, type and density of the artefactual material was realised and further information was gained about the deposits within which the artefacts were contained. This report outlines recovery techniques practised at the site, and also presents the results of a short series of experiments designed to establish the cause and extent of fresh fragmentation and other types of damage which occurred on some of the bone material during the 1988 season.

The results of the experiments suggest that the damage may be attributed to the weight of overlying sediment etc. during post-excavation transportation and the rapid wetting/drying to which the faunal material is subjected. However, the sample used was too small to produce conclusive results. Finally there is a brief discussion of the need for more experimental work and fuller publication of recovery and recording techniques on early prehistoric sites.

Introduction

The rock shelter of Klithi is situated within the lower part of the Vikos Gorge in the Epirus region of Northern Greece. It is one of several palaeolithic rock shelters in the Epirus region and the largest so far known. Excavation of the site has been carried out since 1983 and is an integral part of a programme of research on the palaeolithic of the Epirus region which includes geological and palaeobotanical studies both within the Vikos region and beyond (Bailey *et al.* 1983; 1984; 1986a; Bailey and Thomas 1987; Sturdy and Webley 1987). The dates so far obtained on excavated material from Klithi bracket the prehistoric occupation of the site between 17,000 ± 400bp and 10,420 ± 150bp (Bailey *et al.* 1986b).

Major factors which have influenced the excavation and recovery techniques used on the site have been the overall objectives of the excavation and research project, the size of the site, the richness of the artefacts (i.e. their density within the sediment) and also the general inaccessibility of the site and the 'primitiveness' of its immediate surroundings in terms of facilities available.

The overall objectives of the excavation and the research programme of which it forms a part are fully described by Bailey *et al.* (*ibid.*) and it is only necessary here to note that these objectives include the detailed investigation of the spatial distribution of the cultural materials within the shelter, the identification of features such as hearths, 'dump' areas and other special activity areas, and therefore necessitate the fullest possible recovery of the artefactual material accompanied by recording and understanding of the microstratigraphy within which the material lies.

As has been stated, the shelter itself is the largest of this period in Epirus; currently the shelter opening is 25 m wide and 10 m deep although this may well have varied in the past. Until recently the shelter was used by a modern goat herder and this has produced a flat topped layer of dung over the whole area of 450 m^2—extending slightly out of the overhang. Although the exact depths of archaeological deposit within the entire shelter have not yet been obtained these certainly reach a depth of over 1 m in places and may reach 2 m, whilst seemingly 'sterile' scree deposits have been recovered to a depth of more than 7 m (Bailey and Thomas 1987). The problems of devising strategies and techniques to cope with such a large volume of complex deposits are several, including those of storage and safety, but perhaps the one that dominates is that of time (Bailey in press).

Inaccessibility of the site also dictates to a certain extent the post-excavation techniques used. The site is approximately 25 minutes by goat track to the nearest point which is accessible to a car, and there is a further 20 minute drive to the project house in Aristi where the majority of finds are currently stored and where detailed analysis of the artefacts is carried out. Therefore, it is highly desirable to remove all sediment from the artefactual material at, or close to, the shelter (although a few bags of sediment are carried back each year for specialist analysis/examination).

The excavation is fortunate in having access to running water in the form of the Vikos river which runs directly past the site 30 m below, but it is necessary to walk approximately 500m over very steep terrain to arrive at a point where the river is accessible for sieving or for use in flotation. In 1988, as staffing was limited, it proved necessary to dry-sieve on-site to remove the majority of sediment (<3 mm) and large limestone fragments (>10 mm) before this journey was made. However, this has not always been the case (see below).

Density of artefacts varies greatly across the site and according to context. However, it has been estimated that a single cubic metre of deposit within the shelter can yield as much as 160,000 recoverable specimens of flint and bone (Bailey in press) and during the 1984 season, when all bone material over 3 cm and all flint over 2 cm was individually plotted to the nearest centimetre, one area of the shelter contained approximately 800 plotted flints and bones in a deposit of 1 m^2 x 5 cm deep. This density is partly a function of the richness of the site (i.e. absolute numbers of artefactual debris) but it is also a relative product of the very slow sedimentation rate within the shelter's upper levels, estimated at an average of 0.4 mm per year (Bailey *ibid.*).

Although small mammal and bird bones are comparatively rare—the faunal assemblage is overwhelmingly dominated by ibex, *Capra ibex*, and chamois, *Rupicapra rupicapra* (Gamble, in Bailey unpublished)—recovery of the full size range of material has always been a recognised objective. Faunal material is analysed by quantity, weight and size of fragments (in addition to species, etc.; G. Bailey pers. comm.). In particular, with relevance to these experiments, it is felt that size can give a guide to both localisation of activity types and destruction patterns pre- and post-deposition (but importantly pre-excavation).

Recovery Techniques

1. Pre-1988 Recovery Techniques

Prior to the 1988 season recovery techniques had changed several times in response to results of on-going analysis of the recovered material and changing circumstances on site. Some discussion of this is contained in the interim reports for each field season and the major changes are briefly presented below.

Since 1984 actual tools used in excavation have always remained soft brushes and plastic scoops supplemented occasionally by small metal tools to loosen the more compacted sediments; these tools are felt to ensure that minimal damage is caused to fragile bones or the edges of the flint artefacts.

1983: This was the first season of excavation and the main objective was to evaluate the potential of the site. The team was fairly small and it was desirable to excavate one experimental trench to the base of the archaeological deposits. Spits of 5 cm and occasionally 10 cm were used for recording, with respect for layer changes, and there was no individual plotting of artefacts. The majority of the deposit was passed dry through 20 mm, 8 mm and 2 mm sieves and further samples were selected for water separation and flotation.

1984: Excavation in this year was concentrated in the parts of the shelter which it was believed were largely undisturbed since prehistoric occupation and which contained spatially distinct activity areas. Following the results of the previous year it was felt desirable to commence individual plotting of all bone material above 3 cm and all flint material above 2 cm. A combination of spits and layers was again used for recording and analysing artefacts under the size ranges above, with spit depth being restricted to 5 cm. In the report on the 1984 season it was stated that 'this method also ensures as complete a sample as possible of undamaged specimens, and has already in some cases altered our interpretations of the cultural material' (Bailey *et al.* 1986a). All material was dry-sieved through 10 mm and 2 mm sieves and again there was selective wet-sieving.

1985: Individual plotting was abandoned in this year as it had found to be extremely time-consuming given the density of artefacts and that examination of the deposit and sediment types suggested some vertical and possible horizontal movement may have taken place post-depositionally. Instead material was plotted to the quadrant (of size 50 x 50 x 5 cm, a quarter of an excavation area) and occasionally to mini-quadrants (25 x 25 x 5 cm)—again respecting layer changes. All deposits were now wet-sieved through 1 mm meshes on a flotation unit. This change in wet-sieving practice was made in the light of results gained by wet-sieving 1984 samples, which had been set aside for further analysis. Wet-sieving of these samples had shown that informative material in the 1–2 mm range was being lost by the practice of only dry-sieving. Dry-sieving was felt unnecessary prior to the wet-sieving stage.

1986: As much as possible was recovered at the excavation stage with all finds being provenanced to the mini-quadrant rather than the quadrant to simplify excavation procedures and subsequent statistical analysis. All sediment was again wet-sieved through 1 mm meshes.

1987: No excavation took place but work was commenced on a re-fitting programme for the lithic materials excavated in previous years and trampling experiments also took place to help assess horizontal and vertical movement within this type of loose deposit (Bailey in press; F. Wenban-Smith pers. comm.)

2. 1988 Recovery Techniques

The major changes in recovery techniques that were implemented in 1988 were the decision to bulk sample (within quadrants) rather than attempt to recover any material during excavation, and the re-introduction of dry-sieving through 10 mm and 3 mm meshes on-site prior to wet-sieving through 1mm meshes at the river. Flotation was not used—and had been abandoned since 1985 as results were so poor.

Individual plotting of material had also been discontinued since 1985 as the immense time consumed by this activity was not considered justified when balanced against the loss of overall information caused by restricting the time and therefore the area of the site that could be excavated. Since it had been noted (from analysis and experimentation) that certain areas of the site had also undergone a degree of mixing, this made exact plotting meaningless in some deposits, although it was obviously impossible to state prior to excavation which particular deposits had been disturbed. Results of lithic re-fitting carried out during the 1988 season by Wenban-Smith will shed further light on the integrity of the deposits and may again lead to modification of techniques in subsequent years. Bulk sampling by quadrants, followed by complete recovery through sieving was in a way a natural extension of the policy of not recording exact artefact placement. It had also been noted in 1986 that a two-tier system of some recovery within the trench and some at the sieving stage was time-consuming and generally decreased efficiency as artefacts recovered on-site had to be 'matched up' at a later date with material from the same quadrant (or mini-quadrants) recovered in the wet sieve.

Excavation techniques used in 1985 had been seen to be causing some damage to non-lithic material as it was recovered within the trench, in particular the fragile carbonised remains, and Bailey *et al.* (1986a, 18) stated that it was 'difficult to lift a bone without breaking it'. In 1988 the bulk sampling method was introduced mainly to speed up operations but also in the belief or hope that there would be no great damage to bones, and perhaps less damage than previously noted.

I produce below a brief resumé of the stages of 1988 post-excavation recovery procedure subsequent to removal by bulk excavation:

(a) Immediately after removal all sediment (and archaeological materials contained therein) were placed in a plastic bag ('soil sample' type); three of these bags were usually necessary for removal of a layer from a quadrant, and each bag was given an individual number which recorded the provenance of the material. Each bag contained up to 8 kg of sample.

(b) The contents of each bag were poured onto a standing stack of dry sieves in a shaker frame and agitated for approximately one minute. Sieves were 10 mm and 3 mm mesh (square holes) The bone material retained in the 10 mm sieve was extracted and placed back in the bag along with lithic material retained in this sieve (other than limestone fragments, which were discarded after brief examination). Faunal material and other residues caught in the 3 mm sieve were poured back into the bag. Towards the end of the excavation care was taken to place the >10 mm material back into the bag after the rest of the residue as it was feared that the pressure of the material from the 3 mm sieve might be damaging the bone already placed in the bag.

(c) The bags, now weighing 1–5 kg were placed in a sack with about four others and carried down to the wet-sieve—a journey of about 500 m over rough terrain.

(d) The sediment was poured onto plastic meshes (1 mm mesh size) and agitated in the river. The remaining bone and lithic materials were then laid out in the sun on the plastic meshes and left to dry in the sun for up to 3 hours (given the cold damp nights this was the only method of drying available; it was also necessary to lay out the meshes for as short a time as possible as in the afternoons the goat herder came through the valley and goats appear to regard plastic meshes as a legitimate part of their diet!).

(e) The dry material was poured back into the marked bags (now weighing 0.5–3 kg) loaded into sacks six at a time and carried back up to site.

(f) The contents of each bag were poured onto a table and sorted by hand.

Often there were extended periods of time between one post-excavation stage and the next and bags containing sediment were often moved around the site as on-site activities demanded.

It was at the hand-sorting stage during the 1988 season that fresh breaks were noticed on some of the faunal material. Material was often sorted by the person who excavated it originally and therefore not only were breaks visible by their clean whiteness, but particularly large or 'interesting' pieces might be remembered and so any damage to them commented on.

It is interesting that no fresh breaks were ever noted in the lithics, although they were not specifically examined at this stage for fresh chipping or edge damage.

Report on experiments carried out in 1988

Aims

Since observation of fresh breaks suggested the possibility of the 1988 bulk sampling technique causing damage to bone material, it was decided to carry out a short series of experiments to establish if bone fragmentation was occurring and, if so, to attempt to isolate the main causal factors and roughly to quantify the effects on individual bones, bone 'types', and ratios of bone fragment sizes. It was considered that if bone fragmentation was occurring this would have important consequences: reducing the numbers of pieces that were identifiable and also complicating the interpretation of variation in absolute bone numbers and sizes of fragments between archaeological contexts. It is possible that breakage had occurred in previous years and some idea of this should have emerged in the bone analysis when it was completed for each season, but this had not previously been specifically studied or quantified on site.

Method

To isolate and quantify the effects of the several post-excavation stages fully would have entailed several experiments being run, as each stage would, ideally, be undertaken on freshly excavated material of as near similar type as possible. However, as ever, the time available for this work was extremely limited. The following three experiments were therefore devised to be undertaken during the normal course of excavation on site.

Each experiment took place using the equivalent of a bag of archaeological deposit which was removed from the same quadrant and layer (removal of a quadrant usually necessitating filling three bags).

Experiment 1

This experiment was designed to assess the overall effects of post-excavation treatment on a sample of faunal material. The stages were as follows:

(a) excavation in usual manner of one-third of a quadrant with resulting sediment, etc., placed carefully in a large flat container rather than in a bag, thus minimising the weight placed on the bone material.

(b) measurement and recording of faunal material extracted—this produced the 'baseline' against which breakage was recorded, and also gave an indication of damage caused by excavation technique. All material was then placed in a bag and proceeded through post-excavation in the normal manner as described above.

(c) after sorting, the bone material was re-examined and measured and any breakage or other damage noted.

(d) comparisons were then made between results from stages (b) and (c).

Experiment 2

This was designed to assess the effect of dry-sieving (alone) and wet-sieving (combined with dry-sieving) on the bone material, but without the material being poured in and out of sacks, so minimising the weight factor throughout the whole recovery procedure.

(a) material was excavated into a large flat container and bone material extracted, measured and examined as in Experiment 1.

(b) the bone was placed gently back into the container and re-amalgamated.

(c) material was then put in the dry sieves and agitated, and then placed again into the flat container and the bones extracted and measured again.

(d) material was then placed again into the container, and taken to be wet-sieved as normal and left to dry.

(e) artefacts were then carried back up to site using a large container and sorted in the normal way, the bones being re-examined, measured, etc.

Comparison was made of results at stages (a), (c), and (e).

Experiment 3

This was designed to assess impact of wet-sieving (solely) on the bone material. It was carried out in the same way as Experiment 2, but omitting stage (c). Comparison was to be made before and after wet-sieving.

The information recorded at each examination stage was as follows:

(i) for all bone over 3 cm, and bone under 3 cm but identifiable to bone element, i.e. humerus, tibia, etc. (on brief examination):

maximum length
maximum width
maximum thickness
burnt or unburnt
signs of fresh breakage or other damage
articulations present
identifiable or not
comments

(ii) for all bone over 1 cm but less than 3 cm, not identifiable:

fragment count

(iii) bone under 1 cm was not examined unless it was identifiable to bone type (i.e. small mammal bones)

Each category was also weighed as a group, but sensitive scales were not available so it was felt that it would be misleading to weigh the <1 cm material as accuracy was only in the region of ±5 gm. The results of the experiments are shown in Table 6. Note that bone measurements are not reproduced here.

Discussion of experiments

The main conclusion from the experiments was that damage to the bone material was not as extensive as had been expected from the casual observations that had prompted the whole exercise.

There could be several reasons for this, but I would suggest two main factors. Experiment 1, despite being based on 'normal' post-excavation procedures did not mimic

Experiment 1 (all the bone was lightly burnt)

	Number	Weight (g)	No. Damaged	No. Articulated	No. Identified
1. *Results at stage (b)*					
Bone >3 cm and bone <3 cm identifiable to type	41	100	11	11	29
Bone >1 cm <3 cm	54	40	-	-	-
Teeth fragments	4	-	-	-	-
2. *Results at stage (c)*					
Bone >3 cm and bone <3 cm identifiable to type	36	90	23(+3)*	11	30
Bone >1 cm <3 cm	62	30	-	-	-
Teeth fragments	4	-	-	-	-

*Table 6 (above and opposite). Results of the experiments carried out in 1988. Notes: *—two bones showed signs of cracking and one of surface peeling; †—two bones showed signs of cracking, two of surface peeling, and four of 'edge nibbling'. Experiment 3 (in which all the bone was lightly burnt) was abandoned in view of the lack of damage in Experiment 2.*

either more resistant to damage or has already been as fragmented and damaged as it is likely to get.

As mentioned above, comparison of results from Experiments 1 and 2 suggests that more damage (particularly breakage) takes place when faunal material is subjected to an overlying burden of loose sediment and other artefactual material. Although it would be extremely difficult to replace the soil sample type bags with a receptacle that reduces this weight load (the large washing-up bowl used for the experiments would have been impossible to use during the normal course of recovery), perhaps it should now be considered whether the damage from this factor is great enough to outweigh the advantages of bulk sampling.

Cracking and peeling did occur as a direct result of the washing and drying of the bone. This is obviously a problem that should be considered and, if possible, within the restrictions imposed by the climate and situation, post-excavation procedures altered. Although at this stage it was not severe enough to affect identification it is not known whether further degradation will occur during storage.

The following additional points were also noted and emphasise the difficulty of such on-site experiments as much as giving any absolute results:

(a) More breaks were identified after wet-sieving—but this may well reflect the fact that breaks and damage are difficult to recognise whilst the bone is still covered in sediment and therefore may not necessarily mean that it is the wet-sieving that is causing the damage. This also makes it difficult to ascertain if the excavation techniques alone are causing damage. Further experiments on comparative damage by excavation techniques would be interesting particularly in view of the comments by Bailey *et al.* (1986a) about problems with lifting and my comments above.

Experiment 2 (all the bone was lightly burnt)

	Number	Weight (g)	No. Damaged	No. Articulated	No. Identified
1. *Results at stage (a)*					
Bone >3 cm and bone <3 cm identifiable to type	44	120	2	20	29
Bone >1 cm < 3cm	46	30	-	-	-
2. *Results at stage (c)*					
Bone >3 cm and bone <3 cm identifiable to type	45	110	3	20	29
Bone >1cm <3cm	69	50	-	-	-
3. *Results at stage (e)*					
Bone >3cm and bone <3 cm identifiable to type	45	110	3(+8)†	20	28
Bone >1 cm <3 cm	59	40	-	-	-

and therefore may not necessarily mean that it is the wet-sieving that is causing the damage. This also makes it difficult to ascertain if the excavation techniques alone are causing damage. Further experiments on comparative damage by excavation techniques would be interesting particularly in view of the comments by Bailey *et al.* (1986a) about problems with lifting and my comments above.

(b) More material was recovered at each stage in terms of numbers (and occasionally weight) especially in the 1–3 cm range. Again this might be caused by material becoming easier to recognise as it passed through each stage and sediment is removed. It may mean, however, that material was breaking down into this category.

(c) Loss of identifiability of fragments seemed minimal except in the categories of rib fragments and two vertebral epiphyses which were lost in Experiment 1 from the >3 cm category. *Fragmentation where it occurs appears to be selective, in that certain skeletal elements appear more susceptible to breakage; this may, of course, bias the final analysis in several ways.*

Obviously it would have been preferable to repeat the experiments several times to gain a larger sample and also to use unburnt material. However, further time on site was not available. It would also have been difficult to ensure, in advance, that the material about to be recovered would be unburnt.

Conclusions from the experiments

Despite the very small scale of the experiments, and the consequent problems of interpretation of results, they did prove useful in suggesting the main causes of the bone fragmentation that had been previously noted at the sorting stage, namely crushing by weight and the peeling/cracking caused by rapid wetting and drying. The fact that the damage was less than expected is particularly interesting—this may have been a factor of the experiment design as discussed above or it may be that the sorters had over-estimated the amounts of breakage, as the bones damaged tended to exhibit fresh 'white' areas that were easily visible.

When the detailed specialist analysis is completed on the 1988 faunal material as a whole (including quantification of breakage) then we should be able to compare this with previous seasons and detect any gross changes in patterns of 'fresh' damage although, obviously, comparability will be an even greater problem than was the case for the experimental material which was all specifically taken from the same quadrant and context.

Discussion

The original aim of this article was to present the results of the short experiment on bone fragmentation. The secondary aim which grew from the background reading for the original theme was to make available for discussion the methods of recovery used at Klithi with accompanying record of the changes that have occurred in these methods over the course of the five years of excavation and analysis, in the hope that this would encourage discussion of the techniques used, and subsequent problems and responses to them at other sites, particularly sites of the same period or type.

The very factors which have contributed to the enormous archaeological value of Klithi—namely the richness of the site and wealth of information potentially available, the type, condition and distribution of the artefactual material present, and also the relative inaccessibility of the area—have resulted in the recovery problems which I have outlined above. These are all factors which must have been tackled time and time again in archaeology and face directors at the start of many excavations when decisions on levels of recording and type of recovery practised have to be made. The techniques utilised on a site, subsequent changes and developments in response to pressures of time (and money) and results of on-going analysis are of interest to all who are attempting to formulate their own methods.

With reference, in particular, to early prehistoric sites the decision to bulk sample rather than recover material *in situ*, and not to record the position of each artefact to the centimetre, is one that merits discussion. The majority of palaeolithic and mesolithic sites undergoing excavation in Europe at present favour a system of three-dimensional recording, usually to the centimetre, occasionally to the millimetre and often with comments on angle of declination, axis, and so forth. The decision at Klithi not to continue this practice (following from the results of analysis of breakage, re-fitting, examination of matrix type and assessment of time and information loss at the meso-spatial scale) is one that may encourage wider discussion of reasons for continuing this practice and justifications for it.

There may be a reluctance to change recording or recovery systems part way through an excavation, even as a result of on-going analysis, but overcoming problems caused by changing techniques several seasons into the excavation may not be as time-consuming as the continuation of those techniques if they are more detailed than can be justified—for example, if the matrix was subjected to much post-depositional mixing. It will be realised that this approach puts emphasis on on-going analysis with results of previous season's excavation having to be available when decisions are being made as to techniques to be used in the following season.

On-site 'experiments' such as those of Sebastian Payne (1972; 1975) were of vital importance to the development of currently accepted standards and recovery techniques but, although this work on development of techniques is still carried out by various workers, there are few examples of on-site experimentation and assessment of recording and recovery techniques on 'artefacts' in general. If there appears to be a problem with fragmentation or edge damage, or indeed with the pace or scale of recovery, it is easier to quantify, analyse and successfully address these problems if experiments can take place *alongside* excavation with exact duplication of techniques in the particular circumstance of the site than if analysis and experimentation take place at the close of the season away from the site (often in laboratory conditions) or even after the completion of the excavation of the site entirely.

Perhaps the arena in which work of this kind could best be presented and discussed would be within interim site reports. In a discussion on publication Barker (1977, 244) commented that 'A deficiency of almost all interim reports is that they carry little information regarding the techniques used to recover the results which are summarized so that dissemination of new methods or refinements of old ones is slow and intermittent'.

This article was made possible purely because the interim reports from Klithi *do* include discussions of the recovery techniques used and the reasons for those specific techniques being used. A very brief foray into some interim site reports of palaeolithic and mesolithic sites currently under excavation shows that the Klithi reports are in a minority in this respect. Although description is usually made of the recording system (usually with stress on how much detail has been achieved) little if any comment is made on the recovery system, justification of its use (e.g. factors involved in the choice; reports of experimental work) or assessments of the relationship between time, information and finances which must have been made.

Obviously every site is very different and each director will have to make their own assessment (and re-assessments as the excavation continues) of the appropriateness of particular recovery techniques and scale of recording. Surely these important decisions and the factors which influenced them should be recorded alongside the results that were obtained by their use, both to aid the evaluation and interpretation of those results and to assist those who are themselves involved in making their own difficult decisions.

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101 ways to deal with a dead hedgehog: notes on the preparation of disarticulated skeletons for zoo-archaeological use

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Summary

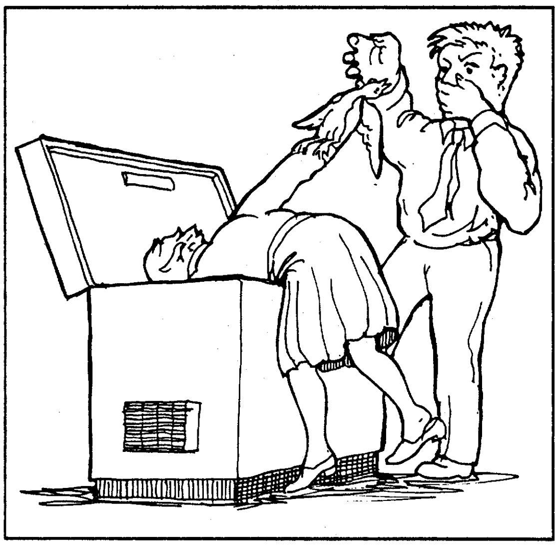
Two methods of preparing skeletons are described. After skinning, gutting and defleshing, large animals are buried for two months to two years in nylon mesh bags in leaf mould. Smaller animals are simmered in water for approximately 15 minutes and then allowed to macerate in warm water with a proteolytic enzyme for one to several days (fish should not be simmered). The resulting disarticulated bones are then thoroughly washed, dried and degreased with acetone or a mixture of methanol and trichloroethane.

Introduction

Over the past twenty years we have between us prepared over 2000 skeletons, working in very varied conditions. The purpose of this note is to offer some suggestions, based on this experience, about how to get hold of animals, how to prepare better skeletons, and how to make the job simpler and less antisocial. It is not intended as a full guide to all the available methods; there are many ways to produce good skeletons depending on the animal you start with, the equipment available, space, climate and so on. All we intend to offer here are some methods that have worked well and reasonably reliably for us, advice that we hope may be useful, and some comments on mistakes to avoid.

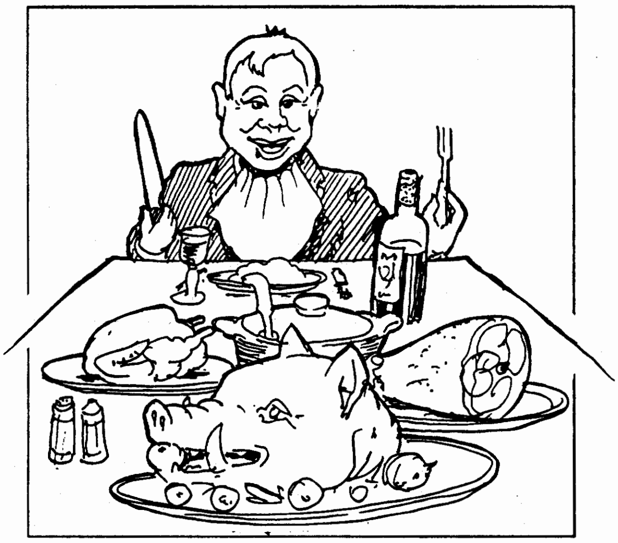
Two general points at the outset. First, there are some risks associated with handling dead animals and preparing skeletons. It is important to be informed about risks from animal-borne diseases such as leptospirosis, psittacosis, tuberculosis and rabies, and pathogens associated with decomposing animal matter. Take sensible precautions such as not handling animals that died from disease or are likely to have died from disease, wear gloves and lab coats or overalls, cover broken skin, avoid and treat sharps injuries, and wash hands before eating, drinking or smoking. Risks should be formally assessed under the recent COSHH (safety) regulations, but should not be exaggerated—neither of us has had any problems, and the worst we know of is a septic finger caused by driving a bone splinter under a nail and ignoring it.

Second, everything is easier and less unpleasant if the animal is reasonably fresh. Never put off dealing with a dead animal: one of us still remembers all too vividly the awful job of finally dealing with a dead hedgehog left in a polythene bag in the engine compartment of a van and half-forgotten for three weeks during a Turkish summer. A deep freeze is an invaluable aid, but large or long backlogs should be avoided: we have cleaned out too many freezers full of half-rotten ten-year-old bodies.



Don't leave animals in the deep freeze for too long

There's no reason not to eat an animal before you prepare it if it's edible—and you'll find out what it tastes like. If you do, stewing does less damage than roasting or frying (we haven't yet tried microwaving); and remember to take notes, measurements, weights and photographs first.

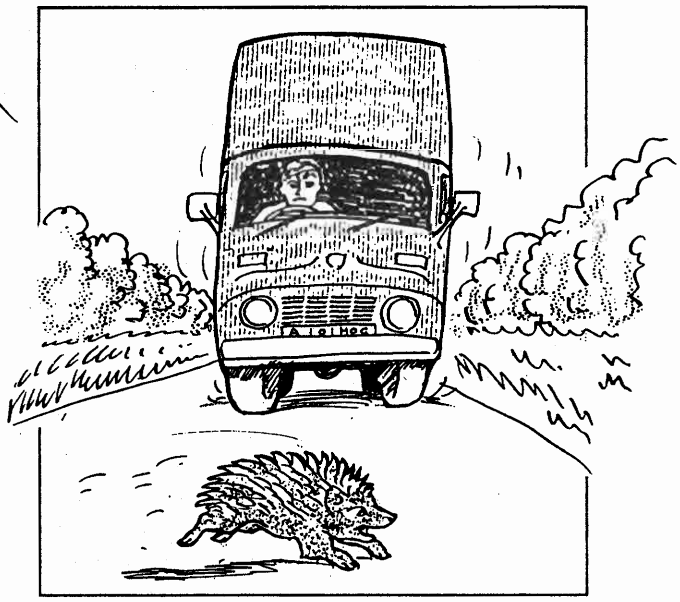


There's no reason not to eat an animal first

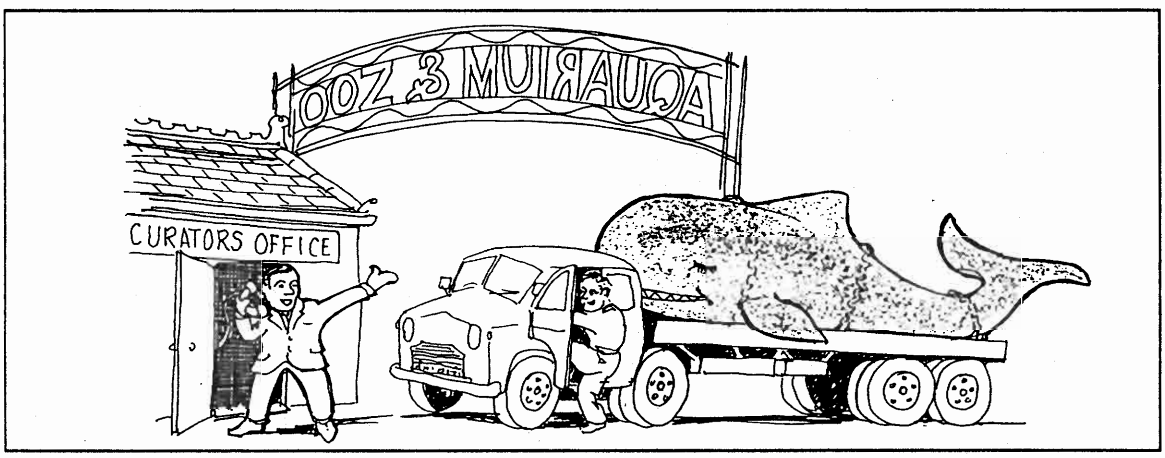
Sources of animals

Times and attitudes have changed since Gilbert White wrote in 1767 (Letter 11): 'Three gross-beaks (*loxia coccothraustes*) appeared some years ago in my fields, in the winter; one of which I shot ....' But there are many other ways of getting hold of dead animals without going out and killing them. First and most important is to ask for help. A wide variety of people come across or deal with dead animals, including amateur naturalists, fishermen, professional zoologists, conservation workers, gamekeepers, people who work on the roads, farmers and animal-breeders, vets, butchers, game dealers and fishmongers. Organisations that may be helpful include societies, museums and zoos.

It's important not to feel that you have to prepare every animal you get hold of. Preparation takes time and effort. It's not worth spending time on a skeleton that is poorly-documented, uncertainly identified, or



First catch your hedgehog



It's important not to feel that you have to prepare every animal offered to you unlikely to be useful: better to spend the time getting hold of and preparing something you really will use. So, if someone gives you something you don't want, thank them kindly (they may bring you something you do want next time), 'phone round colleagues in case they want it, and, if not, dispose of it.

Sending dead animals by post or rail

If someone rings you up and offers you a dead animal, but it's too far away to collect, or if you find an animal when you are a long way from base, it can be carried or sent reasonably easily by post or rail as long as it isn't too large or smelly. The golden rule is to make sure that it is wrapped up well, first with several absorbent layers (newspaper or kitchen towel) in case it starts to drip, then with two or three layers of polythene to contain any smell, and finally with a protective outer cover ('jiffy bag' or box). This should hold things well enough for two or three days. First class post is advisable; in warm weather avoid posting just before a weekend—better to hold the parcel in a deep-freeze and post on Monday. If you aren't there to receive the parcel, make sure that it is clearly marked (e.g. "perishable specimens"), and that you have arranged for someone to put it in the deep freeze when it arrives: you won't be popular if you arrive back from holiday to find a long-dead pigeon in your pigeon-hole.

If at all possible, it's better to take notes, weights, measurements and photographs (see below) and to gut and note sex and reproductive state before packing and sending animals. All these jobs become less pleasant and more difficult when a carcass is a few days older, and the gut and reproductive organs deteriorate particularly rapidly.

Documentation

As with any other scientific collection, good documentation immensely increases the value of a reference collection of skeletons. Useful information includes locality, habitat, date and cause of death, weight and standard measurements, identification, sex and breeding condition, any other comments, a good colour photograph, and a record of the preparation method. It's important to record your reasons for identification in case there are any later doubts, and, if you are in doubt at the time, to get an expert opinion. We accumulate (in the deep freeze) birds that we have difficulty in identifying, and periodically take them to be identified by an expert. For domestic animals, get as much information as possible about breed (including registration and flock/herd number) and history (age, diet, state of health, weight at different ages, and, if female, reproductive history). A copy of the catalogue sheet that we use is reproduced as Fig. 18 at the end of this paper (with a 'mock-up' as Fig. 19).

Small bodies can be sent by post

Labelling and marking are equally important —good documentation is no use if you can't link it to the specimen. Labels must first survive whatever preparation method you use. At the moment we use aluminium foil (0.15 mm thick, supplied by J. Smith and Sons (Clerkenwell) Ltd., 42–56 Tottenham Road, London N1 4BZ; tel. 081 253 1277), scratching or pressing heavily with a defunct biro. In the past we have successfully used 'Dymo' tape (it sometimes loses colour, but the embossing survives), aluminium garden labels (with pencil or scratched), and squares of plastic from yoghurt containers (important to choose a really permanent marking pen!). Once the skeleton is prepared, mark as many bones as you can, preferably with Indian ink. To make this quicker (and take less space on the bone), give each skeleton a number or other short code, and write identification, sex and locality on one of the larger bones as well as the number so that the skeleton is not useless if the records are lost or inaccessible. Indian ink doesn't take properly on greasy bone, which should be de-fatted before marking (see below); if the ink 'spreads' on porous bones, the area to be marked can be prepared with a thin coat of a consolidant such as Paraloid or Primal.

Preparation

There are many ways to produce good skeletons, often by taking advantage of local conditions and of equipment or facilities that are available to you. We start by describing two 'tried and tested' methods that are reasonably easy and usually give good results: maceration in warm water (preferably with an enzyme), which is quick but mildly antisocial and more suitable for smaller animals, and burial in leaf mould, which is slow but less antisocial and better for larger animals. We then comment briefly on a number of other methods.

Warm water/enzyme maceration

Skinning, gutting and defleshing:

Having first taken notes, weights, measurements and photographs, the next thing to do to a mammal, or bird, is to skin it. There is no need to pluck birds before skinning, and no need to remove a neat whole skin (unless you want to keep it); but it's important not to cut into the bones (danger points include the muzzle, wrists and ankles) or to cut away the os penis. Wetting a bird's feathers before you start reduces the risk of disease. With small animals (rodents and most birds), it's usually easier to tear the skin gently away from the body rather than dissect it off; with larger animals it's often simplest to start by cutting off a wide strip of skin down the back, starting from a skin-fold at the nape of the neck, then either tear or cut down from the exposed edges. Small areas of skin, hair and feathers can be left on feet, at the ends of tails, and around eyes, muzzles and beaks, and there is no need to try to skin the 'scaly' parts of smaller birds' legs.

Next gut the animal, remembering to look for and make notes on the condition of the reproductive organs—you may need a lens or binocular microscope to do this for small birds, but won't be able to do it if the animal isn't reasonably fresh. Unless the animal is very small (mouse/vole/thrush and smaller), it should then be roughly defleshed: up to about rabbit size, all that's needed is to cut away the larger muscles, while for larger animals try to leave no more than a centimetre depth of meat anywhere on the skeleton, and remove the diaphragm, heart and lungs. Again take care not to cut into the bones or remove bones that 'float' in soft tissues—parts at particular risk include the patella (don't strip it away with the muscles), the pelvis and shoulder girdle (remember the clavicle in species that have one), the vertebrae, and the hyoid bones (at the base of the tongue).

If you want to keep the vertebrae in sequence, this is the time to thread a nylon line through them. If you want to keep the bones of different feet separate, you'll need to cut them off, label them, and put them in separate containers or in separate mesh bags (we use lengths of old stockings or tights, tied off at both ends) in the same container.

Fish can be dealt with in much the same way, but remember to take a scale sample or to include the skin in the preparation.

Dispose of skin, guts and meat quickly and in a way that won't cause later problems. Small amounts can be treated as kitchen waste, but larger quantities should be incinerated, taken to a suitable dump, or buried: one of us buries waste in trenches below next year's runner beans.

Simmering (mammals and birds only):

Next, heat the whole defleshed carcass in water and bring it to near boiling point for long enough for the heat to penetrate fully. This helps to soften ligaments and tendons, speeding the next stage considerably. Avoid boiling as this may soften young or weak bone, avoid very rapid heating as this may crack the teeth, and don't be tempted to use a pressure cooker. Simmering is unnecessary for fishes, and should be avoided as it may damage their bones.

Maceration:

The defleshed carcass (and label!) should then be put into a container with water or an enzyme solution. Water by itself is much slower and the results not as dependable. We use an enzyme concentrate called Neutrase (available from Novo Nordisk Bioindustries

UK Ltd., 4 St George's Yard, Castle St., Farnham, Surrey GU9 7LW; tel. 0252 711212), which gives faster and better results, mixed about 1:50 with water (about one table spoon per litre). Liquid enzyme concentrates are to be preferred to powders because they are easier to handle safely, but care is still needed to avoid aerosol formation and inhalation of spray. Concentrates should be added to water rather than vice versa, and stirring and pouring should be done slowly. We have also used enzyme washing powders such as Ariel and Biotex, which are better than water but not as good as Neutrase. Trypsin works well but is expensive; papain also works well but is expensive and very smelly! Containers can be glass (e.g. beakers, coffee jars), plastic (e.g. buckets) or ceramic; metal should probably be avoided as it may inhibit bacterial or enzyme activity. Don't use too small a container—there should be at least ten times as much liquid as carcass; and don't cover or close the container—anaerobic conditions give poor results and may even completely destroy bone.

Some smells will be produced during maceration, and more when liquids are poured off; use a fume cupboard, or set things up somewhere where this won't trouble people. Temperature should if possible be kept between about 30°C and 50°C; it should not be allowed to go too high in case enzymes are deactivated and bacteria are killed, and should not be allowed to drop below about 15°C because activity will be too slow and may follow alternative pathways with poorer results. There are various ways of maintaining temperature at the right kind of level: we have used incubators, an aquarium heater, a commercial pie-warmer, radiators, and warm climates; it would also be fairly simple to set up a basic incubator with an insulated container (perhaps a plastic dustbin) and a light bulb. pH should be reasonably close to neutral, but this isn't usually a problem.

Evaporation will be fairly rapid: each container should be checked every two or three days and topped up with fresh enzyme solution if necessary. If enzyme solution is used and temperatures are at the right level the skeleton should be ready within a few days, by which time clean bones will be lying at the bottom of the container in a thin soup of breakdown products. (Fish are particularly quick to prepare.) If water is used by itself, or if temperatures are lower, maceration may take much longer and it may be necessary to change the water; if so, avoid losing bones by pouring off through a sieve. A kitchen sieve is useful for medium-sized mammals, and a fine tea-strainer for small animals.

Once the skeleton is ready, pour off the 'soup' (think about where it's going!) and rinse in several changes of clean hot water, again taking care not to lose bones by pouring off through a sieve. Any remaining hairs or feathers usually come to the surface or stay in suspension at this stage, and can be decanted off, but take care not to lose floating bones. The hot water deactivates any remaining enzyme and helps to remove fat, which rises as globules to the surface. Repeat until the rinsing water is clear, and leave soaking for several hours; if still cloudy, repeat the process. Check that the skeleton is really clean (if not, return it to fresh enzyme solution for another day or two), then drain and set to dry slowly. Avoid rapid drying (sun or heat) as this may make bones crack.

Burial in leaf mould

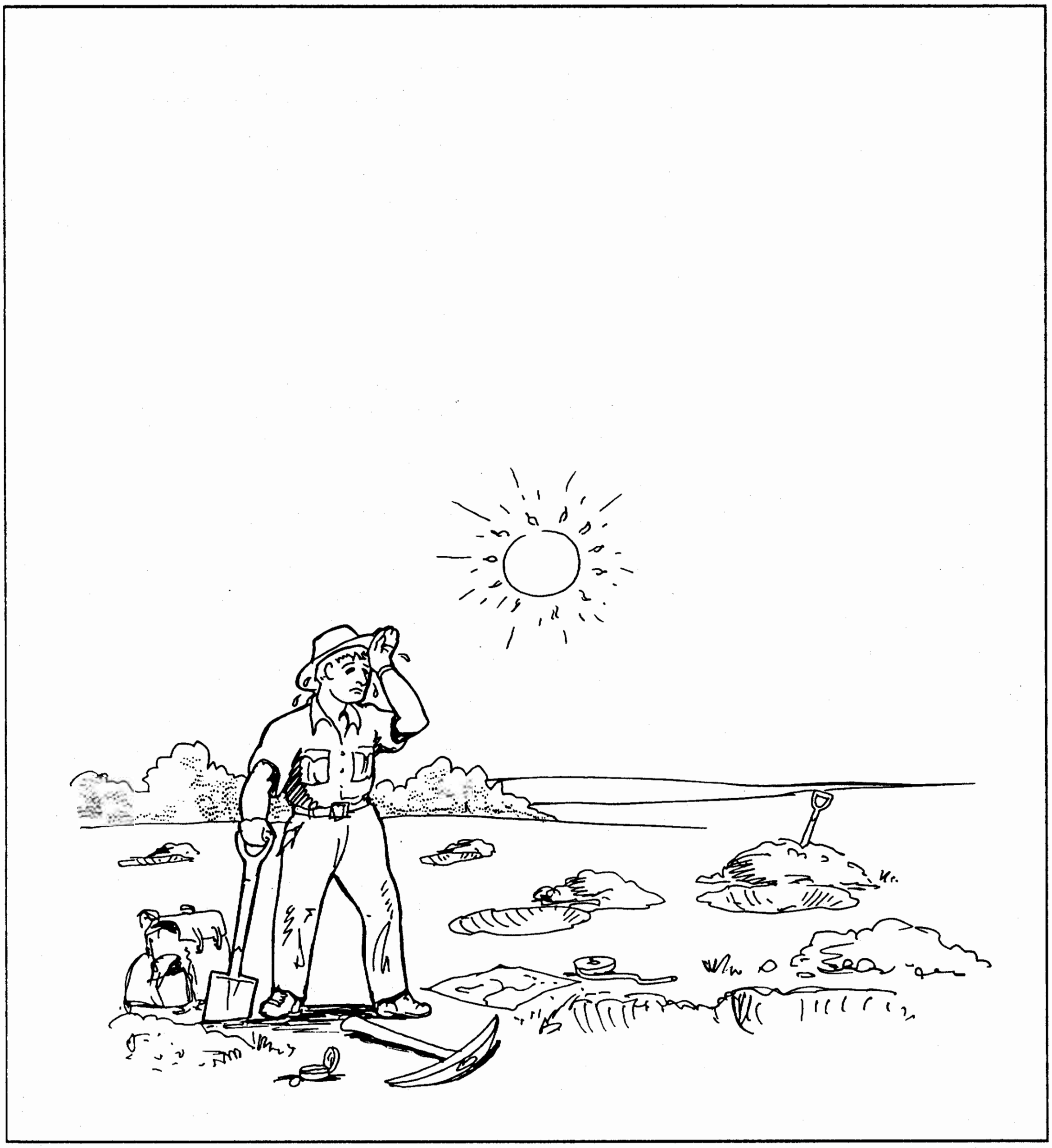
This method is only recommended for larger animals. It's slow, and slightly more trouble, but gives good results and is relatively inoffensive.

Skinning, gutting and defleshing:

Animals are skinned, gutted and defleshed as above, and put (with labels!) into mesh sacks so that bones are not lost. It is important that the mesh used will survive two or three years of burial. Nylon curtain mesh can be used but isn't really strong enough for very large animals (and it's hard to find plain mesh); we use mesh manufactured for use in parachutes ('Quality 186', available from Swiss Net UK, Hartley House, Hucknall Road, Nottingham NG5 1FD, U.K.; telephone: 0602 692500). Very large animals can be cut up and buried in sections. If flies are active, it's worth leaving the defleshed carcass exposed for an hour or two to encourage fly-strike before burial; the maggots will hatch out after burial and do a good job cleaning the skeleton.

Burial:

The mesh sacks are then buried in piles of well-rotted leaf mould (or in pits full of leaf mould), open to the rain. Possible substitutes for rotted leaf mould include well-rotted compost and coconut peat. Fresh leaves, fresh green matter and sawdust should be avoided as they are acid and will slow decomposition and attack the bones. Don't let plants get established on the leaf mould as roots will grow down through the pile and may damage the sacks and the bones; and be careful to cover sacks with at least a foot of leaf mould, otherwise rats or foxes will be attracted and may dig the sacks up and do damage. Medium-sized animals buried during warm weather may only take a few weeks; but larger animals and animals buried during the winter will take longer—perhaps as much as two years. Once a skeleton is ready (leaf-mould is so light that it's fairly easy to dig a sack up, look at its contents and rebury it), it should be soaked in water for a few hours, cleaned by brushing as needed, rinsed in clean water, and laid out to dry. (As above, don't dry too fast or in the sun.)



Don't forget where you buried it

Comments on other methods

Chemical methods:

In our experience these are not to be recommended. Sodium perborate tends to leave bone soft and 'chalky' unless very carefully controlled; sodium and potassium hydroxide damage bone. Maceration in warm dilute ammonia can give reasonable results but is antisocial and tends to produce a very fatty skeleton.

Rotting in the sea:

'She weighted her brother down with stones, and sent him off to Davy Jones. All they ever found were some bones and occasional pieces of skin.' (Tom Lehrer: *The Irish Ballad*)

This can give good results. Defleshed carcasses are put in mesh sacks or cages and placed in the sea so that small marine organisms can clean the bones. The main problem is to secure sacks or cages so that they are safe from storms, tides and disturbance by people. A cat prepared in this way in Greece, in a sack tied to the anchor chain of a disused mooring buoy, took about three weeks. This method may, however, take considerably longer in colder water.

Burial:

Burial in earth gives rather variable results, depending mainly on soil conditions; it's worth experimenting with if you have a reasonably neutral silty soil, but less likely to give good results with acid or shallow alkaline soils, or with clays. We are experimenting at present with burial in silver sand to which some crushed calcite or apatite has been added to buffer any acidity; crushed shell might also be used. Burial in blown shell-sand would probably also give good results. Again, plants should be discouraged to avoid damage by rootlets. Make sure that burials are clearly marked or, if vandals might be a problem, that their positions are accurately recorded. One of us once spent two days fruitlessly digging holes in a Turkish floodplain in search of a buried cow . . .

De-fatting

Greasy skeletons are unpleasant to work with (and possibly also present a minor health hazard). Acid breakdown products of fats and oils may also attack and weaken bone. De-fatting is therefore desirable. Our experience of alkaline hydrolysis is that it is either ineffective or too aggressive to bone. The best solvent we have found is a mixture of three parts of 1,1,1 trichloroethane and one part of methanol, which is able to de-fat small bones in a few days and large bones in a few weeks. We use a sequence of jars of solvent, placing the skeleton in a mesh bag and putting it first in the 'dirty' solvent jar, then in a 'cleaner' jar, and then in the 'clean' jar, each time for a few days (or longer if the bones are large), then removing the sack and letting it drain and then dry. As the solvent mixture is hazardous, everything has to be done in a fume cupboard and gloves have to be worn in case of splashes. To reduce solvent loss, use jars with lids that fit well. When solvent levels go down, the 'dirty' jar is topped up from the 'cleaner' jar, then the 'cleaner' from the 'clean', and finally the 'clean' jar from fresh stock. Alternatively, acetone can be used; it is less effective in removing old grease, but probably to be preferred in dealing with newly-prepared skeletons as it is cheaper, less toxic, and less ozone-unfriendly.

Staining bones with tea

Bleaching and tea-staining

Most preparation manuals will tell you that the final step in preparing a skeleton is to bleach it with hydrogen peroxide. This may produce a more clinical specimen for museum display, but we have found that it isn't as easy to see shape on a dead-white bone (especially under a microscope), and we think that bleaching probably also weakens bones.

Instead, we prefer our skeletons to be a fairly uniform pale or mid-brown, produced by staining them with tea (after de-fatting). Strong Indian tea is best, and should be freshly-brewed; pour hot tea over the bones and then leave for a few minutes before draining, rinsing and drying. Left and right may be differentiated by staining one side and not the other.

Storage

Bones should be stored dry: residual moisture encourages fungal attack, which can seriously damage specimens. We have noticed this to be a problem in bones stored in airtight containers. Extremes of temperature and humidity should be avoided as far as possible, and bones and bone containers should not be stored in direct sunlight.

Further reading

Harris, R. H. (1951). The use of enzymes in the osteological preparation of the emperor penguin. *Museums Journal* **51**, 97.

Luther, P. G. (1949). Enzymatic maceration of skeletons. *Proceedings of the Linnaean Society of London* **161**, 146–7.

Acknowledgements

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Disk copy received: November 1991

Figures 18 (opposite) and 19 (overleaf). Sample catalogue sheets as used by the authors. Figure 18—blank form for reproduction; Figure 19—'mock-up'. Note that the top line comprises basic information, some of it duplicated in entries elsewhere in the sheet. Abbreviations: Loc—Locality of collection; H+B—head and body length; OAL—overall length; HF/Wing—hind foot or wing length; Intention—those parts of the skeletons required, for example: 'whole skeleton' or 'feet only'.

AML No: Identification: Sex: Age: Loc:

OBSERVATIONS AT TIME OF COLLECTION

Collected by: Date: Weight:

Locality, habitat: H+B: OAL:

Tail: HF/Wing:

Ear:

Condition: Sex, reproductive condition:

(Date of birth:)

Date of death or estimate: Breed:

Cause of death: Field/Flock/Ring No:

Notes: History:

IDENTIFICATION

Identified by: Photo:

Reasons for identification:

PREPARATION DETAILS

Intention: Date: Leaf mould/Neutrase/Biotex

De-fatted:

Notes:

State after preparation:

Date:

General: Damage: Missing parts:

SUBSEQUENT ACTIONS/NOTES

AML No: 9999 Identification: Mustela nivalis Sex: ♂ Age: — Loc: Cambridge, Cambs, U.K.

OBSERVATIONS AT TIME OF COLLECTION

Collected by: S. Payne

Date: 30.2.92

Weight: 122 g.

Locality, habitat: 9 Wilberforce Rd., Cambridge. Suburban garden, lawn & rough grass etc. along ditch.

H+B: 205 mm. OAL: —

Tail: 47 mm. HF/Wing:

Ear: —

Condition: Back of head damaged

Sex, reproductive condition: adult ♂

(Date of birth: —)

Date of death or estimate: 30.2.92

Breed: —

Cause of death: Killed by cat

Field/Flock/Ring No: —

Notes:

History: —

IDENTIFICATION

Identified by: S. Davis

Photo:

Reasons for identification: Small mustelid, upper parts bright brown, underparts white, junction wavy, no black tip to tail.

PREPARATION DETAILS

Intention: Whole skeleton

Date: 31.2.92 ~~Leaf mould~~/(Neutrase)/~~Biotex~~

De-fatted: Trichloroethane

Notes: Simmered 10 mins before neutrase

State after preparation:

Date: 10.3.92

General: Good

Damage: Slight damage to back of skull

Missing parts: —

SUBSEQUENT ACTIONS/NOTES

Notes for Contributors

Articles for *Circaea* should be typed double-spaced on A4 paper with generous margins. Line drawings should be in black ink on white paper or drawing film, to fit within a frame 153 x 250 mm maximum. Captions should be supplied on a separate sheet of paper, and labelling on figures should either be in 'Letraset' (or an equivalent) or should be in soft pencil. Half-tone photographs can be accommodated, but authors wishing to make extensive use of photographs, or colour, should note that they may be asked to contribute towards the high cost of production. The editors will modify short contributions to fit the layout and convention of *Circaea*. The same principle will be applied to idiosyncrasies of spelling and punctuation. Scientific articles will be submitted to referees; authors may, if they wish, suggest suitable referees for their articles.

TWO COPIES of scientific articles should be submitted. Authorities must be given to Latin names, either at their first mention or in a comprehensive list, and species lists should follow a named checklist. References should follow the so-called 'modified Harvard' convention, but with journal titles preferably given in full, not abbreviated. *World List* abbreviations will, however, be acceptable if the author indicates a definite preference. For guidance as to the preparation and presentation of material for publication, contributors are referred to the British Ecological Society's booklet *A Guide to Contributors to the Journals of the BES*, and The Royal Society's *General Notes on the Preparation of Scientific Papers* (3rd ed., 1974). Text proofs of papers will be provided and these should be returned to the Editors within three days of receipt.

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